0 or 1, respectively) as the inputs and with the output being the availability flag availableFlagLXCol and the temporal motion vector predictor mvLXCol.

3. The motion vector predictor candidate list, mvpListLX, is constructed as follows.
    1. mvLXA, if availableFlagLXA is equal to 1
    2. mvLXB, if availableFlagLXB is equal to 1
    3. mvLXCol, if availableFlagLXCol is equal to 1
4. When motion vectors have the same value, the motion vectors are removed from the list except the motion vector which has the smallest order in the mvpListLX.
5. When mvpListLX is empty, a zero motion vector is added as follows.

$$mvpListLX[\ 0\ ][0] = 0 \tag{8-128}$$

$$mvpListLX[\ 0\ ][1] = 0 \tag{8-129}$$

6. The variable numMVPCandLX is set to the number of elements within the mvpListLX and maxNumMVPCand is set to 2.
7. The motion vector predictor list is modifed to contain exactly maxNumMVPCand motion vector predictor candidates as follows.
    1. If numMVPCandLX is less than maxNumMVPCand, the derivation process for zero motion vector predictor candidates specified in subclause 8.4.2.1.10 is invoked with mvpListLX and numMVPCandLX given as input and the output is assigned to mvpListLX and numMVPCandLX.
    2. Otherwise (numMVPCandLX is equal to or greater than maxNumMVPCand), all motion vector predictor candidates mvpListLX[idx] with idx greater than maxNumMVPCand – 1 are removed from the list.
8. The motion vector of mvpListLX[mvp_idx_lX[xP, yP]] is assigned to mvpLX.

8.4.2.1.8 Derivation process for motion vector predictor candidates

Inputs to this process are

– a luma location (xP, yP) specifying the top-left luma sample of the current prediction unit relative to the top-left sample of the current picture,

– variables specifying the width and the height of the prediction unit for luma, nPSW and nPSH,

– the reference index of the current prediction unit partition refIdxLX (with X being 0 or 1).

Outputs of this process are (with N being replaced by A, or B)

– the motion vectors mvLXN of the neighbouring prediction units,

– the availability flags availableFlagLXN of the neighbouring prediction units.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000633

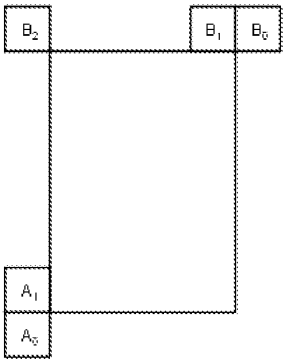


Figure 8-5 – Spatial motion vector neighbours

The function RefPicOrderCnt(pic, refidx, LX) is specified by the value of PicOrderCnt of the picture that is the reference picture RefPicListX[refidx] of pic with X being 0 or 1. PicOrderCnt of the reference picture shall be maintained until the picture is marked as "non-existing"

[Ed. (BB): PicOrderCnt(.) needs to be defined. Currently the Decoding process for picture order count is not described]

The variable isScaledFlagLX with X being 0 or 1 is set equal to 0.

The motion vector mvLXA and the availability flag availableFlagLXA are derived in the following ordered steps:

1. Let a set of two sample locations be (xA_k, yA_k), with k = 0, 1, specifies sample locations with $xA_k = xP - 1$, $yA_0 = yP + nPSH$ and $yA_1 = yA_0$ - MinPuSize. The set of sample locations (xA_k, yA_k) represent the sample locations immediately to the left side of the left partition boundary and it's extended line. [Ed.: (WJ) MinPuSize should be defined somewhere]

2. Let the availability flag availableFlagLXA be initially set equal to 0 and the both components of mvLXA are set equal to 0.

3. For (xA_k, yA_k) from (xA_0, yA_0) to (xA_1, yA_1) where $yA_1 = yA_0$ - MinPuSize, the following applies repeatedly until availableFlagLXA is equal to 1:

   – If the prediction unit covering luma location (xA_k, yA_k) is available, PredMode is not MODE_INTRA, predFlagLX[xA_k][yA_k] is equal to 1 and the reference index refIdxLX[xA_k][yA_k] is equal to the reference index of the current prediction unit refIdxLX, availableFlagLXA is set equal to 1 and the motion vector mvLXA is set equal to the motion vector mvLX[xA_k][yA_k], refIdxA is set equal to refIdxLX[xA_k][yA_k] and ListA is set equal to LX.

   – Otherwise if the prediction unit covering luma location (xAk, yAk) is available, PredMode is not MODE_INTRA, predFlagLY[xA_k][yA_k] (with Y = !X) is equal to 1 and RefPicOrderCnt(currPic, refIdxLY[xA_k][yA_k], LY) is equal to RefPicOrderCnt(currPic, refIdxLX, LX), availableFlagLXA is set equal to 1, the motion vector mvLXA is set equal to the motion vector mvLY[xA_k][yA_k], refIdxA is set equal to refIdxLY[xA_k][yA_k] , ListA is set equal to LY and mvLXA is set equal to mvLXA.

4. When availableFlagLXA is equal to 0, for (xA_k, yA_k) from (xA_0, yA_0) to (xA_1, yA_1) where $yA_1 = yA_0$ - MinPuSize, the following applies repeatedly until availableFlagLXA is equal to 1:

   – If the prediction unit covering luma location (xA_k, yA_k) is available, PredMode is not MODE_INTRA, predFlagLX[xA_k][yA_k] is equal to 1, availableFlagLXA is set equal to 1, the motion vector mvLXA is set equal to the motion vector mvLX[xA_k][yA_k], refIdxA is set equal to refIdxLX[xA_k][yA_k], ListA is set equal to LX.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000634

– Otherwise if the prediction unit covering luma location (xA_k, yA_k) is available, PredMode is not MODE_INTRA, predFlagLY[xA_k][yA_k] (with Y = !X) is equal to 1, availableFlagLXA is set equal to 1, the motion vector mvLXA is set equal to the motion vector mvLY[xA_k][yA_k], refIdxA is set equal to refIdxLY[xA_k][yA_k], ListA is set equal to LY.

– When availableFlagLXA is equal to 1, isScaledFlagLX is set equal to 1 and mvLXA is derived as specified below.

$$tx = (16384 + Abs(td / 2)) / td \quad (8\text{-}130)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}131)$$

$$mvLXA = ClipMv(Sign(DistScaleFactor * mvLXA) * ((Abs(DistScaleFactor * mvLXA) + 127) >> 8)) \quad (8\text{-}132)$$

[Ed. (WJ): software has a clip function for scaled motion vector. Do we need this? AVC does not have it]

where td and tb are derived as

$$td = Clip3(-128, 127, PicOrderCnt(currPic) – RefPicOrderCnt(currPic , refIdxA, ListA)) \quad (8\text{-}133)$$

$$tb = Clip3(-128, 127, PicOrderCnt(currPic) – RefPicOrderCnt(currPic, refIdxLX, LX)) \quad (8\text{-}134)$$

The motion vector mvLXB and the availability flag availableFlagLXB are derived in the following ordered steps:

1. Let a set of three sample location (xB_k, yB_k), with k = 0,1,2, specifies sample locations with $xB_0 = xP + nPSW$, $xB_1 = xB_0$ MinPuSize , $xB_2 = xP$ - MinPuSize and $yB_k = yP – 1$. The set of sample locations (xB_k, yB_k) represent the sample locations immediately to the upper side of the above partition boundary and it's extended line. [Ed.: (WJ) MinPuSize should be defined somewhere]

2. Let the availability flag availableFlagLXB be initially set equal to 0 and the both components of mvLXB are set equal to 0.

3. For (xB_k, yB_k) from (xB_0, yB_0) to (xB_2, yB_2) where $xB_0 = xP +nPSW$, $xB_1 = xB_0$ - MinPuSize , and $xB_2 =$ xP - MinPuSize, the following applies repeatedly until availableFlagLXB is equal to 1:

   – If the prediction unit covering luma location (xB_k, yB_k) is available, PredMode is not MODE_INTRA, predFlagLX[xB_k][yB_k] is equal to 1, and the reference index refIdxLX[xB_k][yB_k] is equal to the reference index of the current prediction unit refIdxLX, availableFlagLXB is set equal to 1 and the motion vector mvLXB is set equal to the motion vector mvLX[xB_k][yB_k], refIdxB is set equal to refIdxLX[xB_k][yB_k] and ListB is set equal to LX.

   – Otherwise if the prediction unit covering luma location (xB_k, yB_k) is available, PredMode is not MODE_INTRA, predFlagLY[xB_k][yB_k] (with Y = !X) is equal to 1 and RefPicOrderCnt(currPic , refIdxLY[xB_k][yB_k], LY) is equal to RefPicOrderCnt(currPic, refIdxLX, LX), availableFlagLXB is set equal to 1, the motion vector mvLXB is set equal to the motion vector mvLY[xB_k][yB_k], refIdxB is set equal to refIdxLY[xB_k][yB_k], and ListB is set equal to LY.

4. When availableFlagLXA or availableFlagLXB is equal to 0 and isScaledFlagLX is equal to 0, availableFlagLXB is set equal to 0 and for (xB_k, yB_k) from (xB_0, yB_0) to (xB_2, yB_2) where $xB_0 = xP +nPSW$, $xB_1 = xB_0$ - MinPuSize , and $xB_2 =$ xP - MinPuSize, the following applies repeatedly until availableFlagLXB is equal to 1:

   – If the prediction unit covering luma location (xB_k, yB_k) is available, PredMode is not MODE_INTRA, predFlagLX[xB_k][yB_k] is equal to 1, availableFlagLXB is set equal to 1, the motion vector mvLXB is set equal to the motion vector mvLX[xB_k][yB_k], refIdxB is set equal to refIdxLX[xB_k][yB_k], ListB is set equal to LX.

   – Otherwise if the prediction unit covering luma location (xB_k, yB_k) is available, PredMode is not MODE_INTRA, predFlagLY[xB_k][yB_k] (with Y = !X) is equal to 1, availableFlagLXB is set equal to 1, the motion vector mvLXB is set equal to the motion vector mvLY[xB_k][yB_k], refIdxB is set equal to refIdxLY[xB_k][yB_k], ListB is set equal to LY.

   – When availableFlagLXB is equal to 1 and RefPicOrderCnt(currPic , refIdxB, ListB) is not equal to RefPicOrderCnt(currPic, refIdxLX, LX),, mvLXB is derived as specified below.

$$tx = (16384 + Abs(td / 2)) / td \quad (8\text{-}135)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}136)$$

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000635

mvLXB = ClipMv(Sign(DistScaleFactor * mvLXA) *
((Abs(DistScaleFactor * mvLXA) + 127) >> 8)) (8-137)

[Ed. (WJ): software has a clip function for scaled motion vector. Do we need this? AVC does not have it]

where td and tb are derived as

td = Clip3(-128, 127, PicOrderCnt(currPic) – RefPicOrderCnt(currPic , refIdxB, ListB)) (8-138)

tb = Clip3(-128, 127, PicOrderCnt(currPic) – RefPicOrderCnt(currPic, refIdxLX, LX)) (8-139)

8.4.2.1.9 Derivation process for temporal luma motion vector prediction

Inputs to this process are

– a luma location (xP, yP) specifying the top-left luma sample of the current prediction unit relative to the top-left sample of the current picture,

– variables specifying the width and the height of the prediction unit for luma, nPSW and nPSH,

– the reference index of the current prediction unit partition refIdxLX (with X being 0 or 1).

Outputs of this process are

– the motion vector prediction mvLXCol,

– the availability flag availableFlagLXCol.

The function RefPicOrderCnt(pic, refidx, LX) is specified by the value of PicOrderCnt of the picture that is the reference picture RefPicListX[refidx] of pic with X being 0 or 1. PicOrderCnt of the reference picture shall be maintained until the picture is marked as “non-existing”.

[Ed. (BB): PicOrderCnt(.) needs to be defined. Currently the Decoding process for picture order count is not described]

Depending on the values of slice_type and collocated_from_l0_flag, the variable colPic, specifying the picture that contains the co-located partition, is derived as follows.

– If slice_type is equal to B and collocated_from_l0_flag is equal to 0, the variable colPic specifies the picture that contains the co-located partition as specified by RefPicList1[0].

– Otherwise (slice_type is equal to B and collocated_from_l0_flag is equal to 1 or slice_type is equal to P) , the variable colPic specifies the picture that contains the co-located partition as specified by RefPicList0[0].

Variable colPu and its position (xPCol, yPCol) are derived in the following ordered steps:

1. Right-bottom luma position of the current prediction unit is defined by

   xPRb = xP + nPSW (8-140)

   yPRb = yP + nPSH (8-141)

2. The variable colPu is set as the prediction unit covering the modified position given by ((xPRb >> 4) << 4, (yPRb >> 4) << 4) inside the colPic.

3. If colPu is coded in an intra prediction mode or colPu is unavailable, the following applies.

   – Central luma position of the current prediction unit is defined by

     xPCtr = (xP + (nPSW >> 1) – 1 (8-142)

     yPCtr = (yP + (nPSH >> 1) – 1 (8-143)

   – The variable colPu is set as the prediction unit covering the modified position given by ((xPCtr >> 4) << 4, (yPCtr >> 4) << 4) inside the colPic.

4. (xPCol, yPCol) is set equal to the top-left luma sample of the colPu relative to the top-left luma sample of the colPic.

The variables mvLXCol and availableFlagLXCol are derived as follows.

– If colPu is coded in an intra prediction mode or colPu is unavailable, both components of mvLXCol are set equal to 0 and availableFlagLXCol is set equal to 0.

– Otherwise (colPu is not coded in an intra prediction mode and colPu is available), the variables mvCol and refIdxCol are derived as follows,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000636

- If PredFlagL0[xPCol][yPCol] is equal to 0, the motion vector mvCol and the reference index refIdxCol are set equal to MvL1[xPCol][yPCol] and RefIdxL1[xPCol][yPCol], respectively.
- Otherwise (PredFlagL0[xPCol][yPCol] is equal to 1), the following applies.
  - If PredFlagL1[xPCol][yPCol] is equal to 0, the motion vector mvCol and the reference index refIdxCol are set equal to MvL0[xPCol][yPCol] and RefIdxL0[xPCol][yPCol], respectively.
  - Otherwise (PredFlagL1[xPCol][yPCol] is equal to 1), the following assignments are made.
    - If all PicOrderCnts of pictures in all reference picture lists are smaller than PicOrderCnt(currPic), the motion vector mvCol, the reference index refIdxCol and ListCol are set equal to MvLN[xPCol][yPCol], RefIdxColLN and LN, respectively, with N being value of RefIdxLX.
    - Otherwise (one of PicOrderCnt of pictures in all reference picture lists are larger than PicOrderCnt(currPic)), the motion vector mvCol, the reference index refIdxCol and ListCol are set equal to MvLN[xPCol][yPCol], RefIdxColLN and LN, respectively, with N being value of collocated_from_l0_flag.

and the variable availableFlagLXCol is set equal to 1 and the following applies.

- If PicOrderCnt(colPic) – RefPicOrderCnt(colPic, refIdxCol, ListCol) is equal to PicOrderCnt(currPic) - RefPicOrderCnt(currPic, refIdxLX, LX),

$$mvLXCol = mvCol \tag{8-144}$$

- Otherwise, mvLXCol is derived as scaled version of the motion vector mvCol as specified below

$$tx = (16384 + Abs(td / 2)) / td \tag{8-145}$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \tag{8-146}$$

$$mvLXCol = ClipMv(Sign(DistScaleFactor * mvLXA) * ((Abs(DistScaleFactor * mvLXA) + 127) >> 8)) \tag{8-147}$$

[Ed. (WJ): software has a clip function for scaled motion vector. Do we need this? AVC does not have it]

where td and tb are derived as

$$td = Clip3(-128, 127, PicOrderCnt(colPic) – RefPicOrderCnt(colPic, refIdxCol, ListCol)) \tag{8-148}$$

$$tb = Clip3(-128, 127, PicOrderCnt(currPic) – RefPicOrderCnt(currPic, refIdxLX, LX)) \tag{8-149}$$

8.4.2.1.10 Derivation process for zero motion vector predictor candidates

Inputs of this process are

- a motion vector predictor list mvpListLX,
- the number of elements numMVPCandLX within mvpListLX.

Outputs of this process are

- the motion vector predictor list mvpListLX,
- the number of elements numMVPCandLX within mvpListLX.

When no motion vector in mvpListLX is equal to (0,0), the zero motion vector predictor candidate is added at the end of mvpListLX and numMVPCandLX is incremented by 1 as follows.

$$mvpListLX[numMVPCandLX][0] = 0 \tag{8-150}$$

$$mvpListLX[numMVPCandLX][1] = 0 \tag{8-151}$$

$$numMVPCandLX = numMVPCandLX + 1 \tag{8-152}$$

8.4.2.1.11 Derivation process for chroma motion vectors

[Ed.: (WJ) 4:2:0 assumption yet]

Inputs to this process are a luma motion vector mvLX and a reference index refIdLX.

Output of this process is a chroma motion vector mvCLX.

A chroma motion vector is derived from the corresponding luma motion vector.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000637

For the derivation of the chroma motion vector mvCLX, the following applies.

mvCLX[0] = mvLX[0] (8-153)

mvCLX[1] = mvLX[1] (8-154)

8.4.2.2 Decoding process for inter prediction samples

Inputs to this process are:

- a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,
- a luma location (xB, yB) specifying the top-left luma sample of the current prediction unit relative to the top-left luma sample of the current coding unit,
- a variable nCS specifying the size of the current coding unit,
- variables specifying the width and the height of the prediction unit, nPSW and nPSH,
- luma motion vectors mvL0 and mvL1, and chroma motion vectors mvCL0 and mvCL1,
- reference indices refIdxL0 and refIdxL1,
- prediction list utilization flags, predFlagL0 and predFlagL1.

Outputs of this process are:

- a (nCS_L)x(nCS_L) array $predSamples_L$ of luma prediction samples, where nCS_L is derived as specified below,
- a (nCS_C)x(nCS_C) array $preSamples_{Cb}$ of chroma prediction samples for the component Cb, where nCS_C is derived as specified below,
- a (nCS_C)x(nCS_C) array $predSamples_{Cr}$ of chroma residual samples for the component Cr, where nCS_C is derived as specified below.

The variable nCS_L is set equal to nCS and the variable nCS_C is set equal to nCS >> 1. [Ed: (WJ) revisit for supporting other chroma formats]

Let $predSamplesL0_L$ and $predSamplesL1_L$ be (nPSW)x(nPSH) arrays of predicted luma sample values and $predSampleL0_{Cb}$, $predSampleL1_{Cb}$, $predSampleL0_{Cr}$, and $predSampleL1_{Cr}$ be (nPSW/2)x(nPSH/2) arrays of predicted chroma sample values.

For LX being replaced by either L0 or L1 in the variables predFlagLX, RefPicListX, refIdxLX, refPicLX, and predPartLX, the following is specified.

When predFlagLX is equal to 1, the following applies.

- The reference picture consisting of an ordered two-dimensional array $refPicLX_L$ of luma samples and two ordered two-dimensional arrays $refPicLX_{Cb}$ and $refPicLX_{Cr}$ of chroma samples is derived by invoking the process specified in subclause 8.4.2.2.1 with refIdxLX and RefPicListX given as input.
- The arrays $predSamplesLX_L$, $predSamplesLX_{Cb}$, and $predSamplesLX_{Cr}$ are derived by invoking the fractional sample interpolation process specified in subclause 8.4.2.2.2 with the luma locations (xC, yC), (xB, yB), the width an the height of the current prediction unit nPSW, nPSH, the motion vectors mvLX, mvCLX, and the reference arrays with $refPicLX_L$, $refPicLX_{Cb}$ and $refPicLX_{Cr}$ given as input.

The array $predSample_L$ of the prediction samples of luma component is derived by invoking the weighted sample prediction process specified in subclause 8.4.2.2.3 with the luma location (xB, yB), the width an the height of the current prediction unit nPSW, nPSH, and the sample arrays $predSamplesL0_L$ and $predSamplesL1_L$ as well as predFlagL0, predFlagL1 and $BitDepth_Y$ given as input.

For C being replaced by Cb, or Cr, the array $predSample_C$ of the prediction samples of component C is derived by invoking the weighted sample prediction process specified in subclause 8.4.2.2.3 with the chroma location (xB/2, yB/2), the width an the height of the current prediction unit $nPSW_C$ set equal to nPSW/2, $nPSH_C$ set equal to nPSH/2, and the sample arrays $predSamplesL0_C$ and $predSamplesL1_C$ as well as predFlagL0, predFlagL1 and $BitDepth_C$ given as input.

8.4.2.2.1 Reference picture selection process

[Ed: (WJ) same as AVC]

8.4.2.2.2 Fractional sample interpolation process

Inputs to this process are:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000638

– a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,

– a luma location (xB, yB) specifying the top-left luma sample of the current prediction unit relative to the top left luma sample of the current coding unit,

– the width and height of this prediction unit, nPSW and nPSH, in luma-sample units,

– a luma motion vector mvLX given in quarter-luma-sample units,

– a chroma motion vector mvCLX given in eighth-chroma-sample units,

– the selected reference picture sample arrays $refPicLX_L$, $refPicLX_{Cb}$, and $refPicLX_{Cr}$.

Outputs of this process are:

– a (nPSW)x(nPSH) array $predSampleLX_L$ of prediction luma sample values,

– two (nPSW/2)x(nPSH/2) arrays $predSampleLX_{Cb}$, and $predSampleLX_{Cr}$ of prediction chroma sample values.

The location (xP, yP) given in full-sample units of the upper-left luma samples of the current prediction unit relative to the upper-left luma sample location of the given reference sample arrays is derived by

$$xP = xC + xB \quad (8\text{-}87)$$
$$yP = yC + yB \quad (8\text{-}88)$$

Let ($xInt_L$, $yInt_L$) be a luma location given in full-sample units and ($xFrac_L$, $yFrac_L$) be an offset given in quarter-sample units. These variables are used only inside this subclause for specifying general fractional-sample locations inside the reference sample arrays $refPicLX_L$, $refPicLX_{Cb}$, and $refPicLX_{Cr}$.

For each luma sample location ($0 <= x_L < nPSW$, $0 <= y_L < nPSH$) inside the prediction luma sample array $predSampleLX_L$, the corresponding prediction luma sample value $predSampleLX_L[x_L, y_L]$ is derived as follows:

– The variables $xInt_L$, $yInt_L$, $xFrac_L$, and $yFrac_L$ are derived by

$$xInt_L = xP + (mvLX[0] >> 2) + x_L \quad (8\text{-}89)$$
$$yInt_L = yP + (mvLX[1] >> 2) + y_L \quad (8\text{-}90)$$

$$xFrac_L = mvLX[0] \& 3 \quad (8\text{-}91)$$
$$yFrac_L = mvLX[1] \& 3 \quad (8\text{-}92)$$

– The prediction luma sample value $predSampleLX_L[x_L, y_L]$ is derived by invoking the process specified in subclause 8.4.2.2.2.1 with ($xInt_L$, $yInt_L$), ($xFrac_L$, $yFrac_L$) and $refPicLX_L$ given as input.

Let ($xInt_C$, $yInt_C$) be a chroma location given in full-sample units and ($xFrac_C$, $yFrac_C$) be an offset given in one-eighth sample units. These variables are used only inside this subclause for specifying general fractional-sample locations inside the reference sample arrays $refPicLX_{Cb}$ and $refPicLX_{Cr}$.

For each chroma sample location ($0 <= x_C < nPSW/2$, $0 <= y_C < nPSH/2$) inside the prediction chroma sample arrays $predSampleLX_{Cb}$ and $predSampleLX_{Cr}$, the corresponding prediction chroma sample values $predSampleLX_{Cb}[x_C, y_C]$ and $predSampleLX_{Cr}[x_C, y_C]$ are derived asfollows:

– The variables $xInt_C$, $yInt_C$, $xFrac_C$, and $yFrac_C$ are derived by

$$xInt_C = (xP / 2) + (mvCLX[0] >> 3) + x_C \quad (8\text{-}93)$$
$$yInt_C = (yP / 2) + (mvCLX[1] >> 3) + y_C \quad (8\text{-}94)$$

$$xFrac_C = mvLX[0] \& 7 \quad (8\text{-}95)$$
$$yFrac_C = mvLX[1] \& 7 \quad (8\text{-}96)$$

– The prediction sample value $predSampleLX_{Cb}[x_C, y_C]$ is derived by invoking the process specified in subclause 8.4.2.2.2.2 with ($xInt_C$, $yInt_C$), ($xFrac_C$, $yFrac_C$) and $refPicLX_{Cb}$ given as input.

– The prediction sample value $predSampleLX_{Cr}[x_C, y_C]$ is derived by invoking the process specified in subclause 8.4.2.2.2.2 with ($xInt_C$, $yInt_C$), ($xFrac_C$, $yFrac_C$) and $refPicLX_{Cr}$ given as input.

8.4.2.2.2.1 Luma sample interpolation process

Inputs to this process are:

– a luma location in full-sample units ($xInt_L$, $yInt_L$),

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000639

– a luma location in fractional-sample units ($xFrac_L$, $yFrac_L$),

– the luma reference sample array $refPicLX_L$.

Output of this process is a predicted luma sample value $predSampleLX_L[x_L, y_L]$

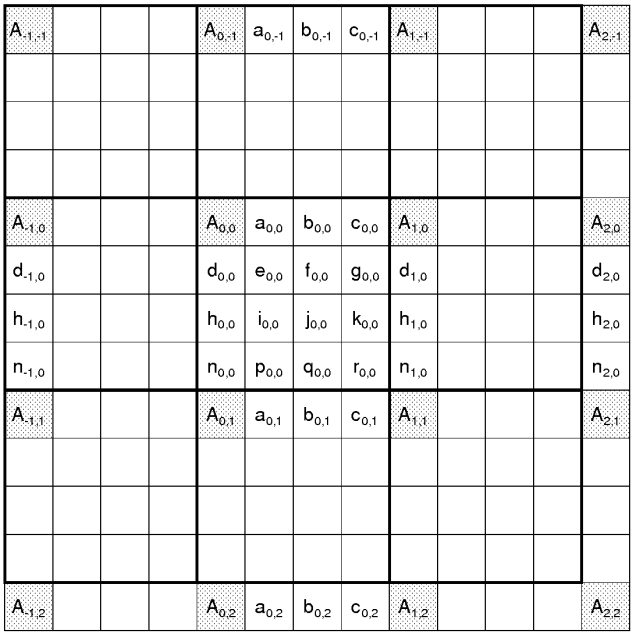


Figure 8-6 – Integer samples (shaded blocks with upper-case letters) and fractional sample positions (un-shaded blocks with lower-case letters) for quarter sample luma interpolation

In Figure 8-6, the positions labelled with upper-case letters $A_{i,j}$ within shaded blocks represent luma samples at full-sample locations inside the given two-dimensional array $refPicLX_L$ of luma samples. These samples may be used for generating the predicted luma sample value $predSampleLX_L[x_L, y_L]$. The locations ($xA_{i,j}$, $yA_{i,j}$) for each of the corresponding luma samples $A_{i,j}$ inside the given array $refPicLX_L$ of luma samples are derived as follows:

$$xA_{i,j} = Clip3(0, PicWidthInSamples_L - 1, xInt_L + i) \quad (8\text{-}97)$$
$$yA_{i,j} = Clip3(0, PicHeightInSamples_L - 1, yInt_L + j) \quad (8\text{-}98)$$

Variables shift1, shift2 and shift3 are derived as follows.

– The variable shift1 is set equal to $BitDepth_Y - 8$, the variable shift2 is set equal to 6, and the variable shift3 is set equal to $14 - BitDepth_Y$.

Given the luma samples $A_{i,j}$ at full-sample locations ($xA_{i,j}$, $yA_{i,j}$), the luma samples '$a_{0,0}$' to '$r_{0,0}$' at fractional sample positions are derived by the following rules.

– The samples labelled $a_{0,0}$, $b_{0,0}$, $c_{0,0}$, $d_{0,0}$, $h_{0,0}$, and $n_{0,0}$ shall be derived by applying the 8-tap filter to the nearest integer position samples:

$$a_{0,0} = (-A_{-3,0} + 4*A_{-2,0} - 10*A_{-1,0} + 57*A_{0,0} + 19*A_{1,0} - 7*A_{2,0} + 3*A_{3,0} - A_{4,0}) >> shift1 \quad (8\text{-}99)$$

$$b_{0,0} = (-A_{-3,0} + 4*A_{-2,0} - 11*A_{-1,0} + 40*A_{0,0} + 40*A_{1,0} - 11*A_{2,0} + 4*A_{3,0} - A_{4,0}) >> shift1 \quad (8\text{-}100)$$

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000640

$$c_{0,0} = (-A_{-3,0} + 3*A_{-2,0} - 7*A_{-1,0} + 19*A_{0,0} + 57*A_{1,0} - 10*A_{2,0} + 4*A_{3,0} - A_{4,0}) >> shift1 \quad (8\text{-}101)$$

$$d_{0,0} = (-A_{0,-3} + 4*A_{0,-2} - 10*A_{0,-1} + 57*A_{0,0} + 19*A_{0,1} - 7*A_{0,2} + 3*A_{0,3} - A_{0,4}) >> shift1 \quad (8\text{-}102)$$

$$h_{0,0} = (-A_{0,-3} + 4*A_{0,-2} - 11*A_{0,-1} + 40*A_{0,0} + 40*A_{0,1} - 11*A_{0,2} + 4*A_{0,3} - A_{0,4}) >> shift1 \quad (8\text{-}103)$$

$$n_{0,0} = (-A_{0,-3} + 3*A_{0,-2} - 7*A_{0,-1} + 19*A_{0,0} + 57*A_{0,1} - 10*A_{0,2} + 4*A_{0,3} - A_{0,4}) >> shift1 \quad (8\text{-}104)$$

– The samples labelled $e_{0,0}$, $f_{0,0}$, $g_{0,0}$, $i_{0,0}$, $j_{0,0}$, $k_{0,0}$, $p_{0,0}$, $q_{0,0}$ and $r_{0,0}$ shall be derived by applying the 8-tap filter to the samples $a_{0,i}$, $b_{0,i}$ and $c_{0,i}$ where $i = -3..4$ in vertical direction:

$$e_{0,0} = (-a_{0,-3} + 4*a_{0,-2} - 10*a_{0,-1} + 57*a_{0,0} + 19*a_{0,1} - 7*a_{0,2} + 3*a_{0,3} - a_{0,4}) >> shift2 \quad (8\text{-}108)$$

$$f_{0,0} = (-a_{0,-3} + 4*a_{0,-2} - 11*a_{0,-1} + 40*a_{0,0} + 40*a_{0,1} - 11*a_{0,2} + 4*a_{0,3} - a_{0,4}) >> shift2 \quad (8\text{-}109)$$

$$g_{0,0} = (-a_{0,-3} + 3*a_{0,-2} - 7*a_{0,-1} + 19*a_{0,0} + 57*a_{0,1} - 10*a_{0,2} + 4*a_{0,3} - a_{0,4}) >> shift2 \quad (8\text{-}110)$$

$$i_{0,0} = (-b_{0,-3} + 4*b_{0,-2} - 10*b_{0,-1} + 57*b_{0,0} + 19*b_{0,1} - 7*b_{0,2} + 3*b_{0,3} - b_{0,4}) >> shift2 \quad (8\text{-}111)$$

$$j_{0,0} = (-b_{0,-3} + 4*b_{0,-2} - 11*b_{0,-1} + 40*b_{0,0} + 40*b_{0,1} - 11*b_{0,2} + 4*b_{0,3} - b_{0,4}) >> shift2 \quad (8\text{-}112)$$

$$k_{0,0} = (-b_{0,-3} + 3*b_{0,-2} - 7*b_{0,-1} + 19*b_{0,0} + 57*b_{0,1} - 10*b_{0,2} + 4*b_{0,3} - b_{0,4}) >> shift2 \quad (8\text{-}113)$$

$$p_{0,0} = (-c_{0,-3} + 4*c_{0,-2} - 10*c_{0,-1} + 57*c_{0,0} + 19*c_{0,1} - 7*c_{0,2} + 3*c_{0,3} - c_{0,4}) >> shift2 \quad (8\text{-}114)$$

$$q_{0,0} = (-c_{0,-3} + 4*c_{0,-2} - 11*c_{0,-1} + 40*c_{0,0} + 40*c_{0,1} - 11*c_{0,2} + 4*c_{0,3} - c_{0,4}) >> shift2 \quad (8\text{-}115)$$

$$r_{0,0} = (-c_{0,-3} + 3*c_{0,-2} - 7*c_{0,-1} + 19*c_{0,0} + 57*c_{0,1} - 10*c_{0,2} + 4*c_{0,3} - c_{0,4}) >> shift2 \quad (8\text{-}116)$$

The positions labelled with lower-case letters within un-shaded blocks represent luma samples at quarter-pel sample fractional locations. The luma location offset in fractional-sample units ($xFrac_L$, $yFrac_L$) specifies which of the generated luma samples at full-sample and fractional-sample locations is assigned to the predicted luma sample value $predSampleLX_L[x_L, y_L]$. This assignment is done according to Table 8-9. The value of $predSampleLX_L[x_L, y_L]$ shall be the output.

Table 8-12 – Assignment of the luma prediction sample $predSampleLX_L[x_L, y_L]$

xFracL	0	0	0	0	1	1	1	1	2	2	2	2	3	3	3	3
yFracL	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
$predSampleLX_L[x_L, y_L]$	A << shift3	d	h	n	a	e	i	p	b	f	j	q	c	g	k	r

8.4.2.2.2.2 Chroma sample interpolation process

Inputs to this process are:

– a chroma location in full-sample units ($xInt_C$, $yInt_C$),

– a chroma location in fractional-sample units ($xFrac_C$, $yFrac_C$),

– the chroma reference sample array $refPicLX_C$.

Output of this process is a predicted chroma sample value $predSampleLX_C[x_C, y_C]$

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000641

seq_parameter_set_rbsp( ) {	Descriptor
profile_idc	u(8)
reserved_zero_8bits /* equal to 0 */	u(8)
level_idc	u(8)
seq_parameter_set_id	ue(v)
max_temporal_layers_minus1	u(3)
pic_width_in_luma_samples	u(16)
pic_height_in_luma_samples	u(16)
[Ed. (BB): video coding syntax missing here, present in HM software]	
bit_depth_luma_minus8	ue(v)
bit_depth_chroma_minus8	ue(v)
[Ed. (BB): chroma bit depth present in HM software but not used further.]	
pcm_bit_depth_luma_minus1	u(4)
pcm_bit_depth_chroma_minus1	u(4)
log2_max_frame_num_minus4	ue(v)
pic_order_cnt_type	ue(v)
if(pic_order_cnt_type == 0)	
log2_max_pic_order_cnt_lsb_minus4	ue(v)
else if(pic_order_cnt_type == 1) {	
delta_pic_order_always_zero_flag	u(1)
offset_for_non_ref_pic	se(v)
num_ref_frames_in_pic_order_cnt_cycle	ue(v)
for(i = 0; i < num_ref_frames_in_pic_order_cnt_cycle; i++)	
offset_for_ref_frame[i]	se(v)
}	
max_num_ref_frames	ue(v)
gaps_in_frame_num_value_allowed_flag	u(1)
[Ed. (BB): not present in HM software, depends on reference list construction design.]	
log2_min_coding_block_size_minus3	ue(v)
log2_diff_max_min_coding_block_size	ue(v)
log2_min_transform_block_size_minus2	ue(v)
log2_diff_max_min_transform_block_size	ue(v)
log2_min_pcm_coding_block_size_minus3	ue(v)
max_transform_hierarchy_depth_inter	ue(v)
max_transform_hierarchy_depth_intra	ue(v)
chroma_pred_from_luma_enabled_flag	u(1)
loop_filter_across_slice_flag	u(1)
sample_adaptive_offset_enabled_flag	u(1)
adaptive_loop_filter_enabled_flag	u(1)
pcm_loop_filter_disable_flag	u(1)
cu_qp_delta_enabled_flag	u(1)
temporal_id_nesting_flag	u(1)
inter_4x4_enabled_flag	u(1)
rbsp_trailing_bits( )	
}	

Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000542

7.3.2.2 Picture parameter set RBSP syntax

pic_parameter_set_rbsp( ) {	Descriptor
pic_parameter_set_id	ue(v)
seq_parameter_set_id	ue(v)
entropy_coding_mode_flag	u(1)
num_temporal_layer_switching_point_flags	ue(v)
for(i = 0; i < num_temporal_layer_switching_point_flags; i++)	
temporal_layer_switching_point_flag[i]	u(1)
num_ref_idx_l0_default_active_minus1	ue(v)
num_ref_idx_l1_default_active_minus1	ue(v)
[Ed. (BB): not present in HM software, depend on inference for constraining decoding.]	
pic_init_qp_minus26 /* relative to 26 */	se(v)
[Ed. (BB): not present in HM software, signaled in slice header as absolute value. slice_qp_delta should be implemented to be used for slice_qp_delta]	
constrained_intra_pred_flag	u(1)
slice_granularity	u(2)
~~shared_pps_info_enabled_flag~~	~~u(1)~~
~~if(shared_pps_info_enabled_flag)~~	
~~if(adaptive_loop_filter_enabled_flag)~~	
~~alf_param( )~~	
~~if(cu_qp_delta_enabled_flag)~~	
~~max_cu_qp_delta_depth~~	~~u(v)~~
[Ed. (BB): not present in HM software, should be implemented.]	
rbsp_trailing_bits( )	
}	

~~7.3.2.3 Adaptation parameter set RBSP syntax~~

~~aps_rbsp( ) {~~	~~Descriptor~~
~~aps_id~~	~~ue(v)~~
~~aps_sample_adaptive_offset_flag~~	~~u(1)~~
~~aps_adaptive_loop_filter_flag~~	~~u(1)~~
~~if(aps_sample_adaptive_offset_flag || aps_adaptive_loop_filter_flag) {~~	
~~aps_cabac_use_flag~~	~~u(1)~~
~~if(aps_cabac_use_flag) {~~	
~~aps_cabac_init_idc~~	~~ue(v)~~
~~aps_cabac_init_qp_minus26~~	~~se(v)~~
~~}~~	
~~}~~	
~~if(aps_sample_adaptive_offset_flag) {~~	
~~sao_data_byte_count~~	~~u(8)~~
~~byte_align( )~~	
~~sao_param( )~~	
~~byte_align( )~~	
~~}~~	
~~if(aps_adaptive_loop_filter_flag) {~~	

Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Highlight
Formatted: Heading 4,Heading 4 Char1,Heading 4 Char Char, Space Before: 0 pt, After: 0 pt, No bullets or numbering,Tab stops: Not at 0.25" + 0.5" + 0.75" + 1"

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000543

alf_data_byte_count	u(8)
byte_align( )	
alf_param( )	
}	
rbsp_trailing_bits( )	
}	

7.3.2.47.3.2.4 **Supplemental enhancement information RBSP syntax**

sei_rbsp( ) {	Descriptor
do	
sei_message( )	
while(more_rbsp_data( ))	
rbsp_trailing_bits( )	
}	

7.3.2.3.47.3.2.4.1 **Supplemental enhancement information message syntax**

sei_message( ) {	Descriptor
payloadType = 0	
while(next_bits(8) == 0xFF) {	
ff_byte /* equal to 0xFF */	f(8)
payloadType += 255	
}	
last_payload_type_byte	u(8)
payloadType += last_payload_type_byte	
payloadSize = 0	
while(next_bits(8) == 0xFF) {	
ff_byte /* equal to 0xFF */	f(8)
payloadSize += 255	
}	
last_payload_size_byte	u(8)
payloadSize += last_payload_size_byte	
sei_payload(payloadType, payloadSize)	
}	

7.3.2.47.3.2.5 **Access unit delimiter RBSP syntax**

access_unit_delimiter_rbsp( ) {	Descriptor
primary_pic_type	u(3)
rbsp_trailing_bits( )	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000544

7.3.2.67.3.2.6 Filler data RBSP syntax

filler_data_rbsp( ) {	Descriptor
while(next_bits(8) == 0xFF)	
ff_byte /* equal to 0xFF */	f(8)
rbsp_trailing_bits( )	
}	

7.3.2.67.3.2.7 Slice layer RBSP syntax

slice_layer_rbsp( ) {	Descriptor
slice_header( )	
slice_data( )	
rbsp_slice_trailing_bits( )	
}	

7.3.2.77.3.2.8 RBSP slice trailing bits syntax

rbsp_slice_trailing_bits( ) {	Descriptor
rbsp_trailing_bits( )	
if(entropy_coding_mode_flag)	
while(more_rbsp_trailing_data( ))	
cabac_zero_word /* equal to 0x0000 */	f(16)
}	

7.3.2.87.3.2.9 RBSP trailing bits syntax

rbsp_trailing_bits( ) {	Descriptor
rbsp_stop_one_bit /* equal to 1 */	f(1)
while(!byte_aligned( ))	
rbsp_alignment_zero_bit /* equal to 0 */	f(1)
}	

7.3.2.10 RBSP byte alignment syntax

byte_align( ) {	Descriptor
while(!byte_aligned( ))	
bit_equal_to_one	f(1)
}	

Formatted: Heading 4,Heading 4 Char1,Heading 4 Char Char

Formatted: Normal

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000545

7.3.3 Slice header syntax

slice_header( ) {	Descriptor
light_weight_copy_slice_flag	u(1)
if(!light_weight_copy_slice_flag) {	
slice_type	ue(v)
pic_parameter_set_id	ue(v)
if(sample_adaptive_offset_enabled_flag || adaptive_loop_filter_enabled_flag)	
aps_id	ue(v)
frame_num	u(v)
if(IdrPicFlag)	
idr_pic_id	ue(v)
/* (BB): not present in HM software, depends on reference list construction design */	
if(pic_order_cnt_type == 0)	
pic_order_cnt_lsb /*	u(v)
/* (BB): always signaled as pic_order_cnt_type 0 in HM software, depends on reference list construction design */	
if(slice_type == P || slice_type == B) {	
num_ref_idx_active_override_flag	u(1)
if(num_ref_idx_active_override_flag) {	
num_ref_idx_l0_active_minus1	ue(v)
if(slice_type == B)	
num_ref_idx_l1_active_minus1	ue(v)
}	
}	
ref_pic_list_modification( )	
/* (BB): not present in HM software, depends on reference list construction design */	
ref_pic_list_combination( )	
if(nal_ref_flag != 0)	
dec_ref_pic_marking( )	
/* (BB): not present in HM software, depends on reference list construction design */	
}	
if(entropy_coding_mode_flag && slice_type != I)	
cabac_init_idc	ue(v)
first_slice_in_pic_flag	u(1)
if(first_slice_in_pic_flag == 0)	
slice_address	u(v)
if(!light_weight_copy_slice_flag) {	
slice_qp_delta	se(v)
/* (BB): coded as absolute value here as in HM software, should be implemented together with pic_init_qp_minus26 */	
if(sample_adaptive_offset_enabled_flag)	
sao_param()	
if(deblocking_filter_control_present_flag) {	
disable_deblocking_filter_idc	u(1)
/* (BB): Although it was agreed to use AVC-like deblock long control syntax, WD and HM should be changed to make use of the AVC-like syntax */	
if(disable_deblocking_filter_idc != 1) {	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000546

slice_alpha_c0_offset_div2	
slice_beta_offset_div2	
}	
}	
if(slice_type = = B)	
collocated_from_l0_flag	u(1)
if(adaptive_loop_filter_enabled_flag && aps_adaptive_loop_filter_flag) {	
if(!shared_pps_info_enabled_flag)byte_align( )	
alf_param( )	
alf_cu_control_param( )	
byte_align( )	
}	
}	
}	

Formatted Table

7.3.3.1 Reference picture list modification syntax

ref_pic_list_modification( ) {	Descriptor
if(slice_type % 5 != 2 && slice_type % 5 != 4) {	
ref_pic_list_modification_flag_l0	u(1)
if(ref_pic_list_modification_flag_l0)	
do {	
modification_of_pic_nums_idc	ue(v)
if(modification_of_pic_nums_idc = = 0 || modification_of_pic_nums_idc = = 1)	
abs_diff_pic_num_minus1	ue(v)
else if(modification_of_pic_nums_idc = = 2)	
long_term_pic_num	ue(v)
} while(modification_of_pic_nums_idc != 3)	
}	
if(slice_type % 5 = = 1) {	
ref_pic_list_modification_flag_l1	u(1)
if(ref_pic_list_modification_flag_l1)	
do {	
modification_of_pic_nums_idc	ue(v)
if(modification_of_pic_nums_idc = = 0 || modification_of_pic_nums_idc = = 1)	
abs_diff_pic_num_minus1	ue(v)
else if(modification_of_pic_nums_idc = = 2)	
long_term_pic_num	ue(v)
} while(modification_of_pic_nums_idc != 3)	
}	
}	

7.3.3.2 Reference picture lists combination syntax

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000547

ref_pic_list_combination( ) {	Descriptor
if(slice_type % 5 = = 1) { // b slice	
ref_pic_list_combination_flag	u(1)
if(ref_pic_list_combination_flag) {	
num_ref_idx lc_active_minus1	ue(v)
ref_pic_list_modification_flag_lc	u(1)
if(ref_pic_list_modification_flag_lc)	
for (i =0; i <= num_ref_idx_lc_active_minus1; i++) {	
pic_from_list_0_flag	u(1)
ref_idx_list_curr	ue(v)
}	
}	
}	
}	

7.3.3.3 Decoded reference picture marking syntax

dec_ref_pic_marking( ) {	Descriptor
if(IdrPicFlag) {	
no_output_of_prior_pics_flag	u(1)
long_term_reference_flag	u(1)
} else {	
adaptive_ref_pic_marking_mode_flag	u(1)
if(adaptive_ref_pic_marking_mode_flag)	
do {	
memory_management_control_operation	ue(v)
if(memory_management_control_operation = = 1 || memory_management_control_operation = = 3)	
difference_of_pic_nums_minus1	ue(v)
if(memory_management_control_operation = = 2)	
long_term_pic_num	ue(v)
if(memory_management_control_operation = = 3 || memory_management_control_operation = = 6)	
long_term_frame_idx	ue(v)
if(memory_management_control_operation = = 4)	
max_long_term_frame_idx_plus1	ue(v)
} while(memory_management_control_operation != 0)	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000548

7.3.3.4 Sample adaptive offset parameter syntax

sao_param( ) {	Descriptor
····sample_adaptive_offset_flag	u(1)
····if(sample_adaptive_offset_flag) {	
····sao_split_param(0, 0, 0, 0)	
····sao_offset_param(0, 0, 0, 0)	
····**sao_flag_cb**	u(1) | ae(v)
····if(sao_flag_cb) {	
···· sao_split_param(0, 0, 0, 1)	
···· sao_split_param(0, 0, 0, 1)	
····}	
····**sao_flag_cr**	u(1) | ae(v)
····if(sao_flag_cr) {	
···· sao_split_param(0, 0, 0, 2)	
···· sao_split_param(0, 0, 0, 2)	
····}	
····}	
}	

sao_split_param(rx, ry, saoDepth , cIdx) {	Descriptor
if(saoDepth < SaoMaxDepth)	
sao_split_flag[cIdx][saoDepth][rx][ry]	u(1) | ae(v)
else	
sao_split_flag[cIdx][saoDepth][rx][ry] = 0	
if(sao_split_flag[cIdx][saoDepth][rx][ry]) {	
sao_split_param(2*rx + 0, 2*ry + 0, saoDepth + 1 , cIdx)	
sao_split_param(2*rx + 1, 2*ry + 0, saoDepth + 1 , cIdx)	
sao_split_param(2*rx + 0, 2*ry + 1, saoDepth + 1 , cIdx)	
sao_split_param(2*rx + 1, 2*ry + 1, saoDepth + 1 , cIdx)	
}	
}	

sao_offset_param(rx, ry, saoDepth , cIdx) {	Descriptor
if(sao_split_flag[cIdx][saoDepth][rx][ry]) {	
sao_offset_param(2*rx + 0, 2*ry + 0, saoDepth + 1 , cIdx)	
sao_offset_param(2*rx + 1, 2*ry + 0, saoDepth + 1 , cIdx)	
sao_offset_param(2*rx + 0, 2*ry + 1, saoDepth + 1 , cIdx)	
sao_offset_param(2*rx + 1, 2*ry + 1, saoDepth + 1 , cIdx)	
} else {	
sao_type_idx[cIdx][saoDepth][rx][ry]	ue(v) | ae(v)
if(sao_type_idx[cIdx][saoDepth][rx][ry] != 0)	
for(i = 0; i < NumSaoClass[sao_type_idx]; i++)	
sao_offset[cIdx][saoDepth][x0][y0][i]	se(v) | ae(v)
}	
}	

[Ed.: (WJ) is it better to assign separate section?]

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000549

7.3.3.5 Adaptive loop filter parameter syntax

alf_param() {	Descriptor
~~adaptive_loop_filter_flag~~	~~ae(1)~~
~~if (adaptive_loop_filter_flag) {~~	
alf_region_adaptation_flag	u(1) | ae(v)
alf_length_luma_minus_5_div2	ue(v) | ae(v)
alf_no_filters_minus1	ue(v) | ae(v)
if (alf_no_filters_minus1 == 1)	
alf_start_second_filter	ue(v) | ae(v)
else if (alf_no_filters_minus1 > 1) {	
for (i=1; i< 16; i++)	
alf_filter_pattern[i]	u(1) | ae(v)
}	
if (AlfNumFilters > 1)	
alf_pred_method	u(1) | ae(v)
alf_min_kstart_minus1	ue(v) | ae(v)
for (i=0; i < AlfMaxDepth; i++)	
alf_golomb_index_bit[i]	u(1) | ae(v)
for (i=0; i< AlfNumFilters; i++)	
for (j=0; j< AlfCodedLengthLuma; j++)	
alf_coeff_luma[i][j]	ge(v) | ae(v)
alf_chroma_idc	ue(v) | ae(v)
if (alf_chroma_idc) {	
alf_length_chroma_minus_5_div2	ue(v) | ae(v)
for(i = 0; i< AlfCodedLengthChroma; i++)	
alf_coeff_chroma[i]	se(v) | ae(v)
}	
~~}~~	
}	

Formatted Table

7.3.3.6 Adaptive loop filter coding unit control parameter syntax

alf_cu_control_param() {	Descriptor
~~if(adaptive_loop_filter_flag) {~~	
alf_cu_control_flag	u(1) | ae(v)
if(alf_cu_control_flag) {	
alf_cu_control_max_depth	ue(v) | ae(v)
alf_length_cu_control_info	se(v) | ae(v)
for(i = 0; i < NumAlfCuFlag; i++)	
alf_cu_flag[i]	u(1) | ae(v)
}	
~~}~~	
}	

Formatted Table

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000550

7.3.4 Slice data syntax

slice_data( ) {	Descriptor
CurrTbAddr = LCUAddress	
moreDataFlag = 1	
if(adaptive_loop_filter_flag && alf_cu_control_flag)	
AlfCuFlagIdx = -1	
do {	
xCU = HorLumaLocation(CurrTbAddr)	
yCU = VerLumaLocation(CurrTbAddr)	
moreDataFlag = coding_tree(xCU, yCU, Log2TbSize, 0)	
CurrTbAddr = NextTbAddress(CurrTbAddr)	
} while(moreDataFlag)	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000551

7.3.5 Coding tree syntax

coding_tree(x0, y0, log2CUSize, cuDepth) {	Descriptor
if(x0 + (1 << log2CUSize) <= PicWidthInSamples$_L$ && y0 + (1 << log2CUSize) <= PicHeightInSamples$_L$ && cuAddress(x0, y0) >= SliceAddress) {	
if(!entropy_coding_mode_flag && slice_type != I)	
cu_split_pred_part_mode[x0][y0]	ce(v)
else if(log2CUSize > Log2MinCUSize)	
split_coding_unit_flag[x0][y0]	u(1) | ae(v)
}	
if(adaptive_loop_filter_flag && alf_cu_control_flag) {	
if(cuDepth <= alf_cu_control_max_depth)	
if(cuDepth == alf_cu_control_max_depth ||	
split_coding_unit_flag[x0][y0] == 0)	
AlfCuFlagIdx++	
}	
if(cu_qp_delta_enabled_flag && log2CUSize >= log2MinCUDQPSize)	
IsCuQpDeltaCoded = 0	
if(split_coding_unit_flag[x0][y0]) {	
x1 = x0 + ((1 << log2CUSize) >> 1)	
y1 = y0 + ((1 << log2CUSize) >> 1)	
if(cuAddress(x1, y0) > SliceAddress)	
moreDataFlag = coding_tree(x0, y0, log2CUSize – 1, cuDepth + 1)	
if(cuAddress(x0, y1) > SliceAddress && moreDataFlag && x1 < PicWidthInSamples$_L$)	
moreDataFlag = coding_tree(x1, y0, log2CUSize – 1, cuDepth + 1)	
if(cuAddress(x1, y1) > SliceAddress && moreDataFlag && y1 < PicHeightInSamples$_L$)	
moreDataFlag = coding_tree(x0, y1, log2CUSize – 1, cuDepth + 1)	
if(moreDataFlag && x1 < PicWidthInSamples$_L$ && y1 < PicHeightInSamples$_L$)	
moreDataFlag = coding_tree(x1, y1, log2CUSize – 1, cuDepth + 1)	
} else {	
if(adaptive_loop_filter_flag && alf_cu_control_flag)	
AlfCuFlag[x0][y0] = alf_cu_flag[AlfCuFlagIdx]	
coding_unit(x0, y0, log2CUSize)	
if(!entropy_coding_mode_flag)	
moreDataFlag = more_rbsp_data( )	
else {	
if(granularity_block_boundary(x0, y0, log2CUSize)) {	
end_of_slice_flag	ae(v)
moreDataFlag = !end_of_slice_flag	
} else	
moreDataFlag = 1	
}	
}	
return moreDataFlag	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000552

[Ed. (WJ): cuAddress(x, y) returns the address of the smallest coding unit at (x, y), expressed in global decoding order smallest coding unit coordinates. granularity_block_boundary(x0, y0, log2CUSize) returns true when the coding unit specified by (x0, y0, log2CUSize) is the last coding unit in the slice in global decoding order. These functions are not defined yet. They will be added later.]

7.3.6 Coding unit syntax

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000553

coding_unit(x0, y0, log2CUSize) {	Descriptor
if(entropy_coding_mode_flag && slice_type != I)	
skip_flag[x0][y0]	u(1) | ae(v)
if(skip_flag[x0][y0])	
prediction_unit(x0, y0 , log2CUSize)	
else {	
if(!entropy_coding_mode_flag) {	
if(slice_type == I && log2CUSize == Log2MinCUSize)	
intra_part_mode	u(1)
} else if(slice_type != I || log2CUSize == Log2MinCUSize)	
pred_type	u(v) | ae(v)
x1 = x0 + ((1 << log2CUSize) >> 1)	
y1 = y0 + ((1 << log2CUSize) >> 1)	
x2 = x1 − ((1 << log2CUSize) >> 2)	
y2 = y1 − ((1 << log2CUSize) >> 2)	
x3 = x1 + ((1 << log2CUSize) >> 2)	
y3 = y1 + ((1 << log2CUSize) >> 2)	
if(PartMode == PART_2Nx2N) {	
prediction_unit(x0, y0 , log2CUSize)	
} else if(PartMode == PART_2NxN) {	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x0, y1 , log2CUSize)	
} else if(PartMode == PART_Nx2N) {	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x1, y0 , log2CUSize)	
} else if(PartMode == PART_2NxnU) {	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x0, y2 , log2CUSize)	
} else if(PartMode == PART_2NxnD) {	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x0, y3 , log2CUSize)	
} else if(PartMode == PART_nLx2N) {	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x2, y0 , log2CUSize)	
} else if(PartMode == PART_nRx2N) {	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x3, y0 , log2CUSize)	
} else { /* PART_NxN */	
prediction_unit(x0, y0 , log2CUSize)	
prediction_unit(x1, y0 , log2CUSize)	
prediction_unit(x0, y1 , log2CUSize)	
prediction_unit(x1, y1 , log2CUSize)	
}	
}	
if(!pcm_flag) {	
transform_tree(x0, y0, log2CUSize, log2CUSize, 0, 0)	
transform_coeff(x0, y0, log2CUSize, log2CUSize, 0, 0)	
transform_coeff(x0, y0, log2CUSize, log2CUSize, 0, 1)	
transform_coeff(x0, y0, log2CUSize, log2CUSize, 0, 2)	
}	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000554

7.3.7 Prediction unit syntax

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000555

prediction_unit(x0, y0, log2CUSize) {	Descriptor
if(skip_flag[x0][y0]) {	
merge_idx[x0][y0]	ue(v) | ae(v)
} else if(PredMode == MODE_INTRA) {	
if(PartMode == PART_2Nx2N && log2CUSize >= Log2MinIPCMCUSize)	
pcm_flag	u(1) | ae(v)
if(pcm_flag) {	
while (!byte_aligned( ))	
pcm_alignment_zero_bit	u(v)
for(i = 0; i < 1 << (log2CUSize << 1); i++)	
pcm_sample_luma[i]	u(v)
for(i = 0; i < (1 << (log2CUSize << 1)) >> 1; i++)	
pcm_sample_chroma[i]	u(v)
} else {	
prev_intra_luma_pred_flag[x0][y0]	u(1) | ae(v)
if(prev_intra_luma_pred_flag[x0][y0])	
mpm_idx[x0][y0]	u(1) | ae(v)
else	
rem_intra_luma_pred_mode[x0][y0]	ce(v) | ae(v)
intra_chroma_pred_mode[x0][y0]	ue(v) | ae(v)
SignaledAsChromaDC = (chroma_pred_from_luma_enabled_flag ? intra_chroma_pred_mode[x0][y0] == 3 : intra_chroma_pred_mode[x0][y0] == 2)	
}	
} else { /* MODE_INTER */	
if(entropy_coding_mode_flag || PartMode != PART_2Nx2N)	
merge_flag[x0][y0]	u(1) | ae(v)
if(merge_flag[x0][y0]) {	
merge_idx[x0][y0]	ue(v) | ae(v)
} else {	
if(slice_type == B) {	
if(!entropy_coding_mode_flag) {	
combined_inter_pred_ref_idx	ue(v)
if(combined_inter_pred_ref_idx == MaxPredRef)	
inter_pred_flag[x0][y0]	ue(v)
} else	
inter_pred_flag[x0][y0]	~~ue(v)~~ | ae(v)
}	
if(inter_pred_flag[x0][y0] == Pred_LC) {	
if(num_ref_idx_lc_active_minus1 > 0) {	
if(!entropy_coding_mode_flag) {	
if(combined_inter_pred_ref_idx == MaxPredRef)	
ref_idx_lc_minus4[x0][y0]	ue(v)
} else	
ref_idx_lc[x0][y0]	ae(v)
}	
if(entropy_coding_mode_flag) {	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000556

mvd_coding_cabac(mvd_lc[x0][y0][0], mvd_lc[x0][y0][1])	
} else {	
mvd_lc[x0][y0][0]	se(v)
mvd_lc[x0][y0][1]	se(v)
}	
mvp_idx_lc[**x0**][**y0**]	ue(v) | ae(v)
}	
else { /* Pred_L0 or Pred_BI */	
if(num_ref_idx_l0_active_minus1 > 0) {	
if(!entropy_coding_mode_flag) {	
if(combined_inter_pred_ref_idx == MaxPredRef)	
ref_idx_l0_minusX[x0][y0]	ue(v)
} else	
ref_idx_l0_minusX[x0][y0]	~~ue(v)~~ | ae(v)
}	
if(entropy_coding_mode_flag) {	
mvd_coding_cabac(mvd_l0[x0][y0][0], mvd_l0[x0][y0][1])	
} else {	
mvd_l0[x0][y0][0]	se(v)
mvd_l0[x0][y0][1]	se(v)
}	
mvp_idx_l0[**x0**][**y0**]	ue(v) | ae(v)
}	
if(inter_pred_flag[x0][y0] == Pred_BI) {	
if(num_ref_idx_l1_active_minus1 > 0) {	
if(!entropy_coding_mode_flag) {	
if(combined_inter_pred_ref_idx == MaxPredRef)	
ref_idx_l1_minusX[x0][y0]	ue(v)
} else	
ref_idx_l1[x0][y0]	~~ue(v)~~ | ae(v)
}	
if(entropy_coding_mode_flag) {	
mvd_coding_cabac(mvd_l1[x0][y0][0], mvd_l1[x0][y0][1])	
} else {	
mvd_l1[x0][y0][0]	se(v)
mvd_l1[x0][y0][1]	se(v)
}	
mvp_idx_l1[**x0**][**y0**]	ue(v) | ae(v)
}	
}	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000557

7.3.7.1 Motion vector difference coding CABAC syntax

mvd_coding_cabac(mvd_x, mvd_y) {	Descriptor
abs_mvd_greater0_flag[0]	ae(v)
abs_mvd_greater0_flag[1]	ae(v)
if(abs_mvd_greater0_flag[0])	
abs_mvd_greater1_flag[0]	ae(v)
if(abs_mvd_greater0_flag[1])	
abs_mvd_greater1_flag[1]	ae(v)
if(abs_mvd_greater0_flag[0]) {	
if(abs_mvd_greater1_flag[0])	
abs_mvd_minus2[0]	ae(v)
mvd_sign_flag[0]	ae(v)
}	
if(abs_mvd_greater0_flag[1]) {	
if(abs_mvd_greater1_flag[1])	
abs_mvd_minus2[1]	ae(v)
mvd_sign_flag[1]	ae(v)
}	
mvd_x = abs_mvd_greater0_flag[0] * (abs_mvd_minus2[0] + 2) * (1 – 2 * mvd_sign_flag[0])	
mvd_y = abs_mvd_greater0_flag[1] * (abs_mvd_minus2[1] + 2) * (1 – 2 * mvd_sign_flag[1])	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000558

7.3.8 Transform tree syntax

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000559

transform_tree(x0, y0, log2TrafoWidth, log2TrafoHeight, trafoDepth, blkIdx) {	Descriptor
if(entropy_coding_mode_flag && trafoDepth == 0 && IntraSplitFlag == 0) {	
if(PredMode != MODE_INTRA)	
no_residual_data_flag	ae(v)
residualDataPresentFlag = !no_residual_data_flag	
} else {	
residualDataPresentFlag = TRUE	
}	
if(residualDataPresentFlag) {	
log2TrafoSize = (log2TrafoWidth + log2TrafoHeight) >> 1	
intraSplitFlag = (IntraSplitFlag && trafoDepth == 0 ? 1 : 0)	
maxDepth = (PredMode == MODE_INTRA ? max_transform_hierarchy_depth_intra + IntraSplitFlag : max_transform_hierarchy_depth_inter)	
xBase = x0 – (x0 & (1 << log2TrafoWidth))	
yBase = y0 – (y0 & (1 << log2TrafoHeight))	
if(!entropy_coding_mode_flag) {	
if(trafoDepth != 0 && !cbf_luma[xBase][yBase][trafoDepth – 1]) {	
if(cbf_cb[xBase][yBase][trafoDepth – 1] && log2TrafoSize > Log2MinTrafoSize)	
cbf_cb[x0][y0] [trafoDepth]	u(1)
if(cbf_cr[xBase][yBase][trafoDepth – 1] && log2TrafoSize > Log2MinTrafoSize)	
cbf_cr[x0][y0] [trafoDepth]	u(1)
if(log2TrafoSize <= Log2MaxTrafoSize && !intraSplitFlag && log2TrafoSize > Log2MinTrafoSize && trafoDepth < maxDepth)	
split_transform_flag[x0][y0] [trafoDepth]	u(1)
} else	
cbp_and_split_transform	vlc(n,v)
}	
if(log2TrafoSize <= Log2MaxTrafoSize && log2TrafoSize > Log2MinTrafoSize && trafoDepth < maxDepth && !intraSplitFlag && entropy_coding_mode_flag)	
split_transform_flag[x0][y0][trafoDepth]	ae(v)
if(PredMode != MODE_INTRA && log2TrafoSize <= Log2MaxTrafoSize && entropy_coding_mode_flag) {	
firstChromaCbf = (log2TrafoSize == Log2MaxTrafoSize || trafoDepth == 0 ? 1 : 0)	
if(firstChromaCbf || log2TrafoSize > Log2MinTrafoSize) {	
if(firstChromaCbf || cbf_cb[xBase][yBase][trafoDepth – 1]) {	
readCbf = true	
if(blkIdx = = 3 && log2TrafoSize < Log2MaxTrafoSize)	
readCbf = cbf_cb[xBase][yBase][trafoDepth] || cbf_cb[xBase + (1 << log2TrafoWidth)][yBase][trafoDepth] || cbf_cb[xBase][yBase + (1 << log2TrafoHeight)][trafoDepth]	
if (!readCbf)	
cbf_cb[x0][y0][trafoDepth] = 1	
else	
cbf_cb[x0][y0][trafoDepth]	ae(v)
}	
if(firstChromaCbf || cbf_cr[xBase][yBase][trafoDepth – 1]) {	
readCbf = true	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000560

if(blkIdx = = 3 && log2TrafoSize < Log2MaxTrafoSize)	
readCbf = cbf_cr[xBase][yBase][trafoDepth] || cbf_cr[xBase + (1 << log2TrafoWidth)][yBase][trafoDepth] || cbf_cr[xBase][yBase + (1 << log2TrafoHeight)][trafoDepth]	
if (!readCbf)	
cbf_cr[x0][y0][trafoDepth] = 1	
else	
cbf_cr[x0][y0][trafoDepth]	ae(v)
}	
}	
}	
if(split_transform_flag[x0][y0][trafoDepth]) {	
if(InterTUSplitDirection = = 2) {	
x1 = x0 + ((1 << log2TrafoWidth) >> 1)	
y1 = y0	
x2 = x0	
y2 = y0 + ((1 << log2TrafoHeight) >> 1)	
x3 = x1	
y3 = y2	
} else {	
x1 = x0 + ((1 << log2TrafoWidth) >> 2) * InterTUSplitDirection	
y1 = y0 + ((1 << log2TrafoHeight) >> 2) * (1 − InterTUSplitDirection)	
x2 = x1 + ((1 << log2TrafoWidth) >> 2) * InterTUSplitDirection	
y2 = y1 + ((1 << log2TrafoHeight) >> 2) * (1 − InterTUSplitDirection)	
x3 = x2 + ((1 << log2TrafoWidth) >> 2) * InterTUSplitDirection	
y3 = y2 + ((1 << log2TrafoHeight) >> 2) * (1 − InterTUSplitDirection)	
log2TrafoHeight = log2TrafoHeight + 2 * InterTUSplitDirection − 1	
log2TrafoWidth = log2TrafoWidth − 2 * InterTUSplitDirection + 1	
}	
transform_tree(x0, y0, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, 0)	
transform_tree(x1, y1, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, 1)	
transform_tree(x2, y2, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, 2)	
transform_tree(x3, y3, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, 3)	
} else if(entropy_coding_mode_flag) {	
if(PredMode = = MODE_INTRA || trafoDepth != 0 || cbf_cb[x0][y0][trafoDepth] || cbf_cr[x0][y0][trafoDepth]) {	
readCbf = true	
if(blkIdx = = 3 && log2TrafoSize < Log2MaxTrafoSize && PredMode != MODE_INTRA)	
readCbf = cbf_luma[xBase][yBase][trafoDepth] || cbf_luma[xBase + (1 << log2TrafoWidth)][yBase][trafoDepth] || cbf_luma[xBase][yBase + (1 << log2TrafoHeight)][trafoDepth] || cbf_cb[xBase][yBase][trafoDepth – 1] || cbf_cr[xBase][yBase][trafoDepth – 1]	
if (!readCbf)	
cbf_luma[x0][y0][trafoDepth] = 1	
else	
cbf_luma[x0][y0][trafoDepth]	ae(v)
}	
if(PredMode = = MODE_INTRA)	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000561

if(log2TrafoSize > Log2MinTrafoSize) {	
cbf_cb[x0][y0][trafoDepth]	ae(v)
cbf_cr[x0][y0][trafoDepth]	ae(v)
} else if(blkIdx == 0) {	
cbf_cb[x0][y0][trafoDepth − 1]	ae(v)
cbf_cr[x0][y0][trafoDepth − 1]	ae(v)
}	
}	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000562

7.3.9 Transform coefficient syntax

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000563

transform_coeff(x0, y0, log2TrafoWidth, log2TrafoHeight, trafoDepth, cIdx) {	Descriptor
if((cIdx = = 0 && cbf_luma[x0][y0][trafoDepth]) || (cIdx = = 1 && cbf_cb[x0][y0][trafoDepth]) || (cIdx = = 2 && cbf_cr[x0][y0][trafoDepth]))) {	
if(cu_qp_delta_enabled_flag && !IsCuQpDeltaCoded) {	
cu_qp_delta	se(v) | ae(v)
IsCuQpDeltaCoded = 1	
}	
if(split_transform_flag[x0][y0][trafoDepth] && (cIdx = = 0 || log2TrafoSize > Log2MinTrafoSize + 1)) {	
if(InterTUSplitDirection = = 2) {	
x1 = x0 + ((1 << log2TrafoWidth) >> 1)	
y1 = y0	
x2 = x0	
y2 = y0 + ((1 << log2TrafoHeight) >> 1)	
x3 = x1	
y3 = y2	
} else {	
x1 = x0 + ((1 << log2TrafoWidth) >> 2) * InterTUSplitDirection	
y1 = y0 + ((1 << log2TrafoHeight) >> 2) * (1 − InterTUSplitDirection)	
x2 = x1 + ((1 << log2TrafoWidth) >> 2) * InterTUSplitDirection	
y2 = y1 + ((1 << log2TrafoHeight) >> 2) * (1 − InterTUSplitDirection)	
x3 = x2 + ((1 << log2TrafoWidth) >> 2) * InterTUSplitDirection	
y3 = y2 + ((1 << log2TrafoHeight) >> 2) * (1 − InterTUSplitDirection)	
log2TrafoHeight = log2TrafoHeight + 2 * InterTUSplitDirection − 1	
log2TrafoWidth = log2TrafoWidth − 2 * InterTUSplitDirection + 1	
}	
transform_coeff(x0, y0, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, cIdx)	
transform_coeff(x1, y1, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, cIdx)	
transform_coeff(x2, y2, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, cIdx)	
transform_coeff(x3, y3, log2TrafoWidth − 1, log2TrafoHeight − 1, trafoDepth + 1, cIdx)	
} else {	
log2TrafoSize = ((log2TrafoWidth + log2TrafoHeight) >> 1) − (cIdx > 0 ? 1 : 2)	
if (PredMode = = MODE_INTRA) {	
if (cIdx = = 0)	
scanIdx = ScanType[log2TrafoSize – 2][IntraPredMode]	
else	
scanIdx = ScanType[log2TrafoSize – 2][IntraPredModeC]	
} else {	
scanIdx = 0	
}	
if (entropy_coding_mode_flag)	
if (scanIdx = = 0)	
scanIdx = 3	
residual_coding_cabac(x0, y0, log2TrafoSize, trafoDepth, scanIdx, cIdx)	
else if (!entropy_coding_mode_flag)	
residual_coding_cavlc(x0, y0, log2TrafoSize, trafoDepth, cIdx)	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000564

}	

[Ed. (BB): the condition (cIdx == 0 || log2TrafoSize > Log2MinTrafoSize + 1) assumes 4:2:0 color sampling and assures that the luma log2TrafoSize is greater than Log2MinTrafoSize for chroma.]

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000565

7.3.10 Residual coding CABAC syntax

residual_coding_cabac(x0, y0, log2TrafoSize, trafoDepth, scanIdx, cIdx) {	Descriptor
last_significant_coeff_x	ae(v)
last_significant_coeff_y	ae(v)
numCoeff = 0	
xC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx][numCoeff][0]	
yC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx][numCoeff][1]	
while((xC != last_significant_coeff_x) || (yC != last_significant_coeff_y)) {	
numCoeff++	
xC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx][numCoeff][0]	
yC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx][numCoeff][1]	
}	
for(n = numCoeff − 1; n >= 0; n− −) {	
xC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx][n][0]	
yC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx][n][1]	
significant_coeff_flag[xC][yC]	ae(v)
}	
numLastSubset = numCoeff >> 4	
for(i = numLastSubset − 1; i >= 0; i− −) {	
offset = i << 4	
for(n = 15; n >= 0; n− −) {	
xC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx0][n + offset][0]	
yC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx0][n + offset`][1]	
if(significant_coeff_flag[xC][yC])	
coeff_abs_level_greater1_flag[n]	ae(v)
}	
for(n = 15; n >= 0; n− −) {	
if(coeff_abs_level_greater1_flag[n])	
coeff_abs_level_greater2_flag[n]	ae(v)
}	
for(n = 15; n >= 0; n− −) {	
xC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx0][n + offset][0]	
yC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx0][n + offset`][1]	
if(significant_coeff_flag[xC][yC]) {	
coeff_sign_flag[n]	ae(v)
}	
for(n = 15; n >= 0; n− −) {	
if(coeff_abs_level_greater2_flag[n])	
coeff_abs_level_minus3[n]	ae(v)
xC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx0][n + offset][0]	
yC = ScanOrder[log2TrafoSize − 2][log2TrafoSize − 2][scanIdx0][n + offset`][1]	
if(significant_coeff_flag[xC][yC]) {	
transCoeffLevel[x0][y0][trafoDepth][cIdx][n + offset] = (coeff_abs_level_minus3[n] + 3) * (1 − 2 * coeff_sign_flag[n])	
} else	
transCoeffLevel[x0][y0][trafoDepth][cIdx][n + offset] = 0	
}	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000566

7.3.11 Residual coding CAVLC syntax

residual_coding_cavlc(x0, y0, log2TrafoSize, trafoDepth, cIdx) {	Descriptor
n = 1 << (log2TrafoSize << 1)	
last_pos_level_one	ce(v)
lastPos = last_pos_level_one % n	
levelGreaterThanOneFlag = (last_pos_level_one > n)	
level_and_sign(levelGreaterThanOneFlag, transCoeffLevel, x0, y0, trafoDepth, cIdx, lastPos)	
runModeFlag = TRUE	
n = lastPos – 1	
sumBigCoeff = 0	
switchThres = (PredMode == MODE_INTRA && cIdx == 0)? 0 : 49	
while (runModeFlag && n >= 0) {	
run_level_one	ce(v)
runOfZeros = run_level_one % n	
levelGreaterThanOneFlag = (run_level_one > n)	
trOne = (trOne = = 0 | | levelGreaterThanOneFlag) ? 0 : Max(4, trOne + 1)	
n = n – runOfZeros	
if(n >= 0) {	
level_and_sign(levelGreaterThanOneFlag, transCoeffLevel, x0, y0, trafoDepth, cIdx, n)	
if (levelGreaterThanOneFlag) {	
sumBigCoeff = sumBigCoeff + level	
if (log2TrafoSize==2 | | n > switchThres | | sumBigCoeff > 2)	
runModeFlag = FALSE	
}	
}	
n--	
}	
while (n >= 0) {	
level	ce(v)
if (level > 0) {	
sign_flag	u(1)
sign = 1 – 2 * sign_flag	
transCoeffLevel[x0][y0][trafoDepth][cIdx][n] = level * sign	
}	
n--	
}	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000567

7.3.12 Level and sign CAVLC syntax

level_and_sign(levelGreaterThanOneFlag, transCoeffLevel, x0, y0, trafoDepth, cIdx, n) {	Descriptor
if (levelGreaterThanOneFlag) {	
level_minus2_and_sign	ce(v)
level = ((level_minus2_and_sign >> 1) + 2	
sign = 1 - 2*(level_minus2_and_sign & 1)	
transCoeffLevel[x0][y0][trafoDepth][cIdx][n] = level * sign	
}	
else {	
sign_flag	u(1)
transCoeffLevel[x0][y0][trafoDepth][cIdx][n] = 1 – 2 *(sign_flag)	
}	
}	

7.4 Semantics

Semantics associated with the syntax structures and with the syntax elements within these structures are specified in this subclause. When the semantics of a syntax element are specified using a table or a set of tables, any values that are not specified in the table(s) shall not be present in the bitstream unless otherwise specified in this Recommendation | International Standard.

7.4.1 NAL unit semantics

NOTE 1 – The VCL is specified to efficiently represent the content of the video data. The NAL is specified to format that data and provide header information in a manner appropriate for conveyance on a variety of communication channels or storage media. All data are contained in NAL units, each of which contains an integer number of bytes. A NAL unit specifies a generic format for use in both packet-oriented and bitstream systems. The format of NAL units for both packet-oriented transport and byte stream is identical except that each NAL unit can be preceded by a start code prefix and extra padding bytes in the byte stream format.

NumBytesInNALunit specifies the size of the NAL unit in bytes. This value is required for decoding of the NAL unit. Some form of demarcation of NAL unit boundaries is necessary to enable inference of NumBytesInNALunit. One such demarcation method is specified in Annex B for the byte stream format. Other methods of demarcation may be specified outside of this Recommendation | International Standard.

forbidden_zero_bit shall be equal to 0.

nal_ref_flag equal to 1 specifies that the content of the NAL unit contains a sequence parameter set, a picture parameter set or a slice of a reference picture.

For coded video sequences conforming to one or more of the profiles specified in Annex A that are decoded using the decoding process specified in clauses 2-9, nal_ref_flag equal to 0 for a NAL unit containing a slice indicates that the slice is part of a non-reference picture.

nal_ref_flag shall not be equal to 0 for sequence parameter set or picture parameter set NAL units. When nal_ref_flag is equal to 0 for one NAL unit with nal_unit_type equal to 1 or 4 of a particular picture, it shall be equal to 0 for all NAL units with nal_unit_type equal to 1 or 4 of the picture.

nal_ref_flag shall not be equal to 0 for NAL units with nal_unit_type equal to 5.

nal_ref_flag shall be equal to 0 for all NAL units having nal_unit_type equal to 6, 9, 10, 11, or 12.

nal_unit_type specifies the type of RBSP data structure contained in the NAL unit as specified in Table 7-1.

NAL units that use nal_unit_type equal to 0 or in the range of 24..63, inclusive, shall not affect the decoding process specified in this Recommendation | International Standard.

NOTE 2 – NAL unit types 0 and 24..63 may be used as determined by the application. No decoding process for these values of nal_unit_type is specified in this Recommendation | International Standard. Since different applications might use NAL unit types 0 and 24..63 for different purposes, particular care must be exercised in the design of encoders that generate NAL units with nal_unit_type equal to 0 or in the range of 24 to 63, inclusive, and in the design of decoders that interpret the content of NAL units with nal_unit_type equal to 0 or in the range of 24 to 63, inclusive.

Decoders shall ignore (remove from the bitstream and discard) the contents of all NAL units that use reserved values of nal_unit_type.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000568

NOTE 3 – This requirement allows future definition of compatible extensions to this Recommendation | International Standard.

Table 7-1 – NAL unit type codes and NAL unit type classes

nal_unit_type	Content of NAL unit and RBSP syntax structure	NAL unit type class
0	Unspecified	non-VCL
1	Coded slice of a non-IDR and non-CRA picture slice_layer_rbsp( )	VCL
2-3	Reserved	n/a
4	Coded slice of a CRA picture slice_layer_rbsp( )	VCL
5	Coded slice of an IDR picture slice_layer_rbsp( )	VCL
6	Supplemental enhancement information (SEI) sei_rbsp( )	non-VCL
7	Sequence parameter set seq_parameter_set_rbsp( )	non-VCL
8	Picture parameter set pic_parameter_set_rbsp( )	non-VCL
9	Access unit delimiter access_unit_delimiter_rbsp( )	non-VCL
10-11	Reserved	n/a
12	Filler data filler_data_rbsp( )	non-VCL
13-23	Reserved	n/a
24..63	Unspecified	non-VCL

Formatted: Centered

In the text, coded slice NAL unit collectively refers to a coded slice of a non-IDR picture NAL unit or to a coded slice of an IDR picture NAL unit. The variable IdrPicFlag is specified as

$$IdrPicFlag = ((nal\_unit\_type == 5) ? 1 : 0) \quad (7\text{-}1)$$

When the value of nal_unit_type is equal to 5 for a NAL unit containing a slice of a particular picture, the picture shall not contain NAL units with nal_unit_type equal to 1 or 4. For coded video sequences conforming to one or more of the profiles specified in Annex A that are decoded using the decoding process specified in clauses 2-9, such a picture is referred to as an IDR picture.

temporal_id specifies a temporal identifier for the NAL unit. The value of temporal_id shall be the same for all NAL units of an access unit. When an access unit contains any NAL unit with nal_unit_type equal to 5, temporal_id shall be equal to 0.

output_flag affects the decoded picture output and removal processes as specified in Annex C.

[Ed. KS: There is no output definition on Annex C yet]

reserved_one_4bits shall be equal to 1. Other values of reserved_one_4bits may be specified in the future by ITU-T | ISO/IEC. Decoders shall ignore the value of reserved_one_4bits.

rbsp_byte[i] is the i-th byte of an RBSP. An RBSP is specified as an ordered sequence of bytes as follows.

The RBSP contains an SODB as follows.

– If the SODB is empty (i.e., zero bits in length), the RBSP is also empty.

– Otherwise, the RBSP contains the SODB as follows:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000569

1) The first byte of the RBSP contains the (most significant, left-most) eight bits of the SODB; the next byte of the RBSP shall contain the next eight bits of the SODB, etc., until fewer than eight bits of the SODB remain.
2) rbsp_trailing_bits( ) are present after the SODB as follows:
   i) The first (most significant, left-most) bits of the final RBSP byte contains the remaining bits of the SODB (if any).
   ii) The next bit consists of a single rbsp_stop_one_bit equal to 1.
   iii) When the rbsp_stop_one_bit is not the last bit of a byte-aligned byte, one or more rbsp_alignment_zero_bit is present to result in byte alignment.
3) One or more cabac_zero_word 16-bit syntax elements equal to 0x0000 may be present in some RBSPs after the rbsp_trailing_bits( ) at the end of the RBSP.

Syntax structures having these RBSP properties are denoted in the syntax tables using an "_rbsp" suffix. These structures shall be carried within NAL units as the content of the rbsp_byte[i] data bytes. The association of the RBSP syntax structures to the NAL units shall be as specified in Table 7-1.

NOTE 6 – When the boundaries of the RBSP are known, the decoder can extract the SODB from the RBSP by concatenating the bits of the bytes of the RBSP and discarding the rbsp_stop_one_bit, which is the last (least significant, right-most) bit equal to 1, and discarding any following (less significant, farther to the right) bits that follow it, which are equal to 0. The data necessary for the decoding process is contained in the SODB part of the RBSP.

emulation_prevention_three_byte is a byte equal to 0x03. When an emulation_prevention_three_byte is present in the NAL unit, it shall be discarded by the decoding process.

The last byte of the NAL unit shall not be equal to 0x00.

Within the NAL unit, the following three-byte sequences shall not occur at any byte-aligned position:

– 0x000000
– 0x000001
– 0x000002

Within the NAL unit, any four-byte sequence that starts with 0x000003 other than the following sequences shall not occur at any byte-aligned position:

– 0x00000300
– 0x00000301
– 0x00000302
– 0x00000303

NOTE 7 – When nal_unit_type is equal to 0, particular care must be exercised in the design of encoders to avoid the presence of the above-listed three-byte and four-byte patterns at the beginning of the NAL unit syntax structure, as the syntax element emulation_prevention_three_byte cannot be the third byte of a NAL unit.

7.4.1.1 Encapsulation of an SODB within an RBSP (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

The form of encapsulation of an SODB within an RBSP and the use of the emulation_prevention_three_byte for encapsulation of an RBSP within a NAL unit is specified for the following purposes:

– to prevent the emulation of start codes within NAL units while allowing any arbitrary SODB to be represented within a NAL unit,
– to enable identification of the end of the SODB within the NAL unit by searching the RBSP for the rbsp_stop_one_bit starting at the end of the RBSP,
– to enable a NAL unit to have a size larger than that of the SODB under some circumstances (using one or more cabac_zero_word).

The encoder can produce a NAL unit from an RBSP by the following procedure:

1. The RBSP data is searched for byte-aligned bits of the following binary patterns:

   '00000000 00000000 000000xx' (where xx represents any 2 bit pattern: 00, 01, 10, or 11),

   and a byte equal to 0x03 is inserted to replace these bit patterns with the patterns:

   '00000000 00000000 00000011 000000xx',

   and finally, when the last byte of the RBSP data is equal to 0x00 (which can only occur when the RBSP ends in a cabac_zero_word), a final byte equal to 0x03 is appended to the end of the data. The last zero byte of a

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000570

byte-aligned three-byte sequence 0x000000 in the RBSP (which is replaced by the four-byte sequence 0x00000300) is taken into account when searching the RBSP data for the next occurrence of byte-aligned bits with the binary patterns specified above.

2. The resulting sequence of bytes is then prefixed as follows.
   - If nal_unit_type is not equal to 14 or 20, the sequence of bytes is prefixed with the first byte of the NAL unit containing the syntax elements forbidden_zero_bit, ~~nal_ref_idcnal_ref_flag~~, and nal_unit_type, where nal_unit_type indicates the type of RBSP data structure the NAL unit contains.
   - Otherwise (nal_unit_type is equal to 14 or 20), the sequence of bytes is prefixed with the first four bytes of the NAL unit, where the first byte contains the syntax elements forbidden_zero_bit, ~~nal_ref_idcnal_ref_flag~~, and nal_unit_type and the following three bytes contain the syntax structure nal_unit_header_svc_extension( ). The syntax element nal_unit_type in the first byte indicates the presence of the syntax structure nal_unit_header_svc_extension( ) in the following three bytes and the type of RBSP data structure the NAL unit contains.

The process specified above results in the construction of the entire NAL unit.

This process can allow any SODB to be represented in a NAL unit while ensuring that

- no byte-aligned start code prefix is emulated within the NAL unit,
- no sequence of 8 zero-valued bits followed by a start code prefix, regardless of byte-alignment, is emulated within the NAL unit.

7.4.1.2 Order of NAL units and association to coded pictures, access units, and video sequences

This subclause specifies constraints on the order of NAL units in the bitstream.

Any order of NAL units in the bitstream obeying these constraints is referred to in the text as the decoding order of NAL units. Within a NAL unit, the syntax in subclauses 7.3, D.1, and E.1 specifies the decoding order of syntax elements. Decoders shall be capable of receiving NAL units and their syntax elements in decoding order.

7.4.1.2.1 Order of sequence, ~~and~~ picture and adaptation parameter set RBSPs and their activation

This subclause specifies the activation process of picture, ~~and~~ sequence and adaptation parameter sets for coded video sequences that conform to one or more of the profiles specified in Annex A that are decoded using the decoding process specified in clauses 2-9.

NOTE 1 – The sequence, ~~and~~ picture and adaptation parameter set mechanism decouples the transmission of infrequently changing information from the transmission of coded macroblock data. Sequence, ~~and~~ picture and adaptation parameter sets may, in some applications, be conveyed "out-of-band" ~~using a reliable transport mechanism~~.

An adaptation parameter set RBSP includes parameters that can be referred to by the coded slice NAL units of one or more coded pictures when at least one of sample_adaptive_offset_enabled_flag or adaptive_loop_filter_enabled_flag are equal to 1. Each adaptation parameter set RBSP is initially considered not active at the start of the operation of the decoding process. At most one adaptation parameter set RBSP is considered active at any given moment during the operation of the decoding process, and the activation of any particular adaptation parameter set RBSP results in the deactivation of the previously-active adaptation parameter set RBSP (if any).

When an adaptation parameter set RBSP (with a particular value of aps_id) is not active and it is referred to by a coded slice NAL unit (using that value of aps_id), it is activated. This adaptation parameter set RBSP is called the active adaptation parameter set RBSP until it is deactivated by the activation of another adaptation parameter set RBSP. An adaptation parameter set RBSP, with that particular value of aps_id, shall be available to the decoding process prior to its activation.

A picture parameter set RBSP includes parameters that can be referred to by the coded slice NAL units or coded slice data partition A NAL units of one or more coded pictures. Each picture parameter set RBSP is initially considered not active at the start of the operation of the decoding process. At most one picture parameter set RBSP is considered active at any given moment during the operation of the decoding process, and the activation of any particular picture parameter set RBSP results in the deactivation of the previously-active picture parameter set RBSP (if any).

When a picture parameter set RBSP (with a particular value of pic_parameter_set_id) is not active and it is referred to by a coded slice NAL unit or coded slice data partition A NAL unit (using that value of pic_parameter_set_id), it is activated. This picture parameter set RBSP is called the active picture parameter set RBSP until it is deactivated by the activation of another picture parameter set RBSP. A picture parameter set RBSP, with that particular value of pic_parameter_set_id, shall be available to the decoding process prior to its activation.

Any picture parameter set NAL unit containing the value of pic_parameter_set_id for the active picture parameter set RBSP for a coded picture shall have the same content as that of the active picture parameter set RBSP for the coded picture unless it follows the last VCL NAL unit of the coded picture and precedes the first VCL NAL unit of another coded picture.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000571

A sequence parameter set RBSP includes parameters that can be referred to by one or more picture parameter set RBSPs or one or more SEI NAL units containing a buffering period SEI message. Each sequence parameter set RBSP is initially considered not active at the start of the operation of the decoding process. At most one sequence parameter set RBSP is considered active at any given moment during the operation of the decoding process, and the activation of any particular sequence parameter set RBSP results in the deactivation of the previously-active sequence parameter set RBSP (if any).

When a sequence parameter set RBSP (with a particular value of seq_parameter_set_id) is not already active and it is referred to by activation of a picture parameter set RBSP (using that value of seq_parameter_set_id) or is referred to by an SEI NAL unit containing a buffering period SEI message (using that value of seq_parameter_set_id), it is activated. This sequence parameter set RBSP is called the active sequence parameter set RBSP until it is deactivated by the activation of another sequence parameter set RBSP. A sequence parameter set RBSP, with that particular value of seq_parameter_set_id, shall be available to the decoding process prior to its activation. An activated sequence parameter set RBSP shall remain active for the entire coded video sequence.

NOTE 2 – Because an IDR access unit begins a new coded video sequence and an activated sequence parameter set RBSP must remain active for the entire coded video sequence, a sequence parameter set RBSP can only be activated by a buffering period SEI message when the buffering period SEI message is part of an IDR access unit.

Any sequence parameter set NAL unit containing the value of seq_parameter_set_id for the active sequence parameter set RBSP for a coded video sequence shall have the same content as that of the active sequence parameter set RBSP for the coded video sequence unless it follows the last access unit of the coded video sequence and precedes the first VCL NAL unit and the first SEI NAL unit containing a buffering period SEI message (when present) of another coded video sequence.

NOTE 3 – If picture parameter set RBSP, ~~or~~ sequence parameter set RBSP or adaptation parameter set RBSP are conveyed within the bitstream, these constraints impose an order constraint on the NAL units that contain the picture parameter set RBSP or sequence parameter set RBSP, respectively. Otherwise (picture parameter set RBSP, ~~or~~ sequence parameter set RBSP or adaptation parameter set RBSP are conveyed by other means not specified in this Recommendation | International Standard), they must be available to the decoding process in a timely fashion such that these constraints are obeyed.

~~When present, a sequence parameter set extension RBSP includes parameters having a similar function to those of a sequence parameter set RBSP. For purposes of establishing constraints on the syntax elements of the sequence parameter set extension RBSP and for purposes of determining activation of a sequence parameter set extension RBSP, the sequence parameter set extension RBSP shall be considered part of the preceding sequence parameter set RBSP with the same value of seq_parameter_set_id. When a sequence parameter set RBSP is present that is not followed by a sequence parameter set extension RBSP with the same value of seq_parameter_set_id prior to the activation of the sequence parameter set RBSP, the sequence parameter set extension RBSP and its syntax elements shall be considered not present for the active sequence parameter set RBSP.~~

All constraints that are expressed on the relationship between the values of the syntax elements (and the values of variables derived from those syntax elements) in sequence parameter sets, ~~and~~ picture parameter sets and adaptation parameter sets and other syntax elements are expressions of constraints that apply only to the active sequence parameter set, ~~and~~ the active picture parameter set and the active adaptation parameter set. If any sequence parameter set RBSP is present that is not activated in the bitstream, its syntax elements shall have values that would conform to the specified constraints if it were activated by reference in an otherwise-conforming bitstream. If any picture parameter set RBSP is present that is not ever activated in the bitstream, its syntax elements shall have values that would conform to the specified constraints if it were activated by reference in an otherwise-conforming bitstream. If any adaptation parameter set RBSP is present that is not ever activated in the bitstream, its syntax elements shall have values that would conform to the specified constraints if it were activated by reference in an otherwise-conforming bitstream.

During operation of the decoding process (see clause 0), the values of parameters of the active picture parameter set and the active sequence parameter set shall be considered in effect. For interpretation of SEI messages, the values of the parameters of the picture parameter set and sequence parameter set that are active for the operation of the decoding process for the VCL NAL units of the primary coded picture in the same access unit shall be considered in effect unless otherwise specified in the SEI message semantics.

7.4.1.2.2 Order of access units and association to coded video sequences

A bitstream conforming to this Recommendation | International Standard consists of one or more coded video sequences.

A coded video sequence consists of one or more access units. For coded video sequences that conform to one or more of the profiles specified in Annex A that are decoded using the decoding process specified in clauses 2-9, the order of NAL units and coded pictures and their association to access units is described in subclause 7.4.1.2.3.

The first access unit of each coded video sequence is an IDR access unit. All subsequent access units in the coded video sequence are non-IDR access units.

The values of picture order count for the coded pictures in consecutive access units in decoding order containing non-reference pictures shall be non-decreasing.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000572

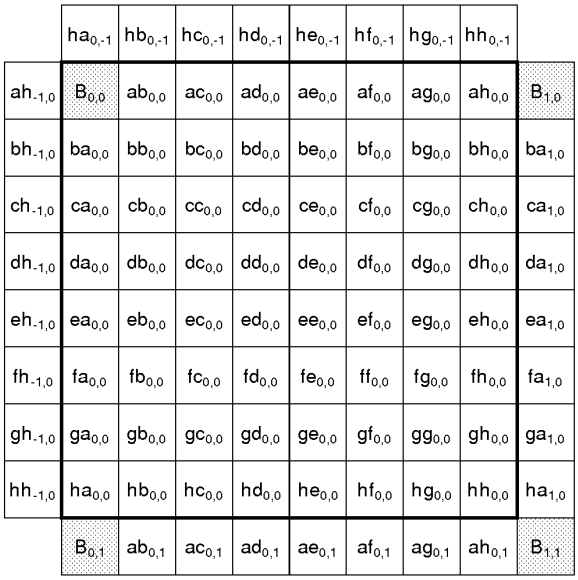


Figure 8-7 – Integer samples (shaded blocks with upper-case letters) and fractional sample positions (un-shaded blocks with lower-case letters) for eighth sample chroma interpolation

In Figure 8-5, the positions labelled with upper-case letters $B_{i,j}$ within shaded blocks represent chroma samples at full-sample locations inside the given two-dimensional array refPicLX$_C$ of chroma samples. These samples may be used for generating the predicted chroma sample value predSampleLX$_C$[x_C, y_C]. The locations ($xB_{i,j}$, $yB_{i,j}$) for each of the corresponding chroma samples $B_{i,j}$ inside the given array refPicLX$_C$ of chroma samples are derived as follows:

$$xB_{i,j} = \text{Clip3}(0, \text{PicWidthInSamples}_C - 1, \text{xInt}_C + i) \quad (8\text{-}117)$$
$$yB_{i,j} = \text{Clip3}(0, \text{PicHeightInSamples}_C - 1, \text{yInt}_C + j) \quad (8\text{-}118)$$

Variables shift1, shift2 and shift3 are derived as follows.

– The variable shift1 is set equal to BitDepth$_C$ – 8, the variable shift2 is set equal to BitDepth$_C$ – 2, and the variable shift3 is set equal to 14 – BitDepth$_C$.

Given the chroma samples $B_{i,j}$ at full-sample locations ($xB_{i,j}$, $yB_{i,j}$), the chroma samples '$ab_{0,0}$' to '$hh_{0,0}$' at fractional sample positions are derived by the following rules.

– The samples labelled $ab_{0,0}$, $ac_{0,0}$, $ad_{0,0}$, $ae_{0,0}$, $af_{0,0}$, $ag_{0,0}$, and $ah_{0,0}$ shall be derived by applying the 4-tap filter to the nearest integer position samples and clipping the filtered value:

$$ab_{0,0} = (-3*B_{-1,0} + 60*B_{0,0} + 8*B_{1,0} - B_{2,0}) >> \text{shift1} \quad (8\text{-}119)$$

$$ac_{0,0} = (-4*B_{-1,0} + 54*B_{0,0} + 16*B_{1,0} - 2*B_{2,0}) >> \text{shift1} \quad (8\text{-}120)$$

$$ad_{0,0} = (-5*B_{-1,0} + 46*B_{0,0} + 27*B_{1,0} - 4*B_{2,0}) >> \text{shift1} \quad (8\text{-}121)$$

$$ae_{0,0} = (-4*B_{-1,0} + 36*B_{0,0} + 36*B_{1,0} - 4*B_{2,0}) >> \text{shift1} \quad (8\text{-}122)$$

$$af_{0,0} = (-4*B_{-1,0} + 27*B_{0,0} + 46*B_{1,0} - 5*B_{2,0}) >> \text{shift1} \quad (8\text{-}123)$$

$$ag_{0,0} = (-2*B_{-1,0} + 16*B_{0,0} + 54*B_{1,0} - 4*B_{2,0}) >> \text{shift1} \quad (8\text{-}124)$$

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000642

$$ah_{0,0} = (-B_{-1,0} + 8*B_{0,0} + 60*B_{1,0} - 3*B_{2,0}) >> shift1 \quad (8\text{-}125)$$

– The samples labelled $ba_{0,0}$, $ca_{0,0}$, $da_{0,0}$, $ea_{0,0}$, $fa_{0,0}$, $ga_{0,0}$, and $ha_{0,0}$ shall be derived by applying the 4-tap filter to the nearest integer position samples and clipping the filtered value:

$$ba_{0,0} = (-3*B_{0,-1} + 60*B_{0,0} + 8*B_{0,1} - B_{0,2}) >> shift1 \quad (8\text{-}126)$$

$$ca_{0,0} = (-4*B_{0,-1} + 54*B_{0,0} + 16*B_{0,1} - 2*B_{0,2}) >> shift1 \quad (8\text{-}127)$$

$$da_{0,0} = (-5*B_{0,-1} + 46*B_{0,0} + 27*B_{0,1} - 4*B_{0,2}) >> shift1 \quad (8\text{-}128)$$

$$ea_{0,0} = (-4*B_{0,-1} + 36*B_{0,0} + 36*B_{0,1} - 4*B_{0,2}) >> shift1 \quad (8\text{-}129)$$

$$fa_{0,0} = (-4*B_{0,-1} + 27*B_{0,0} + 46*B_{0,1} - 5*B_{0,2}) >> shift1 \quad (8\text{-}130)$$

$$ga_{0,0} = (-2*B_{0,-1} + 16*B_{0,0} + 54*B_{0,1} - 4*B_{0,2}) >> shift1 \quad (8\text{-}131)$$

$$ha_{0,0} = (-B_{0,-1} + 8*B_{0,0} + 60*B_{0,1} - 3*B_{0,2}) >> shift1 \quad (8\text{-}132)$$

– The samples labelled $bX_{0,0}$, $cX_{0,0}$, $dX_{0,0}$, $eX_{0,0}$, $fX_{0,0}$, $gX_{0,0}$ and $hX_{0,0}$ for X being replaced by b, c, d, e, f, g and h, respectively, shall be derived by applying the 4-tap filter to the intermediate values $aX_{0,i}$ where $i = -1..2$ in vertical direction:

$$bX_{0,0} = (-3*aX_{0,-1} + 60*aX_{0,0} + 8*aX_{0,1} - aX_{0,2}) >> shift2 \quad (8\text{-}140)$$

$$cX_{0,0} = (-4*aX_{0,-1} + 54*aX_{0,0} + 16*aX_{0,1} - 2*aX_{0,2}) >> shift2 \quad (8\text{-}141)$$

$$dX_{0,0} = (-5*aX_{0,-1} + 46*aX_{0,0} + 27*aX_{0,1} - 4*aX_{0,2}) >> shift2 \quad (8\text{-}142)$$

$$eX_{0,0} = (-4*aX_{0,-1} + 36*aX_{0,0} + 36*aX_{0,1} - 4*aX_{0,2}) >> shift2 \quad (8\text{-}143)$$

$$fX_{0,0} = (-4*aX_{0,-1} + 27*aX_{0,0} + 46*aX_{0,1} - 5*aX_{0,2}) >> shift2 \quad (8\text{-}144)$$

$$gX_{0,0} = (-2*aX_{0,-1} + 16*aX_{0,0} + 54*aX_{0,1} - 4*aX_{0,2}) >> shift2 \quad (8\text{-}145)$$

$$hX_{0,0} = (-aX_{0,-1} + 8*aX_{0,0} + 60*aX_{0,1} - 3*aX_{0,2}) >> shift2 \quad (8\text{-}146)$$

The positions labelled with lower-case letters within un-shaded blocks represent chroma samples at eighth-pel sample fractional locations. The chroma location offset in fractional-sample units (xFracC, yFracC) specifies which of the generated chroma samples at full-sample and fractional-sample locations is assigned to the predicted chroma sample value $predSampleLX_C[x_C, y_C]$. This assignment is done according to Table 8-10. The value of $predSampleLX_C[x_C, y_C]$ shall be the output.

Table 8-13 – Assignment of the chroma prediction sample $predSampleLX_C[x_C, y_C]$ for (X, Y) being replaced by (1, b), (2, c), (3, d), (4, e), (5, f), (6, g), and (7, h), respectively

xFracC	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X
yFracC	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
predSampleLX$_C$[x$_C$, y$_C$]	B << shift 3	b a	c a	d a	e a	f a	g a	h a	a Y	b Y	c Y	d Y	e Y	f Y	g Y	h Y

8.4.2.2.3 Weighted sample prediction process

[Ed.: (KU) only the default weighted prediction part is added for bi-directional averaging]

Inputs to this process are:

– a location (xB, yB) specifying the top-left sample of the current prediction unit relative to the top left sample of the current coding unit,

– the width and height of this prediction unit, nPSW and nPSH,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000643

– two (nPSW)x(nPSH) arrays predSamplesL0 and predSamplesL1,

– prediction list utilization flags, predFlagL0 and predFlagL1,

– the bit-depth of the chroma component, bitDepth.

Outputs of this process are:

– the (nPSW)x(nPSH) array predSamples of prediction sample values.

Variables shift1, shift2, offset1 and offset2 are derived as follows.

– The variable shift1 is set equal to 14 – bitDepth and the variable shift2 is set equal to 15 – bitDepth,

– The variable offset1 is set equal to 1 << (shift1 – 1) and the variable offset2 is set equal to 1 << (shift2 – 1).

Depending on the value of predFlagL0 and predFlagL1, the prediction samples predSamples[x, y] with x = 0..(nPSW)-1 and y = 0..(nPSH)-1 are derived as follows.

– If predFlagL0 is equal to 1 and predFlagL1 is equal to 0,

$$predSamples[x, y] = (predSamplesL0[x, y] + offset1) >> shift1 \quad (8\text{-}147)$$

– Otherwise, if predFlagL0 is equal to 0 and predFlagL1 is equal to 1,

$$predSamples[x, y] = (predSamplesL1[x, y] + offset1) >> shift1 \quad (8\text{-}148)$$

– Otherwise (both predFlagL0 and predFlagL1 are equal to 1),

$$predSamples[x, y] = Clip3(0, (1 << bitDepth) – 1 , predSamplesL0[x, y] + predSamplesL1[x, y] + offset2) >> shift2) \quad (8\text{-}149)$$

8.4.3 Decoding process for the residual signal of coding units coded in inter prediction mode

Inputs to this process are:

– a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top-left luma sample of the current picture,

– a variable log2CUSize specifying the size of the current coding unit.

Outputs of this process are:

– a (nCS_L)x(nCS_L) array $resSamples_L$ of luma residual samples, where nCS_L is derived as specified below,

– a (nCS_C)x(nCS_C) array $resSamples_{Cb}$ of chroma residual samples for the component Cb, where nCS_C is derived as specified below,

– a (nCS_C)x(nCS_C) array $resSamples_{Cr}$ of chroma residual samples for the component Cr, where nCS_C is derived as specified below.

The variable nCS_L is set equal to 1 << log2CUSize and the variable nCS_C is set equal to (1 << log2CUSize) >> 1.

Let $resSamples_L$ be a (nCS_L)x(nCS_L) array of luma residual samples and let $resSamples_{Cb}$ and $resSamples_{Cr}$ be two (nCS_C)x(nCS_C) arrays of chroma residual samples.

Depending on no_residual_data_flag, the following applies:

– If no_residual_data_flag is equal to 1, all samples of the (nCS_L)x(nCS_L) array $resSamples_L$ and all samples of the two (nCS_C)x(nCS_C) arrays $resSamples_{Cb}$ and $resSamples_{Cr}$ are set equal to 0.

– Otherwise (no_residual_data_flag is equal to 0), the following ordered steps apply:

1. The decoding process for luma residual blocks as specified in subclause 8.4.3.1 below is invoked with the luma location (xC, yC), the luma location (xB, yB) set equal to (0, 0), the variable log2TrafoWidth set equal to log2CUSize, the variable log2TrafoHeight set equal to log2CUSize, the variable trafoDepth set equal to 0, the variable nCS set equal to nCSL, and the (nCSL)x(nCSL) array resSamplesL as the inputs and the output is a modified version of the (nCSL)x(nCSL) array resSamplesL.

2. The decoding process for chroma residual blocks as specified in subclause 8.4.3.2 below is invoked with the luma location (xC, yC), the luma location (xB, yB) set equal to (0, 0), the variable log2TrafoWidth set equal to log2CUSize, the variable log2TrafoHeight set equal to log2CUSize, the variable trafoDepth set equal to 0, the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000644

variable cIdx set equal to 1, the variable nCS set equal to nCS_C, and the (nCS_C)x(nCS_C) array $resSamples_{Cb}$ as the inputs and the output is a modified version of the (nCS_C)x(nCS_C) array $resSamples_{Cb}$.

3. The decoding process for chroma residual blocks as specified in subclause 8.4.3.2 below is invoked with the luma location (xC, yC), the luma location (xB, yB) set equal to (0, 0), the variable log2TrafoWidth set equal to log2CUSize, the variable log2TrafoHeight set equal to log2CUSize, the variable trafoDepth set equal to 0, the variable cIdx set equal to 2, the variable nCS set equal to nCS_C, and the (nCS_C)x(nCS_C) array $resSamples_{Cr}$ as the inputs and the output is a modified version of the (nCS_C)x(nCS_C) array $resSamples_{Cr}$.

8.4.3.1 Decoding process for luma residual blocks

Inputs to this process are:

- a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top-left luma sample of the current picture,
- a luma location (xB, yB) specifying the top-left luma sample of the current block relative to the top-left luma sample of the current coding unit,
- a variable log2TrafoWidth specifying the width of the current block,
- a variable log2TrafoHeight specifying the height of the current block,
- a variable trafoDepth specifying the hierarchy depth of the current block relative to the coding unit,
- a variable nCS specifying the size, in luma samples, of the current coding unit,
- a (nCS)x(nCS) array resSamples of luma residual samples.

Output of this process is:

- a modified version of the (nCS)x(nCS) array of luma residual samples.

Depending split_transform_flag[xB][yB][trafoDepth], the following applies:

- If split_transform_flag[xB][yB][trafoDepth] is equal to 1, the following ordered steps apply:
  1. The variables xB1, yB1, xB2, yB2, xB3 and yB3 are derived as follows.
     - If InterTUSplitDirection is equal to 2, the following applies.
       - The variable xB1 is set equal to xB + ((1 << log2TrafoWidth) >> 1).
       - The variable yB2 is set equal to yB + ((1 << log2TrafoHeight) >> 1).
       - The variable xB3 is set equal to xB1.
       - The variable yB3 is set equal to yB2.
       - The variable log2TrafoWidth1 is set equal to log2TrafoWidth − 1.
       - The variable log2TrafoHeight1 is set equal to log2TrafoHeight − 1.
     - Otherwise (InterTUSplitDirection is equal to 0 or 1), the following applies.
       - The variable xB1 is set equal to xB + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
       - The variable yB1 is set equal to yB + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
       - The variable xB2 is set equal to xB1 + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
       - The variable yB2 is set equal to yB1 + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
       - The variable xB3 is set equal to xB2 + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
       - The variable yB3 is set equal to yB2 + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
       - The variable log2TrafoWidth1 is set equal to (log2TrafoWidth – 2) * InterTUSplitDirection.
       - The variable log2TrafoHeight1 is set equal to (log2TrafoHeight − 2) * (1 − InterTUSplitDirection).
  2. The decoding process for luma residual blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB, yB), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000645

3. The decoding process for luma residual blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB1, yB1), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.
4. The decoding process for luma residual blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB2, yB2), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.
5. The decoding process for luma residual blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB3, yB3), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.

– Otherwise (split_transform_flag[xB][yB][trafoDepth] is equal to 0), the following ordered steps apply:

1. The variable nW is set equal to 1 << log2TrafoWidth.
2. The variable nH is set equal to 1 << log2TrafoHeight.
3. The scaling and transformation process as specified in subclause 8.5.1 is invoked with the luma location (xC + xB, yC +yB), the variable trafoDepth, the variable cIdx set equal to 0, the transform width trafoWidth set equal to nW, and the transform height trafoHeight set equal to nH as the inputs and the output is a (nW)x(nH) array resSamplesBlock.
4. The array construction process as specified in subclause 8.5.5 is invoked with the luma location (xB, yB), the variable cIdx set equal to 0, the variable inputArrayWidth set equal to nW, the variable inputArrayHeight set equal to nH, the variable outputArraySize set equal to nCS, the (nW)x(nH) array resSamplesBlock, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.

8.4.3.2 Decoding process for chroma residual blocks

Inputs to this process are:

– a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top-left luma sample of the current picture,
– a luma location (xB, yB) specifying the top-left luma sample of the current block relative to the top-left luma sample of the current coding unit,
– a variable log2TrafoWidth specifying the width of the current block,
– a variable log2TrafoHeight specifying the height of the current block,
– a variable trafoDepth specifying the hierarchy depth of the current block relative to the coding unit,
– a variable cIdx specifying the chroma component of the current block,
– a variable nCS specifying the size, in chroma samples, of the current coding unit,
– a (nCS)x(nCS) array resSamples of chroma residual samples.

Output of this process is:

– a modified version of the (nCS)x(nCS) array of chroma residual samples.

The variable splitChromaFlag is derived as follows:

– If split_transform_flag[xB][yB][trafoDepth] is equal to 1 and log2TrafoSize is greater than Log2MinTrafoSize + 1, splitChromaFlag is set equal to 1.
– Otherwise (split_transform_flag[xB][yB][trafoDepth] is equal to 0 or log2TrafoSize is equal to Log2MinTrafoSize + 1), splitChromaFlag is set equal to 0.

Depending splitChromaFlag, the following applies:

– If splitChromaFlag is equal to 1, the following ordered steps apply:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000646

1. The variables xB1, yB1, xB2, yB2, xB3 and yB3 are derived as follows.
   - If InterTUSplitDirection is equal to 2, the following applies.
     - The variable xB1 is set equal to xB + ((1 << log2TrafoWidth) >> 1).
     - The variable yB1 is set equal to yB.
     - The variable xB2 is set equal to xB.
     - The variable yB2 is set equal to yB + ((1 << log2TrafoHeight) >> 1).
     - The variable xB3 is set equal to xB1.
     - The variable yB3 is set equal to yB2.
     - The variable log2TrafoWidth1 is set equal to log2TrafoWidth − 1.
     - The variable log2TrafoHeight1 is set equal to log2TrafoHeight − 1.
   - Otherwise (InterTUSplitDirection is equal to 0 or 1), the following applies.
     - The variable xB1 is set equal to xB + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
     - The variable yB1 is set equal to yB + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
     - The variable xB2 is set equal to xB1 + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
     - The variable yB2 is set equal to yB1 + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
     - The variable xB3 is set equal to xB2 + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
     - The variable yB3 is set equal to yB2 + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
     - The variable log2TrafoWidth1 is set equal to (log2TrafoWidth − 2) * InterTUSplitDirection.
     - The variable log2TrafoHeight1 is set equal to (log2TrafoHeight − 2) * (1 − InterTUSplitDirection).
2. The decoding process for residual chroma blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB, yB), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable cIdx, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.
3. The decoding process for residual chroma blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB1, yB1), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable cIdx, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.
4. The decoding process for residual chroma blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB2, yB2), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable cIdx, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.
5. The decoding process for residual chroma blocks as specified in this subclause is invoked with the luma location (xC, yC), the luma location (xB3, yB3), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1, the variable trafoDepth set equal to trafoDepth + 1, the variable cIdx, the variable nCS, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.

- Otherwise (splitChromaFlag is equal to 0), the following ordered steps apply:
  1. The variable nW is set equal to (1 << log2TrafoWidth) >> 1.
  2. The variable nH is set equal to (1 << log2TrafoHeight) >> 1.
  3. The scaling and transformation process as specified in subclause 8.5.1 is invoked with the luma location (xC + xB, yC +yB), the variable trafoDepth, the variable cIdx, the transform width trafoWidth set equal to nW, and the transform height trafoHeight set equal to nH as the inputs and the output is a (nW)x(nH) array resSamplesBlock.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000647

4. The array construction process as specified in subclause 8.5.5 is invoked with the luma location (xB, yB), the variable cIdx, the variable inputArrayWidth set equal to nW, the variable inputArrayHeight set equal to nH, the variable outputArraySize set equal to nCS, the (nW)x(nH) array resSamplesBlock, and the (nCS)x(nCS) array resSamples as the inputs and the output is a modified version of the (nCS)x(nCS) array resSamples.

8.5 Scaling, transformation and array construction process prior to deblocking filter process

8.5.1 Scaling and transformation process

Inputs to this process are:

– a luma location (xT, yT) specifying the top-left luma sample of the current transform unit relative to the top-left luma sample of the current picture,

– a variable trafoDepth specifying the hierarchy depth of the current block relative to the coding unit,

– a variable cIdx specifying the chroma component of the current block,

– a variable nW specifying the width of the current transform block.

– a variable nH specifying the height of the current transform block.

Output of this process is:

– a modified version of the (nW)x(nH) array of residual samples r with elements r_{ij}.

The quantization parameter qP is derived as follows.

– If cIdx is equal to 0,

$$qP = QP'_Y \tag{8-150}$$

– Otherwise,

$$qP = QP'_C \tag{8-151}$$

The (nW)x(nH) array of residual samples r are derived as specified in the following ordered steps.

1. The inverse scanning process for transform coefficients as specified in subclause 8.5.2 is invoked with the width of the current transform unit nW, the height of the current transform unit nH, the list of transform coefficients transCoeffLevel[xT][yT][trafoDepth][cIdx] and the variable cIdx as the inputs and the output is a (nW)x(nH) array c_{ij}.
2. The scaling process for transform coefficients as specified in subclause 8.5.3 is invoked with the width of the transform unit nW, the height of the transform unit nH, the (nW)x(nH) array c, the chroma component variable cIdx and the quantization parameter qP as the inputs and the output is a scaled transform coefficient (nW)x(nH) array d.
3. The transformation process for scaled transform coefficients as specified in subclause 8.5.4 is invoked with the width of the transform unit nW, the height of the transform unit nH, the scaled transform coefficient (nW)x(nH) array d and the chroma component variable cIdx as the inputs and the output is a residual samples (nW)x(nH) array r.

8.5.2 Inverse scanning process for transform coefficients

Inputs to this process are:

– a variable nW specifying the width of the current transform unit,

– a variable nH specifying the height of the current transform unit.

– a list of (nW)x(nH) values transCoeffLevel[xT][yT][trafoDepth][cIdx].

– a variable cIdx specifying the chroma component of the current block.

Output of this process is a variable c containing a two-dimensional array of (nW)x(nH) values.

The variable nS is set equal to Sqrt(nW*nH).

The variable scanIdx, indicating wich scan is used to scan the transform coefficients (zigzag, horizontal or vertical), is derived as follows.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000648

– If PredMode is equal to MODE_INTRA, the following applies.
  – If cIdx is equal to 0, scanIdx is set to ScanType[Log2(nS >> 2)][IntraPredMode].
  – Otherwise (cIdx is equal to 1 or 2), scanIdx is set to ScanType[Log2(nS >> 2)][IntraPredModeC]
– Otherwise (PredMode is not equal to MODE_INTRA), scanIdx is set to 0.

When entropy_coding_mode_flag is equal to 1 (CABAC) and scanIdx is equal to 0 (zigzag), scanIdx is set to 3 (diagonal).

The variable c[i][j] which is located in the (i, j) position in the array c is derived as follows.

– The transform coefficient level at scanning position n is mapped to the position (i, j) in the array c using the scan specified by scanIdx as follows.

```
i = ScanOrder[ Log2( nS >> 2 ) ][ Log2( nS >> 2 ) ][ scanIdx ][ n ][ 0 ]
j = ScanOrder[ Log2( nS >> 2 ) ][ Log2( nS >> 2 ) ][ scanIdx ][ n ][ 1 ]
c[ i ][ j ] = transCoeffLevel[ xT ][ yT ][ trafoDepth ][ cIdx ][ n ],
  with n = 0.. ( nS * nS ) – 1                                        (8-152)
```

– When nW is not equal to nH, the coefficients in the array c are reordered as follows.
  – The array c0 is the copy of the (nS)x(nS) array c. For scanning position n, a coefficient at position (i0, j0) of c0 is mapped to the new position (i, j) of the reordered (nW)x(nH) array c using zigzag scan.

```
i0 = ScanOrder[ Log2( nS >> 2 ) ][ Log2( nS >> 2 ) ][ 0 ][ n ][ 0 ]
j0 = ScanOrder[ Log2( nS >> 2 ) ][ Log2( nS >> 2 ) ][ 0 ][ n ][ 1 ]
i = ScanOrder[ Log2( nW >> 2 ) ][ Log2( nH >> 2 ) ][ 0 ][ n ][ 0 ]
j = ScanOrder[ Log2( nW >> 2 ) ][ Log2( nH >> 2 ) ][ 0 ][ n ][ 1 ]
c[ i ][ j ] = c0[ i0 ][ j0 ]
  with n = 0…( nS * nS ) – 1                                          (8-152)
```

[Ed. (BB): Despite different scans NSQT reordering always uses zigzag scan. Needs to be reviewed and may be harmonized with the different scans.]

8.5.3 Scaling process for transform coefficients

Inputs of this process are:

– a variable nW specifying the width of the current transform unit,
– a variable nH specifying the height of the current transform unit,
– a (nW)x(nH) array c of transform coefficients with elements c_{ij},
– a variable cIdx specifying the chroma component of the current block,
– a variable qP specifying the quantization parameter.

Output of this process is scaled transform coefficients as a (nW)x(nH) array of d with elements d_{ij}.

The variable trafoPrecisionExt is derived as follows:

– If nW is greater than 4 or nH is greater than 4,
  – If cIdx is equal to 0 and bit_depth_luma_minus8 is equal to 0, trafoPrecisionExt is set equal to 2.
  – Otherwise, if cIdx is not equal to 0 and bit_depth_chroma_minus8 is equal to 0, trafoPrecisionExt is set equal to 2.
  – Otherwise, trafoPrecisionExt is set equal to 0.
– Otherwise, trafoPrecisionExt is set equal to 0.

[Ed.: (WJ) wait decision on transform precision extension]

The scaled transform coefficient array dij is derived as follows.

$$d_{ij} = (c_{ij} * \text{LevelScale}_{(nW)x(nH)}[qP\%6][i][j]) << (qP/6 + \text{trafoPrecisionExt}), \quad \text{with } i = 0..nW - 1, j = 0..nH - 1 \qquad (8\text{-}158)$$

[Ed: (WJ) $\text{LevelScale}_{(nS)x(nS)}$ should be very large table up to 32x32. Recent contributions (JCTVC-C209 and JCTVC-C255) shown that this matrix could be replaced by one constants per qP without coding efficiency penalty. Maybe it is better to wait.]

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000649

[Ed.: (WJ) dependent on transformation process – should be modified again after transformation process is fixed]

8.5.4 Transformation process for scaled transform coefficients

Inputs of this process are:

- a variable nW specifying the width of the current transform unit,
- a variable nH specifying the height of the current transform unit,
- a (nW)x(nH) array d of scaled transform coefficients with elements d_{ij}.
- a variable cIdx specifying the chroma component of the current block,

Output of this process is residual samples as a (nW)x(nH) array r with elements r_{ij}.

The variable trafoPrecisionExt is derived as follows:

- If nW is greater than 4 or nH is greater than 4,
  - If cIdx is equal to 0 and bit_depth_luma_minus8 is equal to 0, trafoPrecisionExt is set equal to 4.
  - Otherwise, if cIdx is not equal to 0 and bit_depth_chroma_minus8 is equal to 0, trafoPrecisionExt is set equal to 4.
  - Otherwise, trafoPrecisionExt is set equal to 0.
- Otherwise, trafoPrecisionExt is set equal to 0.

[Ed.: (WJ) wait decision on transform precision extension]

[Ed: (WJ) derivation of trafoPrecisionExt is duplicated to that of the scaling process. Better to remove one of two.]

Depending on PredMode and IntraPredMode, the following applies:

- If PredMode is equal to MODE_INTRA, log2(nW*nH) is equal to 4, and cIdx is equal to 0, the variables horizTrType and vertTrType are specified as Table 8-11 with IntraPredMode as input. [Ed. (WJ): DST is applied only for luma 4x4 block]
- Otherwise, the variables horizTrType and vertTrType are set equal to 0.

Table 8-14 – Specification of horizTrType and vertTrType

IntraPredMode	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
horizTrType	0	1	0	1	1	0	0	1	1	1	1	1	0	0	1	1	1	1
vertTrType	1	0	0	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0

IntraPredMode	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
horizTrType	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1
vertTrType	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1

The constructed residual samples are derived as specified in the following ordered steps.

1. The variable nS is derived as follows.
   - If nW is greater than or equal to nH, nS is set to nW.
   - Otherwise (nW is less than nH), nS is set to nH.
2. Each (horizontal) row of scaled transform coefficients d_{ij} (i=0..nW−1, j=0..nH−1) is transformed to e_{ij} (i=0..nW−1, j=0..nH−1) by invoking the one-dimensional transformation process as specified in subclause 8.5.4.1 to 8.5.4.4 according to the width of the transform unit nW, with the (nW)x(nH) array d and the transform type variable horizTrType as the inputs and the output is the (nW)x(nH) array e.
3. Each (vertical) column of the resulting matrix e_{ij} (i=0..nW−1, j=0..nH−1) is transformed to f_{ij} (i=0..nW−1, j=0..nH−1) by invoking the one-dimensional transformation process as specified in subclause 8.5.4.1 to 8.5.4.4

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000650

according to the height of the transform unit nH, with the (nW)x(nH) array e and the transform type variable vertTrType as the inputs and the output is the (nW)x(nH) array f.

4. The residual sample value r_{ij} is derived as follows.
   - If nS is equal to 4 or 8,

     $$r_{ij} = (f_{ij} + 2^{5+trafoPrecisionExt}) >> (6 + trafoPrecisionExt), \text{ with } i=0..(nW)-1, j=0..(nH)-1 \quad (8\text{-}159)$$

   - Otherwise (nS is equal to 16 or 32),

     $$r_{ij} = (f_{ij} + 2^{9+trafoPrecisionExt}) >> (10 + trafoPrecisionExt), \text{ with } i=0..(nW)-1, j=0..(nH)-1 \quad (8\text{-}160)$$

[Ed.: (WJ) dependent on transformation process – should be modified again after transformation process is fixed]

[Ed.: (BB) if modified, the condition on nS for NSQT should be checked]

8.5.4.1 Transformation process for 4 samples

Inputs of this process are an array of 4 samples of the scaled transform coefficients x with elements x_i, with i = 0..3 and the transform type variable trType.

Output of this process is an array of 4 samples of the residual samples y with elements y_i, with i = 0..3.

Depending on trType, the following applies:

– If tyType is equal to 1, the following ordered steps apply:

1. A set of intermediate values c_0, c_1, c_2 and c_3 is calculated as follows:

   $$c_0 = x_0 + x_2 \quad (8\text{-}159)$$
   $$c_1 = x_2 + x_3 \quad (8\text{-}159)$$
   $$c_2 = x_0 - x_3 \quad (8\text{-}159)$$
   $$c_3 = 74 * x_1 \quad (8\text{-}159)$$

2. The output values y_i with i = 0..3 are then specified as follows:

   $$y_0 = (29*c_0 + 55*c_1 + c_3 + 64) >> 7 \quad (8\text{-}159)$$
   $$y_1 = (55*c_2 - 29*c_1 + c_3 + 64) >> 7 \quad (8\text{-}159)$$
   $$y_2 = (74*(x_0 - x_2 + x_3) + 64) >> 7 \quad (8\text{-}159)$$
   $$y_3 = (55*c_0 + 29 * c_2 - c_3 + 64) >> 7 \quad (8\text{-}159)$$

   [Ed. (WJ): proponent's comment - to share the quantization scaling value, transform precision (7-bit in this case) should be synchronized with DCT]

– Otherwise, the following ordered steps apply: [Ed. (WJ): TBD – 4-point DCT]

8.5.4.2 Transformation process for 8 samples

Inputs of this process are an array of 8 samples of the scaled transform coefficients x with elements x_i, with i = 0..7 and the transform type variable trType.

Output of this process is an array of 8 samples of the residual samples y with elements y_i, with i = 0..7.

[Ed: (WJ) TBD]

8.5.4.3 Transformation process for 16 samples

Inputs of this process are an array of 16 samples of the scaled transform coefficients x with elements x_i, with i = 0..15 and the transform type variable trType.

Output of this process is an array of 16 samples of the residual samples y with elements y_i, with i = 0..15.

[Ed: (WJ) TBD]

8.5.4.4 Transformation process for 32 samples

Inputs of this process are an array of 32 samples of the scaled transform coefficients x with elements x_i, with i=0..31 and the transform type variable trType.

Output of this process is an array of 32 samples of the residual samples y with elements y_i, with i=0..31.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000651

[Ed: (WJ) TBD]

8.5.5 Array construction process

Inputs of this process are:

- a luma location (xB, yB) specifying the top-left luma sample of the current block relative to the top-left luma sample of the current coding unit,
- a variable cIdx specifying the chroma component of the current block,
- a variable nW specifying the width of the current block,
- a variable nH specifying the height of the current block,
- a variable nCS specifying the size of the current coding unit,
- a (nW)x(nH) array resSampleBlock specifying the current block samples,
- a (nCS)x(nCS) array resSample specifying the samples of the current coding unit.

Output of this process is a modified (nCS)x(nCS) array resSample specifying the samples of the current coding unit.

The modified array resSample is derived as follows.

resSample[xB+i, yB+j] += resSampleBlock[i, j], with i = 0..nW − 1, j = 0..nH − 1 (8-427)

8.6 In-loop filter process

[Ed: (WJ) overall process description need to be inserted]

8.6.1 Deblocking filter process

A conditional filtering process shall be performed on a treeblock basis after the completion of the picture construction process prior to deblocking filter process for the entire decoded picture (as specified in subclauses XXX and YYY) [Ed.: (WJ) those subclauses seem not defined yet], with all treeblocks in a picture processed in order of increasing treeblock addresses.

Each treeblock is processed on a coding unit basis with the same order as decoding process. For each coding unit, vertical edges are filtered first, starting with the edge on the left-hand side of the coding unit proceeding through the edges towards the right-hand side of the coding unit in their geometrical order. Then, the horizontal edges are filtered starting with the edge on the top of the coding unit proceeding through the edges towards the bottom of the coding unit in their geometrical order.

Sample values above of the current coding unit that may have already been modified by the filtering of horizontal edges of deblocking filter process operation on previous coding unit shall be used as inputs to the deblocking filter process on the current coding unit and may be further modified during the filtering of the current coding unit. Sample values to the left of the current coding unit shall be used as inputs to the deblocking filter process on the current coding unit and may be further modified during the filtering of the current coding unit. Sample values to the left of the current coding unit may be modified by the filtering of vertical edge and may be further modified by the filtering of horizontal edges.

Sample values modified during filtering of vertical edges are used as input for the filtering of the horizontal edges. For sample values modified by both filtering of horizontal edges and filtering of vertical edges, filtering of horizontal edges is applied after filtering of vertical edges.

The deblocking filter process shall be applied to all prediction unit edges and transform unit edges of a picture, except edges at the boundary of the picture, any edges for which the deblocking filter process is disabled by disable_deblocking_filter_slice_flag and any edges coinside with slice boundaries when loop_filter_across_slice_flag is equal to 0. For the transform units and prediction units with edges smaller than 8 samples in either vertical or horizontal direction, only the edges lying on the 8x8 sample grid are filtered.

When disable_deblocking_filter_slice_flag is not equal to 1, the deblocking filter process is invoked as the following ordered steps for each coding unit with the same order as decoding process.

1. The coding unit size nS is set equal to 1 << log2CUSize.
2. The variables FilterInternalEdgesFlag, FilterLeftCuEdgeFlag and FilterTopCuEdgeFlag are derived as follows.
   - The variable FilterInternalEdges is set equal to 1.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000652

- If the left boundary of current coding unit is the left boundary of the picture or if the left boundary of current coding unit is the left boundary of the slice and loop_filter_across_slice_flag is equal to 0, the variable FilterLeftCuEdgeFlag is set equal to 0, otherwise set equal to 1.
- If the top boundary of current coding unit is the top boundary of the picture or if the top boundary of current coding unit is the top boundary of the slice and loop_filter_across_slice_flag is equal to 0, the variable FilterTopCuEdgeFlag is set equal to 0, otherwise set equal to 1.

3. All elements of two-dimensional array of size (nS)x(nS), horEdgeFlags and verEdgeFlags are initialized to zero.
4. The derivation process of transform unit boundary specified in subclause 8.6.1.1 are invoked with the luma location (xB, yB) set equal to (0, 0), the transform unit width log2TrafoWidth set equal to log2CUSize, the transform unit height log2TrafoHeight set equal to log2CUSize and the variable trafoDepth set equal to 0 as the inputs and the modified horEdgeFlags and verEdgeFlags as outputs.
5. The derivation process of prediction unit boundary specified in subclause 8.6.1.2 are invoked with the coding unit size log2CUSize and the prediction partition mode PartMode as inputs, and the modified horEdgeFlags and verEdgeFlags as outputs.
6. The derivation process of the boundary filtering strength specified in subclause 8.6.1.3 is invoked with the luma location (xC, yC), the coding unit size log2CUSize, horEdgeFlags and verEdgeFlags as inputs and an array of size (2)x(nS)x(nS), bS as output.
7. The filtering process for coding unit specified in subclause 8.6.1.4 are invoked with the luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture, the coding unit size log2CUSize and the array bS as inputs and the modified reconstructued picture as output.

8.6.1.1 Derivation process of transform unit boundary

Inputs of this process are:

- a luma location (xB, yB) specifying the top-left luma sample of the current block relative to the top-left luma sample of the current coding unit,
- a variable log2TrafoWidth specifying the width of the current block,
- a variable log2TrafoHeight specifying the height of the current block,
- a variable trafoDepth.

Outputs of this process are:

- two-dimensional arrays of (nS)x(nS), horEdgeFlags and verEdgeFlags.

Depending on split_transform_flag[xB][yB][trafoDepth], the following applies:

- If split_transform_flag[xB][yB][trafoDepth] is equal to 1, the following ordered steps apply:
  1. The variables xB1, yB1, xB2, yB2, xB3 and yB3 are derived as follows.
     - If InterTUSplitDirection is equal to 2, the following applies.
       - The variable xB1 is set equal to xB + ((1 << log2TrafoWidth) >> 1).
       - The variable yB1 is set equal to yB.
       - The variable xB2 is set equal to xB.
       - The variable yB1 is set equal to yB + ((1 << log2TrafoHeight) >> 1).
       - The variable xB3 is set equal to xB1.
       - The variable yB3 is set equal to yB2.
       - The variable log2TrafoWidth1 is set equal to log2TrafoWidth – 1.
       - The variable log2TrafoHeight1 is set equal to log2TrafoHeight – 1.
     - Otherwise (InterTUSplitDirection is equal to 0 or 1), the following applies.
       - The variable xB1 is set equal to xB + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
       - The variable yB1 is set equal to yB + ((1 << (log2TrafoHeight)) >> 2) * (1 – InterTUSplitDirection).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000653

- The variable xB2 is set equal to xB1 + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
- The variable yB2 is set equal to yB1 + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
- The variable xB3 is set equal to xB2 + ((1 << (log2TrafoWidth)) >> 2) * InterTUSplitDirection.
- The variable yB3 is set equal to yB2 + ((1 << (log2TrafoHeight)) >> 2) * (1 − InterTUSplitDirection).
- The variable log2TrafoWidth1 is set equal to (log2TrafoWidth − 2) * InterTUSplitDirection.
- The variable log2TrafoHeight1 is set equal to (log2TrafoHeight − 2) * (1 − InterTUSplitDirection).

2. The deriviation process of transform unit boundary as specified in this subclause is invoked with the luma location (xB, yB), the variable log2TrafoWidth set equal to log2TrafoWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1 and the variable trafoDepth1 set equal to trafoDepth + 1 as inputs and the outputs are the modified versions of two arrays, horEdgeFlags and verEdgeFlags.
3. The deriviation process of transform unit boundary as specified in this subclause is invoked with the luma location (xB1, yB1), the variable log2TrafoWidth set equal to log2TrafoSizeWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1 and the variable trafoDepth1 set equal to trafoDepth + 1 as inputs and the outputs are the modified versions of two arrays, horEdgeFlags and verEdgeFlags.
4. The deriviation process of transform unit boundary as specified in this subclause is invoked with the luma location (xB2, yB2), the variable log2TrafoWidth set equal to log2TrafoSizeWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1 and the variable trafoDepth1 set equal to trafoDepth + 1 as inputs and the outputs are the modified versions of two arrays, horEdgeFlags and verEdgeFlags.
5. The deriviation process of transform unit boundary as specified in this subclause is invoked with the luma location (xB3, yB3), the variable log2TrafoWidth1 set equal to log2TrafoSizeWidth1, the variable log2TrafoHeight set equal to log2TrafoHeight1 and the variable trafoDepth1 set equal to trafoDepth + 1 as inputs and the outputs are the modified versions of two arrays, horEdgeFlags and verEdgeFlags.

– Otherwise (split_transform_flag[xB][yB][trafoDepth] is equal to 0), the following applies:
  - If yB is equal to zero, horEdgeFlags[xB + k][yB] is set equal to FilterTopCuEdgeFlag, otherwise horEdgeFlags[xB + k][yB] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2TrafoWidth) − 1.
  - If xB is equal to zero, verEdgeFlags[xB][yB + k] is set equal to FilterLeftCuEdgeFlag, otherwise verEdgeFlags[xB][yB + k] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2TrafoHeight) − 1.

8.6.1.2 Derivation process of prediction unit boundary

Inputs of this process are:

- a variable log2CUSize specifying the coding unit size,
- a prediction partition mode PartMode.

Outputs of this process are:

- two-dimensional arrays of (nS)x(nS), horEdgeFlags and verEdgeFlags.

Depending on PartMode, the following applies:

- If PartMode is equal to PART_2NxN or PART_NxN, horEdgeFlags[k][1 << (log2CUSize − 1)] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2CUSize) − 1.
- If PartMode is equal to PART_Nx2N or PART_NxN, verEdgeFlags[1 << (log2CUSize − 1)][k] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2CUSize) − 1.
- If PartMode is equal to PART_2NxnU, horEdgeFlags[k][(1 << (log2CUSize − 1)) − (1 << (log2CUSize − 2))] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2CUSize) − 1.
- If PartMode is equal to PART_2NxnD, horEdgeFlags[k][(1 << (log2CUSize − 1)) + (1 << (log2CUSize − 2))] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2CUSize) − 1.
- If PartMode is equal to PART_nLx2N, verEdgeFlags[(1 << (log2CUSize − 1)) − (1 << (log2CUSize − 2))][k] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2CUSize) − 1.
- If PartMode is equal to PART_nRx2N, verEdgeFlags[(1 << (log2CUSize − 1)) + (1 << (log2CUSize − 2))][k] is set equal to FilterInternalEdgesFlag for k = 0.. (1 << log2CUSize) − 1.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000654

8.6.1.3 Derivation process of boundary filtering strength

Inputs of this process are:

- a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top-left luma sample of the current picture,
- a variable log2CUSize specifying the size of the current coding unit,
- a two-dimensional arrays of size (nS)x(nS), horEdgeFlags and verEdgeFlags.

Output of this process is an array of size (2)x(nS)x(nS), bS specifying the boundary filtering strength.

Let (xE_k, yE_j) with k = 0..nE-1 and j = 0..nE-1 specify a set of edge sample locations where nE is set equal to ((1 << log2CUSize) >> 2), $xE_0 = 0$, $yE_0 = 0$, $xE_{k+1} = xE_k + 4$ and $yE_{j+1} = yE_j + 4$.

For (xE_k, yE_j) with k = 0..nE-1 and j = 0..nE-1, the following applies.

- If horEdgeFlags[xE_k][yE_j] is equal to 1,
  - Set sample p_0 = recPicture[xC + xE_k][yC + yE_j – 1] and q_0 = recPicture[xC + xE_k][yC + yE_j].
  - The variable filterDir is set equal to 1.
- Otherwise, if verEdgeFlags[xE_k][yE_j] is equal to 1,
  - Set sample p_0 = recPicture[xC + xE_k – 1][yC + yE_j] and q_0 = recPicture[xC + xE_k][yC + yE_j].
  - The variable filterDir is set equal to 0.
- Depending on the value of filterDir, the variable bS[filterDir][xE_k][yE_j] is derived as follows.
  - If the block edge is also a coding unit edge and the following condition is true, the variable bS[0][xE_k][yE_j] is set equal to 4.
    - The sample p_0 or q_0 is in a coding unit coded with intra prediction mode
  - Otherwise, if the following condition is true, the variable bS[filterDir][xE_k][yE_j] is set equal to 3.
    - The sample p_0 or q_0 is in a coding unit coded with intra prediction mode
  - Otherwise, if the block edge is also a transform unit edge and the following condition is true, the variable bS[filterDir][xE_k][yE_j] is set equal to 2.
    - The sample p_0 or q_0 is in a transform unit which contains non-zero transform coefficient level.
  - Otherwise, if any of the following conditions are true, the variable bS[filterDir][xE_k][yE_j] is set equal to 1.
    - The prediction unit containing sample p_0 has different reference pictures or a different number of motion vectors with the prediction unit containing the sample q_0.

      NOTE – The determination of whether the reference pictures used for the two prediction are the same or different is based on which pictures are referenced, without regard to whether a prediction is formed using an index into list 0 or an index into list 1, and also without regard to whether or not the index position within a reference picture list is different or not.
    - One motion vector is used to predict the prediction unit containing sample p_0, one motion vector is used to predict the prediction unit containing sample q_0, and the absolute difference between the horizontal or vertical component of the motion vector used is greater than or equal to 4 in units of quarter luma samples.
    - [Ed.: (WJ) needs to be checked again whether this condition covers all 2-motion cases] Two motion vectors are used to predict the prediction unit containing sample p_0, two motion vectors are used to predict the prediction unit containing sample q_0, and at least one of the motion vector pairs corresponding the same reference pictures and the different boundary samples p_0 and q_0 satisfies the following condition:

      1. The absolute difference between the horizontal or vertical component of a motion vector used in the prediction of the two prediction units is greater than or equal to 4 in units of quarter luma samples.
  - Otherwise, the variable bS[filterDir][xE_k][yE_j] is set equal to 0.

8.6.1.4 Filtering process for coding unit

Inputs of this process are:

- a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000655

– a variable log2CUSize specifying the coding unit size,

– an array bS specifying the boundary filtering strength.

Output of this process is:

– modified reconstruction of the picture.

The filtering process for luma edges in the current coding unit consists of the following ordered steps:

1. The variable nD is set equal to 1 << (log2CUSize – 3).
2. All elements of the three-dimensional array of size (2)x(nD)x(nD), dEdge are initialized to zero.
3. All elements of the three-dimensional array of size (2)x(nD)x(1<<log2CUSize), dSample are initialized to zero.
4. All elements of the three-dimensional array of size (2)x(nD)x(nD), bStrength ae initialized to zero.
5. For xD_k set equal to xC+(k << 3), k=0..nD – 1, the following applies:
   – For yD_m set equal to yC+(m << 3), m=0..nD – 1, the following ordered steps apply:
     a. Boundary filtering strength bSVer is derived as follows:

        $$bSVer = Max(bS[0][xD_k][yD_m + i]) \text{ for } i = 0..7 \quad (8\text{-}428)$$

     b. bStrength[1][k][m] is set equal to bSVer.
     c. Decision process for luma block edge in subclause 8.6.1.4.1 is invoked with the luma location of the coding unit (xC, yC), the luma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 1, and the boundary filtering strength bSVer as inputs and the decision dEdge[1][k][m] and an array dS of size (8) as outputs.
     d. dSample[1][k][(m<<3)+i] is set equal to dS[i] for i=0..7.
     e. Boundary filtering strength bSHor is derived as follows:

        $$bSHor = Max(bS[1][xD_k + i][yD_m]) \text{ for } i = 0..7 \quad (8\text{-}428)$$

     f. bStrength[0][k][m] is set equal to bSHor.
     g. Decision process for luma block edge in subclause 8.6.1.4.1 is invoked with the luma location of the coding unit (xC, yC), the luma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 0, the boundary filtering strength bSHor as inputs, the decision dEdge[0][k][m] and an array dS of size (8) as outputs.
     h. dSample[0][m][(k<<3)+i] is set equal to dS[i] for i=0..7.
6. For xD_k set equal to xC+(k << 3), k=0..nD - 1, the following applies:
   – For yD_m set equal to yB+(m << 3), m=0..nD – 1, the following ordered steps apply:
     a. dS[i] is set equal to dSample[1][k][(m<<3)+i] for i=0..7.
     b. Filtering process for luma block edge in subclause 8.6.1.4.2 is invoked with the luma location of the coding unit (xC, yC), the luma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 1, the boundary filtering strength bStrength[1][k][m], the decision dEdge[1][k][m], and the array of size (8), dS as inputs and the modified luma picture buffer as outputs.
7. For yD_m set equal to yC+(m << 3), m=0..nD - 1, the following applies:
   – For xD_k set equal to xC+(k << 3), k=0..nD – 1, the following ordered steps apply:
     a. If xD_k is equal to 0, the parameter xPOS is set equal to 1. If xD_k is equal to xB+(nD – 1) << 3) xPOS is set equal to 2. Otherwise xPOS is set to 0.
     b. dS[i] is set equal to dSample[0][m][(k << 3) + i] for i = 0..7.
     c. Filtering process for luma block edge in subclause 8.6.1.4.2 is invoked with the luma location of the coding unit (xC, yC), the luma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 0, the boundary filtering strength bStrength[0][k][m], the decision dEdge[0][k][m], and the array of size (8), dS, xPOS, dS_L[m][], dE_L[m], bS_L[m], and tc_L[m], as inputs and the modified luma picture buffer as output.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000656

- The elements of the two dimensional array of size (3)x(nD), dS_L are set as follows. $dS_L[m][0]$, $dS_L[m][1]$, and $dS_L[m][2]$, are set equal to dS[5], dS[6] and dS[7].
- The elements of the array of size (nD), dE_L are set as follows. $dE_L[m]$ is set equal to dEdge[0][k][m].
- The elements of the array of size (nD), bS_L are set as follows. $bS_L[m]$ is set equal to bStrength[0][k][m].
- The elements of the array of size (nD), t_C are set as follows. $t_{CL}[m]$ is set equal to t_c.

The filtering process for chroma edges in the current coding unit consists of the following ordered steps:

1. The variable nD is set equal to 1 << (Max(log2CUSize, 4) – 4).
2. For xD_k set equal to (xC / 2)+(k << 3), k=0..nD – 1, the following applies:
   - For yD_m set equal to (yC / 2)+(m << 2), m=0..nD*2 – 1, the following ordered steps apply:
     a. Boundary filtering strength bSVer is derived as follows:

        $$bSVer = bS[\ 0\ ][\ xD_k*2\ ][\ yD_m*2\ ] \quad (8\text{-}430)$$

     b. Filtering process for chroma block edge in subclause 8.6.1.4.3 is invoked with the chroma location of the coding unit (xC/2, yC/2), the chroma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 1, a chroma component index cIdx set equal to 1 and the boundary filtering strength bSVer as inputs and the modified chroma picture buffer as output.

     c. Filtering process for chroma block edge in subclause 8.6.1.4.3 is invoked with the chroma location of the coding unit (xC/2, yC/2), the chroma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 1, a chroma component index cIdx set equal to 2 and the boundary filtering strength bSVer as inputs and the modified chroma picture buffer as output.
3. For yD_m set equal to (yC / 2)+(m << 3), m=0..nD – 1, the following applies:
   - For xD_k set equal to (xC / 2)+(k << 2), k=0..nD*2 – 1, the following ordered steps apply:
     a. If xD_k is equal to 0, the parameter xPOS is set equal to 1. If xD_k is equal to xB+((nD*2 – 1) << 2) xPOS is set equal to 2. Otherwise xPOS is set to 0.

     b. Boundary filtering strength bSHor is derived as follows:

        $$bSHor = bS[\ 1\ ][\ xD_k*2\ ][\ yD_m*2\ ] \quad (8\text{-}431)$$

     c. Filtering process for chroma block edge in subclause 8.6.1.4.3 is invoked with the chroma location of the coding unit (xC/2, yC/2), the chroma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 0, a chroma component index cIdx set equal to 1 and the boundary filtering strength bSHor, xPOS, $bS_L[m]$ and $t_{CL}[m]$ as inputs and the modified chroma picture buffer as output.

     d. Filtering process for chroma block edge in subclause 8.6.1.4.3 is invoked with the chroma location of the coding unit (xC/2, yC/2), the chroma location of the block (xD_k, yD_m), a variable verticalEdgeFlag set equal to 0, a chroma component index cIdx set equal to 2 and the boundary filtering strength bSHor, xPOS, $bS_L[m]$ and $t_{CL}[m]$ as inputs and the modified chroma picture buffer as output.

8.6.1.4.1 Decision process for luma block edge

Inputs of this process are:

- a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,
- a luma location (xB, yB) specifying the top-left luma sample of the current block relative to the top left luma sample of the current coding unit,
- a variable verticalEdgeFlag,
- a variable bS specifying the boundary filtering strength,

Output of this process is:

- variables dE, dEp1 and dEq1 containing decisions,
- one-dimensional array of size (8), dS containing decisions.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000657

Let s' represent the luma sample array $recPicture_L$ of the current picture.

A variables β is specified as Table 8-13 with luma quantization parameter qP_L as input.

A variable t_C is specified as follows:

– If bS is greater than 2, the variable t_C is specified specified as Table 8-13 with luma quantization parameter Clip3(0, 55, qP_L + 2) as input,

– Otherwise (bS is equal or less than 2), the variable t_C is specified specified as Table 8-13 with luma quantization parameter qP_L as input.

Depending on verticalEdgeFlag, the following applies:

– If verticalEdgeFlag is equal to 1, the following ordered steps apply:

1. The sample values $p_{i,k}$ and $q_{i,k}$ with i = 0..3 and k = 2,5 are derived as follows:

$$q_{i,k} = s'[\ xC + xB + i,\ yC + yB + k\ ] \quad (8\text{-}447)$$

$$p_{i,k} = s'[\ xC + xB - i - 1,\ yC + yB + k\ ] \quad (8\text{-}448)$$

2. The variables dp, dq and d are derived as follows:

$$dp = |\ p_{2,2} - 2*p_{1,2} + p_{0,2}\ | + |\ p_{2,5} - 2*p_{1,5} + p_{0,5}\ | \quad (8\text{-}449)$$

$$dq = |\ q_{2,2} - 2*q_{1,2} + q_{0,2}\ | + |\ q_{2,5} - 2*q_{1,5} + q_{0,5}\ | \quad (8\text{-}449)$$

$$d = dp + dq \quad (8\text{-}449)$$

3. The variables dE, dEp1 and dEq1 are set equal to 0.
4. If bS is not equal to 0 and d is less than β, the following ordered steps apply:
   a. for each sample location (xC + xB, yC + yB + k), k = 0..7, the following ordered steps apply:
      a. The decision process for a luma sample specified in subclause 8.6.1.4.4 is invoked with sample values $p_{i,k}$, $q_{i,k}$ with i = 0..3, the boundary filtering strength bS and the variables d, β and t_C as inputs and a decision dSam as output.
      b. The variable dS[k] is set equal to dSam
   b. The variable dE is set equal to 1.
   c. If dp is less than (β + (β >> 1)) >> 3, the variable dEp1 is set equal to 1.
   d. If dq is less than (β + (β >> 1)) >> 3, the variable dEq1 is set equal to 1.

– Otherwise (verticalEdgeFlag is equal to 0), the following ordered steps apply:

1. The sample values $p_{i,k}$ and $q_{i,k}$ with i = 0..3 and k = 2,5 are derived as follows:

$$q_{i,k} = s'[\ xC + xB + k,\ yC + yB + i\ ] \quad (8\text{-}435)$$

$$p_{i,k} = s'[\ xC + xB + k,\ yC + yB - i - 1\ ] \quad (8\text{-}436)$$

2. The variables dp, dq and d are derived as follows:

$$dp = |\ p_{2,2} - 2*p_{1,2} + p_{0,2}\ | + |\ p_{2,5} - 2*p_{1,5} + p_{0,5}\ | \quad (8\text{-}437)$$

$$dq = |\ q_{2,2} - 2*q_{1,2} + q_{0,2}\ | + |\ q_{2,5} - 2*q_{1,5} + q_{0,5}\ | \quad (8\text{-}437)$$

$$d = dp + dq \quad (8\text{-}437)$$

3. The variables dE, dEp1 and dEq1 are set equal to 0.
4. If bS is not equal to 0 and d is less than β, the following ordered steps apply:
   a. For each sample location (xC + xB + k, yC + yB), k = 0..7, the following ordered steps apply:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000658

a. The decision process for a luma sample specified in subclause 8.6.1.4.4 is invoked with sample values $p_{i,k}$, $q_{i,k}$ with i = 0..3, the boundary filtering strength bS and the variables d, β and t_C as inputs and a decision dSam as output.

b. The variable dS[k] is set equal to dSam.

b. The variable dE is set equal to 1.

c. If dp is less than (β + (β >> 1)) >> 3, the variable dEp1 is set equal to 1.

d. If dq is less than (β + (β >> 1)) >> 3, the variable dEq1 is set equal to 1.

8.6.1.4.2 Filtering process for luma block edge

Inputs of this process are:

– a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,

– a luma location (xB, yB) specifying the top-left luma sample of the current block relative to the top left luma sample of the current coding unit,

– a variable verticalEdgeFlag,

– a variable bS specifying the boundary filtering strength,

– variables dE, dEp1 and dEq1 containing decisions,

– one-dimensional array of size (8), dS containing decisions,

– a variable bS_L,

– a variable t_{CL},

Output of this process is:

– modified reconstruction of the picture.

Let s' represent the luma sample array $recPicture_L$ of the current picture.

Depending on pcm_flag, a variable β is specified as follows:

– If pcm_flag is equal to 1, the variables β is specified as Table 8-11 with luma quantization parameter 0 as input.

– Otherwise, the variables β is specified as Table 8-11 with luma quantization parameter qP_L as input.

A variable t_C is specified as follows:

– If bS is greater than 2, the variable t_C is specified as Table 8-11 with luma quantization parameter Clip3(0, 55, qP_L + 2) as input,

– Otherwise (bS is equal or less than 2), the variable t_C is specified as Table 8-11 with luma quantization parameter qP_L as input.

Depending on verticalEdgeFlag, the following applies:

– If verticalEdgeFlag is equal to 1, the following ordered steps apply:

1. The sample values $p_{i,k}$ and $q_{i,k}$ with i = 0..3 and k = 0..7 are derived as follows:

$$q_{i,k} = s'[\ xC + xB + i,\ yC + yB + k\ ] \quad (8\text{-}432)$$

$$p_{i,k} = s'[\ xC + xB - i - 1,\ yC + yB + k\ ] \quad (8\text{-}433)$$

2. If dE is not equal to 0, for each sample location (xC + xB, yC + yB + k), k = 0..7, the following ordered steps apply:

a. The filtering process for a luma sample specified in subclause 8.6.1.4.5 is invoked with sample values $p_{i,k}$, $q_{i,k}$ with i = 0..3, the decision dS[k], variables dEp1 and dEq1, the boundary filtering strength bS and the variable t_C as inputs and the number of filtered samples nDp and nDq from each side of the block boundary, and the filtered sample values p_i' and q_j' as outputs.

b. The filtered sample values p_i' and q_j' with i = 0..nDp – 1, j = 0..nDq – 1 replace the corresponding samples inside the sample array s' as follows:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000659

$$s'[\ xC + xB + j, yC + yB + k\ ] = q_j' \quad (8\text{-}435)$$

$$s'[\ xC + xB - i - 1, yC + yB + k\ ] = p_i' \quad (8\text{-}436)$$

– Otherwise (verticalEdgeFlag is equal to 0), the following ordered steps apply:

1. If xPOS is equal to 1, the parameters k_s and k_e are set to -3 and 4 respectively. If xD is equal to 2, the parameters k_s and k_e are set to 0 and 4 respectively. Otherwise k_s and k_e are set to 0 and 7 respectively.
2. The sample values $p_{i,k}$ and $q_{i,k}$ with i = 0..3 and k = k_s..k_e are derived as follows:

$$q_{i,k} = s'[\ xC + xB + k, yC + yB + i\ ] \quad (8\text{-}437)$$

$$p_{i,k} = s'[\ xC + xB + k, yC + yB - i - 1\ ] \quad (8\text{-}438)$$

3. If xPOS is less than 0 and dE_L is not equal to 0, for each sample location (xC + xB + k, yC + yB), k = -3..-1, the following ordered steps apply:
   a. The filtering process for a luma sample specified in subclause 8.6.1.4.5 is invoked with sample values $p_{i,k}$, $q_{i,k}$ with i = 0..3, decision dS_L[k+3], variables dEp1 and dEq1, the boundary filtering strength bS_L and the variable t_{CL} as inputs and the number of filtered samples nDp and nDq from each side of the block boundary and the filtered sample values p_i' and q_j' as outputs.
   b. The filtered sample values p_i' and q_j' with i = 0..nDp – 1, j = 0..nDq – 1 replace the corresponding samples inside the sample array s' as follows:

$$s'[\ xC + xB + k, yC + yB + j\ ] = q_j' \quad (8\text{-}459)$$

$$s'[\ xC + xB + k, yC + yB - i - 1\ ] = p_i' \quad (8\text{-}460)$$

5. If dE is not equal to 0, for each sample location (xC + xB + k, yC + yB), k = 0.. k_e , the following ordered steps apply:
   a. The filtering process for a luma sample specified in subclause 8.6.1.4.5 is invoked with sample values $p_{i,k}$, $q_{i,k}$ with i = 0..3, decision dS[k], variables dEp1 and dEq1, the boundary filtering strength bS and the variable t_C as inputs and the number of filtered samples nDp and nDq from each side of the block boundary and the filtered sample values p_i' and q_j' as outputs.
   b. The filtered sample values p_i' and q_j' with i = 0..nDp – 1, j = 0..nDq – 1 replace the corresponding samples inside the sample array s' as follows:

$$s'[\ xC + xB + k, yC + yB + j\ ] = q_j' \quad (8\text{-}461)$$

$$s'[\ xC + xB + k, yC + yB - i - 1\ ] = p_i' \quad (8\text{-}462)$$

8.6.1.4.3 Filtering process for chroma block edge

[Ed.: (WJ) cIdx cannot be 0 here]

Inputs of this process are:

– a luma location (xC, yC) specifying the top-left chroma sample of the current coding unit relative to the top left chroma sample of the current picture,
– a luma location (xB, yB) specifying the top-left chroma sample of the current block relative to the top left chroma sample of the current coding unit,
– a variable verticalEdgeFlag,
– a variable bS specifying the boundary filtering strength,
– a variable cIdx specifying the chroma component index.
– a variable xPOS,
– a variable bS_L,
– a variable t_{CL}

Output of this process is:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000660

– modified reconstruction of the picture.

Let s' be a variable specifying chroma sample array which is derived as follows.

– If cIdx is equal to 1, s' represents the chroma sample array $recPicture_{Cb}$ of the current picture.

– Otherwise (cIdx is equal to 2), s' represents the chroma sample array $recPicture_{Cr}$ of the current picture.

A variable t_C is specified as follows:

– If bS is greater than 2, the variable t_C is specified as Table 8-13 with luma quantization parameter Clip3(0, 55, qP_L + 2) as input,

– Otherwise (bS is equal or less than 2), the variable t_C is specified as Table 8-13 with luma quantization parameter qP_L as input.

Depending on verticalEdgeFlag, the following applies:

– If verticalEdgeFlag is equal to 1, for each sample location (xC + xB, yC + yB + k), k = 0..3, the following ordered steps apply:

1. The sample values p_i and q_i with i = 0..1 are derived as follows:

$$q_i = s'[\ xC + xB + i,\ yC + yB + k\ ] \quad (8\text{-}442)$$

$$p_i = s'[\ xC + xB - i - 1,\ yC + yB + k\ ] \quad (8\text{-}443)$$

2. If bS is greater than 2, the following ordered steps apply:

   a. The filtering process for a sample specified in subclause 8.6.1.4.6 is invoked with sample values p_i, q_i, with i = 0..1, the boundary filtering strength bS and the variable t_C as inputs and the filtered sample values p_0' and q_0' as outputs.

   b. The filtered sample values p_0' and q_0' replace the corresponding samples inside the sample array s' as follows:

$$s'[\ xC + xB\ ,\ yC + yB + k\ ] = q_0' \quad (8\text{-}444)$$

$$s'[\ xC + xB - 1,\ yC + yB + k\ ] = p_0' \quad (8\text{-}445)$$

– Otherwise (verticalEdgeFlag is equal to 0), the following ordered steps apply:

1. If xPOS is equal to 1, the parameters k_s and k_e are set to -1 and 2 respectively. If xD is equal to 2, the parameters k_s and k_e are set to 0 and 2 respectively. Otherwise k_s and k_e are set to 0 and 3 respectively.

2. The sample values p_i and q_i with i = 0..1 and k = k_s..k_e are derived as follows:

$$q_i = s'[\ xC + xB + k,\ yC + yB + i\ ] \quad (8\text{-}446)$$

$$p_i = s'[\ xC + xB + k,\ yC + yB - i - 1\ ] \quad (8\text{-}447)$$

3. If xPOS is less than 0, and if bS_L, is greater than 2, for each sample location (xC + xB - 1, yC + yB), the following ordered steps apply:

   a. The filtering process for a sample specified in subclause 8.6.1.4.6 is invoked with sample values p_i, q_i, with i = 0..1, the boundary filtering strength bS_L and the variable t_{CL} as inputs and the filtered sample values p_0' and q_0' as outputs.

   b. The filtered sample values p_0' and q_0' replace the corresponding samples inside the sample array s' as follows:

$$s'[\ xC + xB + k,\ yC + yB\ ] = q_0' \quad (8\text{-}452)$$

$$s'[\ xC + xB + k,\ yC + yB - i - 1\ ] = p_i' \quad (8\text{-}445)$$

4. If bS is greater than 2, for each sample location (xC + xB + k, yC + yB), k = 0.. k_e, the following ordered steps apply:

   c. The filtering process for a sample specified in subclause 8.6.1.4.6 is invoked with sample values p_i, q_i, with i = 0..1, the boundary filtering strength bS and the variable t_C as inputs and the filtered sample values p_0' and q_0' as outputs.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000661

d. The filtered sample values p_0' and q_0' replace the corresponding samples inside the sample array s' as follows:

$$s'[xC + xB + k, yC + yB] = q_0' \quad (8\text{-}448)$$

$$s'[xC + xB + k, yC + yB - 1] = p_0' \quad (8\text{-}449)$$

8.6.1.4.4 Decision process for a luma sample

[Ed: (WJ) no filtering when bS is equal to 0]

Inputs of this process are:

- sample values, p_i and q_i with i = 0..2,
- a variable bS specifying the boundary filtering strength,
- variables d, β and t_C.

Output of this process is:

- a variable dSam containing a decision

When the variable bS is not equal to 0, the following applies:

- If d is less than (β >> 2), | $p_3 - p_0$ | + | $q_0 - q_3$ | is less than (β >> 3) and | $p_0 - q_0$ | is less than (5*t_C + 1) >> 1, dSam is set equal to 1.
- Otherwise, dSam is set equal to 0.

8.6.1.4.5 Filtering process for a luma sample

Inputs of this process are:

- sample values, p_i and q_i with i = 0..3,
- a variable dSam containing a decision,
- variables dEp1 and dEq1 containing decisions to filter pixels p1 and q1 respectively,
- a variable t_C.

Output of this process is:

- number of filtered samples nDp and nDq,
- filtered sample values, p_i' and q_j' with i = 0..nDp – 1, j = 0..nDq – 1

Depending on dSam, the following applies:

- When the variable dSam is equal to 1, the following strong filtering applies while nDp and nDq are set equal to 3:

$$p_0' = Clip1_Y((p_2 + 2*p_1 + 2*p_0 + 2*q_0 + q_1 + 4) >> 3) \quad (8\text{-}450)$$

$$p_1' = Clip1_Y((p_2 + p_1 + p_0 + q_0 + 2) >> 2) \quad (8\text{-}451)$$

$$p_2' = Clip1_Y((2*p_3 + 3*p_2 + p_1 + p_0 + q_0 + 4) >> 3) \quad (8\text{-}452)$$

$$q_0' = Clip1_Y((p_1 + 2*p_0 + 2*q_0 + 2*q_1 + q_2 + 4) >> 3) \quad (8\text{-}453)$$

$$q_1' = Clip1_Y((p_0 + q_0 + q_1 + q_2 + 2) >> 2) \quad (8\text{-}454)$$

$$q_2' = Clip1_Y((p_0 + q_0 + q_1 + 3*q_2 + 2*q_3 + 4) >> 3) \quad (8\text{-}455)$$

- Otherwise, the following weak filtering applies while nDp and nDq are set equal to 0:

$$\Delta = (9 * (q_0 - p_0) - 3 * (q_1 - p_1) + 8) >> 4 \quad (8\text{-}456)$$

  - When abs(Δ) is less than tc*10, the following ordered steps apply:

    1. The filtered sample values p0' and q0' are specified as follows:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000662

$$\Delta = Clip3(-tc, tc, \Delta) \quad (8\text{-}456)$$

$$p_0' = Clip1_Y(p_0 + \Delta) \quad (8\text{-}457)$$

$$q_0' = Clip1_Y(q_0 - \Delta) \quad (8\text{-}458)$$

2. If dEp1 is equal to 1, the filtered sample value p_i' is specified as follows:

$$\Delta p = Clip3(-(tc >> 1), tc >> 1, (((p_2 + p_0 + 1) >> 1) - p_1 + \Delta) >> 1) \quad (8\text{-}458)$$

$$p_i' = Clip1_Y(p_1 + \Delta p) \quad (8\text{-}458)$$

3. If dEq1 is equal to 1, the filtered sample value q_i' is specified as follows:

$$\Delta q = Clip3(-(tc >> 1), tc >> 1, (((q_2 + q_0 + 1) >> 1) - q_1 - \Delta) >> 1) \quad (8\text{-}458)$$

$$q_i' = Clip1_Y(q_1 + \Delta q) \quad (8\text{-}458)$$

4. nDp is set equal to dEp1+1 and nDq is set equal to dEq1+1.

Each of the filtered sample values, p_i' with i = 0..nDp-1, is substituted by the corresponding input sample value p_i if all of the following conditions are true.

- p_i is a sample of an I_PCM block.
- pcm_loop_filter_disable_flag value is equal to 1.

Similarly, each of the filtered sample values, q_j' with j = 0..nDq-1, is substituted by the corresponding input sample value q_j if all of the following conditions are true.

- q_j is a sample of an I_PCM block.
- pcm_loop_filter_disable_flag value is equal to 1.

[Ed. (WJ): for PCM case, deblocking filter applies first and the filtered pixels are restored. Rather than this, it's better to skip the filtering itself for PCM samples since first filtering is actually not needed.]

Table 8-15 – Derivation of threshold variables β and t_C from input Q

Q	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
β	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8
t_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Q	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
β	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	32	34	36
t_C	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4
Q	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	
β	38	40	42	44	46	48	50	52	54	56	58	60	62	64	64	64	64	64	
t_C	5	5	6	6	7	8	9	9	10	10	11	11	12	12	13	13	14	14	

8.6.1.4.6 Filtering process for a chroma sample

[Ed: (WJ) no filtering when bS is equal or less than 2]

Inputs of this process are:

- sample values, p_i and q_i with i = 0..1,
- a variable bS specifying the boundary filtering strength.
- a variable t_C.

Output of this process is:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000663

– The filtered sample values, p_0' and q_0'.

When the variable bS is greater than 2, the filtered sample values p_0' and q_0' are derived by

$$\Delta = \text{Clip3}(-t_C, t_C, ((((q_0 - p_0) << 2) + p_1 - q_1 + 4) >> 3)) \quad (8\text{-}461)$$

$$p_0' = \text{Clip1}_C(p_0 + \Delta) \quad (8\text{-}462)$$

$$q_0' = \text{Clip1}_C(q_0 - \Delta) \quad (8\text{-}463)$$

The filtered sample value, p_0' is substituted by the corresponding input sample value p_0 if all of the following conditions are true.

– p_0 is a sample of an I_PCM block.

– pcm_loop_filter_disable_flag value is equal to 1.

Similary, the filtered sample value, q_0' is substituted by the corresponding input sample value q_0 if all of the following conditions are true.

– q_0 is a sample of an I_PCM block.

– pcm_loop_filter_disable_flag value is equal to 1.

[Ed. (WJ): for PCM case, deblocking filter applies first and the filtered pixels are restored. Rather than this, it's better to skip the filtering itself for PCM samples since first filtering is actually not needed.]

8.6.2 Sample adaptive offset process

A sample adaptive offset process shall be conditionally performed after the completion of the deblocking filter process for the decoded picture. This process is invoked when both sample_adaptive_offset_enabled_flag and ~~sample_adaptive_offset_flag~~aps_sample_adaptive_offset_flag are equal to 1.

This process is performed on a region basis which is aligned with the LCU boundaries after the completion of the picture construction process prior to sample adaptive offset process for the entire decoded process.

The sample adaptive offset process is invoked with the region equal to entire picture here.

Depending on ~~sample_adaptive_offset_flag~~aps_sample_adaptive_offset_flag, sao_flag_cb and sao_flag_cr, the following applies:

– When ~~sample_adaptive_offset_flag~~aps_sample_adaptive_offset_flag is equal to 1, the following applies:

  – The sample adaptive offset process for luma region as specified in subclause 8.6.2.1 is invoked with the component index set equal to 0, the region index (0, 0), the largest CU location (0, 0), the variable saoDepth set equal to 0, the variable saoWidthInLCUs set equal to PicWidthInLCUs, and the variable saoHeightInLCUs set equal to PicHeightInLCUs, and the modified luma picture buffer of current region as output.

  – When sao_flag_cb is equal to 1, the sample adaptive offset process for color component Cb as specified in subclause 8.6.2.1 is invoked with the component index set equal to 1, the region index (0, 0), the largest CU location (0, 0), the variable saoDepth set equal to 0, the variable saoWidthInLCUs set equal to PicWidthInLCUs, and the variable saoHeightInLCUs set equal to PicHeightInLCUs, and the modified chroma picture buffer for Cb of current region as output.

  – If sao_flag_cr is equal to 1, the sample adaptive offset process for color component Cr as specified in subclause 8.6.2.1 is invoked with the component index set equal to 2, the region index (0, 0), the largest CU location (0, 0), the variable saoDepth set equal to 0, the variable saoWidthInLCUs set equal to PicWidthInLCUs, and the variable saoHeightInLCUs set equal to PicHeightInLCUs, and the modified chroma picture buffer for Cr of current region as output.

8.6.2.1 Modification process for sample adaptive offset

Inputs to this process are:

– a variable cIdx specifying chroma component index,

– a pair of variables (rx, ry) specifying the region index,

– a sample location (x0, y0) specifying the top-left sample of the current largest coding unit,

– a variable saoDepth specifying the split depth of the region,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000664

– a variable saoWidthInLCUs specifying the number of largest CUs in width of the current region

– a variable saoHeightInLCUs specifying the number of largest CUs in height of the current region.

Output of this process is a modified picture buffer for the chroma component cIdx.

Depending on sao_split_flag[cIdx][saoDepth][rx][ry], the following applies:

– If sao_split_flag[cIdx][saoDepth][rx][ry] is equal to 1 and saoDepth is smaller than SaoMaxDepth, the following ordered stesps apply:

1. Variable nS is set equal to (1 << log2MaxCUSize).
2. Variables saoWidthInLCU1, saoWidthInLCU2, saoHeightInLCU1, saoHeightInLCU2, x1, y1, x2, and y2 are derived as follows:

saoWidthInLCU1 = saoWidthInLCUs >> 1 (8-463)
saoWidthInLCU2 = saoWidthInLCUs – saoWidthInLCU1 (8-463)
saoHeightInLCU1 = saoHeightInLCUs >> 1 (8-463)
saoHeightInLCU2 = saoHeightInLCUs – saoHeightInLCU1 (8-463)

x1 = x0 (8-463)
y1 = y0 (8-463)
x2 = x1 + saoWidthInLCU1 * nS (8-463)
y2 = y1 + saoHeightInLCU1 * nS (8-463)

3. The sample adaptive offset process for region as specified in this subclause is invoked with the component index cIdx, the region index (2*rx, 2*ry), the top-left sample position of largest CU (x0, y0), the variable saoDepth set equal to (saoDepth+1), the variable saoWidthInLCUs set equal to saoWidthInLCU1, and the variable saoHeightInLCUs set equal to saoHeightInLCU1.
4. The sample adaptive offset process for region as specified in this subclause is invoked with the component index cIdx, the region index (2*rx+1, 2*ry), the top-left sample position of largest CU (x1, y0), the variable saoDepth set equal to (saoDepth+1), the variable saoWidthInLCUs set equal to saoWidthInLCU2, and the variable saoHeightInLCUs set equal to saoHeightInLCU1.
5. The sample adaptive offset process for region as specified in this subclause is invoked with the component index cIdx, the region index (2*rx, 2*ry+1), the top-left sample position of largest CU (x0, y1), the variable saoDepth set equal to (saoDepth+1), the variable saoWidthInLCUs set equal to saoWidthInLCU1, and the variable saoHeightInLCUs set equal to saoHeightInLCU2.
6. The sample adaptive offset process for region as specified in this subclause is invoked with the component index cIdx, the region index (2*rx+1, 2*ry+1), the top-left sample position of largest CU (x1, y1), the variable saoDepth set equal to (saoDepth+1), the variable saoWidthInLCUs set equal to saoWidthInLCU2, and the variable saoHeightInLCUs set equal to saoHeightInLCU2.

– Otherwise, (sao_split_flag[cIdx][saoDepth][rx][ry] is equal to 0), the following ordered steps apply:

1. Variable nS is set equal to (1 << log2MaxCUSize).
2. Modification process for samples in a largest coding unit covering (iC, jC) with iC = x0 + k*nS for k = 0..saoWidthInLCU – 1 and jC = y0 + j*nS for j = 0..saoHeightInLCU – 1 specified in subclause 8.6.2.1.1 is invoked with the component index cIdx, the top-left sample of current largest coding unit (iC, jC), the region index (rx, ry), the split depth saoDepth, the offset array saoValueArray set equal to SaoOffsetVal[cIdx][saoDepth][rx][ry] and the largest coding unit size nS as inputs and the output is the modified picture buffer of chroma component cIdx.

8.6.2.1.1 Modification process for luma and chroma samples

Inputs to this process are:

– a variable cIdx specifying chroma component index,

– a sample position (xC, yC),

– a pair of variables (rx, ry) specifying the region index,

– a variable saoDepth specifying the split depth of the region,

– an array saoValueArray specifying offset values,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000665

– a block size nS.

Output of this process is a modified picture buffer for the chroma component cIdx.

Let recSaoPicture represents the processed sample array of the current picture of chroma component cIdx and saoTypeIdx is set equal to sao_type_idx[cIdx][saoDepth][rx][ry].

Variable bitDepth is set equal to $BitDepth_Y$ if cIdx is equal to 0, otherwise, set equal to $BitDepth_C$.

Depending on the value of saoTypeIdx, the following applies:

– If saoTypeIdx is equal to one of the values of 1, 2, 3 or 4, the following ordered steps apply:

1. Arrays hPos[2] and vPos[2] are specified in Table 8-16.
2. A variable edgeIdx is specified as

$$edgeIdx = 2 + \sum_k(Sign(recPicture[xC + i, yC + j] - recPicture[xC + i + hPos[k], yC + j + vPos[k]])) \text{ with } k = 0..1 \quad (8\text{-}463)$$

3. The reconstructed picture buffer is modified as

$$recSaoPicture[xC + i, yC + j] = recPicture[xC + i, yC + j] + saoValueArray[edgeTable[edgeIdx]] \quad (8\text{-}463)$$

with i = 0..nS-1 and j = 0..nS-1 where edgeTable[5] = { 1, 2, 0, 3, 4}.

– Otherwise, if saoTypeIdx is equal to one of the values of 5 or 6, the following ordered steps applies:

1. A variable bandShift is set equal to $BitDepth_Y - 5$ if cIdx is equal to 0, otherwise, set equal to $BitDepth_C - 5$.
2. The reconstructed picture buffer is modified as

$$recSaoPicture[xC + i, yC + j] = recPicture[xC + i, yC + j] + saoValueArray[bandTable[saoTypeIdx - 5][bandIdx]] \quad (8\text{-}463)$$

with i = 0..nS-1 and j = 0..nS-1 where bandIdx is set equal to (recPicture[xC + i, yC + j] >> bandShift) and bandTable is specified in Table 8-17.

– Otherwise (sao_type_idx[cIdx][saoDepth][rx][ry] is equal to 0), the following applies:

$$recSaoPicture[xC + i, yC + j] = recPicture[xC + i, yC + j] \text{ with } i = 0..nS-1 \text{ and } j = 0..nS-1 \quad (8\text{-}463)$$

[Ed. (WJ): copy operation is necessary to use recSaoPicture later.]

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000666

Table 8-16 – Specification of hPos[2] and vPos[2] according to the type of sample adaptive offset process

sao_type_idx[cIdx][saoDepth][rx][ry]	1	2	3	4
hPos[0]	-1	0	-1	1
hPos[1]	1	0	1	-1
vPos[0]	0	-1	-1	1
vPos[1]	0	1	1	-1

Table 8-17 – Specification of array bandTable according to bandIdx

bandIdx	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
bandTable[0][bandIdx]	0	0	0	0	0	0	0	0	1	2	3	4	5	6	7	8
bandTable[1][bandIdx]	1	2	3	4	5	6	7	8	0	0	0	0	0	0	0	0
bandIdx	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
bandTable[0][bandIdx]	9	10	11	12	13	14	15	16	0	0	0	0	0	0	0	0
bandTable[1][bandIdx]	0	0	0	0	0	0	0	0	9	10	11	12	13	14	15	16

8.6.3 Adaptive loop filter process

An adaptive loop filtering process shall be conditionally performed on a treeblock basis after the completion of the sample adaptive offset process for the entire decoded picture, with all treeblocks in a picture processed in order of increasing treeblock addresses.

Each treeblock is processed on a coding unit basis with the same order as decoding process.

This process is invoked when both adaptive_loop_filter_enabled_flag and ~~adaptive_loop_filter_flag~~aps_adaptive_loop_filter_flag are equal to 1.

This process is performed on a coding unit basis after the completion of the slice construction process prior to adaptive loop filter process for the entire decoded slice, with all coding units in a slice processed in order of coding unit scan order.

Filter coefficients c_L for luma samples and c_C for chroma samples are derived by invoking the process specified in subclause 8.6.2.1.Filter index array fIdx for luma samples are derived by invoking the process specified in subclause 8.6.2.2 with the luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture and the coding unit size log2CUSize as inputs.

When interpreting the luma samples of the coding unit as to be filtered, depending on pcm_flag, pcm_loop_filter_disable_flag and alf_cu_control_flag, the following applies.

– If pcm_loop_filter_disable_flag is equal to 1 and pcm_flag is equal to 1, the luma samples are not filtered.

– Otherwise, if alf_cu_control_flag is equal to 0, the luma samples are filtered,

– Otherwise (alf_cu_control_flag is equal to 1), if AlfCuFlag[xC][yC] is equal to 1 where xC and yC are the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture, the luma samples are filtered.

– Otherwise, the luma samples are not filtered.

When interpreting the chroma samples of the coding unit as to be filtered, depending on pcm_flag, pcm_loop_filter_disable_flag and alf_chroma_idc, the following applies.

– If pcm_loop_filter_disable_flag is equal to 1 and pcm_flag is equal to 1, both chroma samples are not filtered.

– Otherwise, if alf_chroma_idc is equal to 1, the Cr samples are filtered.

– Otherwise, if alf_chroma_idc is equal to 2, the Cb samples are filtered.

– Otherwise, if alf_chroma_idc is equal to 3, both chroma samples are filtered.

– Otherwise (alf_chroma_idc is equal to 0), both chroma samples are not filtered.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000667

For the luma samples of the coding unit interpreted as to be filtered, the filtering process for luma samples specified in subclause 8.6.2.3 is invoked with the luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture, the coding unit size log2CUSize, and the filter index array fIdx as inputs and the output is the modified filtered picture, $recFiltPicture_L$.

For the chroma samples of the coding unit interpreted as to be filtered, the filtering process for chroma samples specified in subclause 8.6.2.4 is invoked with the chroma location (xC/2, yC/2) specifying the top-left chroma sample of the current coding unit relative to the top left chroma sample of the current picture, the coding unit size log2CUSize-1 and the chroma component index cIdx equal to 1 as inputs and the output is the modified filtered picture, $recFiltPicture_{Cb}$.

For the chroma samples of the coding unit interpreted as to be filtered, the filtering process for chroma samples specified in subclause 8.6.2.4 is invoked with the chroma location (xC/2, yC/2) specifying the top-left chroma sample of the current coding unit relative to the top left chroma sample of the current picture, the coding unit size log2CUSize-1 and the chroma component index cIdx equal to 2 as inputs and the output is the modified filtered picture, $recFiltPicture_{Cr}$.

[Ed.: (WJ) recPicture: deblocked/output picture and recFiltPicture: ALFed picture]

[Ed.: (WJ) depending ~~adaptive_loop_filter_flag~~aps_adaptive_loop_filter_flag, recFiltPicture should be copied to recPicture in subclause 8.6]

8.6.3.1 Boundary padding process

Inputs of this process are:

- a location (xC, yC) specifying the top-left sample of the current coding unit relative to the top left sample of the current picture,
- a variable log2CUSize specifying the size of the current coding unit.
- a variable cIdx specifying the chroma component index.

Output of this process is the padded luma sample array s''.

Depending on alf_filter_shape, the following applies:

- If alf_filter_shape is equal to 0, a variable alfTapX is set equal to 5, a variable alfTapY is set equal to 5, a variable nExtPixelsX is set equal to (alfTapX >> 1) and a variable nExtPixelsY is set equal to (alfTapY >> 1).
- Otherwise, if alf_filter_shape is equal to 1, a variable alfTapX is set equal to 11, a variable alfTapY is set equal to 5, a variable nExtPixelsX is set equal to (alfTapX >> 1) and a variable nExtPixelsY is set equal to (alfTapY >> 1).

Depending on cIdx, the following applies:

- If cIdx is equal to 0, a luma sample array s' is set equal to $recPicture_L$ and a variable nS is set equal to (1 << log2CUSize).
- Otherwise, if cIdx is equal to 1, a chroma sample array s' is set equal to $recPicture_{Cb}$ and a variable nS is set equal to (1 << (log2CUSize – 1)).
- Otherwise (cIdx is equal to 2), a chroma sample array s' is set equal to $recPicture_{Cr}$ and a variable nS is set equal to (1 << (log2CUSize – 1)).

Depending on loop_filter_across_slice_flag, a varaible s'' specifying the padded luma sample array is derived as:

- If loop_filter_across_slice_flag is equal to 1, s''[xC+x][yC+y] is set equal to s'[xC+x][yC+y] for x = -nExtPixelsX..nS+nExtPixelsX-1 and y = -nExtPixelsY..nS+nExtPixelsY-1.
- Otherwise (loop_filter_across_slice_flag is equal to 0), s''[xC+x][yC+y] is derived by the following ordered steps:

  1. s''[xC+x][yC+y] is set equal to s'[xC+x][yC+y] for x=0..nS – 1 and y=0..nS – 1.
  2. If the left boundary of current block coincides with the slice boundary,

     s''[xC+x][yC+y] = s'[xC][yC+y] for x = -nExtPixelsX..-1 and y = 0..nS-1 (8-462)

  3. If the right boundary of current block coincides with the slice boundary,

     s''[xC+nS+x][yC+y] = s'[xC+nS-1][yC+y] for x = 0..nExtPixelsX-1 and y = 0..nS-1 (8-462)

  4. If the top boundary of current block coincides with the slice boundary,

     s''[xC+x][yC+y] = s'[xC+x][yC] for x = 0..(nP-nExtPixelsX-1) and y = -nExtPixelsY..-1 (8-462)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000668

where nP is set equal to the size of top boundary that needs padding. [Ed. (WJ): needs improvements]

– If current block and s'[xC + nP][yC – 1] are not at the same slice,

s''[xC+x][yC+y] = s'[xC+x][yC] for x = (nP-nExtPixelsX)..(nP-1) and y = -nExtPixelsY..-1 (8-462)

– Otherwise,

s''[xC+x][yC+y] = s'[xC+nP][yC+y] for x = (nP-nExtPixelsX)..(nP-1) and y = -nExtPixelsY..-1 (8-462)

5. If the bottom boundary of current block coincides with the slice boundary,

s''[xC+ x][yC+nS+y] = s'[xC+x][yC+nS-1]
for x = 0..(nS-nP+nExtPixelsX) and y = 0..nExtPixelsY-1 (8-462)

where nP is set equal to the size of bottom boundary that needs padding. [Ed. (WJ): needs improvements]

– If current block and s'[xC+nS-nP-1][yC+nS] are not at the same slice,

s''[xC+x][yC+nS+y] = s'[xC+x][yC+nS-1]
where x = (nS-nP)..(nS-nP+nExtPixelsX-1) and y = 0..nExtPixelsY-1 (8-462)

– Otherwise,

s''[xC+x][yC+nS+y] = s'[xC+nS-nP-1][yC+nS+y]
where x = (nS-nP)..(nS-nP+nExtPixelsX-1) and y = 0..nExtPixelsY-1 (8-462)

6. If the current coding unit and its upper-left coding unit are not at the same slice,

– If the left boundary of current block coincides with the slice boundary but the top boundary of current block does not,

s''[xC+x][yC+y] = s'[xC][yC+y] where x = -nExtPixelsX..-1 and y = -nExtPixelsY..-1 (8-462)

– Otherwise, if the top boundary of current block coincides with the slice boundary but the left boundary of current block does not,

s''[xC+x][yC+y] = s'[xC+x][yC] where x = -nExtPixelsX..-1 and y = -nExtPixelsY..-1 (8-462)

– Otherwise

s''[xC+x][yC+y] = s'[xC][yC] where x = -nExtPixelsX..-1 and y = -nExtPixelsY..-1 (8-462)

7. If the current coding unit and its upper-right coding unit are not at the same slice,

– If the right boundary of current block coincides with the slice boundary but the top boundary of current block does not,

s''[xC+nS+x][yC+y] = s'[xC+nS-1][yC+y] where x = 0..nExtPixelsX-1 and y = -nExtPixelsY..-1 (8-462)

– Otherwise, if the top boundary of current block coincides with the slice boundary but the right boundary of current block does not,

s''[xC+nS+x][yC+y] = s'[xC+nS+x][yC] where x = 0..nExtPixelsX-1 and y = -nExtPixelsY..-1 (8-462)

– Otherwise

s''[xC+nS+x][yC+y] = s'[xC+nS-1][yC] where x = 0..nExtPixelsX-1 and y = -nExtPixelsY..-1 (8-462)

8. If the current coding unit and its bottom-left coding unit are not at the same slice,

– If the left boundary of current block coincides with the slice boundary but the bottom boundary of current block does not,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000669

s''[xC+x][yC+nS+y] = s'[xC][yC+nS+y] where x = -nExtPixelsX..-1 and y = 0..nExtPixelsY-1 (8-462)

– Otherwise, if the bottom boundary of current block coincides with the slice boundary but the left boundary of current block does not,

s''[xC+x][yC+nS+y] = s'[xC+x][yC+nS-1] where x = -nExtPixelsX..-1 and y = 0..nExtPixelsY-1 (8-462)

– Otherwise

s''[xC+ x][yC+nS+y] = s'[xC][yC+nS-1] where x = -nExtPixelsX..-1 and y = 0..nExtPixelsY-1 (8-462)

9. If the current coding unit and its bottom-right coding unit are not at the same slice,

– If the right boundary of current block coincides with the slice boundary but the bottom boundary of current block does not,

s''[xC+nS+x][yC+nS+y] = s'[xC+nS-1][yC+nS+y]
where x = 0..nExtPixelsX-1 and y = 0..nExtPixelsY-1 (8-462)

– Otherwise, if the bottom boundary of current block coincides with the slice boundary but the right boundary of current block does not,

s''[xC+nS+x][yC+nS+y] = s'[xC+nS+x][yC+nS-1]
where x = 0..nExtPixelsX-1 and y = 0..nExtPixelsY-1 (8-462)

– Otherwise

s''[xC+ nS+x][yC+nS+y] = s'[xC+nS-1][yC+nS-1]
where x = 0..nExtPixelsX-1 and y = 0..nExtPixelsY-1 (8-462)

8.6.3.2 Derivation process for filter coefficients

Outputs of this process are filter coefficients c_L for the luma samples and filter coefficients c_C for the chroma samples.

The luma filter coefficients c_L with elements $c_L[i][j]$, i = 0..AlfNumFilters – 1, j = 0..AlfCodedLengthLuma – 1 is derived as follows:

– If alf_pred_method is equal to 0 or the value of i is equal to 0,

$c_L[i][j] = alf\_coeff\_luma[i][j]$ (8-464)

– Otherwise (alf_pred_method is equal to 1 and the value of i is greater than 1),

$c_L[i][j] = alf\_coeff\_luma[i][j] + c_L[i - 1][j]$ (8-465)

Considering the symmetry of the filter, the luma filter coefficients c_L with elements $c_L[i][j]$, i = 0..AlfNumFilters – 1 is derived as follows:

$c_L[i][AlfLengthLuma - 1] = c_L[i][AlfCodedLengthLuma - 1]$ (8-466)

$c_L[i][AlfLengthLuma - 2 - j] = c_L[i][j]$ for j = 0..AlfCodedLengthLuma – 2 (8-467)

The chroma filter coefficients c_C with elements $c_C[i]$, i = 0..AlfCodedLengthChroma – 1 is derived as follows:

– If i is equal to AlfCodedLengthChroma – 1, the coefficient $c_C[i]$ is derived as

$c_C[i] = 255 - sum - alf\_coeff\_chroma[i]$ (8-468)

where

$sum = alf\_coeff\_chroma[AlfCodedLengthChroma - 2] + \Sigma_j(alf\_coeff\_chroma[j] << 1)$ (8-469)

with j = 0..AlfCodedLengthChroma – 3

– Otherwise (i is less than AlfCodedLengthChroma – 1),

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000670

$c_C[i] = alf\_coeff\_chroma[i]$ (8-470)

Considering the symmetry of the filter, the chroma filter coefficients c_C with elements $c_C[i]$, i = 0..AlfLengthChroma – 1 is derived as follows:

$c_C[i][AlfLengthChroma - 1] = c_C[i][AlfCodedLengthChroma - 1]$ (8-471)

$c_C[i][AlfLengthChroma - 2 - j] = c_C[i][j]$ for j = 0..AlfCodedLengthChroma – 2 (8-472)

8.6.3.3 Derivation process for filter index array for luma samples

Inputs of this process are:

– a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,

– a variable log2CUSize specifying the size of the current coding unit.

Output of this process is the two-dimensional filter index array of (nS)x(nS), fIdx.

A variable nS is set equal to (1 << log2CUSize).

The boundary padding process specified in subclause 8.6.3.1 is invoked with the luma location (xC, yC), the size of coding unit log2CUSize and the chroma component index cIdx set equal to 0, and the output is assigned to the luma sample array s''. [Ed. (WJ): s'' is now a picture-size array, but actually CU size + appropriate margin is enough]

The filter index array fIdx is specified in the follows:

– When alf_region_adaptation_flag is equal to 1, the following ordered steps apply.

1. The variables xIdx and yIdx are derived as

$regionTab[16] = \{ 0, 1, 4, 5, 15, 2, 3, 6, 14, 11, 10, 7, 13, 12, 9, 8 \}$ (8-474)
$offset = 1 << (Log2MaxCUSize - 1)$ (8-474)
$xInterval = (((PicWidthInSamples_L + offset) >> Log2MaxCUSize) + 1) >> 2$ (8-474)
$yInterval = (((PicHeightInSamples_L + offset) >> Log2MaxCUSize) + 1) >> 2$ (8-474)
$xIdx = Min(3, Floor((xC + x) / (xInterval << Log2MaxCUSize)))$ (8-474)
$yIdx = Min(3, Floor((yC + y) / (yInterval << Log2MaxCUSize)))$ (8-474)

2. The filter index fIdx[x, y] with x, y = 0..(nS)-1 is derived as

$fIdx[x][y] = regionTab[(yIdx << 2) + xIdx]$ (8-474)

– Otherwise (alf_region_flag is equal to 0), the following ordered steps apply.

1. The variables varTempH[x][y], varTempV[x][y] and varTemp1[x][y] with x, y = 0, 2, 4,...(nS) is derived as

$varTempH[x][y] = | (s''[xC+x, yC+y] << 1) - s''[xC+x-1, yC+y] - s''[xC+x+1, yC+y] |$ (8-474)
$varTempV[x][y] = | (s''[xC+x, yC+y] << 1) - s''[xC+x, yC+y-1] - s''[xC+x, yC+y+1] |$ (8-474)

2. The variables varTempH1[x, y], varTempV1[x, y], and varTemp3[x, y] with x, y = 0..((nS) – 1)>>2 are derived as

$varTempH1[x][y] = \Sigma_i\Sigma_j\ varTempH[(x << 2) + i][(y << 2) + j]$ with i, j = 0, 2 (8-474)
$varTempV1[x][y] = \Sigma_i\Sigma_j\ varTempV[(x << 2) + i][(y << 2) + j]$ with i, j = 0, 2 (8-474)
$varTemp3[x][y] = (varTempH1[x][y] + varTempV1[x][y]) >> 2$ (8-474)

3. The variable direction is derived as

– If varTempV1[x >> 2][y >> 2] is greater than varTempH1[x >> 2][y >> 2] << 1,

direction = 1

– Otherwise, if varTempH1[x >> 2][y >> 2] is greater than varTempV1[x >> 2][y >> 2] << 1,

direction = 2

– Otherwise,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000671

direction = 0

4. The variable avgvar is derived as

varTab[16] = { 0, 1, 2, 2, 2, 3, 3, 3, 3, 3, 4, 4, 4, 4, 4, 4 } (8-475)
avgVar = Clip3(0, 15, (varTemp3[x >> 2][y >> 2] * 1024) >> (3 + BitDepth$_Y$)) (8-475)

5. The filter index fIdx[x, y] with x, y = 0..(nS)-1 is derived as

fIdx[x][y] = Clip3(0, 4, varTab[avgVar]) + 5 * direction (8-504)

8.6.3.4 Filtering process for luma samples

Inputs of this process are:

– a luma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left luma sample of the current picture,

– a variable log2CUSize specifying the size of the current coding unit,

– a filter index array of (nS)x(nS), fIdx.

Output of this process is the filtered reconstruction of luma picture.

The boundary padding process specified in subclause 8.6.3.1 is invoked with the luma location (xC, yC), the size of coding unit log2CUSize and the chroma component index cIdx set equal to 0, and the output is assigned to the luma sample array s''. [Ed. (WJ): s'' is now a picture-size array, but actually CU size + appropriate margin is enough]

A variable nS is set equal to (1 << log2CUSize) and a variable alfTap is set equal to (alf_length_luma_minus_5_div2 << 1) + 5.

Each sample of luma picture recFiltPicture$_L$[xC + x][yC + y] with x, y = 0..(nS)-1, is derived as follows.

$$recFiltPicture_L[xC+x][yC+y] = c_L[fIdx[x][y]][N] + \sum_{i=0}^{N-1}\left(s''[xC+x+horPos[i],\ yC+y+verPos[i]] * c_L[fIdx[x][y]][i]\right) \quad (8\text{-}476)$$

where N is set equal to AlfNumCoeffLuma-1 and horPos[i] and verPos[i] are specified in Table 8-14 and Table 8-15, respectively.

Table 8-18 – Specification of horPos[i] according to alfTap for adaptive loop filter process of luma samples

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
alfTap = 5	0	-1	0	1	-2	-1	0	1	2	-1	0	1	0	-	-	-	-	-	-	-
alfTap = 7	0	-1	0	1	-2	-1	0	1	2	-3	-2	-1	0	1	2	3	-2	-1	0	1
alfTap = 9	-1	0	1	-2	-1	0	1	2	-3	-2	-1	0	1	2	3	-4	-3	-2	-1	0

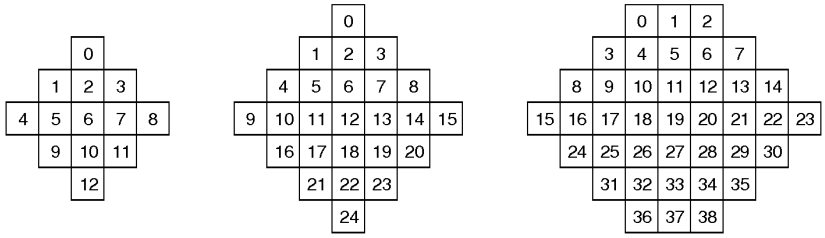
i	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
alfTap = 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
alfTap = 7	2	-1	0	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
alfTap = 9	1	2	3	4	-3	-2	-1	0	1	2	3	-2	-1	0	1	2	-1	0	1

Table 8-19 – Specification of verPos[i] according to alfTap for adaptive loop filter process of luma samples

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
alfTap = 5	-2	-1	-1	-1	0	0	0	0	0	1	1	1	2							
alfTap = 7	-3	-2	-2	-2	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	1	1	1	1
alfTap = 9	-3	-3	-3	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	-1	0	0	0	0	0

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000672

i	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
alfTap = 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
alfTap = 7	1	2	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
alfTap = 9	0	0	0	0	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3



(a) alfTap = 5 (a) alfTap = 7 (a) alfTap = 9

Figure 8-8 Mapping between geometric position and luma adaptive loop filter index according to alfTap (informative)

8.6.3.5 Filtering process for chroma samples

Inputs of this process are:

– a chroma location (xC, yC) specifying the top-left luma sample of the current coding unit relative to the top left chroma sample of the current picture,

– a variable log2CUSize specifying the size of the current coding unit.

– a variable cIdx specifying the chroma component index.

Output of this process is the filtered reconstruction of chroma picture.

The boundary padding process specified in subclause 8.6.3.1 is invoked with the chroma location (xC, yC), the size of coding unit log2CUSize and the chroma component index cIdx, and the output is assigned to the luma sample array s''. [Ed. (WJ): s'' is now a picture-size array, but actually CU size + appropriate margin is enough]

A variable nS is set equal to (1 << log2CUSize) and a variable alfTapChroma is set equal to (alf_length_chroma_minus_5_div2 << 1) + 5.

Filtered samples of chroma picture recFiltPicture[xC + x][yC + y] with x, y = 0..(nS)-1, are derived as follows.

$$recFiltPicture[xC+x][yC+y] = c_C[N] + \sum_{i=0}^{N-1} \left(s''[\, xC+x+horPos[i],\, yC+y+verPos[i]\,] * c_C[i] \right) \quad (8\text{-}477)$$

where

$$N = AlfNumCoeffChroma - 1, \quad (8\text{-}478)$$

horPos[i] = (i % alfTapChroma) – (alfTapChroma >> 1), and (8-479)

verPos[i] = (i / alfTapChroma) – (alfTapChroma >> 1) (8-480)

9 Parsing process

Inputs to this process are bits from the RBSP.

Outputs of this process are syntax element values.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000673

This process is invoked when the descriptor of a syntax element in the syntax tables in subclause 7.3 is equal to ue(v), me(v), se(v), te(v) (see subclause 9.1), ce(v) (see subclause 9.2), or ae(v) (see subclause 9.3).

9.1 Parsing process for Exp-Golomb codes

This process is invoked when the descriptor of a syntax element in the syntax tables in subclause 7.3 is equal to ue(v), me(v), se(v), or te(v). For syntax elements in subclauses 7.3.4 and 7.3.5, this process is invoked only when entropy_coding_mode_flag is equal to 0.

Inputs to this process are bits from the RBSP.

Outputs of this process are syntax element values.

Syntax elements coded as ue(v), me(v), or se(v) are Exp-Golomb-coded. Syntax elements coded as te(v) are truncated Exp-Golomb-coded. The parsing process for these syntax elements begins with reading the bits starting at the current location in the bitstream up to and including the first non-zero bit, and counting the number of leading bits that are equal to 0. This process is specified as follows:

```
leadingZeroBits = −1
for( b = 0; !b; leadingZeroBits++ )                                    (9-1)
    b = read_bits( 1 )
```

The variable codeNum is then assigned as follows:

$$codeNum = 2^{leadingZeroBits} - 1 + read\_bits(leadingZeroBits) \quad (9\text{-}2)$$

where the value returned from read_bits(leadingZeroBits) is interpreted as a binary representation of an unsigned integer with most significant bit written first.

Table 9-1 illustrates the structure of the Exp-Golomb code by separating the bit string into "prefix" and "suffix" bits. The "prefix" bits are those bits that are parsed in the above pseudo-code for the computation of leadingZeroBits, and are shown as either 0 or 1 in the bit string column of Table 9-1. The "suffix" bits are those bits that are parsed in the computation of codeNum and are shown as x_i in Table 9-1, with i being in the range 0 to leadingZeroBits − 1, inclusive. Each x_i can take on values 0 or 1.

Table 9-1 – Bit strings with "prefix" and "suffix" bits and assignment to codeNum ranges (informative)

Bit string form	Range of codeNum
1	0
0 1 x_0	1..2
0 0 1 x_1 x_0	3..6
0 0 0 1 x_2 x_1 x_0	7..14
0 0 0 0 1 x_3 x_2 x_1 x_0	15..30
0 0 0 0 0 1 x_4 x_3 x_2 x_1 x_0	31..62
...	…

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000674

Table 9-2 illustrates explicitly the assignment of bit strings to codeNum values.

Table 9-2 – Exp-Golomb bit strings and codeNum in explicit form and used as ue(v) (informative)

Bit string	codeNum
1	0
0 1 0	1
0 1 1	2
0 0 1 0 0	3
0 0 1 0 1	4
0 0 1 1 0	5
0 0 1 1 1	6
0 0 0 1 0 0 0	7
0 0 0 1 0 0 1	8
0 0 0 1 0 1 0	9
...	…

Depending on the descriptor, the value of a syntax element is derived as follows.

– If the syntax element is coded as ue(v), the value of the syntax element is equal to codeNum.

– Otherwise, if the syntax element is coded as se(v), the value of the syntax element is derived by invoking the mapping process for signed Exp-Golomb codes as specified in subclause 9.1.1 with codeNum as the input.

– Otherwise, if the syntax element is coded as me(v) [Ed. (TW): insert text]

– Otherwise (the syntax element is coded as te(v)), the range of possible values for the syntax element is determined first. The range of this syntax element may be between 0 and x, with x being greater than or equal to 1 and the range is used in the derivation of the value of the syntax element value as follows.

  – If x is greater than 1, codeNum and the value of the syntax element is derived in the same way as for syntax elements coded as ue(v).

  – Otherwise (x is equal to 1), the parsing process for codeNum which is equal to the value of the syntax element is given by a process equivalent to:

```
b = read_bits( 1 )                                    (9-3)
codeNum = !b
```

9.1.1 Mapping process for signed Exp-Golomb codes

Input to this process is codeNum as specified in subclause 9.1.

Output of this process is a value of a syntax element coded as se(v).

The syntax element is assigned to the codeNum by ordering the syntax element by its absolute value in increasing order and representing the positive value for a given absolute value with the lower codeNum. Table 9-3 provides the assignment rule.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000675

Table 9-3 – Assignment of syntax element to codeNum for signed Exp-Golomb coded syntax elements se(v)

codeNum	syntax element value
0	0
1	1
2	−1
3	2
4	−2
5	3
6	−3
k	$(-1)^{k+1}$ Ceil(k÷2)

9.2 CAVLC parsing process for slice data

This process is invoked when the descriptor of a syntax element in the syntax tables in subclause 7.3 is equal to ce(v).

Inputs to this process are bits from the RBSP.

Outputs of this process are syntax element values.

9.2.1 Parsing process for VLC codes

Inputs to this process are bits from the RBSP and the parameter vlcNum specifying the VLC code. If vlcNum is equal to 14, inputs to this process additionally include a parameter cMax.

Output of this process is the variable codeNum specifying an integer value to be used when deriving syntax elements.

If vlcNum is not equal to 8 or 11, and is less than 14, the parsing process for the VLC codes begins with reading the bits starting at the current location in the bitstream up to and including the first non-zero bit, and counting the number of leading bits that are equal to 0. This process is specified as follows.

```
leadingZeroBits = −1
for( b = 0; !b; leadingZeroBits++ )                                    (9-4)
    b = read_bits( 1 )
```

Depending on the value of vlcNum, the value of codeNum is assigned as follows.

– If vlcNum is equal to 0,
  – If leadingZeroBits is less than or equal to 6,

```
codeNum = leadingZeroBits                                              (9-5)
```

  – Otherwise (leadingZeroBits is greater than 6),

```
numBits =  leadingZeroBits – 6                                         (9-6)
codeNum = 5 + (1<< numBits) + read_bits( numBits )
```

– Otherwise, if vlcNum is less than 5,
  – If leadingZeroBits is less than or equal to 6,

```
codeNum = (leadingZeroBits << vlcNum) +  read_bits( vlcNum )           (9-7)
```

  – Otherwise (leadingZeroBits is greater than 6),

```
numBits =  leadingZeroBits – 6 + vlcNum                                (9-8)
codeNum = 5*(1<<vlcNum) + (1<< numBits) + read_bits( numBits)
```

– Otherwise, if vlcNum is less than 8,

```
codeNum = (leadingZeroBits << (vlcNum - 4)) +  read_bits( vlcNum - 4)  (9-9)
```

– Otherwise, if vlcNum is equal to 8,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000676

```
b = read_bits(1)                                                    (9-10)
codeNum = b ? 2 - read_bits(1) : 0
```

– Otherwise, if vlcNum is equal to 9,

  – If leadingZeroBits is equal to 0,

```
b = read_bits(1)
if (b) {
    b = read_bits(1)
    if (b) {
        codeNum = 3 + read_bits(3)                                  (9-11)
    }
    else{
        b = read_bits(1)
        codeNum = b ? 1 + read_bits(1) : 0
    }
}
```

  – Otherwise (leadingZeroBits is greater than 0),

```
codeNum = (leadingZeroBits << 4) + read_bits( 4) + 11               (9-12)
```

– Otherwise, if vlcNum is equal to 10,

```
codeNum = (1<< leadingZeroBits) – 1 + read_bits( leadingZeroBits )  (9-13)
```

– Otherwise, if vlcNum is equal to 11,

```
codeNum = read_bits(3)
if( codeNum ) {
    b = read_bits(1)                                                (9-14)
    codeNum = (codeNum << 1) + b -1
}
```

– Otherwise, if vlcNum is equal to 12,

```
codeNum = (leadingZeroBits << 6) + read_bits( 6 )                   (9-15)
```

– Otherwise, if vlcNum is equal to 13,

```
codeNum = (leadingZeroBits << 4) + read_bits( 4 )                   (9-16)
```

– Otherwise, if vlcNum is equal to 14,

```
leadingZeroBits = –1
for( b = 0; !b && leadingZeroBits < cMax; leadingZeroBits++ )       (9-17)
    b = read_bits( 1 )
codeNum = leadingZeroBits
```

– Otherwise, if vlcNum is equal to 15, codeNum is determined according to Table 9-4.

– Otherwise, if vlcNum is equal to 16

```
codeNum = read_bits(3)
if( codeNum >= 6)
    codeNum = 7 - codeNum
else if (codeNum > 0) {                                             (9-18)
    b = read_bits( 1 )
    codeNum = 13 – (codeNum << 1) - b
}
else {
    b = read_bits( 2 )
    codeNum = 15 – b
}
```

– Otherwise, if vlcNum is equal to 17

```
codeNum = read_bits(3)
if( codeNum ) {                                                     (9-19)
    b = read_bits(1)
```


Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000677

```
        codeNum = 16 -  (codeNum << 1) - b
    }
```

– Otherwise, if vlcNum is equal to 18

```
    codeNum = read_bits(3)
    if( codeNum && codeNum < 4) {
        b = read_bits(1)
        codeNum = 8 -  (codeNum << 1) - b
    } else if (codeNum < 6) {
        b = read_bits(2)
        codeNum = 30 -  (codeNum << 2) - b                    (9-20)
    } else {
        b = read_bits(3)
        codeNum =  (codeNum << 3) + b
        if (codeNum < 62)
            codeNum = 76 – codeNum
        else {
            b = read_bits(1)
            codeNum = 156 - (codeNum << 1) – b
        }
    }
```

– Otherwise, if vlcNum is equal to 19

```
    codeNum = read_bits(3)
    if( codeNum && codeNum < 3) {
        b = read_bits(1)
        codeNum = 6 -  (codeNum << 1) - b
    } else {                                                  (9-21)
        b = read_bits(2)
        codeNum =  (codeNum << 2) + b
        if (codeNum < 25)
            codeNum = 29 – codeNum
        else {
            b = read_bits(1)
            codeNum = 81 - (codeNum << 1) – b
        }
    }
```

– Otherwise, if vlcNum is equal to 20, codeNum is determined according to Table 9-5.

– Otherwise, if vlcNum is equal to 21, codeNum is determined according to Table 9-6.

Table 9-4 – codeNum and codeword with vlcNum equal to 15

codeNum	Codeword
0	0
1	11
2	1001
3	1011
4	1000
5	10100
6	101010
7	101011

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000678

Table 9-5 – codeNum and codeword with vlcNum equal to 20

codeNum	Codeword
0	0000
1	01110
2	01101
3	01100
4	01011
5	01010
6	01001
7	01000
8	00111
9	00110
10	00101
11	00100
12	00011
13	00010
14	011111
15	011110

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000679

Table 9-6 – codeNum and codeword with vlcNum equal to 21

codeNum	Codeword
0	0000
1	00101
2	00100
3	00011
4	00010
5	011000
6	010111
7	010110
8	010101
9	010100
10	010011
11	010010
12	010001
13	010000
14	001111
15	001110
16	001101
17	001100
18	0111110
19	0111101
20	0111100
21	0111011
22	0111010
23	0111001
24	0111000
25	0110111
26	0110110
27	0110101
28	0110100
29	0110011
30	0110010
31	01111111
32	01111110

9.2.2 Initialisation process

Outputs of this process are initialised CAVLC internal variables.

The processes in subclauses 9.2.2.2 through 9.2.2.6 are invoked when starting the parsing of the slice data of a slice in subclause 7.3.4.

9.2.2.1 Counter initialisation for codeword index adaptive mapping

Outputs of this process are initial values of counters that are used for parsing a syntax element.

If the number of counters used for a syntax element is N (N>0), values of the N counters are all initialized to 0. For each set of counters used for parsing a syntax element, there is an associated value, counterSum, to store the number of counter increments since its previous reset. The value of counterSum is also initialized to 0.

9.2.2.2 Initialisation process for lastPosVlcNumIndex

Outputs of this process are initial values of the variable array lastPosVlcNumIndex.

The variable array lastPosVlcIndex is initialized as follows.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000680

lastPosVlcNumIndex [blockType] = 0, for blockType = 0...7 (9-21)

9.2.2.3 Initialisation process for lastPosTable

Outputs of this process are initial values of the variable array lastPosTable.

The variable array lastPosTable is initialized as specified in Table 9-5.

Table 9-7 – Specification of initial values of lastPosTable[tableNum][codeNum]

	codeNum															
tableNum	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
0	0	1	2	3	5	4	7	6	11	8	14	9	16	15	10	13
1	0	1	2	5	7	4	6	3	9	12	11	8	10	14	13	15
2	0	1	2	5	7	4	6	3	9	12	11	8	10	14	13	15

	codeNum															
tableNum	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
0	12	17	18	19	22	31	23	21	27	20	25	30	24	26	28	29
1	16	17	21	22	25	18	28	23	30	26	20	19	27	24	29	31
2	16	17	21	22	25	18	28	23	30	26	20	19	27	24	29	31

9.2.2.4 Initialisation process for splitPredPartModeTable

Outputs of this process are initial values of the variable array splitPredPartModeTable and associated counters.

The variable array splitPredPartModeTable is initialized as specified in Table 9-8.

Table 9-8 – Specification of splitPredPartModeTable[cuDepth][codeNum]

	codeNum										
cuDepth	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	1	2	3	4	5	6	7	8	9	10
1	0	1	2	3	4	5	6	7	8	9	10
2	0	1	2	3	4	5	6	7	8	9	10
3	1	2	3	4	5	0	6	7	8	9	10

For each cuDepth with a value from 0 to (Log2MaxCUSize – Log2MinCUSize), there are four counters used for codeword index adaptive mapping. These counters are initialized according to subclause 9.2.2.1.

9.2.2.5 Initialisation process for intraModeTable

Outputs of this process are initial values of the variable array intraModeTable.

The variable array intraModeTable is initialized as specified in Table 9-6.

Table 9-7 – Specification of intraModeTable[k][codeNum]

	codeNum																
k	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
0	0	3	2	15	8	11	1	10	7	4	14	9	6	5	13	12	
1	0	2	3	29	1	8	30	21	28	16	7	15	20	31	9	11	6

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000681

	codeNum																
k	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
1	4	5	12	10	14	22	19	17	27	13	18	23	26	32	24	25	

9.2.2.6 Initialisation process for cbpSplitTransTable

Outputs of this process are initial values of the variable array cbpSplitTransTable and associated counters.

The values of the variable array cbpSplitTransTable[k][n] are initialized as specified in Table 9-7 where the values of k = 0...5 and n = 0,1. The number of counters used in each case for codeword index adaptive mapping is defined in Table 9-16. These counters are initialized according to subclause 9.2.2.1.

Table 9-8 – Specification of initial values of cbpSplitTransTable[flagPattern-8][n][codeNum]

	k (n = 0)						k (n = 1)					
codeNum	**0**	**1**	**2**	**3**	**4**	**5**	**0**	**1**	**2**	**3**	**4**	**5**
0	14	2	3	6	4	4	0	2	0	0	0	0
1	13	3	1	4	7	7	1	3	2	5	4	4
2	12	1	0	5	0	0	3	0	1	4	5	5
3	10	0	2	7	5	5	7		3	7	6	6
4	6			0	6	6	2			6	1	1
5	11			1	1	1	4			2	7	7
6	9			2	2	2	5			3	2	2
7	8			3	3	3	8			1	3	3
8	5						9					
9	4						11					
10	2						6					
11	7						10					
12	3						12					
13	1						13					
14	0						14					

9.2.3 Codeword index mapping update process

Inputs to this process are a VLC codeword index mapping table indexMappingTable that provides the mapping between VLC codeword indexes and syntax element values, a codeword index value codeNum, and a value counterNum that specifies the number of counters used. If counterNum is not equal to 0, inputs additionally include an array counterArray indexed from 0 to (counterNum-1) that saves the value of counters, a value counterSum that saves the number of all counter increments since its previous reset.

Outputs of this process are indexMappingTable, and if counterNum is not equal to 0 counterArray and counterSum with updated values.

The process is specified in the following ordered steps:

– Syntax element value syntaxVal is set equal to indexMappingTable [codeNum].

– If codeNum is not less than 1, codeNumPre is set equal to (codeNum-1). Otherwise, codeNumPre is set equal to codeNum. Syntax element value syntaxValPre is set equal to indexMappingTable [codeNumPre].

– If codeNum is greater or equal to counterNum, the values of indexMappingTable[codeNumPre] and indexMappingTable[codeNum] are exchanged with each other. No further step is carried out. Otherwise

  – The value of counterArray[codeNum] is increased by 1.

  – If counterArray[codeNum] >= counterArray[codeNumPre], the counter values of counterArray[codeNum] and counterArray[codeNumPre] are swapped, and the values of indexMappingTable [codeNumPre] and indexMappingTable [codeNum] are also swapped.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000682

– If counterSum is not less than 15, the value of counterSum is reset to 0. For i = 0…(counterNum-1), counterArray[i] is set equal to (counterArray[i]>>1).

– Otherwise, the value of counterSum is increased by 1.

9.2.4 Parsing process for transform coefficient syntax elements

This process is invoked when parsing syntax elements with descriptor equal to ce(v) in subclause 7.3.11 and 7.3.12 and when entropy_coding_mode_flag is equal to 0.

Inputs to this process are bits from RBSP, and the variables log2TrafoSize and cIdx, and the variable arrays lastPosVlcNumIndex and lastPosTable.

Outputs of this process are CAVLC syntax elements last_pos_level_one, level_minus2_and_sign, run_level_one, and level, and the variable arrays lastPosTable and lastPosVlcNumIndex.

9.2.4.1 Parsing process for last_pos_level_one

Inputs to this process are bits from RBSP and the variable arrays lastPosVlcNumIndex and lastPosTable.

Output of this process is the syntax element last_pos_level_one, the variables trOne and vlcNumLevel, and the variable arrays lastPosVlcNumIndex and lastPosTable.

The parsing process for last_pos_level_one is specified as follows.

– The variable N is set equal to (1 << log2TrafoSize) >> (cIdx > 0 ? 2 : 0).

– If N is greater than 4, last_pos_level_one is derived in the following ordered steps:

1. The variable blockType is derived as

$$blockType = (cIdx == 0 \ ? (PredMode==MODE\_INTRA \ ? 0 : slice\_type + 1) + (N > 8 \ ? 5 : 2) : cIdx - 1) \quad (9\text{-}23)$$

2. The variable vlcNumIndex is derived as

$$vlcNumIdx = Min(16, lastPosVlcNumIndex[blockType]) \quad (9\text{-}24)$$

3. The variable vlcNum is derived as

$$vlcNum = lastPosVlcNumTable[blockType][vlcNumIdx] \quad (9\text{-}25)$$

The values of the array lastPosVlcNumTable are shown in Table 9-8.

4. The parsing process described in subclause 9.2.1 is invoked with vlcNum as input and the variable codeNum as output.

5. The variable lastPos is derived as follows

```
if (codeNum <= N+N*N)
    if (codeNum != 0 && (codeNum & (N-1)) = = 0)
        lastPos = (codeNum >> Log2(N)) – 1                    (9-26)
    else
        lastPos = codeNum – (codeNum >> Log2(N))
else
    lastPos = codeNum – N*N
```

6. The variable levelGreaterThanOneFlag is derived as

$$levelGreaterThanOneFlag = (codeNum > (N + N*N)) \ || \ (codeNum != 0 \ \&\& \ (codeNum \ \& \ (N-1))) \quad (9\text{-}27)$$

7. The syntax element last_pos_level_one is derived as

$$last\_pos\_level\_one = levelGreaterThanOneFlag \ ? \ codeNum + N : codeNum \quad (9\text{-}28)$$

8. The variable array lastPosVlcNumIndex[blockType] is updated as follows.

```
if ((N = = 8 ? codeNum : codeNum>>2) < lastPosVlcNumIndex[blockType])
    lastPosVlcNumIndex[blockType] -= 1                        (9-29)
else if ((N = = 8 ? codeNum : codeNum>>2) > lastPosVlcNumIndex[blockType])
    lastPosVlcNumIndex[blockType] += 1
```

– Otherwise, (N equal to 4), last_pos_level_one is derived in the following ordered steps:

1. The parsing process described in subclause 9.2.1 is invoked with 2 as input and the variable codeNum as output.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000683

2. The variable tableNum is derived as

$$tableNum = (PredMode==MODE\_INTRA \,||\, cIdx > 0) \,?\, 0 : slice\_type + 1 \quad (9\text{-}30)$$

3. The syntax element last_pos_level_one is derived as

$$last\_pos\_level\_one = lastPosTable[tableNum][codeNum] \quad (9\text{-}31)$$

4. The variable array lastPosTable[tableNum] is updated by invoking process 9.2.3 with lastPosTable[tableNum], codeNum and 0 as inputs.

- The variable trOne is derived as

$$trOne = !\, levelGreaterThanOneFlag \quad (9\text{-}32)$$

- The variable vlcNumLevel is set equal to 0

Table 9-9 – Specification of lastPosVlcNumTable[blockType][vlcNumIdx]

	vlcNumIdx																
blockType	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
0	10	10	10	10	2	2	2	7	9	9	9	9	9	4	4	4	4
1	10	10	10	10	10	2	9	9	9	9	9	9	9	4	4	4	4
2	2	2	2	2	2	7	7	7	7	7	7	7	7	7	4	4	13
3	2	2	2	2	7	7	7	7	7	7	7	7	7	7	7	7	13
4	2	2	2	2	7	7	7	7	7	7	7	7	7	7	7	7	13
5	10	10	10	4	4	4	4	12	12	12	12	12	12	12	12	12	12
6	10	10	10	10	4	4	12	12	12	12	12	12	12	12	12	12	12
7	10	10	10	10	4	4	12	12	12	12	12	12	12	12	12	12	12

9.2.4.2 Parsing process for level_minus2_and_sign

Input to this process are bits from slice data.

Output of this process is level_minus2_and_sign.

The syntax element level_minus2_and sign is derived by invoking the parsing process of subclause 9.2.1 with 0 as input and level_minus2_and sign as output.

9.2.4.3 Parsing process for run_level_one

Inputs to this process are bits from slice data, the scan position n of the previous non-zero transform coefficient in inverse scan order, and the variable TrOne.

Outputs of this process are the syntax element run_level_one and the variable TrOne.

The value of run_level_one is derived as follows.

- The variable N is set equal to (1 << log2TrafoSize) >> (cIdx > 0 ? 2 : 0).
- The variable blockType is derived as

$$blockType = (cIdx == 0 \,?\, (PredMode==MODE\_INTRA \,?\, 0 : slice\_type + 1) + (N > 8 \,?\, 5 : 2) : cIdx - 1) \quad (9\text{-}33)$$

- The variable tableIdx is derived as

$$tableIdx = (blockType == 2 \,||\, blockType == 5) \,?\, (N <= 8 \,?\, 0 : 1) : (N <= 8 \,?\, 2 : 3) \quad (9\text{-}34)$$

- The variable maxRun is set equal to n.
- The variable maxRunIdx is set equal to Min(28, maxRun).
- The variable vlcNum is derived from tableIdx and maxRunIdx as shown in Table 9-9.
- The parsing process described in subclause 9.2.1 is invoked with vlcNum as input and the variable codeNum as output.If blockType is equal to 2 or blockType is equal to 5, the value of run_level_one is derived as follows.
  - If N is equal to 4, the variable largeOnePos is derived from trOne and maxRunIdx as shown in Table 9-10.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000684

– Otherwise (N is greater than 4), the variable largeOnePos is derived from trOne and maxRunIdx as shown in Table 9-11.

– The variables levelGreaterThanOneFlag and runOfZeros are derived as follows.

```
if ( largeOnePos > 0 ) {
    if( codeNum < min(largeOnePos, maxRunIdx + 2 ) ) {
        levelGreaterThanOneFlag = 0
        runOfZeros = codeNum
    } else if( codeNum < (maxRunIdx << 1 ) + 4 – largeOnePos ) {
        if(( codeNum + largeOnePos ) & 1 ) {
            levelGreaterThanOneFlag = 0
            runOfZeros = (codeNum + largeOnePos - 1) >> 1
        } else {
            levelGreaterThanOneFlag = 1
            runOfZeros = (codeNum - largeOnePos)>>1                    (9-35)
        }
    } else {
        levelGreaterThanOneFlag = 1
        runOfZeros = codeNum - maxRunIdx – 2
    }
} else {
    if( codeNum & 1) {
        levelGreaterThanOneFlag = 0
        runOfZeros = (codeNum - 1)>>1
    } else {
        runOfZeros = codeNum >> 1
        levelGreaterThanOneFlag = ((codeNum >> 1) <= maxRunIdx)?1:0
    }
}
```

– The syntax element run_level_one is derived as

$$run\_level\_one = levelGreaterThanOneFlag\ ?\ runOfZeros + maxRun : runOfZeros \quad (9\text{-}36)$$

– Otherwise (blockType is not equal to 2 and blockType is not equal to 5), the value of run_level_one is derived as follows.

– The variable levelGreaterThanOneFlag is derived as

$$levelGreaterThanOneFlag = codeNum <= maxRun + 1\ ?\ 0 : 1 \quad (9\text{-}37)$$

– If maxRun is less than 28, the variable runOfZeros is derived from maxRun and codeNum as shown in Table 9-12.

– Otherwise (maxRun is not less than 28), the variable runOfZeros is derived as

$$runOfZeros = codeNum <= maxRun + 1\ ?\ codeNum : codeNum – maxRun – 2 \quad (9\text{-}38)$$

– The syntax element run_level_one is derived as

$$run\_level\_one = levelGreaterThanOneFlag\ ?\ runOfZeros + n : runOfZeros \quad (9\text{-}39)$$

– The variable trOne is derived as

$$trOne = (trOne == 0\ ||\ levelGreaterThanOneFlag)\ ?\ 0 : Max(4, trOne + 1) \quad (9\text{-}40)$$

Table 9-10 – Derivation of vlcNum from tableIdx and maxRunIdx

	maxRunIdx														
tableIdx	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
0	8	0	0	5	5	5	5	5	5	5	6	6	6	6	6
1	8	0	0	5	5	5	5	5	5	5	6	6	6	6	6
2	8	0	0	0	0	5	5	5	5	5	5	5	5	5	5
3	8	0	1	1	1	1	2	2	2	2	2	2	2	6	6

	maxRunIdx

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000685

tableIdx	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0	6	6	6	6	6	6	6	6	6	6	6	6	6	3	6
1	6	6	6	6	6	6	6	6	6	6	6	6	6	3	6
2	5	5	5	1	1	1	1	1	1	1	1	1	1	2	5
3	6	6	6	6	3	3	3	3	3	3	3	3	3	3	6

Table 9-11 – Derivation of largeOnePos from tableIdx and maxRunIdx when N is equal to 4

	maxRunIdx														
trOne	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0
1	2	3	4	5	6	5	6	7	7	7	7	7	6	4	2
2	2	2	2	3	3	3	3	4	4	4	3	3	3	2	NA
3	2	1	1	2	2	2	2	2	2	2	2	2	1	NA	NA
4	1	1	1	1	1	1	1	1	1	1	1	1	NA	NA	NA

Table 9-12 – Derivation of largeOnePos from tableIdx and maxRunIdx when N is greater than 4

	maxRunIdx														
trOne	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	0	1	2	2	2	2	2	4	5	5	6	6	6	6	6
1	2	4	4	6	6	8	8	10	11	13	15	13	14	15	16
2	2	3	4	5	4	5	6	6	7	8	8	9	9	10	10
3	2	1	2	2	3	3	4	4	5	5	5	6	6	7	7
4	2	1	2	2	2	2	3	3	3	3	4	4	4	4	4

	maxRunIdx													
trOne	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0	6	7	8	7	8	8	9	10	10	10	12	10	9	8
1	18	18	21	20	21	22	23	25	25	26	27	28	29	27
2	11	11	12	13	14	15	16	16	17	18	19	20	19	19
3	7	8	9	9	10	10	11	11	12	12	13	13	13	13
4	5	5	5	5	5	6	6	6	6	6	6	7	7	8

Table 9-13 – Derivation of runOfZeros from maxRun and codeNum

	codeNum% (maxRun+1)														
maxRun	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	1	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	2	1	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	3	0	2	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	4	1	0	2	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	5	0	3	2	4	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	6	0	1	4	5	3	2	NA	NA	NA	NA	NA	NA	NA	NA
6	7	1	0	2	4	3	6	5	NA	NA	NA	NA	NA	NA	NA
7	8	0	3	4	2	1	5	7	6	NA	NA	NA	NA	NA	NA

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000686

8	9	0	5	1	6	4	8	3	2	7	NA	NA	NA	NA	NA
9	10	0	1	6	7	2	9	5	4	3	8	NA	NA	NA	NA
10	11	1	0	2	3	6	7	4	5	8	10	9	NA	NA	NA
11	12	0	3	2	1	4	6	5	7	11	8	9	10	NA	NA
12	13	0	1	5	6	4	2	3	7	8	12	10	11	9	NA
13	14	0	1	7	2	8	6	5	3	4	13	12	9	11	10
14	15	0	1	2	8	3	9	7	6	4	5	14	10	13	12
15	16	0	1	2	3	4	8	7	5	9	6	10	15	11	13
16	17	0	3	1	2	4	5	8	9	7	6	10	11	12	16
17	18	0	1	5	2	6	4	3	7	8	9	10	17	13	14
18	19	0	1	7	8	2	6	3	9	4	5	10	18	15	16
19	20	0	9	1	10	2	8	3	7	4	16	17	6	19	5
20	21	0	1	10	2	11	3	9	5	4	17	20	18	8	7
21	22	1	0	2	3	4	10	11	5	6	9	7	12	8	13
22	23	0	3	4	2	1	5	7	6	10	11	8	9	12	13
23	24	0	5	6	1	4	3	7	2	8	10	11	9	12	15
24	25	0	7	1	8	6	5	2	9	10	4	11	3	12	17
25	26	0	1	9	10	2	8	11	7	3	6	5	12	4	19
26	27	0	1	11	2	10	12	3	9	7	8	4	6	20	13
27	28	0	1	2	12	3	4	11	13	9	5	8	10	7	6

	codeNum% (maxRun+1)													
maxRun	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	14	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16	13	14	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
17	12	15	11	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
18	14	11	13	17	12	NA	NA	NA	NA	NA	NA	NA	NA	NA
19	11	15	12	14	13	18	NA	NA	NA	NA	NA	NA	NA	NA
20	6	12	16	13	15	19	14	NA	NA	NA	NA	NA	NA	NA
21	18	21	17	19	14	20	16	15	NA	NA	NA	NA	NA	NA
22	14	22	18	15	19	20	17	16	21	NA	NA	NA	NA	NA
23	14	13	23	16	19	17	18	21	20	22	NA	NA	NA	NA

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000687

24	16	13	24	18	19	15	20	23	14	21	22	NA	NA	NA
25	13	18	20	14	17	25	21	16	23	24	15	22	NA	NA
26	5	14	26	21	19	18	25	15	16	17	24	22	23	NA
27	21	14	27	15	22	19	16	20	17	26	18	25	23	24

9.2.4.4 Parsing process for level

Inputs to this process are bits from slice data and the variable vlcNumLevel.

Outputs of this process are the syntax element level and the variable vlcNumLevel.

– The syntax element level is determined by invoking the parsing process described in subclause 9.2.1 with vlcNumLevel as input and level as output.

– The variable vlcNumLevel derived in the following ordered steps updated as follows.

1. The variable vlcIdx is set equal to vlcIdx = Min(3,vlcNumLevel)
2. The variable levelThreshold is derived from vlcIdx as shown in Table 9-13.
3. The variable vlcNumLevel is derived as

$$vlcNumLevel = vlcNumLevel + (level > levelThreshold \;\&\&\; vlcNumLevel < 4 \;?\; 1 : 0) \quad (9\text{-}41)$$

Table 9-14 – Derivation of levelThreshold from vlcIdx

vlcIdx	levelThreshold
0	4
1	6
2	14
3	28

9.2.4.5 Parsing process for cu_split_pred_part_mode

This process is invoked when entropy_coding_mode_flag is equal to 0 for parsing syntax element **cu_split_pred_part_mode** in subclause 7.3.5.

Inputs to this process are bits from slice data, splitPredPartModeTable.

Output of this process is the syntax element cu_split_pred_part_mode.

The value of cu_split_pred_part_mode is derived as follows.

– If log2CUSize is greater than Log2MinCUSize, the parsing process described in subclause 9.2.1 is invoked with vlcNum of 14 and cMax of 10 as inputs and the variable codeNum as output.

– Otherwise, the parsing process described in subclause 9.2.1 is invoked with vlcNum of 14 and cMax of 5 as inputs and the variable codeNum as output.

– The syntax element cu_split_pred_part_mode is derived as

$$cu\_split\_pred\_part\_mode = splitPredPartModeTable[Log2MaxCUSize - log2CUSize][codeNum] \quad (9\text{-}41)$$

– If log2CUSize is equal to Log2MinCUSize and cu_split_part_mode has a value of 5, PredMode and PartMode are determined as follows

1. Read one bit and assign its value to a variable b
2. If b is equal to 1, set PredMode to MODE_INTRA and PartMode to PART_2Nx2N
3. Otherwise if inter_4x4_enabled_flag is equal to 0 and log2CUSize is equal to 3, set PredMode to MODE_INTRA and PartMode to PART_NxN
4. Otherwise, read the next one bit and assign its value to the variable b.
    1. If b is equal to 1, set PredMode to MODE_INTRA and PartMode to PART_NxN
    2. Otherwise, set PredMode to MODE_INTER and PartMode to PART_NxN

– The variable array splitPredPartModeTable[Log2MaxCUSize – log2CUSize] is updated by invoking process 9.2.3 with splitPredPartModeTable[Log2MaxCUSize – log2CUSize], codeNum and a value of 4 as inputs.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000688

9.2.4.6 Parsing process for rem_intra_luma_pred_mode

This process is invoked when entropy_coding_mode_flag is equal to 0 for parsing syntax element rem_intra_luma_pred_mode in subclause 7.3.7.

Inputs to this process are bits from slice data, a variable log2CUSize specifying the size of the current coding unit and a variable array intraModeTable.

Outputs of this process are the syntax element rem_intra_luma_pred_mode and value-updated intraModeTable.

The variable log2PUSize is derived as follows.

– If PartMode is equal to PART_NxN, log2PUSize is set equal to log2CUSize – 1,

– Otherwise, log2PUSize is set equal to log2CUSize.

The value of rem_intra_luma_pred_mode is derived as follows.

– Based on log2PUSize, the value of a variable intraPredModeNum indicating the number of intra prediction modes for the given size of prediction unit is obtained according to Table 8-2.

– If intraPredModeNum is equal to 4, read one bit and assign its value to rem_intra_luma_pred_mode. No further step is carried out. Othewise,

– The values of variable k and vlcNum are obtained as follows

  – If intraPredModeNum is equal to 18, set vlcNum and k equal to 20 and 0, respectively.

  – If intraPredModeNum is equal to 35, set vlcNum and k equal to 21 and 1, respectively.

  – The parsing process described in subclause 9.2.1 is invoked with vlcNum as input and the variable codeNum as output.

  – The value of rem_intra_luma_pred_mode is set equal to intraModeTable[k][codeNum].

  – The value of a variable counterNum is set to 0. The variable array intraModeTable[k] is updated by invoking process in subclause 9.2.3 with intraModeTable[k], codeNum and counterNum as inputs.

9.2.4.7 Parsing process for cbp_and_split_transform

This process is invoked when entropy_coding_mode_flag is equal to 0 for parsing syntax element cbp_and_split_transform in subclause 7.3.8.

Inputs to this process are bits from slice data, a variable cbpVlcNumIdx, trafoDepth and a variable array cbpSplitTransTable.

Outputs of this process are the syntax element cbp_and_split_transform and value-updated cbpVlcNumIndex and cbpSplitTransTable.

The value of cbp_and_split_transform is derived as follows.

– Obtain a 4-bit value flagPattern accoding to subclause 7.4.8.

– Derive the value of a variable k according to Table 9-16.

– Set the value of a variable n as

$$n = (PredMode == MODE\_INTRA\ ?\ 0 :\ 1) \tag{9-43}$$

– Obtain a value of vlcNum as follows

  – If flagPattern is equal to 8,

$$vlcNum = (n == 0\ ?\ cbpVlcNumTable[cbpVlcNumIdx]:11) \tag{9-44}$$

  – Otherwise, if flagPattern is equal to 11, 13 or 15 and n is equal to 0, set vlcNum to 15;

  – Otherwise, set vlcNum to 14.

– If vlcNum is euqal to 14, obtain the value of a variable cMax according to Table 9-15.

– The parsing process described in subclause 9.2.1 is invoked with vlcNum and cMax as inputs and the variable codeNum as output.

– Set the value of cbp_and_split_transform equal to cbpSplitTransTable[k][n][codeNum]

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000689

– If flagPattern is not equal to 10 or 12, a variable counterNum is obtained according to Table 9-16 and the variable array cbpSplitTransTable[k][n] is updated by invoking process 9.2.3 with cbpSplitTransTable[k][n], codeNum and counterNum as inputs.

– If flagPattern is euqal to 8 and n is equal to 0, the value of cbpVlcNumIdx is updated as follows

```
if(codeNum < cbpVlcNumIdx)
    cbpVlcNumIdx -= 1                                   (9-45)
else if (codeNum > cbpVlcNumIdx)
    cbpVlcNumIdx += 1
```

– If flagPattern is euqal to 15, the exact values of Cb and Cr in Table 7-13 are determined as follows.

  – The parsing process described in subclause 9.2.1 is invoked with vlcNum of 14 and cMax of 2 as inputs and the variable codeNum as output.

  – Set the value of variable b as

$$b = n? (codeNum + 1) : (3 - codeNum) \quad (9\text{-}46)$$

  – The values of Cb and Cr are set equal to

$$Cb = (b >> 1) \quad (9\text{-}47)$$

$$Cr = (b \,\&\, 0x01) \quad (9\text{-}48)$$

Table 9-15 – Specification of cbpVlcNumTable[cbpVlcNumIdx]

cbpVlcNumIdx	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
vlcNum	1	2	2	2	11	11	11	11	11	11	11	11	11	11	11

Table 9-16 – Derivation of cMax from flagPattern and n

	flagPattern			
n	9	10, 12	11,13,15	14
0	3	3	-	7
1	2	3	6	7

Table 9-17 – Specification of cbpSplitTransTable and counterNum associated

flagPattern	8	9	10, 12	11, 13, 15	14 (trafoDepth=0)	14 (trafoDepth>0)
k	0	1	2	3	4	5
counterNum	2	3	0	4	4	4

9.3 CABAC parsing process for slice data

[Ed. (TW) needs to be extended]

This process is invoked when parsing syntax elements with descriptor ae(v) in subclauses 7.3.4 and 7.3.5 when entropy_coding_mode_flag is equal to 1.

Inputs to this process are a request for a value of a syntax element and values of prior parsed syntax elements.

Output of this process is the value of the syntax element.

When starting the parsing of the slice data of a slice in subclause 7.3.4, the initialisation process of the CABAC parsing process is invoked as specified in subclause 9.3.1.

The parsing of syntax elements proceeds as follows:

For each requested value of a syntax element a binarization is derived as described in subclause 9.3.2.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000690

The binarization for the syntax element and the sequence of parsed bins determines the decoding process flow as described in subclause 9.3.3.

For each bin of the binarization of the syntax element, which is indexed by the variable binIdx, a context index ctxIdx is derived as specified in subclause 9.3.3.1.

For each ctxIdx the arithmetic decoding process is invoked as specified in subclause 9.3.3.2.

The resulting sequence ($b_0..b_{binIdx}$) of parsed bins is compared to the set of bin strings given by the binarization process after decoding of each bin. When the sequence matches a bin string in the given set, the corresponding value is assigned to the syntax element.

In case the request for a value of a syntax element is processed for the syntax element mb_type and the decoded value of mb_type is equal to I_PCM, the decoding engine is initialised after the decoding of any pcm_alignment_zero_bit and all pcm_sample_luma and pcm_sample_chroma data as specified in subclause 9.3.1.2.

9.3.1 Initialisation process

Outputs of this process are initialised CABAC internal variables.

The processes in subclauses 9.3.1.1 and 9.3.1.2 are invoked when starting the parsing of the slice data of a slice in subclause 7.3.4.

9.3.1.1 Initialisation process for context variables

Formatted: Heading 5

Outputs of this process are the initialised CABAC context variables indexed by ctxIdxTable and ctxIdx.

Table 9-21 toTable 9-45 contain the values of the variables n and m used in the initialisation of context variables that are assigned to all syntax elements in subclauses 7.3.4 to 7.3.10 except for the end-of-slice flag and those related to CAVLC.

For each context variable, the two variables pStateIdx and valMPS are initialised.

NOTE 1 – The variable pStateIdx corresponds to a probability state index and the variable valMPS corresponds to the value of the most probable symbol as further described in subclause 9.3.3.2.

The two values assigned to pStateIdx and valMPS for the initialisation are derived from $SliceQP_Y$, which is derived in Equation 7-9. Given the two table entries (m, n), the initialisation is specified by the following pseudo-code process:

```
preCtxState = Clip3( 1, 126, ( ( m * Clip3( 0, 51, SliceQPY ) ) >> 4 ) + n )
if( preCtxState <= 63 ) {
    pStateIdx = 63 − preCtxState
    valMPS = 0                                                    (9-4)
} else {
    pStateIdx = preCtxState − 64
    valMPS = 1
}
```

In Table 9-20, the ctxIdxTable and the ctxIdx for which initialisation is needed for each of the slice types are listed. The referenced context index tables ctxIdxTable include the values of m and n needed for the initialisation.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000691

Table 9-20 – Association of ctxIdx and syntax elements for each slice type in the initialisation process

	Syntax element	ctxIdxTable	Slice Type		
			I	P	B
slice_header()	alf_cu_flag	Table 9-21	0	1	2
coding_tree()	split_coding_unit_flag	Table 9-22	0..2	3..5	6..8
coding_unit()	skip_flag	Table 9-23		0..2	3..5
	cu_qp_delta	Table 9-24	0..3	4..7	8..11
	pred_type	Table 9-25	0	1..4	5..9
prediction_unit()	prev_intra_luma_pred_flag	Table 9-26	0	1	2
	rem_intra_luma_pred_mode	Table 9-27	0	1	2
	intra_chroma_pred_mode	Table 9-28	0..1	2..3	4..5
	merge_flag	Table 9-29		0	1
	merge_idx	Table 9-30		0..3	4..7
	inter_pred_flag	Table 9-31			0..3
	ref_idx_lc, ref_idx_l0, ref_idx_l1	Table 9-32		0..2	3..5
	abs_mvd_greater0_flag	Table 9-33		0	1
	abs_mvd_greater1_flag	Table 9-33		2	3
	mvp_idx_lc, mvp_idx_l0, mvp_idx_l1	Table 9-34		0..1	2..3
transform_tree()	no_residual_data_flag	Table 9-35		0	1
	split_transform_flag	Table 9-36	0..3	4..7	8..11
	cbf_luma	Table 9-37	0..1	2..3	4..5
	cbf_cb	Table 9-38	0..3	4..7	8..11
	cbf_cr	Table 9-39	0..3	4..7	8..11
residual_coding()	last_significant_coeff_x, last_significant_coeff_y	Table 9-40	0..30	31..61	62..92
	significant_coeff_flag		Table 9-41	Table 9-42	Table 9-43
	coeff_abs_level_greater1_flag	Table 9-44	0..79	80..159	160..239
	coeff_abs_level_greater2_flag	Table 9-45	0..79	80..159	160..239

NOTE 2 – ctxIdxTable equal to 0 and ctxIdx equal to 0 are associated with the end_of_slice_flag. The decoding process specified in subclause 9.3.3.2.4 applies to ctxIdxTable equal to 0 and ctxIdx equal to 0. This decoding process, however, may also be implemented by using the decoding process specified in subclause 9.3.3.2.1. In this case, the initial values associated with ctxIdxTable equal to 0 and ctxIdx equal to 0 are specified to be pStateIdx = 63 and valMPS = 0, where pStateIdx = 63 represents a non-adapting probability state.

Table 9-21 – Values of variables m and n for alf_cu_flag ctxIdx

Initialisation variables	alf_cu_flag ctxIdx		
	0	1	2
m	0	0	0
n	64	64	64

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000692

Table 9-22 – Values of variables m and n for split_coding_unit_flag ctxIdx

Initialisation variables	split_coding_unit_flag ctxIdx								
	0	1	2	3	4	5	6	7	8
m	-7	-10	-10	-14	-6	-6	−14	−7	−10
n	68	87	105	71	73	91	71	74	92

Table 9-23 – Values of variables m and n for skip_flag ctxIdx

Initialisation variables	skip_flag ctxIdx					
	0	1	2	3	4	5
m	0	0	0	0	0	0
n	64	64	64	64	64	64

Table 9-24 – Values of variables m and n for cu_qp_delta ctxIdx

Initialisation variables	cu_qp_delta ctxIdx								
	0	1	2	3	4	5	6	7	8
m	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64

Table 9-25 – Values of variables m and n for pred_type

Initialisation variables	pred_type ctxIdx									
	0	1	2	3	4	5	6	7	8	9
m	0	-25	-1	-3	6	6	-1	13	-11	-11
n	73	89	64	63	78	50	56	53	76	70

Table 9-26 – Values of variable m and n for prev_intra_luma_pred_flag ctxIdx

Initialisation variables	prev_intra_luma_pred_flag ctxIdx		
	0	1	2
m	2	0	0
n	54	50	51

Table 9-27 – Values of variable m and n for rem_intra_luma_pred_mode ctxIdx

Initialisation variables	rem_intra_luma_pred_mode ctxIdx		
	0	1	2
m	-3	-2	1
n	65	61	55

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000693

Table 9-28 – Values of variable m and n for intra_chroma_pred_mode ctxIdx

Initialisation variables	intra_chroma_pred_mode ctxIdx					
	0	1	2	3	4	5
m	0	0	0	0	0	0
n	64	64	64	64	64	64

Table 9-29 – Values of variable m and n for merge_flag ctxIdx

Initialisation variables	merge_flag ctxIdx
	0
m	0
n	64

Table 9-30 – Values of variable m and n for merge_idx ctxIdx

Initialisation variables	merge_idx ctxIdx							
	0	1	2	3	4	5	6	7
m	0	0	0	0	1	6	-7	−4
n	64	64	64	64	65	42	75	72

Table 9-31 – Values of variable m and n for inter_pred_flag ctxIdx

Initialisation variables	inter_pred_flag ctxIdx			
	0	1	2	3
m	-2	-5	-9	1
n	58	70	85	61

Table 9-32 – Values of variable m and n for ref_idx_lc, ref_idx_l0, ref_idx_l1 ctxIdx

Initialisation variables	ref_idx_lc, ref_idx_l0, ref_idx_l1 ctxIdx					
	0	1	2	3	4	5
m	-6	-17	1	-9	-12	-18
n	59	96	59	55	86	55

Table 9-33 – Values of variable m and n for abs_mvd_greater0_flag and abs_mvd_greater1_flag ctxIdx

Initialisation variables	abs_mvd_greater0_flag, abs_mvd_greater1_flag ctxIdx			
	0	1	2	3
m	5	-2	-7	14
n	61	79	89	39

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000694

Table 9-34 – Values of variable m and n for mvp_idx_lc, mvp_idx_l0, mvp_idx_l1 ctxIdx

Initialisation variables	mvp_idx_lc, mvp_idx_l0, mvp_idx_l1 ctxIdx			
	0	1	2	3
m	0	0	0	0
n	64	64	64	64

Table 9-35 – Values of variable m and n for no_residual_data_flag ctxIdx

Initialisation variables	no_residual_data_flag ctxIdx	
	0	1
m	−22	−36
n	85	103

Table 9-36 – Values of variable m and n for split_transform_flag ctxIdx

Initialisation variables	split_transform_flag ctxIdx											
	0	1	2	3	4	5	6	7	8	9	10	11
m	0	12	22	-2	0	-28	-30	-34	-11	-31	-42	-47
n	64	12	4	49	13	89	99	106	38	88	118	130

Table 9-37 – Values of variable m and n for cbf_luma ctxIdx

Initialisation variables	cbf_luma ctxIdx					
	0	1	2	3	4	5
m	-22	-5	-18	-41	-11	-32
n	116	75	98	120	80	83

Table 9-38 – Values of variable m and n for cbf_cb ctxIdx

Initialisation variables	cbf_cb ctxIdx											
	0	1	2	3	4	5	6	7	8	9	10	11
m	-35	-12	-9	-10	-46	-42	-11	-19	-22	-48	-7	-37
n	116	61	73	75	114	119	74	90	52	123	68	121

Table 9-39 – Values of variable m and n for cbf_cr ctxIdx

Initialisation variables	cbf_cr ctxIdx											
	0	1	2	3	4	5	6	7	8	9	10	11
m	-29	-12	-5	-6	-43	-41	-17	-25	-19	-48	-21	-9
n	104	59	65	67	107	118	86	101	45	123	94	73

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000695

Table 9-40 – Values of variable m and n for last_significant_coefficient_x and last_significant_coefficient_y ctxIdx

Initialisation variables	last_significant_coefficient_x and last_significant_coeff_y ctxIdx															
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	
m	14	10	12	22	10	9	17	15	16	17	18	16	23	20	24	
n	25	38	41	25	37	40	19	21	18	16	13	18	-2	-2	-9	
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	
m	24	18	9	22	37	35	53	31	13	21	35	22	18	9	14	
n	-7	10	24	-7	9	14	-5	21	39	28	2	17	23	40	32	
	30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	
m	7	12	12	13	21	24	23	13	22	29	29	27	20	25	30	
n	44	35	40	47	16	10	15	34	10	10	-8	-5	7	13	-8	
	45	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	
m	35	37	42	42	43	21	22	35	11	22	27	-3	14	23	27	
n	-20	-29	-41	-45	-46	36	37	27	53	27	18	83	35	18	3	
	60	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	
m	32	17	12	12	13	21	24	23	13	22	29	29	27	20	25	
n	-11	11	35	40	47	16	10	15	34	10	10	-8	-5	7	13	
	75	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	
m	30	35	37	42	42	43	21	22	35	11	22	27	-3	14	23	
n	-8	-20	-29	-41	-45	-46	36	37	27	53	27	18	83	35	18	
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**	
m	27	32	17													
n	3	-11	11													

Table 9-41 – Values of variable m and n for significant_coeff_flag ctxIdx (A)

Initialisation variables	significant_coeff_flag ctxIdx															
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	32	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
m	-22	-14	-17	-26	5	-2	-32	-19	-7	-24	0	-1	2	0	-15	0
n	128	96	99	113	31	65	125	72	69	111	25	49	54	64	97	64
	48	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	64	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
m	-4	0	-4	-5	17	2	-8	1	2	-11	6	5	2	0	-8	0
n	88	68	75	74	7	56	80	36	52	85	12	41	54	65	82	64
	80	**81**	**82**	**83**	**84**	**85**	**86**	**87**								
m	-8	-7	-7	-9	-18	-7	-11	-29								
n	95	77	73	74	77	72	81	92								

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000696

Table 9-42 – Values of variable m and n for significant_coeff_flag ctxIdx (B)

Initialisation variables	significant_coeff_flag ctxIdx															
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	32	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
m	-22	-14	-17	-26	5	-2	-32	-19	-7	-24	0	-1	2	0	-15	0
n	128	96	99	113	31	65	125	72	69	111	25	49	54	64	97	64
	48	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	64	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
m	-4	0	-4	-5	17	2	-8	1	2	-11	6	5	2	0	-8	0
n	88	68	75	74	7	56	80	36	52	85	12	41	54	65	82	64
	80	**81**	**82**	**83**	**84**	**85**	**86**	**87**								
m	-8	-7	-7	-9	-18	-7	-11	-29								
n	95	77	73	74	77	72	81	92								

Table 9-43 – Values of variable m and n for significant_coeff_flag ctxIdx (C)

Initialisation variables	significant_coeff_flag ctxIdx															
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	32	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
m	-34	-20	-23	38	3	-4	-17	-9	-4	-16	-1	0	-1	-12	-14	0
n	146	108	111	41	34	69	103	50	66	97	24	50	61	90	97	64
	48	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**
m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	64	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
m	-12	-4	-8	-7	15	2	-10	4	-10	-9	-9	6	3	-1	-14	0
n	99	75	81	80	13	57	85	27	75	81	46	41	56	69	96	64
	80	**81**	**82**	**83**	**84**	**85**	**86**	**87**								
m	-7	-22	-12	-35	-5	-16	-9	-26								
n	85	102	79	121	55	88	78	73								

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000697

Table 9-44 – Values of variable m and n for coeff_abs_level_greater1_flag ctxIdx

Initialisation variables	coeff_abs_level_greater1_flag ctxIdx														
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
m	-11	-20	-16	-13	-10	-5	-8	-8	-3	-9	0	-5	-12	-9	-1
n	87	64	68	71	73	67	26	37	36	56	63	39	56	57	52
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
m	-4	-19	-28	-23	-3	-2	-27	-22	-14	-1	-10	-22	-13	-6	-5
n	72	73	88	85	59	72	97	89	77	58	86	74	63	57	63
	30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
m	-4	16	9	5	-7	-6	-13	-12	-18	-14	-5	-8	-22	-35	-3
n	70	-2	23	41	67	63	-5	42	53	59	65	36	67	89	47
	45	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**
m	-12	-20	-51	-44	-23	-1	-58	-71	-67	-91	-1	20	13	2	5
n	77	66	113	109	84	64	127	143	134	187	64	-3	21	46	48
	60	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**
m	-4	29	1	-6	-9	-6	23	3	-5	5	-12	-2	-15	-11	-3
n	71	-5	45	58	67	66	-7	26	42	31	79	45	67	62	54
	75	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**
m	-4	-13	-3	-26	-18	-9	-30	-24	-43	-6	4	34	21	14	5
n	70	68	100	91	84	83	103	90	122	66	59	-11	10	25	44
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**
m	-4	40	19	-11	-6	-11	12	17	-6	11	-11	1	-26	-28	-2
n	69	-33	8	65	59	68	-2	-10	34	14	70	27	71	79	47
	105	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**
m	6	-23	-47	-55	-21	1	-38	-34	-45	10	9	41	32	14	17
n	47	67	107	117	83	59	82	77	95	25	46	-31	-17	19	18
	120	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**	**141**	**142**
m	-2	18	10	-2	-7	-6	19	-5	-7	-4	-23	-3	2	-32	-16
n	65	22	33	55	64	67	11	50	53	54	99	51	41	102	79
	135	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**
m	-8	-21	-26	-33	-4	-31	-34	-25	-43	-6	3	23	12	11	8
n	77	84	91	104	61	122	110	96	124	70	60	12	30	33	40
	150	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**	**161**	**162**	**163**	**164**
m	-2	40	0	-5	7	-39	31	1	-35	-32	-15	16	-43	-75	-8
n	66	-20	46	54	37	116	-27	22	82	85	72	0	102	152	55
	165	**166**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**
m	-9	-12	-84	-93	25	-104	-40	-51	110	3	17	55	28	-5	29
n	68	54	171	186	12	222	92	93	-169	52	33	-45	1	55	-4

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000698

Table 9-45 – Values of variable m and n for coeff_abs_level_greater2_flag ctxIdx

Initialisation variables	coeff_abs_level_greater2_flag ctxIdx														
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
m	-12	-10	-11	-14	-35	-10	-1	-17	-5	-22	-13	-2	-13	-21	-3
n	72	79	87	94	136	58	54	86	70	105	70	59	81	96	73
	15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
m	-24	-19	-1	1	-17	-7	-20	-11	-27	-12	-9	-8	-4	-3	-9
n	90	88	63	60	97	69	95	84	110	96	72	76	75	76	94
	30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
m	-11	-4	-9	-24	-24	-18	-10	-19	-28	6	-12	-17	-8	-44	-17
n	65	66	82	107	111	58	61	82	97	47	50	73	66	115	86
	45	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**
m	-26	-4	-43	-58	-51	-51	-85	-47	-95	-65	-2	7	-2	3	4
n	74	48	115	141	137	117	176	120	202	159	53	43	67	62	67
	60	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**
m	-2	-13	-11	-13	-24	-4	-17	-16	-19	-28	-12	-11	-18	-6	-19
n	49	81	82	88	112	44	77	82	89	110	64	70	88	67	97
	75	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**
m	-17	-27	-18	-13	-17	-11	-15	-10	-10	-12	-8	-7	-6	-8	-9
n	76	100	88	84	94	73	83	77	80	91	63	71	73	80	90
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**
m	14	-7	-4	-8	-50	2	11	-4	-41	-60	-12	-6	1	-5	-12
n	20	68	66	76	148	22	15	49	117	149	49	55	44	58	73
	105	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**
m	13	5	-29	0	-23	-12	6	35	42	22	24	11	2	-5	4
n	9	26	101	46	92	57	30	-4	-24	24	0	34	61	75	62
	120	**129**	**130**	**131**	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**	**141**	**142**
m	0	-6	-7	-31	-25	-20	-14	-20	-21	-6	-19	-34	-27	-7	-7
n	43	65	71	117	109	76	73	88	92	71	73	108	101	69	75
	135	**136**	**137**	**138**	**139**	**140**	**141**	**142**	**143**	**144**	**145**	**146**	**147**	**148**	**149**
m	-18	-7	-20	-9	-7	-26	-13	-6	-12	-2	-3	-6	-7	-6	-11
n	77	64	91	75	78	98	81	69	83	70	50	66	73	75	91
	150	**151**	**152**	**153**	**154**	**155**	**156**	**157**	**158**	**159**	**160**	**161**	**162**	**163**	**164**
m	19	2	4	-4	-32	13	-29	-64	-90	26	-24	8	-10	-16	-27
n	10	49	52	69	114	-1	85	143	186	4	68	30	61	78	96
	165	**166**	**167**	**168**	**169**	**170**	**171**	**172**	**173**	**174**	**175**	**176**	**177**	**178**	**179**
m	31	-12	-15	-68	31	-8	-32	-36	-53	36	26	19	-22	5	8
n	-16	54	70	158	12	44	63	81	106	12	-5	17	101	54	53

9.3.1.2 Initialisation process for the arithmetic decoding engine

This process is invoked before decoding the first treeblock of a slice.

Outputs of this process are the initialised decoding engine registers codIRange and codIOffset both in 16 bit register precision.

The status of the arithmetic decoding engine is represented by the variables codIRange and codIOffset. In the initialisation procedure of the arithmetic decoding process, codIRange is set equal to 510 and codIOffset is set equal to the value returned from read_bits(9) interpreted as a 9 bit binary representation of an unsigned integer with most significant bit written first.

The bitstream shall not contain data that result in a value of codIOffset being equal to 510 or 511.

NOTE – The description of the arithmetic decoding engine in this Recommendation | International Standard utilizes 16 bit register precision. However, a minimum register precision of 9 bits is required for storing the values of the variables codIRange and codIOffset after invocation of the arithmetic decoding process (DecodeBin) as specified in subclause 9.3.3.2. The arithmetic

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000699

decoding process for a binary decision (DecodeDecision) as specified in subclause 9.3.3.2.1 and the decoding process for a binary decision before termination (DecodeTerminate) as specified in subclause 9.3.3.2.4 require a minimum register precision of 9 bits for the variables codIRange and codIOffset. The bypass decoding process for binary decisions (DecodeBypass) as specified in subclause 9.3.3.2.3 requires a minimum register precision of 10 bits for the variable codIOffset and a minimum register precision of 9 bits for the variable codIRange.

9.3.2 Binarization process

Input to this process is a request for a syntax element.

Output of this process is the binarization of the syntax element, maxBinIdxCtx, ctxIdxOffset, and bypassFlag.

Table 9-46 specifies the type of binarization process, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset associated with each syntax element.

The specification of the unary (U) binarization process, the truncated unary (TU) binarization process, the truncated Rice (TR), the k-th order Exp-Golomb (EGk) binarization process, and the fixed-length (FL) binarization process are given in subclauses 0 to 9.3.2.5, respectively. Other binarizations are specified in subclauses 9.3.2.6 to 9.3.2.10.

The binarizations for the syntax element coeff_abs_level_minus3 as specified in subclause 9.3.2.9 consist of bin strings given by a concatenation of prefix and suffix bit strings. For these binarization processes, the prefix and the suffix bit string are separately indexed using the binIdx variable as specified further in subclause 9.3.3. The two sets of prefix bit strings and suffix bit strings are referred to as the binarization prefix part and the binarization suffix part, respectively.

Associated with each binarization or binarization part of a syntax element is a specific value of the context index table (ctxIdxTable) variable and the related context index offset (ctxIdxOffset) variable and a specific value of the maxBinIdxCtx variable as given in Table 9-46. When two values for each of these variables are specified for one syntax element in Table 9-46, the value in the upper row is related to the prefix part while the value in the lower row is related to the suffix part of the binarization of the corresponding syntax element.

The use of the DecodeBypass process and the variable bypassFlag is derived as follows.

– If no value is assigned to ctxIdxOffset for the corresponding binarization or binarization part in Table 9-46 labelled as "na", all bins of the bit strings of the corresponding binarization or of the binarization prefix/suffix part are decoded by invoking the DecodeBypass process as specified in subclause 9.3.3.2.3. In such a case, bypassFlag is set equal to 1, where bypassFlag is used to indicate that for parsing the value of the bin from the bitstream the DecodeBypass process is applied.

– Otherwise, for each possible value of binIdx up to the specified value of maxBinIdxCtx given in Table 9-46, a specific value of the variable ctxIdx is further specified in subclause 9.3.3. bypassFlag is set equal to 0.

The possible values of the context index ctxIdx vary depending on the value of ctxIdxTable. The value assigned to ctxIdxOffset specifies the lower value of the range of ctxIdx assigned to the corresponding binarization or binarization part of a syntax element.

ctxIdxTable = 0 and ctxIdx = ctxIdxOffset = 0 are assigned to the syntax element end_of_slice_flag as further specified in subclause 9.3.3.1. For parsing the value of the corresponding bin from the bitstream, the arithmetic decoding process for decisions before termination (DecodeTerminate) as specified in subclause 9.3.3.2.4 is applied.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000700

Table 9-46 – Syntax elements and associated types of binarization, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset

Syntax element		Type of binarization	maxBinIdx Ctx	ctxIdxTable	ctxIdxOffset
alf_cu_flag	I	FL, cMax = 1	0	Table 9-21	0
	P		0	Table 9-21	1
	B		0	Table 9-21	2
end_of_slice_flag	all	FL, cMax = 1	0	0	0
split_coding_unit_flag	I	FL, cMax = 1	0	Table 9-22	0
	P		0	Table 9-22	3
	B		0	Table 9-22	6
skip_flag	P	FL, cMax = 1	0	Table 9-23	0
	B		0	Table 9-23	3
cu_qp_delta	I	as specified in subclause 9.3.2.6	2	Table 9-24	0
	P		2	Table 9-24	3
	B		2	Table 9-24	6
pred_type	I	as specified in subclause 9.3.2.7	0	Table 9-25	0
	P		3	Table 9-25	1
	B		4	Table 9-25	5
pcm_flag	all	FL, cMax = 1	0	0	0
prev_intra_luma_pred_flag	I	FL, cMax = 1	0	Table 9-26	0
	P		0	Table 9-26	1
	B		0	Table 9-26	2
rem_intra_luma_pred_mode	I	as specified in subclause 9.3.2.8	0	Table 9-27	0
	P		0	Table 9-27	1
	B		0	Table 9-27	2
intra_chroma_pred_mode (IntraPredMode < 4)	I	TU, cMax = 3	1	Table 9-28	0
	P		1	Table 9-28	2
	B		1	Table 9-28	4
intra_chroma_pred_mode (4 <= IntraPredMode < 34)	I	TU, cMax = 4	1	Table 9-28	0
	P		1	Table 9-28	2
	B		1	Table 9-28	4
merge_flag	P	FL, cMax = 1	0	Table 9-29	0
	B		0	Table 9-29	1
merge_idx	P	TU, cMax = 5	3	Table 9-30	0
	B		3	Table 9-30	4
inter_pred_flag	B	FL, cMax = 1	0	Table 9-31	0

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000701

Table 9-46 – Syntax elements and associated types of binarization, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset

Syntax element		Type of binarization	maxBinIdxCtx	ctxIdxTable	ctxIdxOffset
ref_idx_lc	B	TU, cMax = num_ref_idx_lC_active_minus1	2	Table 9-32	3
ref_idx_l0	P	TU, cMax = num_ref_idx_l0_active_minus1	2	Table 9-32	0
	B		2	Table 9-32	3
ref_idx_l1	B	TU, cMax = num_ref_idx_l1_active_minus1	2	Table 9-32	3
abs_mvd_greater0_flag[ ]	P	FL, cMax = 1	0	Table 9-33	0
	B		0	Table 9-33	1
abs_mvd_greater1_flag[ ]	P	FL, cMax = 1	0	Table 9-33	2
	B		0	Table 9-33	3
abs_mvd_minus2[ ]	P/B	EG1	na	na	na, (uses Decode Bypass)
mvd_sign_flag[ ]	P/B	FL, cMax = 1	na	na	na, (uses Decode Bypass)
mvp_idx_lc	B	TU, cMax = 2	1	Table 9-34	2
mvp_idx_l0	P	TU, cMax = 2	1	Table 9-34	0
	B		1	Table 9-34	2
mvp_idx_l1	B	TU, cMax = 2	1	Table 9-34	2
no_residual_data_flag	P	FL, cMax = 1	0	Table 9-35	0
	B		0	Table 9-35	1
split_transform_flag	I	FL, cMax = 1	0	Table 9-36	0
	P		0	Table 9-36	4
	B		0	Table 9-36	8
cbf_luma	I	FL, cMax = 1	0	Table 9-37	0
	P		0	Table 9-37	2
	B		0	Table 9-37	4
cbf_cb	I	FL, cMax = 1	0	Table 9-38	0
	P		0	Table 9-38	4
	B		0	Table 9-38	8
cbf_cr	I	FL, cMax = 1	0	Table 9-39	0
	P		0	Table 9-39	4
	B		0	Table 9-39	8
last_significant_coeff_x, last_significant_coeff_y	I	prefix and suffix as specified in subclause 9.3.2.9	30	Table 9-40	0
	P		30	Table 9-40	31
	B		30	Table 9-40	62

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000702

Table 9-46 – Syntax elements and associated types of binarization, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset

Syntax element		Type of binarization	maxBinIdx Ctx	ctxIdxTable	ctxIdxOffset
significant_coeff_flag	I	FL, cMax = 1	0	Table 9-41	0
	P		0	Table 9-42	0
	B		0	Table 9-43	0
coeff_abs_level_greater1_flag	I	FL, cMax = 1	0	Table 9-44	0
	P		0	Table 9-44	60
	B		0	Table 9-44	120
coeff_abs_level_greater2_flag	I	FL, cMax = 1	0	Table 9-45	0
	P		0	Table 9-45	60
	B		0	Table 9-45	120
coeff_abs_level_minus3	all	prefix and suffix as specified in subclause 9.3.2.9	prefix: na suffix: na	prefix: na suffix: na	prefix: na, (uses Decode Bypass) suffix: na, (uses Decode Bypass)
coeff_sign_flag	all	FL, cMax = 1	na	na	na, (uses Decode Bypass)

[Ed. (BB): The TU binarization for last_significant_coeff_x and last_significant_coeff_y is using 0s and a terminating 1 instead of using 1s and a terminating 0.]

9.3.2.1 Unary (U) binarization process

Input to this process is a request for a U binarization for a syntax element.

Output of this process is the U binarization of the syntax element.

The bin string of a syntax element having (unsigned integer) value synElVal is a bit string of length synElVal + 1 indexed by binIdx. The bins for binIdx less than synElVal are equal to 1. The bin with binIdx equal to synElVal is equal to 0.

Table 9-47 illustrates the bin strings of the unary binarization for a syntax element.

Table 9-47 – Bin string of the unary binarization (informative)

Value of syntax element	Bin string					
0 (I_NxN)	0					
1	1	0				
2	1	1	0			
3	1	1	1	0		
4	1	1	1	1	0	
5	1	1	1	1	1	0
…						
binIdx	0	1	2	3	4	5

9.3.2.2 Truncated unary (TU) binarization process

Input to this process is a request for a TU binarization for a syntax element and cMax.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000703

Output of this process is the TU binarization of the syntax element.

For syntax element (unsigned integer) values less than cMax, the U binarization process as specified in subclause 9.3.2.1 is invoked. For the syntax element value equal to cMax the bin string is a bit string of length cMax with all bins being equal to 1.

NOTE – TU binarization is always invoked with a cMax value equal to the largest possible value of the syntax element being decoded.

9.3.2.3 Truncated Rice (TR) binarization process

Input to this process is a request for a TR binarization for a syntax element, cRiceParam and cTRMax.

Output of this process is the TR binarization of the syntax element.

A TR bin string is a concatenation of a prefix bit string and a suffix bit string. The prefix of the binarization is specified by invoking the TU binarization process for the prefix part of the value specified by synElVal >> cRiceParam with cMax = cTRMax >> cRiceParam. The suffix of the TR bin string is the binary representation of synElVal – ((synElVal >> cRiceParam) << cRiceParam).

NOTE – For the input parameter cRiceParam = 0 the TR binarization is exactly the TU binarization.

9.3.2.4 k-th order Exp-Golomb (EGk) binarization process

Input to this process is a request for an EGk binarization for a syntax element.

Output of this process is the EGk binarization of the syntax element.

The bin string of the EGk binarization process of a syntax element synVal is specified by a process equivalent to the following pseudo-code:

```
absV = Abs( synVal )
stopLoop = 0
do {
    if( absV >= ( 1 << k ) ) {
        put( 1 )
        absV = absV – ( 1 << k )
        k++
    } else {
        put( 0 )                                                    (9-5)
        while( k– – )
            put( ( absV >> k ) & 1 )
        stopLoop = 1
    }
} while( !stopLoop )
```

NOTE 1 – The specification for the k-th order Exp-Golomb (EGk) code uses 1's and 0's in reverse meaning for the unary part of the Exp-Golomb code of 0-th order as specified in subclause 9.1.

9.3.2.5 Fixed-length (FL) binarization process

Input to this process is a request for a FL binarization for a syntax element and cMax.

Output of this process is the FL binarization of the syntax element.

FL binarization is constructed by using a fixedLength-bit unsigned integer bin string of the syntax element value, where fixedLength = Ceil(Log2(cMax + 1)). The indexing of bins for the FL binarization is such that the binIdx = 0 relates to the least significant bit with increasing values of binIdx towards the most significant bit.

9.3.2.6 Binarization process for cu_qp_delta

Input to this process is a request for a binarization for the syntax element cu_qp_delta.

Output of this process is the binarization of the syntax element.

The bin string of this binarization process of a syntax element value synVal is specified by a process equivalent to the following pseudo-code.

```
absV = Abs( synVal )
if( absV = = 0 ){
    put( 0 )
} else {
    put( 1 )
```


Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000704

```
        signV = ( synVal > 0 ) ? 0 : 1
        put( signV )
        cMax = 24 + ( QpBdOffsetY >> 1 ) + signV
        cNum = absV − 1
        absVGreaterThan1Flag = ( absV = = 1 ) ? 0 : 1
        put( absVGreaterThan1Flag )
        if( absVGreaterThan1Flag ){
            while( cNum−− )
                put( 1 )
            if( cMax > absV − 1 )
                put( 0 )
        }
    }
```

9.3.2.7 Binarization process for pred_type

Input to this process is a request for a binarization for the syntax element pred_type and a variable cLog2CUSize specifying the current CU size.

Output of this process is the binarization of the syntax element.

The binarization for pred_type is given by Table 9-48 depending on slice type and the size of the coding unit.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000705

Table 9-48 – Binarization for pred_type

Slice type	Value of pred_type	PredMode	PartMode	Bin string		
				cLog2CUSize > Log2MinCUSize	cLog2CUSize = = Log2MinCUSize	
					cLog2CUSize = = 3 && !inter_4x4_enabled_flag	cLog2CUSize > 3 || inter_4x4_enabled_flag
I	0	MODE_INTRA	PART_2Nx2N	-	1	1
	1	MODE_INTRA	PART_NxN	-	0	0
P	0	MODE_INTER	PART_2Nx2N	0 1	0 1	0 1
	1	MODE_INTER	PART_2NxN	0 011	0 01	0 01
	2	MODE_INTER	PART_Nx2N	0 001	0 00	0 001
	4	MODE_INTER	PART_2NxnU	0 0100	-	-
	5	MODE_INTER	PART_2NxnD	0 0101	-	-
	6	MODE_INTER	PART_nLx2N	0 0000	-	-
	7	MODE_INTER	PART_nRx2N	0 0001	-	-
	3	MODE_INTER	PART_NxN	-	-	0 000
	4	MODE_INTRA	PART_2Nx2N	1	11	11
	5	MODE_INTRA	PART_NxN	-	10	10
B	0	MODE_INTER	PART_2Nx2N	1	1	1
	1	MODE_INTER	PART_2NxN	011	01	01
	2	MODE_INTER	PART_Nx2N	001	001	001
	4	MODE_INTER	PART_2NxnU	0100	-	-
	5	MODE_INTER	PART_2NxnD	0101	-	-
	6	MODE_INTER	PART_nLx2N	0000	-	-
	7	MODE_INTER	PART_nRx2N	0001	-	-
	3	MODE_INTER	PART_NxN	-	-	0001
	4	MODE_INTRA	PART_2Nx2N	000	000 0	0000 0
	5	MODE_INTRA	PART_NxN	-	000 1	0000 1

9.3.2.8 Binarization process for rem_intra_luma_pred_mode

Input to this process is a request for the syntax element rem_intra_luma_pred_mode and cNumBins.

Output of this process is the binarization of the syntax element.

The binarization for rem_intra_luma_pred_mode is given by Table 9-49.

Table 9-49 – Binarization for rem_intra_luma_pred_mode

Value of rem_intra_luma_pred_mode	Bin string
less than 32	FL, cMax = cNumBins
32	111110
33	111111

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000706

9.3.2.9 Binarization process for last_significant_coefficient_x and last_significant_coefficient_y

Input to this process is a request for a binarization for the syntax element last_significant_coefficient_pos with pos being x or y and log2TrafoSize.

Output of this process is the binarization of the syntax element.

The variable halfTrafoSize is set equal to 1 << (log2TrafoSize – 1).

- If log2TrafoSize is smaller than 3, the TU binarization process as specified in subclause 9.3.2.2 is invoked with the value of the syntax element last_significant_coeff_position and cMax = halfTrafoSize + 1 as input and the bin string as output.
- Otherwise if last_significant_coefficient_pos is smaller than halfTrafoSize, the TU binarization process as specified in subclause 9.3.2.2 is invoked with the value of the syntax element last_significant_coefficient_pos and cMax = halfTrafoSize as input and the bin string as output.
- Otherwise (log2TrafoSize is greater than 2 and last_significant_coefficient_pos is greater than halfTrafoSize – 1), the bin string of the syntax element consists of a prefix bin string and suffix bin string as follows.
  - The prefix bin string is derived by the TU binarization process as specified in subclause 9.3.2.2 with the symbol value of halfTrafoSize and cMax = halfTrafoSize as input and the bin string as output.
  - The suffix bin string is derived by the FL binarization process as specified in subclause 9.3.2.5 with the symbol value of last_significant_coefficient_pos – halfTrafoSize and cMax = halfTrafoSize – 1 as input and the bin string as output.

9.3.2.10 Binarization process for coeff_abs_level_minus3

Input to this process is a request for a binarization for the syntax element coeff_abs_level_minus3[n].

Output of this process is the binarization of the syntax element.

The variables cLastSE and cLastRiceParam are derived as follows.

- If n is equal to 0 or all previous syntex elements coeff_abs_level_minus3[pos] with pos less than n are derived to be equal to 0 instead of being explicitly parsed, cLastSE and cLastRiceParam are set equal to 0.
- Otherwise (n is not equal to 0), cLastSE is set equal to coeff_abs_level_minus3[n – 1] and cLastRiceParam is set equal to the value of cRiceParam that has been derived during the invocation of this subclause for the syntax element coeff_abs_level_minus2[n – 1] of the same transform block.

The variable cRiceParam is derived as follows.

- If cLastSE is equal to 0 or 1 and cLastRiceParam is equal to 0, cRiceParam is set equal to 0.
- Otherwise if cLastSE is equal to 2 or 3 and cLastRiceParam is equal to 0 or 1, cRiceParam is set equal to 1.
- Otherwise if one of the following conditions is true, cRiceParam is set equal to 2.
  - cLastSE is in the range of 4 to 12 and cLastRiceParam is equal to 0.
  - cLastSE is in the range of 4 to 10 and cLastRiceParam is equal to 1.
  - cLastSE is in the range of 4 to 9 and cLastRiceParam is equal to 2.
- Otherwise, cRiceParam is set equal to 3.

The variable cTRMax is derived from cRiceParam as given in Table 9-50.

Table 9-50 – Specifcation of cTRMax depending on cRiceParam

cRiceParam	cTRMax
0	7
1	20
2	42
3	70

The binarization of coeff_abs_level_minus3 consists of a prefix part and (when present) a suffix part. The prefix part of the binarization is derived by invoking the TR binarization process as specified in subclause 9.3.2.3 for the syntax element coeff_abs_level_minus3[n] with the variables cRiceParam and cTRMax as the inputs.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000707

When the prefix bit string is not equal to the bin string that consists of (cTRMax + 1 >> cRiceParam) + cRiceParam ones, the bin string consists of a prefix bin string and a suffix bin string. The suffix bin string is derived using the EG0 binarization as specified in subclause 9.3.2.4.

9.3.3 Decoding process flow

Input to this process is a binarization of the requested syntax element, maxBinIdxCtx, bypassFlag, ctxIdxTable and ctxIdxOffset as specified in subclause 9.3.2.

Output of this process is the value of the syntax element.

This process specifies how each bit of a bit string is parsed for each syntax element.

After parsing each bit, the resulting bit string is compared to all bin strings of the binarization of the syntax element and the following applies.

– If the bit string is equal to one of the bin strings, the corresponding value of the syntax element is the output.

– Otherwise (the bit string is not equal to one of the bin strings), the next bit is parsed.

While parsing each bin, the variable binIdx is incremented by 1 starting with binIdx being set equal to 0 for the first bin.

When the binarization of the corresponding syntax element consists of a prefix and a suffix binarization part, the variable binIdx is set equal to 0 for the first bin of each part of the bin string (prefix part or suffix part). In this case, after parsing the prefix bit string, the parsing process of the suffix bit string related to the binarizations specified in subclauses 9.3.2.5 9.3.2.3 and 9.3.2.10 9.3.2.10 is invoked depending on the resulting prefix bit string as specified in subclauses 9.3.2.39.3.2.5 and 9.3.2.109.3.2.10.

Depending on the variable bypassFlag, the following applies.

– If bypassFlag is equal to 1, the bypass decoding process as specified in subclause 9.3.3.2.3 is applied for parsing the value of the bins from the bitstream.

– Otherwise (bypassFlag is equal to 0), the parsing of each bin is specified by the following two ordered steps:

1. Given binIdx, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset, ctxIdx is derived as specified in subclause 9.3.3.1.
2. Given ctxIdxTable and ctxIdxIdx, the value of the bin from the bitstream as specified in subclause 9.3.3.2 is decoded.

9.3.3.1 Derivation process for ctxIdx

Inputs to this process are binIdx, maxBinIdxCtx, ctxIdxTable, and ctxIdxOffset.

Output of this process is ctxIdx.

Table 9-51 shows the assignment of ctxIdx increments (ctxIdxInc) to binIdx for all ctxIdxTable and ctxIdxOffset.

The ctxIdx to be used with a specific binIdx is specified by first determining the ctxIdxTable and ctxIdxOffset associated with the given bin string or part thereof. The ctxIdxTable and the ctxIdxOffset ~~is~~ are listed in Table 9-51, the ctxIdx for a binIdx is the sum of ctxIdxOffset and ctxIdxInc, which is found in Table 9-51. When more than one value is listed in Table 9-51 for a binIdx, the assignment process for ctxIdxInc for that binIdx is further specified in the subclauses given in parenthesis of the corresponding table entry.

All bins with binIdx greater than maxBinIdxCtx are parsed using the value of ctxIdx being assigned to binIdx equal to maxBinIdxCtx.

All entries in Table 9-51 labelled with "na" correspond to values of binIdx that do not occur for the corresponding ctxIdxOffset.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000708

Table 9-51 – Assignment of ctxIdxInc to binIdx for all ctxIdxTable and ctxIdxOffset values

Syntax element	ctxIdxTable, ctxIdxOffset		binIdx				
			0	1	2	3	>=4
alf_cu_flag	Table 9-21	0	0	na	na	na	na
		1	0	na	na	na	na
		2	0	na	na	na	na
split_coding_unit_flag	Table 9-22	0	0,1,2 (subclause 9.3.3.1.1.1)	na	na	na	na
		3	0,1,2 (subclause 9.3.3.1.1.1)	na	na	na	na
		6	0,1,2 (subclause 9.3.3.1.1.1)	na	na	na	na
skip_flag	Table 9-23	0	0,1,2 (subclause 9.3.3.1.1.1)	na	na	na	na
		3	0,1,2 (subclause 9.3.3.1.1.1)	na	na	na	na
cu_qp_delta	Table 9-24	0	0	na (uses Decode Bypass)	1	2	2
		3	0	na (uses Decode Bypass)	1	2	2
		6	0	na (uses Decode Bypass)	1	2	2
pred_type	Table 9-25	0	0	na	na	na	na
		1	0	1	2	3	na
		5	0	1	2	3	4
prev_intra_luma_pred_flag	Table 9-26	0	0	na	na	na	na
		1	0	na	na	na	na
		2	0	na	na	na	na
rem_intra_luma_pred_mode	Table 9-27	0	0	0	0	0	0
		1	0	0	0	0	0
		2	0	0	0	0	0
intra_chroma_pred_mode	Table 9-28	0	0	1	1	1	na
		2	0	1	1	1	na
		4	0	1	1	1	na
merge_flag	Table 9-29	0	0	na	na	na	na
		1	0	na	na	na	na
merge_idx	Table 9-30	0	0,1,2,3 (subclause 9.3.3.1.1.2)	0,1,2,3 (subclause 9.3.3.1.1.2)	0,2,3 (subclause 9.3.3.1.1.2)	3	na
		4	0,1,2,3 (subclause 9.3.3.1.1.2)	0,1,2,3 (subclause 9.3.3.1.1.2)	0,2,3 (subclause 9.3.3.1.1.2)	3	na
inter_pred_flag	Table 9-31	0	cuDepth	na	na	na	na

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000709

Table 9-51 – Assignment of ctxIdxInc to binIdx for all ctxIdxTable and ctxIdxOffset values

Syntax element	ctxIdxTable, ctxIdxOffset		binIdx				
			0	1	2	3	>=4
ref_idx_l0	Table 9-32	0	0	1	2	2	2
ref_idx_l0, ref_idx_l1, ref_idx_lc	Table 9-32	3	0	1	2	2	2
abs_mvd_greater0_flag[ ]	Table 9-33	0	0	na	na	na	na
		1	0	na	na	na	na
abs_mvd_greater1_flag[ ]	Table 9-33	2	0	na	na	na	na
		3	0	na	na	na	na
mvp_idx_l0	Table 9-34	0	0	1	1	1	1
mvp_idx_l0, mvp_idx_l1, mvp_idx_lc	Table 9-34	2	0	1	1	1	1
no_residual_data_flag	Table 9-35	0	0	na	na	na	na
		1	0	na	na	na	na
split_transform_flag	Table 9-36	0	cuDepth + trafoDepth	na	na	na	na
		4	cuDepth + trafoDepth	na	na	na	na
		8	cuDepth + trafoDepth	na	na	na	na
cbf_luma	Table 9-37	0	(trafoDepth = = 0) || (log2TrafoSize = = Log2MaxTrafoSize) ? 1 : 0	na	na	na	na
		2	(trafoDepth = = 0) || (log2TrafoSize = = Log2MaxTrafoSize) ? 1 : 0	na	na	na	na
		4	(trafoDepth = = 0) || (log2TrafoSize = = Log2MaxTrafoSize) ? 1 : 0	na	na	na	na
cbf_cb	Table 9-38	0	trafoDepth	na	na	na	na
		4	trafoDepth	na	na	na	na
		8	trafoDepth	na	na	na	na
cbf_cr	Table 9-39	0	trafoDepth	na	na	na	na
		4	trafoDepth	na	na	na	na
		8	trafoDepth	na	na	na	na

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000710

Table 9-51 – Assignment of ctxIdxInc to binIdx for all ctxIdxTable and ctxIdxOffset values

Syntax element	ctxIdxTable, ctxIdxOffset		binIdx				
			0	1	2	3	>=4
last_significant_coeff_x, last_significant_coeff_y	Table 9-40	0	0..30 (subclause 9.3.3.1.1.3)				
		31	0..30 (subclause 9.3.3.1.1.3)				
		62	0..30 (subclause 9.3.3.1.1.3)				
significant_coeff_flag	Table 9-41	0	0..87 (subclause 9.3.3.1.1.4)	na	na	na	na
	Table 9-42	0	0..87 (subclause 9.3.3.1.1.4)	na	na	na	na
	Table 9-43	0	0..87 (subclause 9.3.3.1.1.4)	na	na	na	na
coeff_abs_level_greater1_flag	Table 9-44	0	0..59 (subclause 9.3.3.1.1.5)	na	na	na	na
		60	0..59 (subclause 9.3.3.1.1.5)	na	na	na	na
		120	0..59 (subclause 9.3.3.1.1.5)	na	na	na	na
coeff_abs_level_greater2_flag	Table 9-45	0	0..59 (subclause 9.3.3.1.1.6)	na	na	na	na
		60	0..59 (subclause 9.3.3.1.1.6)	na	na	na	na
		120	0..59 (subclause 9.3.3.1.1.6)	na	na	na	na

9.3.3.1.1 Assignment process of ctxIdxInc using neighbouring syntax elements

Subclause 9.3.3.1.1.1 specifies the derivation process of ctxIdxInc for the syntax elements split_coding_unit_flag and skip_flag.

9.3.3.1.1.1 Derivation process of ctxIdxInc using left and above syntax elements

Input to this process is the luma location (xP, yP) specifying the top-left luma sample of the current prediction unit relative to the top-left sample of the current picture.

Output of this process is ctxIdxInc.

Let the luma location (xL, yL) specify a location covered by the prediction unit to the left of the top-left luma sample of the current prediction unit with xL = xP − MinPuSize and yL = yP, the variable availableL is derived as follows. [Ed.: (BB) MinPuSize should be defined somewhere]

– If the prediction unit covering location (xL, yL) is available, availableL is set equal to 1.

– Otherwise (the prediction unit covering location (xL, yL) is not available), availableL is set equal to 0.

Let the luma location (xA, yA) specify a location covered by the prediction unit above the top-left luma sample of the current prediction unit with xA = xP and yA = yP − MinPuSize, the variable availableA is derived as follows. [Ed.: (BB) MinPuSize should be defined somewhere]

– If the prediction unit covering location (xA, yA) is available, availableA is set equal to 1.

– Otherwise (the prediction unit covering location (xA, yA) is not available), availableA is set equal to 0

The assignment of ctxIdxInc for the syntax elements alf_cu_flag and skip_flag is specified in Table 9-52.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000711

Table 9-52 – Specifcation of ctxIdxInc using left and above syntax elements

Syntax element	condL	condA	ctxIdxInc
split_coding_unit_flag	cuDepth[xL][yL] > cuDepth[xP][yP]	cuDepth[xA][yA] > cuDepth[xP][yP]	(condL && availableL) + (condA && availableA)
skip_flag	skip_flag[xL][yL]	skip_flag[xA][yA]	(condL && availableL) + (condA && availableA)

9.3.3.1.1.2 Derivation process of ctxIdxInc for the syntax element merge_index

Input to this process is binIdx.

Output of this process is ctxIdxInc.

The variable ctxIdxInc is derived as follows.

– If binIdx is equal to 0, the following applies.
  – If availableLeft is equal to 1and availableAbove is equal to 1, ctxIdxInc is set equal to 0.
  – Otherwise if availableLeft is equal to 1 or availableAbove is equal to 1, ctxIdxInc is set equal to 2.
  – Otherwise (availableLeft is equal to 0 and availableAbove is equal to 0), ctxIdxInc is set equal to 3.
– Otherwise if binIdx is equal to 1 and NumMergeCand is greater than 2, the following applies.
  – If availableAbove is equal to 1, ctxIdxInc is set equal to 2.
  – Otherwise (availableAbove is equal to 0), ctxIdxInc is set equal to 3.
– Otherwise if binIdx is equal to 2 and NumMergeCand is greater than 3, ctxIdxInc is set equal to 3.
– Otherwise, ctxIdxInc is set equal to 0.

When ctxIdxInc is not equal to 0, ctxIdxInc is derived as follows.

$$ctxIdxInc = ctxIdxInc - availableCollocated \quad (9\text{-}51)$$

[Ed. (BB): The flags availableLeft, availableAbove, availableCollocated need to be defined or a simpler context derivation should be used.]

9.3.3.1.1.3 Derivation process of ctxIdxInc for the syntax elements last_significant_coeff_x and last_significant_coeff_y

Inputs to this process are the binIdx, the color component index cIdx and the transform block size log2TrafoSize.

Output of this process is ctxIdxInc.

Table 9-53 – Specifcation of lastCtx[i]

i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
lastCtx	0	1	2	3	3	4	4	5	5	5	5	6	6	6	6	7
i	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
lastCtx	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	

The vector lastCtx[i] is specified in Table 9-53. For the derivation of ctxIdxInc, the following applies.

– If log2TrafoSize is less than or equal to 2, ctxIdxInc is derived as follows.

$$ctxIdxInc = lastCtx[\ binIdx\ ] \quad (9\text{-}52)$$

– Otherwise (log2TrafoSize is greater than 2), ctxIdxInc is derived as follows.

$$ctxIdxInc = lastCtx[\ (\ 1 << (\ log2TrafoSize - 1\ )\ ) + binIdx\ ] \quad (9\text{-}53)$$

When cIdx is greater than 0, ctxIdxInc is modified as follows.

$$ctxIdxInc = ctxIdxInc + 19 \quad (9\text{-}54)$$

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000712

[Ed. (BB): The context derivation assumes maximum transform sizes less than or equal to 32x32 for luma and 16x16 for chroma and minimum transform sizes greater than or equal to 4x4.]

9.3.3.1.1.4 Derivation process of ctxIdxInc for the syntax element significant_coeff_flag

Inputs to this process are the color component index cIdx, the current coefficient scan position (xC , yC) and the transform block size log2TrafoSize.

Output of this process is ctxIdxInc.

The variable sigCtx depends on the current position (xC, yC), the transform block size and previsously decoded bins of the syntax element significant_coeff_flag. For the derivation of sigCtx, the following applies.

– If log2TrafoSize is less than or equal to 3, sigCtx is derived as follows.

```
shift  = log2TrafoSize == 3 ? 1 : 0
sigCtx = ( shift * 15 ) + ( ( yC >> shift ) << 2 ) + ( xC >> shift )        (9-55)
```

– Otherwise if xC + yC is less than 2, sigCtx is derived as follows.

```
sigCtx = 31 + ( yC << 1 ) + xC                                              (9-56)
```

– Otherwise if xC + yC is less than 5, sigCtx is derived as follows.

```
temp = significant_coeff_flag[ xC + 1 ][ yC ] + significant_coeff_flag[ xC + 2 ][ yC ] +
       significant_coeff_flag[ xC ][ yC + 1 ] + significant_coeff_flag[ xC + 1 ][ yC + 1 ] +
       significant_coeff_flag[ xC ][ yC + 2 ]                               (9-57)
sigCtx = 34 + Min( 4, temp )
```

– Otherwise (xC + yC is greater than 4), sigCtx is derived using previously decoded bins of the syntax element significant_coeff_flag as follows.

  – The variable sigCtx is initialized as follows.

```
sigCtx = 39                                                                 (9-58)
```

  – When xC is less than (1 << log2TrafoSize) – 1, the following applies.

```
sigCtx = sigCtx + significant_coeff_flag[ xC + 1 ][ yC ]                    (9-59)
```

  – When xC and yC are less than (1 << log2TrafoSize) – 1, the following applies.

```
sigCtx = sigCtx + significant_coeff_flag[ xC + 1 ][ yC + 1 ]                (9-60)
```

  – When xC is less than (1 << log2TrafoSize) – 2, the following applies.

```
sigCtx = sigCtx + significant_coeff_flag[ xC + 2 ][ yC ]                    (9-61)
```

  – When yC is less than (1 << log2TrafoSize) – 1, the following applies.

```
sigCtx = sigCtx + significant_coeff_flag[ xC ][ yC + 1 ]                    (9-62)
```

  – When yC is less than (1 << log2TrafoSize) – 2 and sigCtx is less than 43, the following applies.

```
sigCtx = sigCtx + significant_coeff_flag[ xC ][ yC + 2 ]                    (9-63)
```

The context index increment ctxIdxInc is derived using the color component index cIdx and sigCtx as follows.

– If cIdx is equal to 0, ctxIdxInc is derived as follows.

```
ctxIdxInc = sigCtx                                                          (9-64)
```

– Otherwise (cIdx is greater than 0), ctxIdxInc is derived as follows.

```
ctxIdxInc = 44 + sigCtx                                                     (9-65)
```


Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000713

[Ed. (BB): The context derivation assumes maximum transform sizes less than or equal to 32x32 for luma and 16x16 for chroma and minimum transform sizes greater than or equal to 4x4.]

9.3.3.1.1.5 Derivation process of ctxIdxInc for the syntax element coeff_abs_level_greater1_flag

Inputs to this process are the color component index cIdx, the 16 coefficient subset index i and the current coefficient scan index n within the current subset.

Output of this process is ctxIdxInc.

The variable ctxSet specifies the current context set and for its derivation the following applies.

- If n is equal to 15 or all previous syntax elements coeff_abs_level_greater1_flag[pos] with pos greater than n are derived to be equal to 0 instead of being explicitly parsed, the following applies.
  - The variable ctxSet is initialized as follows.
    - If the current subset index i is equal to 0, the following applies.

      $$ctxSet = 0 \quad (9\text{-}66)$$

    - Otherwise (i is greater than 0), the following applies.

      $$ctxSet = 3 \quad (9\text{-}67)$$

  - When the subset i is not the first one to be processed in this subclause, the following applies.
    - The variable numGreater1 is set equal to the variable numGreater1 that has been derived during the last invocation of subclause 9.3.3.1.1.6 for the syntax element coeff_abs_level_greater2_flag for the subset i + 1.
    - When (numGreater1 >> 1) is greater than 0, ctxSet is incremented by one as follows.

      $$ctxSet = ctxSet + 1 \quad (9\text{-}68)$$

    - When (numGreater1 >> 1) is greater than 3, ctxSet is incremented by one as follows.

      $$ctxSet = ctxSet + 1 \quad (9\text{-}69)$$

  - The variable greater1Ctx is set equal to 1.
- Otherwise (coeff_abs_level_greater1_flag[n] is not the first to be parsed within the current subset i),.for the derivation of ctxSet and greater1Ctx the following applies.
  - The variable ctxSet is set equal to the variable ctxSet that has been derived during the last invocation of this subclause.
  - The variable greater1Ctx is set equal to the variable greater1Ctx that has been derived during the last invocation of this subclause.
  - When greater1Ctx is greater than 0, the variable lastGreater1Flag is set equal to the syntax element coeff_abs_level_greater1_flag that has been used during the last invocation of this subclause and greater1Ctx is modifed as follows.
    - If lastGreater1Flag is equal to 1, greater1Ctx is set equal to 0.
    - Otherwise (lastGreater1Flag is equal to 0), greater1Ctx is incremented by 1.

The context index increment ctxIdxInc is derived using the current context set ctxSet and the current context greater1Ctx as follows.

$$ctxIdxInc = (ctxSet * 5) + Min(4, greater1Ctx) \quad (9\text{-}70)$$

When cIdx is greater than 0, ctxIdxInc is modified as follows.

$$ctxIdxInc = ctxIdxInc + 30 \quad (9\text{-}71)$$

9.3.3.1.1.6 Derivation process of ctxIdxInc for the syntax element coeff_abs_level_greater2_flag

Inputs to this process are the color component index cIdx, the 16 coeffcient subset index i and the current coefficient scan index n within the current subset.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000714

Output of this process is ctxIdxInc.

The variable ctxSet specifies the current context set and for its derivation the following applies.

– If n is equal to 15 or all previous syntex elements coeff_abs_level_greater2_flag[pos] with pos greater than n are derived to be equal to 0 instead of being explicitly parsed, the following applies.
  – The variable ctxSet is initialized as follows.
    – If the current subset index i is equal to 0, the following applies.

      ctxSet = 0 (9-72)

    – Otherwise (i is greater than 0), the following applies.

      ctxSet = 3 (9-73)

  – The variable numGreater1 is set equal to 0.
  – When the subset i is not the first one to be processed in this subclause, the following applies.
    – The variable numGreater1 is set equal to the variable numGreater1 that has been derived during the last invocation of this subclause for the subset i + 1 and is modifed as follows.

      numGreater1 = numGreater1 >> 1 (9-74)

    – When numGreater1 is greater than 0, ctxSet is incremented by one as follows.

      ctxSet = ctxSet + 1 (9-75)

    – When numGreater1 is greater than 3, ctxSet is incremented by one as follows.

      ctxSet = ctxSet + 1 (9-76)

  – The variable greater2Ctx is set equal to 0.
– Otherwise (coeff_abs_level_greater2_flag[n] is not the first to be parsed within the current subset i), for the derivation of ctxSet and greater2Ctx the following applies.
  – The variable ctxSet is set equal to the variable ctxSet that has been derived during the last invocation of this subclause.
  – The variable greater2Ctx is set equal to the variable greater2Ctx that has been derived during the last invocation of this subclause incremented by 1.
  – The variable numGreater1 is set equal to the variable numGreater1 that has been derived during the last invocation of this subclause incremented by 1.

The context index increment ctxIdxInc is derived using the current context set ctxSet and the current context greater2Ctx as follows.

ctxIdxInc = (ctxSet * 5) + Min(4, greater2Ctx) (9-77)

When cIdx is greater than 0, ctxIdxInc is modified as follows.

ctxIdxInc = ctxIdxInc + 30 (9-78)

9.3.3.2 Arithmetic decoding process

Inputs to this process are the bypassFlag, ctxIdxTable, and ctxIdx as derived in subclause 9.3.3.1, and the state variables codIRange and codIOffset of the arithmetic decoding engine.

Output of this process is the value of the bin.

Figure 9-1 illustrates the whole arithmetic decoding process for a single bin. For decoding the value of a bin, the context index table ctxIdxTable and the ctxIdx is passed to the arithmetic decoding process DecodeBin(ctxIdxTable, ctxIdx), which is specified as follows.

– If bypassFlag is equal to 1, DecodeBypass( ) as specified in subclause 9.3.3.2.3 is invoked.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000715

– Otherwise, if bypassFlag is equal to 0, ctxIdxTable is equal 0 and ctxIdx is equal to 0, DecodeTerminate( ) as specified in subclause 9.3.3.2.4 is invoked.

– Otherwise (bypassFlag is equal to 0, ctxIdxTable is not equal to 0 and ctxIdx is not equal to 0), DecodeDecision( ) as specified in subclause 9.3.3.2.1 is applied.

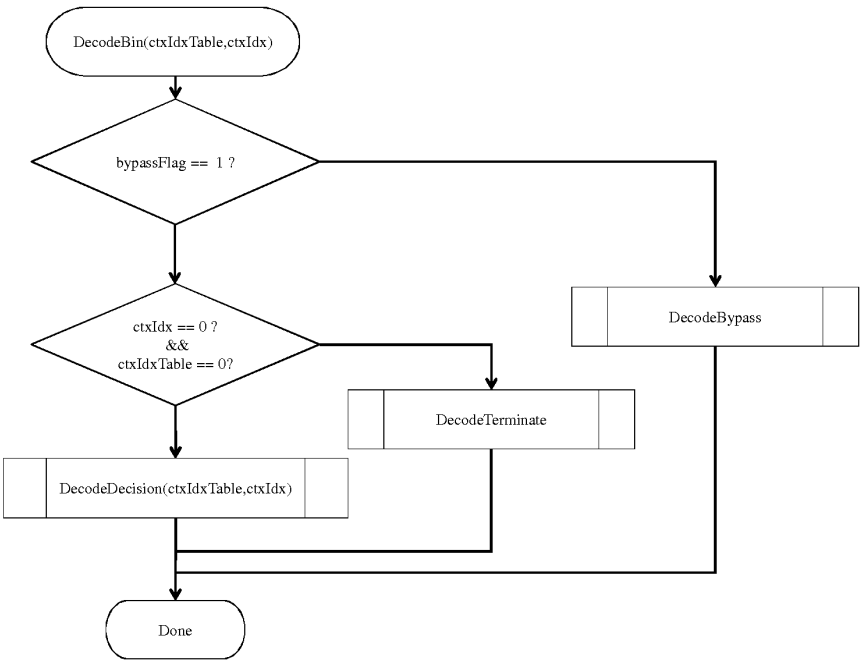


Figure 9-1 – Overview of the arithmetic decoding process for a single bin (informative)

NOTE – Arithmetic coding is based on the principle of recursive interval subdivision. Given a probability estimation p(0) and p(1) = 1 – p(0) of a binary decision (0, 1), an initially given code sub-interval with the range codIRange will be subdivided into two sub-intervals having range p(0) * codIRange and codIRange – p(0) * codIRange, respectively. Depending on the decision, which has been observed, the corresponding sub-interval will be chosen as the new code interval, and a binary code string pointing into that interval will represent the sequence of observed binary decisions. It is useful to distinguish between the most probable symbol (MPS) and the least probable symbol (LPS), so that binary decisions have to be identified as either MPS or LPS, rather than 0 or 1. Given this terminology, each context is specified by the probability p_{LPS} of the LPS and the value of MPS (valMPS), which is either 0 or 1.

The arithmetic core engine in this Recommendation | International Standard has three distinct properties:

– The probability estimation is performed by means of a finite-state machine with a table-based transition process between 64 different representative probability states { p_{LPS}(pStateIdx) | 0 <= pStateIdx < 64 } for the LPS probability p_{LPS}. The numbering of the states is arranged in such a way that the probability state with index pStateIdx = 0 corresponds to an LPS probability value of 0.5, with decreasing LPS probability towards higher state indices.

– The range codIRange representing the state of the coding engine is quantised to a small set {Q_1,…,Q_4} of pre-set quantisation values prior to the calculation of the new interval range. Storing a table containing all 64x4 pre-computed product values of Q_i * p_{LPS}(pStateIdx) allows a multiplication-free approximation of the product codIRange * p_{LPS}(pStateIdx).

– For syntax elements or parts thereof for which an approximately uniform probability distribution is assumed to be given a separate simplified encoding and decoding bypass process is used.

9.3.3.2.1 Arithmetic decoding process for a binary decision

Inputs to this process are ctxIdxTable, ctxIdx, codIRange, and codIOffset.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000716

Outputs of this process are the decoded value binVal, and the updated variables codIRange and codIOffset.

Figure 9-2 shows the flowchart for decoding a single decision (DecodeDecision):

1. The value of the variable codIRangeLPS is derived as follows.
   – Given the current value of codIRange, the variable qCodIRangeIdx is derived by

     qCodIRangeIdx =(codIRange >> 6) & 3 (9-29)

   – Given qCodIRangeIdx and pStateIdx associated with ctxIdxTable and ctxIdx, the value of the variable rangeTabLPS as specified in Table 9-40 is assigned to codIRangeLPS:

     codIRangeLPS = rangeTabLPS[pStateIdx][qCodIRangeIdx] (9-30)

2. The variable codIRange is set equal to codIRange – codIRangeLPS and the following applies.
   – If codIOffset is greater than or equal to codIRange, the variable binVal is set equal to 1 – valMPS, codIOffset is decremented by codIRange, and codIRange is set equal to codIRangeLPS.
   – Otherwise, the variable binVal is set equal to valMPS.

Given the value of binVal, the state transition is performed as specified in subclause 9.3.3.2.1.1. Depending on the current value of codIRange, renormalization is performed as specified in subclause 9.3.3.2.2.

9.3.3.2.1.1 State transition process

Inputs to this process are the current pStateIdx, the decoded value binVal and valMPS values of the context variable associated with ctxIdxTable and ctxIdx.

Outputs of this process are the updated pStateIdx and valMPS of the context variable associated with ctxIdx.

Depending on the decoded value binVal, the update of the two variables pStateIdx and valMPS associated with ctxIdx is derived as specified by the following pseudo-code:

```
if( binVal == valMPS )
    pStateIdx = transIdxMPS( pStateIdx )
else {                                                    (9-31)
    if( pStateIdx == 0 )
        valMPS = 1 – valMPS
    pStateIdx = transIdxLPS( pStateIdx )
}
```

Table 9-41 specifies the transition rules transIdxMPS( ) and transIdxLPS( ) after decoding the value of valMPS and 1 – valMPS, respectively.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000717

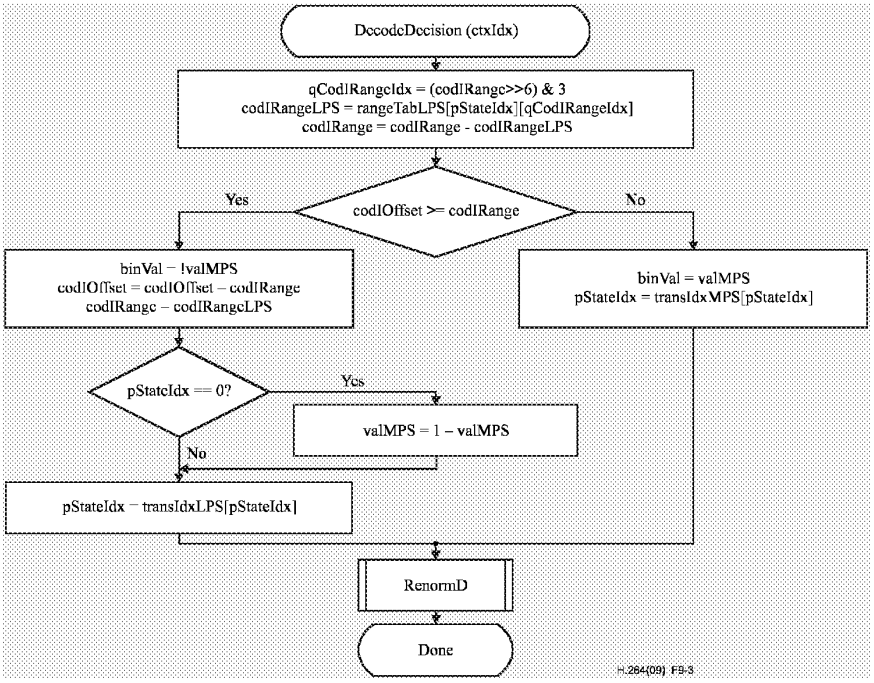


Figure 9-2 – Flowchart for decoding a decision

Table 9-53 – Specification of rangeTabLPS depending on pStateIdx and qCodIRangeIdx

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000718

pStateIdx	qCodIRangeIdx				pStateIdx	qCodIRangeIdx			
	0	1	2	3		0	1	2	3
0	128	176	208	240	**32**	27	33	39	45
1	128	167	197	227	**33**	26	31	37	43
2	128	158	187	216	**34**	24	30	35	41
3	123	150	178	205	**35**	23	28	33	39
4	116	142	169	195	**36**	22	27	32	37
5	111	135	160	185	**37**	21	26	30	35
6	105	128	152	175	**38**	20	24	29	33
7	100	122	144	166	**39**	19	23	27	31
8	95	116	137	158	**40**	18	22	26	30
9	90	110	130	150	**41**	17	21	25	28
10	85	104	123	142	**42**	16	20	23	27
11	81	99	117	135	**43**	15	19	22	25
12	77	94	111	128	**44**	14	18	21	24
13	73	89	105	122	**45**	14	17	20	23
14	69	85	100	116	**46**	13	16	19	22
15	66	80	95	110	**47**	12	15	18	21
16	62	76	90	104	**48**	12	14	17	20
17	59	72	86	99	**49**	11	14	16	19
18	56	69	81	94	**50**	11	13	15	18
19	53	65	77	89	**51**	10	12	15	17
20	51	62	73	85	**52**	10	12	14	16
21	48	59	69	80	**53**	9	11	13	15
22	46	56	66	76	**54**	9	11	12	14
23	43	53	63	72	**55**	8	10	12	14
24	41	50	59	69	**56**	8	9	11	13
25	39	48	56	65	**57**	7	9	11	12
26	37	45	54	62	**58**	7	9	10	12
27	35	43	51	59	**59**	7	8	10	11
28	33	41	48	56	**60**	6	8	9	11
29	32	39	46	53	**61**	6	7	9	10
30	30	37	43	50	**62**	6	7	8	9
31	29	35	41	48	**63**	2	2	2	2

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000719

Table 9-54 – State transition table

pStateIdx	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
transIdxLPS	0	0	1	2	2	4	4	5	6	7	8	9	9	11	11	12
transIdxMPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
pStateIdx	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
transIdxLPS	13	13	15	15	16	16	18	18	19	19	21	21	22	22	23	24
transIdxMPS	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
pStateIdx	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
transIdxLPS	24	25	26	26	27	27	28	29	29	30	30	30	31	32	32	33
transIdxMPS	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
pStateIdx	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**
transIdxLPS	33	33	34	34	35	35	35	36	36	36	37	37	37	38	38	63
transIdxMPS	49	50	51	52	53	54	55	56	57	58	59	60	61	62	62	63

9.3.3.2.2 Renormalization process in the arithmetic decoding engine

Inputs to this process are bits from slice data and the variables codIRange and codIOffset.

Outputs of this process are the updated variables codIRange and codIOffset.

A flowchart of the renormalization is shown in Figure 9-3. The current value of codIRange is first compared to 256 and further steps are specified as follows.

– If codIRange is greater than or equal to 256, no renormalization is needed and the RenormD process is finished;

– Otherwise (codIRange is less than 256), the renormalization loop is entered. Within this loop, the value of codIRange is doubled, i.e., left-shifted by 1 and a single bit is shifted into codIOffset by using read_bits(1).

The bitstream shall not contain data that result in a value of codIOffset being greater than or equal to codIRange upon completion of this process.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000720

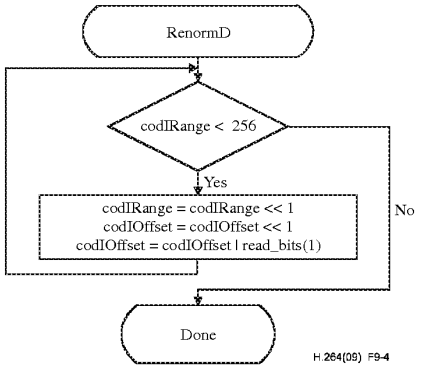


Figure 9-3 – Flowchart of renormalization

9.3.3.2.3 Bypass decoding process for binary decisions

Inputs to this process are bits from slice data and the variables codIRange and codIOffset.

Outputs of this process are the updated variable codIOffset and the decoded value binVal.

The bypass decoding process is invoked when bypassFlag is equal to 1. Figure 9-4 shows a flowchart of the corresponding process.

First, the value of codIOffset is doubled, i.e., left-shifted by 1 and a single bit is shifted into codIOffset by using read_bits(1). Then, the value of codIOffset is compared to the value of codIRange and further steps are specified as follows.

– If codIOffset is greater than or equal to codIRange, the variable binVal is set equal to 1 and codIOffset is decremented by codIRange.

– Otherwise (codIOffset is less than codIRange), the variable binVal is set equal to 0.

The bitstream shall not contain data that result in a value of codIOffset being greater than or equal to codIRange upon completion of this process.

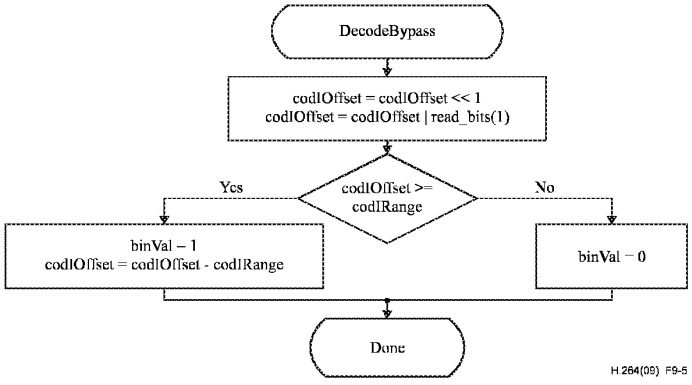


Figure 9-4 – Flowchart of bypass decoding process

9.3.3.2.4 Decoding process for binary decisions before termination

Inputs to this process are bits from slice data and the variables codIRange and codIOffset.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000721

Outputs of this process are the updated variables codIRange and codIOffset, and the decoded value binVal.

This special decoding routine applies to decoding of end_of_slice_flag and pcm_flag corresponding to ctxIdxTable equal to 0 and ctxIdx equal to 0. Figure 9-5 shows the flowchart of the corresponding decoding process, which is specified as follows.

First, the value of codIRange is decremented by 2. Then, the value of codIOffset is compared to the value of codIRange and further steps are specified as follows.

– If codIOffset is greater than or equal to codIRange, the variable binVal is set equal to 1, no renormalization is carried out, and CABAC decoding is terminated. The last bit inserted in register codIOffset is equal to 1. When decoding end_of_slice_flag, this last bit inserted in register codIOffset is interpreted as rbsp_stop_one_bit.

– Otherwise (codIOffset is less than codIRange), the variable binVal is set equal to 0 and renormalization is performed as specified in subclause 9.3.3.2.2.

NOTE – This procedure may also be implemented using DecodeDecision(ctxIdxTable, ctxIdx) with ctxIdxTable = 0 and ctxIdx = 0. In the case where the decoded value is equal to 1, seven more bits would be read by DecodeDecision(ctxIdxTable, ctxIdx) and a decoding process would have to adjust its bitstream pointer accordingly to properly decode following syntax elements.

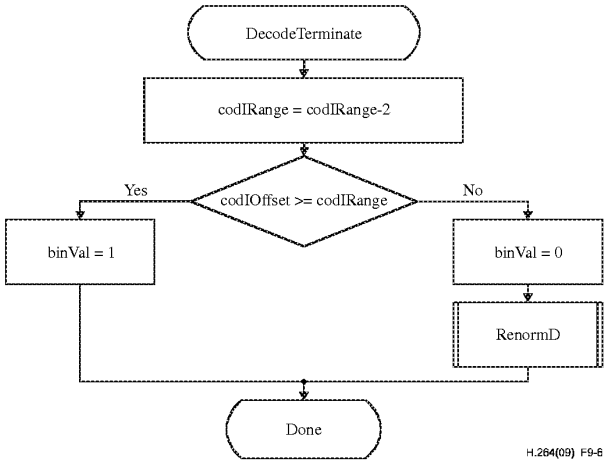


Figure 9-5 – Flowchart of decoding a decision before termination

9.3.4 Arithmetic encoding process (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

Inputs to this process are decisions that are to be encoded and written.

Outputs of this process are bits that are written to the RBSP.

This informative subclause describes an arithmetic encoding engine that matches the arithmetic decoding engine described in subclause 9.3.3.2. The encoding engine is essentially symmetric with the decoding engine, i.e., procedures are called in the same order. The following procedures are described in this section: InitEncoder, EncodeDecision, EncodeBypass, EncodeTerminate, which correspond to InitDecoder, DecodeDecision, DecodeBypass, and DecodeTerminate, respectively. The state of the arithmetic encoding engine is represented by a value of the variable codILow pointing to the lower end of a sub-interval and a value of the variable codIRange specifying the corresponding range of that sub-interval.

9.3.4.1 Initialisation process for the arithmetic encoding engine (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

This process is invoked before encoding the first macroblock of a slice, and after encoding any pcm_alignment_zero_bit and all pcm_sample_luma and pcm_sample_chroma data for a coding unit of type I_PCM.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000722

Outputs of this process are the values codILow, codIRange, firstBitFlag, bitsOutstanding, and BinCountsInNALunits of the arithmetic encoding engine.

In the initialisation procedure of the encoder, codILow is set equal to 0, and codIRange is set equal to 510. Furthermore, firstBitFlag is set equal to 1 and the counter bitsOutstanding is set equal to 0.

Depending on whether the current slice is the first slice of a coded picture, the following applies.

– If the current slice is the first slice of a coded picture, the counter BinCountsInNALunits is set equal to 0.

– Otherwise (the current slice is not the first slice of a coded picture), the counter BinCountsInNALunits is not modified. The value of BinCountsInNALunits is the result of encoding all the slices of a coded picture that precede the current slice in decoding order. After initialising for the first slice of a coded picture as specified in this subclause, BinCountsInNALunits is incremented as specified in subclauses 9.3.4.2, 9.3.4.4, and 9.3.4.5.

NOTE – The minimum register precision required for storing the values of the variables codILow and codIRange after invocation of any of the arithmetic encoding processes specified in subclauses 9.3.4.2, 9.3.4.4, and 9.3.4.5 is 10 bits and 9 bits, respectively. The encoding process for a binary decision (EncodeDecision) as specified in subclause 9.3.4.2 and the encoding process for a binary decision before termination (EncodeTerminate) as specified in subclause 9.3.4.5 require a minimum register precision of 10 bits for the variable codILow and a minimum register precision of 9 bits for the variable codIRange. The bypass encoding process for binary decisions (EncodeBypass) as specified in subclause 9.3.4.4 requires a minimum register precision of 11 bits for the variable codILow and a minimum register precision of 9 bits for the variable codIRange. The precision required for the counters bitsOutstanding and BinCountsInNALunits should be sufficiently large to prevent overflow of the related registers. When maxBinCountInSlice denotes the maximum total number of binary decisions to encode in one slice and maxBinCountInPic denotes the maximum total number of binary decisions to encode a picture, the minimum register precision required for the variables bitsOutstanding and BinCountsInNALunits is given by Ceil(Log2(maxBinCountInSlice + 1)) and Ceil(Log2(maxBinCountInPic + 1)), respectively.

9.3.4.2 Encoding process for a binary decision (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

Inputs to this process are the context index ctxIdx, the value of binVal to be encoded, and the variables codIRange, codILow and BinCountsInNALunits.

Outputs of this process are the variables codIRange, codILow, and BinCountsInNALunits.

Figure 9-6 shows the flowchart for encoding a single decision. In a first step, the variable codIRangeLPS is derived as follows.

Given the current value of codIRange, codIRange is mapped to the index qCodIRangeIdx of a quantised value of codIRange by using Equation 9-6. The value of qCodIRangeIdx and the value of pStateIdx associated with ctxIdx are used to determine the value of the variable rangeTabLPS as specified in Table 9-8, which is assigned to codIRangeLPS. The value of codIRange – codIRangeLPS is assigned to codIRange.

In a second step, the value of binVal is compared to valMPS associated with ctxIdx. When binVal is different from valMPS, codIRange is added to codILow and codIRange is set equal to the value codIRangeLPS. Given the encoded decision, the state transition is performed as specified in subclause 9.3.3.2.1.1. Depending on the current value of codIRange, renormalization is performed as specified in subclause 9.3.4.3. Finally, the variable BinCountsInNALunits is incremented by 1.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000723

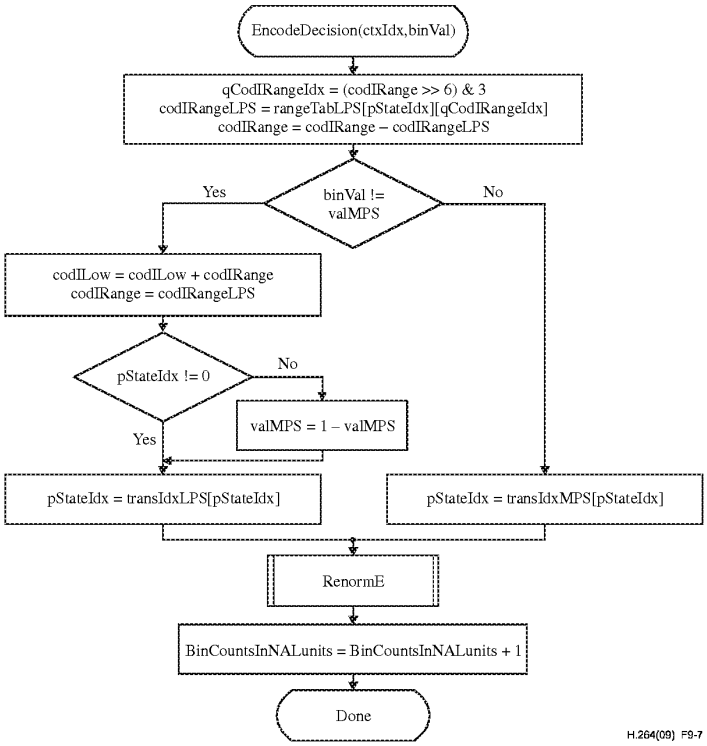


Figure 9-6 – Flowchart for encoding a decision

9.3.4.3 Renormalization process in the arithmetic encoding engine (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

Inputs to this process are the variables codIRange, codILow, firstBitFlag, and bitsOutstanding.

Outputs of this process are zero or more bits written to the RBSP and the updated variables codIRange, codILow, firstBitFlag, and bitsOutstanding.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000724

Renormalization is illustrated in Figure 9-7.

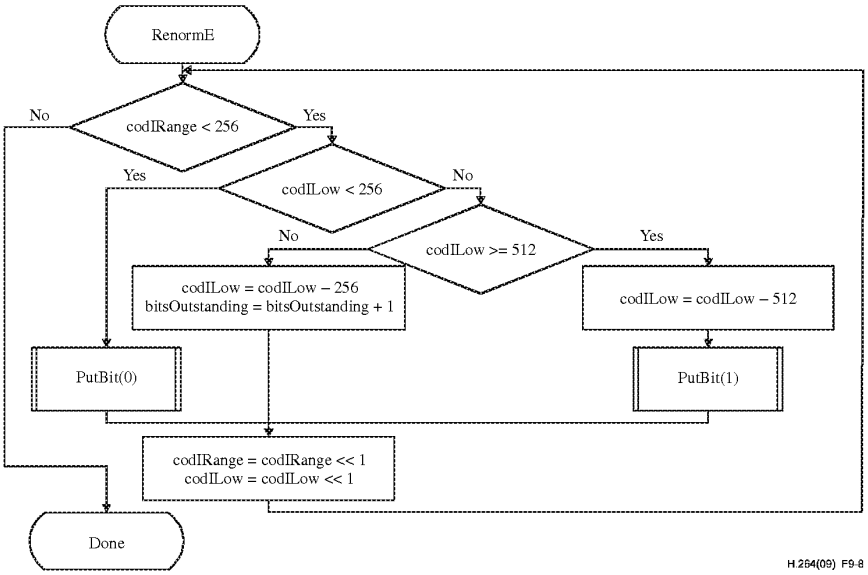


Figure 9-7 – Flowchart of renormalization in the encoder

The PutBit( ) procedure described in Figure 9-8 provides carry over control. It uses the function WriteBits(B, N) that writes N bits with value B to the bitstream and advances the bitstream pointer by N bit positions. This function assumes the existence of a bitstream pointer with an indication of the position of the next bit to be written to the bitstream by the encoding process.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000725

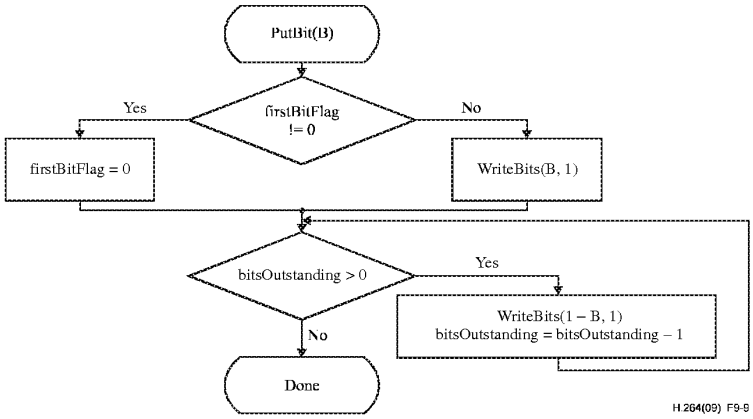


Figure 9-8 – Flowchart of PutBit(B)

9.3.4.4 Bypass encoding process for binary decisions (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

Inputs to this process are the variables binVal, codILow, codIRange, bitsOutstanding, and BinCountsInNALunits.

Output of this process is a bit written to the RBSP and the updated variables codILow, bitsOutstanding, and BinCountsInNALunits.

This encoding process applies to all binary decisions with bypassFlag equal to 1. Renormalization is included in the specification of this process as given in Figure 9-9.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000726

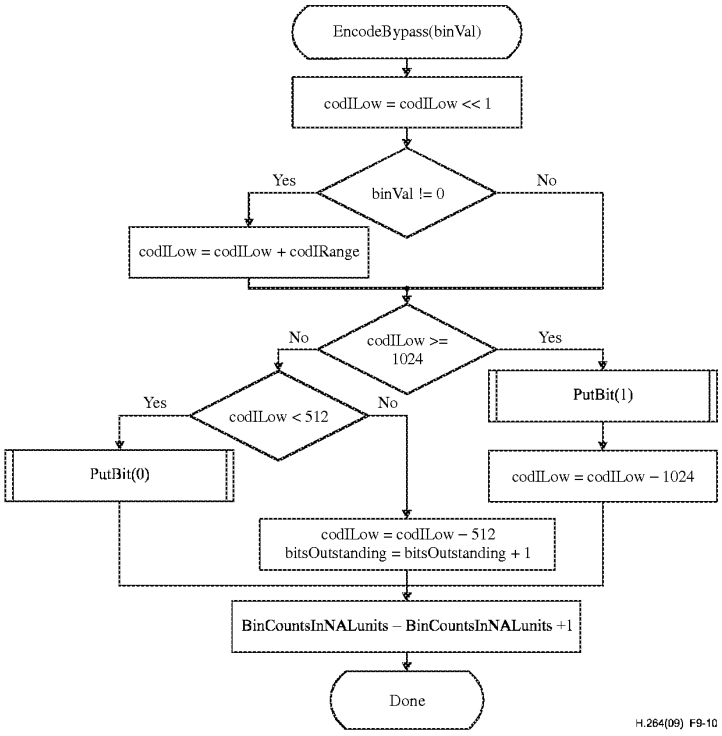


Figure 9-9 – Flowchart of encoding bypass

9.3.4.5 Encoding process for a binary decision before termination (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

Inputs to this process are the variables binVal, codIRange, codILow, bitsOutstanding, and BinCountsInNALunits.

Outputs of this process are zero or more bits written to the RBSP and the updated variables codILow, codIRange, bitsOutstanding, and BinCountsInNALunits.

This encoding routine shown in Figure 9-10 applies to encoding of the end_of_slice_flag and pcm_flag indicating the I_PCM mode both associated with ctxIdx equal to 276.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000727

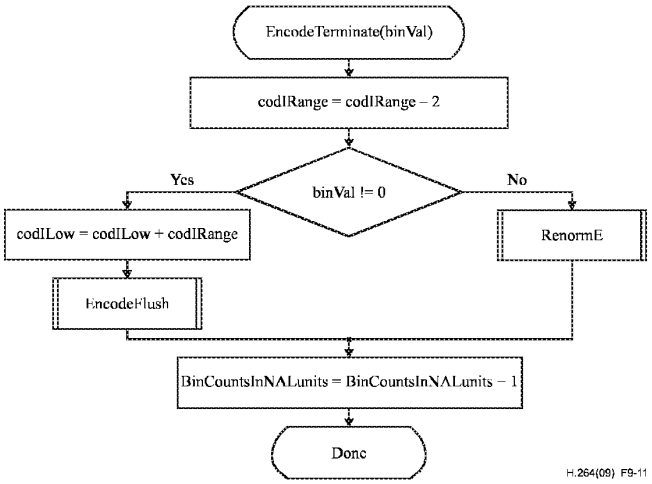


Figure 9-10 – Flowchart of encoding a decision before termination

When the value of binVal to encode is equal to 1, CABAC encoding is terminated and the flushing procedure shown in Figure 9-11 is applied. In this flushing procedure, the last bit written by WriteBits(B, N) is equal to 1. When encoding end_of_slice_flag, this last bit is interpreted as the rbsp_stop_one_bit.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000728

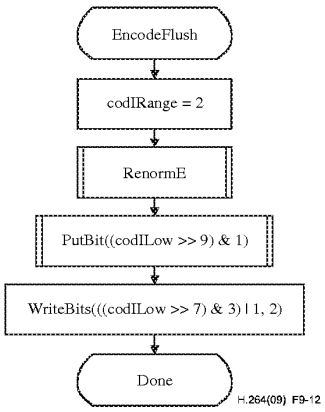


Figure 9-11 – Flowchart of flushing at termination

9.3.4.6 Byte stuffing process (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

This process is invoked after encoding the last macroblock of the last slice of a picture and after encapsulation.

Inputs to this process are the number of bytes NumBytesInVclNALunits of all VCL NAL units of a picture, the number of macroblocks PicSizeInMbs in the picture, and the number of binary symbols BinCountsInNALunits resulting from encoding the contents of all VCL NAL units of the picture.

NOTE – The value of BinCountsInNALunits is the result of encoding all slices of a coded picture. After initialising for the first slice of a coded picture as specified in subclause 9.3.4.1, BinCountsInNALunits is incremented as specified in subclauses 9.3.4.2, 9.3.4.4, and 9.3.4.5.

Outputs of this process are zero or more bytes appended to the NAL unit.

Let the variable k be set equal to Ceil((Ceil(3 * (32 * BinCountsInNALunits – RawMbBits * PicSizeInMbs) ÷ 1024) – NumBytesInVclNALunits) ÷ 3). Depending on the variable k the following applies.

– If k is less than or equal to 0, no cabac_zero_word is appended to the NAL unit.

– Otherwise (k is greater than 0), the 3-byte sequence 0x000003 is appended k times to the NAL unit after encapsulation, where the first two bytes 0x0000 represent a cabac_zero_word and the third byte 0x03 represents an emulation_prevention_three_byte.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000729

Annex A

Profiles and levels

(This annex forms an integral part of this Recommendation | International Standard)

Profiles and levels specify restrictions on bitstreams and hence limits on the capabilities needed to decode the bitstreams. Profiles and levels may also be used to indicate interoperability points between individual decoder implementations.

NOTE 1 – This Recommendation | International Standard does not include individually selectable "options" at the decoder, as this would increase interoperability difficulties.

Each profile specifies a subset of algorithmic features and limits that shall be supported by all decoders conforming to that profile.

NOTE 2 – Encoders are not required to make use of any particular subset of features supported in a profile.

Each level specifies a set of limits on the values that may be taken by the syntax elements of this Recommendation | International Standard. The same set of level definitions is used with all profiles, but individual implementations may support a different level for each supported profile. For any given profile, levels generally correspond to decoder processing load and memory capability.

The profiles that are specified in subclause A.2 are also referred to as the profiles specified in Annex A.

A.1 Requirements on video decoder capability

Capabilities of video decoders conforming to this Recommendation | International Standard are specified in terms of the ability to decode video streams conforming to the constraints of profiles and levels specified in this annex. For each such profile, the level supported for that profile shall also be expressed.

Specific values are specified in this annex for the syntax elements profile_idc and level_idc. All other values of profile_idc and level_idc are reserved for future use by ITU-T | ISO/IEC.

NOTE – Decoders should not infer that when a reserved value of profile_idc or level_idc falls between the values specified in this Recommendation | International Standard that this indicates intermediate capabilities between the specified profiles or levels, as there are no restrictions on the method to be chosen by ITU-T | ISO/IEC for the use of such future reserved values.

A.2 Profiles

All constraints for picture parameter sets that are specified are constraints for picture parameter sets that are activated in the bitstream. All constraints for sequence parameter sets that are specified in subclause A.2.1 are constraints for sequence parameter sets that are activated in the bitstream.

A.2.1 ABC profile

A.3 Levels

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000730

Table A-9-55 – Level limits [Ed. (TW) Kept for convenience]

Level number	Max macroblock processing rate MaxMBPS (MB/s)	Max picture size MaxFS (MBs)	Max decoded picture buffer size MaxDpbMbs (MBs)	Max video bit rate MaxBR (1000 bits/s, 1200 bits/s, cpbBrVclFactor bits/s, or cpbBrNalFactor bits/s)	Max CPB size MaxCPB (1000 bits, 1200 bits, cpbBrVclFactor bits, or cpbBrNalFactor bits)	Vertical MV component range MaxVmvR (luma picture samples)	Min compression ratio MinCR	Max number of motion vectors per two consecutive MBs MaxMvsPer2Mb
1	1 485	99	396	64	175	[−64,+63.75]	2	-
1b	1 485	99	396	128	350	[−64,+63.75]	2	-
1.1	3 000	396	900	192	500	[−128,+127.75]	2	-
1.2	6 000	396	2 376	384	1 000	[−128,+127.75]	2	-
1.3	11 880	396	2 376	768	2 000	[−128,+127.75]	2	-
2	11 880	396	2 376	2 000	2 000	[−128,+127.75]	2	-
2.1	19 800	792	4 752	4 000	4 000	[−256,+255.75]	2	-
2.2	20 250	1 620	8 100	4 000	4 000	[−256,+255.75]	2	-
3	40 500	1 620	8 100	10 000	10 000	[−256,+255.75]	2	32
3.1	108 000	3 600	18 000	14 000	14 000	[−512,+511.75]	4	16
3.2	216 000	5 120	20 480	20 000	20 000	[−512,+511.75]	4	16
4	245 760	8 192	32 768	20 000	25 000	[−512,+511.75]	4	16
4.1	245 760	8 192	32 768	50 000	62 500	[−512,+511.75]	2	16
4.2	522 240	8 704	34 816	50 000	62 500	[−512,+511.75]	2	16
5	589 824	22 080	110 400	135 000	135 000	[−512,+511.75]	2	16
5.1	983 040	36 864	184 320	240 000	240 000	[−512,+511.75]	2	16

Levels with non-integer level numbers in Table A-9-8 are referred to as "intermediate levels".

NOTE 4 – All levels have the same status, but some applications may choose to use only the integer-numbered levels.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000731

Annex B

Byte stream format

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies syntax and semantics of a byte stream format specified for use by applications that deliver some or all of the NAL unit stream as an ordered stream of bytes or bits within which the locations of NAL unit boundaries need to be identifiable from patterns in the data, such as ITU-T Rec. H.222.0 | ISO/IEC 13818-1 systems or ITU-T Rec. H.320 systems. For bit-oriented delivery, the bit order for the byte stream format is specified to start with the MSB of the first byte, proceed to the LSB of the first byte, followed by the MSB of the second byte, etc.

The byte stream format consists of a sequence of byte stream NAL unit syntax structures. Each byte stream NAL unit syntax structure contains one start code prefix followed by one nal_unit(NumBytesInNALunit) syntax structure. It may (and under some circumstances, it shall) also contain an additional zero_byte syntax element. It may also contain one or more additional trailing_zero_8bits syntax elements. When it is the first byte stream NAL unit in the bitstream, it may also contain one or more additional leading_zero_8bits syntax elements.

B.1 Byte stream NAL unit syntax and semantics

B.1.1 Byte stream NAL unit syntax

byte_stream_nal_unit(NumBytesInNALunit) {	C	Descriptor
while(next_bits(24) != 0x000001 && next_bits(32) != 0x00000001)		
leading_zero_8bits /* equal to 0x00 */		f(8)
if(next_bits(24) != 0x000001)		
zero_byte /* equal to 0x00 */		f(8)
start_code_prefix_one_3bytes /* equal to 0x000001 */		f(24)
nal_unit(NumBytesInNALunit)		
while(more_data_in_byte_stream( ) && next_bits(24) != 0x000001 && next_bits(32) != 0x00000001)		
trailing_zero_8bits /* equal to 0x00 */		f(8)
}		

B.1.2 Byte stream NAL unit semantics

The order of byte stream NAL units in the byte stream shall follow the decoding order of the NAL units contained in the byte stream NAL units (see subclause 7.4.1.2). The content of each byte stream NAL unit is associated with the same access unit as the NAL unit contained in the byte stream NAL unit (see subclause 7.4.1.2.3).

leading_zero_8bits is a byte equal to 0x00.

NOTE – The leading_zero_8bits syntax element can only be present in the first byte stream NAL unit of the bitstream, because (as shown in the syntax diagram of subclause B.1.1) any bytes equal to 0x00 that follow a NAL unit syntax structure and precede the four-byte sequence 0x00000001 (which is to be interpreted as a zero_byte followed by a start_code_prefix_one_3bytes) will be considered to be trailing_zero_8bits syntax elements that are part of the preceding byte stream NAL unit.

zero_byte is a single byte equal to 0x00.

When any of the following conditions are fulfilled, the zero_byte syntax element shall be present:

– the nal_unit_type within the nal_unit( ) is equal to 7 (sequence parameter set) or 8 (picture parameter set),

– the byte stream NAL unit syntax structure contains the first NAL unit of an access unit in decoding order, as specified by subclause 7.4.1.2.3.

start_code_prefix_one_3bytes is a fixed-value sequence of 3 bytes equal to 0x000001. This syntax element is called a start code prefix.

trailing_zero_8bits is a byte equal to 0x00.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000732

B.2 Byte stream NAL unit decoding process

Input to this process consists of an ordered stream of bytes consisting of a sequence of byte stream NAL unit syntax structures.

Output of this process consists of a sequence of NAL unit syntax structures.

At the beginning of the decoding process, the decoder initialises its current position in the byte stream to the beginning of the byte stream. It then extracts and discards each leading_zero_8bits syntax element (if present), moving the current position in the byte stream forward one byte at a time, until the current position in the byte stream is such that the next four bytes in the bitstream form the four-byte sequence 0x00000001.

The decoder then performs the following step-wise process repeatedly to extract and decode each NAL unit syntax structure in the byte stream until the end of the byte stream has been encountered (as determined by unspecified means) and the last NAL unit in the byte stream has been decoded:

1. When the next four bytes in the bitstream form the four-byte sequence 0x00000001, the next byte in the byte stream (which is a zero_byte syntax element) is extracted and discarded and the current position in the byte stream is set equal to the position of the byte following this discarded byte.
2. The next three-byte sequence in the byte stream (which is a start_code_prefix_one_3bytes) is extracted and discarded and the current position in the byte stream is set equal to the position of the byte following this three-byte sequence.
3. NumBytesInNALunit is set equal to the number of bytes starting with the byte at the current position in the byte stream up to and including the last byte that precedes the location of any of the following conditions:
   - A subsequent byte-aligned three-byte sequence equal to 0x000000,
   - A subsequent byte-aligned three-byte sequence equal to 0x000001,
   - The end of the byte stream, as determined by unspecified means.
4. NumBytesInNALunit bytes are removed from the bitstream and the current position in the byte stream is advanced by NumBytesInNALunit bytes. This sequence of bytes is nal_unit(NumBytesInNALunit) and is decoded using the NAL unit decoding process.
5. When the current position in the byte stream is not at the end of the byte stream (as determined by unspecified means) and the next bytes in the byte stream do not start with a three-byte sequence equal to 0x000001 and the next bytes in the byte stream do not start with a four byte sequence equal to 0x00000001, the decoder extracts and discards each trailing_zero_8bits syntax element, moving the current position in the byte stream forward one byte at a time, until the current position in the byte stream is such that the next bytes in the byte stream form the four-byte sequence 0x00000001 or the end of the byte stream has been encountered (as determined by unspecified means).

B.3 Decoder byte-alignment recovery (informative)

This subclause does not form an integral part of this Recommendation | International Standard.

Many applications provide data to a decoder in a manner that is inherently byte aligned, and thus have no need for the bit-oriented byte alignment detection procedure described in this subclause.

A decoder is said to have byte-alignment with a bitstream when the decoder is able to determine whether or not the positions of data in the bitstream are byte-aligned. When a decoder does not have byte alignment with the encoder's byte stream, the decoder may examine the incoming bitstream for the binary pattern '00000000 00000000 00000000 00000001' (31 consecutive bits equal to 0 followed by a bit equal to 1). The bit immediately following this pattern is the first bit of an aligned byte following a start code prefix. Upon detecting this pattern, the decoder will be byte aligned with the encoder and positioned at the start of a NAL unit in the byte stream.

Once byte aligned with the encoder, the decoder can examine the incoming byte stream for subsequent three-byte sequences 0x000001 and 0x000003.

When the three-byte sequence 0x000001 is detected, this is a start code prefix.

When the three-byte sequence 0x000003 is detected, the third byte (0x03) is an emulation_prevention_three_byte to be discarded as specified in subclause 7.4.1.

When an error in the bitstream syntax is detected (e.g., a non-zero value of the forbidden_zero_bit or one of the three-byte or four-byte sequences that are prohibited in subclause 7.4.1), the decoder may consider the detected condition as an indication that byte alignment may have been lost and may discard all bitstream data until the detection of byte alignment at a later position in the bitstream as described in this subclause.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000733

Annex C

Hypothetical reference decoder

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies the hypothetical reference decoder (HRD) and its use to check bitstream and decoder conformance.

Two types of bitstreams are subject to HRD conformance checking for this Recommendation | International Standard. The first such type of bitstream, called Type I bitstream, is a NAL unit stream containing only the VCL NAL units and filler data NAL units for all access units in the bitstream. The second type of bitstream, called a Type II bitstream, contains, in addition to the VCL NAL units and filler data NAL units for all access units in the bitstream, at least one of the following:

– additional non-VCL NAL units other than filler data NAL units,

– all leading_zero_8bits, zero_byte, start_code_prefix_one_3bytes, and trailing_zero_8bits syntax elements that form a byte stream from the NAL unit stream (as specified in Annex B).

Figure C-9-12 shows the types of bitstream conformance points checked by the HRD.

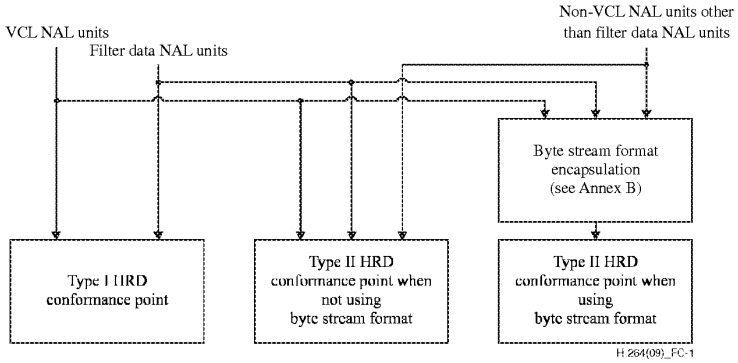


Figure C-9-12 – Structure of byte streams and NAL unit streams for HRD conformance checks

The syntax elements of non-VCL NAL units (or their default values for some of the syntax elements), required for the HRD, are specified in the semantic subclauses of clause 7, Annexes D and E.

The HRD contains a coded picture buffer (CPB), an instantaneous decoding process, a decoded picture buffer (DPB), and output cropping as shown in Figure C-9-13.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000734

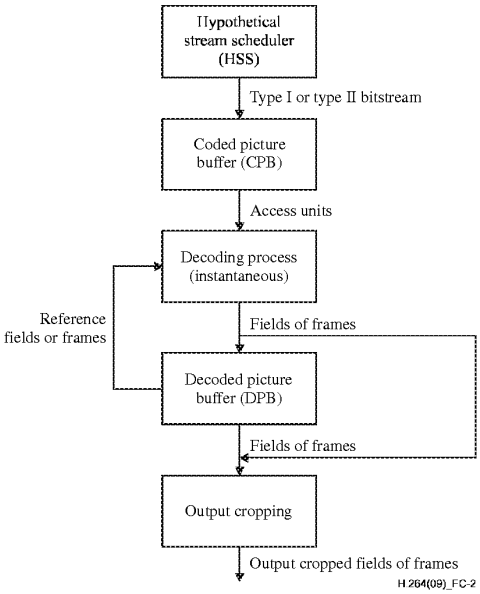


Figure C-9-13 – HRD buffer model

C.1 Operation of coded picture buffer (CPB)

The specifications in this subclause apply independently to each set of CPB parameters that is present and to both the Type I and Type II conformance points shown in Figure C-9-12.

C.1.1 Timing of bitstream arrival

C.1.2 Timing of coded picture removal

C.2 Operation of the decoded picture buffer (DPB)

C.3 Bitstream conformance

C.4 Decoder conformance

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000735

Annex D

Supplemental enhancement information

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies syntax and semantics for SEI message payloads.

SEI messages assist in processes related to decoding, display or other purposes. However, SEI messages are not required for constructing the luma or chroma samples by the decoding process. Conforming decoders are not required to process this information for output order conformance to this Recommendation | International Standard (see Annex 0 for the specification of conformance). Some SEI message information is required to check bitstream conformance and for output timing decoder conformance.

In Annex D, specification for presence of SEI messages are also satisfied when those messages (or some subset of them) are conveyed to decoders (or to the HRD) by other means not specified by this Recommendation | International Standard. When present in the bitstream, SEI messages shall obey the syntax and semantics specified in subclauses 7.3.2.3 and 0 and this annex. When the content of an SEI message is conveyed for the application by some means other than presence within the bitstream, the representation of the content of the SEI message is not required to use the same syntax specified in this annex. For the purpose of counting bits, only the appropriate bits that are actually present in the bitstream are counted.

D.1 SEI payload syntax

[Ed. (TW): insert table]

D.2 SEI payload semantics

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000736

Annex E

Video usability information

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies syntax and semantics of the VUI parameters of the sequence parameter sets.

VUI parameters are not required for constructing the luma or chroma samples by the decoding process. Conforming decoders are not required to process this information for output order conformance to this Recommendation | International Standard (see Annex 0 for the specification of conformance). Some VUI parameters are required to check bitstream conformance and for output timing decoder conformance.

In Annex E, specification for presence of VUI parameters is also satisfied when those parameters (or some subset of them) are conveyed to decoders (or to the HRD) by other means not specified by this Recommendation | International Standard. When present in the bitstream, VUI parameters shall follow the syntax and semantics specified in subclauses 7.3.2.1 and 7.4.2.1 and this annex. When the content of VUI parameters is conveyed for the application by some means other than presence within the bitstream, the representation of the content of the VUI parameters is not required to use the same syntax specified in this annex. For the purpose of counting bits, only the appropriate bits that are actually present in the bitstream are counted.

E.1 VUI syntax

E.1.1 VUI parameters syntax

[Ed. (TW): insert table]

E.2 VUI semantics

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000737

Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14-22 July, 2011

Document: JCTVC-F052

Title: **CE9: Results of Experiment ROB04**

Status: Input Document to JCT-VC

Purpose: Proposal

Author(s) or Contact(s): Jian-Liang Lin, Yi-Wen Chen, Yu-Wen Huang, and Shawmin Lei
No. 1, Dusing Rd. 1, Hsinchu Science Park, Hsinchu, Taiwan 30078

Shawmin Lei
Tel: +886-3-5670766 ext. 25555
Email: {jl.lin, yiwen.chen, yuwen.huang, shawmin.lei}@mediatek.com

Source: MediaTek Inc.

Abstract

This contribution reported the performance results of CE9 ROB04 experiment on parsing robustness. In this experiment, a basic scheme with parsing robustness by skipping the process of removing redundant motion vector predictors (MVPs) and forcing the availability of the temporal MVP was firstly provided. The experiment results reported that this basic scheme resulted in average 1.3%, 1.3%, 1.9%, and 2.0% bit rate increases for high HE-RA, LC-RA, HE-LD, and LC-LD, respectively. To reduce the bit rate increases, two approaches were tested in ROB04. The first approach was replacing the redundant MVPs by other substitutes, and the second approach was reducing redundant MVPs without comparing motion vector values. It was reported that combing both approaches caused 0.3%, 0.4%, 0.3%, and 0.5% bit rate increases for HE-RA, LC-RA, HE-LD, and LC-LD, respectively, while providing the ability to prevent all parsing errors caused by any data loss of reference pictures.

1 Introduction

The ROB04 experiment was approved at the 5th JCT-VC meeting in CE9 [1]. The ROB04 experiment is to evaluate the coding efficiency of the parsing robustness solution for MVPs. In HM-3.0 [2] and WD-3.0 [3], to reduce the bits used to encode the index of motion vector predictor (MVP), redundant MVPs are removed from the MVP candidate set. However, this can cause parsing errors leading to severe error propagation. When a motion vector (MV) of a previous picture cannot be decoded correctly, a mismatch between the candidate set on the encoder side and that on the decoder side may occur, resulting in parsing error of the index of the best MVP. Then, the rest of the current picture cannot be parsed or decoded properly. What is even worse, this parsing error can affect subsequent inter pictures that also use temporal MVPs. ROB04 was proposed to achieve the parsing robustness. The evaluation was based on the HM-3.0 with a fix of bug #146. The rest of this contribution is organized as follows. The experiment of ROB04 will be described in Section 2, simulation results will be shown in Section 3, and finally, conclusions will be given in Section 4.

2 Experiment description

To achieve parsing robustness, two constraints are applied for the basic approach of parsing robustness:

a. Avoid the process of removing redundant MVPs
b. Force the availability of the temporal MVP as long as it is inside the picture boundaries

In order to avoid the parsing problem caused by incorrect MV data, the process of removing redundant MVPs is avoided. Moreover, the temporal MVP is forced to be available as long as the temporal block is

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000738

inside the boundaries of that co-located picture. Even if the temporal block in the co-located picture is an Intra block, the parsing robustness system still force the temporal MVP to be available to prevent the case that the mode type (Inter or Intra) of the block in the co-located picture is lost or wrong. When the temporal MVP is not available, a zero MV is simply used to represent the temporal MVP. Two tools are applied to improve the coding efficiency of the parsing robustness solution. The first tool replaces redundant MVPs by other substitutes, and the second tool reduces redundant MVPs without comparing MV values.

2.1 Tool 1 – Replacing redundant MVPs

Since the process of removing redundant MVPs is avoided for parsing robustness, the redundant MVPs are replaced by other substitutes to reduce the redundancy.

In HM-3.0, the top MVP in Inter mode is defined as the first available and non-redundant one searching within B_0, B_1, B_2 as shown in Figure 1 based on the following order:

- B_0' MV with the same list and the same reference picture
- B_1' MV with the same list and the same reference picture
- B_2' MV with the same list and the same reference picture
- B_0' MV with different list or/and different reference picture
- B_1' MV with different list or/and different reference picture
- B_2' MV with different list or/and different reference picture

Please note that "the same list," "the same reference picture," "different list," and "different reference picture" mean the "the same list as the current list," "the same reference picture as the current picture," "different list from the current list," and "different reference picture from the current reference picture." Moreover, the description "MV with different list or/and different reference picture" actually means three sequential items with the order as: "MV with different list and the same reference picture," "MV with the same list and different reference picture," and "MV with different list and different reference picture."

In our approach, the top MVP is only searched within

- B_0' MV with the same list and the same reference picture
- B_1' MV with the same list and the same reference picture

Therefore, the top MVP exists only when B_0 or B_1 has a MV with the same list and the same reference picture. If the top MVP exists and all the possible MVPs are identical to the left MVP, the substitute is searched based on the following order:

- B_2' MV with the same list and the same reference picture
- B_0' MV with different list or/and different reference picture
- B_1' MV with different list or/and different reference picture
- B_2' MV with different list or/and different reference picture

After all these substitutes are searched and the top MVP is still redundant, the left MVP plus 1/4 pixel in both horizontal and vertical directions is used.

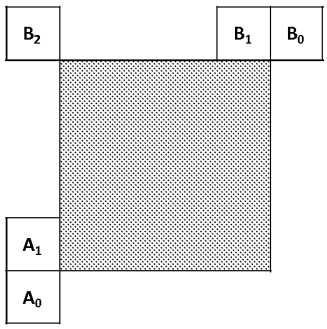


Figure 1. Spatial blocks.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000739

For the spatial MVPs in Merge/Merge-Skip modes, if one spatial MVP exists and is identical to one of the previously derived MVPs, we simply use a zero MV to replace the redundant MVP.

For the temporal MVP in Inter and Merge/Merge-Skip modes, as an example shown in Figure 2 where the gray area denotes the current prediction unit (PU), if the temporal MVP derived from H is redundant, a substitute is searched within T_c, T_o, F, and G until the first non-redundant one is found. If after these blocks are searched and the temporal MVP is still redundant, the zero MV is used.

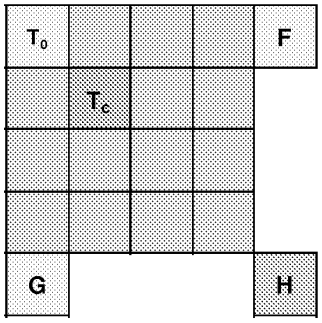


Figure 2. Temporal blocks.

2.2 Tool 2 – Reducing redundant MVPs without comparing MV values

Tool 2 tries to reduce redundant MVPs without using MV values before finding other substitutes for the redundancy reduction. In tool 2, motion identification (ID) is proposed to describe the inheritance process of motion information passed from a coded PU to the current PU to follow the trail of the MV. A unique motion ID is assigned for each new MV created in the Inter mode and can be inherited through the Merge and Merge-Skip modes. By comparing the motion ID, the MVP having the same motion ID as a previous MVP in the candidate set can thus be removed.

3 Simulation results

Several experiments are conducted to evaluate the coding efficiency and parsing robustness. HM-3.0 software [2] is used for the evaluation and the common test conditions specified in JCTVC-E700 [4] are followed. The anchor is HM-3.0 with the fix of bug #146 as described in CE9 [1].

Since the parsing problem is caused by including the temporal MVP in the candidate set, in experiment 1, we simply disable the temporal MVP for all pictures to avoid the parsing problem. The results are shown in Table 1. It shows that disabling temporal MVPs causes 2.3%, 2.2%, 2.4%, and 2.4% bit rate increases for high efficiency random access (HE-RA), low complexity random access (LC-RA), high efficiency low delay (HE-LD), and low complexity low delay (LC-LD), respectively.

In experiment 2, the basic approach for parsing robustness is implemented to avoid the parsing error by skipping the process of removing redundant MVPs and forcing the availability of the temporal MVP. The results are shown in Table 2. The basic approach for parsing robustness causes 1.3%, 1.3%, 1.9%, and 2.0% bit rate increases for HE-RA, LC-RA, HE-LD, and LC-LD while providing the ability to prevent parsing errors caused by data loss of reference pictures.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000740

Table 1. Results of experiment 1: disabling temporal MVPs for all pictures.

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	3.1	2.6	2.8	3.3	2.8	2.8
Class B	2.0	1.4	1.4	1.7	1.1	1.1
Class C	2.1	2.1	2.2	2.0	2.0	2.1
Class D	2.1	2.0	2.0	2.0	1.8	1.8
Class E						
All	**2.3**	**2.0**	**2.0**	**2.2**	**1.9**	**1.9**
Enc Time[%]	92%			93%		
Dec Time[%]	97%			96%		

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	2.1	1.8	1.2	2.3	1.6	1.5
Class C	2.5	2.6	2.7	2.6	2.4	2.4
Class D	2.2	1.8	2.1	2.2	1.2	1.3
Class E	2.9	2.7	2.1	2.6	1.4	2.0
All	**2.4**	**2.2**	**2.0**	**2.4**	**1.7**	**1.8**
Enc Time[%]	93%			93%		
Dec Time[%]	98%			94%		

Table 2. Results of experiment 2: basic approach – skipping the process of removing redundant MVPs and forcing the availability of the temporal MVP.

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	1.0	0.9	1.0	1.2	1.0	1.0
Class B	1.3	0.8	0.8	1.4	1.0	0.9
Class C	1.4	1.3	1.3	1.4	1.3	1.4
Class D	1.3	1.1	1.1	1.3	0.9	1.1
Class E						
All	**1.3**	**1.0**	**1.0**	**1.3**	**1.0**	**1.1**
Enc Time[%]	108%			107%		
Dec Time[%]	100%			97%		

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	1.6	1.2	0.7	1.7	1.2	1.2
Class C	1.5	1.3	1.2	1.4	1.0	1.2
Class D	1.5	1.0	1.6	1.4	1.0	0.9
Class E	3.6	3.4	2.7	4.1	2.9	3.5
All	**1.9**	**1.6**	**1.4**	**2.0**	**1.4**	**1.6**
Enc Time[%]	107%			106%		
Dec Time[%]	98%			99%		

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000741

In experiment 3, the tool 1 described in section 2.1 is implemented to find other substitutes for redundant MVPs. According to the results shown in Table 3, tool 1 causes 0.9%, 0.9%, 1.4%, and 1.3% bit rate increases for HE-RA, LC-RA, HE-LD, and LC-LD, respectively.

In experiment 4, the tool 2 described in Section 2.2 is implemented to reduce redundant MVPs without using MV values. According to the results shown in Table 4, Tool 2 causes 0.5%, 0.7%, 0.6%, and 0.9% bit rate increases for HE-RA, LC-RA, HE-LD, and LC-LD, respectively.

In experiment 5, we combine tool 1 and tool 2. The motion ID is firstly applied to reduce redundant MVPs. For the remaining redundant MVPs that cannot be removed by using motion IDs, tool 1 is then applied to find the replacement. According to the results shown in Table 5, experiment 5 achieves 0.3%, 0.4%, 0.3%, and 0.5% bit rate increases for HE-RA, LC-RA, HE-LD, and LC-LD, respectively, while providing the ability of parsing robustness.

Table 3. Results of experiment 3: proposed tool 1 – replacing redundant MVPs by the substitutes described in Section 2.1.

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.7	0.9	1.1	0.7	0.8	0.8
Class B	0.9	0.6	0.5	0.9	0.7	0.7
Class C	1.0	1.0	1.0	1.0	0.9	1.0
Class D	0.9	0.8	0.9	0.8	0.6	0.8
Class E						
All	**0.9**	**0.8**	**0.8**	**0.9**	**0.8**	**0.8**
Enc Time[%]	109%			108%		
Dec Time[%]	98%			97%		

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	1.1	0.6	0.4	1.0	0.6	0.7
Class C	1.0	0.6	0.7	0.8	0.6	0.5
Class D	1.0	0.8	0.9	0.9	0.5	0.5
Class E	3.0	2.8	3.1	3.0	2.4	3.2
All	**1.4**	**1.1**	**1.1**	**1.3**	**0.9**	**1.1**
Enc Time[%]	108%			107%		
Dec Time[%]	99%			105%		

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000742

Table 4. Results of experiment 4: proposed tool 2 – reducing redundant MVPs by comparing motion IDs instead of MV values as described in Section 2.2.

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.6	0.9	0.8	0.7	0.8	0.8
Class B	0.5	0.3	0.3	0.6	0.5	0.5
Class C	0.6	0.6	0.7	0.9	0.9	1.1
Class D	0.5	0.5	0.5	0.6	0.5	0.6
Class E						
All	**0.5**	**0.6**	**0.6**	**0.7**	**0.7**	**0.7**
Enc Time[%]	101%			102%		
Dec Time[%]	100%			102%		

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	0.5	0.3	0.1	0.7	0.4	0.1
Class C	0.6	0.5	0.5	0.7	0.7	0.5
Class D	0.4	0.0	0.4	0.6	0.2	0.0
Class E	1.3	1.2	0.4	1.8	1.1	1.6
All	**0.6**	**0.5**	**0.3**	**0.9**	**0.5**	**0.5**
Enc Time[%]	102%			104%		
Dec Time[%]	100%			101%		

Table 5. Results of experiment 5: proposed tool 1 and tool 2 – first reducing redundant MVPs by comparing motion IDs instead of MV values as described in Section 2.2 and then replacing redundant MVPs by the substitutes described in Section 2.1.

	HE-RA			LC-RA		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.3	0.6	0.6	0.4	0.6	0.6
Class B	0.2	0.2	0.2	0.3	0.3	0.3
Class C	0.4	0.4	0.6	0.6	0.7	0.7
Class D	0.4	0.4	0.3	0.4	0.4	0.3
Class E						
All	**0.3**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**
Enc Time[%]	102%			102%		
Dec Time[%]	101%			102%		

	HE-LD			LC-LD		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	0.2	-0.1	-0.2	0.3	0.1	0.1
Class C	0.3	0.1	0.1	0.4	0.4	0.3
Class D	0.2	-0.1	0.8	0.3	0.3	-0.2
Class E	0.8	1.0	-0.2	1.3	1.2	1.2
All	**0.3**	**0.2**	**0.1**	**0.5**	**0.4**	**0.3**
Enc Time[%]	103%			104%		
Dec Time[%]	102%			102%		

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000743

4 Conclusions

ROB04 was tested in CE9. Experiment 2 could solve the parsing problem caused by data loss of reference pictures and two tools are proposed to improve the coding efficiency of the parsing robustness solution. The first tool is replacing redundant MVPs by substitutes, and the second tool is reducing redundant MVPs by comparing motion IDs instead of MV values. The experimental results reportedly showed that the parsing robustness solution combining the proposed two tools caused 0.3%, 0.4%, 0.3%, and 0.5% bit rate increases for HE-RA, LC-RA, HE-LD, and LC-LD, respectively, while providing the ability to prevent all parsing errors caused by any data loss of reference pictures.

5 Patent rights declaration(s)

MediaTek Inc. may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

6 References

[1] Y.-W. Huang, B. Bross, M. Zhou, W.-J. Chien, I.-K. Kim, "Description of Core Experiment 9 (CE9): MV Coding and Skip/Merge Operations," Document of Joint Collaborative Team on Video Coding, JCTVC-E709, Mar. 2011.

[2] K. McCann, S. Sekiguci, B. Bross, W.-J. Han, "HEVC Test Model 3 (HM 3) Encoder Description," Document of Joint Collaborative Team on Video Coding, JCTVC-E602, Mar. 2011.

[3] T. Wiegand, B. Bross, W.-J. Han, J.-R. Ohm, G. J. Sullivan, "WD3: Working Draft 3 of High-Efficiency Video Coding," Document of Joint Collaborative Team on Video Coding, JCTVC-E603, Mar. 2011.

[4] F. Bossen, "Common test conditions and software reference configurations," Document of Joint Collaborative Team on Video Coding, JCTVC-E700, Mar. 2011.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000744

OA Office Action, Due 21.10.2015, "OA Date 21.08.2015"
Korean Patent Appln. No. 2014-7015093

• Type of Action:	Notice of Preliminary Rejection
• Due Date:	October 21, 2015
• Pending Claim(s):	Claims 1 to 22
• Rejected Claim(s):	Claims 1, 2, 5 to 7, 10 to 12, 15 to 17 and 20 to 22
• Allowable Claim(s):	Claims 3, 4, 8, 9, 13, 14, 18 and 19
• Rejection Ground(s):	(i) Lack of inventiveness [Claims 1, 2, 5 to 7, 10 to 12, 15 to 17 and 20 to 22] (ii) Failure to meet the description requirement for the claims [Claims 5 and 10]
• Cited reference(s):	T. Wiegand et al., "WD3: Working Draft 3 of High Efficiency Video Coding", 5th Meeting: Geneva, CH, 16-23 March, 2011

Summary of the rejection reasons

1. The Examiner rejected claims 1, 2, 5 to 7, 10 to 12, 15 to 17 and 20 to 22 under Article 29(2) of the Korean Patent Law, for the following reasons:

(1) As for claim 1

Claim 1, which is directed to a method of encoding a video image, recites, inter alia:
[…]
selecting a first spatial motion vector prediction candidate from the set of spatial

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000745

motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit ("feature a");

determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate ("feature b");

[…]

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list ("feature c").

In this connection, cited reference 1 provides teachings regarding, e.g., deriving merging candidates from neighboring prediction unit partitions and constructing a merging candidate list by using flags of neighboring blocks (corresponding to feature a), using the positions of spatial neighbors A, B, C, and D relative to a current prediction unit (corresponding to feature b), and determining whether to include the candidate of the neighboring prediction unit by using available flags (corresponding to feature c).

Although cited reference 1 does not expressively disclose a portion of feature a, i.e., "[the] subset of spatial motion vector," such portion is inherent in the aforementioned teachings of cited reference 1.

Accordingly, claim 1 is obvious to those skilled in the art over the cited reference.

(2) As for claims 2 and 5

Claims 2 and 5 recite features regarding "at most one other spatial motion vector prediction candidate" and "selecting one motion vector prediction candidate," respectively. However, such features can be easily conceived from those skilled in the art from cited reference 1 which discloses that a motion vector is selected among motion vectors of candidate blocks which are collocated with neighboring blocks.

(3) As for claims 6, 11, 16, 21 and 22

Claims 6, 11, 16, 21 and 22 are substantially identical to claim 1, except their categories, and, therefore, are rejected for the same reason as set forth above with respect to claim 1.

(4) As for claims 7, 12 and 17

Claims 7, 12 and 17 are substantially identical to claim 2, except their categories, and, therefore, are rejected for the same reason as set forth above with respect to claim 2.

(5) As for claims 10, 15 and 20

Claims 10, 15 and 20 are substantially identical to claim 5, except their categories, and, therefore, are rejected for the same reason as set forth above with respect to claim 5.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000746

2. The Examiner rejected claims 5 and 10 under Article 42(4)(ii) of the Korean Patent Law, for the following reason:

According to the Examiner's interpretation of the expression "The method […] to represent …" recited claims 5 and 10, these claims are unclear since their subject-matters are considered different from those of their base claims.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000747

발송번호: 9-5-2015-056594865
발송일자: 2015.08.21.
제출기일: 2015.10.21.

수신 서울특별시 서초구 마방로 60 (양재동, 트러스트 타워)(제일특허법인)
제일특허법인[이혜원]

06775

YOUR INVENTION PARTNER

특 허 청

의견제출통지서

출원인	성명	노키아 코포레이션 (출원인코드: 520000368439)	
	주소	핀랜드 02610 에스푸 카라카리 7	
대리인	명칭	제일특허법인	
	주소	서울특별시 서초구 마방로 60 (양재동, 트러스트 타워)(제일특허법인)	
	지정된변리사	이혜원 외 2명	
발명자	성명	비치 메메트 오구즈	
	주소	핀랜드 에프아이-33500 탐페르 탐멜란 푸이스토카투 1-3 디 46	
발명자	성명	라이네마 자니	
	주소	핀랜드 에프아이-33230 탐페르 키사켄탄카투 12 비 6	
발명자	성명	우구르 케말	
	주소	핀랜드 에프아이-33100 탐페르 라핀티에 6디 25	

출원번호	10-2014-7015093
출원일자	2014.06.03.
발명의 명칭	비디오 인코딩 방법 및 장치

1. 이 출원에 대한 심사결과 다음과 같은 거절이유가 있어 특허법 제63조에 따라 이를 통지하오니 의견이 있거나 보정이 필요할 경우에는 상기 제출기일(2015.10.21.)까지 의견(답변, 소명)서[특허법시행규칙 별지 제24호서식] 또는/및 보정서[특허법시행규칙 별지 제9호서식]를 제출하여 주시기 바랍니다.

2. 상기 제출기일(2015.10.21.)을 연장하려는 경우에는 지정기간연장신청을 통해 그 제출기일을 4개월까지 연장할 수 있습니다. 이 경우 연장신청은 1개월 단위로 해야 하며, 필요 시 4개월을 초과하지 않는 범위에서 2개월 이상을 일괄하여 연장신청할 수 있습니다. 불가피한 사유의 발생(하단의 안내참조)으로 4개월을 초과하여 지정기간을 연장받고자 하는 때에는 그 사유를 기재한 소명서를 추가로 첨부해서 연장신청을 해야 합니다.

[심사결과]

□ 심사 대상 청구항 : 제1-22항

□ 이 출원의 거절이유가 있는 부분과 관련 법조항

순번	거절이유가 있는 부분	관련 법조항
1	청구항 제1항, 제2항, 제5항, 제6항, 제7항, 제10항, 제11항, 제12항, 제15항, 제16항, 제17항, 제20항 내지 제22항	특허법 제29조제2항
2	청구항 제5항, 제10항	특허법 제42조제4항제2호

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000748

□ 특허 가능한 청구항 : 제3-4, 8-9, 13-14, 18-19항

※ 위 특허 가능한 청구항은 의견제출통지시점에서의 심사의견이며 추후 변경될 수 있습니다. 이 출원이 특허결정을 받기 위해서는 이 출원에 대해 지적된 거절이유가 모두 해소되어야 합니다.

[구체적인 거절이유]

1. 이 출원의 특허청구범위의 청구항 제1항, 제2항, 제5항, 제6항, 제7항, 제10항, 제11항, 제12항, 제15항, 제16항, 제17항, 제20항 내지 제22항에 기재된 발명은 아래와 같이 그 출원 전에 이 발명이 속하는 기술분야에서 통상의 지식을 가진 자가 용이하게 발명할 수 있는 것이므로 특허법 제29조제2항에 따라 특허를 받을 수 없습니다.

- 아 래 -

본원 발명과 인용발명1을 비교하면 인용발명1(T. Wiegand et al., "WD3: Working Draft 3 of High Efficiency Video Coding", 5th Meeting: Geneva, CH, 16-23 March, 2011, 공개일:2011년06월27일, 첨부1 참조, 이하 '인용발명1'이라고 함)과 발명의 목적에서 비교해 보면 본원 발명은 "공간적 움직임 벡터 예측 후보들을 이용하여 병합리스트를 생성하는 것"으로 인용발명1의 "현재 블록과 이웃하는 블록들의 움직임 벡터를 머지 리스트로 생성하는 것"과 발명의 목적에서 동일하며 효과면에 현저성이 없습니다.

1-1. 독립 청구항 제1항을 인용발명1과 비교해 보면, 주요 특징부에서 청구항 제1항은 "a)제1공간적 움직임 벡터 예측 후보를 예측 유닛에 대한 병합리스트에 포함될 잠재적인 공간적 움직임 벡터 예측 후보로서 선택, b)연관된 블록의 우치를 기초로하여 공간적 움직임 벡터 예측들의 서브세트를 결정, c)공간적 움직임 벡터 예측 후보들의 움직임 벡터 정보가 서로 부합한다는 표시하는 경우 병합리스트에서 제외"가 기재되어 있고, 인용발명1에는 "A)주변의 예측 유닛 분할로부터 병합 후보들을 생성과 주변 블록의 플래그 정보를 이용해서 병합후보리스트를 생성, B)현재 블록의 주변위치인 A,B,C,D를 이용하여 , C)이용가능플래그를 이용해서 주변 예측 유닛의 후보를 포함할지 여부를 결정"이 기재되어 있어 각각 대응됩니다. 다만 차이점이 있다면, 청구항 제1항에서는 "움직임 벡터 예측의 서브세트"를 기재하고 있고, 인용발명1에서는 단지 현재 블록에 인접한 후보들의 위치만 기재하고 있어 차이가 있으나, 후보들의 위치에 따라서 서브세트를 당연히 구성할 수 있는 것이므로 양자는 통상의 기술자 수준에서 단순한 표현상의 차이일 뿐입니다. 따라서 청구항 제1항은 인용발명1로 용이하게 발명할 수 있습니다.

1-2. 종속 청구항 제2, 5항과 인용발명1을 비교해 보면, 청구항들의 특징부는 "최대한 하나의 다른 공간적 움직임 벡터 예측 후보, 하나의 움직임 벡터 예측 후보를 선택"이 기재되어 있고, 인용발명1에도 "콜로케이트된 후보 블록의 움직임 벡터, 주변 블록들과 콜로케이트된 후보 중 움직임 벡터 선택"이라는 기재가 있어 차이가 있으나 양자는 하다는 점들으로 보아 실질적으로 동일한 특징부에 해당됩니다. 따라서 청구항 제2,5항은 인용발명1로 용이하게 발명할 수 있습니다.

1-3. 청구항 제6,7,10항과 인용발명1을 비교해 보면, 상기 청구항들의 특징부는 디코딩하는

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000749

방법 청구항으로 인코딩하는 방법 청구항인 제1,2,5항의 특징부와 실질적으로 동일하며 단지 그 발명의 청구대상만 달리하여 청구한 것에 불과하므로 인용발명1로 용이하게 발명할 수 있습니다.

1-4. 청구항 제11,12,15항과 제16,17,20항과 인용발명1을 비교해 보면, 상기 청구항들의 특징부는 장치 청구항으로 방법 청구항인 제1,2,5항과 제6,7,10항의 특징부와 실질적으로 동일하며 단지 그 발명의 청구대상만 달리하여 청구한 것에 불과하므로 인용발명1로 용이하게 발명할 수 있습니다.

1-5. 청구항 제21,22항과 인용발명1을 비교해 보면, 상기 청구항들의 특징부는 기록 매체 청구항으로 방법 청구항인 제1항과 제6항의 특징부와 실질적으로 동일하며 단지 그 발명의 청구대상만 달리하여 청구한 것에 불과하므로 인용발명1로 용이하게 발명할 수 있습니다.

2. 이 출원은 특허청구범위의 청구항 제5항, 제10항의 기재가 아래에 지적한 바와 같이 불비하여 특허법 제42조제4항제2호에 따른 요건을 충족하지 못하므로 특허를 받을 수 없습니다.

- 아 래 -

2-1. 청구항 제5,10항은 “~나타내는 방법”으로 청구항 말미를 기재하고 있으나 상기 청구항이 인용하는 항에는 포함하는 방법으로 기재되어 있어 청구대상이 불분명하므로 상기 청구항들의 발명이 간결하고 명확하게 기재되어 있다고 볼 수 없습니다.

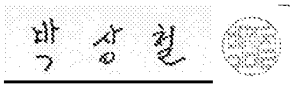
[첨 부]

첨부1 T. Wiegand et al., "WD3: Working Draft 3 of High Efficiency Video Coding", 5th Meeting: Geneva, CH, 16-23 March, 2011 끝.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000750

2015.08.21.

특허청 특허심사3국

멀티미디어방송심사팀 심사관 박상철 

<< 안내 >>

1. 특허법 제47조제2항에 따라 특허출원서에 최초로 첨부된 명세서 또는 도면에 기재된 사항의 범위 안에서 명세서 또는 도면을 보정할 수 있음을 알려드립니다. (참고 : 최후거절이유통지 후 및 특허거절결정에 대한 재심사청구시의 보정에 대해서는 특허법 제47조제3항 규정도 적용됨을 알려드립니다.)

2. 보정료 납부안내 o 명세서 또는 도면을 보정하기 위하여 명세서등 보정서를 전자문서로 제출할 경우 매건 4,000원, 서면으로 제출할 경우 매건 14,000원의 보정료를 납부하여야 합니다. o 보정료는 접수번호를 부여받아 이를 납부자번호로 "특허료등의 징수규칙" 별지 제1호서식에 기재하여, 접수번호를 부여받은 날의 다음 날까지 납부하여야 합니다. 다만, 납부일이 공휴일(토요휴무일을 포함한다)에 해당하는 경우에는 그날 이후의 첫 번째 근무일까지 납부하여야 합니다. o 보정료는 국고수납은행(대부분의 시중은행)에 납부하거나, 인터넷지로(www.giro.or.kr)로 납부할 수 있습니다. 다만, 보정서를 우편으로 제출하는 경우에는 보정료에 상응하는 통상환을 동봉하여 제출하시면 특허청에서 납부해드립니다.

3. 지정기간연장 안내 : 연장가능기간(4개월)을 초과하여 지정기간을 연장하고자 소명서를 첨부하여 지정기간연장신청서를 제출한 경우 심사관은 아래의 사유에 해당되는지를 판단하여 지정기간연장의 승인 여부 및 연장할 수 있는 기간을 정하여 통지합니다. 【4개월을 초과하여 지정기간연장을 할 수 있는 사유】 ① 기간만료 전 1개월 이내에 최초로 대리인을 선임하거나 선임된 대리인 모두를 해임·변경한 경우 ② 기간만료 전 1개월 이내에 출원인변경신고서를 제출한 경우 ③ 기간만료 전 2개월 이내에 외국특허청의 심사결과를 받은 경우로서 동 심사결과를 보정서에 반영하고자 하는 경우(이 경우 신청서 제출 시 해당 심사결과 사본 및 그 기초가 된 청구범위 사본도 같이 제출해야 함) ④ 의견제출통지서의 송달이 1개월 이상 지연된 경우(1개월 추가 연장 가능) ⑤ 원출원 또는 분할출원이 심판이나 소송에 계류 중인 경우 ⑥ 거절이유와 관련된 시험 및 결과측정에 기간이 더 필요한 경우 ⑦ 기타 불가피하게 기간연장이 필요하다고 인정되는 경우 단, 제3자가 심사청구한 때에는 ①~⑤의 경우라도 불승인

4. 보정안 리뷰(사전검토) 서비스 안내 o 보정서 제출기간 만료일 1개월 이전에 보정안을 제출하고 보정안 리뷰를 신청할 경우 면담을 통해 거절이유 해소 여부 등 보정안에 대한 심사관의 사전검토 서비스를 받을 수 있습니다. ※ 보정안은 보정서 또는 의견서의 형태로 보정안 리뷰 신청 전에 제출하여야 합니다. o 보정안 리뷰 서비스는 특허로 홈페이지(www.patent.go.kr)의 '출원신청 - 보정안리뷰 신청' 메뉴를 통해 신청할 수 있습니다.※ 이 통지서의 내용에 대해 문의사항이 있으시면 특허청 ☎ 042-481-8372(담당심사관 박상철)로, 서식 또는 절차에 대하여는 특허고객상담센터 ☎1544-8080로 문의하시기 바랍니다.

※ 우 35208 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000751

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	23601419
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	25-SEP-2015
Filing Date:	01-NOV-2012
Time Stamp:	10:31:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	15369
Deposit Account	160605
Authorized User	ALSTON & BIRD, LLP
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264-IDS.pdf	235156 65432fbc59050c9e93188186e9c6073aacfd8cea	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
2	Non Patent Literature	467264-Wiegand_WD3_Working_Draft_NPL.pdf	2552498 6e5d2c619ddf428cb37523ca491d58e77199e47d	no	239
Warnings:					
Information:					
3	Non Patent Literature	467264-Bross_WD4_Working_Draft_NPL.PDF	1821768 ff0766439239504726 48d8d18c05a12d1d410332	no	232
Warnings:					
Information:					
4	Non Patent Literature	467264-CE9_Results_NPL.pdf	102529 bd54227d992df8178fbbff95920c624d3e147acd	no	7
Warnings:					
Information:					
5	Non Patent Literature	467264-korean_office_action.pdf	1383331 9634634c15decfe289d2e6919da9563a3890d373	no	7
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30676 ed0745d0ae47b4e1a977cd1ce56cf34b1f05e758	no	2
Warnings:					
Information:					

Total Files Size (in bytes):	6125958

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Mehmet Oguz Bici	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	11/01/2012	Examiner:	Clifford Hilaire
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(c)

Attached is a list of documents on form PTO-1449 along with a copy of any cited foreign patent documents and non-patent literature document in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

It is requested that the Examiner consider these documents and officially make them of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. § 1.97(c), before final Office Action or Allowance, whichever is earlier.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,

/Douglas E. McKay/

Douglas E. McKay
Registration No. 70,175

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Bici et al.	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	November 1, 2012		
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CORRECTED FILING RECEIPT

In reviewing the Filing Receipt for the above-referenced application, Applicant notes that errors appear as noted on the enclosed copy of the Filing Receipt. Applicant requests that a corrected Filing Receipt be issued.

Respectfully submitted,

/Douglas E. McKay/

Douglas E. McKay
Registration No. 70,175

Customer No. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/666,680	11/01/2012	2488	2640	042933/467264	20	8

CONFIRMATION NO. 4782

CORRECTED FILING RECEIPT

10949
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

OC000000077598891

Date Mailed: 09/23/2015

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Mehmet Oguz BICI, Tampere, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;

Applicant(s)

Nokia Technologies Oy, Espoo, FINLAND;

Assignment For Published Patent Application

~~NOKIA CORPORATION, Espoo, FINLAND~~ **Nokia Technologies Oy, Espoo, FINLAND;**

Power of Attorney: The patent practitioners associated with Customer Number 10949

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/555,703 11/04/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 11/20/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/666,680**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000759

Title

METHOD FOR CODING AND AN APPARATUS

Preliminary Class

375

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications:

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000760

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Electronic Acknowledgement Receipt

EFS ID:	24423480
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jason P. Cooper/Dennis Avery
Filer Authorized By:	Jason P. Cooper
Attorney Docket Number:	042933/467264
Receipt Date:	21-DEC-2015
Filing Date:	01-NOV-2012
Time Stamp:	12:26:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Corrected Filing Receipt	467264_CFR_Request_12-21-2015.pdf	403255 af9d84ebd189ca2ae5ddcd1155dffc6e99a180b8	no	4

Warnings:	
Information:	

Total Files Size (in bytes):	403255

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264

CONFIRMATION NO. 4782

10949
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

IMPROPER CFR REQUEST

OC000000079594886

Date Mailed: 12/30/2015

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Power of Attorney, Claims, Fees, System Limitations, and Miscellaneous

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- An Application Data Sheet is needed to make this change.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/sstephanos/

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000764

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear
	1	US-2004/0234144 A1	11-25-2004	Sugimoto et al.	
	2	US-2008/0159401 A1	07-03-2008	Lee et al.	
	3	US-2011/0182362 A1	07-28-2011	Kim et al.	

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	4	Taiwanese Office Action and Search Report from Taiwanese Patent Application No. 101140777 dated December 2, 2015	

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36095683v1

Submitted December 29, 2015

正本

檔　　號：
保存年限：

經濟部智慧財產局　審查意見通知函

機關地址：臺北市大安區辛亥路2段185號3樓
聯 絡 人：王紋星
聯絡電話：(02)23764143
電子郵件：
傳　　真：(02)23779875

受文者：諾基亞股份有限公司（代理人：惲軼群　專利師、陳文郎　專利代理人）

發文日期：中華民國104年11月30日
發文字號：（104）智專二（三）04372字第10421639210號
速　　別：
密等及解密條件或保密期限：
附　　件：如文

10421639210

主旨：第101140777號專利申請案經審查後認有如說明一所述情事，台端（貴公司）請於文到次日起3個月內提出申復說明(一式2份)或修正至局。逾期未復者，本局將依現有資料續行審查，請查照。

說明：

一、本案經審查認為：

（一）本案「編碼方法與裝置」依申請人申請時所送資料內容審查，本案申請專利範圍共20項，其中第1、9、15~20項為獨立項，其餘為附屬項。

（二）　本案申請專利範圍第1、9、19、20項，不符專利法第26條第2項之規定；本案申請專利範圍第4~8、12~14項，不符專利法第26條第4項暨其施行細則第18條之規定。

1、 本案申請專利範圍第1、9、19、20項所載標的「一

經濟部智慧財產局電子公文
簽收時間 104/12/02(2015/12/02) 09:10:40

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000766

種方法」、「一種設備」未敘明係使用於何種技術領域，請查明修正。

2、 本案申請專利範圍第4~8、12~14項係多項附屬項，為直接或間接依附於多項附屬項，請查明修正。

（三）本案除上述指出請求項以外之請求項發明，於現在時點並未發現不予專利理由，如有發現新的不予專利理由時，會再通知不予專利理由。

二、本案如有修正、訂正，應依專利法第43條、第44條第3項、專利法施行細則第36條至第38條之規定辦理，並請依專利修正申請書、專利誤譯訂正申請書之規定撰寫。

三、若希望來局當面示範或說明，請於申復說明書內註明「申請面詢」並繳交規費新臺幣1千元正，本局認為有必要時，將另行通知面詢地點及時間。

四、檢送本案檢索報告1份。

正本：諾基亞股份有限公司（代理人：惲軼群　專利師、陳文郎　專利代理人）
副本：

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000767

附件

第101140777號專利申請案檢索報告

1.申 請 日： 101年11月2日	
2.優先權日： 2011年11月4日	
3.本案國際專利分類號(IPC)： ***H04N7/28*** (2006.01) ， ***H04N7/26*** (2006.01)	
4.檢索國際專利分類號(IPC)範圍： H04N11/02 (2006.01),G06K9/36 (2006.01),H04N7/26 (2006.01)	
5.檢索使用資料庫名稱(關鍵詞)： TIPO 國內外專利資料庫	
關聯性代 碼	引用文獻資料與相關段落處 / 相關聯請求項
A	1. US 2011/0170602 A1 2011/07/14 全文 — 1~20
A	2. US 2011/0182362 A1 2011/07/28 全文 — 1~20
A	3. US 2004/0234144 A1 2004/11/25 全文 — 1~20
A	4. US 2008/0159401 A1 2008/07/03 全文 — 1~20

關聯性代碼說明：

X：單獨引用即足以否定發明新穎性或進步性之特別相關的文獻。

Y：結合一或多篇其他文獻後足以否定發明進步性之特別相關的文獻。

A：一般技術水準之參考文獻。

D：說明書已記載之文獻。

E：申請在前、公開／公告在後之專利文獻。

O：公開使用、販賣或展覽陳列之文件。

P：申請日與優先權日間公開之文獻。

L：其他理由引用之文獻。

完成日： 104年11月26日

簽收時間 104/12/02(2015/12/02) 09:10:40

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000768

Electronic Acknowledgement Receipt

EFS ID:	24475845
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	29-DEC-2015
Filing Date:	01-NOV-2012
Time Stamp:	11:45:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264-IDS.pdf	249813 115b2e7eaac9960db50101b5741ce29b28c6f2c5	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Information Disclosure Statement (IDS) Form (SB08)	2	2

Warnings:					
Information:					
2	Non Patent Literature	467264-TW_OA_and_Search_Report.pdf	475313 30a566fc9522ecae69e884a5094097fca66cbb94	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	725126		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Mehmet Oguz Bici	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	11/01/2012	Examiner:	Clifford Hilaire
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(c)

Attached is a list of documents on form PTO-1449 along with a copy of any cited foreign patent documents and non-patent literature document in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

It is requested that the Examiner consider these documents and officially make them of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. § 1.97(c), before final Office Action or Allowance, whichever is earlier.

In accordance with the requirements of 37 C.F.R. § 1.97(c), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement. In this regard, Applicants note that the communication from the foreign patent office was not received by any individual designated by 37 CFR 1.56(c) more than thirty (30) days prior to the filing of this Information Disclosure Statement.

Respectfully submitted,

/Douglas E. McKay/

Douglas E. McKay
Registration No. 70,175

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Dec 30, 2015 05:24:40 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	M327	12/30/2015	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/666,680	Confirmation No.: 4782
Applicant(s):	Bici et al.	
Filed:	November 1, 2012	
Art Unit:	2488	
Examiner:	Clifford Hilaire	
Title:	METHOD FOR CODING AND AN APPARATUS	

Docket No.: 042933/467264
Customer No.: 10949

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. § 1.111

In response to the Office Action dated July 6, 2015, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 13 of this paper.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000773

Amendments to the Claims:

1. (Currently Amended) A method comprising:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of ~~the~~ spatial motion vector prediction ~~candidate~~ candidates in the determined subset of spatial motion vector prediction candidates; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

2. (Original) The method according to claim 1 comprising selecting spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order.

3. (Original) The method according to claim 1 , comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000774

4. (Original) The method according to claim 1 comprising examining whether the received block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

5. (Original) The method according to claim 1, further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number .

6. (Currently Amended) The method according to claim ~~1~~ 5 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether a prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

for the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000775

for the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for the potential spatial motion vector prediction candidate, which is on the right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for the potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for the potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000776

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

7. (Original) The method according to claim 1 further comprising including a temporal motion prediction candidate into the merge list.

8. (Original) The method according to claim 1 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the block of pixels.

9. (Currently Amended) A method comprising:

receiving an encoded block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of another spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000777

10. (Original) The method according to claim 9 comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

11. (Original) The method according to claim 9 comprising examining whether the received encoded block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

12. (Original) The method according to claim 9 further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number.

13. (Currently Amended) The method according to claim ~~9~~ 12 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether a prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

for the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000778

– the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for the potential spatial motion vector prediction candidate, which is on the right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for the potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit; and

for the potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000779

– all the other potential spatial motion vector prediction candidates have been included in the merge list;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

14. (Original) The method according to claim 9 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the received encoded block of pixels.

15. (Currently Amended) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

~~receiving~~ receive a block of pixels including a prediction unit;

~~determining~~ determine a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

~~selecting~~ select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

~~determining~~ determine a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000780

~~comparing~~ compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates; and

if at least one the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

16. (Currently Amended) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive an encoded block of pixels including a prediction unit;

determine a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determine a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates; and

exclude the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000781

17. (Currently Amended) A ~~storage~~ non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

18. (Currently Amended) A ~~storage~~ non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving an encoded block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000782

included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

19. (Currently Amended) An apparatus comprising:

means for receiving a block of pixels including a prediction unit;

means for determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

means for selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

means for determining a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

means for comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates; and

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000783

means for excluding the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other.

20. (Currently Amended) An apparatus comprising:

means for receiving an encoded block of pixels including a prediction unit;

means for determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

means for selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

means for determining a subset of spatial motion vector ~~predictions~~ prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

means for comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates; and

means for excluding the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000784

REMARKS

Claim Rejections - 35 USC § 112

Claims 1, 6, 9,13, 15, 16, 17, 18, 19, and 20 were rejected under 35 USC § 112(b) or 35 USC § 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. These claims have been amended. No new matter is added. Reconsideration of this rejection is respectfully requested.

Claim Rejections - 35 USC § 101

Claims 17 and 18 were rejected under 35 USC § 101 as not falling within one of the four statutory categories of invention. Claims 17 and 18 have been amended so as to no longer recite "A storage medium." Instead, the independent Claims 17 and 18 has been amended to recite "A ~~storage~~ non-transitory computer readable medium" as suggested by the Office Action. As such, it is submitted that the rejection under 35 USC § 101 of independent Claims 17 and 18, as amended, is overcome.

Claim Rejections - 35 USC § 103

Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, and 20 were rejected under pre-AIA 35 USC § 103(a) as being unpatentable over Han et al. (*Improved Video Compression Efficiency Through Flexible Unit Representation and Corresponding Extension of Coding Tools*) in view of Tai et al. (*A Multi-Pass True Motion Estimation Scheme With Motion Vector Propagation for Frame Rate Up-Conversion Applications.*).

The Office Action agrees that the Han does not teach or suggest the feature of "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000785

candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit; determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate; comparing motion information of the first spatial motion vector prediction candidate with motion information of ~~the~~ spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates; if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list," and cite Tai for these missing teaching from Han. (See the Office Action, page 5-6) Applicant respectfully asserts that Tai fails to cure the deficiencies of Han. While Applicants respectfully disagree with the above-noted rejections, Applicants have amended the independent claims to clarify and further distinguish the claims from the cited art. In this regard, the independent claims have been amended to recite that the merge list is selected based on the motion information and if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list. Support for the amendment is provided at least by paragraphs [0120]-[0122] of the published application.

Applicant respectfully asserts that Tai fails to cure the deficiencies of Han. Specifically, the Office Action cites Col 1, ¶ 4-5 of Tai with respect to the rejection of these recitations of the independent claims. However, neither the cited portion and, indeed, no other portion of Tai teaches or suggests these elements. Instead, the cited portion describes selecting minimum distortion in the current pass to refer in the future pass. However, Tai fails to teach or suggest the "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information," as recited in independent Claims 1, 9, and 15-20. Specifically, Tai doesn't disclose various merge lists and select certain merge list based on the motion information to store spatial motion vector prediction candidate. As such, Tai fails to teach excluding the spatial

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000786

motion vector prediction candidate from the selected merge list. In addition, Tai does not teach such exclusion as Tai merely select PMV pattern with minimal distortion. Consequently, Tai does not teach or suggest "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information...if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list," as recited in independent Claims 1, 9, and 15-20.

Applicants therefore assert that none of the cited references, taken alone or in combination, teach or suggest: "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information; determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate; comparing motion information of the first spatial motion vector prediction candidate with motion information of ~~the~~ spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates; if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list," as recited by independent Claims 1, 9, and 15-20. For each of the foregoing reasons, it is submitted that the rejection under pre-AIA 35 USC § 103(a) of the independent claims, as amended, as well as the claims which depend therefrom, is overcome.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000787

CONCLUSION

In view of the amendments to the claims and the remarks presented above, it is respectfully submitted that all of the claims of the present application are in condition for immediate allowance. It is therefore respectfully requested that a Notice of Allowance be issued. The Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

The patentability of the independent claims has been argued as set forth above and thus Applicants will not take this opportunity to argue the merits of the rejection with regard to specific dependent claims. However, Applicants do not concede that the dependent claims are not independently patentable and reserve the right to argue the patentability of dependent claims at a later date if necessary.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610
Customer No. Error! Reference source not found.
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

ELECTRONICALLY FILED USING THE EFS-WEB ELECTRONIC FILING SYSTEM OF THE UNITED STATES PATENT & TRADEMARK OFFICE ON January 6, 2016

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000788

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Jonathan Abbott Thomas/Patricia Forbes
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1400	1400
Miscellaneous:				
		Total in USD ($)		**1400**

Electronic Acknowledgement Receipt

EFS ID:	24547373
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Patricia Forbes
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	06-JAN-2016
Filing Date:	01-NOV-2012
Time Stamp:	17:03:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1400
RAM confirmation Number	3991
Deposit Account	160605
Authorized User	ALSTON & BIRD, LLP
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 CFR 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 CFR 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264_AmendmentEoT.PDF	9560286 60e084100ccf40d17eeeaab52ca9571509ddf617	yes	17

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Extension of Time	1	1
Amendment/Req. Reconsideration-After Non-Final Reject	2	2
Claims	3	13
Applicant Arguments/Remarks Made in an Amendment	14	17

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	31097 b07533a5c61db03227ce80bafcfb6a3fa14f3328	no	2

Warnings:

Information:

Total Files Size (in bytes):	9591383

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/22 (03-13)
Approved for use through 7/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 042933/467264

Application Number: 13/666,680

Filed: November 1, 2012

For: METHOD FOR CODING AND AN APPARATUS

Art Unit: 2488

Examiner: Clifford Hilaire

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☐ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$
☑ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$ 1,400.00
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 16-0605.

☐ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 34,610.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Guy R. Gosnell/ — Signature

January 6, 2016 — Date

Guy R. Gosnell — Typed or printed name

704-444-1000 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/666,680	Filing Date 11/01/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	01/06/2016	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	=	X $ =	
	Independent (37 CFR 1.16(h))	* 8	Minus	***8	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/KATRINA . TURNER/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 03/01/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
HILAIRE, CLIFFORD

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
03/01/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000795

Office Action Summary	Application No. 13/666,680	Applicant(s) BICI ET AL.	
	Examiner CLIFFORD HILAIRE	Art Unit 2488	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01/06/2016*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-20* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-20* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *11/01/2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☒ All b)☐ Some** c)☐ None of the:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *09/25/2015;12/29/2015*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000796

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Applicant(s) Response to Official Action

2. The response filed on 01/06/2016 has been entered and made of record.

Response to Arguments/Amendments

3. Presented arguments have been fully considered, but are rendered moot in view of the new ground(s) of rejection necessitated by amendment(s) initiated by the applicant(s).

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 6 & 13 rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

5. Claims 6 & 13 recites the limitations:

"**the** potential spatial motion vector prediction candidate **on the left side of** the prediction unit",

"**the** spatial motion vector prediction candidate **above** the prediction unit",

"**the** potential spatial motion vector prediction candidate **above** the prediction unit",

"**the** spatial motion vector prediction candidate on **the left side** of the prediction unit",

"**the** potential spatial motion vector prediction candidate, **which is on the right side of** the potential spatial motion vector prediction candidate above the prediction unit",

"**the** potential spatial motion vector prediction candidate, **which is below** the potential spatial motion vector prediction candidate on the left side of the prediction unit", and

"**the** potential spatial motion vector prediction candidate **cornerwise** neighboring the prediction unit" in lines 7, 16, 18, 26, 28, 33 and 39 respectively.

There are insufficient antecedent bases for these limitation in the claims.

6. Claim 6 recites the limitations:

"- **the received block of pixels** is vertically divided into a first prediction unit and a second prediction unit, and **the prediction unit** is the second prediction unit" *(line 10),*

"- **the received block of pixels** is horizontally divided into a first prediction unit and a second prediction unit, and if **the prediction unit** is the second prediction unit" *(line 13)* and

"- **the received block of pixels** is horizontally divided into a first prediction unit and a second prediction unit, and **the prediction unit** is the second prediction unit" *(line 21)*.

The original antecedent basis for "**received block of pixels**" is traced back to claim 1 "receiving a **block of pixels** including a **prediction unit**" *(line 2)*. From the latter citation, "**received block of pixels**" can be interpreted as a set of prediction units (RBP_N) and "a **prediction unit**" can be identified as (PU_i), where $RBP_N = \{PU_i | \ i \in [1, N]\}$ and N is a non-zero number of prediction unit included in RBP_N.

Then in claim 6, "**a prediction unit**" *(line 4)* is introduced anew to the one in claim 1, as underlined above, without mentioning any correspondence to (RBP_N). If "**the received block of pixels** is vertically divided into a first prediction unit and a second prediction unit **"** or "**the received block of pixels** is horizontally divided into a first prediction unit and a second prediction unit", said set of prediction units if further limited to $RBP_2 = \{PU_1, PU_2\}$ where any of PU_1 or PU_2 is "**the prediction unit**" for which the antecedent basis resides in claim 1.

Finally, "**the prediction unit** is the second prediction unit" does not bring any substance or limitation since it has already been proven, as described above, that "**the prediction unit**" can either be PU_1 or PU_2, where any one of them can be a first prediction unit and a second prediction unit. Therefore, conditions "for the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled" and "for the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:" will always have at least the above analyzed condition true. Examiner cannot resolve the conflict on whether "prediction unit" in claim 1 is the same or different from the introduced "prediction unit" in claim 6 and how it applies to the conditions for "excluding the potential spatial motion vector prediction candidate from the merge list".

7. Claim 13 recites the limitations:

"- **the received encoded block of pixels** is vertically divided into a first prediction unit and a second prediction unit, and **the prediction unit** is the second prediction unit" *(line 10),*

"- **the received encoded block of pixels** is horizontally divided into a first prediction unit and a second prediction unit, and if **the prediction unit** is the second prediction unit" *(line 13),* and

"- **the received encoded block of pixels** is horizontally divided into a first prediction unit and a second prediction unit, and **the prediction unit** is the second prediction unit" *(line 21)*.

The original antecedent basis for "**received block of pixels**" is traced back to claim 9 "receiving an **encoded block of pixels** including a **prediction unit**". From the latter citation, "**received encoded block of pixels**" can be interpreted as a set of prediction units (RBP_N) and "a **prediction unit**" can be identified as (PU_i) where $RBP_N = \{PU_i | \ i \in [1, N]\}$ and N is a non-zero number of prediction unit included in RBP_N.

Then in claim 13, "**a prediction unit**" is introduced anew to the one in claim 9, as underlined above, without mentioning any correspondence to (RBP_N). If "**the received encoded block of pixels** is vertically divided into a first prediction unit and a second prediction unit **"** or "**the received encoded block of pixels** is horizontally divided into a first prediction unit and a second prediction unit", said set of prediction units if further limited to $RBP_2 = \{PU_1, PU_2\}$ where any of PU_1 or PU_2 is "**the prediction unit**" for which the antecedent basis resides in claim 9.

Finally, "**the prediction unit** is the second prediction unit" does not bring any substance or limitation since it has already been proven, as described above, that "**the prediction unit**" can either be PU_1 orPU_2, where any one of them can be a first prediction unit and a second prediction unit. Therefore, conditions "for the potential spatial motion vector prediction candidate on the left

side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled" and "for the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:" will always have at least the above analyzed condition true. Examiner cannot resolve the conflict on whether "prediction unit" in claim 9 is same or different from the introduced "prediction unit" in claim 13 and how it applies to the conditions for "excluding the potential spatial motion vector prediction candidate from the merge list".

Important Note:

Examiner will attempt to interpret and examine the claims in his best abilities, despite the multiple indefiniteness issue found in the claims, using representation in the Application presented in fig. 5a and 5b for the encoder in claim 6; 8a and 8b for the decoder in claim 13 and fig 9 regarding the block pixel in both claims.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which

said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1,

148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

8. Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17. 18, 19 and 20 rejected under pre-AIA 35 U.S.C. 103 (a) as being unpatentable over Woo-Jin Han et al. *["Improved Video Compression Efficiency Through Flexible Unit Representation and Corresponding Extension of Coding Tools"]* in view of Shen-Chuan Tai et al.*["A Multi-Pass True Motion Estimation Scheme With Motion Vector Propagation for Frame Rate Up-Conversion Applications"]* and further in view of Ai-Mei Huang et al. *["A Multistage Motion Vector Processing Method for Motion-Compensated Frame Interpolation"]*.

Regarding claim 1, Han teaches

1. A method comprising *(i.e. a novel video compression scheme based on a highly flexible hierarchy of unit representation which includes three block concepts: coding unit (CU), prediction unit (PU), and transform unit (TU) - Abstract)*:

receiving a block of pixels including a prediction *(i.e. prediction unit (PU)- Abstract)* unit *(i.e. Fig. 1 shows all proposed building blocks of the decoder. All the coding tools are extended to support the proposed flexible architecture. Intra prediction is extended to support an arbitrary number of angles rather than the conventional 9-modes defined in H.264/AVC. Fast integer transforms larger than 8 × 8 are developed to support large TU sizes. Edge definition for the deblocking filter is modified according to the CU, PU, and TU concepts. Partition information in quadtreebased adaptive loop filter (QALF) [13] is replaced with CU splitting information- page 1710, ¶ 3)*;

However, Han does not teach explicitly:

determining a set of spatial motion vector prediction candidates for the block of pixels;

the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit,

determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates;

In the same field of endeavor, Tai teaches:

determining a set *(i.e.* $CS^i(\vec{X},t)$*)* of spatial motion vector prediction candidates for the block of pixels *(i.e. The MV search in block in the ith pass is performed in accordance with (1). As shown, the search is confined to the vectors defined in the* ***candidate vector set*** $CS^i(\vec{X},t)$*), i.e., a full search is not performed- Page 189, Col 2, ¶ 3)*;

the spatial motion vector prediction candidates being provided with motion information *(i.e. The basic principle of the multi-pass ME strategy proposed in this study is to utilize* ***the motion information*** *relating to neighboring blocks*

generated in the previous pass to gradually refine the accuracy of the MV in the current block- Page 189, Col 2, ¶ 3);

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates *(i.e. $\vec{V}$ - Equation 2)* as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit *(i.e. Every motion vector $\vec{V}$ in the candidate vector set is comprised by a single PMV and a update vector $\vec{U}$ selected from update vector set- page 190, Col 1, ¶ 3),*

determining a subset of spatial motion vector predictions based on the location of the block associated *(i.e. $\vec{X}$ represent the current block location as shown in fig 2- Page 190, Col 1, ¶ 3)* with the first spatial motion vector prediction candidate (*i.e. for each pass, i takes an integer α value between 1 and 12 included thereby defining a subset of $CS^{\alpha}(\vec{X},t)$ which is defined for different linear combination of $\overrightarrow{PMV}^{\alpha}$ and $\vec{U} \in US^{\alpha}$ - Page 190, Col 1, ¶ 3, equation 2)*;

comparing motion information of the first spatial motion vector prediction candidate *(i.e. The metric, $\overrightarrow{MV}^{i}(\overrightarrow{X},t) = arg_{\vec{V}\in CS^{i}(\vec{X},t)} \min\left(e(\vec{V},\vec{X},t)\right), 1 \leq i \leq 12,$ is used to compare determine PMV pattern which has minimal distortion among all $\vec{V}$ of the subset $CS^{\alpha}(\vec{X},t)$ - Page 190, col 1, ¶ 5, equation 1)* with motion information of the spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates *(i.e. Each pass in the proposed ME scheme is performed using one of the PMV predictor patterns (see*

Fig. 3) and then one MV in the selected PMV pattern which has minimal distortion is selected as the final PMV of this pass- Page 190; Col 1, ¶ 5); and

It would have been obvious to one with ordinary skill in the art at the time of invention, to modify the teachings of Han with the teachings of Tai to use the geometric relationship proposed in [2] describing the correlation between the current block position and the motion edge to reduce the number of PMV predictors to be evaluated *(Tai- Page 190, Col 1, ¶ 4)*.

However, Han and Tai do not teach explicitly:

where the merge list is selected based on the motion information;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

In the same field of endeavor, Huang teaches:

where the merge list is selected based on the motion *(i.e. reliability of MV- Page 697, ¶ 2; equation 2)* information *(i.e. The merging process is performed on a MB basis, and all MBs that contain unreliable MVs will be examined in a raster scan order- page 697, ¶ 10)*;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other *(i.e. if MV's is reliable or possibly reliable will not be merged in a group- page 697, ¶ 10)*, excluding the first spatial motion vector prediction candidate from the merge list *(i.e. That is, onlythose **MBs** that have unreliable **MVs** connecting to each*

other in vertical, horizontal and diagonal directions will be merged- page 697, ¶ 10).

It would have been obvious to one with ordinary skill in the art at the time of invention, to modify the teachings of Han and Tai with the teachings of Huang to preserve edge information and maintain the integrity of moving object structure, we use MB merging to correct unreliable MVs by finding a best single MV*(Huang- Page 698, ¶ 4)*.

Regarding claim 2, Han, Tai and Huang teach all the limitations of claim 1. Han further teaches:

comprising selecting spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order *(i.e. comprising selecting spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order- page 1712, Col 2, ¶ 4)*.

Regarding claim 3, Han, Tai and Huang teach all the limitations of claim 1. However, Han and Huang not teach explicitly:

comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion

vector prediction candidate of the set of spatial motion vector prediction candidates.

In the same field of endeavor, Tai teaches:

comprising comparing motion information of the potential spatial motion vector prediction candidate *(i.e.* $\overrightarrow{MV}^i(\vec{X},t) = arg_{\vec{V}\in CS^i(\vec{X},t)} \min\left(e(\vec{V},\vec{X},t)\right), 1 \le i \le 12;$ *equation 1)*with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates *(i.e. Each pass in the proposed ME scheme is performed using one of the PMV predictor patterns (see Fig. 3) and then one MVin the selected PMV pattern which has minimal distortion is selected as the final PMV of this pass- Page 190; Col 1, ¶ 5).*

Regarding claim 4, Han, Tai and Huang teach all the limitations of claim 1. Han further teaches:

comprising examining whether the received block of pixels is divided into a first prediction unit and a second prediction unit *(i.e. tu size flag is equal to one)*; and if so, excluding the potential spatial motion vector prediction candidate from the merge list *(i.e. the transform may be applied to the residue generated by multiple PU partitions with different motion vectors or prediction methods- Page 1711, ¶ 4-5)* if the prediction unit is the second prediction unit *(i.e. When the tu size flag is equal to zero, the TU size is set equal to that of the CU which it belongs to. When tu size flag is equal to one, the TU size is set as N × N for symmetric PU*

splitting's and N/2 × N/2 for asymmetric PU splitting's, respectively. This ensures that the transform which is not applied across motion boundaries can be tested in the rate-distortion optimization process for asymmetric PU partitions. It should be noted that the transform may be applied to the residue generated by multiple PU partitions with different motion vectors or prediction methods- Page 1711, ¶ 4-5)

Regarding claim 5, Han, Tai and Huang teach all the limitations of claim 1. Han further teaches:

further comprising determining a maximum number *(i.e. N)* of spatial motion vector prediction candidates to be included in a merge *(i.e. A')* list *(i.e. Fig. 3 shows the spatially adjacent motion vectors which can be considered the candidate for the prediction. Let A =$\{\mathbf{a}_0, \mathbf{a}_1, \ldots, \mathbf{a}_N\}$, A'⊂ A, and $I_{A'}$ denote the set of motion vectors above the current PU, the set of the available motion vectors in A, and the set which includes the indices of the elements in A' respectively- page 1712, col 2, ¶ 3)*; and

limiting the number *(i.e. A'⊂ A)* of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number *(i.e. The set of the available motion vectors, A', is derived from A by verifying whether the corresponding reference index is the same as that of the current PU partition- page 1712, col 2, ¶ 3)*.

Regarding claim 6, Han, Tai and Huang teach all the limitations of claim 5. Han further teaches:

comprising:

examining *(i.e. When A'= Ø, the candidate motion vector **a** from A' is excluded from the candidate set, and a zero vector is used when taking the median of spatial motion vector predictors- Page 1712, ¶ 3)*, if the number of spatial motion vector prediction candidates in the merge list smaller *(i.e. if the subset of A' is not the empty set must be a smaller set of A- page 1712, ¶ 3)* than the maximum number *(i.e. When A'= Ø, the candidate motion vector **a** from A' is excluded from the candidate set, and a zero vector is used when taking the median of spatial motion vector predictors. The candidate motion vectors **b** and **c** from B = {**b**0… $\mathbf{b}_M$} and C = {**c**0, **c**1, **c**2} are also determined using the same algorithm, and the resulting spatially adjacent motion vectors are used in the proposed AMVP method.- Page 1712, ¶ 3)*;

if so, examining whether a prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction *(i.e. The set of the available motion vectors, A' is derived from A by verifying whether the corresponding reference index is the same as that of the current PU partition- Page 1712, ¶ 3)*;

if so, performing at least **one** of the following *(i.e. The overhead for signaling the index of the best predictor is reduced by re-organizing the set of candidate predictors- page 1712, ¶ 4)*:

for the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding *()* the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled *(i.e.* ***duplicate predictors*** *and the predictors which* ***can be excluded*** *based on the parsed* ***MVD*** *values at the decoder side are eliminated from the set- page 1712, ¶ 4)*:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar *(i.e. duplicate- page 1712, ¶ 4)* motion information than the spatial motion vector prediction candidate above the prediction unit *(i.e.* ***duplicate predictors*** *and the predictors which can be excluded based on the parsed* ***MVD*** *values at the decoder side are eliminated from the set- page 1712, ¶ 4)*;

for the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for the potential spatial motion vector prediction candidate, which is on the right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

Note: The claim has been interpreted to the Examiner's best abilities for prior reference rejection despite the multiple 112(b) issues it presents.

Regarding claim 7, Han, Tai and Huang teach all the limitations of claim 1. Han further teaches:

further comprising including a temporal motion prediction candidate into the merge list *(i.e. This paper proposes the AMVP method, which is adapted to the proposed flexible unit representation. It allows the selection of the best predictor from the set which consists of three spatially adjacent motion vectors, their median, and a temporal motion vector- Page 1712, Col 2, ¶ 2)*.

Regarding claim 8, Han, Tai and Huang teach all the limitations of claim 1. Han further teaches:

comprising selecting one motion vector prediction candidate *(i.e. the best predictor is selected)* from the merge list to represent a motion vector prediction for the block of pixels*(i.e. the best predictor is selected from a given set through rate-distortion optimization- Page 1712, Col 2, ¶ 1).*

Regarding claim 9, Han teaches

9. A method comprising *(i.e. a novel video compression scheme based on a highly flexible hierarchy of unit representation which includes three block concepts: coding unit (CU), prediction unit (PU), and transform unit (TU)- Abstract)*:

receiving a encoded block of pixels including a prediction unit *(i.e. Fig. 1 shows all proposed building blocks of the decoder. All the coding tools are extended to support the proposed flexible architecture. Intra prediction is extended to support an arbitrary number of angles rather than the conventional 9-modes defined in H.264/AVC. Fast integer transforms larger than 8 × 8 are developed to support large TU sizes. Edge definition for the deblocking filter is modified according to the CU, PU, and TU concepts. Partition information in quadtreebased adaptive loop filter (QALF) [13] is replaced with CU splitting information- page 1710, ¶ 3)*;

However, Lin does not teach explicitly:

determining a set of spatial motion vector prediction candidates for the encoded block of pixels;

the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit,

determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates;

In the same field of endeavor, Tai teaches:

determining a set *(i.e.* $CS^i(\vec{X},t)$*)* of spatial motion vector prediction candidates for the encoded block of pixels *(i.e. The MV search in block in the ith pass is performed in accordance with (1). As shown, the search is confined to the vectors defined in the* ***candidate vector set*** $CS^i(\vec{X},t)$*), i.e., a full search is not performed- Page 189, Col 2, ¶ 3)*;

the spatial motion vector prediction candidates being provided with motion information *(i.e. The basic principle of the multi-pass ME strategy proposed in this study is to utilize* ***the motion information*** *relating to neighboring blocks*

generated in the previous pass to gradually refine the accuracy of the MV in the current block- Page 189, Col 2, ¶ 3);

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates *(i.e. $\vec{V}$ - Equation 2)* as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit *(i.e. Every motion vector $\vec{V}$ in the candidate vector set is comprised by a single PMV and a update vector $\vec{U}$ selected from update vector set- page 190, Col 1, ¶ 3),*

determining a subset of spatial motion vector predictions based on the location of the block associated *(i.e. $\vec{X}$ represent the current block location as shown in fig 2- Page 190, Col 1, ¶ 3)* with the first spatial motion vector prediction candidate (*i.e. for each pass, i takes an integer α value between 1 and 12 included thereby defining a subset of $CS^{\alpha}(\vec{X},t)$ which is defined for different linear combination of $\overrightarrow{PMV}^{\alpha}$ and $\vec{U} \in US^{\alpha}$- Page 190, Col 1, ¶ 3, equation 2)*;

comparing motion information of the first spatial motion vector prediction candidate *(i.e. $\overrightarrow{MV}^{i}(\overrightarrow{X},t) = arg_{\vec{V}\in CS^{i}(\vec{X},t)} \min\left(e(\vec{V},\vec{X},t)\right), 1 \leq i \leq 12$; equation 1)* with motion information of another spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates *(i.e. Each pass in the proposed ME scheme is performed using one of the PMV predictor patterns (see Fig. 3) and then one MV in the selected PMV pattern which has minimal distortion is selected as the final PMV of this pass- Page 190; Col 1, ¶ 5)*; and

However, Han and Tai do not teach explicitly:

where the merge list is selected based on the motion information;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

In the same field of endeavor, Huang teaches:

where the merge list is selected based on the motion *(i.e. reliability of MV- Page 697, ¶ 2; equation 2)* information *(i.e. The merging process is performed on a MB basis, and all MBs that contain unreliable MVs will be examined in a raster scan order- page 697, ¶ 10)*;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other *(i.e. if MV's is reliable or possibly reliable will not be merged in a group- page 697, ¶ 10)*, excluding the first spatial motion vector prediction candidate from the merge list *(i.e. That is, onlythose **MBs** that have unreliable **MVs** connecting to each other in vertical, horizontal and diagonal directions will be merged- page 697, ¶ 10)*.

Regarding claim 10, Han, Tai and Huang teach all the limitations of claim 9.

However, Han and Huang do not teach explicitly:

comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion

vector prediction candidate of the set of spatial motion vector prediction candidates.

In the same field of endeavor, Tai teaches:

comprising comparing motion information of the potential spatial motion vector prediction candidate *(i.e.* $\overrightarrow{MV}^i(\vec{X},t) = arg_{\vec{V}\in CS^i(\vec{X},t)} \min\left(e(\vec{V},\vec{X},t)\right), 1 \le i \le 12;$ *equation 1)*with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates *(i.e. Each pass in the proposed ME scheme is performed using one of the PMV predictor patterns (see Fig. 3) and then one MVin the selected PMV pattern which has minimal distortion is selected as the final PMV of this pass- Page 190; Col 1, ¶ 5).*

Regarding claim 11, Han, Tai and Huang teach all the limitations of claim 9. Han further teaches:

comprising examining whether the received encoded block of pixels is divided into a first prediction unit and a second prediction unit *(i.e. tu size flag is equal to one)*; and if so, excluding the potential spatial motion vector prediction candidate from the merge list *(i.e. the transform may be applied to the residue generated by multiple PU partitions with different motion vectors or prediction methods)* if the prediction unit is the second prediction unit *(i.e. When the tu size flag is equal to zero, the TU size is set equal to that of the CU which it belongs to. When tu size flag is equal to one, the TU size is set as N × N for symmetric PU splitting's and*

N/2 × N/2 for asymmetric PU splitting's, respectively. This ensures that the transform which is not applied across motion boundaries can be tested in the rate-distortion optimization process for asymmetric PU partitions. It should be noted that the transform may be applied to the residue generated by multiple PU partitions with different motion vectors or prediction methods- Page 1711, ¶ 4-5)

Regarding claim 12, Han and Tai teach all the limitations of claim 9. Han further teaches:

further comprising determining a maximum number *(i.e. N)* of spatial motion vector prediction candidates to be included in a merge *(i.e. A')* list *(i.e. Fig. 3 shows the spatially adjacent motion vectors which can be considered the candidate for the prediction. Let A =$\{\mathbf{a}_0, \mathbf{a}_1, \ldots, \mathbf{a}_N\}$, A'⊂ A, and $I_{A'}$ denote the set of motion vectors above the current PU, the set of the available motion vectors in A, and the set which includes the indices of the elements in A' respectively- page 1712, col 2, ¶ 3)*; and

limiting the number *(i.e. A'⊂ A)* of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number *(i.e. The set of the available motion vectors, A', is derived from A by verifying whether the corresponding reference index is the same as that of the current PU partition- page 1712, col 2, ¶ 3)*.

Regarding claim 13, Han, Tai and Huang teach all the limitations of claim 12.

Han further teaches:

comprising:

examining *(i.e. When A'= ∅, the candidate motion vector **a** from A' is excluded from the candidate set, and a zero vector is used when taking the median of spatial motion vector predictors- Page 1712, ¶ 3)*, if the number of spatial motion vector prediction candidates in the merge list smaller *(i.e. if the subset of A' is not the empty set must be a smaller set of A- page 1712, ¶ 3)* than the maximum number *(i.e. When A'= ∅, the candidate motion vector **a** from A' is excluded from the candidate set, and a zero vector is used when taking the median of spatial motion vector predictors. The candidate motion vectors **b** and **c** from B = {**b**0… $\mathbf{b}_M$} and C = {**c**0, **c**1, **c**2} are also determined using the same algorithm, and the resulting spatially adjacent motion vectors are used in the proposed AMVP method.- Page 1712, ¶ 3)*;

if so, examining whether a prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction *(i.e. The set of the available motion vectors, A' is derived from A by verifying whether the corresponding reference index is the same as that of the current PU partition- Page 1712, ¶ 3)*;

if so, performing at least **one** of the following *(i.e. The overhead for signaling the index of the best predictor is reduced by re-organizing the set of candidate predictors- page 1712, ¶ 4)*:

for the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding *(i.e. **can be excluded**- page 1712, ¶ 4)* the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled *(i.e**. duplicate predictors** and the predictors which **can be excluded** based on the parsed **MVD** values at the decoder side are eliminated from the set- page 1712, ¶ 4)*:

- the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar *(i.e. duplicate- page 1712, ¶ 4)* motion information than the spatial motion vector prediction candidate above the prediction unit *(i.e. **duplicate predictors** and the predictors which can be excluded based on the parsed **MVD** values at the decoder side are eliminated from the set- page 1712, ¶ 4)*;

for the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for the potential spatial motion vector prediction candidate, which is on the right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

Note: The claim has been interpreted to the Examiner's best abilities for prior reference rejection despite the multiple 112(b) issues it presents.

Regarding claim 14, Han and Tai teach all the limitations of claim 9. Han further teaches:

comprising selecting one motion vector prediction candidate *(i.e. the best predictor is selected)* from the merge list to represent a motion vector prediction for the received encoded block of pixels*(i.e. the best predictor is selected from a given set through rate-distortion optimization- Page 1712, Col 2, ¶ 1).*

Regarding claim 15 and 19, apparatus claim 15 and 19 is drawn to the apparatus using/performing the same method as claimed in claim 1. Therefore apparatus claim 15 and 19 corresponds to method claim 1, and is rejected for the same reasons of obviousness as used above.

Regarding claim 16 and 20, apparatus claim 16 and 20 is drawn to the apparatus using/performing the same method as claimed in claim 9. Therefore apparatus claim 16 and 20 corresponds to method claim 9, and is rejected for the same reasons of obviousness as used above.

Regarding claim 17, computer-readable medium storing instructions claim 17 corresponds to the same method as claimed in claim 1, and therefore is also rejected for the same reasons of obviousness as listed above.

Regarding claim 18, computer-readable medium storing instructions claim 50 corresponds to the same method as claimed in claim 9, and therefore is also rejected for the same reasons of obviousness as listed above.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP

§ 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CLIFFORD HILAIRE whose telephone number is (571)272-8397. The examiner can normally be reached on Monday-Friday- 0800-1700, EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sathyanarayanan Perungavoor can be reached on (571)272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/C. H./
Examiner, Art Unit 2488

/Geepy Pe/
Primary Examiner, Art Unit 2488
2/24/16

Notice of References Cited	Application/Control No. 13/666,680	Applicant(s)/Patent Under Reexamination BICI ET AL.	
	Examiner CLIFFORD HILAIRE	Art Unit 2488	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
	A	US-				
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Han, Woo-Jin, et al. "Improved video compression efficiency through flexible unit representation and corresponding extension of coding tools." Circuits and Systems for Video Technology, IEEE Transactions on 20.12 (2010): 1709-1720. (Previously Presented But with additional annotations)
	V	Tai, Shen-Chuan, et al. "A multi-pass true motion estimation scheme with motion vector propagation for frame rate up-conversion applications." Journal of display technology 4.2 (2008): 188-197. (Previously Presented But with additional annotations)
	W	Huang, Ai-Mei, and Truong Q. Nguyen. "A multistage motion vector processing method for motion-compensated frame interpolation." Image Processing, IEEE Transactions on 17.5 (2008): 694-708.
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000827

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 4782

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/666,680	11/01/2012 RULE	375	2488	042933/467264

APPLICANTS
Nokia Technologies Oy, Espoo, FINLAND;

INVENTORS
Mehmet Oguz BICI, Tampere, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;

**** CONTINUING DATA ***************************
This appln claims benefit of 61/555,703 11/04/2011

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
11/20/2012

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ Yes ☑ No	☐ Yes ☑ No	/CLIFFORD HILAIRE/ Examiner's Signature	☐ Initials	FINLAND	13	20	8

ADDRESS

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

TITLE

METHOD FOR CODING AND AN APPARATUS

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
2640	No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000828

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13666680	BICI ET AL.
	Examiner	Art Unit
	CLIFFORD HILAIRE	2488

CPC- SEARCHED		
Symbol	Date	Examiner
H04N19/52; H04N19/513; H04N19/176; H04N19/61; H04N19/51; H04N19/597; H04N19/56; H04N19/139; H04N19/573; H04N19/521; H04N19/103; H04N19/30	6/25/2015	CH

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	240	6/25/2015	CH

SEARCH NOTES		
Search Notes	Date	Examiner
See Attached EAST Search History Document	2/24/2016	CH
IEEEXplore Search	2/24/2016	CH
Google Scholar	2/24/2016	CH

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/CLIFFORD HILAIRE/ Examiner.Art Unit 2488	

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear
	1	US-2004/0234144 A1	11-25-2004	Sugimoto et al.	
	2	US-2008/0159401 A1	07-03-2008	Lee et al.	
	3	US-2011/0182362 A1	07-28-2011	Kim et al.	

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	4	Taiwanese Office Action and Search Report from Taiwanese Patent Application No. 101140777 dated December 2, 2015	

Examiner Signature	/CLIFFORD HILAIRE/	Date Considered	02/19/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36095683v1

Submitted December 29, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.H/

Improved Video Compression Efficiency Through Flexible Unit Representation and Corresponding Extension of Coding Tools

Woo-Jin Han, *Member, IEEE,* Junghye Min, Il-Koo Kim, Elena Alshina, Alexander Alshin, Tammy Lee, Jianle Chen, Vadim Seregin, Sunil Lee, *Member, IEEE,* Yoon Mi Hong, Min-Su Cheon, Nikolay Shlyakhov, Ken McCann, Thomas Davies, and Jeong-Hoon Park

***Abstract*—This paper proposes a novel video compression scheme based on a highly flexible hierarchy of unit representation which includes three block concepts: coding unit (CU), prediction unit (PU), and transform unit (TU). This separation of the block structure into three different concepts allows each to be optimized according to its role; the CU is a macroblock-like unit which supports region splitting in a manner similar to a conventional quadtree, the PU supports nonsquare motion partition shapes for motion compensation, while the TU allows the transform size to be defined independently from the PU. Several other coding tools are extended to arbitrary unit size to maintain consistency with the proposed design, e.g., transform size is extended up to 64×64 and intraprediction is designed to support an arbitrary number of angles for variable block sizes. Other novel techniques such as a new noncascading interpolation filter design allowing arbitrary motion accuracy and a leaky prediction technique using both open-loop and closed-loop predictors are also introduced. The video codec described in this paper was a candidate in the competitive phase of the high-efficiency video coding (HEVC) standardization work. Compared to H.264/AVC, it demonstrated bitrate reductions of around 40% based on objective measures and around 60% based on subjective testing with 1080p sequences. It has been partially adopted into the first standardization model of the collaborative phase of the HEVC effort.**

***Index Terms*—Flexible unit representation, HEVC, video coding.**

I. Introduction

RECENTLY, with the ever increasing popularity of high-definition (HD) video content, video compression technologies which can provide higher coding efficiency than existing video coding standards have received increased attention. Early video coding standards such as MPEG-1 [1] and MPEG-2 [2] employ fixed-size block motion compensation method with a macroblock size of 16 × 16. In the state-of-the-art standard H.264/AVC [3], this macroblock size is retained but with the addition of a depth-2 quadtree, which significantly improves coding efficiency. However, it has been observed that the maximum 16 × 16 block size is too small when applied to high resolution video and causes inefficiency [4], [5]. To solve this problem, recent Visual Coding Experts Group (VCEG) proposals have extended the maximum motion block size up to 64×64 by adding additional large motion block modes on top of the conventional 16 × 16 H.264/AVC macroblock syntax [6]–[8].

Although those approaches suggested that the coding efficiency for the high resolution video materials can be improved by providing a better tradeoff between prediction performance and side information, they simply tried to add the large size motion partition while maintaining the existing 16 × 16 macroblock sizes, which imposes restrictions on the flexibility of the quadtree structure. For example, spatial/temporal prediction mode switching, intracoding tools and spatial transforms are still defined based on the 16 × 16 macroblock sizes, thus the schemes generally suffer from lower coding efficiency in intracoded blocks.

There has been extensive research on introducing a general multidepth quadtree for variable block-size motion compensation [9]–[12]. A frame is typically divided into fixed-size superblocks, with each superblock able to be further split. This kind of generic quadtree can provide a consistent codec design; however, focusing only on motion compensation does not exploit the full potential of the technique.

This paper describes a video compression framework where the whole codec has been designed to exploit flexible block sizes. A highly flexible hierarchical structure based on the generic quadtree scheme is defined by three independent block concepts: coding unit (CU), prediction unit (PU), and transform unit (TU). CU is the basic unit of region splitting. CU is analogous to the concept of macroblock, but it does not restrict the maximum size and it allows recursive splitting into four equal size CUs to improve the contents adaptivity. PU is the

Manuscript received July 23, 2010; revised October 11, 2010; accepted October 19, 2010. Date of publication November 15, 2010; date of current version January 22, 2011. This paper was recommended by Associate Editor T. Wiegand.

W. J. Han, J. Min, I. K. Kim, E. Alshina, A. Alshin, T. Lee, J. Chen, V. Seregin, S. Lee, Y. M. Hong, M. S. Cheon, N. Shlyakhov, and J. H. Park are with the Digital Media and Communication Research and Development Center, Samsung Electronics, Suwon 443-742, Korea (e-mail: wjhan.han@samsung.com; jh643.min@samsung.com; ilkoo.kim@samsung.com; elena_a.alshina@samsung.com; alexander_b.alshin@samsung.com; tammy.lee@samsung.com; jianle.chen@samsung.com; v.seregin@samsung.com; sunil.lee@samsung.com; yoonmi.hong@samsung.com; minsu.cheon@samsung.com; n.shlyakhov@samsung.com; jeonghoon@samsung.com).

K. McCann is with ZetaCast, Bath, BA2 6NZ, U.K. (e-mail: ken@zetacast.com).

T. Davies is with British Broadcasting Corporation, London, W1A 1AA, U.K. (e-mail: thomas.davies@bbc.co.uk).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TCSVT.2010.2092612

1051-8215/$26.00 © 2010 IEEE

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000831

basic unit of inter/intraprediction and it may contain multiple arbitrary shape partitions in a single PU to effectively code irregular image patterns. TU is the basic unit of transform. It can be defined independently from the PU; however, its size is limited to the CU which the TU belongs to. This separation of the block structure into three different concepts allows each to be optimized according to its role, which results in the improved coding efficiency.

From these unit definitions, all coding processes can be defined in a very consistent way; large block sizes are supported in both motion compensation and intraprediction schemes, prediction mode switching is allowed at any block sizes and spatial transforms larger than 16×16 are also supported in both inter and intracoded blocks. Due to this consistency, every syntax element can be defined in exactly the same way independent of the unit sizes, which makes the specification and parsing process much simpler than would be the case with an extension scheme on top of a conventional 16×16 macroblock syntax.

Fig. 1 shows all proposed building blocks of the decoder. All the coding tools are extended to support the proposed flexible architecture. Intra prediction is extended to support an arbitrary number of angles rather than the conventional 9-modes defined in H.264/AVC. Fast integer transforms larger than 8×8 are developed to support large TU sizes. Edge definition for the deblocking filter is modified according to the CU, PU, and TU concepts. Partition information in quadtree-based adaptive loop filter (QALF) [13] is replaced with CU splitting information.

The rest of this paper is organized as follows. Section II introduces the details of the unit definitions and Section III presents the proposed coding tools for the interframe prediction. The remaining coding tools for the intraframe prediction, spatial transform, in-loop filtering, and entropy coding are introduced in Sections IV, V, VI, and VII, respectively. Section VIII summarizes the coding efficiency of the proposed techniques based on the objective and subjective results. Finally, Section IX concludes the paper. For a more complete description for the coding tools, please refer to [14] and [15].

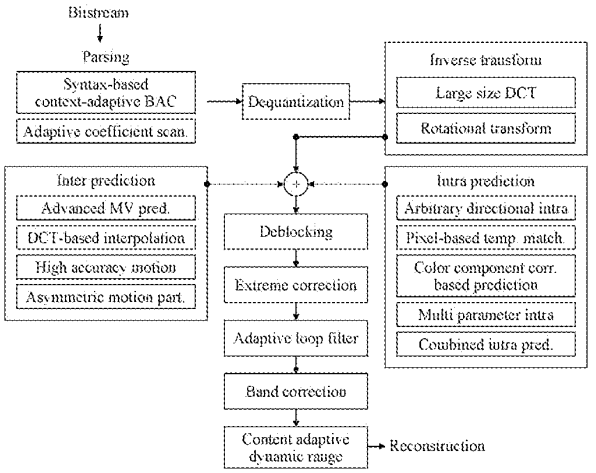


Fig. 1. All building blocks to decode the input bit-stream.

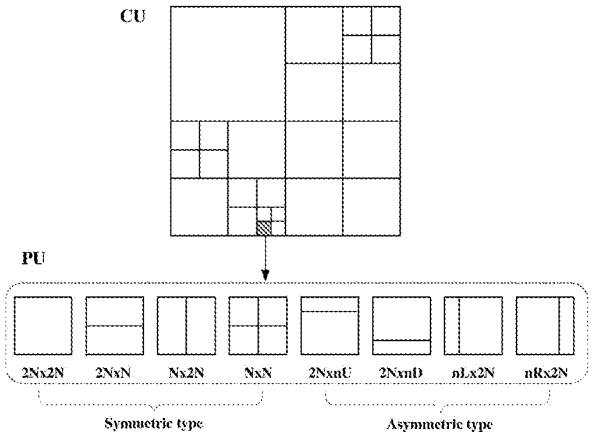


Fig. 2. Relationship between CU and PU.

II. Unit Definition

For efficient and flexible representation of video content with various resolutions, a triplet of CU, PU, and TU are introduced. The following subsections describe the details of each unit.

A. Coding Unit

The picture is divided into slices, with each slice composed of a sequence of largest coding units (LCUs). The LCU size is specified in the sequence parameter set (SPS) or slice header; the optimum LCU size is dependent on the application.

Fig. 2 shows quad-tree based CU structure. The LCU can be divided into four CUs by a 1-bit syntax, split_flag. Each split CU can be divided into four CUs recursively up to the maximum allowed hierarchical depth, also specified in the SPS or slice header. For example, if LCU size is equal to 128 and the maximum hierarchical depth is equal to 5, then 5 kinds of CU sizes are possible: 128×128 (LCU), 64×64, 32×32, 16×16, and 8×8. The three syntax elements, LCU size, maximum hierarchical depth, and split_flags, completely specify the generic multidepth quadtree.

B. Prediction Unit

Coupled with CU, this paper introduces a basic unit for prediction: the PU. The PU is defined only for the leaf node CU which is not split in quadtree structure, and the size of the PU is limited to that of the CU. The prediction method is specified by the prediction mode and the PU splitting. As with H.264/AVC, the prediction mode can be one of the values among skip, intra, and inter. Fig. 2 shows different PU splitting strategy for a CU of size $2N \times 2N$, which is dependent on the property of each prediction mode.

Skip mode can be thought of as a special intermode in which no motion vector and residue information are transmitted. Typically it is used in an area of the image with smooth motion, thus no further splitting is necessary and only $2N \times 2N$ partition is used. For the normal intermode, a set of eight splitting options are defined to cover possible motion boundaries

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000832

inside the PU. Given a PU of size $2N \times 2N$, four symmetric splittings ($2N \times 2N$, $2N \times N$, $N \times 2N$, $N \times N$) and four asymmetric splittings ($2N \times$nU, $2N \times$nD, nL$\times 2N$, nR$\times 2N$) are defined. The asymmetric PU splittings are included in the design to improve the coding efficiency for the irregular object boundaries, which otherwise would be constrained to being represented less efficiently by further CU splittings to the deeper depth. For the intramode, only two possible splittings $2N \times 2N$ and $N \times N$ are defined.

All information related to the prediction is signaled on a PU basis, for example, the prediction mode and PU splitting type are specified for each PU. Once the prediction mode and PU splitting are given, motion vector difference, intraprediction direction, reference indices for each PU partition are specified on a PU partition basis.

C. Transform Unit

The TU, for transform and quantization, is the third basis unit. Although, in principle, TU can be defined in a similar way to PU to support arbitrary shape transforms, only two TU partitions are used in this paper considering the implementation complexity.

When the tu_size_flag is equal to zero, the TU size is set equal to that of the CU which it belongs to. When tu_size_flag is equal to one, the TU size is set as $N \times N$ for symmetric PU splittings and $N/2 \times N/2$ for asymmetric PU splittings, respectively. This ensures that the transform which is not applied across motion boundaries can be tested in the rate-distortion optimization process for asymmetric PU partitions.

It should be noted that the transform may be applied to the residue generated by multiple PU partitions with different motion vectors or prediction methods. This approach is especially beneficial for coding semirandom residuals generated by complex texture areas where neighboring partitions share common signal characteristics, which can exploit the better energy compaction of larger transform [14].

D. Size-Independent Syntax Representation

The proposed unit definitions allow us to design a size-independent syntax representation which specifies all syntax elements in a consistent way independent of the unit size. By contrast, in H.264/AVC and its extension in [6]–[8], block level syntax elements such as prediction_mode, transform_flag, coded_block_flag, and intra_pred_mode are coded differently depending on block size. This size-independent method of representation allows syntax elements to be specified generically for all the remaining coding tools. This property can greatly simplify the specification effort as well as the actual parsing process, especially if a large number of hierarchical depths is allowed.

III. Interprediction

In this paper, three aspects of interframe prediction are improved: motion accuracy, interpolation filter, and motion vector prediction. For motion accuracy, quarter-pel precision with 1/12-pel optional refinement is used to improve the coding efficiency while minimizing the additional overhead for signaling the motion information. For motion compensation, noncascaded spatial filtering using a discrete cosine transform (DCT)-based interpolation filter is used for every motion accuracy position. For motion vector prediction, advanced motion vector prediction (AMVP), which is a motion vector competition method [16] adapted to the flexible unit representation, is used to reduce overhead for motion information.

A. High Accuracy Motion

Even though higher motion accuracy results in less prediction error, it does not guarantee improved coding efficiency, since it leads to an increase in the bit rate to convey the motion information. For example, 1/8-pel motion accuracy may often result in a reduction in the overall coding efficiency, except for particular sequences [17].

In this paper, high accuracy motion (HAM), which adaptively refines the motion information to an arbitrary accuracy, is proposed. In the HAM method, motion information at quarter-pel accuracy is followed by a refinement flag and optional refinement information at 1/12-pel accuracy. The refinement flag is set equal to 1 only when the refinement provides the gain in the rate-distortion optimization sense, otherwise, the flag is set to 0 and no refinement information is signaled. Although the refinement information can represent any accuracy, the current design uses 1/12-pel, since refinement in 1/8-pel accuracy results in the redundancy in the refinement information.

B. DCT-Based Interpolation Filter

Motion compensation with fractional pel accuracy requires interpolation of the reference signal. In H.264/AVC standard, the prediction values at half-pel positions are obtained using a 6-tap Wiener filter, while those at quarter-pel positions are obtained by bilinear combination of the samples at integer and half-pel positions [3]. This paper proposes a DCT-based interpolation filter (DCT-IF), which can directly provide the interpolated value at the desired fractional accuracy from the samples at integer-pel positions. Since the DCT-IF can provide the interpolated value without cascaded filtering, the motion compensation process can be simplified and the complexity can also be reduced for samples at quarter-pel accuracy. Furthermore, the DCT-IF provides a unified way to generate the interpolation filters supporting motion accuracy higher than quarter-pel, e.g. 1/8-pel, 1/12-pel, etc. Note that 12-tap and 6-tap DCT-IFs are used for luma and chroma, respectively.

1) *Filter Coefficient Generation:* In this paper, trigonometric interpolation, which has been widely used for the other applications [18], is exploited to construct DCT-IF for high accuracy motion compensation. Let $p(\alpha)$ denote the sample value at the fractional position $\alpha \in [-(M-1), M]$, where M is a positive integer. Then, $p(\alpha)$ can be derived as follows:

$$p(\alpha) = \mathbf{f}_{(\alpha)}^T \mathbf{p} = \left(\mathbf{w}_{(\alpha)}^T D\right) \mathbf{p} \tag{1}$$

where $\mathbf{p} = [p_{-(M-1)}, \ldots, p_M]^T$ is the vector of the given samples at the integer-pel positions, D is the $2M \times 2M$ DCT

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000833

TABLE I
FILTER COEFFICIENTS OF 6-TAP DCT-IF

α	$2M$ = 6 (6-tap filter)						
−1/12	{	−4,	19,	254,	−19,	8,	−2 }
1/12	{	4,	−16,	252,	22,	−8,	2 }
2/12	{	6,	−28,	242,	48,	−17,	5 }
3/12	{	9,	−37,	227,	75,	−25,	7 }
4/12	{	11,	−42,	208,	103,	−33,	9 }
5/12	{	12,	−44,	184,	132,	−39,	11 }
6/12	{	11,	−43,	160,	160,	−43,	11 }
7/12	{	11,	−39,	132,	184,	−44,	12 }
8/12	{	9,	−33,	103,	208,	−42,	11 }
9/12	{	7,	−25,	75,	227,	−37,	9 }
10/12	{	5,	−17,	48,	242,	−28,	6 }

matrix whose element is given as

$$d_{ij} = \frac{1}{M}\cos\left(\frac{(2j-1+2M)i\pi}{4M}\right) \tag{2}$$

where $0 \le i \le (2M-1)$, $(-M+1) \le j \le M$, and $\mathbf{w}_{(\alpha)} = [w_0^{(\alpha)}, \ldots, w_{(2M-1)}^{(\alpha)}]^T$ is given as

$$w_i^{(\alpha)} = \begin{cases} \frac{1}{2}, & i = 0 \\ \cos\left(\frac{\pi(2\alpha-1+2M)i}{4M}\right), & 1 \le i \le (2M-1). \end{cases} \tag{3}$$

By using $\mathbf{f}_{(\alpha)}$ of (1), one can easily calculate the filter coefficients for an arbitrary number of filter taps ($2M$) and arbitrary fractional position α. Table I shows the coefficients of the 6-tap filters generated for 1/12-pel motion accuracy. Note that the filter coefficients are scaled by 256, H.264/AVC uses 5 bits for filter coefficients.

2) *Low Complexity Optimization:* An efficient hardware implementation requires multiplication-free representation for all the calculations. In order to minimize the number of arithmetical operations (shifts and additions), the filter coefficients in Table I can be slightly changed without significant loss in coding efficiency. Table II shows 5 bits representation for optimized filter coefficients for the quarter-pel positions, together with the required number of arithmetical operations. The proposed DCT-IF is a noncascaded interpolation scheme, i.e. only one spatial filtering is performed for all the possible positions. It can be implemented by a multiplication-free design. Thus, the 6-tap DCT-IF has the smaller number of operations compared to the interpolation filter of H.264/AVC since samples at the quarter-pel position can be generated by one 6-tap filtering operation whereas H.264/AVC uses a combination of 6-tap and bi-linear filters. The 12-tap DCT-IF filter requires twice as many operations as the 6-tap DCT-IF, however it provides similar performance to the well-known adaptive interpolation filter (AIF) scheme [19] while being less complex and more suitable for hardware implementation.

TABLE II
OPTIMIZED FILTER COEFFICIENTS FOR 6-TAP DCT-IF AT QUARTER-PEL POSITIONS

α	2M = 6 (6-tap filter)								Add	Shift
1/4	{	1,	−4,	28,	9,	−3,	1	}	8	2
2/4	{	1,	−5,	20,	20,	−5,	1	}	6	2
3/4	{	1,	−3,	9,	28,	−4,	1	}	8	2

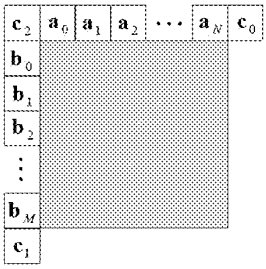


Fig. 3. Spatially adjacent motion vectors for the AMVP.

C. Advanced Motion Vector Prediction

In H.264/AVC standard, motion vectors are predicted from a median of the motion vectors of the spatially adjacent blocks [3]. To further improve the efficiency of the motion vector prediction, a few competition-based prediction methods have been proposed [16], [20], where the best predictor is selected from a given set through rate-distortion optimization.

This paper proposes the AMVP method, which is adapted to the proposed flexible unit representation. It allows the selection of the best predictor from the set which consists of three spatially adjacent motion vectors, their median, and a temporal motion vector.

Fig. 3 shows the spatially adjacent motion vectors which can be considered the candidate for the prediction. Let $A = \{\mathbf{a}_0, \mathbf{a}_1, \ldots, \mathbf{a}_N\}$, $A' \subset A$, and $I_{A'}$ denote the set of motion vectors above the current PU, the set of the available motion vectors in A, and the set which includes the indices of the elements in A', respectively. The set of the available motion vectors, A', is derived from A by verifying whether the corresponding reference index is the same as that of the current PU partition. When $A' = \emptyset$, the candidate motion vector $\mathbf{a}$ from A' is excluded from the candidate set, and a zero vector is used when taking the median of spatial motion vector predictors. Otherwise, $\mathbf{a}$ is determined as $\mathbf{a} = \mathbf{a}_n$, where n is the smallest element of $I_{A'}$. The candidate motion vectors $\mathbf{b}$ and $\mathbf{c}$ from $B = \{\mathbf{b}_0, \ldots, \mathbf{b}_M\}$ and $C = \{\mathbf{c}_0, \mathbf{c}_1, \mathbf{c}_2\}$ are also determined using the same algorithm, and the resulting spatially adjacent motion vectors are used in the proposed AMVP method.

The overhead for signaling the index of the best predictor is reduced by re-organizing the set of candidate predictors. First, the predictors in the candidate set are reordered based on the PU splitting, so that the most probable motion predictor appears first in the set. Then, duplicate predictors and the predictors which can be excluded based on the parsed MVD values at the decoder side are eliminated from the set [20].

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000834

Note that, when only one predictor remains as a result of the re-organization, no overhead is signaled, since it can be also derived at the decoder.

Although AMVP is developed to predict the motion vector, it is also applied to the skip and direct modes, which do not transmit the additional motion vector differences. It should be noted that exactly the same process is applied to all cases to simplify the design. For comparison, H.264/AVC uses a slightly different scheme for the skip mode.

IV. Intraprediction

To improve the performance of intraprediction, five new intracoding tools are included. Arbitrary directional intra (ADI) extends the conventional nine-direction intraprediction to support any arbitrary number of angles in a unified way. Multiparameter intra (MPI) tries to apply post processing filters to the prediction samples from the ADI. To exploit the interchannel correlation between luminance and chrominance, color component correlation based prediction (CCCP) is introduced. Pixel-based template matching (PTM) is included to improve the coding efficiency for repeated regular patterns. Finally, the combined intraprediction (CIP) allows combining the closed-loop predictor generated from the above methods with an open-loop predictor to further improve the performance.

A. Arbitrary Directional Intra (ADI)

In H.264/AVC intracoding, nine intraprediction modes are supported for 4×4 and 8×8 blocks but only four intraprediction modes for 16×16 blocks. Intra-coded 16×16 blocks were intended to code homogeneous regions in low resolution video. However, even relatively large blocks ($\geq 16 \times 16$) cover only a small part of objects or background in high resolution video, which may contain strong directional patterns.

Arbitrary directional intra (ADI) is a coding tool designed to extend the directional intraprediction scheme used in H.264/AVC to give more accurate representation of directions and better suit larger prediction units. In the ADI scheme, up to 30 angles are generated using the integer pair (dx, dy) to represent the direction of lines which each mode uses for context pixel extrapolation as illustrated in Fig. 4.

Like H.264/AVC, ADI uses the reconstructed pixels. However, in some cases, the down-left region is available for the prediction process as depicted in Fig. 4. When the down-left region is not available, that region is generated using the nearest reconstructed pixel value.

Due to the large variety of the possible unit sizes, it is beneficial to adjust the number of angles according to the unit size. For example, PU partitions with 64×64 and 128×128 sizes are usually used for homogeneous areas which can be generated by using only some prediction modes, such as DC and plane modes. In this case, the number of supported prediction modes of the current PU partition may differ from that of the neighboring PU partitions. Intra prediction modes of the neighboring PU partitions are converted to the nine most frequently used modes to predict the current intraprediction mode in a unified way.

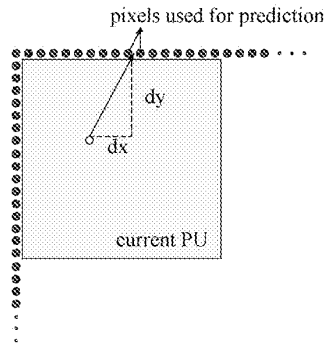


Fig. 4. Neighboring pixels and angles defined by (dx, dy).

B. Multiparameter Intra

Directional intraprediction sometimes results in nonsmooth and unnatural patterns which are not transform-friendly. This problem can be alleviated by applying a smoothing filter to the prediction signal obtained by the ADI scheme described in Section IV-A. Multiparameter intra (MPI) allows the use of the 4-point filter in (4) for each pixel to increase the probability of generating a prediction signal well-suited to the following transform stages. For each PU partition, mpi_flag is used to specify whether or not the MPI scheme is applied.

$$p'[x, y] = (p[x, y] + p[x-1, y] + p[x, y-1] + p[x, y+1] + 2) >> 2 \quad (4)$$

where $p[x, y]$ and $p'[x, y]$ are the original and the smoothed prediction value at (x, y) coordinates, respectively, and $>>$ is the bit-wise shift to the right.

C. Color Component Correlation Based Prediction

There have been some studies on predicting chrominance pixels using the correlation with luminance [21]. Although most approaches try to predict the pixel values of one color channel by another color channel, the color component correlation based prediction (CCCP) scheme derives an object segmentation map of the chrominance channel from the already coded luma channel, and applies it to intraprediction.

The CCCP procedure is as follows. Firstly, the size of the reconstructed luma samples including the neighboring luma pixels are adjusted to match that of the chroma samples according to the given chroma format. Then, simple thresholding using the mean value is exploited to generate the binary segmentation map. After that, two mean values are computed from the neighboring chroma pixels according to the segmentation map and assigned to the inner part of the chroma block. Finally, a 3×3 averaging filter is applied to improve the smoothness of the prediction. Fig. 5 shows a brief flow of the CCCP process.

D. Pixel Based Template Matching (PTM)

Whilst directional extrapolation based intraprediction tools are very efficient for regions with directional patterns, they are not well-suited to regions with repeated regular patterns. To overcome this limitation, several intratechniques using some

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000835

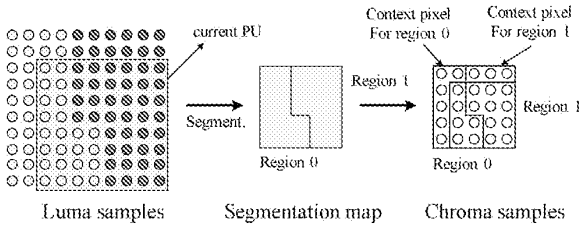


Fig. 5. Processing flow of color component correlation based prediction (CCCP).

form of template matching based on the already decoded pixels have been proposed [22], [23]. Although the reported schemes were proven to provide good coding gains for the targeted areas, a major drawback was the high complexity at the decoder side.

In this paper, a simple pixel based template matching (PTM) approach is proposed. PTM is designed to apply template matching at the pixel level to maximize the degrees of freedom. PTM uses only three pixels as template. Search candidates are also restricted to neighboring 27 pixels, which results in complexity reduction in matching process. Another difference of PTM compared with previous methods is that already prediction samples in the same prediction unit are also used as template and search candidate. This allows use very limited search area even for large block prediction.

E. Combined Intraprediction

Combined intraprediction (CIP) is a coding tool for providing improved prediction, especially in large blocks where a directional linear prediction may not work well, even with the large range of angles available to ADI. CIP predictions comprise a weighted combination of the prediction samples provided by other intracoding tools together with a pixel-by-pixel local mean prediction of pixels within the block to be transformed.

The local mean is constructed as the average of pixel values to the left, top-left and above the current pixel. In the decoder and within the local decoder in the encoder, these values are the reconstructed values after inverse quantization and transform. In the encoder, the reconstructed values are not available in the interior of the block because this would require quantization, transform and inverse transform to have been performed, and the pixels used for prediction lie within the block. Instead original values are used, although the encoder may select any suitable values. This local mean prediction is therefore different between forward prediction (encoder only) and reconstruction (encoder and decoder). Due to this property, CIP can be seen as a leaky prediction method to combine the conventional closed-loop predictor and an open-loop predictor. The advantage of CIP is that it provides pixel-by-pixel adaptation but is a simpler tool than, for example, local template matching approaches.

The combination factor is a 5-bit number between 0 and 31/32 which determines the proportion of local mean in the prediction. Since this number is less than 1, the prediction/reconstruction difference noise is damped, and pixel-by-pixel prediction adaptation is possible without noise blow-up. The ADI component provides an overall prediction direction and the local mean prediction provides local adaptation.

V. Spatial Transforms

It is well known that transforms larger than 8×8 provides better energy compaction and less quantization error for smooth and coarse textured video areas at the expense of computational complexity [24], [25]. In this paper, 16×16, 32×32 and 64×64 fast integer transforms are presented in addition to the conventional 4×4 and 8×8 transforms to support large TUs. In addition, a rotational transform (ROT) tool, which can adaptively compact the energy into low frequency components by rotating the transform basis, is also proposed as a second transform.

A. Large Integer Transform (16×16, 32×32, and 64×64)

The DCT is independent of input signal while it still provides near optimal decorrelation properties. Moreover, many fast DCT algorithms have been developed. All large transforms proposed in this paper are scaled integer DCTs based on Chen's fast factorizations [26]. Chen's fast DCT has a regular butterfly structure which is beneficial to hardware implementation.

Similarly to the H.264/AVC 4×4 core transform, each multiplication factor in the flow graph of the fast algorithm is scaled and approximated by some fixed precision values p, i.e., each constant is approximated by the dyadic rational of the form $q/2^p$, which can be implemented with only additions and bit-shifting operations. The precision value p can be chosen according to the dynamic range limitation and coding efficiency. As all multiplication factors are approximated, the core transform may not be truly orthogonal. However, this minor nonorthogonality does not result in any perceptible negative effect on the compression performance, whilst the complexity can be significantly reduced. Furthermore, it is still possible to achieve perfect reconstruction using a lifting scheme that can be applied additionally to the butterfly structure [27].

After all multiplication factors are determined, the forward 2-D transform is performed separately in vertical and horizontal direction as follows:

$$Y = C_f(C_f X^T)^T = C_f X C_f^T \tag{5}$$

where X is $N \times N$ residual data, C_f is the core N-point forward transform, and Y is $N \times N$ transformed coefficients. The calculation of $C_f X^T$ is performed from left to right in the flow graph of the fast algorithm. For the inverse transform, the computation order is reversed from right to left. Since the core transform C_f is scaled DCT, the remaining scaling factors should be integrated into the quantization stage.

B. Rotational Transform

While DCT is the most widely used block transform for video and image codecs, the DCT basis functions are not optimal for some types of residual signal. For example, a residual signal having strong diagonal components cannot

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000836

be represented efficiently with the DCT basis vectors. Typically, directional transform schemes are proposed to exploit this problem such as mode dependent directional transform (MDDT) [28], [29].

However, the direct use of directional transform is not appropriate to the proposed flexible unit definitions since it is difficult to design the directional transform by a fast butterfly structure such as DCT. In addition, the number of transforms would be almost doubled because both DCT and the directional transform for various TU sizes would be kept in the codec design.

In this paper, ROT is proposed as a second transform that could be applied after the core integer transform instead of introducing completely new transform cores. The main idea of ROT is to change the coordinate system of the transform basis, instead of direct rotation of the input residual. For example, the rotation matrices of horizontal and vertical directions for a 4×4 block with the rotation angles of $(\alpha_1, \alpha_2, \alpha_3)$ and $(\alpha_4, \alpha_5, \alpha_6)$ are defined as

$$R_{\text{ver}}(\alpha_1, \alpha_2, \alpha_3) = \begin{pmatrix} C_1C_3 - S_1C_2S_3 & -S_1C_3 - C_1C_2S_3 & S_2S_3 & 0 \\ C_1S_3 + S_1C_2C_3 & -S_1S_3 + C_1C_2C_3 & -S_2C_3 & 0 \\ S_1S_2 & C_1S_2 & C_2 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (6)$$

$$R_{\text{hor}}(\alpha_4, \alpha_5, \alpha_6) = \begin{pmatrix} C_4C_6 - S_4C_5S_6 & -S_4C_6 - C_4C_5S_6 & S_5S_6 & 0 \\ C_4S_6 + S_4C_5C_6 & -S_4S_6 + C_4C_5C_6 & -S_5C_6 & 0 \\ S_4S_5 & C_4S_5 & C_5 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (7)$$

where $C_k = \cos\alpha_k$ and $S_k = \sin\alpha_k$ for $k = 1, \ldots, 6$. The rotation matrices for 8×8 block can be defined similar to those for 4×4 block.

Each set of angles $\{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6\}$ specifies one element in the ROT dictionary. In ROT, only four out of all possible rotational angles sets are used. These RT matrices minimize the discrepancy between forward-inverse RT in integer arithmetic realization and provide better energy compaction. These sets of rotational angles were selected using the training with VCEG test sequences, and they provide similar performance for other video sequences including the test sequences for the HEVC standardization. This proves that these angles sets capture and exploit general characteristic of natural images. The index of rotational angles in the dictionary is signaled to the decoder for each CU explicitly.

Furthermore, since ROT is a second transform, not all of the DCT coefficients are processed. For TUs larger than 4×4, only 8×8 low-frequency areas are processed. It has been found that this restriction does not degrade the coding efficiency since most of the coefficients are already compacted into these low-frequency areas.

The final 2-D spatial transform process when the ROT is used can be summarized as

$$Y = R_{\text{ver}}(C_f X C_f^T) R_{\text{hor}} \quad (8)$$

where X is residual data, C_f is the core forward transform, and Y is output coefficients.

VI. In-Loop Filtering

After reconstruction, several in-loop filters are applied to reduce the distortion between the original and the reconstructed video frames. In addition to a modified H.264/AVC deblocking filter for the CU/PU/TU structure, a CU-synchronized adaptive loop filter (CU-ALF) is introduced to reduce the average distortion of the reconstructed frame. Extreme correction (EXC) and band correction (BDC) techniques are applied to reduce the distortion further by considering object-based pixel classifications. Finally, content adaptive dynamic range (CADR) is proposed to reduce the performance loss from the rounding effects of the various internal processes.

A. Deblocking Filter

The same process as used in H.264/AVC is employed for the deblocking filter. However, the use of a large size transform can effectively reduce the complexity of the deblocking filter, by reducing the number of deblocked pixels. It was reported that the number of deblocked pixels was reduced by 43% on average [14] for the 1080p sequences used in [30].

B. CU-Synchronized Adaptive Loop Filter (CU-ALF)

QALF [13] is known to provide significant coding gain by effectively combining both the Wiener filter approach and the quadtree based on/off selections. In QALF, along with filter coefficients, the information representing the quadtree structure is coded independently with the prediction quadtree structure, which results in large amount of side information in the slice header.

Since the proposed unit representations provides a generic quadtree structure similar to the original design of QALF, this information can be reutilized for the adaptive loop filter process. CU-synchronized adaptive loop filter (CU-ALF) is based on the QALF approach; however, it uses the already coded CU hierarchy as the on/off control for the adaptive loop filter process instead of coding separate quadtree information in the slice header.

It has been reported that the proposed CU-ALF provides comparable coding gain to QALF, while eliminating the need for any side information related to the quadtree partition in the slice header and reducing the encoder complexity [14].

C. Extreme Correction and Band Correction

EXC is designed to compensate the distortion according to the identified pixel classes. Each pixel is categorized as local maxima, local minima, or object edge by simple computation based on the four neighboring pixel values: left, above, right, and bottom. For each pixel class, the mean difference between the original and the reconstructed signals is computed and transmitted to the decoder. A fuller description is given in [14].

BDC is another form of pixel classification, based on pixel value ranges. The main motivation is to equalize the different probability distribution functions of the reconstructed signal with the original. In this paper, up to 16 value ranges are defined; the mean difference for each band is computed and transmitted to the decoder.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000837

D. Content Adaptive Dynamic Range

Internal bit depth increase (IBDI) is a technique to reduce the rounding error by enlarging the internal data precision [31]. Typically, IBDI is implemented by increasing the source bit-depth, which makes the encoder implementation more difficult. CADR is related to IBDI, but is a more general form of source scaling. Using the CADR, a pixel value x is adaptively scaled to $F(x)$ as follows:

$$F(x) = (2^{\text{bit}} - 1)(x - \text{Min})/(\text{Max} - \text{Min}) \tag{9}$$

where bit, Max, and Min are the bit-depth, the maximum value, and the minimum value of the input source, respectively. It should be noted that the parameters Min and Max can be adjusted at sequence, slice, or even block level.

CADR can be used to reduce the rounding error without requiring increased bit-depth in the encoder. For example, source material that is known to be constrained by the [16, 235] safe range of BT.709 can be mapped to [0, 255] to reduce rounding errors in the internal representation.

VII. Entropy Coding

In this paper, syntax-based context-adaptive binary arithmetic coder (SBAC) is used for the entropy coding of syntax elements. Additionally, adaptive coefficient scanning (ACS), which provides multiple scanning patterns for the transform coefficients, is also proposed to improve the coding efficiency while reducing the complexity.

A. Syntax-Based Context-Adaptive Binary Arithmetic Coding

As with the context-adaptive binary arithmetic coding (CABAC) of H.264/AVC [32], the SBAC consists of four major steps: syntax-based binarization, context modeling, probability estimation, and binary arithmetic coding. The syntax-based binarization and the context modeling are adapted to the syntax elements obtained from the flexible unit representation and the extended coding tools. For example, the assignment of context models for the syntax elements related to transform coefficients (e.g. significance map, coefficient level, etc.) is dependent on the hierarchical depth of the CU. The probability estimation and binary arithmetic coding are based on an improved version of the arithmetic coding method specified in Annex D of the JPEG still image coding standard [33]. Specifically, the table-based probability update and the multiplication-free design are improved, and the bypass mode for equi-probable binary symbols is added to reduce complexity [14].

B. Adaptive Coefficient Scanning

Since large transforms frequently have very sparse coefficient distributions, a fixed zigzag scanning method may result in long coefficient scanning lists including many zeroes, resulting in inefficient coding. ACS that adaptively chooses the best scanning method for each TU is used to avoid this problem.

Given the quantized transform coefficients, the best scanning pattern is chosen from conventional zigzag, horizontal, and vertical scanning patterns, and then its index is explicitly signaled in each TU. Note that the ACS index is signaled only when nonzero AC coefficients exist in the TU, since there is no difference between the patterns when the TU includes only the DC coefficient.

When the horizontal or vertical scanning methods are chosen as the best scanning method, the mapping process from the coefficient array indices to the scanning order indices is not necessary. Thus, the complexity for the coefficient indexing can be reduced and also the memory bandwidth to access the zigzag mapping table can be saved.

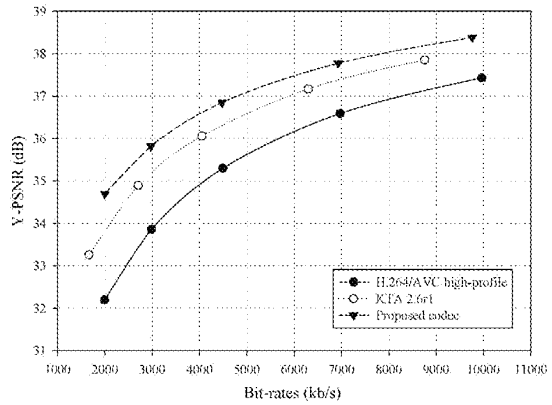


Fig. 6. Rate distortion curve of BasketballDrive 1080p sequence.

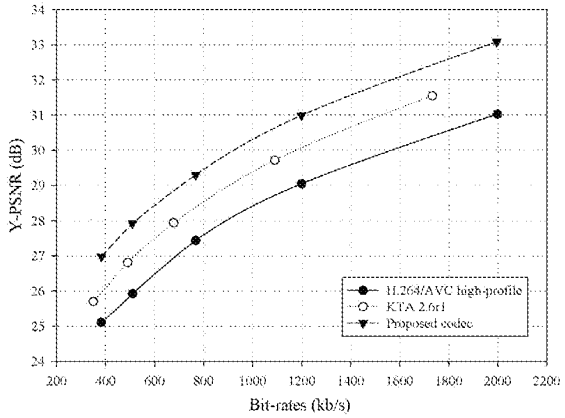


Fig. 7. Rate distortion curve of PartyScene WVGA sequence.

VIII. Performance Analysis

To verify the performance of the proposed coding tools, they were implemented into one complete video codec software which is available at [14]. This section provides both objective performance based on the peak signal-to-noise ratio (PSNR) measure and the subjective performance based on the mean opinion score (MOS) values for the proposed video codec.

A. Objective Compression Efficiency

1) *Overall Performance:* The coding efficiency of the proposed system is verified using two sets of coding configurations defined in the Call for Proposals [30]—constraint

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000838

set 1 (CS1) and constraint set 2 (CS2) which correspond to a random access case and a low delay case, respectively. Figs. 6 and 7 show typical examples of rate-distortion curves when video sequences are coded using CS1 configuration. As shown in the figures, the proposed codec consistently showed significant coding benefits over H.264/AVC High Profile. For comparison with other recent advances in the video coding area, the results of the key technology area (KTA) 2.6r1 [34] with the same test configurations are also included. This test configuration is same as in [35], where all major tools of KTA including enhanced AIF, MV competition, MDDT, high precision filter, ALF, and extended block size are enabled. It should be noted that the improved coding efficiency can be observed with both high resolution and low resolution video material.

Table III summarizes the performance of the proposed codec relative to the H.264/AVC High Profile. The average compression performance improvement over all sequences is 39.49% in CS1 and 39.48% in CS2, respectively. Class B (1080p resolution) achieves 43.29% (CS1) and 43.66% (CS2) bit saving on average, with BQTerrace as the best sequence in both configurations, showing 54.06% (CS1) and 60.62% (CS2) performance improvement, respectively. RaceHorses in Class D (WQVGA resolution) shows the lowest performance improvement in both configurations, at 27.08% in CS1 and 21.59% in CS2, respectively. The performance summarized in Table III shows that the proposed codec consistently achieves the excellent coding performance regardless of the resolution of input video sequences and the coding configuration.

2) *Performance of Each Set of Coding Tools:* It is hard to evaluate the performance of each individual coding tool, since the coding tools interact with each others and the tool-wise evaluation cannot measure the performance improvement introduced by the interaction. Therefore, the proposed coding tools are categorized to five sets—large transform (16×16, 32×32, and 64×64 transforms), AMVP, inter (DCT-IF and HAM), intra (ROT, MPI, ADI, CCCP, TMI, and CIP), and in-loop (EXC, ALF, and CADR)—and the performance of each set of coding tools is evaluated by measuring the performance loss introduced by turning off the tools in the corresponding set. The performance of the large motion partition is not evaluated since its performance has been already verified in the literatures [6]–[8]. Table IV summarizes the performance of each set of coding tools and the alternative setting which is enabled when the corresponding tool set is turned off. Note that only 1-second tests using CS1 configuration were carried out to reduce the experiment time. The results show that all the sets of coding tools contribute to the overall performance improvement almost equally.

B. Subjective Compression Efficiency

A large scale subjective test was carried out for all the proposals submitted to the Call for Proposals. In this test, it was shown that the proposed codec provided excellent subjective improvements over H.264/AVC in all configurations and it gave one of the best overall results of all of the proposals that were submitted, based on MOS values. The official report of subjective test results can be found in [36].

TABLE III
SUMMARIZED BD-RATE REDUCTIONS FOR VARIOUS RESOLUTIONS

Class (Size)	Sequence Name	CS1 (%)		CS2 (%)	
		BD-Rate	Average	BD-Rate	Average
A (4K)	*Traffic*	40.59	35.21	N/A	N/A
	PeopleOnStreet	29.84		N/A	
B (1080p)	*Kimono*	44.42	43.29	44.45	43.66
	ParkScene	32.96		31.18	
	Cactus	40.78		34.74	
	BasketballDrive	44.21		47.29	
	BQTerrace	54.06		60.62	
C (WVGA)	*BasketballDrill*	43.09	39.94	36.82	35.58
	BQMall	39.69		37.06	
	PartyScene	41.13		40.45	
	RaceHorses	35.86		27.99	
D (WQVGA)	*BasketballPass*	30.55	36.45	26.93	32.16
	BQSquare	54.19		51.87	
	BlowingBubbles	33.97		28.24	
	RaceHorses	27.08		21.59	
E (720p)	*Vidyo 1*	N/A	N/A	48.38	47.48
	Vidyo 3	N/A		46.26	
	Vidyo 4	N/A		47.79	
Total average		39.49		39.48	

TABLE IV
PERFORMANCE OF EACH SET OF CODING TOOLS

Tool Set	Alternative Setting	Class (%)				
		A	B	C	D	Average
Large tr.	Max tr. size = 8×8	2.2	7.2	1.9	1.0	3.5
AMVP	Median predictor [3]	4.4	3.7	2.9	2.4	3.2
Inter	6-tap/bi-linear filter [3]	0.4	1.3	4.2	7.6	3.6
Intra	Directional intra [3]	3.5	3.3	4.4	2.4	3.4
In-loop	Deblocking only	8.8	6.1	3.6	2.9	4.3

Table V shows several pairs of MOS values for H.264/AVC High Profile and the proposed codec for the five 1080p sequences. Each pair has been selected to give similar MOS values, to verify the bit-rate reduction that the proposed codec provides for similar subjective visual quality. As shown in the table, the proposed codec operating at an average of 2.4 Mbit/s provides similar visual quality to H.264/AVC High Profile operating at an average of 6.4 Mbit/s. This corresponds to approximately 60% bit-rate savings, indicating that the proposed codec provides even greater improvement in subjective visual quality than would be expected from objective metrics such as PSNR.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000839

TABLE V
SUMMARIZED MOS VALUES FOR 1080P SEQUENCES

Sequence	H.264/AVC		Proposed		
	Bit rates (kb/s)	MOS	Bit rates (kb/s)	MOS	Reduction (%)
Kimono	4000	8.86	1600	8.56	60.0
ParkScene	4000	7.41	1600	7.78	60.0
Cactus	7000	8.61	3000	8.24	57.1
BasketballDrive	7000	7.44	3000	8.17	57.1
BQTerrace	10000	8.77	3000	9.17	70.0
Average	6400	8.22	2440	8.38	60.9

IX. CONCLUSION

In this paper, a new flexible unit representation composed of CU, PU, and TU was proposed. The proposed scheme provides a generic quadtree structure while defining the relationship between region splitting, prediction method, and transform sizes with minimal signaling overhead.

In addition, various other coding tools were extended in a very consistent way according to the proposed unit representation. For example, the number of directions in the directional intraprediction scheme was extended to arbitrary angles and the supported transform size was extended up to 64×64.

By combining other novel coding tools designed under the proposed unit representation, the proposed codec showed about 40% performance improvement over the state-of-the-art H.264/AVC standard based on objective PSNR measurements. The large-scale subjective testing results show that an average of about 60% coding gain can be achieved for the 1080p sequences.

The video codec described in this paper was a candidate in the competitive phase of the HEVC standardization work and it has been partially adopted into the first standardization model of the collaborative phase of the HEVC effort.

ACKNOWLEDGMENT

The authors would like to thank their colleagues including, but not limited to, H. K. Jung, J. C. Lee, S. R. Lee, D. Y. Kim, K. H. Lee, Y. M. Sohn, Y. Y. Lee, B. K. Lee, S. M. Park, H. S. Song, J. B. Choi, B. D. Choi, C. H. Lee, S. S. Jung, and D. S. Cho for their invaluable contributions and continuous comments on this paper.

REFERENCES

[1] *Information Technology—Coding of Moving Pictures and Associated Audio for Digital Storage Media at up to About 1.5 Mbit/s: Video*, ISO/IEC 11172-2, ISO/IEC JTC1/SC29/WG11, Aug. 1993.

[2] *Information Technology—Generic Coding of Moving Pictures and Associated Audio Information: Video*, ISO/IEC 13818-2, ISO/IEC JTC1/SC29/WG11, 1996.

[3] *Final Draft International Standard of Joint Video Specification*, ITU-T Rec. H.264, ISO/IEC 14496-10, ISO/IEC JTC1/SC29/WG11, Mar. 2003.

[4] K. H. Lee, E. Alshina, J. H. Park, W. J. Han, and J. H. Min, "Technical considerations for ad hoc group on new challenges in video coding standardization," in *Proc. 85th MPEG Meeting*, Jul. 2008, no. M15580.

[5] E. Alshina, K. H. Lee, W. J. Han, and J. H. Park, "Technical considerations for ad hoc group on new challenges in video coding standardization," in *Proc. 86th MPEG Meeting*, Oct. 2008, no. M15899.

[6] P. Chen, Y. Ye, and M. Karczewicz, "Video coding using extended block sizes," in *Proc. 36th VCEG Meeting*, Oct. 2008, no. VCEG-AJ23.

[7] T. Yoshino, S. Naito, and S. Sakazawa, "Preliminary response for draft call for evidence on high performance video coding," in *Proc. 87th MPEG Meeting*, Feb. 2009, no. M16082.

[8] S. Sekiguchi and S. Yamagishi, "On coding efficiency with extended block size for UHDTV," in *Proc. 87th MCEG Meeting*, Feb. 2009, no. M16019.

[9] A. Puri, H. M. Hang, and D. Schilling, "An efficient block-matching algorithm for motion-compensated coding," in *Proc. ICASSP*, vol. 12. Aug. 1997, pp. 1063–1066.

[10] M. H. Chan, Y. B. Yu, and A. G. Constantinides, "Variable size block matching motion compensation with applications to video coding," *Commun. Speech Vis. IEE Proc. I*, vol. 137, no. 4, pp. 205–212, Aug. 1990.

[11] G. J. Sullivan and R. L. Baker, "Efficient quadtree coding of images and video," *IEEE Trans. Image Process.*, vol. 3, no. 3, pp. 327–331, May 1994.

[12] J. J. Zhang, M. O. Ahmad, and M. N. Swamy, "Quadtree structured region-wise motion compensation for video compression," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 9, no. 5, pp. 808–822, Aug. 1999.

[13] T. Chujoh, N. Wada, and G. Yasuda, *Quadtree-Based Adaptive Loop Filter*, document VCEG-C181, ITU-T Study Group 16, Jan. 2009.

[14] K. McCann, W. J. Han, I. K. Kim, J. H. Min, E. Alshina, A. Alshin, T. Lee, J. Chen, V. Seregin, S. Lee, Y. M. Hong, M. S. Cheon, and N. Shlyakhov, "Samsung's response to the call for proposals on video compression technology," in *Proc. 1st JCT-VC Meeting*, Apr. 2010, no. JCTVC-A124.

[15] JCT of ISO/IEC MPEG & ITU-T VCEG, "Test model under consideration," in *Proc. 1st JCT-VC Meeting*, Apr. 2010, no. JCTVC-A205.

[16] J. Jung and G. Laroche, "Competition-based scheme for motion vector selection and coding," in *Proc. 29th VCEG Meeting*, Jul. 2006, no. VCEG-AC06.

[17] T. Wedi, "Hybrid video coding based on high-resolution displacement vectors," in *Proc. VCIP*, Jan. 2001, pp. 186–193.

[18] C. C. Tseng and S. L. Lee, "Design of fractional delay FIR filter using discrete cosine transform," in *Proc. APCCAS*, Nov. 2008, pp. 858–861.

[19] T. Wedi and H. G. Musmann, "Motion- and aliasing-compensated prediction for hybrid video coding," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 13, no. 7, pp. 577–586, Jul. 2003.

[20] S.-D. Kim and J. B. Ra, "An efficient motion vector coding scheme based on minimum bitrate prediction," *IEEE Trans. Image Process.*, vol. 8, no. 8, pp. 1117–1120, Aug. 1999.

[21] S. H. Lee and N. I. Cho, "Intra prediction method based on the linear relationship between the channels for YUV 4:2:0 intra coding," in *Proc. ICIP*, 2009, pp. 1037–1040.

[22] T. K. Tan, C. S. Boon, and Y. Sujuki, "Intra prediction by template matching," in *Proc. ICIP*, 2006, pp. 1693–1696.

[23] J. Balle and M. Wien, "Extended texture prediction for H.264/AVC intra coding," in *Proc. ICIP*, 2007, pp. VI-93–VI-96.

[24] S. Ma and C.-C. J. Kuo, "High-definition video coding with supermacroblocks," in *Proc. VCIP*, Jan. 2007.

[25] J. Dong, K. N. Ngan, C. K. Fong, and W. K. Cham, "2-D order-16 integer transforms for HD video coding," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 19, no. 10, pp. 1462–1474, Oct. 2009.

[26] W.-H. Chen, C. H. Smith, and S. Fralick, "A fast computational algorithm for the discrete cosine transform," *IEEE Trans. Commun.*, vol. 25, no. 9, pp. 1004–1009, Sep. 1977.

[27] J. Liang and T. D. Tran, "Fast multiplierless approximations of the DCT with the lifting scheme," *IEEE Trans. Signal Process.*, vol. 49, no. 12, pp. 3032–3044, Dec. 2001.

[28] Y. Ye and M. Karczewicz, *Improved Intra Coding*, Contribution C257, ITU-T Q.6/SG16, Geneva, Switzerland, Jun. 2007.

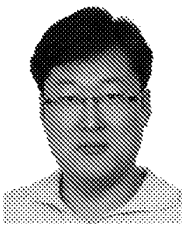
[29] Y. Ye and M. Karczewicz, *Improved Intra Coding*, VCEG Contribution VCEG-AG11, no. 20, Shenzhen, China, Oct. 2007.

[30] ISO/IEC JTC1/SC29/WG11, "Joint call for proposals on video compression technology," in *Proc. 91st MPEG Meeting*, Apr. 2010, no. N11113.

[31] T. Chujoh and R. Noda, "Internal bit depth increase for coding efficiency," in *Proc. 31st VCEG Meeting*, Jan. 2007, no. VCEG-AE13.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000840

[32] D. Marpe, H. Schwarz, and T. Wiegand, "Context-based adaptive binary arithmetic coding in the H.264/AVC video compression standard," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 13, no. 7, pp. 620–636, Jul. 2003.
[33] *Coding of Still Pictures*, ISO/IEC IS 10918-1, ITU-T Rec. T.81, ISO/IEC JTC1/SC29/WG1, Sep. 1993.
[34] ITU-T VCEG. (2010). *Key Technology Area (KTA) Software* [Online]. Available: http://iphome.hhi.de/suehring/tml/download/KTA
[35] T. K. Tan, G. Sullivan, and T. Wedi, *Recommended Simulation Common Condition for Coding Efficiency Experiments Revision 1*, VCEG Contribution VCEG-AJ10, Jul. 2008.
[36] V. Baroncini, J. R. Ohm, and G. Sullivan, "Report of subjective test results of responses to the joint call for proposals (cfp) on video coding technology for high efficiency video coding (HEVC)," in *Proc. 1st JCT-VC Meeting*, Apr. 2010, no. JCTVC-A204.



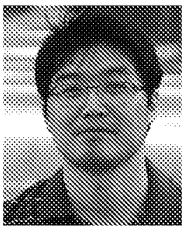
Woo-Jin Han (M'02) received the M.S. and Ph.D. degrees in computer science from the Korea Advanced Institute of Science and Technology, Daejeon, Korea, in 1997 and 2002, respectively.

He is currently a Principal Engineer with the Multimedia Platform Laboratory, Digital Media and Communication Research and Development Center, Samsung Electronics, Suwon, Korea. Since 2002, he has contributed successfully to the ISO/IEC Moving Pictures Experts Group, Joint Video Team, and Joint Collaborative Team standardization efforts. His current research interests include high-efficiency video compression techniques, scalable video coding, multi-view synthesis, and visual contents understanding.



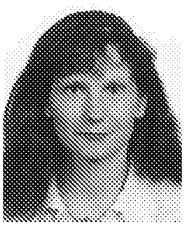
Junghye Min received the B.S. degree in mathematics from Ewha Women's University, Seoul, Korea, in 1995, and the M.E. and Ph.D. degrees in computer science and engineering from Pennsylvania State University, University Park, in 2003 and 2005, respectively.

From 1995 to 1999, she was a S/W Engineer with Telecommunication Systems Business, Samsung Electronics, Suwon, Korea. She is currently a Principal Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics. Her current research interests include video content analysis, motion tracking, pattern recognition, and video coding.



Il-Koo Kim received the M.S. and Ph.D. degrees from the School of Electrical Engineering, Seoul National University, Seoul, Korea, in 2001 and 2006, respectively.

After joining the Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea, in 2006, he has worked to develop high efficiency video codec. His current research interests include video compression and transmission.



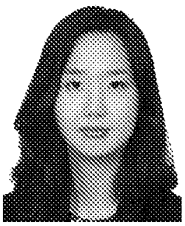
Elena Alshina received the M.S. degree in physics from Lomonosov Moscow State University (MSU), Moscow, Russia, in 1995. She continued her postgraduate study at the Faculty of Computational Mathematics and Cybernetics, MSU, and received the Ph.D. degree in mathematical modeling in 1998.

Since that time, she has been with the Institute for Mathematical Modeling, Russian Academy of Sciences, Moscow, performing research on high accuracy numerical methods and new finite-difference scheme development. Simultaneously, she was an Associate Professor for the Moscow Institute of Electronic Technology, Moscow. In 2006, she joined Samsung Electronics (first at the Moscow Research Center, before moving to Korea). Currently, she is a Senior Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea, where she makes high efficiency video codecs.



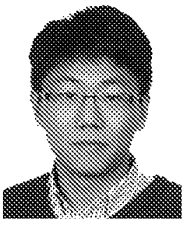
Alexander Alshin received the M.S. and Ph.D. degrees in mathematical physics from Moscow State University (MSU), Moscow, Russia, in 1995 and 1998, respectively.

From February 1998 to January 2006, he was a Senior Researcher with the Physical Department, MSU. Since 2006, he has been with Samsung Electronics, Suwon, Korea, and currently works with the Multimedia Platform Laboratory, DMC Research and Development Center, Samsung Electronics, as a Senior Engineer. His current research interests include theory of non-classical PDEs, nonlinear functional analysis, applied mathematics, numerical analysis, and their applications to video compression.



Tammy Lee received the B.S. degree in mathematics education from Ewha Women's University, Seoul, Korea, in 2000, and the M.S. degree in computer science from New York University, New York, in 2005.

She is currently a Senior Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea. Her current research interests include image and video compression.



Jianle Chen received the B.S. and Ph.D. degrees in information and communication system from Zhejiang University, Hangzhou, China, in 2001 and 2006, respectively.

Currently, he is a Senior Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea. His current research interests include video/image compression, computer vision, and image/video processing.



Vadim Seregin received the M.S. (honors) degree in physics from Moscow State University (MSU), Moscow, Russia, and the Ph.D. degrees in mathematical modeling, and numerical methods and software systems from MSU, in 2002 and 2005 respectively.

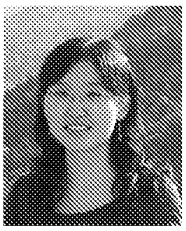
Currently, he is a Senior Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea. His current research interests include quasi-gasdynamics, numerical methods, and the field of image and video processing with a focus on video compression.



Sunil Lee (S'02–M'08) received the B.S. degree in electrical engineering from Yonsei University, Seoul, Korea, in 2001, and the M.S. and Ph.D. degrees in electrical engineering and computer science from the Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea, in 2002 and 2008, respectively.

From March 2008 to August 2008, he was a Post-Doctoral Researcher with the Division of Electrical Engineering, School of Electrical Engineering and Computer Science, KAIST. He is currently a Senior Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea. His current research interests include multimedia retrieval, multimedia security, digital watermarking, multirate signal processing, and video coding.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000841



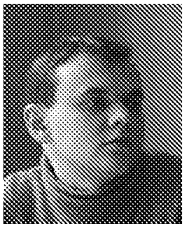
Yoon Mi Hong received the B.S. degree in mathematics from Yonsei University, Seoul, Korea, in 2003, and the M.S. degree in applied mathematics and the Ph.D. degree in mathematical sciences from the Korea Advanced Institute of Science and Technology, Daejeon, Korea, in 2005 and 2009, respectively.

She is currently a Senior Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea. Her current research interests include time-frequency analysis, sampling theory, and its applications in signal processing, as well as video coding.



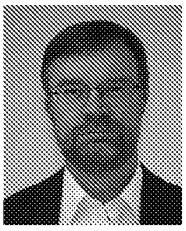
Min-Su Cheon received the B.S. and M.S. degrees in electrical engineering from Kyunghee University, Suwon, Korea, in 2005 and 2007, respectively.

He is currently an Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon. His current research interests include high-efficient video coding, multiview video coding, 3-D video coding, scalable video coding, and bioimage processing.



Nikolay Shlyakhov received the M.S. degree in applied mathematics from the Moscow Institute of Physics and Technology (MIPT), Moscow, Russia, in 1999. From 1999 to 2007, he was pursuing the Ph.D. degree from the Institute for Mathematical Modeling of the Russian Academy of Sciences, Moscow.

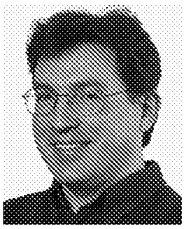
From 2003 to 2007, he was an Assistant Professor with the Department of Higher Mathematics, MIPT. Since 2007, he has been an Engineer with the Multimedia Platform Laboratory, Digital Media and Communications Research and Development Center, Samsung Electronics, Suwon, Korea. His current research interests include numerical mathematics, theory of approximation, and video coding.



Ken McCann graduated from Glasgow University, Glasgow, U.K., with the B.S. degree in natural philosophy in 1979. He received the M.S. degree in systems engineering from Surrey University, Surrey, U.K., in 1982.

He is currently a Director and Co-Founder of ZetaCast, Bath, U.K., an independent U.K.-based technology consultancy company specializing in digital TV and related systems. Prior to founding ZetaCast, he was the Technology Director with NTL Broadcast (now Arqiva), the main provider of broadcasting infrastructure in the U.K. Before that, he was with Symbionics Instruments, Cambridge, U.K., the Independent Broadcasting Authority and Philips Research Laboratories. He contributed significantly to the development of the MPEG-2 standard, has chaired the DVB technical group responsible for audio-visual coding specification since its inception over 15 years ago, and is currently an active member of the Joint Collaborative Team on Video Coding, working on the new high efficiency video coding standard.

Mr. McCann has been a member of the IET in the U.K. (and its predecessor, the IEE) since 1982.



Thomas Davies graduated from Oxford University, Oxford, U.K., with the M.A. degree in mathematics and philosophy in 1991. He received the M.S. and Ph.D. degrees in mathematics from Warwick University, Coventry, U.K., in 1992 and 1996, respectively.

He is currently a Lead Research and Development Engineer with Research and Development, British Broadcasting Corporation, London, U.K., having joined in 2000. He specializes in video compression, and image and signal processing, and was responsible for developing the open source Dirac video compression algorithms, the intra coding part of which is standardized as SMPTE VC-2. He is actively participating in the development of the MPEG high efficiency video coding standard under the auspices of the Joint Collaborative Team on Video Coding. Prior to joining the BBC, he was a Technology Consultant in systems engineering and satellite networking.



Jeong-Hoon Park received the B.S. and M.S degrees in electrical engineering from Hanyang University, Seoul, Korea, in 1991 and 1994, respectively.

He is currently a Principal Engineer with the Multimedia Platform Laboratory, Digital Media and Communication Research and Development Center, Samsung Electronics, Suwon, Korea. In 1998, he was a Visiting Scholar with the University of California, Los Angeles, where he researched error resilient video compression and transmission. Since then, he has contributed to the ITU-T Video Coding Experts Group and ISO/IEC Moving Pictures Experts Group. From 2002 to 2004, he has been involved in developing mobile broadcasting technology as an active member of WorldDMB forum. His current research interests include audio and video compression technology, medical image processing, and multimedia systems including video broadcasting and communications.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000842

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from corresponding Korean Patent Application No. 2014-7015093, dated August 21, 2015	YES
	2	**Wiegand, Tomas, et al.**; *"WD3: Working Draft 3 of High-Efficiency Video Coding"*; Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11; 5th Meeting; Geneva, CH, 16-23 March, 2011; Document JCTVC-E603; 239 pages	
	3	**Bross, Benjamin, et al.**; *"WD4: Working Draft 4 of High-Efficiency Video Coding"*; Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11; 6th Meeting; Torino, IT; 14-22 July 2011; Document JCTVC-F803_d; 232 pages	
	4	**J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei;** *"CE9: Results of Experiment ROB04"*; JCT-VC Doc. JCTVC-F052, Turin; Jul 2011	

Examiner Signature	/CLIFFORD HILAIRE/	Date Considered	02/19/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35874174v1

Submitted September 25, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.H/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S3	9	((Mehmet) near2 (BICI)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/24 17:00
S4	85	((Jani) near2 (LAINEMA)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/24 17:00
S5	59	((Kemal) near2 (UGUR)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/24 17:00
S6	4	("20110170602" | "20120307905").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/25 09:41
S7	2	("20110170602" | "20120307905").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:41
S8	9	((Mehmet) near2 (BICI)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:43
S9	85	((Jani) near2 (LAINEMA)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:43
S10	59	((Kemal) near2 (UGUR)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:43
S11	104	S8 S9 S10	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:43
S12	45	S11 and merg$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:43
S13	12	S11 and merg$4 near list$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:44
S14	45	S11 and merg$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 09:44
S15	18	S11 and merg$4 same candidate	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:10
S16	67	S11 and candidate	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:11
S17	63	S11 and candidate with motion	US-PGPUB; USPAT;	OR	ON	2015/06/25 10:13

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000844

			USOCR			
S18	55	S11 and candidate with motion with vector	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:13
S19	45	S11 and candidate with motion with vector same block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:14
S20	28	S11 and (candidate and list and vector)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:15
S21	5805	S11 and (candidate and list and vector)".clm"	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:15
S22	4	S11 and (candidate and list and vector).clm.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:15
S23	1	"20130114723".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:52
S24	1	"20130114723".pn. and (candidate with vector with motion) same (merg$4 set list subset)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:53
S25	1812	(candidate with vector with motion) same (merg$4 set list subset)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:55
S26	27634	((H04N19/52 OR H04N19/513 OR H04N19/176 OR H04N19/61 OR H04N19/51 OR H04N19/597 OR H04N19/56 OR H04N19/139 OR H04N19/573 OR H04N19/521 OR H04N19/103 OR H04N19/30).CPC.)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 10:57
S27	1	"20130034162".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:08
S28	1	"20130034162".pn. and (candidate with motion with vector)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:16
S29	1	"20130034162".pn. and (candidate with motion with vector) same block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:17
S30	1	"20130034162".pn. and (candidate)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:18
S31	1	"20130034162".pn. and (candidate) and (list set subset)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:19
S32	1	"20130034162".pn. and (candidate same block) and (list set subset)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:19
S33	1274	(candidate with vector with motion) same (merg$4 set list subset) and (motion vector) with search$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:32
S34	1064	(candidate with vector with motion) same (merg$4 set list subset) and (motion vector) near4 search$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:32
S35	888	(candidate with vector with motion) with (merg$4 set list subset) and	US-PGPUB; USPAT;	OR	ON	2015/06/25 11:32

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000845

		(motion vector) near4 search$4	USOCR			
S36	618	(candidate with vector with motion) near4 (merg$4 set list subset) and (motion vector) near4 search$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:33
S37	112	(candidate with vector with motion) near4 (merg$4 set list subset) same (motion vector) near4 search$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:33
S38	92	(candidate with vector with motion) near4 (merg$4 set list subset) same (motion vector) near4 search$4 and "375".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:33
S39	150592	(candidate with vector with motion) near4 (merg$4 set list subset) same (motion vector) near4 search$4 same block "375".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:33
S40	51	(candidate with vector with motion) near4 (merg$4 set list subset) same (motion vector) near4 search$4 same block and "375".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:34
S41	8	(candidate with vector with motion) near4 (merg$4 set list subset) same (motion vector) near4 search$4 same block and subset and "375".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:42
S42	2	(candidate with vector with motion) near4 (merg$4 set list subset) same (motion vector) near4 search$4 same block and subset and (remov$4 exclud$4) with (list set merg$4 subset)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 11:45
S43	50	("5719627" "5815602" "4989089" "5428403" "5781249" "5838391" "4851906" "4989087" "5235419" "5371549" "5414469" "5457481" "5506622" "5521642" "5532746" "5546129" "5557341" "5574663" "5579050" "5581308" "5587741" "5598216" "5612743" "5614954" "5617144" "5619281" "5625417" "5627591" "5638129" "5642166" "5646867" "5654761" "5689306" "5694487" "5717463" "5719630" "5724369" "5731851" "5751362" "5862261" "5903672" "5991447" "6005980" "6020925" "6023298" "6026195" "6057884" "6091777" "6154519" "6205177").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 13:29
S44	25	S43 and (candidate same motion)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 13:30
S45	0	S43 and (candidate same motion) and merg$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 13:30
S46	4	S43 and (candidate same motion) and exclud$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 13:31
S47	4	S43 and (candidate) with (vector motion) and exclud$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/25 13:32
S48	3	(US-20130034162-$ or US-	US-PGPUB	OR	ON	2015/06/25

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000846

		20120106645-$ or US-20120106638-$).did.				13:44
S49	0	S48 and "PU "	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/25 13:44
S50	2	S48 and prediction with unit	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/25 13:44
S52	9	((Mehmet) near2 (BICI)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:02
S53	85	((Jani) near2 (LAINEMA)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:02
S54	59	((Kemal) near2 (UGUR)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:02
S55	104	S52 S53 S54	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:02
S56	55	S55 and candidate with motion with vector	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:02
S57	10	S55 and candidate with motion with vector and transcod$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:03
S58	8	S55 and candidate with motion with vector and transcod$4 and encod$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:04
S59	53	S55 and candidate with motion with vector and encod$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:05
S60	29	S55 and candidate with motion with vector same encod$4	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:05
S61	24	S55 and candidate with motion with vector same encod$4 and unit and (block macroblock)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:07
S62	18	S55 and candidate with motion with vector same encod$4 and (unit near predict$5) and (block macroblock)	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:10
S63	23	S55 and prediction near unit	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:11
S64	22	S55 and prediction near unit and candidate	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:11
S65	872	prediction near unit and candidate near4 motion near4 vector	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:14

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000847

S66	713	prediction near unit and candidate near4 motion near4 vector same block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:14
S67	653	prediction near unit and candidate near4 motion near4 vector with block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:14
S68	172	prediction near unit same candidate near4 motion near4 vector with block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:14
S69	42	prediction near unit same candidate near4 motion near4 vector with block same encoded	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:15
S70	32	("prediction unit" PU) with block with encoded same candidate near4 motion near4 vector	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:17
S71	483	PU and candidate with motion with vector	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:35
S72	209	PU same candidate with motion with vector	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:36
S73	160	PU same candidate with motion with vector same block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:36
S74	142	PU same candidate with motion with vector same block and "375".clas.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 06:36
S75	1	(US-20120134415-$).did.	US-PGPUB	OR	ON	2015/06/26 07:05
S76	0	S75 and encoded	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 07:05
S77	0	S75 and encod$4 with block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 07:05
S78	1	S75 and coded with block	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 07:05
S79	126	PU same candidate with motion with vector same block and merge with list	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/26 07:06
S80	1	(US-20120008688-$).did.	US-PGPUB	OR	ON	2015/06/26 08:47
S81	1	(US-20120008688-$).did.	US-PGPUB	OR	ON	2015/06/26 08:52
S82	1	(US-20120008688-$).did. and (PU prediction near unit)	US-PGPUB	OR	ON	2015/06/26 08:53
S83	1	(US-20120008688-$).did. and (PU prediction near unit) and receiv$4	US-PGPUB	OR	ON	2015/06/26 08:54
S84	1	(US-20120008688-$).did. and (PU prediction near unit) and (encod$4 cod$4 decod$4 receiv$4)	US-PGPUB	OR	ON	2015/06/26 08:55
S85	3	"20130114723".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2016/02/19 16:31

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000848

			DERWENT; IBM_TDB			
S86	2	"20130114723".pn. and exclud$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:33
S87	2	"20130114723".pn. and "merge list"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:34
S88	2	"20130114723".pn. and "merge list" same compar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:37
S89	0	"20130114723".pn. and "merge list" same "not" near includ$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:40
S90	0	"20130114723".pn. and "merge list" same "not" near3 includ$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:40
S91	1	"20130114723".pn. and "merge list" same2 compare	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:42
S92	2	"20130114723".pn. and "merge list" same2 compar$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/02/19 16:42
S93	1	"20130114723".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 11:08
S94	1	"20130114723".pn. and "5a"	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 11:10
S95	1	"20130114723".pn. and "90"?	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 12:02

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000849

S97	1	"20120236942".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 14:45
S98	1	"20120236942".pn. and (left upper right above)	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 14:51
S99	1	"20120236942".pn. and (left upper right above lower)	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:07
S100	1	"20130114723".pn. and "90"? and "A"? and "B"?	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:12
S101	1	"20120236942".pn. and (left upper right above lower) and merg$4	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:31
S102	1	"20120236942".pn. and (left upper right above lower) and merg$4 and remov$4	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:33
S103	28401	"20120236942".pn. and (left upper right above lower) and merg$4 and remov$4 "b.sub.0"	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:34
S104	1	"20120236942".pn. and (left upper right above lower) and merg$4 and remov$4 and "b.sub.0"	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:35
S105	1	"20120236942".pn. and (left upper right above lower top) and merg$4 and remov$4 and "b.sub.0"	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:35
S106	1	"20120236942".pn. and (left upper right above lower top bottom) and merg$4 and remov$4 and "b.sub.0"	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:36
S107	1	"20130230103".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:45
S108	644	"merge list"	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:54
S109	142	"merge list" same candidate	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:54
S110	51	"merge list" same candidate same spatial	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:54
S111	252	merg$4 near2 (list set) same candidate same spatial	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:55
S112	221	merg$4 near2 (list set) same candidate with spatial	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:55
S113	62	merg$4 near2 (list set) same candidate with spatial same (remov$4 exclud$4 flag)	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 15:56
S114	527	"merge mode" same skip	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 16:02
S115	252	"merge mode" same skip same (candidate potential)	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 16:02

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000850

S116	193	"merge mode" same skip same (candidate potential) same vector	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 16:03
S117	190	"merge mode" same skip same (candidate potential) same vector near3 motion	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 16:03
S118	182	"merge mode" same skip same (candidate potential) same vector near3 motion and spatial	US-PGPUB; USPAT; USOCR	OR	ON	2016/02/23 16:03
S119	1	(US-20120134415-$).did.	US-PGPUB	OR	ON	2016/02/23 16:05

2/ 24/ 2016 10:30:33 AM
C:\ Users\ chilaire\ Documents\ EAST\ Workspaces\ 13666680.wsp

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000851

A Multistage Motion Vector Processing Method for Motion-Compensated Frame Interpolation

Ai-Mei Huang, *Student Member, IEEE*, and Truong Q. Nguyen, *Fellow, IEEE*

***Abstract*—In this paper, a novel, low-complexity motion vector processing algorithm at the decoder is proposed for motion-compensated frame interpolation or frame rate up-conversion. We address the problems of having broken edges and deformed structures in an interpolated frame by hierarchically refining motion vectors on different block sizes. Our method explicitly considers the reliability of each received motion vector and has the capability of preserving the structure information. This is achieved by analyzing the distribution of residual energies and effectively merging blocks that have unreliable motion vectors. The motion vector reliability information is also used as a prior knowledge in motion vector refinement using a constrained vector median filter to avoid choosing identical unreliable one. We also propose using chrominance information in our method. Experimental results show that the proposed scheme has better visual quality and is also robust, even in video sequences with complex scenes and fast motion.**

***Index Terms*—Frame rate up-conversion, motion-compensated frame interpolation (MCFI), motion vector processing, residual energy.**

I. Introduction

MOTION-compensated frame interpolation (MCFI) that uses the received motion vectors (MVs) has recently been studied to improve temporal resolution by increasing the frame rate at the decoder. MCFI is particularly useful for video applications that have a low bandwidth requirement and need to reduce frame rate to improve spatial quality. However, MCFI that directly uses the received MVs often suffers from annoying artifacts such as blockiness and ghost effect. This is because the received motion vector field (MVF) is usually generated using block-based motion estimation at the encoder by minimizing prediction errors, rather than finding true motion. To solve this problem, a number of works have focused on producing a smoother MVF for better frame interpolation by finding true motion in motion estimation or processing the received MVs at the decoder.

In order to get true motion at the encoder, MVs are estimated by further considering spatial and temporal correlations in addition to block matching algorithm (BMA) [1]. Krishnamurthy *et al.* proposed using a multiscale optical-flow-based motion estimator to produce smooth, natural motion fields [2]. Motion estimation at the decoder has also been studied to re-estimate MVs, instead of relying on the encoder to produce a smooth MVF. Chen proposed estimating the forward and backward MVs between two frames reconstructed at the decoder by exploiting the spatial correlation of motion among adjacent blocks [3]. Ha *et al.* suggested using an overlapped block-based motion estimation to get more accurate motion trajectory [4]. The works in [5] and [6] reduced the computational complexity by selectively performing motion estimation with prior classification. Shinya and Akira proposed re-estimating MVs using BMA but with the concept that a larger block size should be used for global motion regions while a smaller block size is used for local motion regions [7]. It needs to perform motion estimation up to three times at the decoder in order to identify a global motion region and find its motion. To get more accurate and smoother MVFs, object-based motion refinement by performing image segmentation was presented in [8]. The method in [9] also used motion-based segmentation to find object boundaries and applied mesh-based motion compensation to interpolate the regions inside the objects.

Alternatively, instead of producing a smooth MVF using motion estimation, which requires higher complexity, MV processing techniques have been proposed by simply removing MV outliers and/or refining MVs from its neighborhood. A commonly used method is to apply vector median filter [10]. Alparone *et al.* proposed using adaptively weighted vector median filter based on prediction errors to obtain a smoother MVF *at the encoder* after motion estimation [11]. Dane *et al.* addressed the same concept and applied vector median filter *at the decoder* to correct irregular MVs [12]. The authors further presented another MV processing method in [13] that resamples MVs with smoothness measurement to decrease blockiness artifact. The work in [14] analyzed the reliability of the received MVF according to the number of intracoded macroblocks (MBs), isolated MB detection and MV variance. It does not interpolate the frame if the received MVF is not reliable to use. Sekiguchi *et al.* used weighted averaging of neighboring MVs based on their prediction errors to obtain a smooth motion field [15]. Zhang *et al.* proposed a method that detects isolated MVs and selects the best motion from adjacent blocks based on temporal modeling [16]. These MV processing techniques are also useful for other applications, such as error concealment and transcoding [17], [18].

In addition to MV processing, several works have also discussed how to reduce visual artifacts by adaptively choosing forward, backward, or bidirectional interpolations. This is because in areas where occlusion happens, unidirectional interpolation may provide better visual quality. A pixel-wise nonlinear

Manuscript received March 9, 2007; revised January 3, 2008. This work was supported in part by Conexant, Inc., and in part by the University of California Discovery program. The associate editor coordinating the review of this manuscript and approving it for publication was Dr. Dimitri Van De Ville.

The authors are with the Department of Electrical and Computer Engineering, University of California, San Diego, La Jolla, CA 92093 USA (e-mail: aihuang@ucsd.edu; nguyent@ece.ucsd.edu).

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TIP.2008.919360

1057-7149/$25.00 © 2008 IEEE

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000852

filtering approach for frame interpolation was first addressed in [19]. Krishnamurthy *et al.* proposed sending side information to inform the decoder which interpolation scheme should be used [2]. A similar concept of this encoder assisted approach was presented in [20], where the encoder decides how to interpolate the frame based on several predefined interpolation equations and sends that information as side information to the decoder. The work in [3] suggested choosing the forward and backward predictions adaptively based on their corresponding boundary absolute difference. Lee *et al.* also addressed this concept but used weighted averaging interpolation by considering multiple motion trajectories and prediction errors [21]. A theoretical analysis of adaptively choosing forward and backward interpolation was presented in [22].

In general, it is difficult for an encoder to accurately capture all the motion in a video frame using block-based motion estimation, or coding efficiency will significantly be reduced in order to send such detailed motion information. It is also unrealistic to assume that all the encoders are made aware of frame interpolation at the decoder. Even though MVs can be re-estimated at the decoder by considering spatial and temporal correlations, the true motion can easily be distorted due to coding artifacts such as blockiness and blurriness. The MV processing methods that remove outliers using vector median filter or refine MVs using smaller block sizes can only perform well in the areas with smooth and regular motion. That is, they are based on the assumption that the MVF should be smooth. However, this is usually not true as a video frame may contain complex motion, especially on the motion boundaries, where the true motion field is not smooth at all. As a result, irregular motion may appear in the received MVF and dominate the vector median filtering process to use those irregular MVs as the true motion. In addition, since many of the methods only operate on a smaller block size, they often fail to consider the edge continuity and the structure of the objects. We can often see broken edges and destroyed structures in an interpolation frame. Besides, MBs that are intracoded also make frame interpolation difficult as their MVs are not available. Some methods use object-based motion estimation and interpolation at the decoder to maintain the object structure and minimize the interpolation errors [8], [9]. However, high computational complexity may prevent them from being used in resource limited devices such as mobile phones. Therefore, frame interpolation still remains a very challenging problem as the artifacts due to the use of improper MVs can be very noticeable, or an extremely complex method has to be employed.

In [23], we have shown that the correlation between the residual information and the reliability of received MVs. We also observed that the interpolation usually fails at the areas where the density of inaccurate MVs is high. Therefore, instead of correcting MVs using smaller block sizes, we suggested finding a single MV for a group of adjacent MBs [24]. The preliminary results have shown that they are able to reduce visual artifacts in an interpolated frame. However, the approach in [23] performs better when the motion is relatively smooth because it corrects unreliable MVs based on 8×8 and 4×4 block size. On the other hand, the method proposed in [24] only addresses the problem of having fast and complex motion by grouping MBs that have unreliable MVs into a larger block size up to 32×32 to maintain object structures. It may not be able to capture all the detailed motion information inside a larger block.

In this paper, we further propose a hierarchical MV processing method that also exploits both of the residual information and bidirectional prediction difference by analyzing their energy distribution. We first work on correcting unreliable MVs using larger block size to maintain object structures and gradually refine the motion of smaller blocks to capture the detailed motion information. First, based on the received information, we identify MVs that are likely to produce visual artifacts during frame interpolation by exploiting the strong correlation between the reliability of a MV and the residual energy it produces. That is, residual energy of each block is analyzed to determine the reliability of the corresponding received MV. We also consider using chrominance information in MV reliability classification and in all MV processing stages, which is found very useful to identify and correct unreliable MVs and has not explicitly been considered in the literature. Then, before refining those unreliable MVs by further partitioning each block into smaller blocks, we propose to merge MBs that have unreliable MVs by analyzing the distribution of the residual energies. This MB merging process can effectively group MBs located on the motion boundaries. In order to prevent deformed structures, each merged group is assigned a single MV selected from its own and neighboring reliable MVs by minimizing the difference between the forward and backward predictions. This is different from the method in [7], which proposes only merging global motion regions into one larger block but uses smaller blocks in local motion regions. This is also different from the work in [24], since we exploit residual distribution to avoid gathering improper MBs as a merged group.

We further propose an effective MV refinement method that adaptively adjusts unreliable MVs in a smaller block size (of 8×8) by applying a *reliability and similarity constrained vector median filter* to their neighboring MVs. As MVF has been updated and residual information is no longer available, we propose using the bidirectional prediction difference (BPD) to obtain reliability information of each MV as a prior knowledge in the refinement process. Unlike the methods in [11], which uses prediction difference as the weighting factor for each MV in vector median filter, our method simply does not use those neighboring unreliable MVs. In addition, in order not to choose the same unreliable MV, we remove identical and similar MVs in the neighborhood from consideration. To further reduce blockiness effect, we adopt MV smoothing as in [13] on a even finer block size (of 4×4) as the last step in our MV processing method. During frame interpolation, we propose unidirectional frame interpolation for those MBs on the frame boundaries by adaptively selecting forward and backward predictions based on the motion.

Experimental results show that the proposed method significantly improves visual quality, especially in the areas with different motion or the motion boundaries. Our method can successfully maintain object structure and has less blockiness and ghost artifacts. It is also robust even in those video sequences with complex scenes and fast motion. Moreover,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000853

low-complexity can be achieved since no motion estimation or object detection are involved at the decoder.

The rest of this paper is organized as follows. We first briefly review MCFI and illustrate the correlation between MV reliability and the energy of residual signals in Section II. In Section III, we describe the algorithms to create a MV reliability map and a MB merging map. The proposed MV processing method is described in details in Section IV. In Section V, we analyze the effect of chosen parameters for the proposed MV processing method. The simulation results and analysis on various compressed video sequences are demonstrated in Section VI. Finally, some conclusions are given in Section VII.

II. Motion-Compensated Frame Interpolation

In MCFI, the skipped frame is often interpolated based on the received MVF between two consecutive reconstructed frames, denoted by f_{t-1} and f_{t+1} respectively. Based on the assumption in which objects move along the motion trajectory, the skipped frame f_t can be interpolated bidirectionally using the following equation:

$$f_t(x,y) = w_f \cdot f_{t-1}\left(x + \frac{1}{2}v_x, y + \frac{1}{2}v_y\right) + w_b \cdot f_{t+1}\left(x - \frac{1}{2}v_x, y - \frac{1}{2}v_y\right) \quad (1)$$

where $\mathbf{v} = (v_x, v_y)$ is the received MVF in the bitstream for reconstructing the frame f_{t+1}. w_f and w_b are the weights for the forward and backward compensations, respectively, and are often set to 0.5. This frame interpolation method is also called the *direct* MCFI as it assumes that the received MVs can represent true motion and can directly be used.

The assumption used by the direct MCFI method does not always hold as the received MVs are often unreliable and do not represent the actual motion. This is because they are usually computed at the encoder by maximizing coding efficiency, instead of finding true motion. In addition, most video coding standards adopt block-based motion estimation, which usually has difficulties to represent finer motion inside a block. In such a case, the video encoder usually chooses the MVs that yield the smallest prediction errors and encodes the residues to compensate for the areas with different motion. Consequently, the estimated MVs are unreliable and unsuitable for the use of frame interpolation. Visual artifacts occur frequently when those unreliable MVs are used in (1). For example, Fig. 1(a) shows the interpolated frame 14 in the Foreman sequence using the direct MCFI method from reconstructed frames 13 and 15. The received MVs in frame 15 are used for interpolation. Artifacts such as blockiness and deformed structures appear in areas where the residual energies are high or in areas where no MV is available. These artifacts can also be observed even when the frame is interpolated by advanced MV processing methods such as in [10] and [12].

In order to illustrate our observation, Fig. 1(b) shows the residual energy of each 16×16 block of frame 15. We analyze where frame interpolation is likely to fail if the received MVs are directly used, and clearly, all the artifacts appear in the MBs where residual energies are high, such as the boundaries of the face and the ear, and the edges of the collar and the neck. From Fig. 1(a) and (b), it is reasonable to argue that there exists a strong correlation between MV reliability and its associated residual energy. That is, when residual energy is high, it is likely that the corresponding MV is not reliable for frame interpolation.

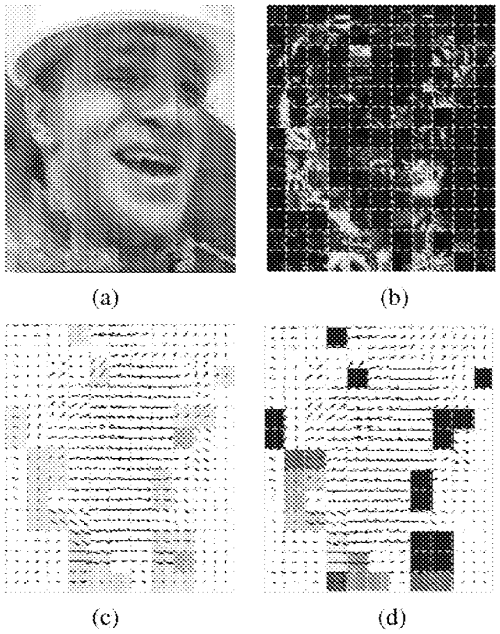


Fig. 1. (a) Interpolation result of the frame 14 of Foreman sequence using direct MCFI from reconstructed frames 13 and 15. (b) Residual energy of the reconstructed frame 15. (c) MV reliability classification map. Unreliable MVs are marked in yellow color and intracoded MBs are marked in cyan color. (d) MB merging map.

From Fig. 1(a) and (b), we also observe that the edge and structure of the shirt collar are not maintained. This is because the MVs of those MBs on the edge of the collar are chosen to represent the motion of the cheek and the collar is compensated with higher prediction residues. In most existing methods, the MVs of those blocks are usually re-estimated or corrected separately. There is no guarantee that those blocks that belong to the collar will have the same MV to perfectly assemble the collar. However, if we look closely at how these high residual energies are distributed, we can roughly tell the boundary where the motion starts to differ. Then, for the portions that belong to the collar, we should assign them the same MV so that the structure can first be maintained before any MV refinement. The easiest way to do so is to properly merge those blocks by carefully analyzing the residual energy distribution and its *connectivity* between the MBs, and find a single MV. In such a way, we can avoid having disconnected structures by finding an object motion for a merged group. Please note that this object motion is still block-based in order to describe the global motion in that local neighborhood. It will further be refined as part of our MV processing method to capture the detailed motion inside each merged block.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000854

III. Prediction Residual Energy Analysis and Its Application for Frame Interpolation

Based on these observations of received residual, we propose using residual energy to assist MV processing by creating a MV reliability map and a MB merging map. The MV reliability map is to determine the reliability level of each received MVs to make sure that unreliable ones are not used and are corrected. The MB merging map is to indicate whether the neighboring MBs should be grouped together in order to maintain the integrity of the entire moving object. The algorithms to generate the MV reliability map and the MB merging map are described below.

A. Motion Vector Reliability Classification

The first step is to determine if the MVs in the received bitstream are reliable. Let $\mathbf{v}_{m,n}$ denote the MV of each 8×8 block, $\mathbf{b}_{m,n}$. We classify $\mathbf{v}_{m,n}$ into three different reliability levels, *reliable*, *possibly reliable*, and *unreliable*, based on its residual energy, the reliability level of its neighboring blocks and the coding type. The reason why we choose a block size of 8×8 for MV reliability classification is that in MPEG-4 and H.263 coding standards, the prediction residues are generated and encoded based on 8×8 block size. For a MB with only one MV, we simply assign the same MV to all four 8×8 blocks.

For each block $\mathbf{b}_{m,n}$, we first calculate its residual energy, $E_{m,n}$, by taking the sum of the absolute value of each reconstructed prediction error of each pixel. In our algorithm, we consider both luminance and chrominance residues. This is because the motion estimation often uses pixel values in the luminance domain. This may result in an unreliable MV that minimizes the luminance difference but the colors are often mismatched. Therefore, we include chrominance information in residual energy calculation to identify those unreliable MVs. $E_{m,n}$ is computed as follows:

$$E_{m,n} = \sum_{(i,j)\in \mathbf{b}^{Y}_{m,n}} |r_Y(i,j)| + \alpha \cdot \left(\sum_{(i,j)\in \mathbf{b}^{Cb}_{m,n}} |r_{Cb}(i,j)| + \sum_{(i,j)\in \mathbf{b}^{Cr}_{m,n}} |r_{Cr}(i,j)| \right) \quad (2)$$

where $r_Y(i,j), r_{\mathrm{Cb}}(i,j)$, and $r_{\mathrm{Cr}}(i,j)$ are the reconstructed residual signals of Y, Cb and Cr components of the block, $\mathbf{b}_{m,n}$, respectively. α is the weight used to emphasize the degree of color difference. Please note that the residual signals have to be reconstructed during decoding process; therefore, there is no additional computation of using such information other than (2).

We then compare $E_{m,n}$ with a predefined threshold, ε_1, to determine if $\mathbf{v}_{m,n}$ is unreliable. If $E_{m,n}$ is greater than or equal to ε_1, it will be considered as *unreliable* and included into the reliability set L_1. For intracoded MBs, since they do not have MVs, we temporarily assign zero MVs and consider them as unreliable and place them in L_1.

Once an unreliable MV is identified, its neighboring MVs in the same MB and in its eight adjacent MBs will be classified as *possibly reliable* and placed into the second reliability set L_2, even if their residual energy levels are below the threshold. The reason is that when one MB contains at least one block with high residual energy, it is likely that this MB and the surrounding MBs are on the motion boundary. Hence, those MVs may not represent the actual motion, depending on how motion estimation is performed at the encoder. Thus, in order to ensure that all MVs used for frame interpolation are reliable, we mark these MVs as possibly reliable and they will be revisited in a later stage of the MV correction process for further verification. For example, for a MB with four MVs, if only one block exceeds the threshold, the other three blocks as well as all the MVs in the eight adjacent MBs will be considered to be possibly reliable and put into L_2. But if their residual energies are high, they will still be classified into L_1 instead of L_2.

For those MVs that are not classified yet and their $E_{m,n}$ are less than ε_1, they will be classified as *reliable* and placed into the third reliability set L_3. Therefore, we can create a MV reliability map (MVRM) by assigning the reliability level to each MV as follows:

$$\mathrm{MVRM}(m,n) = \begin{cases} L_1, & \text{if } E_{m,n} \geq \varepsilon_1 \\ L_2, & \text{if any MV in the same MB or in the adjacent MBs } \in L_1 \\ L_3, & \text{otherwise.} \end{cases} \quad (3)$$

Fig. 1(c) demonstrates the MV reliability map based on Fig. 1(b) using predefined values, α and ε_1. The selection of ε_1 is discussed in Section V. Since the luminance values of the collar and skin are very similar, some of the wrong MVs can only be detected by chrominance residues instead of luminance residues. The MVs in white color MBs are reliable MVs and those yellow color MBs contain at least one unreliable MV. We purposely mark intracoded MBs in cyan color so that we can differentiate their impact on the interpolation quality from intercoded MBs. However, in our reliability classification, they are considered unreliable as we initially assign zero MVs. As expected, we can successfully identify the regions where frame interpolation is most likely to fail by classifying the MV reliability.

B. Macroblock Merging Based on Motion Vector Reliability

After classifying the reliability of each MV, instead of correcting those unreliable MVs separately, we should consider to merge them by analyzing the connectivity of the residual energies. The merging process is performed on a MB basis, and all MBs that contain unreliable MVs will be examined in a raster scan order. For an intercoded MB that has unreliable MVs, we check if its unreliable MVs connect to other unreliable MVs in the adjacent MBs that have not yet been merged. That is, only those MBs that have unreliable MVs connecting to each other in vertical, horizontal and diagonal directions will be merged. If two adjacent MBs have unreliable MVs that are not next to each other in those three directions, those two MBs will not be merged. If there are no unreliable MVs in the neighborhood, this MB will remain as a single 16×16 block.

All possible shapes after MB merging are shown in Fig. 2. All the MBs that are merged together will be given a single MV in the first stage of the proposed MV processing. We choose 32×32 block size as the maximum block size after merging.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000855

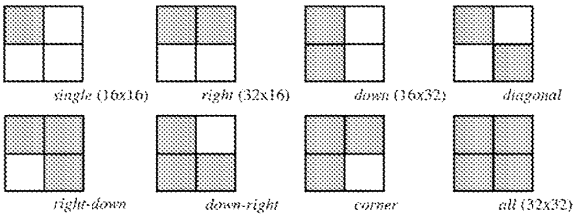


Fig. 2. Merging shapes for intercoded MBs that contain at least one unreliable MV and also for intracoded MBs except for the diagonal shape.

This is sufficient to obtain a good MV to describe the object motion to maintain the edges of an object on those MBs. Further increasing the block size to 48×48 or even larger is found to reduce the quality of interpolated frame as it is too large to represent all the motion inside. Moreover, the proposed MV processing method corrects MVs in a larger shape first and then refines them in smaller blocks later. Increasing the size of the merged block makes the motion refinement process difficult.

It is noted that intracoded MBs are automatically considered in this merging process as their MVs are unreliable. We assume that the intracoded MBs adjacent to unreliable MVs have higher prediction errors so that the encoder decides to encode those MBs using the intracoded mode. In addition, if there are adjacent intracoded MBs, these MBs are assumed to cover the same object in our method. That is, in the merging process, we have four types of MB merging: inter–inter, inter–intra, intra–inter, and intra–intra. However, the diagonal shape in Fig. 2 is not considered for intra–intra MB merging. It is because that the possibility for two diagonal intracoded MBs belonging to the same object is lower. Therefore, there are seven merging modes for intra–intra MB merging type and 8 merging modes for other MB merging types. We can create a MB merging map (MBMM) by assigning a unique number to the MBs that are merged, indicating that they should be considered together to find one MV in the MV processing stage.

Fig. 1(d) shows the MB merging map, where all the MBs in the same merged group is marked in the same color. Different colors are used to differentiate adjacent merged groups. Blue color is the default color if a merged group has no other merged groups next to it. Comparing Fig. 1(b) with Fig. 1(d), we observe that some blocks with high residual energies have been grouped together to form larger blocks such as those in the collar and ear areas. The MB merging map is created based on the predefined shapes of the residual energy distribution, which is very different from the work in [24]. In [24], the merging process simply groups all neighboring MBs as a larger block to find true motion.

IV. Proposed Multistage Motion Vector Processing Method

In this section, we propose a novel MV processing algorithm based on the MV reliability map and the MB merging map described in the previous section. In order to preserve edge information and maintain the integrity of moving object structure, we use MB merging to correct unreliable MVs by finding a best single MV, which is selected based on minimizing the difference of the forward and backward predictions. This new MV for each merged group is considered as a "global" MV in that merged group. However, there may still be smaller areas inside the MBs where this new MV cannot represent their motion well. Since the original residual energy information is no longer useful, we check the difference of forward and backward predictions resulting from the selected MV to reclassify those unreliable MVs. From the second classification, further MV refinement will be applied to those unreliable MVs based on the block size of 8×8. As a larger block size is considered to find a single MV in the first stage, this refinement process can be seen as a local motion adjustment within each merged group. In the final step, we use motion smoothing technique to reduce the blockiness artifact by increasing the number of MVs based on the block size of 4×4. In addition to the MV processing, we also adopt different interpolation strategy for those MBs on the frame boundaries. It is because mismatched bidirectional predictions often happen when moving objects appear along the frame boundary.

The block diagram of our proposed method is illustrated in Fig. 3. According to the MV reliability map (MVRM), the MB merging map (MBMM), and the originally received motion vector field (MVF^0), the first MV processing step is to select the best MV for each merged group, and meanwhile, this MV reliability reclassification can help subsequent MV refinement processing stages to differentiate improper motion. Our method can be considered as a hierarchical approach in the sense that the MVs in each merged group of block size up to 32×32 are first corrected and assigned a single MV, and then these selected MVs as well as other possibly reliable MVs are further refined and smoothed based on the block sizes of 8×8 and 4×4, respectively. In Fig. 3, we also demonstrate how the image quality can gradually be improved after each MV processing stage. In the following sections, we describe the proposed hierarchical, multistage MV processing method in greater details. As to the selection of parameters for corresponding motion vector processing stages is discussed in Section V.

A. Motion Vector Selection

Instead of re-estimating motion for each merged group, we propose MV selection. From the MB merging map, the MBs in each merged group have their own MVs and also the neighboring MVs in the adjacent MBs. These MVs are the candidates for our MV selection process. That is, we choose the best MV, $\mathbf{v}_b^*$, from these candidates by minimizing the averaged absolute bidirectional prediction difference (ABPD) between the forward and backward predictions

$$\mathbf{v}_b^* = \arg\min_{\mathbf{v} \in S}(\mathrm{ABPD}(\mathbf{v})) \tag{4}$$

where

$$\mathrm{ABPD}(\mathbf{v}) = \frac{1}{N_G} \sum_{x,y \in G} \left| f_{t-1}\left(x + \frac{1}{2}v_x, y + \frac{1}{2}v_y\right) - f_{t+1}\left(x - \frac{1}{2}v_x, y - \frac{1}{2}v_y\right) \right|.$$

S denotes the set of the MV candidates. G denotes the merged group in one of the 8 possible shapes in Fig. 2. It is noted that we

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000856

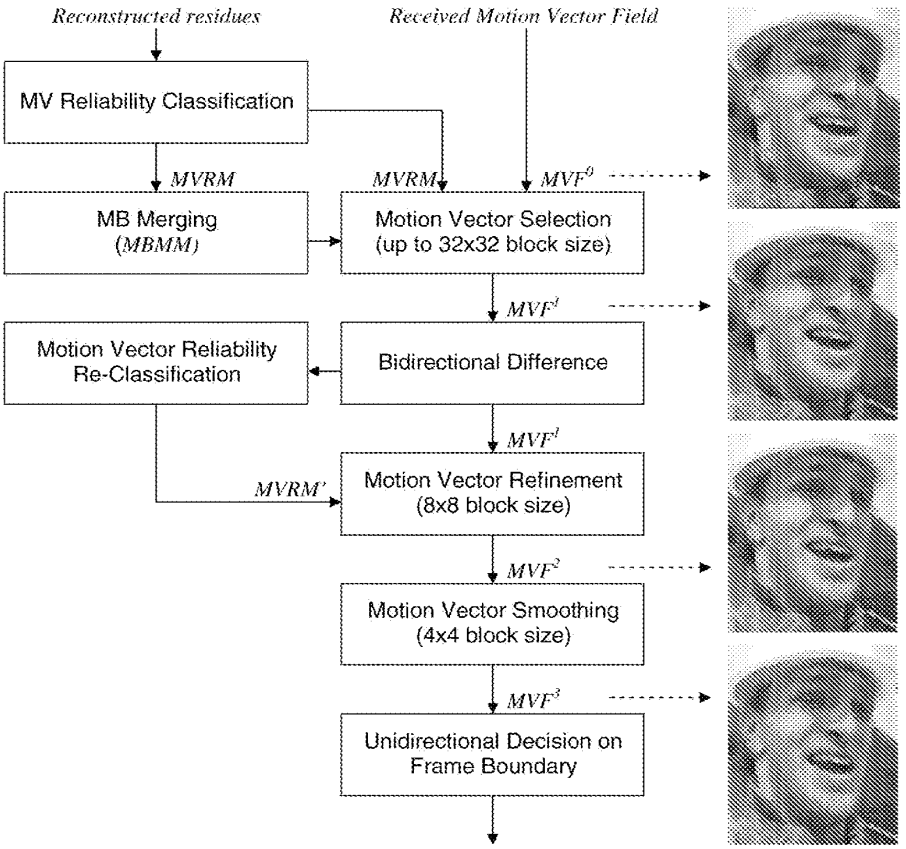


Fig. 3. Block diagram of the proposed algorithms. MVF^k denotes the updated motion vector field after each process.

consider both luminance and chrominance information in BPD calculation in (5) and use the same weighting factor as in (2).

Once the best MV is found, before we assign it to the merged MBs in G, we need to check if this selected MV is good enough by comparing its ABPD with a threshold ε_2. If it is less than ε_2, the MVs of the merged MBs in G will be replaced by the new MV $\mathbf{v}_b^*$ and marked done. However, if it is larger than or equal to ε_2, we drop the selected MV and skip this merged group temporarily to see if some of the neighboring MVs are updated to better ones when other merged groups are corrected. That is, we wait until a proper MV propagates to its neighborhood. If the ABPD of the selected MV is still higher than ε_2 and the neighboring MVs are no longer updated, we still assign the best MV $\mathbf{v}_b^*$ and refine it in the MV refinement stage. The MV selection process stops until all merged groups have been assigned new MVs.

To further illustrate how the proposed MV selection works, an example is shown in Fig. 4. Each MB has four MVs, which are denoted as v_{mn}, where m and n are the row and the column index, respectively. Assume that we have a moving object whose motion boundary is represented by the blue line as shown in Fig. 4(a). The left side of blue line is the moving object, and the opposite side is the background. We observe that since the motion along with the object edge differs, there should exist high residual energies around the blue line. Using our MV classification approach, high residual energy areas are identified and indicated in yellow color. The proposed merging

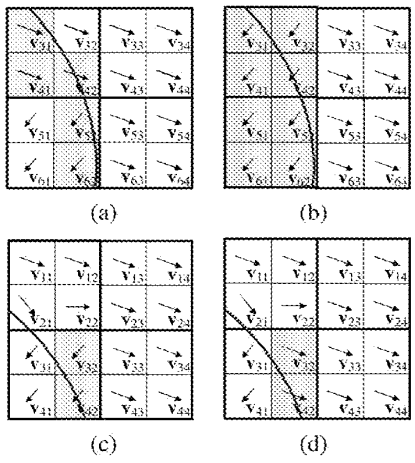


Fig. 4. (a) Motion vector field before the merging process. (b) The motion vector field after the merging process and MV selection. (c) The reclassification map for motion refinement. (d) The motion vector field after motion refinement.

algorithm groups the left two MBs, and a proper motion is assigned using (5). Fig. 4(b) demonstrates the updated MVF and modified MVs are in grey color. We can find the correct motion of the moving object and maintain the integrity of its structure after interpolation. However, as described previously,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000857

```
output_MVF = zero array;

DO
{
   Finish_Flag = (output_MVF == input_MVF) ? TRUE : FLASE;
   output_MVF = input_MVF;
   FOR (all MB(i,j))
   {
      IF (MBMM(i,j) != 0)
      {
         Merged_Group(i,j) = MB(i,j) + neighboring MBs with the same index;
         new_MV =
         MV with min(ABPD(adjacent MVs and MVs in Merged_Group(i,j)));
         IF (ABPD(new_MV) <ε2 || Finish_Flag == TRUE)
         {
            output_MVF(Merged_Group(i,j)) = new_MV;
            MBMM(Merged_Group(i,j)) = 0;
            Merged_Blks(i,j) = 8x8 partitions of Merged_Group(i,j);
            MVRM (Merged_Blks(i,j)) = ABPD(new MV) < ε3 ? L3 : L1;
         }
      }
   }
}WHILE (Finish_Flag == FALSE)
```

Fig. 5. Pseudocode of the proposed MV selection.

this updated MV is still block-based and is limited to represent finer local details, such as $\mathbf{v}_{32}$ and $\mathbf{v}_{42}$, where the background motion should be chosen. Therefore, we need to perform MV re-classification described in the next section and motion refinement to further correct these unreliable MVs. The pseudocode of MV selection is shown in Fig. 5. According to MBMM, every merged group with the same nonzero index number will be examined and assigned a best MV. Please note that we will check if the new obtained MVF is identical to the input MVF. If yes, all unreliable MVs that are not corrected yet will be certainly corrected in the next pass.

B. Motion Vector Reclassification Based on Bidirectional Prediction Difference

As a consequence of the MV selection process, a MB in a high residual area will only have one single MV that presents major motion. As the MB consists of multiple motions, regions having different motion can be easily detected by high difference error between forward and backward predictions. Therefore, we propose using BPD to re-classify those unreliable MVs in MVF[1]. In addition, we revisit those possibly reliable MVs and check their BPD to see if they are truly reliable. For those MVs that are reliable, they will still remain reliable in this stage. That is, in the MV re-classification, we only work on those MVs that are unreliable (L_1) and possibly reliable (L_2) in the first place.

The MV reclassification process is similar to the classification method described in Section III-A. Since we already use different weights on luminance and chroma while calculating residual energy in the previous classification and MV selection as well, here we simply sum up difference error based on 8×8 block size using same criteria to obtain the new energy distribution $\mathrm{BPD}(m,n)$

$$\mathrm{BPD}_{m,n} = \mathrm{BPD}^{Y}_{m,n} + \alpha \cdot \left(\mathrm{BPD}^{\mathrm{Cb}}_{m,n} + \mathrm{BPD}^{\mathrm{Cr}}_{m,n}\right) \quad (5)$$

where $\mathrm{BPD}^{Y}(m,n), \mathrm{BPD}^{\mathrm{Cb}}(m,n)$, and $\mathrm{BPD}^{\mathrm{Cr}}(m,n)$ are the sums of bidirectional prediction difference for Y, Cb, and Cr components of block $\mathbf{b}_{m,n}$ using the updated MV, $\mathbf{v}^{*}_{m,n}$, respectively.

If the $\mathrm{BPD}_{m,n}$ is higher than a threshold ε_3, then the MV $\mathbf{v}^{*}_{m,n}$ will be classified as unreliable and put in L_1. Those MVs with $\mathrm{BPD}_{m,n}$ lower than ε_3 will be classified as reliable in L_3. The classification can be written as

$$\mathrm{MVRM}(m,n) = \begin{cases} L_1, & \text{if } \mathrm{BPD}(m,n) \geq \varepsilon_3 \\ L_3, & \text{if } \mathrm{BPD}(m,n) < \varepsilon_3. \end{cases} \quad (6)$$

Please note that there is no more possibly reliable MV (L_2) in MVRM. All the L_2 MVs will be classified into L_1 or L_3 in this stage. L_3 MVs will remain L_3 in the updated MVRM.

From our observation, the difference between the forward and backward predictions usually has larger scale values than the received prediction error. As a result, we increase the threshold value to find improper MVs that will lead to noticeable artifacts. The updated classification map, MVRM, is the reference map in the MV refinement process. A simplified example is demonstrated in Fig. 4(c), where yellow blocks indicate unreliable MVs after the MV reliability re-classification. The reason why $\mathbf{v}_{31}$ is not classified as unreliable MV is that the high threshold value can only detect significant artifacts. We will leave minor difference error for the last stage of MV processing with a finer block size.

C. Motion Vector Refinement

From the updated classification map, we correct those unreliable MVs in L_1 by using a *reliability and similarity constrained vector median filter* as follows:

$$\mathbf{v}^{*}_{m,n} = \arg\min_{\mathbf{v} \in S} \sum_{i=m-1}^{m+1} \sum_{j=n-1}^{n+1} w_{i,j} \|\mathbf{v} - \mathbf{v}_{i,j}\|_2 \quad (7)$$

where

$$w_{i,j} = \begin{cases} 0, & \text{if } \mathrm{MVRM}(i,j) = L_1 \\ 1, & \text{if } \mathrm{MVRM}(i,j) = L_3 \text{ and } d_{i,j} > \varepsilon_4. \end{cases}$$

S contains the neighboring MVs of $\mathbf{v}_{m,n}$, and $d_{i,j}$ denotes the distance between $\mathbf{v}_{i,j}$ and $\mathbf{v}_{m,n}$ using the angular difference

$$d_{i,j} = 1 - \frac{\mathbf{v}_{m,n} \cdot \mathbf{v}_{i,j}}{|\mathbf{v}_{m,n}||\mathbf{v}_{i,j}|} = 1 - \cos\theta$$

where θ is the angle between $\mathbf{v}_{i,j}$ and $\mathbf{v}_{m,n}$. The distance is used for measuring the similarity of the candidate MVs and the original MV. Two MVs are considered to be similar if the distance is below a threshold, ε_4. Since we know those 8×8 blocks have different motion or belong to another object, we should prevent getting the same or similar MV. Hence, the vector median filter sorts the candidate MVs that have passed the similarity check and chooses the most probable one. Unlike [23], the filter is adopted to correct those unreliable MVs identified by the BPD classification.

When more than half of MVs of a MB have high difference error energy, motion refinement will not be applied in this case. It is because MV selection is supposed to select a major motion for this current MB, and it seems that the resultant high difference error is not caused by the motion boundary but other issues such as luminance or chrominance changes. In such case, performing motion refinement may break structures that have been well established by MV selection.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000858

```
output_MVF = input_MVF;
Finish_Flag = FALSE;

WHILE (Finish_Flag == FALSE)
{
    FOR (all MB(i,j) )
    {
        IF (MBRM(i,j) != 0)
        {
            new_MV = RSCVMF(adjacent MVs);
            IF (ABPD(new_MV) < ABPD(input_MVF(i,j)))
            {
                output_MVF(i,j) = new_MV;
            }
        }
    }
    Finish_Flag = (output_MVF == input_MVF) ? TRUE : FLASE;
    Input_MVF = output_MVF;
}
```

Fig. 6. Pseudocode of the proposed MV refinement. RSCVMF denotes reliability and similarity constrained vector median filter.

Before we update the MV, we need to perform energy check on BPD of the candidate MV whose error energy must be smaller than the original one. If the candidate MV, $\mathbf{v}^*_{m,n}$, fails to pass energy check, we will not update its unreliability level and try to correct it in the next iteration if a different MV can be found with an updated MVF. Similarly, the refinement MV process stops when the MVF no longer has changes. It is possible that MVs with reliability level L_1 remain unreliable after the refinement. Depending on how structure information distributes on a 8×8 block, the energy check decides if the candidate MV can represent the major motion. If not, we skip this refinement and further modify this unreliable MV with finer block size 4×4 in the MV smoothing process.

We again use Fig. 4 to illustrate MV refinement process. From Fig. 4(c) to (d), we can observe that due to the MV similarity constraint, we prevent using identical and similar MVs, $\{\mathbf{v}_{31}, \mathbf{v}_{41}, \mathbf{v}_{51}, \mathbf{v}_{52}\}$, to correct $\mathbf{v}_{42}$. Instead, this unreliable MV can be effectively corrected using one of $\{\mathbf{v}_{33}, \mathbf{v}_{43}, \mathbf{v}_{53}\}$, which have passed the similarity check. According to the distribution of the motion boundary in this area, these new obtained MVs should have lower difference error since they can better represent the major motion for these 8×8 blocks. As we can see, there still have high bidirectional difference in finer areas in Fig. 4(d) and this will cause blockiness artifact. Therefore, MV smoothing is used in the last stage of the MV processing method to reduce blockiness. For implementation issues, please see the pseudocode in Fig. 6.

D. Motion Vector Smoothing

In order to reduce the blocking artifact, we adopt the method in [13] as our final stage of the MV processing to create a motion field with a finer scale. In [13], each 8×8 block can be further partitioned into four 4×4 sub-blocks and the MVs of these four sub-blocks can be obtained simultaneously by minimizing a smoothness measure Ψ, which is defined as follows:

$$\Psi = \Psi_N + \Psi_S + \Psi_E + \Psi_W + \Psi_D + \Psi_C. \tag{8}$$

The subscripts $\{N, S, E, W, D, C\}$ of Ψ individually represents the smoothness measures between the centered MVs and their adjacent MVs in north, south, east, west, diagonal and center directions. For example, the smoothness measure of these four MVs in their north direction is defined as

$$\Psi_N = \left\|\mathbf{v}^1_{m,n} - \mathbf{v}^3_{m,n-1}\right\|^2 + \left\|\mathbf{v}^2_{m,n} - \mathbf{v}^4_{m,n-1}\right\|^2 + \left\|\mathbf{v}^3_{m,n} - \mathbf{v}^1_{m,n}\right\|^2 + \left\|\mathbf{v}^4_{m,n} - \mathbf{v}^2_{m,n}\right\|^2.$$

In the equation, the MV $\mathbf{v}_{m,n}$ in the block $b_{m,n}$ is partitioned into four sub-blocks $b^i_{m,n}, i = 1, 2, 3, 4$ in scan order, with initial MV $\mathbf{v}^i_{m,n} = \mathbf{v}_{m,n}$. Similarly, we can derive smoothness measures for all other directions. The optimal solution is obtained by combining different direction smoothness measures into a matrix form and minimizing Ψ in (8) with respect to the four MVs.

We only use this resampling approach on MVs with original reliability levels, L_1 and L_2, because they are the major cause of visual artifacts in the frame interpolation. Please note that we use corrected MVs in MVF^3 and produce a denser MVF MVF^4 during the smoothing process while the method in [13] uses the original received MVF MVF^0. As a matter of fact, smoothness measurement aims to lessen the difference among MVs, so using proper MVs can effectively decrease blockiness whereas improper motion can induce serious ghost artifact.

TABLE I
WEIGHT VALUES FOR FORWARD AND BACKWARD MOTION-COMPENSATION ON FRAME BOUNDARY

$n = 1$	w_f	w_b	$m = 1$	w_f	w_b
$v_y \le 0$	0	1	$v_x \le 0$	0	1
$v_y > 0$	1	0	$v_x > 0$	1	0
$n = N$	w_f	w_b	$m = M$	w_f	w_b
$v_y \le 0$	1	0	$v_x \le 0$	1	0
$v_y > 0$	0	1	$v_x > 0$	0	1

E. Motion Adaptive Unidirectional Interpolation on the Frame Boundary

MPEG4 and H.263+ allow motion estimation to search out of frame boundary by extending the boundary pixel values for better coding efficiency. However, for frame interpolation, it is difficult to get good interpolation results by using bidirectional interpolation in (1). For example, for MBs in the first row, if the MV in vertical direction, v_y, is less than zero, it implies that a new object appears in the next frame and the previous frame only has part of the content. Simply averaging the forward and backward predictions will cause visual artifacts. Hence, for those MBs on the frame boundary, we propose using unidirectional interpolation based on the directions of their MVs. That is, we adaptively change the weights of forward and backward predictions based on the MVs. Assume that each frame has N × M MBs, the weights can be summarized as in Table I.

V. PARAMETER ANALYSIS

In our implementation, MV reliability classification, MV selection, MV reclassification, MV refinement and even the iteration limitation number all make use of predefined threshold values for the proposed MV processing method. In this section, these parameters are analyzed and their impacts on the PSNR performance are also discussed in more details. By doing this,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000859

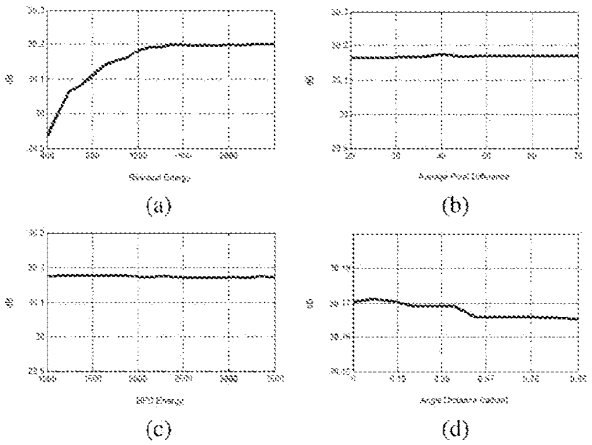


Fig. 7. (a)–(d) PSNR performances with corresponding residual energy threshold, MV selection threshold, MV reclassification threshold, and MV refinement threshold, respectively.

not only can we realize how sensitive the proposed method will be, but also we can select better thresholds and apply same values for all test video sequences so that the implementation can be simplified. The Foreman sequence of CIF size is used here for parameter analysis, which includes $\varepsilon_1, \varepsilon_2, \varepsilon_3$, ε_4, and iteration numbers for MV selection and MV refinement, respectively.

The iteration number is determined by comparing the input MVF and the resulting MVF. If the resulting MVF is static, MV refinement will simply stop MV processing. However, MV selection will continue MV processing once again to ensure that all merged groups have been assigned a single MV when the resulting MVF no longer changes. We compute the iteration number required for each frame and obtain average values, 1.47 and 1.30, for MV selection and MV refinement, respectively. As a result, the iteration varies between 1 and 2. In order to reduce the complexity, we set the iteration number to be 2 for MV selection and increase ε_2 to a very high value in the second iteration so that all merged blocks will certainly be assigned new MVs. With the same manner, we also set an iteration number to be 2 for the motion refinement process.

The overall PSNR performance with different corresponding threshold values is illustrated in Fig. 7. In Fig. 7(a), as the residual energy threshold increases, the PSNR performance increases as well. It is because for low ε_1, many correct MVs are identified as unreliable and are merged with improper neighboring MVs for MV selection. In such case, the MVF will be rearranged badly that makes it difficult to correct unreliable MVs in the MV refinement and MV smoothing steps. Therefore, the chosen parameter of the residual classification should be low enough to identify as many possibly unreliable MVs as possible, but at the same time, it should be high enough for not merging too many improper MBs as a merged group. Note that we do not show the simulation results of either extremely low or extremely high threshold values in Fig. 7(a). It is because extremely low value case means that the received MVF will be modified thoroughly by MV selection using 32×32 block size and extremely high value case means direct MCFI where the received MVF is used directly. Obviously, both scenarios cannot yield good interpolation results.

For ε_2 in Fig. 7(b), we observe that the chosen parameter does not affect the PSNR performance considerably. That is, as the resulting MVF becomes static, the MV with minimum ABPD will still be selected even its ABPD is greater than ε_2. Similarly, if ε_2 is too large, the MVs with minimum ABPD are also assigned to all merged blocks. The reason why we place a threshold value for MV selection is to check if there will be new MVs propagating to the neighborhood. In Fig. 7(c), it also shows that the scale of ε_3 does not have too much influence on MV reclassification since the energy check of MV refinement can avoid choosing unsuitable MVs. However, this threshold value has to effectively detect all significant visible artifacts introduced by MV selection and other possible unreliable MVs that are not identified yet during the residual classification. As to the angle threshold for the MV refinement, ε_4, we observe that the PSNR performance degrades gradually in Fig. 7(d) when the angle difference increases. The reason is that the MV choices for MV refinement become less. We also notice that zero angle difference does not obtain the best average PSNR. That is, similarity check can help us avoid getting same MVs to correct unreliable MVs especially on motion boundaries.

To get the best MCFI performance, these threshold values should be adjustable to different video sequences. However, based on the analysis of these parameters, we observe that the proposed MV processing method is only sensitive to ε_1 and ε_4. In order to reduce the complexity, we use same parameters to all test video clips in the simulation and set $\{\varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4\}$ to be 1100, 45, 2000, and 0.15, respectively. These values are not chosen to optimize MCFI results of the Foreman sequence but to have the ability to process general video cases. Therefore, we select the values around saturated points in Fig. 7(a) and (d) for ε_1 and ε_4 and averaged values in Fig. 7(b) and (c) for ε_2 and ε_3.

VI. Simulations

In this section, we present simulation results to evaluate the performance of the proposed method. We compare our method with direct interpolation, vector median filter, adaptive vector median filter [11], MV smoothing [13], multisize block matching algorithm [7], and proposed MV selection from the neighboring MVs by minimizing the bidirectional prediction difference. Eight video sequences, Foreman, Formula1, Walk, Bus, Fast Food, Stephan, Rugby, and Football, of CIF frame resolution are used with original frame rate of 30 frame per second (fps). They are all encoded using H.263, where even frames are skipped to generate video bitstreams of 15 fps. The skipped frames are interpolated at the decoder and they are used to evaluate different interpolation schemes. The rate control function is disabled by fixing quantization parameter (QP) values. The averaged bit rates of all test sequences are 395.77, 474.50, 430.39, 509.43, 499.36, 503.10, 340.90, and 429.32 Kbps for Foreman, Formula1, Walk, Bus, Fast Food, Stephan, Rugby, and Football, respectively.

The visual comparisons are presented in Figs. 8–13. Figs. 8 and 9 show the visual comparisons for Foreman sequence. In Fig. 8, blockiness can easily be seen in Fig. 8(b) and (d)–(g). The blockiness artifacts can be removed by MV smoothing method

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000860

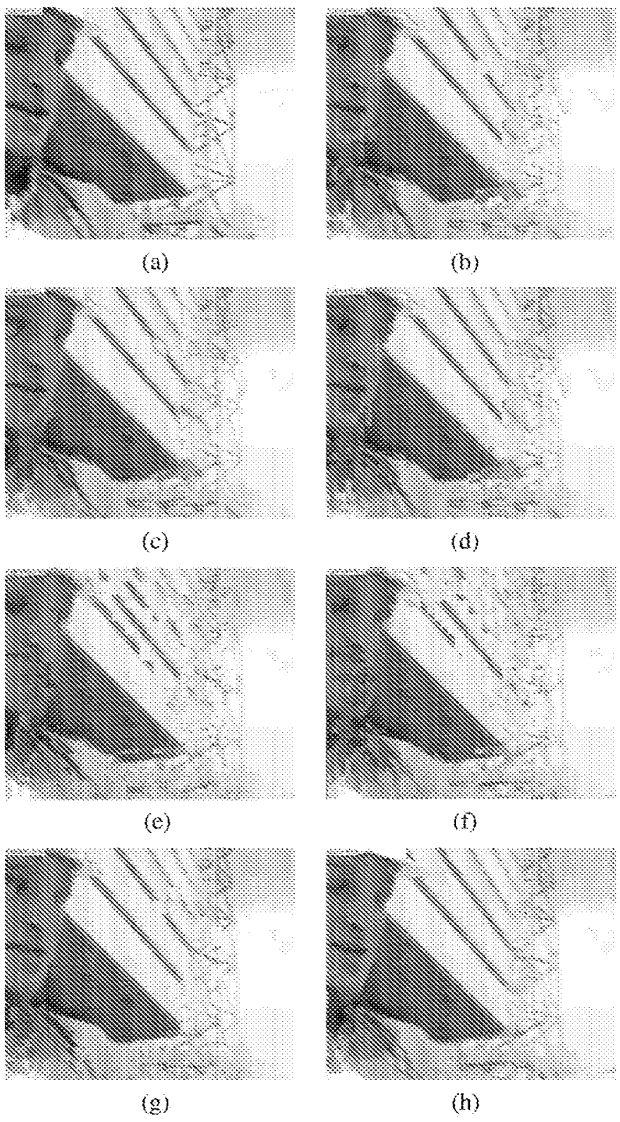


Fig. 8. Interpolated results of frame 186 of Foreman sequence using (a) original frame; (b) direct interpolation (PSNR: 24.43 dB, SSIM: 0.7259); (c) MV smoothing (PSNR: 24.59 dB, SSIM: 0.7233); (d) vector median filtering (PSNR: 24.72 dB, SSIM: 0.7431); (e) adaptive vector median filter (PSNR: 22.20 dB, SSIM: 0.5513); (f) multisize block matching algorithm (PSNR: 22.44 dB, SSIM: 0.5646); (g) proposed MV selection (PSNR: 25.23 dB, SSIM: 0.7811); and (h) the proposed multistage MV processing method (PSNR: 24.85 dB, SSIM: 0.8270), respectively.

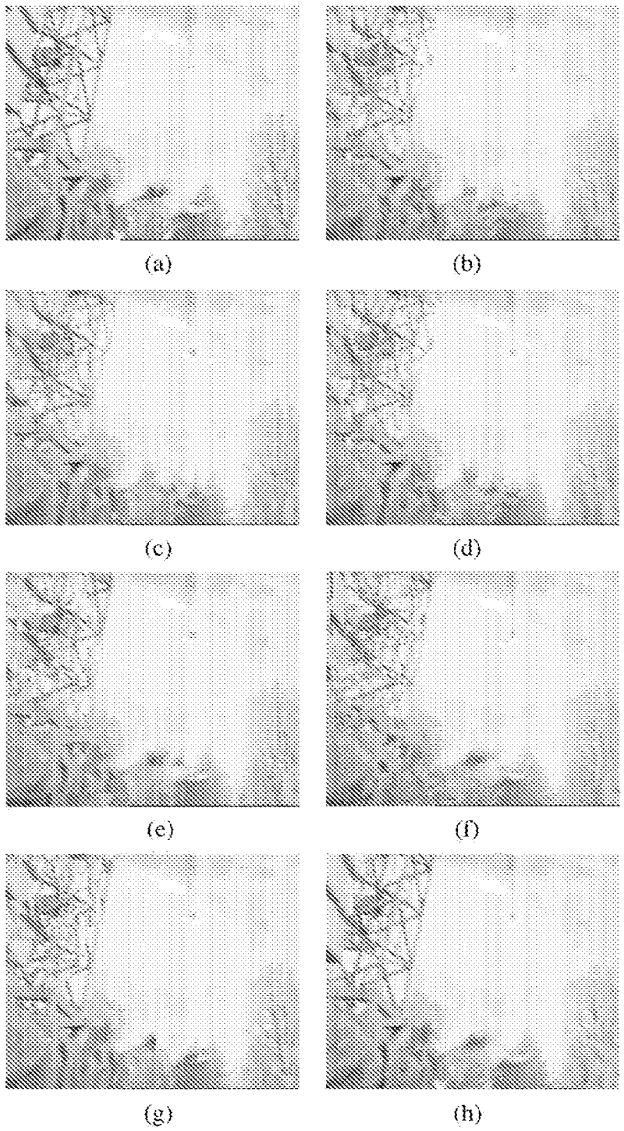


Fig. 9. Interpolated results of frame 196 of FOREMAN sequence using (a) original frame; (b) direct interpolation (PSNR: 24.43 dB, SSIM: 0.7353); (c) MV smoothing (PSNR: 24.42 dB, SSIM: 0.7328);, (d) vector median filtering (PSNR: 24.44 dB, SSIM: 0.7363);, (e) adaptive vector median filter (PSNR: 24.90 dB, SSIM: 0.7389); (f) multisize block matching algorithm (PSNR: 24.76 dB, SSIM: 0.7269); (g) proposed MV selection (PSNR: 25.70 dB, SSIM: 0.8316); and (h) the proposed multistage MV processing method (PSNR: 26.61 dB, SSIM: 0.9278), respectively.

as shown in Fig. 8(c). However, ghost artifacts are then generated because incorrect MVs have impacts on the smoothing process such as the areas around the face. Also, the structure of the building and the tower cannot be maintained. In Fig. 8(e) and (f), the performance of motion estimation is greatly degraded due to image distortion. MV selection can recover the contour of the face and some of edge information as shown in Fig. 8(g). However, it is more likely to fail when a frame has repeated structures or fairly smooth areas around the MBs that have edge information. This is because minimizing the bidirectional prediction difference may choose a MV that points to the smooth area, which will cause a broken edge as shown on the building in Fig. 8(g).

Fig. 9 shows another example of Foreman sequence. In Fig. 9(g), we can clearly see that the hand is deformed and replaced by the sky because the sky is a smoother area around the hand. Moreover, the structure of the yellow tower is destroyed since each MB searches its own motion without considering object structures. As to the results using the proposed method in Figs. 8(h) and 9(h), these artifacts have successfully been eliminated. The ghost effect in Fig. 8(c) and Fig. 9(c) does not appear in our results since our proposed method corrects those

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000861

unreliable MVs before smoothing. Comparing to MV selection, our results can better preserve edge information such as the yellow tower by taking object structures into consideration during the MB merging process. Moreover, due to the unidirectional interpolation scheme, we also perform better than other six methods on the frame boundary. It is because those MBs on the frame boundaries have motion moving to the right direction, and part of the content disappears in the subsequent frame. As we use unidirectional MCFI on the frame boundary, the content mismatched effect can be removed.

As one might notice, our PSNR value is lower than that of MV selection in Fig. 8, even though our method has better visual quality. This is because PSNR measures signal fidelity to its original frame, instead of perceived visual quality. Any pixel shifting may cause significant PSNR degradation but we may not see the difference. In addition, our proposed method attempts to refine motion by maintaining structure integrity in order to provide better visual experience, instead of recovering the original pixel values. Afterall, the users do not know the original frames that are skipped at the decoder as long as the motion is smooth and the images have no visible artifacts. Therefore, we adopt an alternative objective measurement, structure similarity (SSIM) index, for quality assessment [25], which has been used in [5]. It examines degradation of structure information and is less sensitive to the pixel shift effect. In this way, the quality numeric analysis can truly reflect structure integrity in interpolated frames. As we can see in Fig. 8, although our PSNR is lower than MV selection, our performance is better in terms of SSIM index. In Fig. 9, our performance is better in terms of both PSNR and SSIM.

It is noted that SSIM values are derived by averaging all index values within a frame, and, therefore, the difference between our method and MV selection may be seen smaller. That is, if we divide a frame into 11×9 units of size 32×32 for CIF video sequences, the obtained index value is an average of 99 local index values. Hence, the averaging process lowers the influence of local visual artifacts. Even though the difference of SSIM indexes is not much due to the averaging process, our SSIM still performs better than others.

Figs. 10 and 11 demonstrate two examples in Walk sequence. In Fig. 10, because the background has complex patterns, which is a challenge to find accurate MVs, the four methods that we compare with fail and all have deformed structures severely as shown in Fig. 10(b)–(g). Our method, however, can recover the background without any artifact even through the frame has many intracoded MBs and high-residual energy intercoded MBs. This proves that our MV reliability classification and MB merging can truly help MV processing to obtain a better motion as well as to maintain complex object structures. Our method also outperforms in terms of PSNR and SSIM. Our PSNR value is at least 1.39 dB higher and our SSIM value is at least 0.1299 higher than the other methods.

Another interpolation results of a different frame number are demonstrated in Fig. 11. As we can see, the MV selection method can recover many areas except the face where eyes and the nose have been replaced by smooth skin texture, not to mention that direct interpolation, vector median filtering, MV smoothing, adaptive vector median filter, and multisize block matching algorithm all result in many visual artifacts in both the face and body areas. The proposed method provides much better quality than these four methods by eliminating most of the artifacts as illustrated in Fig. 11(h).

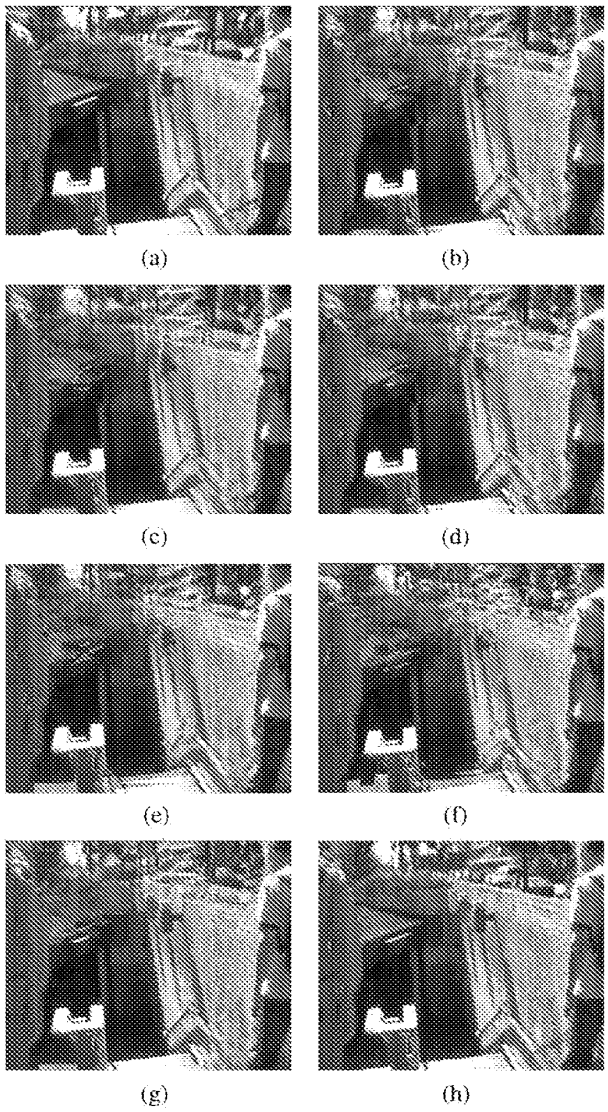


Fig. 10. Interpolated results of frame 18 of WALK sequence using (a) original frame; (b) direct interpolation (PSNR: 19.66 dB, SSIM: 0.6278); (c) MV smoothing (PSNR: 19.76 dB, SSIM: 0.6323); (d) vector median filtering (PSNR: 19.67 dB, SSIM: 0.6280); (e) adaptive vector median filter (PSNR: 19.26 dB, SSIM: 0.5934); (f) multisize block matching algorithm(PSNR: 19.34 dB, SSIM: 0.6234); (g) proposed MV selection (PSNR: 19.94 dB, SSIM: 0.6786); and (h) the proposed multistage MV processing method (PSNR: 21.33 dB, SSIM: 0.8085), respectively.

The interpolation results of the Formula1 sequence are shown in Fig. 12. Fast motion is involved as the camera tries to catch up with the race car and also the intensity of luminance between grass and pavement is very similar. These factors account for the failed interpolation on the white lines in the background as shown in Fig. 12(b)–(g). Bidirectional difference of color components and the MB merging algorithm assist us to find more

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000862

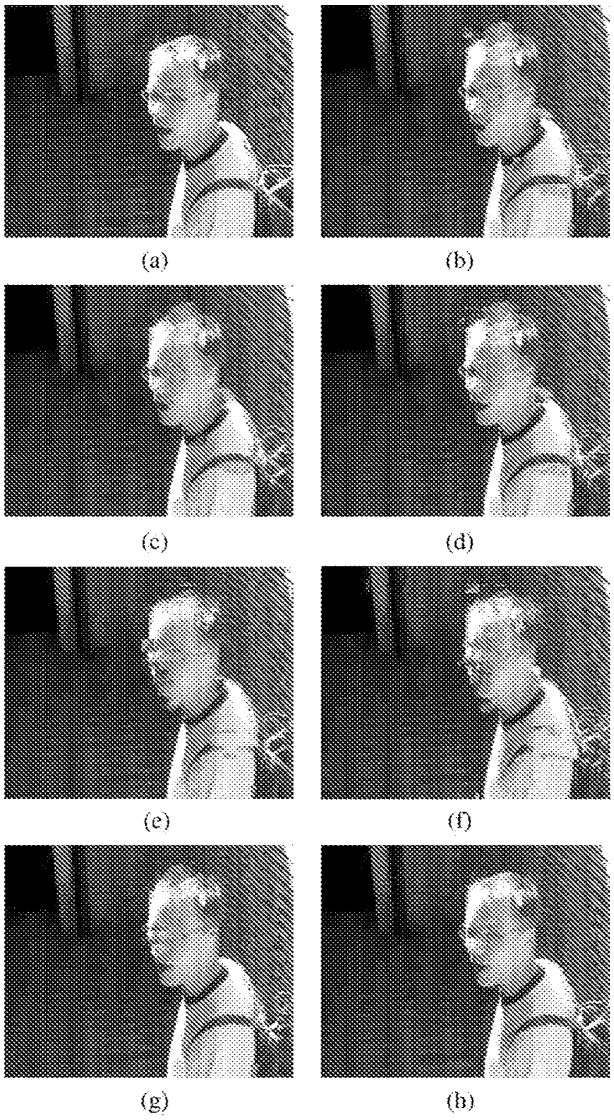


Fig. 11. Interpolated results of frame 288 of WALK sequence using (a) original frame; (b) direct interpolation (PSNR: 21.92 dB, SSIM: 0.7183); (c) MV smoothing (PSNR: 22.35 dB, SSIM: 0.7407); (d) vector median filtering (PSNR: 22.04 dB, SSIM: 0.7224); (e) adaptive vector median filter (PSNR: 21.37 dB, SSIM: 0.6874); (f) multisize block matching algorithm (PSNR: 21.58 dB, SSIM: 0.7024); (g) proposed MV selection (PSNR: 22.22 dB, SSIM: 0.7388); and (h) the proposed multistage MV processing method (PSNR: 22.39 dB, SSIM: 0.7606), respectively.

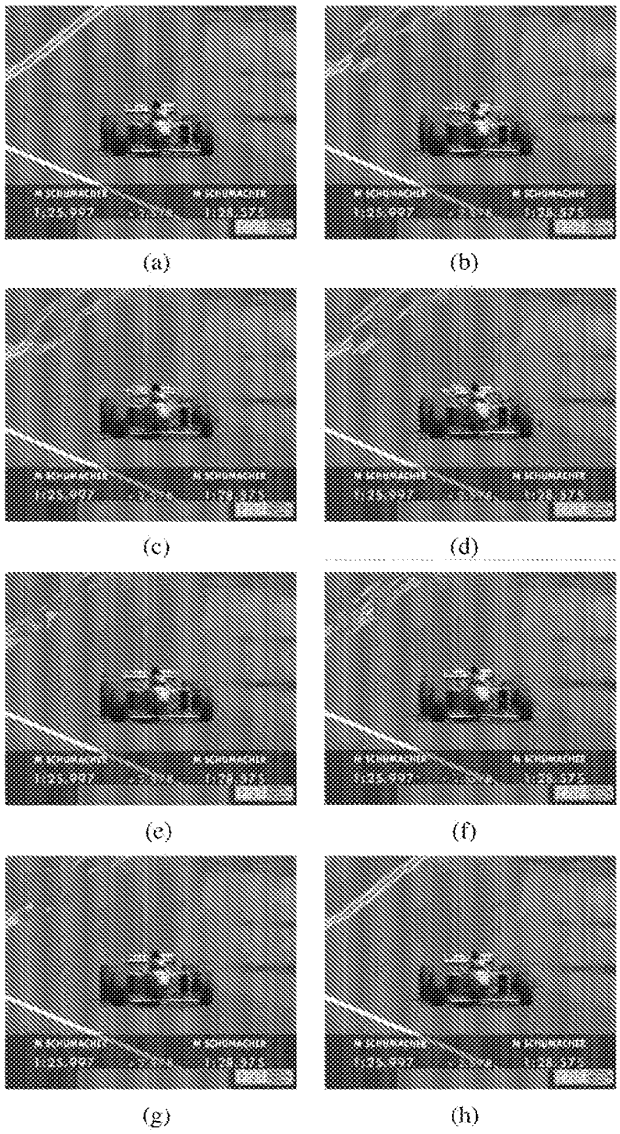


Fig. 12. Interpolated results of frame 56 of the Formula1 sequence using (a) original frame; (b) direct interpolation (PSNR: 29.68 dB, SSIM: 0.9050); (c) MV smoothing (PSNR: 29.46 dB, SSIM: 0.9013); (d) vector median filtering (PSNR: 29.80 dB, SSIM: 0.9067); (e) adaptive vector median filter (PSNR: 29.91 dB, SSIM: 0.9155); (f) multisize block matching algorithm (PSNR: 29.85 dB, SSIM: 0.9149); (g) proposed MV selection (PSNR: 30.23 dB, SSIM: 0.9225); and (h) the proposed multistage MV processing method (PSNR: 31.56 dB, SSIM: 0.9567), respectively.

suitable motion to represent this area so that our white lines are consistent, as illustrated in Fig. 12(h).

In order to prove the feasibility of our proposed method, we also apply our algorithm to video sequences with a larger frame size, 720×480, as shown in Fig. 13. This sequence is encoded with the bit rate of 1.7 Mbps. Obviously, our method still significantly outperforms other four motion vector processing methods. PSNR is 4.57 dB higher and SSIM is 0.1 higher.

We list averaged PSNR and SSIM values for these eight video sequences in Tables II and III. As observed, our SSIM performance is consistently better than others motion vector processing methods but PSNR performance is only better in Walk, Bus, and Fast Food. PSNR is derived from the quantity of fidelity difference while SSIM emphasizes on the similarity of object structures. According to their properties, SSIM is adequate to MCFI case since avoiding deformed structures and achieving video consistency are the most important requirement in MCFI application. A counter example is demonstrated in Fig. 8(h) where our result has better visual quality but PSNR is lower than Fig. 8(g). However, its SSIM index can more effectively reflect the subjective ratings. For the Bus sequence, we perform

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000863

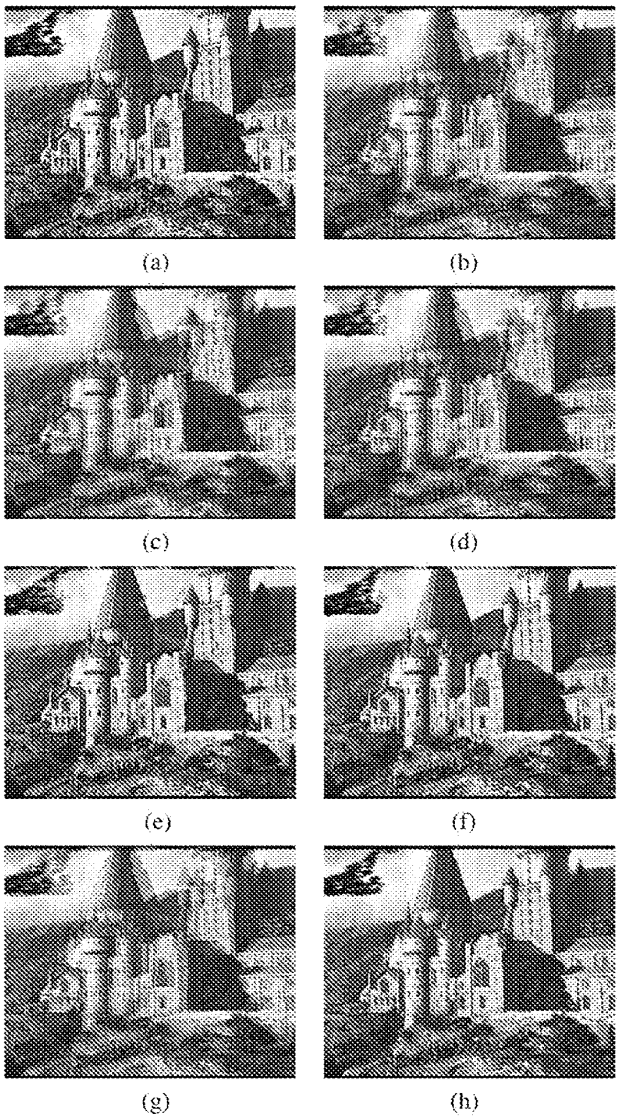


Fig. 13. Interpolated results of frame 12 of CASTLE AND TREE sequence using (a) original frame; (b) direct interpolation (PSNR: 21.43 dB, SSIM: 0.8289); (c) MV smoothing (PSNR: 21.80 dB, SSIM: 0.8415); (d) vector median filtering (PSNR: 21.57 dB, SSIM: 0.8342); (e) adaptive vector median filter (PSNR: 24.38 dB, SSIM: 0.9189); (f) multisize block matching algorithm (PSNR: 25.62 dB, SSIM: 0.9322); (g) proposed MV selection (PSNR: 21.89 dB, SSIM: 0.8452); and (h) the proposed multistage MV processing method (PSNR: 26.46 dB, SSIM: 0.9422), respectively.

slightly worse than adaptive vector median filter and multisize block matching algorithm. This is because the quality of the re-estimated MVF is much better than the received MVF. Comparing to Direct MCFI, the proposed motion vector processing approach has 1.24 dB improvement in average PSNR.

For further comparisons, we plot PSNR and SSIM values of interpolated frames using vector median filtering, MV selection, and the proposed method for the entire Bus sequence, as illustrated in Fig. 14. The overall performance of the proposed method is generally the best. Please note that in some difficult frames, where a lot of MVs are unreliable and there are many

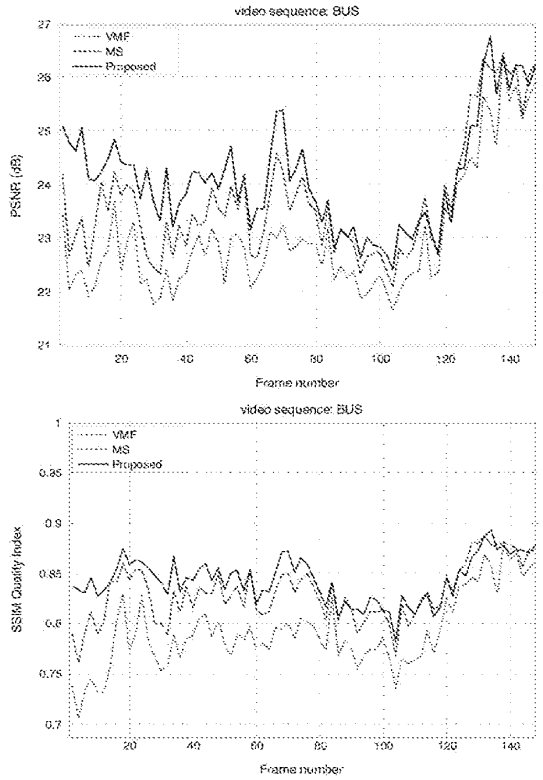


Fig. 14. PSNR and SSIM plots for Bus sequence. The green line denotes vector median filter, the red line denotes proposed MV selection with fixed searching size, and the blue line denotes the proposed multistage MV Processing.

intracoded MBs, the proposed method always has less structure degradation. It also seems that our method can keep the performance at a higher level so that the visual quality can be maintained relatively constant during video playback. More results can be found at http://videoprocessing.ucsd.edu/~aihuang/Paper1.htm.

VII. Conclusion

Frame interpolation that uses motion information in the received bitstream is an efficient and effective technique for compressed video to improve temporal quality by increasing frame rate at the decoder. However, not all received motion information is suitable for frame interpolation as block-based motion estimation at the encoder often fails to find true motion. In this paper, we have shown that those unreliable MVs can be identified by their prediction residual energies. We further use this MV reliability information and presented a hierarchical MV processing algorithm to produce a more reliable MVF for frame interpolation to remove artifacts. The proposed method classifies the MVs into different reliability levels and also analyzes the distribution of high residual energies to effectively merge MBs that are on the motion boundaries. This can avoid using complicated object-based segmentation or edge detection to maintain edge information.

We then propose refining unreliable MVs hierarchically by gradually reducing block size. In addition, for those MBs on

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000864

TABLE II
PSNR PERFORMANCE COMPARISONS AMONG FIVE FRAME INTERPOLATION METHODS AND THE PROPOSED METHOD FOR EIGHT VIDEO SEQUENCES

Sequences	Direct	VMF	AVMF	Smooth	MS BMA	Selection	Multi-Stage
WALK	22.88	22.95	22.90	22.99	23.00	23.04	**23.11**
FORMULA 1	28.09	28.24	28.17	27.85	28.34	**28.54**	28.36
BUS	22.92	23.03	24.69	22.64	**24.77**	23.72	24.16
FAST FOOD	25.67	25.84	25.10	25.69	25.41	26.31	**26.66**
FOREMAN	31.43	31.48	31.11	31.19	31.12	**31.75**	30.16
STEPHAN	23.80	23.87	23.73	23.68	23.77	**24.09**	23.93
FOOTBALL	24.88	24.95	22.97	24.99	23.05	**25.25**	25.21
RUGBY	24.58	24.75	24.28	24.76	24.45	**24.97**	24.81

TABLE III
SSIM PERFORMANCE COMPARISONS AMONG FIVE FRAME INTERPOLATION METHODS AND THE PROPOSED METHOD FOR EIGHT VIDEO SEQUENCES

Sequences	Direct	VMF	AVMF	Smooth	MS BMA	Selection	Multi-Stage
WALK	0.7869	0.7889	0.7862	0.7908	0.7911	0.7958	**0.8025**
FORMULA 1	0.8276	0.8305	0.8310	0.8251	0.8363	0.8388	**0.8432**
BUS	0.7893	0.7924	0.8651	0.7755	**0.8690**	0.8307	0.8438
FAST FOOD	0.8270	0.8304	0.7933	0.8275	0.8045	0.8566	**0.8819**
FOREMAN	0.9311	0.9319	0.9210	0.9295	0.9237	0.9406	**0.9467**
STEPHAN	0.7814	0.7818	0.7744	0.7743	0.7771	0.7993	**0.8116**
FOOTBALL	0.6752	0.6775	0.6580	0.6793	0.6634	0.7012	**0.7151**
RUGBY	0.7335	0.7397	0.7173	0.7416	0.7265	0.7585	**0.7694**

the frame boundaries, we should consider their motion and use unidirectional interpolation as the movement may go outside the frame. Besides, chrominance information should be consider explicitly as it provides valuable information to identify and correct unreliable MVs. Afterall, SSIM indexes and visual comparisons show that our MV processing algorithm can work with complicated MVF with complex texture, and more importantly, structure information is better preserved. The proposed method is very robust in eliminating artifacts for various video sequences. Moreover, our method is a low-complexity, standard compliant solution at the decoder since we only perform MV processing to accomplish the concept similar to object-based frame interpolation but without actual edge detection or motion estimation. The resulting simulation confirms the advantages of the proposed methods comparing to other conventional approaches. In the future works, we will apply the proposed MV processing method to H.264 decoder for MCFI and transcoding applications.

REFERENCES

[1] G. Haan, P. W. A. C. Biezen, H. Huijgen, and O. A. Ojo, "True-motion estimation with 3-D recursive search block matching," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 3, no. 5, pp. 368–379, Oct. 1993.

[2] R. Krishnamurthy, J. W. Woods, and P. Moulin, "Frame interpolation and bidirectional prediction of video using compactly encoded optical-flow fields and label fields," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 9, no. 5, pp. 713–726, Aug. 1999.

[3] T. Chen, "Adaptive temporal interpolation using bidirectional motion estimation and compensation," in *Proc. Int. Conf. Image Processing*, Sep. 2002, vol. 2, pp. 313–317.

[4] T. Ha, S. Lee, and J. Kim, "Motion compnesated frame interpoaltion by new block-based motion estimation algorithm," *IEEE Trans. Consum. Electron.*, vol. 50, no. 2, pp. 752–759, May 2004.

[5] J. Wang, N. Patel, and W. Grosky, "A fast block-based motion compensated video frame interpolation approach," in *Proc. Asilomar Conf. Signals, Systems, Computers*, Nov. 2004, pp. 1740–1743.

[6] J. Zhai, J. L. K. Yu, and S. Li, "A low complexity motion compensated frame interpolation method," in *Proc. ISCAS*, Sep. 2005, vol. 2, pp. 4927–4930.

[7] S. Fujiwara and A. Taguchi, "Motion-compensated frame rate up-conversion based on block matching algorithm with multi-size blocks," in *Proc. Int. Symp. Intelligent Signal Processing and Communication Systems*, Dec. 2005, pp. 353–356.

[8] H. Blume, G. Herczeg, O. Erdler, and T. G. Noll, "Object based refinement of motion vector field applying probabilistic homogenization rules," *IEEE Trans. Consum. Electron.*, vol. 48, no. 3, pp. 694–701, Aug. 2002.

[9] B.-D. Choi, J.-W. Han, C.-S. Kim, and S.-J. Ko, "Frame rate up-conversion using perspective transform," *IEEE Trans. Consum. Electron.*, vol. 52, no. 3, pp. 975–982, Aug. 2006.

[10] J. Astola, P. Haavisto, and Y. Neuvo, "Vector median filters," *Proc. IEEE*, vol. 78, pp. 678–689, Apr. 1990.

[11] L. Alparone, M. Barni, F. Bartolini, and V. Cappellini, "Adaptively weighted vector-median filters for motion-fields smoothing," in *Proc. ICASSP*, May 1996, vol. 4, pp. 2267–2270.

[12] G. Dane and T. Q. Nguyen, "Motion vector processing for frame rate up conversion," in *Proc. ICASSP*, May 2004, vol. 3, pp. 309–312.

[13] G. Dane and T. Q. Nguyen, "Smooth motion vector resampling for standard compatible video post-processing," presented at the Asilomar Conf. Signals, Systems, Computers, 2004.

[14] H. Sasai, S. Kondo, and S. Kadono, "Frame-rate up-conversion using reliable analysis of transmitted motion information," in *Proc. ICASSP*, May 2004, vol. 5, pp. 257–260.

[15] S. Sekiguchi, Y. Idehara, K. Sugimoto, and K. Asai, "A low-cost video frame-rate up conversion using compressed-domain information," in *Proc. Int. Conf. Image Processing*, Sep. 2005, vol. 2, pp. 974–977.

[16] J. Zhang, L. Sun, S. Yang, and Y. Zhong, "Position prediction motion-compensated interpoaltion for frame rate up-conversion using temporal modeling," presented at the Int. Conf. Image Processing, 2005.

[17] T. Shanableh and M. Ghanbari, "Loss concealment using b-pictures motion information," *IEEE Trans. Multimedia*, vol. 5, no. 2, pp. 257–266, Jun. 2003.

[18] C. C. A. Vetro and H. Sun, "Video transcoding architectures and techniques: An overview," *IEEE Signal Process. Mag.*, pp. 18–29, Mar. 2003.

[19] O. A. Ojo and G. Haan, "Robust motion-compensated video upconversion," *IEEE Trans. Consum. Electron.*, vol. 43, no. 4, pp. 1045–1056, Nov. 1997.

[20] G. Dane, K. El-Maleh, and Y.-C. Lee, "Encoder-assisted adaptive video frame interpolation," in *Proc. ICASSP*, 2005, vol. 2, pp. 349–352.

[21] S.-H. Lee, O. Kwon, and R.-H. Park, "Weighted-adaptive motion-compensated frame rate up-conversion," *IEEE Trans. Consum. Electron.*, vol. 49, no. 3, pp. 485–492, Aug. 2003.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000865

[22] G. Dane and T. Q. Nguyen, "Optimal temporal interpolation filter for motion-compensated frame rate up conversion," *IEEE Trans. Image Process.*, vol. 15, no. 4, pp. 978–991, Apr. 2006.
[23] A. Huang and T. Nguyen, "A novel motion compensated frame interpolation based on block merging and residual energy," in *Proc. Multimedia Signal Processing Workshop*, Sep. 2006, vol. 4, pp. 353–356.
[24] A. Huang and T. Nguyen, "Motion vector processing based on residual energy information for motion compensated frame interpolation," in *Proc. Int. Conf. Image Processing*, Sep. 2006, vol. 4, pp. 353–356.
[25] Z. Wang, A. C. Conrad, H. R. Sheikh, and E. P. Simoncelli, "Image quality assessment: From error visibility to structure similarity," in *Proc. Multimedia Signal Processing Workshop*, Apr. 2004, vol. 13, no. 4, pp. 600–612.



Ai-Mei Huang (S'06) received the B.S. degree in communications engineering from the National Chiao Tung University, Hsien Chu, Taiwan, R.O.C., in 1999, and the M.S. degree in electrical engineering from National Taiwan University, Taipei, in 2001. She is currently pursuing the Ph.D. degree at the University of California at San Diego, La Jolla.

Her research interests include signal/image processing, video coding techniques, and video applications in broadcasting and TV display.



Truong Q. Nguyen (F'06) received the B.S., M.S., and Ph.D. degrees in electrical engineering from the California Institute of Technology, Pasadena, in 1985, 1986, and 1989, respectively.

He was with the Massachusetts Institute of Technology (MIT) Lincoln Laboratory, Cambridge, from June 1989 to July 1994, as a member of technical staff. During the academic year 1993–1994, he was a Visiting Lecturer at MIT and an Adjunct Professor at Northeastern University, Boston, MA. From August 1994 to July 1998, he was with the the Electrical and Computer Engineering Department, University of Wisconsin, Madison. He was with Boston University from August 1996 to June 2001. He is currently a Professor at the Electrical and Computer Engineering Department, University of California at San Diego, La Jolla. He is the coauthor (with Prof. G. Strang) of a popular textbook, *Wavelets & Filter Banks* (Wellesley-Cambridge Press, 1997) and the author of several Matlab-based toolboxes on image compression, electrocardiogram compression, and filter bank design. He has authored over 200 publications. His research interests are video processing algorithms and their efficient implementation.

Prof. Nguyen received the IEEE Transaction in Signal Processing Paper Award (Image and Multidimensional Processing area) for the paper he co-wrote with Prof. P. P. Vaidyanathan on linear-phase perfect-reconstruction filter banks (1992). He received the National Science Foundation Career Award in 1995 and is currently the Series Editor (Digital Signal Processing) for Academic Press. He served as Associate Editor for the IEEE TRANSACTION ON SIGNAL PROCESSING from 1994–1996, the IEEE TRANSACTION ON CIRCUITS AND SYSTEMS—II: ANALOG AND DIGITAL SIGNAL PROCESSING from 1996–1997, the IEEE SIGNAL PROCESSING LETTERS from 2001–2003, and the IEEE TRANSACTION ON IMAGE PROCESSING from 2001–2004.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000866

A Multi-Pass True Motion Estimation Scheme With Motion Vector Propagation for Frame Rate Up-Conversion Applications

Shen-Chuan Tai, Ying-Ru Chen, Zheng-Bin Huang, and Chuen-Ching Wang

***Abstract*—This paper presents a robust true motion estimation algorithm, designated as MPMVP (Multi-pass and Motion Vector Propagation), to enhance the accuracy of the motion vector fields in frame rate up-conversion applications. The MPMVP uses a multi-pass scheme to progressively refine approximate motion vectors to true motion vectors based upon the motion information acquired in previous passes. The multi-pass motion estimation process uses a large block size to detect the motion vectors within the objects themselves and small block sizes to detect the motion vectors along the object boundaries. Actually, the block size is progressively reduced during the search process. When the motion vector of a block is considered to be sufficiently accurate for motion estimation purposes, the block is said to be converged and the local motion vector search process terminates. A novel technique, referred to as motion vector propagation, is then applied to propagate the motion vector of the converged block to its neighboring blocks. This technique not only ensures that neighboring motion vectors within the same object have a high degree of spatial correlation, but also accelerates the convergence of the motion vectors in the neighboring blocks and therefore reduces the overall computational time and expense of the multi-pass motion vector search procedure. A novel distortion criterion is proposed to enhance the tolerance of the traditional sum-of-absolute-difference measurement technique applied in the motion estimation scheme to noise and shadow effects. The experimental results demonstrate that the proposed true motion estimation algorithm outperforms the traditional full search, 3DRS and TCSBP algorithms in terms of both the smoothness of the generated motion vector fields and the visual quality of the up-converted frames.**

***Index Terms*—Candidate motion vector, distortion criterion, frame rate up-conversion (FRUC), recursive search, true motion, variable block-size.**

I. Introduction

MODERN video formats have a wide variety of resolutions, aspect ratios, frame rates, and so forth. Typically, the frame rates of capturing devices vary between 24 and 60 Hz. However, the frame rates used by most display devices tend to range from 50 to 120 Hz, for example. Therefore, when playing back video sequences, it is necessary to interpolate some additional frames based on the original video sequence using some form of frame rate up-conversion (FRUC) algorithm. However, traditional schemes such as picture repetition, linear interpolation and other non-motion compensated methods generally produce visual artifacts such as trembling or blurring in the interpolated frames. The quality of the interpolated frames can be improved by combining the FRUC scheme with motion estimation (ME) techniques. Many complex algorithms for interpolating frames based upon the motion information of objects between successive frames have been proposed [1]–[15]. However, they tend to be highly time consuming and computationally expensive.

The ME schemes used in FRUC algorithms differ from the conventional ME techniques applied in coding standards. Generally speaking, ME algorithms used in frame rate up-conversion applications are termed "true ME" schemes in order to emphasize the importance of obtaining accurate motion vectors for all of the objects in the frame. True ME is employed not only in FRUC schemes, but also in such diverse applications as video encoding, [16], surveillance system tracking [17], de-interlacing schemes [18], error concealment in decoding systems [19], [20], and so forth. Briefly, the objective of video coding systems is to minimize the motion compensated residual. In block-matching ME algorithms, the features of moving objects are tracked using distortion criteria such as the sum of absolute difference (SAD) or the sum of square error (SSE). However, video sequences tend to contain high levels of noise, and, therefore, the motion vectors (MVs) extracted by minimal SAD/SSE-based coding systems do not always accurately reflect the true motions of the objects in the frame. In FRUC schemes, it is essential to obtain accurate motion vectors to ensure the quality of the interpolated frames, and therefore the ME algorithms used in such schemes require a robust ability to deal with the effects of noise. Unfortunately, the ME algorithms conventionally used in block-matching coding systems, e.g., full search, logarithmic search, diamond search, and so on, fail to address this requirement.

In frame rate up-conversion, the optimal image quality is obtained when the objects in the frames are interpolated along their respective motion trajectories. 3-D recursive search block matching (3DRS) [4] and temporal compensated motion estimation with simple block-based prediction (TCSBP) [2] have proposed ME algorithms based on predictive motion vectors (PMVs) to accelerate the block-matching speed and to enhance the degree of spatial correlation between neighboring blocks. In [3], the authors used an overlapped block-based motion estimation (OBME) scheme possessing enhanced ME capabil-

Manuscript received August 8, 2006; revised November 12, 2006, April 23, 2007, and October 20, 2007.

S.-C. Tai, Y.-R. Chen, and Z.-B. Huang are with the Department of Electrical Engineering, National Cheng Kung University, Tainan 701, Taiwan, R.O.C. (e-mail: cyr91d@dcmc.ee.ncku.edu.tw).

C.-C. Wang is with the Institute of Electrical Engineering, National Changhua University of Education, Changhua City 500, Taiwan, R.O.C.

Color versions of one or more figures are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/JDT.2007.916014

1551-319X/$25.00 © 2008 IEEE

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000867

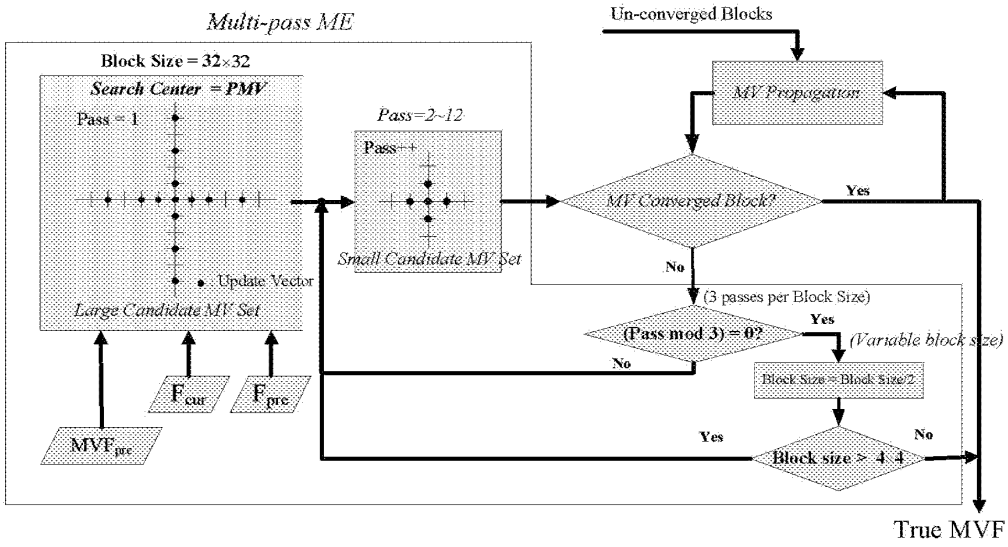


Fig. 1. Flow diagram of overall system.

ities and the ability to detect global motion through the use of a large-block matching mechanism. However, without accurate and sufficient information regarding the object shape, OBME schemes are unable to predict the motion of the object boundaries with any degree of accuracy, and therefore result in an incorrect motion aggregation in the motion vector field (MVF). A fundamental requirement of all true ME schemes is to achieve a high degree of spatial motion correlation inside a frame since all of the blocks within the same object must necessarily move in the same direction. Although several algorithms have been presented [4]–[6], [13] which employ some form of penalty function to enhance motion correlation, they are incapable of resolving the problem of incorrect motion propagation. In [10], [11], the MVs were established using hierarchical block-matching algorithms and were then propagated between hierarchical levels based on the regions of the objects. However, obtaining the regions of the objects requires a time-consuming segmentation process and the accuracy of the segmentation results cannot be guaranteed. In [14], a variable block size technique was used to enhance the ME accuracy. In this approach, the MVs were initially found for small blocks and were then used as the criteria for merging neighboring blocks. Having merged neighboring blocks, the MV search procedure was then repeated. However, this method is not only computationally expensive, but also achieves only limited success since small blocks cannot provide sufficient information regarding the global characteristics of an object and thus the reliability of the merging process cannot be ensured.

Accordingly, this paper presents a robust true ME scheme for FRUC applications. The remainder of this paper is organized as follows. Section II presents an overview of the major components of the proposed scheme, including the multiple-pass, the MV convergence decision technique, the MV convergence propagation scheme, and the distortion criterion used to suppress the effects of noise and shadow in the interpolated frames. Section III presents the experimental results obtained by the proposed true ME scheme for the MVFs of several well-known video test sequences, and compares the performance of the proposed scheme with that of the full search, 3DRS and TCSBP schemes when applied to frame rate up-conversion applications. Finally, Section IV presents some brief conclusions.

II. Multi-Pass Motion Estimation Strategy and MV Propagation Rule for True Motion Estimation

The proposed ME scheme searches for the true MVs using a multi-pass strategy in which the block size is progressively reduced from 32×32 to 4×4. After each pass, a convergence decision rule is applied to determine whether or not the MV identified for the block is sufficiently accurate. If the MV has acceptable accuracy, the block is said to be converged and the local MV search procedure is terminated. As indicated above, the largest block size used in the multi-pass ME scheme is 32×32. When an object is bigger than this block size, a technique referred to as MV propagation can be applied to spread the MV of the converged block to all of the blocks within the object. Fig. 1 presents an overall view of the multi-pass MV search procedure and associated MV propagation routine.

A. Multi-Pass Motion Estimation Strategy

The basic principle of the multi-pass ME strategy proposed in this study is to utilize the motion information relating to neighboring blocks generated in the previous pass to gradually refine the accuracy of the MV in the current block. The multi-pass search scheme executes a maximum of 12 passes. In the first three passes, the MV search is performed using a block size of 32×32. However, in the next three passes, the block size is reduced to 16×16, while in the final two sets of three passes, the block size is further reduced to 8×8 and 4 × 4, respectively. The MV for block $\vec{X}$ found in frame t in the ith pass is defined as $\overrightarrow{MV}^i(\vec{X}, t)$. The MV search in block $\vec{X}$ in the i th pass is performed in accordance with (1). As shown, the search is confined to the vectors $\vec{V}$ defined in the candidate vector set $CS^i(\vec{X}, t)$, i.e., a full search is not performed. As discussed later, the term

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000868

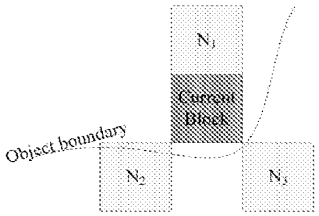


Fig. 2. Geometric relation between motion edge and block position.

¶ 1 $e(\vec{V}, \vec{X}, t)$ in (1) is a new distortion criterion based upon the conventional SAD distortion criterion.

$$\overrightarrow{MV}^{i}(\vec{X}, t) = \arg \min_{\vec{V} \in CS^{i}(\vec{X}, t)} (e(\vec{V}, \vec{X}, t)), \qquad 1 \le i \le 12. \tag{1}$$

¶ 2 The candidate vector set $CS^{i}(\vec{X}, t)$ is comprised by a single PMV and a set of update vectors. Let $\vec{X}$ represent the block location and let t be the frame number. The candidate vector set for this particular block in the ith pass are then defined as

$$CS^{i}(\vec{X}, t) = \left\{ \vec{V} \,|\, \vec{V} = \overrightarrow{\text{PMV}}^{i}(\vec{X}) + \vec{\text{U}}, \vec{\text{U}} \in US^{i} \right\} \tag{2}$$

where $\overrightarrow{\text{PMV}}^{i}(\vec{X})$ is the PMV of block $\vec{X}$ and is chosen from the MVs of the neighboring blocks and US^{i} is a set of update vectors. Every motion vector $\vec{V}$ in the candidate vector set is comprised by a single PMV and a update vector $\vec{U}$ selected from update vector set US^{i}.

¶ 3 *1) PMV:* Although the MVs of all eight neighboring blocks can theoretically be used as PMV predictors for the current block, evaluating each of these predictors in order to establish the most suitable PMV among them is computationally expensive and time consuming. Therefore, this study uses the geometric relationship proposed in [2] describing the correlation between the current block position and the motion edge to reduce the number of PMV predictors to be evaluated. As shown in Fig. 2, at least one of the three neighboring blocks and the current block must belong to the same object no matter where the object boundary crosses, and, therefore, the number of PMV

¶ 4 predictors which must be considered can be reduced from 8 to just 3. The scheme presented in [2] involved a single ME pass, and therefore employed a single PMV predictor pattern. However, as described above, the current search scheme executes a maximum of 12 passes. In general, different PMV predictor patterns may result in different levels of accuracy. Therefore, the current multi-pass ME scheme considers 12 different PMV predictor patterns, as shown in Fig. 3.

Each pass in the proposed ME scheme is performed using one of the PMV predictor patterns (see Fig. 3) and then one MV in the selected PMV pattern which has minimal distortion is

¶ 5 selected as the final PMV of this pass. In traditional single-pass ME algorithms, the current block has no information regarding the motion of the succeeding blocks because their MVs are not obtained yet. However, in multi-pass ME algorithms, the motion information of all blocks in current pass can be referred in future passes.

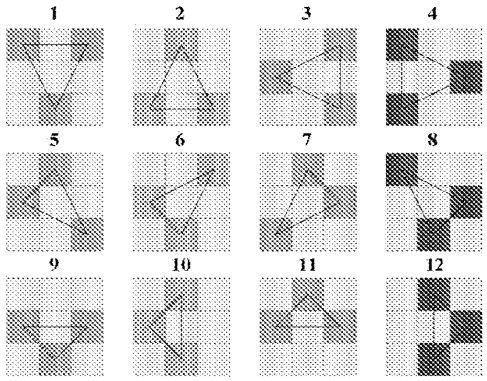


Fig. 3. PMV predictor patterns.

2) Update Vector Set: In (2), the term US^{i} represents the set of update vectors in the ith pass and has the form

$$US^{i} = \begin{cases} US_{\text{large}}, & i = 1 \\ US_{\text{small}}, & 2 \le i \le 12 \end{cases}$$

$$US_{\text{small}} = \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \pm 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ \pm 1 \end{pmatrix} \right\}$$

$$US_{\text{large}} = US_{\text{small}} \cup \left\{ \begin{pmatrix} \pm 2 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ \pm 3 \end{pmatrix}, \begin{pmatrix} \pm 4 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ \pm 5 \end{pmatrix} \right\}. \tag{3}$$

The update vector sets employed in the proposed algorithm vary between different passes. The proposed scheme uses a large update vector set (i.e., a greater number of larger MVs) in the initial passes when employing a large block size to detect coarse motions in the frame. When the update vectors have a large range, e.g., ±(5,5), finding good approximations to the true MVs in blocks which cross object boundaries is straightforward. Furthermore, in the first pass, the motion information of neighboring blocks is simply copied from the previous frame and therefore there is no guarantee that this information is reliable. As a result, the PMV obtained for the block is not necessarily an accurate representation of the true MV. However, using a large update vector set increases the probability of obtaining a good approximation to the true MV. In later passes of the search procedure, a highly precise PMV with a small update vector set (i.e., fewer and smaller vectors) is used to refine these initial non-true motion estimates into true motion estimates.

As indicated earlier, the term $e(\vec{V}, \vec{X}, t)$ in (1) is a new distortion criterion based on the conventional SAD distortion criterion and has the form

$$e(\vec{V}, \vec{X}, t) = \sum_{i,j \in \text{block}} \text{weightAD}(\vec{V}, \overrightarrow{X_{ij}}, t)/\text{blocksize}$$

$$\text{AD}(\vec{V}, \overrightarrow{X_{ij}}, t) = \text{abs}(I(\overrightarrow{X_{ij}}, t) - I(\overrightarrow{X_{ij}} + \vec{V}, t - T))$$

$$\text{weight} = \begin{cases} 0, & \text{AD}(\vec{V}, \overrightarrow{X_{\text{ij}}}, t) < 5 \\ 1, & 5 \le \text{AD}(\vec{V}, \overrightarrow{X_{\text{ij}}}, t) < 30 \\ 2, & \text{otherwise} \end{cases} \tag{4}$$

where $I(\vec{X}_{\text{ij}}, t)$ is the gray level of a pixel located at coordinates (i,j) in block $\vec{X}$ of frame t and abs indicates absolute value. According to Weber's law, human eyes have a noise threshold

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000869

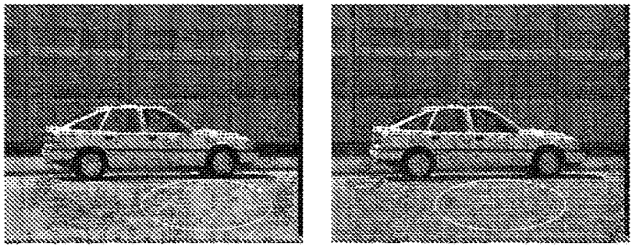


Fig. 4. MVFs of frames with Gaussian noise: (a) MVF produced by proposed algorithm with traditional SAD distortion criterion, and (b) MVF produced by proposed algorithm with new distortion criterion.

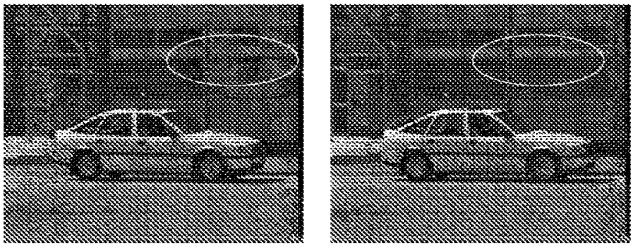


Fig. 5. Up-converted frames from VECTRA sequence. (a) MVF produced by 3DRS with penalty function. (b) MVF produced by 3DRS with proposed distortion criterion.

of approximately 5 grayscale value (for contrast) in pictures. For experience, an edge often leads to a gradient greater than 30 grayscale value. Therefore, if the absolute difference (AD) between current pixel and referred pixel in previous frame is less than 5, the human eye will ignore the distortion. However, if it is greater than 30, the distortion will be very noticeable. Hence, as shown in (4), the distortion criterion applied in the current ME search scheme has the form of a piecewise linear function. In general, noise has a particularly serious effect on the accuracy of the MV search process in smooth areas of the frame, i.e., background area. Therefore, the piecewise linear function in (4) allows small distortions (AD $<$ 5) caused by noise to be ignored while simultaneously placing more emphasis on the large distortions (AD $\geq$ 30) caused by the edges, and therefore the accuracy of the MV is enhanced.

Fig. 4 shows the MVFs obtained by the proposed ME scheme using the conventional SAD distortion criterion and the new distortion criterion given in (4), respectively, for a frame with Gaussian noise. Comparing the two frames, it is apparent that the improved noise suppression characteristics of the proposed distortion criterion yield more accurate MVs vectors in the smooth regions of the image, i.e., on the grass. Fig. 5 presents two up-converted frames from the VECTRA test sequence obtained by the 3DRS search scheme using the original penalty function and the new distortion criterion, respectively. It can be seen that the MVF produced by 3DRS using the new distortion criterion is more smooth. For example, in Fig. 5(b) more motion vectors of the window area indicate to the same direction than in Fig. 5(a). In other words, the proposed distortion criterion is applicable not only to the multi-pass scheme presented in the current study, but also to existing true ME algorithms.

B. Decision Rules for MV Converged Block

To reduce the computational complexity and expense of the proposed ME search scheme, processing within a local block terminates as soon as the block is converged, irrespective of the number of passes which have been completed. Furthermore, the degree of motion correlation among neighboring blocks is enhanced by using a MV propagation technique that will be described in Section II-C. The degree of spatial motion correlation between neighboring blocks is determined in accordance with

$$\Delta\mathrm{MV}(\overrightarrow{C},\overrightarrow{N}) = \mathrm{abs}(\mathrm{MV}(\overrightarrow{C},t).x - \mathrm{MV}(\overrightarrow{N},t).x) + \mathrm{abs}(\mathrm{MV}(\overrightarrow{C},t).y - \mathrm{MV}(\overrightarrow{N},t).y) \quad (5)$$

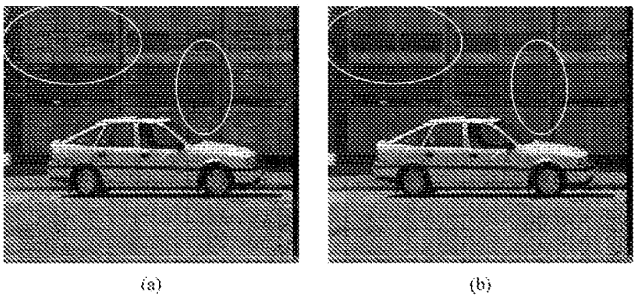


Fig. 6. (a) Proposed ME scheme without convergence propagation and (b) proposed ME scheme with convergence propagation.

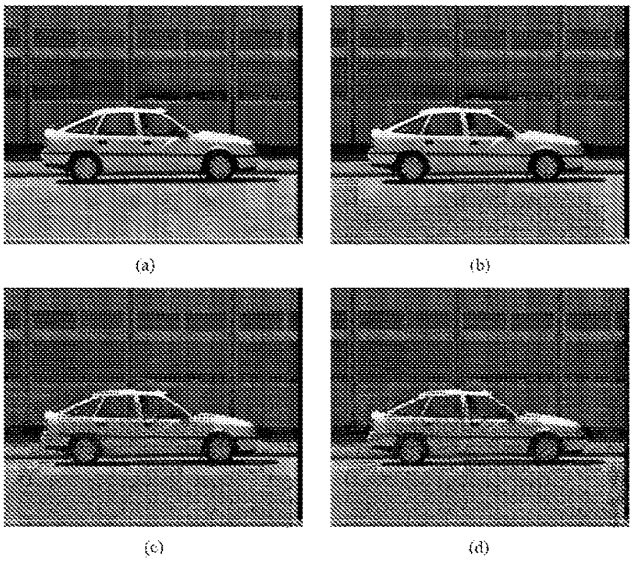


Fig. 7. Motion vectors of converged Blocks (MV is shown by block-size 4×4). (a) 3rd Pass: block size is 32 × 32, (b) 6th Pass: block size is 16×16. (c) 9th Pass: block size is 8×8. (d) 12th Pass: block size is 4×4.

where $\overrightarrow{C}$ and $\overrightarrow{N}$ are the current block and a neighboring block in spatial motion correlation test range, respectively, and x and y are the horizontal and vertical MV components. True motion is obtained when the distortion value is low, i.e., $e(\overrightarrow{C},\overrightarrow{X},t) < T_1$ and the degree of motion correlation between the current block and all of its adjacent blocks in the spatial motion correlation

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000870

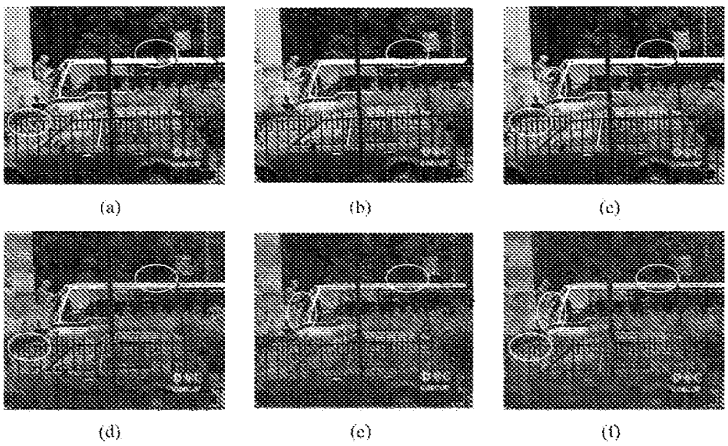


Fig. 8. (a), (d) Interpolated frame from BUS sequence and corresponding MVF obtained from 3DRS, (b), (e) Interpolated frame from BUS sequence and corresponding MVF obtained from TCSBP. (c), (f) Interpolated frame from BUS sequence and corresponding MVF obtained from proposed MPMVP algorithm.

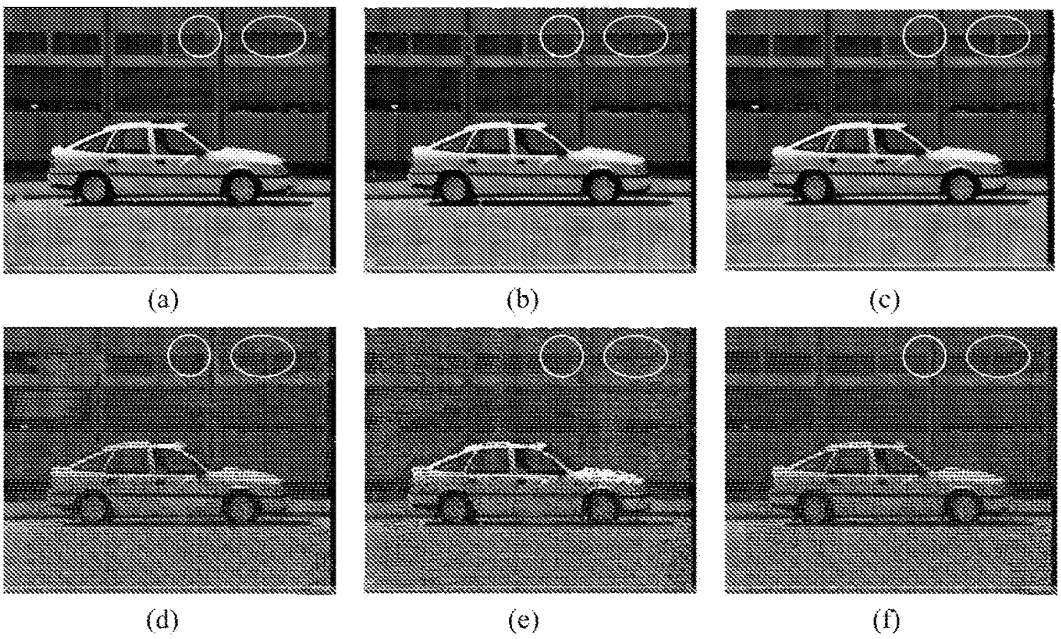


Fig. 9. (a), (d) Interpolated frame from VECTRA sequence and corresponding MVF obtained from 3DRS. (b), (e) Interpolated frame from VECTRA sequence and corresponding MVF obtained from TCSBP. (c), (f) Interpolated frame from VECTRA sequence and corresponding MVF obtained from proposed MPMVP algorithm.

test range is high, i.e., $\Delta\mathrm{MV}(\overrightarrow{C}, \overrightarrow{N}) < T_2$, where T_1 is a distortion threshold and T_2 is a threshold value designed to enable sufficient activity for the MV search to prevent the clustering of inappropriate MVs. In other words, the current scheme considers both the distortion value and the degree of motion correlation when searching for true MV. This approach differs from existing ME algorithms, which typically terminate the MV evaluation process as soon as an acceptable distortion value has been obtained.

The threshold for the distortion value T_1 in ith pass is set as $5 + i/3$ in accordance with experience. Furthermore, the spatial motion correlation test ranges used in the current algorithm are 3×3 and 5×5, respectively. Since there are three passes during specific-block-size ME, the larger test range is applied in the first two passes, while the smaller test range is used in the final pass. Meanwhile, T_2 is assigned a value of 0 for block sizes larger than 8×8 and a value of 1 for smaller blocks. Note that this threshold is deliberately assigned a stricter value for larger blocks to prevent them from converging prematurely.

C. MV Propagation Method

The MV propagation technique employed in the current scheme is designed to enhance the degree of motion correlation in large textureless regions of the frame. When a block converges, i.e., it has a high degree of spatial motion correlation and a low distortion, its MV is automatically offered to the neighboring unconverged blocks as a potential MV for their own motions. If the difference between the original distortion value of the neighboring block and the new distortion value of the block produced by accepting the propagated MV is

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000871

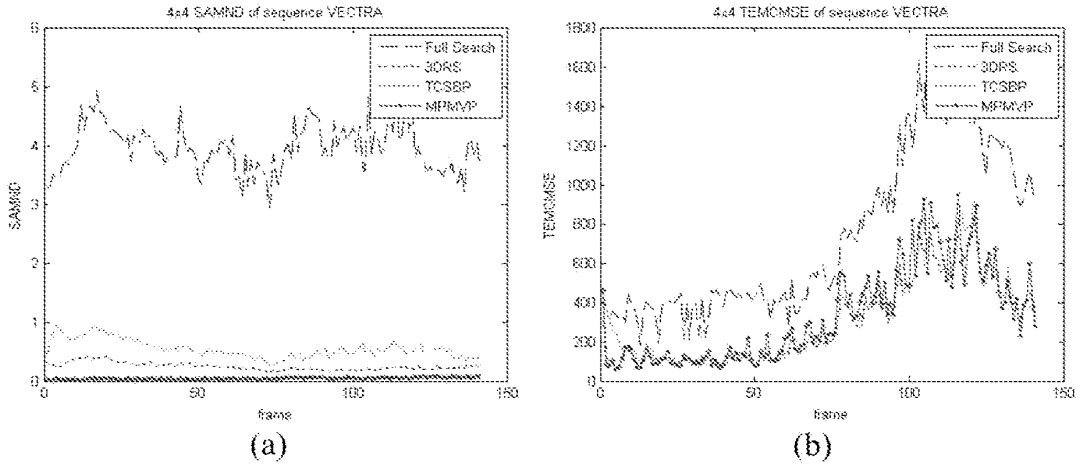


Fig. 10. SAMND and TEMC-MSE comparisons for full search (± 32), 3DRS, TCSBP and proposed algorithm. (Note results relate to VECTRA test sequence).

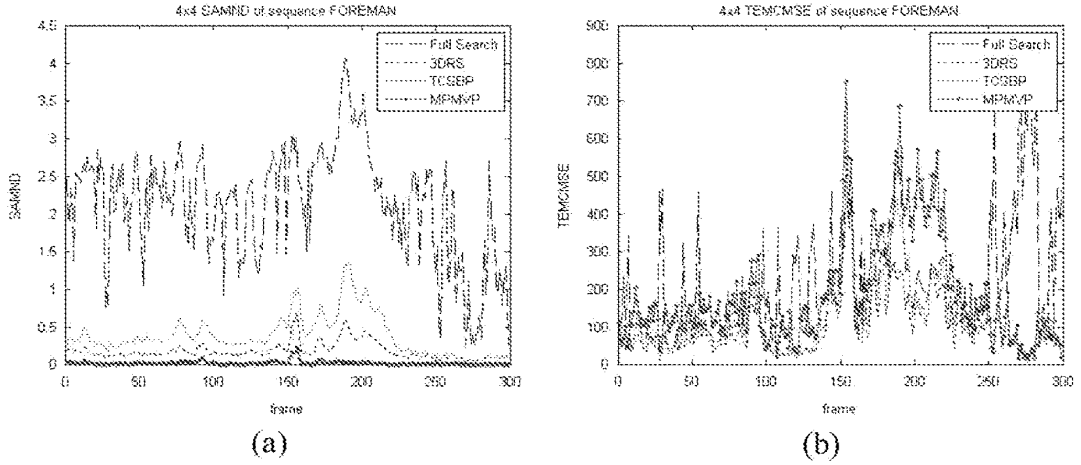


Fig. 11. SAMND and TEMC-MSE comparisons for full search (± 16), 3DRS, TCSBP and proposed algorithm. (Note results relate to FOREMAN test sequence).

sufficiently small, i.e., $15 - 2/3^{*}i$, the neighboring block accepts the propagated MV as its own MV. Having accepted the propagated MV, the block then checks to see whether or not the MV causes it to become converged. When a block has converged, irrespective of whether or not convergence is induced by the propagated MV, the same MV is propagated to the neighbors of the new converged block.

The convergence propagation technique is used to expand size of the region, which has the similar MV, into the size of object. Convergence propagation ensures that the MVs of the background regions of a frame have a high degree of spatial correlation. In other words, the background appears as a single, continuous region with no obvious areas of demarcation, even across strong edge areas, as shown in Fig. 6.

III. Experimental Results

In the figures discussed in the following, the MVFs and interpolated frames are based on a block size of 4×4. For example, a MV of block size 32×32 will be presented by 64 MVs of block size 4×4. Each MV is colored in red, originates from the center of the 4×4 block and terminates with a solid blue point. Fig. 7 presents the MVs of converged blocks obtained by the proposed ME scheme with different block sizes. The MVs of the background regions of the frame are found in the earlier passes of the ME search process performed using a larger block size. The use of a variable block size in the search procedure enables the block size of MV to gradually fit the contour of the objects in each pass and therefore the accuracy of the identified MVs is greatly enhanced. As a result, Fig. 7 demonstrates that the algorithm successfully divides the frame into two distinct objects, namely the background and the moving car.

In general, interpolated (i.e., up-converted) frames are generated using a motion compensation technique. Some uncovered regions (i.e., regions with no MVs) can be interpolated based on neighboring available pixels. Since the areas of these uncovered regions usually are small, we use spatial bilinear interpolation to interpolate uncovered regions in motion compensation step of this paper. Figs. 8 and 9 present the MVFs and corresponding interpolated frames obtained using the 3DRS [4], TCSBP [2] and proposed MPMVP ME algorithms for the BUS and VECTRA video sequences, respectively. Note that in every case, the test sequences are in a CIF format, have an original frame rate of 30 frames/s, and are up-converted to a rate of 60 frames/s. Observing these figures, it is apparent that the 3DRS and TCSBP

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000872

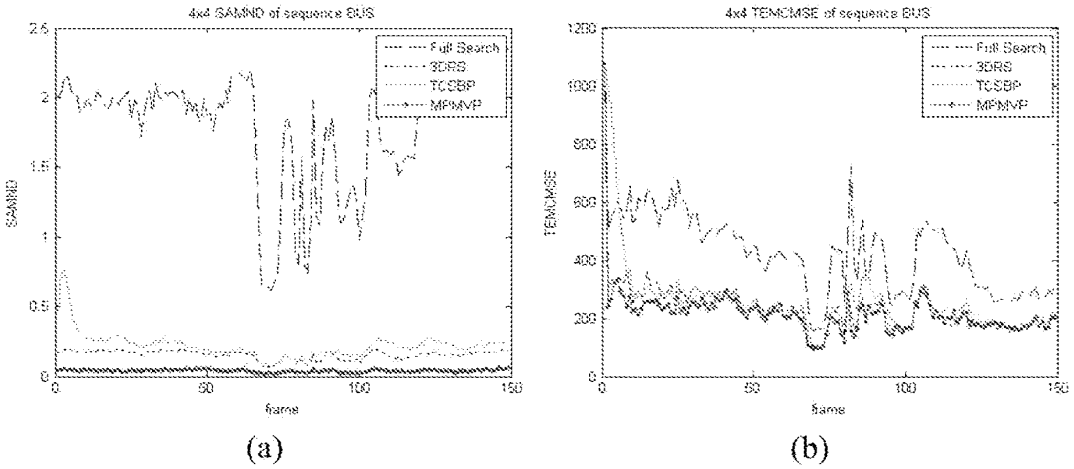


Fig. 12. SAMND and TEMC-MSE comparisons for full search (±16), 3DRS, TCSBP and proposed algorithm. (Note results relate to BUS sequence).

schemes generate incorrect MVs in the smooth, expansive background regions of the frame because they fail to propagate the MVs efficiently among neighboring blocks.

The quality of the interpolated frames produced in FRUC applications is generally assessed using subjective visual quality measure. However, in [2], the authors proposed two new evaluation criteria with which to measure the motion correlation of interpolated frames. The first criterion was the spatial consistency indicator (i.e., the sum of absolute minimum neighboring difference, designated as SAMND), while the second criterion related to the temporal continuity of the motion field between successive frames (i.e., temporal extending motion compensation mean square error, designated as TEMC-MSE). SAMND evaluates the MV differences between neighboring blocks in accordance with

$$\mathrm{SAMND} = \sum_{\vec{X} \in \mathrm{MVF}_t} \min(\mathrm{abs}(\mathrm{Vec}_{\vec{X},t} - \mathrm{Vec}_{\vec{X}+\vec{\delta},t})) \quad (6)$$

where $\vec{X}$ is the block location, *Vec* is the MV of the block, and δ is the 3×3 neighboring region. Meanwhile, the TEMC-MSE criterion measures the temporal MV ductility and focuses on the smooth regions of the frame such as the background where the MVs in the previous frame are also valid for the current frame. The TEMC-MSE criterion has the form

$$\mathrm{TEMC-MSE} = \frac{\sum_{\vec{P}} (I(\vec{P},t) - I(\vec{P} - \mathrm{Vec}_{\vec{P},t-T}, t-T))^2}{M \times N} \quad (7)$$

where

I	luminance component of a frame;
$\vec{P}$	pixel position;
$M \times N$	total number of sampling pixels in the frame;
$\mathrm{Vec}_{\vec{P},t-T}$	MV of position $\vec{P}$ at frame $t-T$, and can be estimated from the luminance fields $I(\vec{P}, t-T)$ and $I(\vec{P}, t-2T)$.

Figs. 10–12 compares the SAMND and TEMC-MSE metrics for the full search, 3DRS, TCSBP and proposed MPMVP for the VECTRA sequence (characterized by fast and complicated motions), FOREMAN sequence (characterized by low motions) and BUS sequences (characterized by complicated motions), respectively. In general, Figs. 10–12 show that the MVs generated by the proposed algorithm have the highest degree of spatial correlation of all the MVs produced by the four algorithms. However, in Fig. 11(b), the proposed algorithm has the poorest TEMC-MSE performance. The poor performance arises because the proposed distortion criterion deliberately ignores small distortion values in order to enhance the noise resistance. However, when checking the up-converted FOREMAN sequence by human eyes, it is found that the proposed algorithm generates the highest quality interpolated frames of the four algorithms. For example, Fig. 13 shows frames 154 and 155 of the original FOREMAN sequence together with the corresponding interpolated frames generated using the full search, 3DRS, TSCBP and proposed MPMVP schemes, respectively. It can be seen the visual quality of MPMVP is the best. [Note that these particular frames are deliberately chosen here because frame 154 has a high TEMC-MSE value in Fig. 11(b)]. These figures also show that the full search scheme has the poorest performance of the four algorithms in terms of both the SAMND and the TEMC-MSE metrics since it is not specifically designed to focus on motion correlation.

Although the ME scheme proposed in this study is a recursive motion search method, the convergence decision rules and MV propagation technique greatly reduce its computational time and complexity. For full search, the computation is decided by search range, i.e., for search range n, the computation is $(2n+1)^2$ ADs/pixel, where n is often set as 7, 15, 31, or even 63. For a worst-case in MPMVP, the computation is 101 ADs/pixel for MPMVP. Because in the first pass, the proposed algorithm takes the motion vector in the previous field as the PMV and then evaluates the 13 search points defined in $\mathrm{US}_{\mathrm{large}}$ [see (3)]. In the following 11 passes, the algorithm evaluates 3 PMV predictors and each of the 5 search points defined in $\mathrm{US}_{\mathrm{small}}$. Therefore, the maximal computational complexity is 13+(11*(3+5)) = 101 ADs/pixel. Bus in general cases, the actually evaluated search points are much less than 101 ADs/pixel.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000873

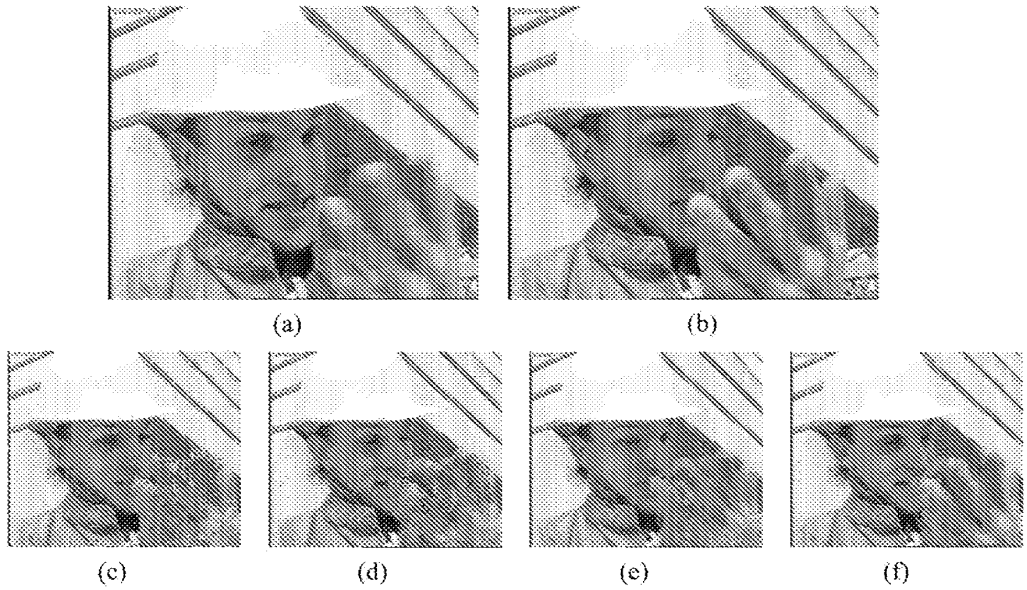


Fig. 13. (a), (b) Frames 154 and 155 in FOREMAN sequence. (c)-(f) Frames interpolated by full search, 3DRS, TCSBP and proposed algorithm, respectively.

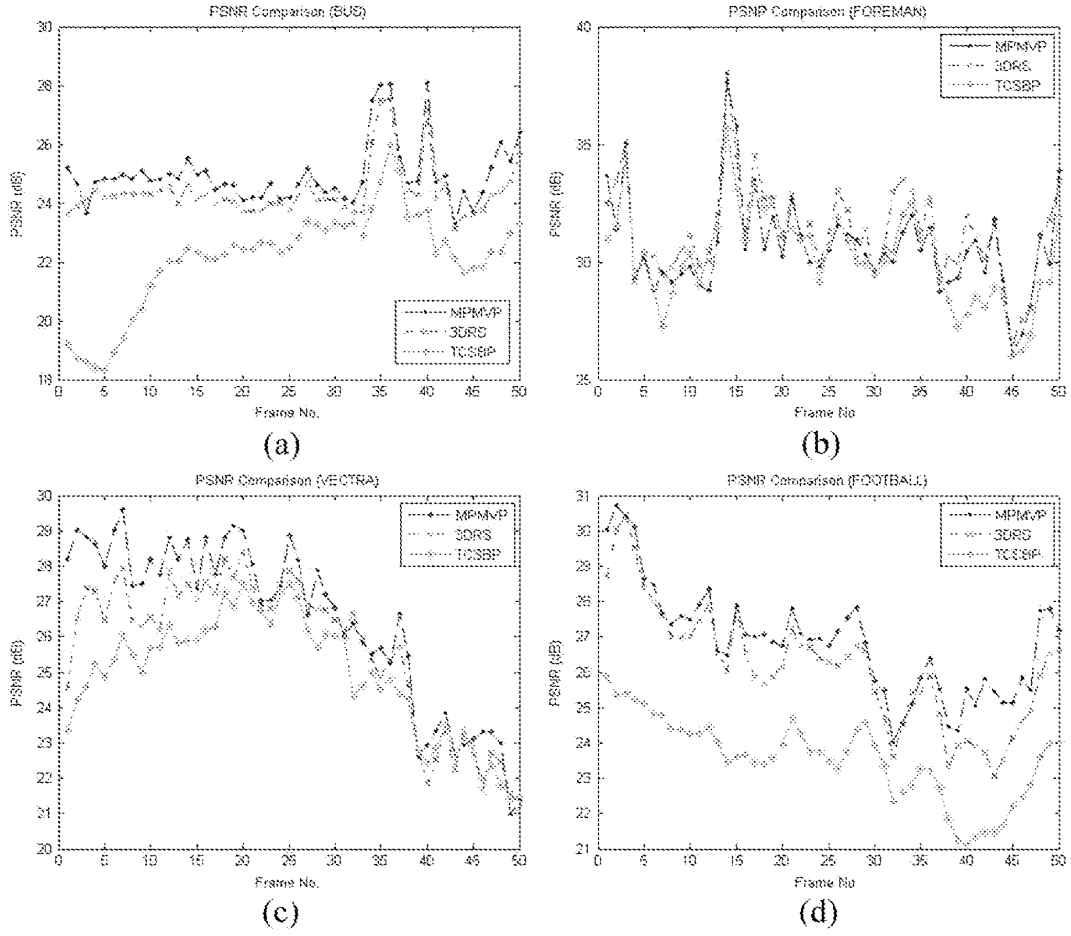


Fig. 14. PSNR comparisons on up-converted test sequences. (a) BUS. (b) FOREMAN. (c) VECTRA. (d) FOOTBALL. (a), (b), (c) are in CIF format and (d) is in de-interlaced D1 format.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000874

TABLE I
MOTION ESTIMATION TIMES SPENT IN 3DRS, TCSBP AND PROPOSED MPMVP ALGORITHM

Time (sec/frame) / Sequence	3DRS	TCSBP	MPMVP
BUS (CIF)	0.317	0.037	0.145
FOREMAN (CIF)	0.315	0.036	0.074
VECTRA (CIF)	0.305	0.038	0.116
FOOTBALL (D1)	2.186	0.264	1.143

We have tested the motion search time and PSNR performance for 3DRS, TCSBP and the proposed MPMVP scheme for three CIF format test sequences. The frame rate of these sequences are firstly down-sampled from 30 to 15 fps and then up-converted to 30 fps. We calculate the PSNR between the up-converted frames and the original frames in 30 fps sequence. The PSNR curves of the first 50 up-converted frames are shown in Fig. 14, while the corresponding motion estimation times are listed in Table I. In order to test the performance of the proposed MPMVP in larger resolution sequences, one de-interlaced D1 sequence (50 fps), FOOTBALL, is down-sampled from 50 to 25 fps and then up-converted to 50 fps. The experimental result of FOOTBALL is also shown in Fig. 14 and Table I. From those data, it can be seen that using our MPMVP scheme in frame rate up-conversion applications not only can achieve higher quality up-converted frames, but also can save significant computation.

IV. CONCLUSION

This paper has presented a new highly-accurate, low-complexity ME scheme for FRUC applications. The proposed algorithm is based upon a multi-pass, variable block-size approach and features a new noise-resistant distortion criterion to improve the quality of the interpolated frames. Furthermore, efficient MV convergence criteria and MV propagation techniques are employed to reduce the overall computational time and cost of the scheme. The experimental results have shown that the proposed ME scheme not only achieves a higher MV accuracy than existing ME schemes, but also yields significant computational savings. The quality of our true MV generated up-converted frames are better than other ME algorithm generated frames.

REFERENCES

[1] B.-T. Choi, S.-H. Lee, and S.-J. Ko, "New frame rate up-conversion using bi-directional motion estimation," *IEEE Trans. Consumer Electron.*, vol. 46, no. 3, pp. 603–609, Aug. 2000.

[2] J. Wang, D. Wang, and W. Zhang, "Temporal compensated motion estimation with simple block-based prediction," *IEEE Trans. Broadcast.*, vol. 49, no. 3, pp. 241–248, Sep. 2003.

[3] H. Taehyeun, L. Seongjoo, and K. Jaeseok, "Motion compensated frame interpolation by new block-based motion estimation algorithm," *IEEE Trans. Consumer Electron.*, vol. 50, no. 2, pp. 752–759, May 2004.

[4] G. de Haan, P. W. A. C. Biezen, H. Huijgen, and O. A. Ojo, "True-motion estimation with 3-D recursive search block matching," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 3, no. 5, pp. 368–379, Oct. 1993.

[5] R. Braspenning and G. de Haan, "True-motion estimation using feature correspondence," *SPIE, Proc. VCIP*, pp. 396–407, Jan. 2004.

[6] G. de Haan and P. W. A. C. Biezen, "An efficient true-motion estimator using candidate vectors from a parametric motion model," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 8, no. 1, pp. 85–91, Feb. 1998.

[7] A. Pelagotti and G. de Haan, "A new algorithm for high quality video format conversion," in *2001 Proc. Int. Conf. on Image Process.*, Oct. 2001, vol. 2, pp. 375–378.

[8] S.-H. Lee, Y.-C. Shin, Y. Seungjoon, H.-H. Moon, and R.-H. Park, "Adaptive motion-compensated interpolation for frame rate up-conversion," *IEEE Trans. Consumer Electron.*, vol. 48, no. 3, pp. 444–450, Aug. 2002.

[9] S.-H. Lee and S. Yang, "Adaptive motion-compensated frame rate up-conversion," *Electron. Lett.*, vol. 38, no. 10, pp. 451–452, May 2002.

[10] B.-W. Jeon, G.-I. Lee, S.-H. Lee, and R.-H. Park, "Coarse-to-fine frame interpolation for frame rate up-conversion using pyramid structure," *IEEE Trans. Consumer Electron.*, vol. 49, no. 3, pp. 499–508, Aug. 2003.

[11] D. Wang and D. Lauzon, "Hybrid algorithm for estimating true motion fields," *Opt. Eng.*, vol. 39, no. 11, pp. 2876–2881, Nov. 2000.

[12] K. Hilman, H.-W. Park, and Y.-M. Kim, "Using motion compensated frame-rate conversion for the correction of 3:2 pulldown artifacts in video sequences," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 10, no. 6, pp. 869–877, Sep. 2000.

[13] P. Ishwar and P. Moulin, "On spatial adaptation of motion-field smoothness in video coding," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 10, no. 6, pp. 980–989, Sep. 2000.

[14] S. Fujiwara and A. Taguchi, "Motion-compensated frame rate up-conversion based on block matching algorithm with multi-size blocks," in *Proc. 2005 Int. Symp. on Intell. Signal Process. Commun. Syst.*, Dec. 2005, vol. 13–16, pp. 353–356.

[15] B.-D. Choi, J.-W. Han, C.-S. Kim, and S.-J. Ko, "Frame rate up-conversion using perspective transform," *IEEE Trans. Consumer Electron.*, vol. 52, no. 3, Aug. 2006.

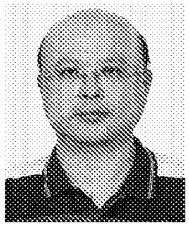
[16] O. EePing, H. Wang, and P. Xue, "Video coding based on true motion estimation," in *Proc. 2003 IEEE Int. Conf. on Acoust., Speech, and Signal Process.,*, Apr. 2003, vol. 3, no. 6–10, pp. 409–12.

[17] J. E. Santos Conde, A. Teuner, and B. J. Hosticka, "Hierarchical locally adaptive multigrid motion estimation for surveillance applications," in *Proc. 1999 IEEE Int. Conf. on Acoust., Speech, Signal Process.*, Mar. 1999, vol. 6, pp. 3365–3368.

[18] G. de Haan, "IC for motion-compensated de-interlacing, noise reduction, and picture-rate conversion," *IEEE Trans. Consumer Electron.*, vol. 45, no. 3, pp. 617–624, Aug. 1999.

[19] J.-W. Suh and Y.-S. Ho, "Error concealment technique based on optical flow," *Electron. Lett.*, vol. 38, no. 18, pp. 1020–1021, Aug. 2002.

[20] J.-Y. Pyun, J.-S. Lee, J.-W. Jeong, J.-H. Jeong, and S.-J. Ko, "Robust error concealment for visual communications in burst-packet-loss networks," *IEEE Trans. Consumer Electron.*, vol. 49, no. 4, pp. 1013–1019, Nov. 2003.



Shen-Chuan Tai received the B.S. and M.S. degrees in electrical engineering from National Taiwan University, Taipei, Taiwan, in 1982 and 1986, respectively, and received the Ph.D. degree in computer science from National Tsing Hua University, Hsinchu, Taiwan, R.O.C., in 1989.

He is currently a professor in the Department of Electrical Engineering, National Cheng Kung University, Tainan, Taiwan. His teaching and research interests include data compression, DSP, VLSI array processors, computerized electrocardiogram processing, and multimedia systems.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000875



Ying-Ru Chen received the B.S. degree in education from the Department of Information and Computer Education, National Taiwan Normal University, Taipei, Taiwan, R.O.C., in 2000, and the M.S. degree in electrical engineering from National Cheng Kung University, Tainan, Taiwan, R.O.C., in 2002, and where she is currently working toward the Ph.D. degree candidate in the Department of Electrical Engineering, National Cheng Kung University, Tainan, Taiwan, R.O.C.

Her research interests include video signal processing, data compression, multimedia systems, and digital watermarking.



Zheng-Bin Huang received the B.S. degree in electrical engineering and the B.S. degree in mechanical engineering from National Cheng Kung University, Tainan, Taiwan, R.O.C., both in 2004, and the M.S. degree in electrical engineering from the National Cheng Kung University, Tainan, Taiwan, R.O.C., in 2006.

His research interests include video compression, image processing, and fast true motion estimation algorithms.



Chuen-Ching Wang received B.S., M.S., and Ph.D. degrees in electrical engineering from the National Cheng Kung University, Taiwan, R.O.C., in 1986, 1994, and 2003, respectively.

He was a section chief at Directorate General Telecommunications in the Ministry of Transportation and Communications. He is currently an assistant professor at the institute of electrical engineering, National Changhua University of Education, Taiwan, R.O.C. His research interests include digital signal processing, image processing, computer network, mobile computing and multimedia communications.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000876

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13666680	BICI ET AL.
	Examiner	Art Unit
	CLIFFORD HILAIRE	2488

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/26/2015	02/22/2016							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	✓							
	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							
	20	✓	✓							

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000877

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from corresponding Canadian Patent Application No. 2,854,495, dated October 7, 2015	YES

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36219768v1

Submitted February 26, 2016

Office de la propriété intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An Agency of Industry Canada

RECEIVED
OCT 13 2015
SIM & McBURNEY
SIM, LOWMAN, ASHTON & McKAY LLP

7 October 2015 (07-10-2015)

SIM & MCBURNEY
6th Floor
330 University Avenue
TORONTO Ontario
M5G 1R7

Application No.	:	**2,854,495**
PCT No.	:	**FI2012051070**
Owner	:	NOKIA CORPORATION
Title	:	**METHOD FOR VIDEO CODING AND AN APPARATUS**
Classification	:	H04N 19/593 (2014.01)
Your File No.	:	**15083-3 DAR**
Examiner	:	Minghui Shi

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(*a*) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE **SIX (6)** MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the:

Description,	pages 1 - 34, as originally filed;
Claims,	1 - 22, as received on 30 September 2014 (30-09-2014) during the international phase; and
Drawings,	pages 1/13 - 13/13, as originally filed.

This application has been examined taking into account applicant's correspondence on prior art received in this office on 30 September 2014 (30-09-2014).

The number of claims in this application is 22.

Documents Cited:

D1:* Han et al., "Improved Video Compression Efficiency Through Flexible Unit Representation and Corresponding Extension of Coding Tools", *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY*, Vol. 20, No. 12, Pages 1709 - 1720, 31 December 2010 (31-12-2010)

D2:* Tai et al., "A Multi-Pass True Motion Estimation Scheme With Motion Vector Propagation for Frame Rate Up-Conversion Applications", *JOURNAL OF DISPLAY TECHNOLOGY*, Vol. 4, No. 2, Pages 188 - 197, 30 June 2009 (30-06-2009)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000879

* document cited by a foreign patent office

The examiner has identified the following defects in the application:

Obviousness

Claims 1 - 22 do not comply with section 28.3 of the *Patent Act*. These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which it pertains having regard to D1 in view of D2 and common general knowledge.

Regarding claims 1, 6, 11, 16 and 21 - 22, D1 discloses a method comprising (abstract): receiving a block of pixels including a prediction unit (fig. 1; page 1710, left col., 3rd par.);

D1 does not teach explicitly the remaining features. However, D2 discloses these features. Specifically, D2 discloses

> determining a set of spatial motion vector prediction candidates for the block of pixels, the spatial motion vector prediction candidates being provided with motion information (Page 189, right col., 3rd par.) ;
> selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates (eq. (2); Page 190, left col., 2nd par.) as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit (page 190, left col. , 3rd par.);
> determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate (eq. (1) - (2));
> comparing motion information of the first spatial motion vector prediction candidate (eq. (1)) with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates (fig. 3; page 150, left col. 5th par.);
> if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list (page 150, left col. 5th par.).

It would have been obvious to a person skilled in the art to combine the teachings of D1 and D2 to reduce the number of PMV predictors to be evaluated.

Claims 2 - 5, 7 - 10, 12 - 15 and 17 - 20 do not introduce any additional features which patentably distinguish over D1 and D2 in light of the common general knowledge in the art.

Claims

Claims 4, 9, 14 and 19 are indefinite and do not comply with subsection 27(4) of the *Patent Act*. The term "the maximum number" (claims 4, 9, 14 and 19, the first limitation) has no antecedent.

Claims 1, 6, 11, 16 and 21 - 22 are indefinite and do not comply with subsection 27(4) of the *Patent Act*. The term "the determined subset of spatial motion vector prediction candidates" (claims 1, 6, 11, 16 and 21 - 22, the next to last limitation) has no antecedent.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000880

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

Minghui Shi
Patent Examiner
819-997-7623

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, Leah Smith, can be reached at 819-639-9981.

2854495A_MSH.docm

The Examination Search Report is provided for reference only and is not part of any requisition made by the examiner in accordance with the *Patent Act* or *Rules*. The applicant is not required to respond to the information contained in the Examination Search Report.

Examination Search Report

Box I: General Information

Application No.	2,854,495	Search Report Date	28-09-2015
Title	METHOD FOR VIDEO CODING AND AN APPARATUS		
Examiner	Minghui Shi	Search Conducted?	Yes

Box II: Family Prosecution

Family Member	File Wrapper Reviewed	Status of Prosecution
WO2013064749A1	28-09-2015	Completed
US2013114723A1	28-09-2015	In Progress
EP2774375A1	28-09-2015	Not Started

Box III: Prior Art Submissions

Type of submissions	Reviewed?

Box IV: Search History

Claims Searched	1 - 22	Date of Search	28-09-2015

Type of Search Conducted (select all that apply):

Canadian first to file search	■	Supplemental/top up search	☐
Inventor/applicant search	☐	Non laid open search	☐
Comprehensive search	☐	In-house searcher	☐

Search History from Databases Consulted:

```
###### CANADIAN PATENT DATABASE ##########

2. (((filing-date <= 2012-11-02 <AND> filing-date > 1000-01-01) <OR> (issue-date <=
2012-11-02 <AND> issue-date > 1000-01-01) <OR> (priority-date <= 2012-11-02 <AND>
priority-date > 1000-01-01)) <AND> (filing-date > 2007-11-02)) <and> ((H04N 19/593 <IN>
ipc) <OR> (H04N 19/14 <IN> ipc) <OR> (H04N 19/176 <IN> ipc) <OR> (H04N 19/52 <IN> ipc) <OR>
(G06T 9/00 <IN> ipc)) <AND> (spatial motion vector <NEAR/10> predict*)

16

  1. (((filing-date <= 2012-11-02 <AND> filing-date > 1000-01-01) <OR> (issue-date <=
2012-11-02 <AND> issue-date > 1000-01-01) <OR> (priority-date <= 2012-11-02 <AND>
```

priority-date > 1000-01-01)) <AND> (filing-date > 2007-11-02)) <and> ((H04N 19/593 <IN> ipc) <OR> (H04N 19/14 <IN> ipc) <OR> (H04N 19/176 <IN> ipc) <OR> (H04N 19/52 <IN> ipc) <OR> (G06T 9/00 <IN> ipc))

503

Version 8

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	25031319
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	26-FEB-2016
Filing Date:	01-NOV-2012
Time Stamp:	11:49:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	26404
Deposit Account	160605
Authorized User	ALSTON & BIRD, LLP
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264-IDS.pdf	245878 2fa85713aac87f68cb81de29abc00477ff8dd822	yes	3
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	3	
Warnings:					
Information:					
2	Non Patent Literature	467264-CA_Office_Action.PDF	233204 44e03b31166c821c910d3f6d66754c488ed6830c	no	6
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30676 a906aa9e86a6b7f17f9d46c5e856cae7c1ba1bf1	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	509758		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Acknowledgement Receipt

EFS ID:	25031319
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	26-FEB-2016
Filing Date:	01-NOV-2012
Time Stamp:	11:49:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	26404
Deposit Account	160605
Authorized User	ALSTON & BIRD, LLP
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264-IDS.pdf	245878 2fa85713aac87f68cb81de29abc00477ff8dd822	yes	3
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	3	
Warnings:					
Information:					
2	Non Patent Literature	467264-CA_Office_Action.PDF	233204 44e03b31166c821c910d3f6d66754c488ed6830c	no	6
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30676 a906aa9e86a6b7f17f9d46c5e856cae7c1ba1bf1	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	509758		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Mehmet Oguz Bici	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	11/01/2012	Examiner:	Clifford Hilaire
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(c)

Attached is a list of documents on form PTO-1449 along with a copy of any cited foreign patent documents and non-patent literature document in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

It is requested that the Examiner consider these documents and officially make them of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. § 1.97(c), before final Office Action or Allowance, whichever is earlier.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza

101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Mar 01, 2016 05:26:06 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	CTFR	03/01/2016	042933/467264
	892	03/01/2016	042933/467264
	1449	03/01/2016	042933/467264
	1449	03/01/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

Substitute for form SB08 (Revised 07/09)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/666,680
				Filing Date	November 1, 2012
				First Named Inventor	Bici et al.
				Art Unit	2488
				Examiner Name	Clifford Hilaire
Sheet	*1*	of	*1*	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Extended European Search Report for corresponding European Application No. 12845839.5 dated March 21, 2016, 10 pages	
	2	**Nakamura, H. et al.**, *Unification of derivation process for merge mode and MVP*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting; Torino, IT, 14-22 July, 2011; Document JCTVC-F419; URL: http://wftp3.itu.int/AV-ARCH/JCTVC-SITE/2011_07_F_Torino/, 10 pages	
	3	**Zheng, Y. et al.**, *Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting, Torino, IT, 14-22 July, 2011; Document JCTVC-F302, 6 pages	
	4	**Bross, B. et al.**, *Core Experiment 9: MV Coding and Skip/Merge Operations*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting, Torino, IT, 14-22 July, 2011; Document JCTVC-F909, 13 pages	
	5	**Jeon, Y. et al.**, *On MVP list pruning process*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting, Torino, IT, 14-22 July, 2011, Document JCTVC-F105, 7 pages	
	6	**Bici, O. et al.**, *Non-CE13: Simplification of merge mode*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 7th Meeting: Geneva, CH, 21-30 November, 2011, Document JCTVC-G593; URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, 13 pages	

Examiner Signature		Date Considered	

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. LEGAL02/32811780v3

Submitted April 25, 2016

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?
Contact Customer Services at www.epo.org/contact

Nokia Corporation
Intellectual Property Department
Karakaari 7
02610 Espoo
FINLANDE

Date
21.03.16

Reference	Application No./Patent No.
NC77198EP	12845839.5 - 1905 / 2774375 PCT/FI2012051070
Applicant/Proprietor	
Nokia Technologies Oy	

Communication

The extended European search report is enclosed.

The extended European search report includes, pursuant to Rule 62 EPC, the supplementary European search report (Art. 153(7) EPC) and the European search opinion.

Copies of documents cited in the European search report are attached.

☑ 0 additional set(s) of copies of such documents is (are) enclosed as well.

Refund of the search fee
If applicable under Article 9 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.

Should you wish to further prosecute this application in the examination phase, your attention is drawn to the provisions of Rule 70a EPC. An invitation to respond to the extended European search report will be issued shortly (R. 70(2) EPC).

Europäisches Patentamt • European Patent Office • Office européen des brevets

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000897

The examination is being carried out on the **following application documents**

Description, Pages

1-34 as published

Claims, Numbers

1-18 filed with entry into the regional phase before the EPO

Drawings, Sheets

1/13-13/13 as published

Reference is made to the following documents; the numbering will be adhered to in the rest of the procedure.

D1 NAKAMURA H ET AL: "Unification of derivation process for merge mode and MVP", 6. JCT-VC MEETING; 97. MPEG MEETING; 14-7-2011 - 22-7-2011; TORINO; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, no. JCTVC-F419, 1 July 2011 (2011-07-01), XP030009442

D2 WIEGAND T ET AL: "WD3: Working Draft 3 of High-Efficiency Video Coding", 5. JCT-VC MEETING; 96. MPEG MEETING; 16-3-2011 - 23-3-2011; GENEVA; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, INTERNET ENGINEERING TASK FORCE, IETF, CH, no. JCTVC-E603, 29 March 2011 (2011-03-29), XP030009014, ISSN: 0000-0003

D3 ZHENG Y ET AL: "Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode", 97. MPEG MEETING; 18-7-2011 - 22-7-2011; TORINO; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11), no. m20723, 17 July 2011 (2011-07-17), XP030049286

D4 BROSS B ET AL: "Description of Core Experiment 9: MV Coding and Skip/Merge Operations", 6. JCT-VC MEETING; 97. MPEG MEETING; 14-7-2011 - 22-7-2011; TORINO; (JOINT COLLABORATIVE TEAM ON

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000898

VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, no. JCTVC-F909, 22 July 2011 (2011-07-22), XP030009810

D5 JEON Y ET AL: "On MVP list pruning process", 6. JCT-VC MEETING; 97. MPEG MEETING; 14-7-2011 - 22-7-2011; TORINO; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/ WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/ JCTVC-SITE/, no. JCTVC-F105, 1 July 2011 (2011-07-01), XP030009128

1 The application does not meet the requirements of Article 84 EPC.

1.1 Claims 1, 9 and 15-18 do not meet the requirements of Article 84 EPC in that the matter for which protection is sought is not defined. By defining "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit" and "determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate" without specifying how this is actually achieved, the claims attempt to define the subject-matter in terms of the result to be achieved. Such a definition is only allowable under the conditions elaborated in the Guidelines F-IV, 4.10. In this instance, however, such a formulation is not allowable because it appears possible to define the subject-matter in more concrete terms, viz. in terms of how the effect is to be achieved.

1.2 Claims 6 and 13 refer to "the potential spatial motion vector prediction candidate on the left side [...]", "the potential spatial motion vector prediction candidate above [...]", "the potential spatial motion vector prediction candidate, which is on the right side [...]", "the potential spatial motion vector prediction candidate, which is below [...]" and "the potential spatial motion vector prediction candidate cornerwise neighbouring" the prediction unit. Since no definition of these potential spatial motion vector prediction candidates has been previously provided, these terms used in claims 6 and 13 are vague and unclear and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject-matter of said claims unclear (Article 84 EPC).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000899

1.3 The term "essentially similar motion" used in claims 6 and 13 is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear (Article 84 EPC; see also Guidelines F-IV, 4.7).

2 Document D1 explicitly refers to document D2 (see reference [1] of D1). The teaching of D2 is therefore regarded as incorporated into document D1 (see Guidelines, G-IV, 8).

3 The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claims 1, 9 and 15-18 is not new within the meaning of Article 54(1) and (2) EPC.

3.1 A method comprising:
receiving a block of pixels including a prediction unit;
determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;
selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit;
determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate (D1: abstract, section 2.2.1, fig. 1(a) and 2(b));
comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates;
if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list (D1: fig. 1(a); see also D2: sections 8.4.2.1.3 and 8.4.2.1.3; see also section 2 of this communication).

The subject-matter of claim 1 is therefore not new (Article 54(1) and (2) EPC).

3.2 The same reasoning and objection with respect to novelty as raised against claim 1 in section 3.1 of this communication also apply, mutatis mutandis, to claims 15 and 17, since their subject-matter corresponds to the subject-matter

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000900

of claim 1.
The subject-matter of claims 15 and 17 is therefore not new (Article 54(1) and (2) EPC).

3.3 Claims 9, 16 and 18 address a decoding method, apparatus and computer-readable medium that correspond to the encoding method, apparatus and computer-readable medium of claims 1, 15 and 17, respectively. The same reasoning and objection with respect to novelty as raised against claims 1, 15 and 17 in sections 3.1 and 3.2 of this communication therefore also apply, mutatis mutandis, to claims 9, 16 and 18.
The subject-matter of claims 9, 16 and 18 is therefore not new (Article 54(1) and (2) EPC).

4 Dependent claims 1-8 and 10-14 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the EPC with respect to novelty (Article 54(1) and (2) EPC) and/or inventive step (Article 56 EPC).

4.1 Claim 2 (lack of novelty, Article 54(1) and (2) EPC):
D1: section 2, table 4, 4th row.

4.2 Claims 3 and 10 (lack of novelty, Article 54(1) and (2) EPC):
D1: section 2, table 2, last row.

4.3 Claims 4 and 11 (lack of novelty, Article 54(1) and (2) EPC):
D2: section 8.4.2.1.4 (see also D3: section 1, fig. 1, which provides a summary the procedure of HM3.0 in case of 2NxN, Nx2N PU mode ("According to the current HM3.0, motion information of the candidate that's located inside the left or upper neighboring PU is always not to be used [...].")); see also section 2 of this communication.

4.4 Claims 5 and 12 (lack of novelty, Article 54(1) and (2) EPC):
D1: section 2.

4.5 Claims 6 and 13 (lack of inventive step, Article 56 EPC):
D1 (with D2 incorporated; see also D3: section 1, fig. 1 which provides a summary the procedure of HM3.0 in case of 2NxN, Nx2N PU mode ("According to the current HM3.0, motion information of the candidate that's located inside the left or upper neighboring PU is always not to be used. Any other candidate that shares the same motion information with that candidate is also not to be used."); see also section 2 of this communication) in combination with D4: section 2.2; see also document D5 of which D4 provides a summary in section 2.2).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000901

The selection conditions for "the potential spatial motion vector prediction candidate on the left side of the prediction unit" and "the potential spatial motion vector prediction candidate above the prediction unit" are anticipated by D1 (with D2 incorporated) in combination with D4 (see also section 1.3 of this communication).
It is further unclear what advantage is achieved by the particular sequence of comparisons defined in claims 6 and 13 that are performed for "the potential spatial motion vector prediction candidate, which is on the right side of the prediction unit", "the potential spatial motion vector prediction candidate, which is below the prediction unit" and "the potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit". This particular sequence of comparisons therefore appears to be merely one of several straightforward possibilities which the skilled person would select, depending on the circumstances, in order to derive a subset of spatial motion vector prediction candidates.
The subject-matter of claims 6 and 13 therefore cannot be considered to involve an inventive step within the meaning of Article 56 EPC.

4.6 Claim 7 (lack of novelty, Article 54(1) and (2) EPC):
D1: section 2.

4.7 Claims 8 and 14 (lack of novelty, Article 54(1) and (2) EPC):
D2: section 8.4.2.1.3; see also section 2 of this communication.

5 It is not at present apparent which part of the application could serve as a basis for a new, allowable claim.

5.1 Should the applicant nevertheless regard some particular matter as patentable, an independent claim should be filed taking account of Rule 43(1) EPC. When filing amended claims, the applicant is requested to comment on novelty and inventive step, in particular by explaining the invention as claimed in terms of problem-solution with regard to the closest prior art.

5.2 The subject-matter should be defined in terms of a single independent claim in each category followed by dependent claims introducing only additional features that are merely optional (Rule 43(2-4) EPC).

5.3 In order to facilitate the examination of the conformity of the amended application with the requirements of Article 123(2) EPC, the applicant should clearly identify the amendments made, irrespective of whether they concern amendments by addition, replacement or deletion, and indicate the passages of the application as filed on which these amendments are based.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000902

Information on Search Strategy - Pilot phase (see OJ 2015, A86)
The type of information contained in this sheet may change during the pilot for improving the usefulness of this new service.

Application Number
EP 12 84 5839

TITLE: METHOD FOR VIDEO CODING AND AN APPARATUS

APPLICANT: Nokia Technologies Oy

IPC CLASSIFICATION: H04N19/52

EXAMINER: Mayer, Claudia

CONSULTED DATABASES: DOSYS, EPODOC, INET, NPL, XPI3E, XPVIDEO, WPI

CLASSIFICATION SYMBOLS DEFINING EXTENT OF THE SEARCH:

IPC:

CPC: H04N19/52

FI/F-TERMS:

KEYWORDS OR OTHER ELEMENTS FEATURING THE INVENTION:
Determining a set of spatial motion vector prediction candidates being provided with motion information; selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit; determining a subset of spatial motion vector predictions based on the location of the block associated with the first spatial motion vector prediction candidate;comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates;if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

EPO FORM P04A42

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000903

Europäisches Patentamt
European Patent Office
Office européen des brevets

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number
EP 12 84 5839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	NAKAMURA H ET AL: "Unification of derivation process for merge mode and MVP", 6. JCT-VC MEETING; 97. MPEG MEETING; 14-7-2011 - 22-7-2011; TORINO; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-F419, 1 July 2011 (2011-07-01), XP030009442,	1-5, 7-12, 14-18	INV. H04N19/52
Y	* abstract * * sections 1 and 2 * * figures 1-2 * * tables 2-4 *	6,13	
A	WIEGAND T ET AL: "WD3: Working Draft 3 of High-Efficiency Video Coding", 5. JCT-VC MEETING; 96. MPEG MEETING; 16-3-2011 - 23-3-2011; GENEVA; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, INTERNET ENGINEERING TASK FORCE, IETF, CH, no. JCTVC-E603, 29 March 2011 (2011-03-29) , XP030009014, ISSN: 0000-0003 * sections 8.4.2.1.3 and sections 8.4.2.1.4 *	1-18	

-/--

The supplementary search report has been based on the last set of claims valid and available at the start of the search.

TECHNICAL FIELDS SEARCHED (IPC)
H04N

Place of search	Date of completion of the search	Examiner
The Hague	14 March 2016	Mayer, Claudia

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

2

EPO FORM 1503 03.82 (P04C04)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000904

Europäisches Patentamt
European Patent Office
Office européen des brevets

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number
EP 12 84 5839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	ZHENG Y ET AL: "Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode", 97. MPEG MEETING; 18-7-2011 - 22-7-2011; TORINO; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m20723, 17 July 2011 (2011-07-17), XP030049286, * abstract * * sections 1 and 2 * * figures 1-2 * -----	4,6,11, 13	
Y	BROSS B ET AL: "Description of Core Experiment 9: MV Coding and Skip/Merge Operations", 6. JCT-VC MEETING; 97. MPEG MEETING; 14-7-2011 - 22-7-2011; TORINO; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-F909, 22 July 2011 (2011-07-22), XP030009810, * sections 2.2 and 2.3 * -----	6,13	TECHNICAL FIELDS SEARCHED (IPC)
A	JEON Y ET AL: "On MVP list pruning process", 6. JCT-VC MEETING; 97. MPEG MEETING; 14-7-2011 - 22-7-2011; TORINO; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-F105, 1 July 2011 (2011-07-01), XP030009128, * abstract * * sections 1 and 2 * ----- -/--	6,13	

The supplementary search report has been based on the last set of claims valid and available at the start of the search.

Place of search	Date of completion of the search	Examiner
The Hague	14 March 2016	Mayer, Claudia

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C04)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000905

Europäisches Patentamt
European Patent Office
Office européen des brevets

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number
EP 12 84 5839

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,P	BICI O ET AL: "Non-CE13: Simplification of merge mode", 7. JCT-VC MEETING; 98. MPEG MEETING; 21-11-2011 - 30-11-2011; GENEVA; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-G593, 8 November 2011 (2011-11-08), XP030110577, * abstract * * sections 1 and 2 * * figure 1 * -----	1-18	

TECHNICAL FIELDS SEARCHED (IPC)

The supplementary search report has been based on the last set of claims valid and available at the start of the search.

Place of search	Date of completion of the search	Examiner
The Hague	14 March 2016	Mayer, Claudia

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

2

EPO FORM 1503 03.82 (P04C04)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000906

Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14-22 July, 2011

Document: JCTVC-F419

Title: **Unification of derivation process for merge mode and MVP**

Status: Input Document to JCT-VC

Purpose: Proposal

Author(s) or Contact(s):

Hiroya Nakamura
Shigeru Fukushima
Masayoshi Nishitani

JVC KENWOOD Holdings, Inc.
58-7, Shinmei-cho, Yokosuka,
Kanagawa 239-8550, Japan

Tel: +81-46-836-6459
Email:
nakamura.hiroya@jk-holdings.com
fukushima.shigeru@jk-holdings.com
nishitani.masayoshi@jk-holdings.com

Source: JVC KENWOOD Holdings, Inc.

Abstract

This contribution presents simplifications of derivation process for merge mode and motion vector predictor (MVP). In this proposal, the positions of the spatial neighbors that can be used as merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP. In addition, the proposed techniques attempt unification of the derivation process for merge mode and MVP. This proposal tries to reduce the number of candidates in the spatial derivation process to reduce the number of times of comparison in the removal process.

The simulation results indicate that the proposed technique provides 0.1-0.2% BD-rate loss for random access, and 0.0-0.2% loss for low delay.

1 Introduction

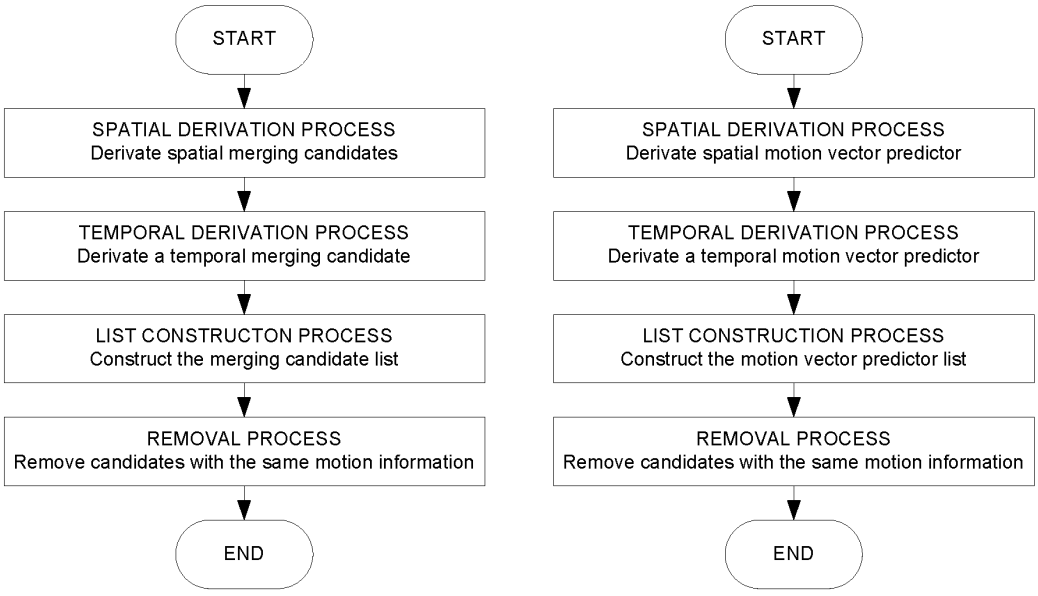
This proposal is for the improvement of derivation method of the candidates for merge mode and motion vector predictor (MVP). In this proposal, the positions of the spatial neighbors that can be used as merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP. In addition, the proposed techniques attempt unification of the derivation process for merge mode and MVP.

2 Proposed techniques

2.1 Derivation process for merge mode and MVP

Figure 1 (a) and (b) illustrate the derivation process for merge mode and motion vector predictor (MVP) in the WD3 [1].

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000907



(a) Derivation Process for merge mode (b) Derivation Process for motion vector predictor

Figure 1 Derivation Process of merge mode and MVP in WD3

2.2 Proposed techniques

The proposed techniques simplify the derivation process for merge mode and MVP.

2.2.1 Proposal 1: Proposed technique for merge mode

Changes of our proposal for merge modes from HM3.0 are as follows:

- The positions of the spatial neighbors that can be used for merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP.
- Two spatial merging candidates are derived in the spatial derivation process.
- The merging candidate list is constructed of two spatial merging candidates and a temporal merging candidate.

Figure 2 (a) and (b) illustrate the position of the spatial neighbors A, B, C, D and E relative to the current prediction unit in the HM3.0 and the proposed technique, respectively.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000908

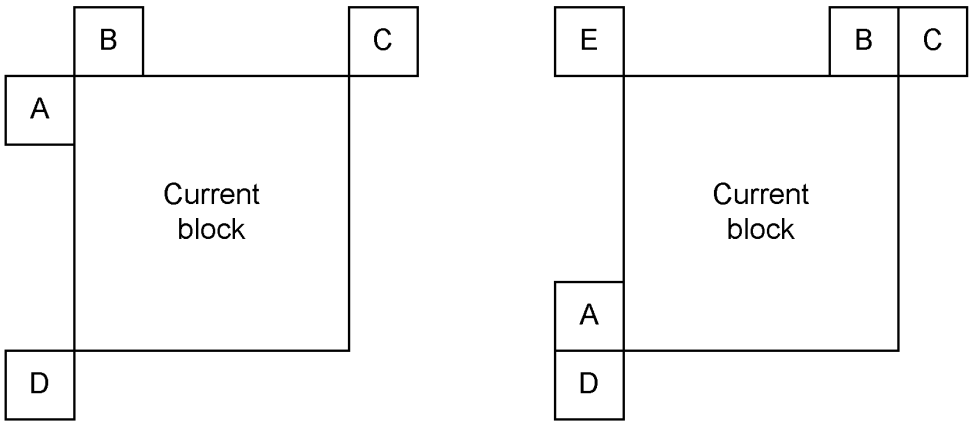


Figure 2 Spatial neighbors that can be used as merging candidates.

In this proposal, two spatial candidates and a temporal candidate are derived. The number of candidates is reduced in the spatial derivation process to reduce the number of times of comparison in the removal process. Table 1 presents the number of times of comparison in the removal process in each the number of candidates. The number of times of comparison in the removal process in HM3.0 is ten times. On the other hand, the number of times of comparison in the removal process in the proposed technique is three times.

Table 1 The number of comparison in the removal process

The number of candidates in the spatial and temporal derivation process	The number of times of comparison in the removal process	Notes
3 (=2+1)	3 [times]	Proposed technique
4 (=3+1)	6 [times]	-
5 (=4+1)	10 [times]	HM3.0
6 (=5+1)	15 [times]	-

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000909

Table 2 presents the comparison between HM3.0 and proposed technique for merge mode.

Table 2 Comparison between HM3.0 and proposed technique for merge mode

	HM3.0	Proposal 1
The number of spatial candidates	4 in 4 [positions]	2 in 5 [positions]
Spatial derivation order	A, B, C, D	A, B, C, D, E
The number of times of comparison of redundant candidates in the spatial derivation process	0 [time]	0 [time]
The number of temporal candidates	1	1
Merging candidate list order	A, B, Col, C, D	S_0, S_1, Col
The number of times of comparison in the removal process	10 [times] (A vs B, Col, C, D, B vs Col, C, D, Col vs C, D, and C vs D)	3 [times] (S_0 vs S_1, S_0 vs Col, and S_1 vs Col)

Notes:

S_0: The first spatial candidate found in the spatial derivation process

S_1: The second spatial candidate found in the spatial derivation process

2.2.2 Proposal 2: Proposed technique for motion vector predictor (MVP)

Changes of our proposal for MVP from HM3.0 are as follows:

- Two in five spatial candidates are derived without grouping of the neighbors in the spatial derivation process.
- The comparison step is not used in the spatial derivation process.

Figure 3 (a) and (b) illustrate the position of the spatial neighbors relative to the current prediction unit in HM3.0 and proposal, respectively.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000910

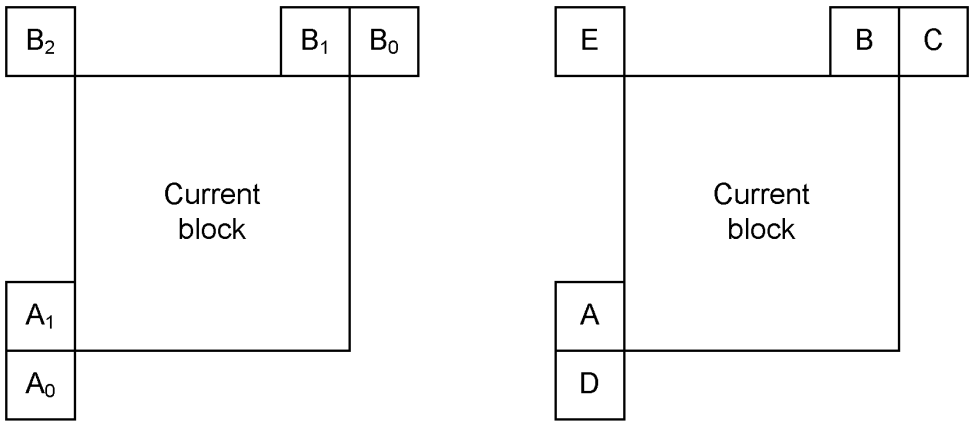


Figure 3 Spatial motion vector neighbors that can be used as MVP candidates.

In this proposal, two spatial candidates and a temporal candidate are derived. The removal process in the spatial derivation process is not applied.

Table 3presents the comparison between HM3.0 and proposed technique for merge mode.

Table 3 Comparison of HM3.0 between HM3.0 and proposed technique for MVP

	HM3.0	Proposal 2
The number of spatial candidates	2 in 5 [positions]	2 in 5 [positions]
Grouping of the neighbors in the spatial derivation process	Group A: Left (A_0, A_1) Group B: Upper (B_0, B_1, B_2)	without grouping
Spatial derivation order	Group A: A_0, A_1 Group B: B_0, B_1, B_2	C, D, A, B, E
The number of times of checking per spatial neighbors in the spatial derivation process	2 [times]	1 [time]
The number of times of comparison of redundant candidates in the spatial derivation process	6 [times] (mvLXA vs $mvLXB_0$, mvLXA vs $mvLXB_1$, and mvLXA vs $mvLXB_2$) x 2	0 [time]
The number of temporal candidates	1	1
MVP list order	mvLXA, mvLXB, mvLXCol	$mvLXS_0$, $mvLXS_1$, mvLXCol
The number of times of comparison in the removal process	2 [times] (mvLXA vs mvLXCol, and mvLXB vs mvLXCol)	3 [times] ($mvLXS_0$ vs $mvLXS_1$, $mvLXS_0$ vs mvLXCol, and $mvLXS_1$ vs mvLXCol)

Notes:

$mvLXS_0$: MVP of the first spatial candidate found in the spatial derivation process

$mvLXS_1$: MVP of the second spatial candidate found in the spatial derivation process

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000911

2.2.3 Proposal 1 and 2: Unification of derivation process for merge mode and motion vector predictor (MVP)

Table 4 presents the comparison of derivation process between merge mode and MVP in the proposal.

Table 4 Comparison of derivation process between merge mode and MVP

	Proposal 1: merge mode	Proposal2: MVP
The number of spatial candidates	2 of 5	2 of 5
Grouping in the spatial derivation process	without grouping	without grouping
Spatial derivation order	A, B, C, D, E	C, D, A, B, E
The number of times of comparison of redundant candidates in the spatial derivation process	0 [time]	0 [time]
The number of temporal candidates	1	1
Merge/MVP list order	S_0, S_1, Col	$mvLXS_0$, $mvLXS_1$, mvLXCol
The number of times of comparison in the removal process	3 [times] (S_0 vs S_1, S_0 vs Col, and S_1 vs Col)	3 [times] ($mvLXS_0$ vs $mvLXS_1$, $mvLXS_0$ vs mvLXCol, and $mvLXS_1$ vs mvLXCol)

2.3 Implementation

2.3.1 Software

This proposed technique is implemented into HM3.0 software (CE1/CE9 anchor: revision 828).

2.3.2 Syntax structure

The syntax of this proposed technique is not revised from HM3.0.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000912

3 Experiments

3.1 Test conditions

The common test conditions [2] are used.

3.2 Simulation environments

Table 5 and Table 6 show the simulation environments for encoding and decoding experiments, respectively.

Table 5 Simulation environment for encoding experiments

CPU	Intel Core i7 870 2.93GHz
Memory	16GB (DDR3)
OS	Windows 7 Professional 64bit
Compiler	Microsoft Visual C++ 2008 Express edition SP1
Executable	x64

Table 6 Simulation environment for decoding experiments

CPU	Intel Core i7 870 2.93GHz
Memory	16GB (DDR3)
OS	Windows 7 Professional 64bit
Compiler	Microsoft Visual C++ 2008 Express edition SP1
Executable	x64

Notes: The decoding time is measured with the writing of yuv file.

3.3 Simulation results

3.3.1 Simulation results only applying Proposal 1 (merge mode)

Table 7 and Table 8 report the simulation results only applying Proposal 1 for random access and low delay, respectively.

Table 7 Simulation results of Proposal 1 for random access

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1	0.1	0.1	0.2	0.1	0.0
Class B	0.1	0.0	0.0	0.2	0.1	0.1
Class C	0.0	0.2	0.2	0.2	0.1	0.2
Class D	0.1	0.1	0.0	0.1	0.0	0.0
Class E						
Overall	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	**0.1**
Enc Time[%]	99%			99%		
Dec Time[%]	101%			101%		

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000913

Table 8 Simulation results of Proposal 1 for low delay

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.1	0.3	0.0	0.3	0.0	0.2
Class C	0.1	-0.1	0.1	0.1	0.0	0.0
Class D	0.0	-0.3	0.4	0.2	0.0	-0.1
Class E	-0.1	0.4	-0.3	0.2	-0.2	0.6
Overall	**0.1**	**0.1**	**0.1**	**0.2**	**0.0**	**0.1**
Enc Time[%]	99%			99%		
Dec Time[%]	100%			99%		

The simulation results report that the proposed technique provides 0.1-0.2% loss BD-rate [3] for random access, and 0.1-0.2% loss for low delay with 99% encoder runtime and 99-101% decoder runtime. (See the attached excel sheet)

3.3.2 Simulation results only applying Proposal 2 (MVP)

Table 9 and Table 10 report the simulation results only applying Proposal 2 for random access and low delay, respectively.

Table 9 Simulation results of Proposal 2 for random access

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0	0.1	0.0	0.1	0.2	0.0
Class B	0.0	0.0	-0.1	0.0	0.0	0.0
Class C	0.0	0.0	0.1	0.1	0.0	0.0
Class D	0.1	0.1	0.0	0.0	-0.1	-0.1
Class E						
Overall	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**
Enc Time[%]	100%			100%		
Dec Time[%]	101%			101%		

Table 10 Simulation results of Proposal 2 for low delay

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0	0.1	-0.2	0.0	-0.1	0.0
Class C	0.0	0.1	0.0	0.0	-0.1	-0.2
Class D	0.0	0.0	0.5	0.0	-0.3	0.0
Class E	0.0	0.6	0.0	0.0	0.1	0.2
Overall	**0.0**	**0.1**	**0.1**	**0.0**	**-0.1**	**0.0**
Enc Time[%]	100%			99%		
Dec Time[%]	102%			101%		

The simulation results report that the proposed technique provides no loss for both random access, and for low delay with 100% encoder runtime and 100-102% decoder runtime. (See the attached excel sheet)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000914

3.3.3 Simulation results applying Proposal 1 and 2 (merge mode and MVP)

Table 11 and Table 12 report the simulation results applying Proposal 1 and 2 for random access and low delay, respectively.

Table 11 Simulation results for random access

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1	0.1	0.3	0.2	0.2	0.0
Class B	0.1	0.0	0.0	0.2	0.1	0.1
Class C	0.1	0.1	0.1	0.2	0.2	0.3
Class D	0.1	0.1	0.0	0.1	0.0	0.0
Class E						
Overall	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	**0.1**
Enc Time[%]	99%			99%		
Dec Time[%]	101%			101%		

Table 12 Simulation results for low delay

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.1	0.2	-0.2	0.3	0.1	0.1
Class C	0.1	0.1	0.0	0.2	0.1	0.0
Class D	0.0	-0.3	0.6	0.2	-0.2	0.0
Class E	0.0	0.0	-0.1	0.1	-0.3	0.3
Overall	**0.0**	**0.0**	**0.1**	**0.2**	**0.0**	**0.1**
Enc Time[%]	98%			99%		
Dec Time[%]	102%			101%		

The simulation results report that the proposed technique provides 0.1-0.2% BD-rate loss for random access, and 0.0-0.2% loss for low delay with 98-99% encoder runtime and 101-102% decoder runtime. (See the attached excel sheet)

4 Conclusions

We recommend that the proposed technique be further studied in CE activity.

5 Future Work

We would like to study in CE activity as follows:

- Each of the number of spatial candidates (2, 3, 4 and 5).
- Each of the method (the number of times) of checking in the spatial derivation process
- Comparison/no comparison of redundant candidates in the spatial derivation process
- Evaluation of this proposed technique under robustness conditions

6 References

[1] "WD3: Working Draft 3 of High-Efficiency Video Coding",
JCTVC-E603, Geneva, March 2011

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000915

[2] Frank Bossen “Common test conditions and software reference configurations”, JCTVC-E700, Geneva, March 2011

[3] G. Bjøntegaard, “Improvements of the BD-PSNR model,” ITU-T SG16 Q.6 Document, VCEG-AI11, Berlin, July 2008.

7 Patent rights declaration(s)

JVC KENWOOD Holdings, Inc. and Victor Company of Japan, Limited may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000916

Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14-22 July, 2011

Document: JCTVC-F302

Title: **Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode**

Status: Input Document to JCT-VC

Purpose: Proposal

Author(s) or Contact(s):

Yunfei Zheng
Xianglin Wang
Wei-Jung Chien
Marta Karczewicz

5775 Morehouse Dr.
San Diego, CA 92121, USA

Tel: 1-858-651-9568
Email: zhengy@qualcomm.com
xianglin@qualcomm.com
wchien@qualcomm.com
martak@qualcomm.com

Source: Qualcomm Inc.

Abstract

This contribution proposes a change to the rules currently used in determining merge candidates for a PU under 2NxN, Nx2N or NxN mode. Based on the proposal, when a current PU under these partition modes is not the first PU in a CU, the previous PU's merge index is checked to determine if motion information of the previous PU can be used as a merge candidate for the current PU. It is asserted that the proposed changes can help solve the parsing robustness issue while preserving coding efficiency.

1 Introduction

In Merge mode, neighboring motion information is borrowed and directly used for a current block. In 2NxN, Nx2N, or NxN partition mode as shown in Figure 1, potential candidate locations for deriving motion information for the second or fourth PU (marked in orange) are indicated with green blocks. According to the current HM3.0, motion information of the candidate that's located inside the left or upper neighboring PU is always not to be used. Any other candidate that shares the same motion information with that candidate is also not to be used.

More exactly, such checking is performed as follows:

> For Nx2N and 2NxN as shown in Figure 1, when coding the second PU (PU_1), motion information of each merge candidate (L, A, T, RA, and BL) will be compared with that of the first PU (PU_0). If some candidate has the same motion information as PU_0, the candidate will be set invalid and to be avoided.
>
> For NxN mode as shown in Figure 1, when coding the last PU (PU_3), motion information of each candidate (L, A, T, RA, and BL) will be compared with those of PU_1 and PU_2, to avoid forming the 2Nx2N, Nx2N or 2NxN modes which are redundant.

The reason of doing so is to avoid obtaining a merge mode which is already available under a larger size partition, such as 2Nx2N.

Motion information comparison between different candidate locations is needed during the checking process described above. However, such comparison operation may cause issues to parsing robustness. One way of solving the issue is to use all neighboring candidates without considering the possibility of

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000917

the mode being redundant relative to a merge mode under a larger partition. However, such a scheme can also cause coding performance degradation.

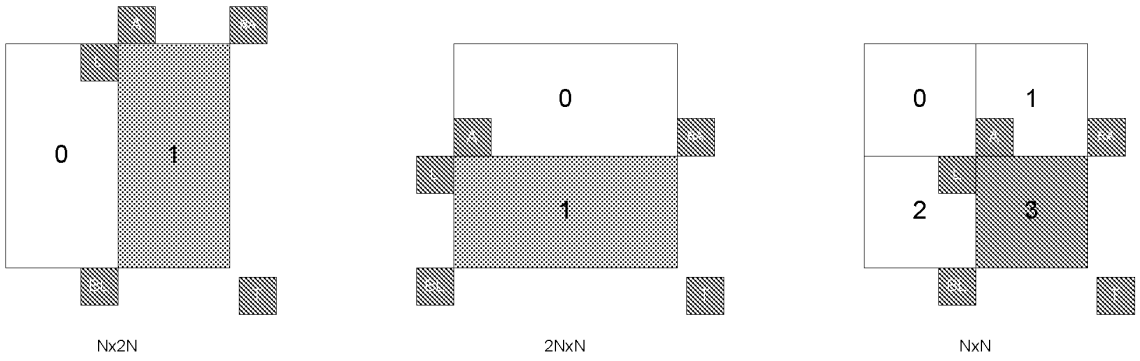


Figure 1. Merge candidate checking positions PUs

2 Proposed Method

In this contribution, for a second PU shown in Figure 1, we propose to check the merge index of the first PU to determine whether the motion information of the candidate that's located inside that first PU should be used. The checking of the first PU's merge index can be used to effectively avoid obtaining a merge mode which is already available under a larger size partition.

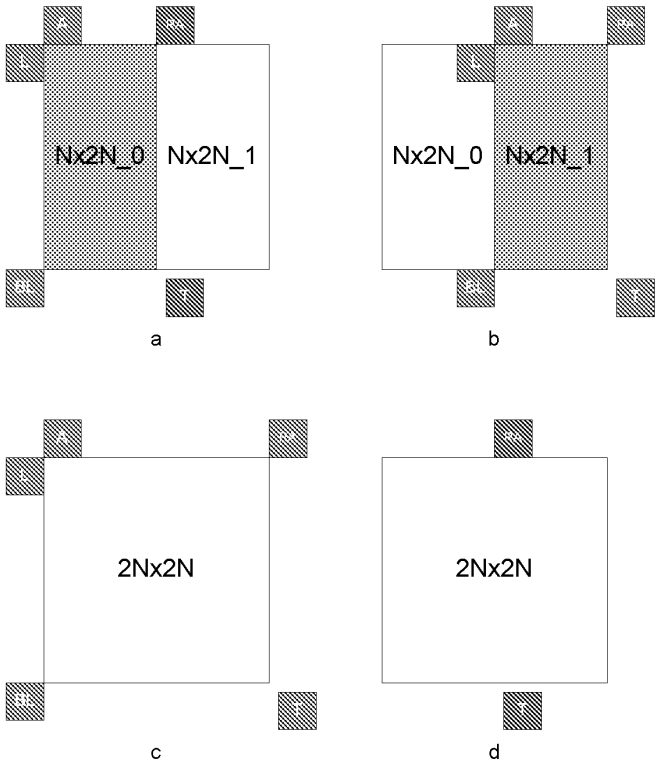


Figure 2. Example of Nx2N

Figure 2 shows an example of an Nx2N CU for illustration of the proposed method. Figure 2-a shows the Nx2N CU and the merge candidates (green or red colored blocks) of the first partition (Nx2N_0, orange colored block). Figure 2-b shows the same CU and the merge candidates (green colored blocks) of the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000918

second partition (Nx2N_1, orange colored block). According to HM3.0, candidate L of the second partition is not to be used based on the assumption that such a case should have been covered under 2Nx2N merge mode. However, when the selected merge index of the first partition is RA or T (red colored blocks), it can be seen that even if candidate L of the second partition is used, the resulted merge mode is actually different from those covered under 2Nx2N merge mode shown in Figure 2-c. Instead, the resulted merge mode derives its motion information from RA or T, as shown in Figure 2-d. Since such cases are not covered under 2Nx2N merge mode, enabling it may improve coding efficiency. The same analysis is also true for a CU with 2NxN partition.

According to this proposal, for an Nx2N CU, if the merge index of the first PU indicates candidate RA or T, the candidate L of the second PU is considered as a valid merge candidate. More exactly, the scheme can be described as follows:

For Nx2N mode, candidate L of PU_1 is checked. If merge index of PU_0 equals to T or RA, candidate L of PU_1 is valid. Otherwise, it is invalid.

For 2NxN mode, candidate A of PU_1 is checked. If merge index of PU_0 equals to T or BL, candidate A of PU_1 is valid. Otherwise, it is invalid.

Since the case under NxN mode rarely happens, for simplicity there is no change for this case.

It is mentioned above that motion comparison and pruning currently used in merge mode may incur parsing issue. One way of avoiding parsing issue is proposed in [2]. It can address the issue efficiently with coding performance well preserved. It is worth mentioning that the proposed scheme works with this solution in addressing the parsing issue.

3 Experimental Results

The proposed method is implemented in HM3.0 with bug 146 fixed (CE9 anchor) and simulated under the common test conditions [1]. **Error! Reference source not found.** summarizes the results of the proposed scheme. There is around 0.1% coding gain comparing to the anchor.

If the scheme in [2] is used in addressing the parsing issue, **Error! Reference source not found.**Table 2 summarizes results relative to anchor with and without the proposed method respectively. It can be seen that relatively there is also about 0.1~0.2% improvement with the proposed method.

There is no obvious complexity increasing at both encoder and decoder. The detailed simulation results can be found in the attached excel sheet.

Table 1. Proposed method compared to CE9 anchor

	HE			LC		
	Y	U	V	Y	U	V
RA	-0.1	-0.1	-0.1	0.0	0.0	0.1
LB	-0.1	-0.1	0.0	-0.1	-0.1	0.0

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000919

Table 2. Scheme in [2], without and with the proposed method

	JCTVC-F474 [2]						JCTVC-F474 [2]+ Proposed method					
	HE			LC			HE			LC		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
RA	0.6	0.6	0.6	0.4	0.4	0.4	0.5	0.5	0.4	0.2	0.3	0.3
LB	0.8	0.6	0.4	0.4	0.4	0.7	0.7	0.4	0.4	0.3	0.5	0.5

4 Conclusion

This proposal presents a scheme in which the merge index of a previous neighboring PU is used to determine whether the motion information of the candidate located inside that previous neighboring PU shall be used for a current PU. The proposed solution improves coding performance with little complexity overhead. It also works when parsing issue is addressed. We recommend the proposed changes to be adopted into HM.

5 Reference

[1] Frank Bossen, "Common test conditions and software reference configurations", JCTVC-E700, JCT-VC 5th Meeting: Geneva, March, 2011.

[2] Guillaume Laroche, Patrice Onno, Tangi Poirier, Christophe Gisquet (Canon), "CE9: Description of experiments ROB01 and ROB02", JCTVC-F474, JCT-VC 6th Meeting: Torino, July, 2011

6 Patent rights declaration(s)

Qualcomm may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000920

7 Proposed Draft Text

Derivation process for spatial merging candidates

Inputs to this process are

– a luma location (xP, yP) specifying the top-left luma sample of the current prediction unit relative to the top-left sample of the current picture,

– variables specifying the width and the height of the prediction unit for luma, nPSW and nPSH,

– a variable PartIdx specifying the index of the current prediction unit within the current coding unit.

Outputs of this process are (with N being replaced by A, B, C, or D and with X being replaced by 0 or 1)

– the availability flags availableFlagN of the neighbouring prediction units,

– the reference indices refIdxLXN of the neighbouring prediction units,

– the prediction list utilization flags predFlagLXN of the neighbouring prediction units,

– the motion vectors mvLXN of the neighbouring prediction units.

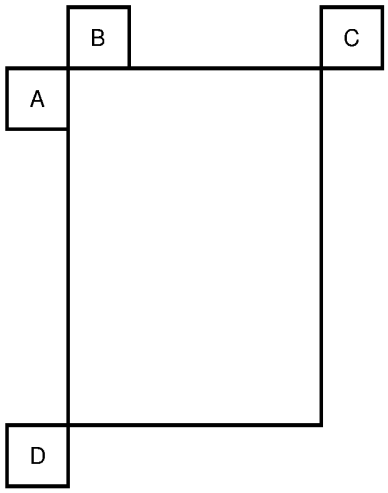


Figure 7-1 – Spatial neighbours that can be used as merging candidates (informative) illustrates the position of the spatial neighbours A, B, C and D relative to the current prediction unit.

For the derivation of availableFlagN, with N being A, B, C or D and (xN, yN) being (xP – 1, yP), (xP, yP – 1), (xP + nPSW, yP – 1) or (xP – 1, yP+nPSH) the following applies.

– If one of the following conditions is true, the availableFlagN is set equal to 0, both components mvLXN are set equal to 0, refIdxLXN and predFlagLX[xN, yN] of the prediction unit covering luma location (xN, yN) are assigned respectively to mvLXN, refIdxLXN and predFlagLXN.

  – The prediction unit covering luma location (xN, yN) is not available or PredMode is MODE_INTRA.

  – PartMode of the current prediction unit is PART_2NxN and PartIdx is equal to 1 and the prediction units covering luma location (xP, yP – 1) (PartIdx = 0) have merge_idx equals to 0, 1, or 4.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000921

- PartMode of the current prediction unit is PART_Nx2N and PartIdx is equal to 1 and the prediction units covering luma location (xP – 1, yP) (PartIdx = 0) have merge_idx equals to 0, 1, or 3.
- PartMode of the current prediction unit is PART_NxN and PartIdx is equal to 3 and the prediction units covering luma location (xP – 1, yP) (PartIdx = 2) and luma location (xP – 1, yP – 1) (PartIdx = 0) have identical motion parameters:
  - mvLX[xP – 1, yP] == mvLX[xP – 1, yP – 1]
  - refIdxLX[xP – 1, yP] == refIdxLX[xP – 1, yP – 1]
  - predFlagLX[xP – 1, yP] == predFlagLX[xP – 1, yP – 1]

  and the prediction units covering luma location (xP, yP – 1) (PartIdx = 1) and luma location (xN, yN) (Cand. N) have identical motion parameters:
  - mvLX[xP, yP – 1] == mvLX[xN, yN]
  - refIdxLX[xP, yP – 1] == refIdxLX[xN, yN]
  - predFlagLX[xP, yP – 1] == predFlagLX[xN, yN]
- PartMode of the current prediction unit is PART_NxN and PartIdx is equal to 3 and the prediction units covering luma location (xP, yP – 1) (PartIdx = 1) and luma location (xP – 1, yP – 1) (PartIdx = 0) have identical motion parameters:
  - mvLX[xP, yP – 1] == mvLX[xP – 1, yP – 1]
  - refIdxLX[xP, yP – 1] == refIdxLX[xP – 1, yP – 1]
  - predFlagLX[xP, yP – 1] == predFlagLX[xP – 1, yP – 1]

  and the prediction units covering luma location (xP – 1, yP) (PartIdx = 2) and luma location (xN, yN) (Cand. N) have identical motion parameters:
  - mvLX[xP – 1, yP] == mvLX[xN, yN]
  - refIdxLX[xP – 1, yP] == refIdxLX[xN, yN]
  - predFlagLX[xP – 1, yP] == predFlagLX[xN, yN]
- Otherwise, availableFlagN is set equal to 1 and the variables mvLX[xN, yN], refIdxLX[xN, yN] and predFlagLX[xN, yN] of the prediction unit covering luma location (xN, yN) are assigned respectively to mvLXN, refIdxLXN and predFlagLXN.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000922

Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14-22 July, 2011

Document: JCTVC-F105

Title:	**On MVP list pruning process**
Status:	Input Document to JCT-VC
Purpose:	Proposal

Author(s) or Contact(s): Yongjoon Jeon
Byeongmoon Jeon
#221 Yangjae-dong, Seoucho-gu,
Seoul 137-130,
Korea

Email: yongjoon.jeon@lge.com

Source: LG Electronics

Abstract

In the AMVP process, 'identical' MVP (Motion Vector Predictor) candidates are removed from the MVP list. This contribution proposes to allow 'different' MVP candidates to be removed from the MVP list if the difference between motion vectors is smaller than or equal to a threshold value. Various threshold values are tested and the threshold value is determined to 5 considering overall coding efficiency. The proposed technique changes only one condition in the AMVP process and this minor change results in 0.2% BD-rate reduction for the random access and low delay high efficiency configurations and 0.1% BD-rate reduction for the random access and low delay low complexity configurations.

1 Introduction

AMVP (Advanced Motion Vector Coding) [1] is a technique to improve the accuracy of MVP (Motion Vector Predictor) by using the MVP index that specifies the best MVP in terms of the R-D optimization.

In the AMVP process, MVP candidates are derived from neighboring prediction unit partitions and a MVP list is constructed. Among the motion vectors in the MVP list, redundant motion vectors which have the same value could exist. Since the redundant motion vectors have the same value, they only make the number of MVP candidates increased, which results in the unnecessary bit increase for the MVP index. Therefore AMVP has the MVP list pruning process which removes identical motion vectors from the MVP list.

Even though the MVP list pruning process minimizes the bits for the MVP index, the current process might not be the optimal in terms of the R-D optimization perspective in the following reason. : In the current process, different motion vectors cannot be removed from the list even though the impact of using all of them is negligibly small. However, if the impact of using all the different MVP candidates is negligibly small, it is better to remove some of them because the bits for the MVP index can be saved by removing them. For instance, if there are two motion vectors in the list and the impact of using both of them is negligibly small, it is better to remove one of them because the MVP index does not need to be sent to decoder if we remove one of them. Similar cases could be happen when there are more than two motion vectors. Therefore, if we consider some different MVP candidates as redundant and remove them in terms of RD optimization perspective, the number of MVP candidates can be reduced so the bits for the MVP index can be reduced further. In this sense, there is still a room for improvement in the current MVP list pruning process.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000923

2 Proposed method

In the MVP list pruning process, the pruning condition is modified so that the MVP candidates are removed from the MVP list if the motion vectors have the difference smaller than or equal to a threshold value with other motion vectors in the MVP list.

The following pseudo codes summarize the change by the proposed method. It is supposed that mvA has lower order than mvB in the MVP list.

HM

- if(mvA.x == mvB.x && mvA.y == mvB.y)
  - remove mvB from the MVP list

Proposed

- if(|mvA.x - mvB.x| + |mvA.y - mvB.y| < threshold)
  - remove mvB from the MVP list

The relevant draft text is provided at the end of this document.

3 Experimental results

This proposed scheme is implemented into HM3.0 software. Various threshold values (1 to 10) are tested to find the optimal threshold value. The common test conditions [2] are used. Table 1 shows the overall BD-rate reduction for all threshold values for each coding configurations. Detailed results can be found in the accompanying excel sheet.

Table 1. Overall BD-rate reduction for various threshold values

	RAHE			RALC			LDHE			LDLC		
Threshold	BD-Y	BD-U	BD-V	BD-Y	BD-U	BD-V	BD-Y	BD-U	BD-V	BD-Y	BD-U	BD-V
1	0.0	0.0	-0.1	0.0	0.0	0.0	-0.1	-0.1	0.1	-0.1	-0.1	-0.2
2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.4
3	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.3
4	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.2	-0.2	-0.2	-0.1	-0.3	-0.3
5	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1	-0.3
6	-0.2	-0.2	-0.1	0.0	-0.1	0.0	-0.2	-0.1	-0.1	-0.1	-0.3	-0.3
7	-0.1	-0.2	-0.1	0.0	-0.1	-0.1	-0.2	-0.1	-0.2	-0.1	-0.1	-0.3
8	-0.1	-0.1	-0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
9	-0.1	-0.2	-0.1	0.0	-0.1	0.0	-0.1	-0.2	-0.1	-0.1	-0.1	-0.3
10	-0.1	-0.2	-0.1	0.0	0.0	0.1	-0.2	0.1	0.0	-0.1	-0.1	-0.3

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000924

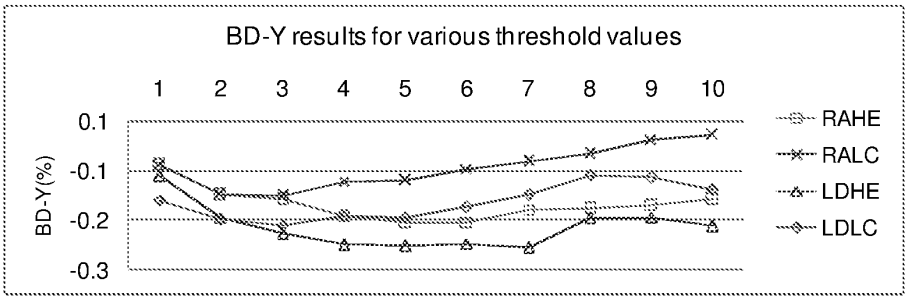


Fig. 1. BD-Y results for various threshold values

The best threshold values for each configuration are as follows.

- Random Access High Efficiency : threshold 5
- Random Access Low Complexity : threshold 5
- Low Delay High Efficiency : threshold 4
- Low Delay Low Complexity : threshold 3

The best threshold value is determined to 5 considering overall coding efficiency for all the configurations. The following figures show the results for threshold 5.

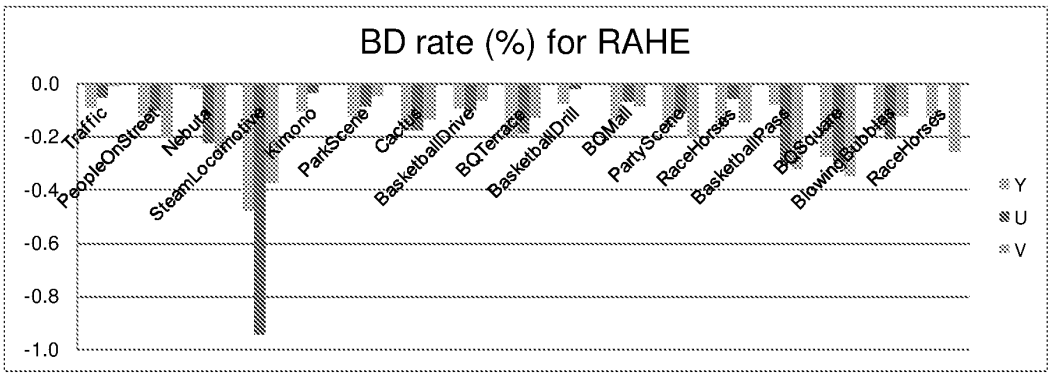


Fig. 2. BD rate (%) for Random Access High Efficiency configuration

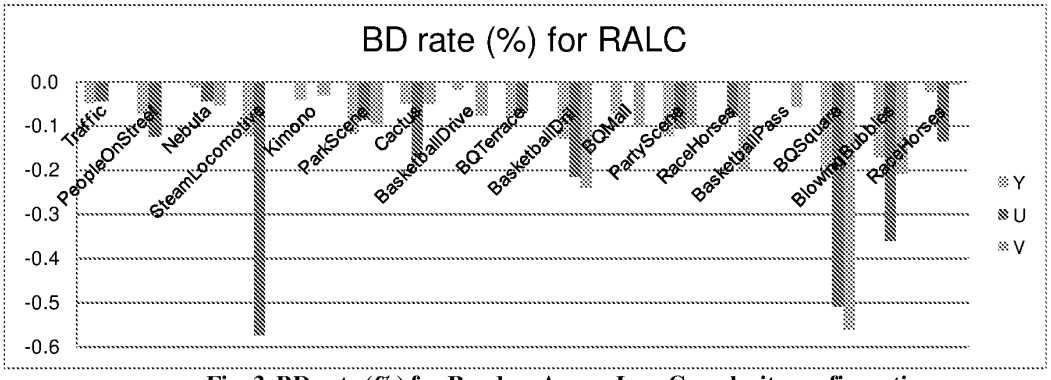


Fig. 3. BD rate (%) for Random Access Low Complexity configuration

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000925

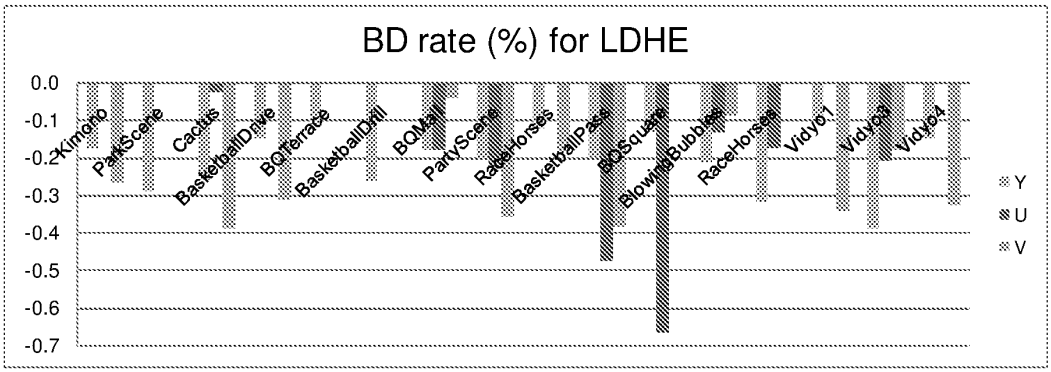


Fig. 4. BD rate (%) for Low Delay High Efficiency configuration

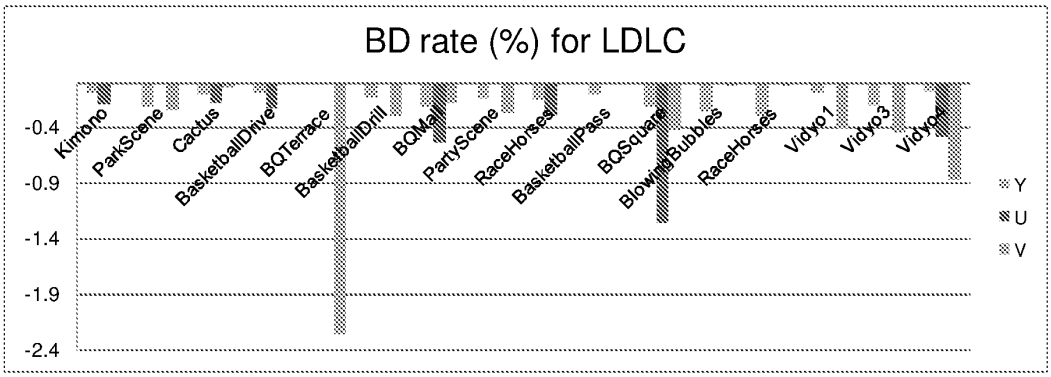


Fig. 5. BD rate (%) for Low Delay Low Complexity configuration

Fig.6 summarizes the results for threshold 5.

	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.2	-0.3	-0.2	-0.1	-0.2	0.1
Class B	-0.1	-0.1	-0.1	-0.1	0.0	0.0
Class C	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
Class D	-0.2	-0.2	-0.3	-0.1	-0.2	-0.2
Class E						
All	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1
Enc Time[%]	98%			97%		
Dec Time[%]	100%			100%		

	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	-0.2	0.2	-0.1	-0.1	-0.1	-0.5
Class C	-0.2	-0.1	-0.1	-0.2	0.0	-0.2
Class D	-0.2	-0.4	0.0	-0.2	-0.1	-0.1
Class E	-0.2	0.0	-0.3	-0.1	0.0	-0.6
All	-0.2	0.0	-0.1	-0.1	-0.1	-0.3
Enc Time[%]	97%			96%		
Dec Time[%]	100%			99%		

Fig. 6 Results for threshold 5

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000926

4 Conclusion

This contribution proposes to allow different MVP candidates removed from the MVP list if the difference between motion vectors is smaller than or equal to a threshold value, which is different from the current design where only the identical motion vectors can be removed from the MVP list.

The proposed scheme changes only one condition in the AMVP process and this minor change results in 0.2% BD-rate reduction for the random access and low delay high efficiency configurations and 0.1% BD-rate reduction for the random access and low delay low complexity configurations. Therefore, we recommend the proposed technique to be adopted in the next version of HM.

5 Patent rights declaration(s)

LG Electronics may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

6 Reference

[1] JCTVC-E603, "WD3: Working Draft 3 of High-Efficiency Video Coding," 5th JCT-VC Meeting, 5th Meeting: Geneva, CH, 16-23 March, 2011.

[2] JCTVC-E700, "Common test conditions and software reference configurations", 5th JCT-VC Meeting, 5th Meeting: Geneva, CH, 16-23 March, 2011.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000927

Annex – draft text

In the current draft, the MVP list pruning process is described with only one sentence. However, we think that this sentence does not describe the process specifically. Therefore the current description for the process should be replaced for the specific description as follows.

From

If several motion vectors have the same value, the motion vectors are removed from the list except the motion vector which has the smallest order in the mvpListLX.

To

The pruning process for motion vector predictor list in subclause 8.4.2.1.8 is invoked with the mvpListLX and the number of elements NumMVPCand(LX) within the mvpListLX as the inputs and with the output being the modified mvpListLX and the modified number of elements NumMVPCand(LX) within the mvpListLX.

8.4.2.1.8 Pruning process for motion vector predictor list

Inputs to this process are (with N being replaced by A,or B)

– the motion vector predictor candidate list mvpListLX,

– the number of elements NumMVPCand(LX) within the mvpListLX

Outputs of this process are

– the modified motion vector predictor candidate list mvpListLX,

– the modified number of elements NumMVPCand(LX) within the mvpListLX

If numMVPCand(LX) is greater than 0, the following applies:

– The variable listIdx is initially set to 0.

– The variable numMvpCand is set equal to NumMVPCand(LX).

– The following procedure is conducted with the variable array of motion vectors mvList as follows.

```
mvList[ listIdx ][ 0 ] = mvpListLX[ 0 ][ 0 ]
mvList[ listIdx ][ 1 ] = mvpListLX[ 0 ][ 1 ]
listIdx++
for( i = 1; i < numMvpCand; i++ ) {
   for( j = listIdx – 1; j >= 0; j-- ) {
      if(mvpListLX[ i ][ 0 ] == mvList[ j ][ 0 ] && mvpListLX[ i ][ 1 ] == mvList[ j ][ 1 ] )
         break
   }
   if( j < 0 ) {
      mvList[ listIdx ][ 0 ] = mvpListLX[ i ][ 0 ]
      mvList[ listIdx ][ 1 ] = mvpListLX[ i ][ 1 ]
      listIdx++
   }
}
for( i = 0; i < listIdx; i++ ) {
   mvpListLX[ i ] = mvList[ i ]
}
NumMVPCand( LX ) = listIdx
```


Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000928

Based on the above description, the process is modified to reflect the proposed change as follows. The change by the proposed method is marked in yellow.

The pruning process for motion vector predictor list in subclause 8.4.2.1.8 is invoked with the mvpListLX and the number of elements NumMVPCand(LX) within the mvpListLX as the inputs and with the output being the modified mvpListLX and the modified number of elements NumMVPCand(LX) within the mvpListLX.

8.4.2.1.8 Pruning process for motion vector predictor list

Inputs to this process are (with N being replaced by A,or B)

– the motion vector predictor candidate list mvpListLX,

– the number of elements NumMVPCand(LX) within the mvpListLX

Outputs of this process are

– the modified motion vector predictor candidate list mvpListLX,

– the modified number of elements NumMVPCand(LX) within the mvpListLX

If numMVPCand(LX) is greater than 0, the following applies:

– The variable listIdx is initially set to 0.

– The variable numMvpCand is set equal to NumMVPCand(LX).

– The following procedure is conducted with the variable array of motion vectors mvList as follows.

```
mvList[ listIdx ][ 0 ] = mvpListLX[ 0 ][ 0 ]
mvList[ listIdx ][ 1 ] = mvpListLX[ 0 ][ 1 ]
listIdx++
for( i = 1; i < numMvpCand; i++ ) {
   for( j = listIdx – 1; j >= 0; j-- ) {
      if(mvpListLX[ i ][ 0 ] == mvList[ j ][ 0 ] && mvpListLX[ i ][ 1 ] == mvList[ j ][ 1 ] )
      diff = Abs( mvpListLX[ i ][ 0 ] – mvList[ j ][ 0 ] ) + Abs( mvpListLX[ i ][ 1 ] – mvList[ j ][ 1 ] )
      if( diff <= 5 )
            break
   }
   if( j < 0 ) {
      mvList[ listIdx ][ 0 ] = mvpListLX[ i ][ 0 ]
      mvList[ listIdx ][ 1 ] = mvpListLX[ i ][ 1 ]
      listIdx++
   }
}
for( i = 0; i < listIdx; i++ ) {
   mvpListLX[ i ] = mvList[ i ]
}
NumMVPCand( LX ) = listIdx
```


Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000929

Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
7th Meeting: Geneva, CH, 21-30 November, 2011

Document: JCTVC-G593

Title: **Non-CE13: Simplification of merge mode**

Status: Input Document to JCT-VC

Purpose: Proposal

Author(s) or Contact(s): Oguz Bici — Email: ext-oguz.bici@nokia.com
Jani Lainema — jani.lainema@nokia.com
Kemal Ugur — kemal.ugur@nokia.com

Source: Nokia

Abstract

This contribution comprises three parts aiming at reducing complexity of the merge process. In the first part, it is proposed to reduce number of motion comparisons during the first pruning process by comparing each spatial candidate with a limited number of spatial candidates and exempting the temporal motion vector prediction candidate from the pruning process. In the second part, it is proposed to derive redundancy information for the combined candidates during the first pruning process and exempting other additional candidates from pruning. In the third part, number of contexts used for the merge index is reduced to two and the contexts are assigned according to being a skip mode or inter-merge mode. Combination of all the three parts provides the merge mode having a total of one full motion comparison per PU where other motion comparisons are either removed or replaced by simpler operations. The reported compression efficiency impact in terms of BD rate is 0.1%, 0.1%, 0.1%, 0.2% for RA_HE, LB_HE, RA_LC and LB_LC, respectively.

1 Introduction

Current HM4 design includes two pruning processes during the merge mode. In the first pruning process, redundant candidates among the initial available spatial and temporal candidates are eliminated from the merge list by comparing motion information of candidates. In the second pruning process, redundant candidates among the additional candidates, which are generated to obtain a merge list of 5 candidates, are excluded from the merge list by comparing their motion information to previously added merge candidates. This contribution comprises three parts aiming at reducing complexity of the merge process associated with candidate generation and motion information comparison:

- Part 1: This part is concerned with reducing the number of motion comparisons during the first pruning process by comparing each spatial candidate with a limited number of spatial candidates and exempting the temporal motion vector prediction candidate from the pruning process.
- Part 2: This part is concerned with decreasing the complexity of the second pruning process by deriving redundancy information for the combined candidates during the first pruning process and exempting other additional candidates (non-scaled and zero candidates) from redundancy checks. In this way, no motion comparison is needed during the second pruning process.
- Part 3: In this part, number of contexts used for coding the merge index with CABAC is reduced to two and the contexts are assigned according to being a skip mode or inter-merge mode.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000930

2 Part 1: Simplification of the first pruning process

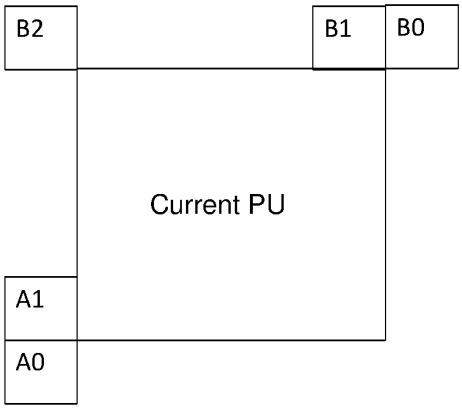


Figure 1 Five spatial locations used during the merge process

In the current HM4, the merge process initially considers five spatial candidates (located at A1, B1, B0, A0 and B2 in Figure 1) and a temporal candidate. A spatial candidate is identified as unavailable if the associated block does not exist or is intra or the current PU is a 2nd PU of a rectangle CU and the spatial candidate has same motion as the 1st PU. Then, maximum of 4 available spatial candidates and the temporal candidate (if available) undergo the 1st pruning process where redundant candidates are removed from the merge list. After the removals, the remaining candidates constitute the initial MVP list.

Part 1 of this contribution aims to reduce complexity of generation of the initial candidates, which correspond to the generation of candidates with the 1st pruning process in HM4.. For this purpose, it is proposed to perform a smaller number of motion comparisons between the candidates and to use simpler comparison logic for some of the candidates. The proposed changes are as follows:

1. The condition of "the current PU being a 2nd PU of a rectangle CU and the spatial candidate having same motion as the 1st PU", called as the "2nd PU condition" throughout the contribution, for determining availability of each spatial candidate is modified. The modified conditions to identify if the spatial candidate is unavailable for each spatial candidate are as follows:
    - A1: No change with the 2nd PU condition
        - Note that, rather than blindly comparing motion of A1 with that of 1st PU, equivalently, it is proposed to check whether the current CU is vertically or horizontally splitted into two PUs and decide accordingly. Because if it is vertical, then the 1st PU already covers A1 and there is no need to perform a motion comparison. If it is horizontal, then the 1st PU has same motion as B1. Therefore, it is sufficient to compare motions of A1 and B1 and the result of this comparison is also shared with the availability derivation for B1, as seen below.
    - B1: In addition to the 2nd PU condition, following condition is added:
        - B1 has same motion as A1
        - Note that, again similarly for the 2nd PU condition, rather than blindly comparing motion of B1 with that of 1st PU, it is sufficient to check if the CU is horizontally split into two PUs. Because in this case, the 1st PU already covers B1 and there is no need to perform motion comparison. Moreover, there is no need to check if the CU is vertically split since in this case, the 1st PU would cover A1 and motion comparison of B1 and A1 is always checked for B1 in the proposed method.
    - B0: The 2nd PU condition is removed, following condition is added:
        - B0 has same motion as B1
    - A0: The 2nd PU condition is removed, following condition is added:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000931

        - A0 has same motion as A1
    - B2: The 2nd PU condition is removed, following condition is added:
        - B2 has same motion as A1 or has same motion as B1

2. In order to reduce complexity of comparing the motion information of the candidate pairs B0 with B1, A0 with A1, B2 with A1 and B2 with B1, it is proposed to define and process simpler variables. This is achieved by defining for each 4x4 partition (or simply partition) the following 2 types of data: the information of how many consecutive partitions to the left have the same motion information and the information of how many consecutive partitions to the above have the same motion information. Updating these values is described later in this Section. Utilizing these two types of data, the motion comparisons during the availability check for B0, A0 and B2 are realized as follows:
    - B0 has same motion as B1: The number of consecutive partitions with same motion to the left of B0 is greater than 0
    - A0 has same motion as A1: The number of consecutive partitions with same motion to the above of A0 is greater than 0
    - B2 has same motion as B1: The number of consecutive partitions with same motion to the left of B1 is greater than the number of partitions between B2 and B1
    - B2 has same motion as A1: The number of consecutive partitions with same motion to the above of A1 is greater than the number of partitions between B2 and A1
3. The 1st pruning process is removed, i.e. when the available spatial and temporal candidates are obtained, no more motion comparison between the candidates is performed. In addition to the complexity reduction, this step has also side benefit of improved error resiliency. This is achieved as the temporal motion vector prediction candidate is not removed from the merge list based on comparing its motion with the previous spatial candidates. In HM4, in case of loss of reference picture(s) and consequently loss of TMVP information, the decoder cannot know if the TMVP is removed from the merge list as it cannot compare its motion information with previous candidates. As a result, it becomes uncertain for a merge index greater than the last spatial candidate to determine if it corresponds to the TMVP or the following additional candidates. This uncertainty is avoided in this step by removing the 1st pruning process.

As mentioned, it is proposed to define for each 4x4 partition the information of number of consecutive partitions on the left/above with same motions. Each of them (left and above) require 5 bits (total of 10 bits) per 4x4 partition as the maximum number of consecutive partitions checked is 16 for a PU with a maximum dimension of 64. These data are updated after the motion information of an inter PU is decoded. It is enough to update/store only bottom-most partitions of the PU for the information of number of consecutive partitions on the left with same motions; and only right-most partitions of the PU for the information of number of consecutive partitions above with same motions. If the current PU is a non-merge inter PU, it is assumed that left and above neighbor PUs have different motion and number of partitions with same motion on the left/above information is updated only within the current PU as illustrated in Figure 2. Otherwise, if the current PU is using a merge mode (inter merge or skip CU), the consecutively same motion information of left (A1 partition) and above (B1 partition) neighbors is utilized during the update. This is achived by making use of:

- the information whether A1 and B1 has same motion, which is already obtained during the merge process
- the information whether the selected merge candidate is A1 or B1

For updating the right-most partitions, first it is determined whether the PU above has same motion by checking if the selected merge candidate is B1, or the selected merge candidate is A1 and A1 has same motion as B1. Then, the right-most partitions are updated by adding the value of number of consecutive partitions having same motion above for the partition located at B1. For updating the bottom-most partitions, first it is determined whether the PU on the left has same motion by checking if the selected

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000932

merge candidate is A1, or the selected merge candidate is B1 and A1 has same motion as B1. Then, the bottom-most partitions are updated by adding the value of number of consecutive partitions having same motion on the left for the partition located at A1. The procedure is depicted in Figure 3.

Note that it is not required to update all the partitions of the PU; it is sufficient to update only bottom-most and right-most partitions. Moreover, the update procedure can be carried in parallel with the subsequent processes taking place after the motion vector is obtained.

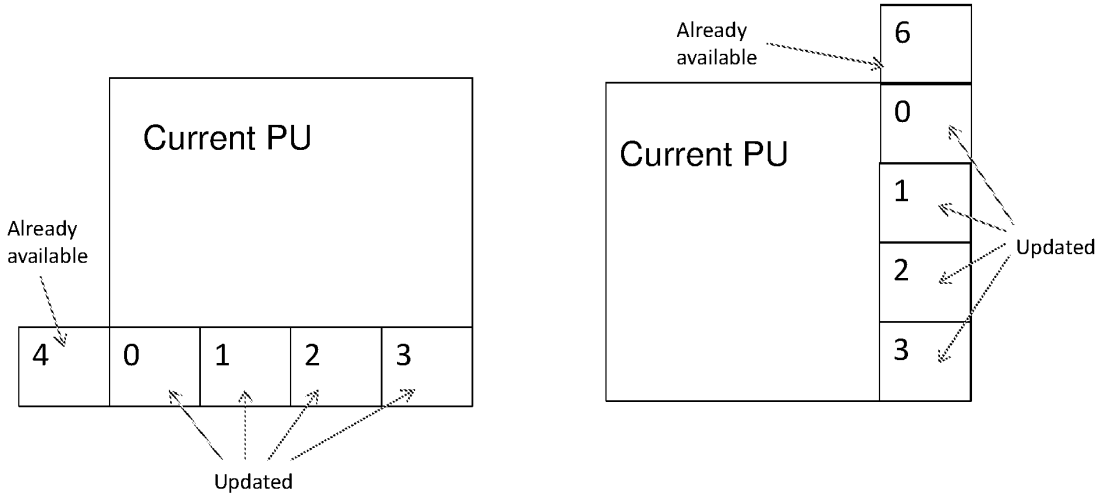


Figure 2 Updating consecutively same motion information for a non-merge inter PU. Left side: Updating number of partitions with same motions on the left for bottom-most partitions. Right side: Updating number of partitions with same motions above for right-most partitions.

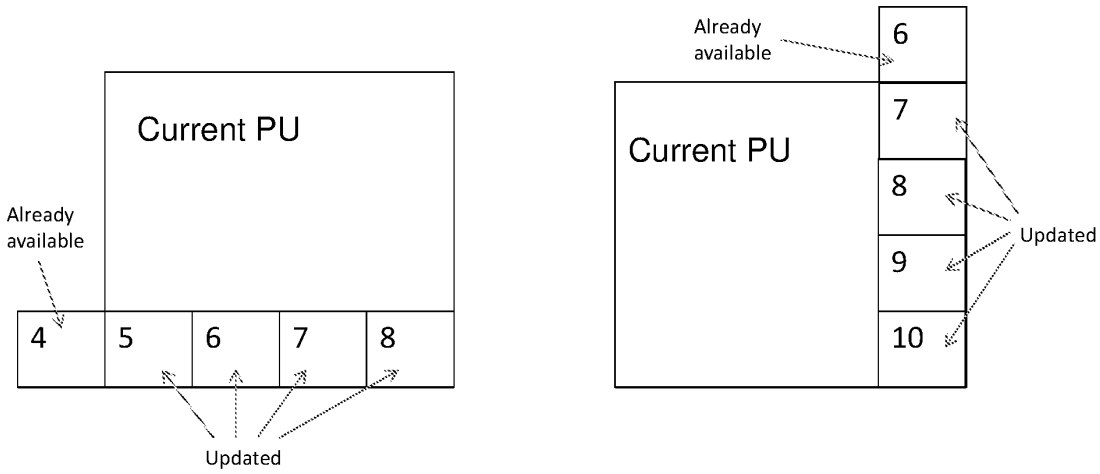


Figure 3 Updating consecutively same motion information for a merge based PU. Left side: Updating number of partitions with same motions on the left for bottom-most partitions. Right side: Updating number of partitions with same motions above for right-most partitions.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000933

2.1 *Experimental results*

HM4.0 software is used for the implementation of the tool and the results are compared against HM4.0 as the anchor under the common test conditions and reference configurations specified in [1]. The same common test conditions and reference configurations are used in the rest of the contribution. Compression efficiency performance of Part 1 is presented in Table 1. Note that encoding times may include some variations due to heterogeneous resources and workloads of the nodes in the simulation cluster.

Table 1 Results of Part 1

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1%	-0.1%	0.0%	0.0%	0.1%	0.0%
Class B	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Class C	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Class D	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Class E						
Overall	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]		103%			100%	
Dec Time[%]		95%			99%	

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.1%	0.0%	0.1%	0.1%	0.2%	0.3%
Class C	0.1%	-0.1%	0.1%	0.1%	0.1%	0.0%
Class D	0.1%	0.2%	0.3%	0.1%	0.2%	-0.3%
Class E	0.2%	0.7%	1.0%	0.2%	0.7%	0.3%
Overall	0.1%	0.1%	0.3%	0.1%	0.3%	0.1%
	0.1%	0.1%	0.3%	0.1%	0.2%	0.0%
Enc Time[%]		96%			102%	
Dec Time[%]		96%			95%	

2.2 *Comments*

With the proposed changes described in Part 1, it is possible obtain the initial MVP list by performing a single motion comparison whereas HM4 requires 10 motion comparisons during the first pruning process in the worst case. In the proposed method, some of the motion comparisons are removed and some of them are replaced by simpler operations. It is observed that the impact on the compression efficiency is limited. In addition, the proposed changes are more suitable for parallel processing, and reduces memory bandwidth requirements since motion and reference index information of some of the candidates are not required. Also, with the removal of redundancy checks of the first pruning process, it becomes possible for a decoder to exit merge process as soon as the candidate corresponding to the decoded merge index is generated. Finally, as a side benefit, error resiliency of the merge process is improved since the temporal motion vector predictor is not removed from the list based on comparing its motion information.

3 Part 2: Simplification of the second pruning process

In this part, the goal is to simplify the 2nd pruning process during the merge mode. In HM4, after the 1st pruning process, additional candidates (combined, non-scaled and zero candidates) are generated and added to the merge list if its motion information is not same as a previously added candidate. In this

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000934

contribution, it is proposed to completely remove the redundancy checks of the additional candidates. This is achieved by deriving redundancy information for specific pairs of the combined candidates during the 1st pruning process (to be described in detail), and removing redundancy checks for the non-scaled and zero additional candidates.

Derivation of redundancy information for the combined candidates: During the 1st pruning process, redundant candidates are eliminated by comparing the motion information with other candidates. The comparison includes the whole motion information, i.e. comparing equivalence of both List0 and List1. Assume that two candidates have the same List0 motion but different List1 motion. In this case, none of the candidates are eliminated during the 1st pruning process. However, it can be derived that combinations of these candidates will be redundant. Moreover, combination of the second candidate with remaining candidates will be redundant as well. Similar arguments are also valid in case List1 motions are the same but List0 motions are different.

The aforementioned redundancies are illustrated with an example in Figure 4. In the example, there are three candidates after the 1st pruning (Cand 0,1,2) and four example combinations of these candidates (Comb Cand 0&1, 1&0, 0&2, 1&2). Motion information of the candidates per list is denoted by MotX, X={A,B,C,D,E}. In the example, Cand 0 and Cand 1 have the same List0 motion. As a result, as seen in the Figure, combination of Cand 0 and Cand 1 has same motion as Cand 1 and combination of Cand 1and Cand 0 has same motion as Cand 0, making these combined candidates redundant. Moreover, it is also observed that combination of Cand 0 and Cand 2 has same motion as combination of Cand 1and cand 2, making the latter combination redundant.

Candidates	List0	List1
Cand 0	MotA	MotB
Cand 1	MotA	MotC
Cand 2	MotD	MotE
Comb Cand 0&1	MotA	MotC
Comb Cand 1&0	MotA	MotB
Comb Cand 0&2	MotA	MotE
Comb Cand 1&2	MotA	MotE

Figure 4 Example case of three candidates from the initial MVP list and four combinations of these candidates

In order to utilize these pre-detectable redundancies, it is proposed to define an availability map for the combined candidates, which is initialized by setting all the combinations as available. Then this combined availability mapis updated during the 1st pruning process. Whenever two candidates are being compared during 1st pruning process, if either list 0 or list 1 motion information is identified as same, then redundant combined candidates are derived and updated as unavailable in the availability map. Figure 5 shows an example candidate list before the combined candidates are generated, Figure 6 shows a corresponding initialized availability map, and Figure 7 and Figure 8 show example update cases when motion information of candidates 0 and 1 are same for the lists 0 and 1, respectively.

	Reference Picture list0		Reference Picture list1	
CandIdx	MV	RefIdx	MV	RefIdx
0	MV0List0	RefIdx0List0	MV0List1	RefIdx0List1
1	MV1List0	RefIdx1List0	MV1List1	RefIdx1List1
2	MV2List0	RefIdx2List0	MV2List1	RefIdx2List1
3	MV3List0	RefIdx3List0	MV3List1	RefIdx3List1

Figure 5 Example candidate list

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000935

CandIdx	0	1	2	3
0	0	1	1	1
1	1	0	1	1
2	1	1	0	1
3	1	1	1	0

Figure 6 Initialized combined availability map

CandIdx	0	1	2	3
0	0	0	1	1
1	0	0	0	0
2	1	1	0	1
3	1	1	1	0

Figure 7 updating the combined availability map when MV0List0 is equal to MV1List0 and RefIdx0List0 is equal to RefIdx1List0

CandIdx	0	1	2	3
0	0	0	1	1
1	0	0	1	1
2	1	0	0	1
3	1	0	1	0

Figure 8 updating the combined availability map when MV0List1 is equal to MV1List1 and RefIdx0List1 is equal to RefIdx1List1

As a result, at the end of the 1st pruning, there exists an availability map for the combined candidates, describing which combinations are redundant. In this way, it is proposed to remove redundancy check of the combined candidates with the previous candidates; instead, it is proposed to use the derived availability map to determine whether it is redundant. For the remaining non-scaled and zero candidates, it is proposed to disable redundancy checks without further modifications.

3.1 Experimental results

HM4.0 software is used for the implementation of the tool and the results are compared against HM4.0 as the anchor. Table 2 shows the compression efficiency performance of only using the combined availability map, where the redundancy check for the non-scaled and zero candidates is still applicable. Table 3 shows the compression efficiency performance of Part 2, where combined availability map is used for the combined candidates as well as the redundancy check for the non-scaled and zero candidates is disabled. Note that encoding times may include some variations due to heterogeneous resources and workloads of the nodes in the simulation cluster.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000936

Table 2 Results of using only the combined availability map

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0%	-0.2%	-0.1%	0.0%	0.2%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Class C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class E						
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Enc Time[%]		N/A			N/A	
Dec Time[%]		100%			100%	

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0%	-0.2%	-0.1%	0.0%	0.0%	0.0%
Class C	0.0%	-0.1%	-0.1%	0.0%	0.1%	-0.1%
Class D	0.0%	0.1%	0.1%	0.0%	0.6%	0.0%
Class E	0.0%	0.2%	0.5%	0.0%	0.4%	-0.1%
Overall	0.0%	0.0%	0.1%	0.0%	0.2%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.2%	-0.1%
Enc Time[%]		N/A			N/A	
Dec Time[%]		101%			100%	

Table 3 Results of Part 2 (both using combined availability map and disabling redundancy check for the non-scaled and zero candidates)

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1%	0.0%	-0.1%	0.0%	0.0%	0.1%
Class B	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Class C	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Class D	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%
Class E						
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Enc Time[%]		100%			101%	
Dec Time[%]		100%			100%	

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	0.0%	-0.1%	0.0%	0.1%	0.2%	-0.1%
Class D	0.0%	0.3%	-0.1%	0.0%	-0.1%	-0.1%
Class E	0.1%	0.0%	0.8%	0.1%	0.4%	0.4%
Overall	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%
	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%
Enc Time[%]		101%			101%	
Dec Time[%]		96%			100%	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000937

3.2 *Comments*

In summary, Part 2 of this contribution provides a realization of the 2nd pruning process which does not include any motion comparisons. Compared to the worst case of HM4, HM4 requires 60 motion comparisons during the second pruning process [3]. This is achieved by utilizing partial list motion equivalence information, which can be obtained without extra effort during the 1st pruning. Experimental results show that the proposed complexity reduction is achieved with almost no effect on the compression performance.

4 Combination of Part 1 and Part 2

In this part, the ideas presented in Part 1 and Part 2 are jointly utilized. In order to generate the availability map of Part 2, the simplified set of motion comparisons presented in Part 1 is used. Since partial list motion comparisons are required, the information of number of consecutive motions with same motions on the left/above is now stored for each list.

In summary, combination of Part 1 and Part 2 results in the merge mode having only one full motion comparison per PU. Other comparisons for redundancy removals are either removed or replaced by simpler operations.

4.1 *Experimental Results*

Compression efficiency results for the combination of Part 1 and Part 2 are presented in Table 4 and Table 5. In Table 4, the anchor is HM4.0. In Table 5, the fix related to merge mode selection in the encoder released by Samsung on CE13 reflector is applied to both the proposed combination of Part 1 and 2 and the anchor. This fix is denoted by MrgEncFix throughout the rest of this document.

Table 4 Results of combination of Part 1 and 2; anchor is HM4

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1%	-0.1%	-0.1%	0.1%	0.1%	0.0%
Class B	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%
Class C	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
Class D	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%
Class E						
Overall	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%
	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%
Enc Time[%]		101%			101%	
Dec Time[%]		99%			99%	

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.2%	0.1%	0.1%	0.2%	0.2%	0.2%
Class C	0.1%	0.1%	0.2%	0.1%	0.2%	0.0%
Class D	0.2%	0.4%	0.6%	0.2%	0.2%	0.2%
Class E	0.3%	0.7%	1.4%	0.6%	1.2%	0.9%
Overall	0.2%	0.3%	0.5%	0.2%	0.4%	0.3%
	0.2%	0.3%	0.5%	0.2%	0.4%	0.3%
Enc Time[%]		101%			101%	
Dec Time[%]		97%			98%	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000938

Table 5 Results of combination of Part 1 and 2 with MrgEncFix; anchor is HM4 with MrgEncFix

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.1%	0.1%	0.1%	0.1%	0.0%	-0.1%
Class B	0.1%	0.2%	0.2%	0.1%	0.1%	0.0%
Class C	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%
Class D	0.1%	0.1%	0.2%	0.1%	-0.1%	0.0%
Class E						
Overall	0.1%	0.1%	0.2%	0.1%	0.0%	0.0%
	0.1%	0.1%	0.2%	0.1%	0.0%	0.0%
Enc Time[%]		N/A			N/A	
Dec Time[%]		99%			99%	

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.2%	0.2%	0.1%	0.2%	0.1%	0.0%
Class C	0.1%	0.0%	0.1%	0.2%	0.3%	0.2%
Class D	0.1%	0.4%	0.4%	0.1%	-0.3%	0.2%
Class E	0.4%	0.3%	0.2%	0.4%	0.4%	0.5%
Overall	0.2%	0.2%	0.2%	0.2%	0.1%	0.2%
	0.2%	0.3%	0.2%	0.2%	0.1%	0.2%
Enc Time[%]		N/A			N/A	
Dec Time[%]		97%			97%	

4.2 Comments

It is observed that impact of the combination of Part1 and Part2 on the compression efficiency is still limited while the complexity reductions described previously are retained.

5 Part 3: Modified context assignments for the merge index

Part 3 of this contribution concerns with the coding of the merge index with CABAC. Currently in HM4, four contexts are used, one per each bin, for the merge index. In this part, it is proposed to use a total of two contexts, both assigned to coding of the first bin. One of the contexts is used when the merge mode is used for a Skip CU and the other is used when the merge mode is a Merge PU. The remaining three bins are coded with equal probability.

Compression efficiency results of Part 3 when initial context probabilities for the merge index are assigned same as in HM4 are presented in Table 6.

Table 6 Results of Part3 with context probability initializations as in HM4

	Random Access HE		
	Y	U	V
Class A	0.0%	0.0%	-0.2%
Class B	0.0%	0.0%	0.0%
Class C	0.0%	-0.1%	0.0%
Class D	0.0%	-0.1%	0.0%
Class E			
Overall	0.02%	-0.1%	0.0%
	0.0%	-0.1%	0.0%
Enc Time[%]		N/A	
Dec Time[%]		101%	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000939

	Low delay B HE		
	Y	U	V
Class A			
Class B	0.0%	-0.1%	0.2%
Class C	-0.1%	0.0%	0.0%
Class D	0.0%	0.1%	0.3%
Class E	-0.1%	0.4%	0.4%
Overall	-0.04%	0.1%	0.2%
	0.0%	0.0%	0.2%
Enc Time[%]	N/A		
Dec Time[%]	99%		

Compression efficiency results of Part 3 when initial context probabilities for the merge index are assigned as equal probabilities are presented in Table 7.

Table 7 Results of Part3 with equal probability context initializations

	Random Access HE		
	Y	U	V
Class A	0.0%	-0.1%	-0.2%
Class B	0.0%	0.0%	0.0%
Class C	0.0%	0.0%	0.0%
Class D	0.0%	0.1%	0.0%
Class E			
Overall	0.02%	0.0%	-0.1%
	0.02%	0.00%	-0.04%
Enc Time[%]	N/A		
Dec Time[%]	99%		

	Low delay B HE		
	Y	U	V
Class A			
Class B	0.0%	0.0%	0.0%
Class C	-0.1%	0.0%	-0.1%
Class D	0.0%	0.0%	0.2%
Class E	-0.2%	-0.2%	1.1%
Overall	-0.08%	0.0%	0.2%
	-0.07%	-0.03%	0.13%
Enc Time[%]	N/A		
Dec Time[%]	100%		

6 Experimental results for combination of Part 1, Part 2 and Part 3

Compression efficiency results for the combination of all proposed parts (Part 1 + Part 2 + Part 3) are presented in Table 8 and Table 9. In these results, same context initializations as in HM4 are used. In Table 8, the anchor is HM4.0. In Table 9, the MrgEncFix is applied to both the proposed combination and the anchor HM4.0.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000940

Table 8 Results of combination of all proposed parts; anchor is HM4

	Random Access HE		
	Y	U	V
Class A	0.1%	-0.1%	-0.2%
Class B	0.1%	0.1%	0.1%
Class C	0.1%	0.0%	0.2%
Class D	0.1%	0.2%	0.0%
Class E			
Overall	0.1%	0.1%	0.0%
	0.1%	0.1%	0.1%
Enc Time[%]	102%		
Dec Time[%]	99%		

	Low delay B HE		
	Y	U	V
Class A			
Class B	0.1%	0.0%	0.0%
Class C	0.1%	0.1%	0.0%
Class D	0.1%	0.6%	-0.2%
Class E	0.3%	0.8%	1.4%
Overall	0.1%	0.3%	0.2%
	0.1%	0.3%	0.2%
Enc Time[%]	101%		
Dec Time[%]	97%		

Table 9 Results of combination of all proposed parts with MrgEncFix; anchor is HM4 with MrgEncFix

	Random Access HE		
	Y	U	V
Class A	0.1%	0.1%	-0.1%
Class B	0.1%	0.2%	0.2%
Class C	0.1%	0.1%	0.2%
Class D	0.1%	0.1%	0.2%
Class E			
Overall	0.1%	0.1%	0.1%
	0.1%	0.1%	0.2%
Enc Time[%]	N/A		
Dec Time[%]	99%		

	Low delay B HE		
	Y	U	V
Class A			
Class B	0.1%	0.4%	0.0%
Class C	0.1%	-0.1%	0.2%
Class D	0.1%	0.6%	0.3%
Class E	0.3%	0.5%	0.1%
Overall	0.1%	0.3%	0.1%
	0.1%	0.3%	0.1%
Enc Time[%]	N/A		
Dec Time[%]	99%		

6.1 Comments

It can be noticed that the application of Part3 improves the compression efficiency of Part+Part2 by 0.1% BD-rate for Low Delay B configuration and achieves similar efficiency for Random Access

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000941

configuration. Moreover, number of contexts for coding the merge index is reduced to two from four and three out of four bins of the merge index are coded with equal probability.

7 Conclusion

In this contribution, three parts aiming at reducing the complexity of the merge candidate generation have been presented. With the application of all parts in the contribution, the worst case number of required motion comparisons per merge PU in the decoder is reduced to 1 from 70 (10 in the first pruning and 60 in the second pruning). Also, application of the proposed modifications may lead to simpler logic and/or increased throughput and/or improved average memory bandwidth. On the other hand, the impact on the compression efficiency is reported to be limited. The resultant compression performance in terms of BD rate is reported to be 0.1%, 0.1%, 0.1%, 0.2% for RA_HE, LB_HE, RA_LC and LB_LC, respectively. Therefore, it is recommended to adopt the proposed changes in the next HM and WD.

8 References

[1] F. Bossen, "Common test conditions and software reference configurations," JCTVC-F900, Jul 2011

[2] B. Bross, W.-J. Han, J.-R. Ohm, G. J. Sullivan, T. Wiegand, "WD4: Working Draft 4 of High-Efficiency Video Coding," JCTVC-F803, Jul 2011

[3] M. Zhou, "CE13: Test results on maxNumMergeCand signaling and simplification of merge MVP list pruning process," JCTVC-G091, Nov 2011

9 WD Changes

Changes to WD are provided as separate documents.

Nokia may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000942

Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14-22 July, 2011

Document: JCTVC-F909

Title: **Core Experiment 9: MV Coding and Skip/Merge Operations**

Status: Output Document

Purpose: Core Experiments Description

Author(s) or Contact(s):

Benjamin Bross
Einsteinufer 37
10587 Berlin
Tel:
Email: benjamin.bross@hhi.fraunhofer.de

Joel Jung
38-40 rue du Général Leclerc
92130 ISSY LES MOULINEAUX
France
Tel: +33 1 45 29 53 66
Email: joelb.jung@orange-ftgroup.com

Wei-Jung Chien

Il-Koo Kim

Minhua Zhou

Source: CE coordinators

Abstract

At the 6th JCT-VC meeting in Torino, several changes were adopted into the HM design regarding Inter, Skip, and Merge modes. As the major modification, for parsing throughput/robustness reasons, the parsing and reconstruction for motion data is decoupled now.

1 Participants List

Company/Institute	Name	E-mail address
Fraunhofer HHI	Benjamin Bross Simon Oudin	benjamin.bross@hhi.fraunhofer.de simon.oudin@hhi.fraunhofer.de
Orange Labs	Joel Jung	joelb.jung@orange-ftgroup.com
Qualcomm	Wei-Jung Chien Xianglin Shawn Wang Yunfei Zheng	wchien@qualcomm.com xianglin@qualcomm.com zhengy@qualcomm.com
Samsung	Il-Koo Kim Jianle Chen	ilkoo.kim@samsung.com jianle.chen@samsung.com
TI	Minhua Zhou	zhou@ti.com
JVC KENWOOD	Shigeru Fukushima Hiroya Nakamura Hideki Takehara Motoharu Ueda	fukushima.shigeru@jvckenwood.com nakamura.hiroya@jvckenwood.com takehara.hideki@jvckenwood.com ueda.motoharu@jvckenwood.com
Panasonic	Toshiyasu Sugio	sugio.toshiyasu@jp.panasonic.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000943

LGE	Yongjoon Jeon Seungwook Park Joonyoung Park	yongjoon.jeon@lge.com seungwook.park@lge.com jy.park@lge.com
ETRI	H. Y. Kim S.-C. Lim J. Lee	hykim5@etri.re.kr sclim@etri.re.kr jinosoul@etri.re.kr
KHU	K. Y. Kim S. M. Kim G. H. Park	kimky@khu.ac.kr jephiros@khu.ac.kr ghpark@khu.ac.kr
Toshiba	T. Shiodera T. Chujoh A. Tanizawa	taichiro.shiodera@toshiba.co.jp takeshi.chujoh@toshiba.co.jp akiyuki.tanizawa@toshiba.co.jp
Motorola Mobility	Yue Yu Krit Panusopone	yyu@motorola.com krit@motorola.com
Canon	Patrice Onno Guillaume Laroche	patrice.onno@crf.canon.fr guillaume.laroche@crf.canon.fr
NTT DOCOMO	Yoshinori Suzuki T.K. Tan Akira Fujibayashi	suzukiyos@rd.nttdocomo.co.jp tktan.p@rd.nttdocomo.co.jp fujibayashi@nttdocomo.co.jp
Sony	Kazushi Sato	kazushi.sato@jp.sony.com
Institute for Infocomm Research (I2R)	Tan Yih Han	yhtan@i2r.a-star.edu.sg
BBC	Marta Mrak	marta.mrak@bbc.co.uk
Mitsubishi	Kazuo Sugimoto Yusuke Itani	sugimoto.kazuo@ak.mitsubishielectric.co.jp itani.yusuke@dx.mitsubishielectric.co.jp
Sejong Univ. SK Telecom	Ju Ock Lee Joo-Hee Moon Jeongyoen Lim	jolee@sju.ac.kr jhmoon@sejong.ac.kr jeongyeon@sk.com
Fujitsu	Kimihiko Kazui	kazui.kimihiko@jp.fujitsu.com
Nokia	Oguz Bici	ext-oguz.bici@nokia.com
MediaTek	Yu-Wen Huang Jian-Liang Lin Yi-Wen Chen	yuwen.huang@mediatek.com jl.lin@mediatek.com yiwen.chen@mediatek.com
HiSilicon	Xiaozhen Zheng	zhengxiaozhen@huawei.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000944

2 Contribution and Experiment Description

2.1 Simplification

JCTVC-F081 CE1: Evaluation results on A.09, A.13-16 and an alternative solution [M. Zhou (TI)]

Remove TMVP center position by setting:

```
#define FT_TCTR_MRG     0          ///< central colocated in MERGE
#define FT_TCTR_AMVP    0          ///< central colocated in AMV
```

JCTVC-F083 CE9: Evaluation results on disabling TMVP from AMVP list construction (ROB05) [M. Zhou (TI)]

In this test, the coding efficiency of TMVP in the AMVP list will be quantified. The following the following three tests will be carried out:

1. disabling TMVP from the AMVP but retaining it in ME as one of initial motion vector
2. disabling TMVP from both the AMVP and ME
3. disabling TMVP from AMVP, ME and merge/skip mode

Removing TMVP from the AMVP would reduce the AMVP implementation cost and improve parsing robustness.

Test	Description	Related Doc.	Tester1	Tester2
SP01	Remove TMVP center position	JCTVC-F081	TI	Orange Labs
SP02	Disable AMVP TMVP use it in ME	JCTVC-F083	TI	Motorola Mobility
SP03	Disable AMVP TMVP	JCTVC-F083	TI	Motorola Mobility
SP04	Disable AMVP and merge/skip TMVP	JCTVC-F083	TI	Qualcomm

2.2 Modification of the AMVP/merge list pruning

JCTVC-F105 On MVP list pruning process [Y. Jeon, B. Jeon (LGE)]

JCTVC-F105 modified the condition for removing duplicated candidates in the list in a way that the distance between motion vectors is checked by a threshold value and the motion vectors that satisfy the condition are removed from the list whereas only identical motion vectors are removed from the list in HM3.0. The effect of using the pruning condition of JCTVC-F105 is to be investigated with HM4.0.

There are several duplicate checks/pruning processes in HM4.0.

- The 1st pruning : pruning process after merge/AMVP list construction with spatial and temporal candidates.
- The 2nd pruning : pruning process after additional candidates are added which are introduced to compensate the coding loss coming from robust index coding.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000945

The pruning condition will be tested for 1st and/or 2nd pruning of Merge/Skip and/or AMVP. The combinations of the tests are as follows.

Test	Description	Related Doc.	Tester1	Tester2
MRG_PRUN01	Prune candidates by threshold in the 1st pruning of Merge/Skip	JCTVC-F105	LGE	Qualcomm
MRG_PRUN02	Prune candidates by threshold in the 2nd pruning of Merge/Skip	JCTVC-F105	LGE	Qualcomm
MRG_PRUN03	Prune candidates by threshold in the 1st and 2nd pruning of Merge/Skip	JCTVC-F105	LGE	Qualcomm
AMVP_PRUN01	Prune candidates by threshold in the 1st pruning of AMVP	JCTVC-F105	LGE	MediaTek
AMVP_PRUN02	Prune candidates by threshold in the 2nd pruning of AMVP	JCTVC-F105	LGE	MediaTek
AMVP_PRUN03	Prune candidates by threshold in the 1st and 2nd pruning of AMVP	JCTVC-F105	LGE	MediaTek
MRG_AMVP_PRUN01	Prune candidates by threshold in the 1st pruning of Merge/Skip and AMVP	JCTVC-F105	LGE	ETRI/KHU
MRG_AMVP_PRUN02	Prune candidates by threshold in the 2nd pruning of Merge/Skip and AMVP	JCTVC-F105	LGE	ETRI/KHU
MRG_AMVP_PRUN03	Prune candidates by threshold in the 1st and 2nd pruning of Merge/Skip and AMVP	JCTVC-F105	LGE	ETRI/KHU

2.3 Modification of the AMVP candidate selection

JCTVC-F419 Unification of derivation process for merge mode and MVP [H. Nakamura, S. Fukushima, M. Nishitani (JVC Kenwood)]

During the 6th JCT-VC meeting, it was proposed to modify the spatial candidates' selection process on AMVP using one group for the candidates.

In HM4.0, two spatial candidates A and B are derived by scanning spatial neighboring positions A0, A1, B0, B1 and B2 in two groups, one for A and one for B. The first available candidate in the scanning order gets chosen. The scanning orders for candidates A and B are as follows.

A:

A0 non-scaled, A1 non-scaled, A0 scaled, A1 scaled

B:

B0 non-scaled, B1 non-scaled, B2 non-scaled, B0 scaled (if A is not scaled), B1 scaled (if A is not scaled), B2 scaled (if A is not scaled)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000946

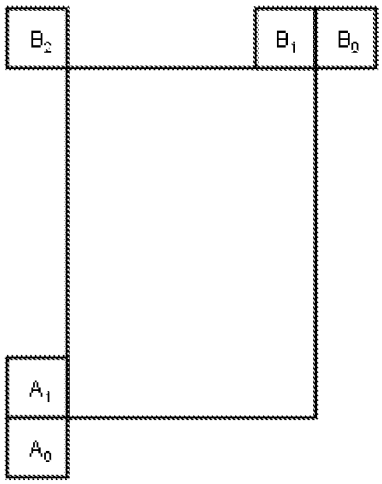


Figure 1 Spatial motion vector neighbors

It is proposed to derive two spatial candidates S0 and S1 by scanning spatial neighboring positions A0, A1, B0, B1 and B2 in one group. The first available candidate in this scanning order is S0 and the second available one is S1. For application of the restriction that the number of scaled spatial MVP candidate is less or equal to one, AMVP_SEL01 and AMVP_SEL02 will be tested.

AMVP_SEL01 one-pass scanning

To derive S0 and S1, non-scaled and scaled candidates are checked by one-pass scanning with the scanning order as follows.

> B0 non-scaled, B0 scaled (if S0 is not scaled), A0 non-scaled, A0 scaled (if S0 is not scaled), A1 non-scaled, A1 scaled (if S0 is not scaled), B1 non-scaled, B1 scaled (if S0 is not scaled), B2 non-scaled, B2 scaled (if S0 is not scaled)

When S0 and S1 are derived, scanning process is terminated.

AMVP_SEL02 two-pass scanning

To derive S0 and S1, non-scaled and scaled candidates are checked separately by two-pass scanning. In the first pass scanning, non-scaled candidates are checked - in the second pass scanning, scaled candidates are checked.

first pass:	B0 non-scaled, A0 non-scaled, A1 non-scaled, B1 non-scaled, B2 non-scaled
second pass:	B0 scaled (if S0 is not scaled), A0 scaled (if S0 is not scaled), A1 scaled (if S0 is not scaled), B1 scaled (if S0 is not scaled), B2 scaled (if S0 is not scaled)

When S0 and S1 are derived, scanning process is terminated. When S0 or S1 is derived during the second pass, scanning process is terminated.

JCTVC-F575 Simplification of MVP Design for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

The contribution JCTVC-F575 by Motorola Mobility proposed a simplification of MVP design for HEVC when bi-prediction is used. Specifically, MVP_list0 for MV0 is first obtained by using the same procedure as in HM4.0 AMVP. MVP_list1 is then calculated from MVP_list0.

In test 1, MVP_list1 is scaled from MVP_list0 with a scaling factor set to be a ratio according to the temporal distance. Sign of the scaling factor is positive when MV of list 0 points in the same direction as MV of list 1, and is negative when MV of list 0 points in an opposite direction to MV of list 1.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000947

In test 2, MVP_list1 is scaled from MVP_list0 with a scaling factor equal to 1. Sign of the scaling factor is positive when MV of list 0 points in the same direction as MV of list 1, and is negative when MV of list 0 points in an opposite direction to MV of list 1.

Test	Description	Related Doc.	Tester1	Tester2
AMVP_SEL01	one-pass scanning	JCTVC-F419	JVC Kenwood	Sony
AMVP_SEL02	two-pass scanning	JCTVC-F419	JVC Kenwood	Sony
AMVP_SEL03	Scaling factor based on temporal distance	JCTVC-F575	Motorola Mobility	TI
AMVP_SEL04	Scaling factor equal to 1	JCTVC-F575	Motorola Mobility	TI

2.4 Parallel merge/skip

JCTVC-F069 Parallelized merge/skip mode for HEVC [M.Zhou (TI)]

This contribution proposes to add a slice level syntax element, **log2_parallel_merge_level_minus2**, to signal the parallel merge/skip level so that all the PUs inside a motion estimation region (MER) can be searched in parallel to the regular motion estimation in the parallel motion estimation environment. In the proposed tests, a LCU are divided into a number of non-overlapped MERs of square shape based on value of **log2_parallel_merge_level_minus2**, within a MER all motion vectors are estimated in parallel, while from MER to MER motion estimation is performed sequentially. Parallel motion estimation at certain block level is required for practical encoder designs due to throughput and cost constraints. In this test the coding efficiency of proposed design will be evaluated against the HM4.0 for parallel merge (motion estimation level) of 64x64, 32x32, 16x16, and 8x8. Specifically, to allow merge/skip search in parallel to regular motion estimation in parallel ME environment, HM4.0 and proposed handle the merge/skip mode differently, and as follows:

- HM4.0: has to disable merge/skip mode for those CUs and PUs whose upper-left corner is not coincident with the upper-left corner of a MER.
- Proposed: is able to enable merge/skip mode for all PUs and CUs inside a MER by marking those spatial neighboring PUs as unavailable for the merge/skip candidate list derivation process if they belong to a same MER as the current PU.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000948

Test	log2_parallel_merge_level_minus2	Motion estimation region size	Merge/skip mode handling in parallel ME environment	Tester1	Tester2
HM4.0 reference	0	4 x 4		-	-
MRG_PAR01a	1	8 x 8	HM4.0	TI	Microsoft
MRG_PAR01b	1	8 x 8	proposed	TI	Microsoft
MRG_PAR02a	2	16 x 16	HM4.0	TI	Microsoft
MRG_PAR02b	2	16 x 16	proposed	TI	Microsoft
MRG_PAR03a	3	32 x 32	HM4.0	TI	LGE
MRG_PAR03b	3	32 x 32	proposed	TI	LGE
MRG_PAR04a	4	64 x 64	HM4.0	TI	LGE
MRG_PAR04b	4	64 x 64	proposed	TI	LGE

2.5 Additional merge mode

JCTVC-F373 Merge based MVD transmission [S. Fukushima, M. Ueda, K. Arakage, S. Sakazume (JVC KENWOOD)]

During the 6th JCT-VC meeting, an additional merge mode that was named merge mvd mode was proposed to improve coding efficiency. The motion vector derivation process for merge mvd mode is shared with existing merge mode and one mvd is transmitted.

In merge mvd mode, bi-predictive motion compensation is used based on merge parameter in merge mode. The syntax element mvd_ls is transmitted as mvd for merge mvd mode according to the condition of merge parameter in merge mode.

If inter_pred_mode in merge parameter is uni-prediction, the reference index of the other list which is not selected by merge parameter is set to 0 for bi-prediction in merge_mvd mode. The reference picture on which mvd_ls is added to mvp is the picture indicated by the reference index in the other list.

Otherwise if inter_pred_mode in merge parameter is bi-prediction, same reference picture as for the merge mode is used for the merge mvd mode. The reference picture on which mvd_ls is added to mvp is selected based on the distance to the current picture.

The detailed relationship between merge parameter in merge mode and parameters of motion compensation in merge mvd mode is presented in the following table.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000949

parameters of motion compensation in merge mvd mode	inter pred mode in merge parameter			
	Uni-pred(L0)	Uni-pred(L1)	Bi-pred	
			abs(poc_ref_l0-cur_poc) <=abs(poc_ref_l1-cur_poc)	abs(poc_ref_l0-cur_poc) >abs(poc_ref_l1-cur_poc)
ref_idx_l0	ref_idx_l0 in merge parameter	0	ref_idx_l0 in merge parameter	ref_idx_l0 in merge parameter
ref_idx_l1	0	ref_idx_l1 in merge parameter	ref_idx_l1 in merge parameter	ref_idx_l1 in merge parameter
mvp_l0	mvp_l0 in merge parameter	scaled mvp_l1	mvp_l0 in merge parameter	mvp_l0 in merge parameter
mvp_l1	scaled mvp_l0	mvp_l1 in merge parameter	mvp_l1 in merge parameter	mvp_l1 in merge parameter
mvd_l0	not transmitted	mvd_ls (transmitted)	not transmitted	mvd_ls (transmitted)
mvd_l1	mvd_ls (transmitted)	not transmitted	mvd_ls (transmitted)	not transmitted
mv_l0	mvp_l0	mvp_l0 + mvd_l0	mvp_l0	mvp_l0 + mvd_l0
mv_l1	mvp_l1 + mvd_l1	mvp_l1	mvp_l1 + mvd_l1	mvp_l1

The merge mvd mode is signaled by merge_mvd_flag that is inserted just after inter_pred_flag. CABAC context model for merge_mvd_flag is the same as for merge_flag. Merge_mvd_flag for CAVLC is transmitted when ref_idx_l0 and ref_idx_l1 are equal to 0.

For use of merge mvd mode to flexible encoding environment, three configurations will be tested. In ADD_MRG01-02, merge_idx is transmitted just after merge mvd flag. The number of the candidates is the same as merge mode. The decoding specification is identical in ADD_MRG01-02. The difference between ADD_MRG01 and ADD_MRG 02 is whether to use additional motion estimation in encoder. ADD_MRG01 uses no additional motion estimation. ADD_MRG02 uses additional motion estimation. In ADD_MRG01, mvd_ls is determined by just calculating difference for the motion vector that has been detected for AMVP mode. Motion estimation for merge mvd mode is executed as bi-pred ME for small search area. Initial search position is based on motion vector that has been calculated for AMVP mode with motion estimation in the HM4.0.

Furthermore, it will be tested not to transmit merge_idx for the merge mvd mode in ADD_MRG03. The merge mvd mode can be used only for one merge candidate indicated by merge_idx equal to 0 in the case of merge mode. merge_mvd_mode is inferred to be equal to 0.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000950

Test	Description	Related Doc.	Tester1	Tester2
MRG_MVD01	five candidates No additional ME	JCTVC-F373	JVC Kenwood	Fujitsu
MRG_MVD02	five candidates Additional ME	JCTVC-F373	JVC Kenwood	Panasonic
MRG_MVD03	one candidate (merge_idx = 0) Additional ME	JCTVC-F373	JVC Kenwood	Qualcomm

2.6 Merge/Skip operations for identical motion

During the 6th JCT-VC meeting, it was reported in JCTVC-F356 that roughly 30% and 5% area of forward B-Slices are observed to have identical motion information (i.e., mvL0==mvL1 and refPOC0==refPOC1) within each PU, under HM3 LD and RA configuration, respectively. It was also indicated that Merge and Skip operations in this case could be modified to maximize the bi-prediction averaging effect for improved coding efficiency.

In this category of this CE, several methods for improving coding efficiency for identical motion cases are to be investigated. The criterion for selection of the technology will be whether a better trade-off between coding efficiency and runtime than HM 4.0 could be achieved or not.

Summary of relevant contributions and corresponding tests to be conducted are listed as follows:

JCTVC-F325 Modified temporal MV derivation process for merge/skip mode [T. Shiodera, A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)]

In Proposal-2 of this contribution, if the two reference frames for the collocated MV candidates are identical, collocated picture for L1 motion vector is changed from RefPicList1[0] to RefPicList1[1].

This method corresponds to "Variation A" of MRG_ID01 in this CE. In "Variation B" of MRG_ID01, the same derivation process as the above is performed if both reference frames and MVs of the collocated merge candidates are identical,

JCTVC-F712 Additional results on JCTVC-F356 (MC complexity reduction) [H. Y. Kim (ETRI), K. Y. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)]

The goal of this contribution is to improve coding efficiency when the collocated motion information of a bi-predicted Merge/SKIP PU is identical (i.e., mvL0==mvL1 and refPOCL0==refPOCL1 for the collocated merge candidate).

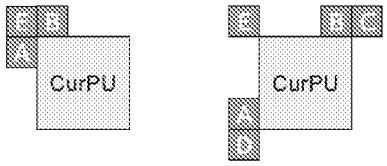
In Method-B of this contribution, the PUs spatially neighboring to the current PU are searched for a non-zero motion vector when the identical motion is recognized. More specifically, list0 MVs are searched for this purpose. If such a MV is found, it is used as mvL1Col. If the MVs are still the same, the prediction mode is inferred to uni-prediction rather than bi-prediction. This method corresponds to test MRG_ID02 of this CE.

During the discussion of this contribution in the 6th JCT-VC meeting, a participant suggested to, instead of looking for a MV that is non-zero, look for one that is different from what would otherwise be inferred. If no MV is found, the prediction mode is inferred to uni-prediction rather than bi-prediction. This method corresponds to MRG_ID03 of this CE.

Note that, when performing MRG_ID02 and MRG_ID03 tests, the HM4.0 Merge candidates would be searched instead of the originally proposed search positions in JCTVC-F712, so as to make the proposed

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000951

scheme to be more aligned and consistent to HM4.0. The following figure compares the search positions of JCTVC-F712 and HM4.0.



<JCTVC-F712> <HM 4.0>

Related to MRG_ID02 and MRG_ID03 tests, the following two ways of handling the refIdxL1Col would also be investigated: 1) keep the refIdxL1Col and search for such a MV that the reference picture of which is the same as the one pointed by refIdxL1Col, 2) ignore the original refIdxL1Col, search for a MV, then assign the list1 reference index pointing to the reference picture of the found MV as refIdxL1Col. These two variations are identified by "A" and "B", respectively, in the following table.

Combination of the best results would also be tested as listed in the following table. These combinatory tests correspond to test MRG_ID04 and MRG_ID05.

Test	Description	Related Doc.	Variation	Tester1	Tester2
MRG_ID01	MV from different collocated picture	JCTVC-F325	A: When refPOCs are identical	Toshiba	ETRI/KHU
			B: When both MVs and refPOCs are identical	Toshiba	ETRI/KHU
MRG_ID02	Non-zero MV from spatial neighbor	JCTVC-F712	A: Keep the original refIdxL1Col	ETRI/KHU	Samsung
			B: Derive refIdxL1Col from the one related to the found MV	ETRI/KHU	Samsung
MRG_ID03	Different MV from spatial neighbor	JCTVC-F712	A: Keep the original refIdxL1Col	ETRI/KHU	LGE
			B: Derive refIdxL1Col from the one related to the found MV	ETRI/KHU	LGE
MRG_ID04	Combination of MRG_ID02 and MRG_ID03 (Non-zero and different MV from spatial neighbor)		A: Keep the original refIdxL1Col	ETRI/KHU	Toshiba
			B: Derive refIdxL1Col from the one related to the found MV	ETRI/KHU	Toshiba
MRG_ID05	Combination of the best result from MRG_ID01 and the best result from {MRG_ID02, MRG_ID03, MRG_ID04}			Toshiba	Canon

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000952

3 Test Sequences / Test Points / SW Configuration

Simulation results will be generated for sequences and coding conditions specified in the document JCTVC-F900. Latest version of the HM (HM 4.0) will be used for evaluation.

4 Definition of Performance Measurement Criteria

4.1Coding Performance Measurements

Measure impact on bitrate/PSNR using provided data (4 points, BD-Rate).

4.2Complexity Considerations

To provide an indicative assessment of complexity, the following numbers should be provided:

- Encoding time (compared to the default configuration)
- Decoding time (compared to the default configuration)

5 Timeline

T1	4 weeks after the meeting (2011-August 19)	Final CE description and description of proposals
T2	HM4.0 is available (2011-August 23)	Start of tool integration
T3	3 weeks after HM4.0 is available (2011-September 13)	Completion of tool integration, test configuration announcement Start of testing
T4	2011-October 7	Testing complete Reporting of all results to CE9 participants complete
T5	2011-October 21	Input documents uploaded
T6	2011-October 28	CE9 summary report uploaded

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000953

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Guy Randall Gosnell/Jennifer Son
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	25582769
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Guy Randall Gosnell/Jennifer Son
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/467264
Receipt Date:	25-APR-2016
Filing Date:	01-NOV-2012
Time Stamp:	11:57:03
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	10067
Deposit Account	160605
Authorized User	Son, Jennifer
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 CFR 1.16 (National application filing, search, and examination fees) Charge any Additional Fees required under 37 CFR 1.17 (Patent application and reexamination processing fees)	

Charge any Additional Fees required under 37 CFR 1.19 (Document supply fees)

Charge any Additional Fees required under 37 CFR 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264IDS.pdf	55539 2d8a67e936197b231403b2c5f2527a0e64077a81	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
2	Non Patent Literature	467264EPSearchReport.pdf	409069 18bcd27e8123f6fb6e1cf16a492a8efcf6456fba	no	10
Warnings:					
Information:					
3	Non Patent Literature	467264Nakamura.pdf	111757 b48f442aa41baa31284cd4d6f51e92bcbdff93fa	no	10
Warnings:					
Information:					
4	Non Patent Literature	467264Zheng.pdf	71392 0e99b072d5795e76a4c8b9cf52152094370fefbc	no	6
Warnings:					
Information:					
5	Non Patent Literature	467264Jeon.pdf	189110 152b68a3d2351235d1a13b37ab011b7526be04c7	no	7
Warnings:					
Information:					
6	Non Patent Literature	467264Bici.pdf	151614 26faa339bbc8cc9472aa2ca49c403dc615a13dd1	no	13
Warnings:					
Information:					

7	Non Patent Literature	467264Bross.pdf	141579 fbcd49e67ab749f018fe313b5b018ca5dffa7a1b	no	11
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	30676 f625f35af130b8f9315ab07547d4f4712386c286	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	1160736	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Bici et al.	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	November 1, 2012	Examiner:	Clifford Hilaire
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Final Office Action under 37 C.F.R. § 1.113. The Final Office Action was mailed on March 1, 2016.

Attached is a list of documents on form SB08 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

PATENT

RESPONSE UNDER 37 C.F.R. 1.116 - EXPEDITED PROCEDURE - EXAMINING GROUP 2488

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/666,680	Confirmation No.: 4782
Applicant(s):	Bici et al.	
Filed:	November 1, 2012	
Art Unit:	2488	
Examiner:	Clifford Hilaire	
Title:	METHOD FOR CODING AND AN APPARATUS	

Docket No.: 042933/467264
Customer No.: 10949

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER FINAL UNDER 37 CFR § 1.116

In response to the Final Office Action dated March 1, 2016, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 13 of this paper.

Amendments to the Claims:

1. (Currently Amended) A method comprising:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

2. (Original) The method according to claim 1 comprising selecting spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order.

3. (Original) The method according to claim 1 , comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000961

4. (Original) The method according to claim 1 comprising examining whether the received block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

5. (Original) The method according to claim 1, further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number .

6. (Currently Amended) The method according to claim 5 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether [[a]] the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

for [[the]] a potential spatial motion vector prediction candidate on [[the]] a left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit~~, and the prediction unit is the second prediction unit~~;
- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000962

candidate has essentially similar motion information than [[the]] a spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is on [[the]] a right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000963

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

7. (Original) The method according to claim 1 further comprising including a temporal motion prediction candidate into the merge list.

8. (Original) The method according to claim 1 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the block of pixels.

9. (Currently Amended) A method comprising:

receiving an encoded block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of another spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000964

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

10. (Original) The method according to claim 9 comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

11. (Original) The method according to claim 9 comprising examining whether the received encoded block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

12. (Original) The method according to claim 9 further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number.

13. (Currently Amended) The method according to claim 12 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether [[a]] <u>the</u> prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000965

for [[the]] a potential spatial motion vector prediction candidate on [[the]] a left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit~~, and the prediction unit is the second prediction unit~~;
- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than [[the]] a spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is on [[the]] a right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000966

potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit; and

for [[the]] a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

14. (Original) The method according to claim 9 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the received encoded block of pixels.

15. (Currently Amended) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive a block of pixels including a prediction unit;

determine a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000967

determine a subset of spatial motion vector-prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

if at least one the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

16. (Currently Amended) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive an encoded block of pixels including a prediction unit;

determine a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determine a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000968

exclude the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other

17. (Currently Amended) A non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

18. (Currently Amended) A non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving an encoded block of pixels including a prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000969

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

19. (Currently Amended) An apparatus comprising:

means for receiving a block of pixels including a prediction unit;

means for determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

means for selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

means for determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000970

means for comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

means for excluding the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other.

20. (Currently Amended) An apparatus comprising:

means for receiving an encoded block of pixels including a prediction unit;

means for determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

means for selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is selected based on the motion information;

means for determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

means for comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset; and

means for excluding the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000971

REMARKS

Claim Rejections - 35 USC § 112

Claims 6 and 13 were rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. Claims 6 and 13 were amended accordingly. No new matter is added by this amendment. The rejection of Claims 6 and 13 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, is therefore overcome.

Claim Rejections - 35 USC § 103

Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, and 20 were rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Woo-Jin Han et al. ("Improved video compression efficacy through flexible representation and corresponding extension of coding tools") in view of Shen-Chuan Tai et al ("A multi-pass true motion estimation scheme with motion vector propagation for frame rate up-conversion applications") and further in view of Ai-Mei Huang et al. (" A multistage motion vector processing method for motion-compensated frame interpolation")

The Office Action agrees that the Han does not teach or suggest the feature of "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit; determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate; comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates; if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000972

excluding the first spatial motion vector prediction candidate from the merge list," and cites Tai for these missing teachings from Han. (See the Office Action, page 10-11) Applicant respectfully asserts that Tai fails to cure the deficiencies of Han. While Applicants respectfully disagree with the above-noted rejections, Applicants have amended the independent claims to clarify and further distinguish the claims from the cited art. In this regard, the independent claims have been amended to recite that comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset. Support for the amendment is provided at least by paragraphs [0157]-[0159] and [0243] of the published application.

Applicant respectfully asserts that Tai fails to cure the deficiencies of Han. Specifically, the Office Action cites Col 1, ¶ 4-5 of Tai with respect to the rejection of these recitations of the independent claims (prior to their amendment). However, neither the cited portion nor any other portion of Tai teaches or suggests these elements. Instead, the cited portion describes selecting the minimum distortion in the current pass for reference in a future pass. Tai does not disclose or suggest various merge lists and the selection of certain merge list based on the motion information to store spatial motion vector prediction candidates. As such, Tai fails to teach or suggest excluding the spatial motion vector prediction candidate from the selected merge list. In addition, Tai does not teach or suggest such exclusion as Tai merely selects the PMV pattern with minimal distortion. Notably, Tai compares all the possible candidate pairs and does not teach or suggest comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset, as now recited by the amended independent claims.

Applicants therefore assert that none of the cited references and, therefore, no proper combination of the cited references teach or suggest: "comparing motion information of the first

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000973

spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison with other spatial motion vector prediction candidates that are not included within the subset," as recited by independent Claims 1, 9, and 15-20. For each of the foregoing reasons, it is submitted that the rejection under pre-AIA 35 USC § 103(a) of the independent claims, as amended, as well as the claims which depend therefrom, is overcome.

CONCLUSION

In view of the amendments to the claims and the remarks presented above, it is respectfully submitted that all of the claims of the present application are in condition for immediate allowance. It is therefore respectfully requested that a Notice of Allowance be issued. The Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

The patentability of the independent claims has been argued as set forth above and thus Applicants will not take this opportunity to argue the merits of the rejection with regard to specific dependent claims. However, Applicants do not concede that the dependent claims are not independently patentable and reserve the right to argue the patentability of dependent claims at a later date if necessary.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000974

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

Customer No. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

ELECTRONICALLY FILED USING THE EFS-WEB ELECTRONIC FILING SYSTEM OF THE UNITED STATES PATENT & TRADEMARK OFFICE ON July 1, 2016

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000975

Doc Code: A.NE.AFCP
Document Description: After Final Consideration Pilot Program Request

PTO/SB/434 (05-13)

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Practitioner Docket No.:	Application No.:	Filing Date:
042933/467264	13/666680	11/1/12
First Named Inventor:	**Title:**	
Bici et al.	METHOD FOR CODING AND AN APPARATUS	

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:
    - Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
    - The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
        - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
        - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
            - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
            - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature	Date
/Guy R. Gosnell/	2016-07-01
Name (Print/Typed) Guy R. Gosnell	**Practitioner Registration No.** 34610

***Note**: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

☐ * Total of _____ forms are submitted.

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Guy Randall Gosnell/Lauren Martin
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	200	200
Miscellaneous:				
			Total in USD ($)	**200**

Electronic Acknowledgement Receipt

EFS ID:	26242185
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Guy Randall Gosnell/Lauren Martin
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/467264
Receipt Date:	01-JUL-2016
Filing Date:	01-NOV-2012
Time Stamp:	15:05:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$200
RAM confirmation Number	070516INTEFSW00002226160605
Deposit Account	160605
Authorized User	Lauren Martin
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2016-07-01-467264-AmendAF-AFCP-AsFiled.PDF	272031 1baebd60cbbcec0935c82799c65aa6ac2b1c9154	yes	17
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Response After Final Action		1	1	
	Claims		2	12	
	Applicant Arguments/Remarks Made in an Amendment		13	16	
	After Final Consideration Program Request		17	17	
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30860 08f8a898cfff7c170be2f486b30584c8788eb2ee	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	302891		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/666,680	Filing Date 11/01/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	07/01/2016	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 8	Minus	***8	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/GAIL WOOTEN/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 07/11/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
HILAIRE, CLIFFORD

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
07/11/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000983

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 13/666,680	**Applicant(s)** BICI ET AL.	
	Examiner CLIFFORD HILAIRE	**Art Unit** 2488	**AIA (First Inventor to File) Status** No

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 01 July 2016 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☒ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☒ The period for reply expires 4 months from the mailing date of the final rejection.
   b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection. The current period for reply expires months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.
   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANT'S FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☒ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☒ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☐ They raise the issue of new matter (see NOTE below);
   c) ☒ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: *See Continuation Sheet*. (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicant's reply has overcome the following rejection(s): _____.
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☒ For purposes of appeal, the proposed amendment(s): (a) ☒ will not be entered, or (b) ☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
13. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☒ Other: See Attachment PTO-2323.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
    Claim(s) allowed: .
    Claim(s) objected to: .
    Claim(s) rejected: 1-20.
    Claim(s) withdrawn from consideration: .

/CLIFFORD HILAIRE/ Examiner, Art Unit 2488	/Geepy Pe/ Primary Examiner, Art Unit 2488

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000984

Continuation of 3. NOTE: Amendments "without making a comparison with other spatial motion vector prediction candidates that are not included within the subset" to independent claims 1, 9, 15, 15, 17, 18, 19 and 20 changed the scope of the claim enough to require further extensive search. Applicant's request for entry into AFCP 2.0 is acknowledged, but is denied because the response cannot be reviewed and a search conducted in the limited amount of time authorized for this pilot program. Therefore, the response is being reviewed under pre-pilot practice.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000985

AFCP 2.0 Decision	Application No.	Applicant(s)
	13/666,680	BICI ET AL.
	Examiner	Art Unit
	CLIFFORD HILAIRE	2488

This is in response to the After Final Consideration Pilot request filed 07/01/2016.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

   ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.

   ☐ A non-broadening amendment to at least one independent claim was not submitted.

   ☐ A proper AFCP 2.0 request was submitted in response to the most recent final rejection.

   ☐ Other:

2. **Proper Request**

   A. After final amendment submitted with the request will not be treated under AFCP 2.0.
   The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

   ☒ The after final amendment will be treated under pre-pilot procedure.

   B. Updated search and/or completed additional consideration.
   The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

   ☐ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.

   ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action. See attached interview summary for further details.

   ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.

   ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.

   ☐ 5. Other:

   Examiner Note: Please attach an interview summary when necessary as described above.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000986

07/05/2016

PATENT

RESPONSE UNDER 37 C.F.R. 1.116 - EXPEDITED PROCEDURE - EXAMINING GROUP 2488

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/666,680	Confirmation No.: 4782
Applicant(s):	Bici et al.	
Filed:	November 1, 2012	
Art Unit:	2488	
Examiner:	Clifford Hilaire	
Title:	METHOD FOR CODING AND AN APPARATUS	

Docket No.: 042933/467264
Customer No.: 10949

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER FINAL UNDER 37 CFR § 1.116

In response to the Final Office Action dated March 1, 2016, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 13 of this paper.

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Jul 11, 2016 05:28:57 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	CTAV	07/11/2016	042933/467264
	A.NE.AFCP.D	07/11/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 08/19/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
HILAIRE, CLIFFORD

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
08/19/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000989

Applicant-Initiated Interview Summary	**Application No.**	**Applicant(s)**	
	13/666,680	BICI ET AL.	
	Examiner	**Art Unit**	
	CLIFFORD HILAIRE	2488	

All participants (applicant, applicant's representative, PTO personnel):

(1) *CLIFFORD HILAIRE*.

(2) *GUY GOSNELL (Reg. No 34,610)*.

(3) *RAGIP KURCEREN (Reg No. 60,158)*.

(4)_____.

Date of Interview: *09 August 2016*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1*.

Identification of prior art discussed: *Woo-Jin Han et al. ["Improved Video Compression Efficiency Through Flexible Unit Representation and Corresponding Extension of Coding Tools"], Shen-Chuan Tai et al.["A Multi-Pass True Motion Estimation Scheme With Motion Vector Propagation for Frame Rate Up-Conversion Applications"] and Ai-Mei Huang et al. ["A Multistage Motion Vector Processing Method for Motion-Compensated Frame Interpolation"].*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Applicant presented tentative amendment to limitation "comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates" by appending "without making a comparison with other spatial motion vector prediction candidates that are not included within the subset" to overcome the prior references of record.
Examiner let the Applicant know that no support was found in the original disclosure to support such amendment as claimed.
Examiner further elaborate that more explicit language needs to be added to the claim to elaborate on the use of the role "merge list" vis-à-vis "determining a subset of spatial motion vector prediction candidates…" and distinguish the invention from the prior reference on record..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/CLIFFORD HILAIRE/ Examiner, Art Unit 2488	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000990

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

———

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Aug 19, 2016 05:44:50 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	INTV.SUM.APP	08/19/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Aug 19, 2016 05:44:50 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	INTV.SUM.APP	08/19/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Aug 19, 2016 05:44:50 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	INTV.SUM.APP	08/19/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Aug 19, 2016 05:44:50 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	INTV.SUM.APP	08/19/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	13/666,680
Filing Date	11/01/2012
First Named Inventor	Bici
Art Unit	2488
Examiner Name	Clifford Hilaire
Attorney Docket Number	042933/467264

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      Ii. ☐ Other _____

   b. ☑ Enclosed

      I. ☑ Amendment/Reply

      ii. ☐ Affidavit(s)/ Declaration(s)

      iii. ☐ Information Disclosure Statement (IDS)

      iv. ☐ Other _____

2. Miscellaneous

   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 16-0605.

      i. ☑ RCE fee required under 37 CFR 1.17(e)

      ii. ☑ Extension of time fee (37 CFR 1.136 and 1.17)

      iii. ☐ Other _____

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/Guy R. Gosnell/	Date	2016-09-01
Name (Print/Type)	Guy R. Gosnell	Registration No.	34610

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature			
Name (Print/Type)		Date	

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/666,680	Confirmation No.: 4782
Applicant(s):	Bici et al.	
Filed:	November 1, 2012	
Art Unit:	2488	
Examiner:	Clifford Hilaire	
Title:	METHOD FOR CODING AND AN APPARATUS	

Docket No.: 042933/467264
Customer No.: 10949

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

In response to the Final Office Action dated March 1, 2016 and the Advisory Action dated July 11, 2016 and concurrent with the filing of a Request for Continued Examination, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 16 of this paper.

Amendments to the Claims:

1. (Currently Amended) A method comprising:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

determining a subset of spatial motion vector prediction candidates based on ~~the~~ a location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

causing information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000998

2. (Original) The method according to claim 1 comprising selecting spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order.

3. (Original) The method according to claim 1, comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

4. (Original) The method according to claim 1 comprising examining whether the received block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

5. (Original) The method according to claim 1, further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number .

6. (Currently Amended) The method according to claim 5 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether [[a]] <u>the</u> prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 000999

for [[the]] a potential spatial motion vector prediction candidate on [[the]] a left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit~~, and the prediction unit is the second prediction unit~~;
- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than [[the]] a spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is on [[the]] a right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001000

potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

7. (Original) The method according to claim 1 further comprising including a temporal motion prediction candidate into the merge list.

8. (Original) The method according to claim 1 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the block of pixels.

9. (Currently Amended) A method comprising:

receiving an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001001

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of another spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

selecting a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

10. (Original) The method according to claim 9 comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

11. (Original) The method according to claim 9 comprising examining whether the received encoded block of pixels is divided into a first prediction unit and a second prediction

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001002

unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

12. (Original) The method according to claim 9 further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number.

13. (Currently Amended) The method according to claim 12 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether [[a]] the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

for [[the]] a potential spatial motion vector prediction candidate on [[the]] a left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit~~, and the prediction unit is the second prediction unit~~;
- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than [[the]] a spatial motion vector prediction candidate above the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001003

for [[the]] a potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is on [[the]] a right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for [[the]] a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit; and

for [[the]] a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001004

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

14. (Original) The method according to claim 9 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the received encoded block of pixels.

15. (Currently Amended) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive a block of pixels including a prediction unit;

determine a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

determine a subset of spatial motion vector-prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001005

if at least one the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, ~~excluding~~ exclude the first spatial motion vector prediction candidate from the merge list; and

cause information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

16. (Currently Amended) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

determine a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates;

determine a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001006

exclude the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other; and

select a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

17. (Currently Amended) A non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001007

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

causing information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

18. (Currently Amended) A non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001008

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

selecting a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

19. (Currently Amended) An apparatus comprising:

means for receiving a block of pixels including a prediction unit;

means for determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

means for selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

means for determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

means for comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001009

means for excluding the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other; and

means for causing information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

20. (Currently Amended) An apparatus comprising:

means for receiving an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

means for determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

means for selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is ~~selected~~ constructed based on the motion information of the spatial motion vector prediction candidates;

means for determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

means for comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric; ~~and~~

means for excluding the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other; and

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001010

means for selecting a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001011

REMARKS

Interview

At the outset, Applicant's undersigned representative notes with appreciation the interview conducted August 9, 2016. During the interview, the claims were discussed and the Examiner suggested that the merge list be further defined in order to distinguish the claims from the cited references. The independent claims have now been amended to further define the merge list. In this regard, independent Claims 1, 15, 17 and 19 have been amended to recite that the merge list is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit. See at least paragraph [0133] of the published application. Additionally, independent Claims 1, 15, 17 and 19 have been amended to recite that information identifying the one spatial motion vector prediction candidate from the merge list is caused to be transmitted to a decoder or to be stored. See at least paragraphs [0223] and [0244] of the published application. Similarly, independent Claims 9, 16, 18 and 20 have been amended to recite the receipt of information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder. See at least paragraph [0244] of the published application. Additionally, independent Claims 9, 16, 18 and 20 have been amended to recite that the spatial motion vector prediction candidate is selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate. Id. Thus, the merge list has been further defined as suggested by the Examiner in order to further distinguish the claims from the cited references.

During the interview, the Examiner also suggested a couple of other terms that could be clarified and further defined. Each of these other terms identified by the Examiner has also been addressed by the amended set of claims. For example the manner in which motion information of the first spatial motion vector prediction candidate is compared with motion information of the subset spatial motion vector prediction candidates has been further defined by each of the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001012

independent claims. In this regard, the comparison has now been defined to include the performance of an equivalence check or comparing a difference in motion information to a threshold or other similarity metric.

Claim Rejections - 35 USC § 112

Claims 6 and 13 were rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. Claims 6 and 13 were amended accordingly. No new matter is added by this amendment. The rejection of Claims 6 and 13 under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, is therefore overcome.

Claim Rejections - 35 USC § 103

Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19 and 20 were rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Woo-Jin Han et al. ("Improved video compression efficacy through flexible representation and corresponding extension of coding tools") in view of Shen-Chuan Tai et al ("A multi-pass true motion estimation scheme with motion vector propagation for frame rate up-conversion applications") and further in view of Ai-Mei Huang et al. (" A multistage motion vector processing method for motion-compensated frame interpolation")

The Office Action recognizes that the Han does not teach or suggest the feature of "selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit; determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate; comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001013

determined subset of spatial motion vector prediction candidates; if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list," and cites Tai for these missing teachings from Han. (See the Office Action, page 10-11) Applicant respectfully asserts that Tai fails to cure the deficiencies of Han. While Applicants respectfully disagree with the above-noted rejections, Applicants have amended the independent claims to clarify and further distinguish the claims from the cited art. In this regard, the independent claims have been amended to recite that comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates is performed without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates. Support for the amendment is provided at least by paragraphs [0153] and [0158] of the published application.

Applicant respectfully asserts that Tai fails to cure the deficiencies of Han. Specifically, the Office Action cites Col 1, ¶ 4-5 of Tai with respect to the rejection of these recitations of the independent claims (prior to their amendment). However, like, Han, neither the cited portion nor any other portion of Tai teaches or suggests comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, as recited by the amended independent claims. Instead, the cited portion of Tai describes selecting the minimum distortion in the current pass for reference in a future pass. Tai does not disclose or suggest the comparison of motion information of certain spatial motion vector prediction candidates during the construction of a merge list without comparing every possible candidate pair from the set of spatial motion vector prediction candidates. As such, Tai fails to teach or suggest excluding the spatial motion vector prediction candidate from the selected merge list. Indeed, Tai selects the PMV pattern with the minimal distortion following the comparison of all the possible candidate pairs.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001014

Applicants therefore assert that none of the cited references and, therefore, no proper combination of the cited references teach or suggest: "comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates," as recited by independent Claims 1, 9 and 15-20, as amended. For this reason as well as those highlighted above in conjunction with the amendments to the independent claims that were introduced as a result of the interview, it is submitted that the rejection under pre-AIA 35 USC § 103(a) of the independent claims, as amended, as well as the claims which depend therefrom, is overcome.

CONCLUSION

In view of the amendments to the claims and the remarks presented above, it is respectfully submitted that all of the claims of the present application are in condition for immediate allowance. It is therefore respectfully requested that a Notice of Allowance be issued. The Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

The patentability of the independent claims has been argued as set forth above and thus Applicants will not take this opportunity to argue the merits of the rejection with regard to specific dependent claims. However, Applicants do not concede that the dependent claims are not independently patentable and reserve the right to argue the patentability of dependent claims at a later date if necessary.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001015

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

Customer No. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

ELECTRONICALLY FILED USING THE EFS-WEB ELECTRONIC FILING SYSTEM OF THE UNITED STATES PATENT & TRADEMARK OFFICE ON September 1, 2016.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001016

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Guy Randall Gosnell/Lauren Martin
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $200 paid	1253	1	1200	1200
Miscellaneous:				
RCE- 1st Request	1801	1	1200	1200
		Total in USD ($)		**2400**

Electronic Acknowledgement Receipt

EFS ID:	26817159
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Guy Randall Gosnell/Lauren Martin
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/467264
Receipt Date:	01-SEP-2016
Filing Date:	01-NOV-2012
Time Stamp:	16:35:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$2400
RAM confirmation Number	090216INTEFSW00003318160605
Deposit Account	160605
Authorized User	Lauren Martin
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2016-09-01-467264-RCE-Amend-AsFiled.PDF	752411 555aaa5a75a624450360760 3c43b3c94b8f9b9ca	yes	21

Multipart Description/PDF files in .zip description

Document Description	Start	End
Request for Continued Examination (RCE)	1	1
Amendment Submitted/Entered with Filing of CPA/RCE	2	2
Claims	3	16
Applicant Arguments/Remarks Made in an Amendment	17	21

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32568 ab3d89e9cf3a91c0039e5cfa1afc48ae8b93c08a	no	2

Warnings:

Information:

Total Files Size (in bytes):	784979

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application No. 2014-7015093 dated August 22, 2016	YES

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36636444v1

Submitted September 2, 2016

Electronic Acknowledgement Receipt

EFS ID:	26823436
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	02-SEP-2016
Filing Date:	01-NOV-2012
Time Stamp:	11:41:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	467264-KR_OA-8-22-2016.PDF	1383740 98ef2a151da3eef0b2bc088fff08b988adb6fa8e	no	5

Warnings:

Information:					
2		467264-IDS.pdf	136711 88a6dcf26fbf301e33c7fdc9ef77d92244b8090f	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
		Total Files Size (in bytes):	1520451		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

OA Office Action, Due 22.09.2016,
"Final Rejection Date 22.08.2016, Appeal or RCE Case"
Korean Patent Appln. No. 2014-7015093

• Type of Action:	Notice of Final Rejection
• Due Date:	August 22, 2016
• Pending Claim(s):	Claims 1 to 28
• Rejected Claim(s):	Claims 1, 2, 5 to 7, 10 to 12, 15 to 17 and 20 to 22
• Allowable Claim(s):	Not indicated
• Rejection Ground(s):	Lack of inventiveness [Claims 1, 2, 5 to 7, 10 to 12, 15 to 17 and 20 to 22]
• Cited reference(s):	The same reference as cited in the preliminary rejection dated August 21, 2015. (T. Wiegand et al., "WD3: Working Draft 3 of High Efficiency Video Coding", 5th Meeting: Geneva, CH, 16-23 March, 2011)

Summary of the rejection reasons

In the Final Rejection, after reexamining the subject application on the basis of the Remarks and the Amendments submitted on February 22, 2016, the Examiner continues to take the position that claims 1, 2, 5 to 7, 10 to 12, 15 to 17 and 20 to 22 of the subject application are still obvious over the cited reference.

Specifically, the Examiner alleges that all of the features recited in claim 1 can be readily derived by those skilled in the art from the cited reference for the reasons summarized below:

> In the Amendments, Applicant has corrected certain expressions recited in some of the claims in order to address the claim indefiniteness rejection reasons; and has amended claims 5, 10, 15 and 20 by way of adding thereto the feature of "*providing in an encoded bitstream an index to the merge list identifying the selected motion vector prediction for the block of pixels*" in order to overcome the art-based rejection reasons. Further, Applicant has added new dependent claims 23 to 28.
>
> In the Remarks, Applicant argued that the cited reference merely discloses that each of the merging candidates in the merging candidate list are compared with **every** other available candidates to remove the redundant candidates, and, thus, the cited reference fails to disclose or suggest, among other things, the features of "*determining a subset of spatial motion vector predictions based on the location of the*

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001025

block associated with the first spatial motion vector prediction candidate; ***comparing motion information of the first spatial motion vector prediction candidate [only] with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates****, […] if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list*," (emphasis added) as recited in claim 1.

However, Applicant's response above does not place the subject application in condition for allowance, as further discussed below.

With regard to the above-mentioned features of claim 1, the cited reference discloses motion vector predictor candidates derived from neighboring prediction units (*see* section "8.4.2.1.4 Derivation process for luma motion vector prediction" thereof) and the positions of such neighboring prediction units (*see* Fig. 8-5 thereof). The cited reference further discloses that the motion vector predictor list, mvpListLX, is allowed to include as its elements mvLXCol, mvLXA and/or mvLXB only when the respective flags corresponding thereto are set to 1 (*see* section "8.4.2.1.4 Derivation process for luma motion vector prediction" thereof). Such teachings of the cited reference suggest that mvpListLX corresponds to the claimed **subset** of spatial motion vector prediction candidates. Accordingly, it is believed that the claimed feature for excluding certain motion vector prediction from the merge list by way of using the limited number of comparison can be easily conceived from the above-mentioned teachings of the cited reference. Accordingly, Applicant's arguments are not persuasive, and claim 1 is still obvious over the cited reference. The remaining independent claims, i.e., claims 6, 11, 16, 21 and 22, have substantially the same technical features as those of claim 1, except for their categories; and therefore, are also obvious over the cited reference for the same reasons as set forth above with regard to claim 1.

With regard to the feature added to claims 5, 10, 15 and 20, such feature can be easily conceived by those skilled in the art from the cited reference which discloses that the prediction candidates are generated based on the motion vectors of the spatial neighbors relative to the current prediction unit (*see* Fig. 8-4 thereof) and that the motion vector predictor list, mvpListLX, is constructed (*see* section "8.4.2.1.4 Derivation process for luma motion vector prediction" thereof).

Please note that newly added claims 23 to 28 has not yet been examined.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001026

발송번호: 9-5-2016-060126378
발송일자: 2016.08.22.

수신 서울특별시 서초구 마방로 60 (양재동, 트러스트 타워)(제일특허법인)
제일특허법인[이혜원]

06775

YOUR INVENTION PARTNER

특 허 청

3년의 혁신 30년의 성장

특허거절결정서

출 원 인 성 명 노키아 테크놀로지스 오와이 (출원인코드: 520150079753)
주 소 핀랜드 02610 에스푸 카라포티 3
대 리 인 명 칭 제일특허법인
주 소 서울특별시 서초구 마방로 60 (양재동, 트러스트 타워)(제일특허법인)
지정된변리사 이혜원 외 2명

출 원 번 호 10-2014-7015093
발 명 의 명 칭 비디오 인코딩 방법 및 장치

2016.02.22.자 접수된 [명세서등 보정]보정서 및 [거절이유 등 통지에 따른 의견]의견(답변, 소명)서에 의하여 다시 심사한바 2015.08.21.자 거절이유를 해소하지 못하였으므로 이 출원에 대하여 특허법 제62조에 따라 거절결정합니다.

[다시 심사한 결과]

□ 심사 대상 청구항 : 제1-28항

□ 이 출원의 거절이유가 해소되지 않은 부분과 관련 법조항

순번	거절이유가 해소되지 않은 부분	관련 법조항
1	청구항 제1항, 제2항, 제5항, 제6항, 제7항, 제10항, 제11항, 제12항, 제15항, 제16항, 제17항, 제20항 내지 제22항	특허법 제29조제2항

[거절결정의 이유]

이 출원의 특허청구범위의 청구항 제1항, 제2항, 제5항, 제6항, 제7항, 제10항, 제11항, 제12항, 제15항, 제16항, 제17항, 제20항 내지 제22항에 기재된 발명은 아래와 같이 그 출원 전에 이 발명이 속하는 기술분야에서 통상의 지식을 가진 자가 용이하게 발명할 수 있는 것이므로 특허법 제29조제2항에 따라 특허를 받을 수 없습니다.

- 아 래 -

1-1. 보정서 및 의견서 내용

2016.02.22일자로 보정서와 의견서가 접수되었습니다. 상기 보정서에서, 출원인은 청구

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001027

항 제5,10,15,20항에 “픽셀 블록에 대한 움직임 벡터 예측, 병합 리스트에 대한 인덱스를 비트스트림에 제공”에 관한 사항을 추가하는 보정을 실시하였고, 제23항 내지 제28항을 신설하는 보정을 실시하였고, 나머지 항에는 기재를 명확하게 하는 수준의 보정을 하였습니다.

또한 의견서에서는 본원 발명의 특징부인 1)병합 리스트에 포함될 잠재적인 공간적 움직임 벡터 예측 후보(즉, 제1의 공간적 움직임 벡터 예측 후보)의 움직임 정보와, 제1의 공간적 움직임 벡터 예측 후보와 연관된 블록의 위치를 기초로 하여 결정한 공간적 움직임 벡터 예측들의 서브세트 내 상기 공간적 움직임 벡터 예측 후보들의 움직임 정보를 비교함으로써 제한된 일부 쌍에 대해서만 비교를 수행하는 특징이 인용발명1에 기재되어 있지 않아 본원 발명은 인용발명1과 상이하다고 주장하고 있습니다.

1-2. 보정서 및 의견서 검토

위 보정서에 나타난 보정된 내용과 의견서에서 출원인이 주장하는 바를 상세히 살펴보면, 이전 의견제출통지서에서 이미 전항에 대한 거절이유를 통지한 바 있고 새롭게 추가한 한정사항에 대해서는 인용발명1의 도면 8-4에 “현재 블록의 주변에 위치한 블록의 모션 벡터를 이용해 예측 후보로 생성”, 8.4.2.1.4 Derivation process for luma motion vector prediction에는 “모션 벡터 예측자 리스트 정보 mvpListLX를 정보를 생성”하는 것이 나타나 있어 본원 발명에서 추가된 구성부와 실질적으로 동일한 것입니다.

의견서에서 주장하는 것을 인용발명1에서 상세히 살펴보면, 본원 발명의 1)특징부와 대응되는 구성이 인용발명1의 8.4.2.1.4 Derivation process for luma motion vector prediction에는 “주변 예측 유닛으로 부터 모션 벡터 예측자 후보를 유추”, 도면 8-5에는 주변 예측 유닛의 위치가 나타나 있고, 또한 “병합 후보들이 동일한 값을 가지는 경우 리스트에서 제거”된다는 기재가 분명히 나타나 있으나, 의견서에서는 “중복되는 후보들을 병합 리스트에서 제외하기 위하여, 모든 쌍의 후보들의 비교가 필수적”이어서 인용발명1이 본원 발명과 차이가 난다고 주장하고 있으나 인용발명1의 8.4.2.1.4 Derivation process for luma motion vector prediction의 기재에는 모션 벡터 후보 리스트에는 mvLXCol과 mvLXA, mvLXB를 따로 관리하여 그 해당 플래그가 1일 경우에만 포함시키는 것이 나타나 있어 각각이 서브 셋에 해당하며, 이를 이용해서 동일한 값을 제거한다고 분명히 나타나 있습니다. 따라서 서브셋 별로 모션 벡터 예측 후보에 포함될 수 있는 것이므로 서브셋 별로 동일한 값을 제거하는 정도는 통상의 기술자 수준에서 단순 설계변경 사항에 불과합니다.

따라서 본원 발명의 주요 특징부가 이미 인용발명1에 나타나 있고 양자간의 차이는 단순한 설계 변경 상의 차이에 불과한 것이 분명하므로 본원 발명이 인용발명1과 차이가 있다는 주장은 받아들일 수 없습니다.

1-3. 결론

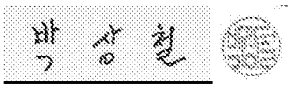
따라서, 출원인이 의견서에서 주장하는 차이점은 인정되지 않고, 구성면에서도 본원 발명의 모든 구성이 인용발명1에 나타나 있고, 목적과 효과면에서도 동일한 목적 및 효과가 있으므로 청구항 청구항 제1항, 제2항, 제5항, 제6항, 제7항, 제10항, 제11항, 제12항, 제15항, 제16항, 제17항, 제20항 내지 제22항은 의견제출통지의 거절이유를 여전히 포함하고 있어 인용발명1과 목적이 동일하고 효과의 현저성이 없으므로, 상기 인용발명1의 구성으로 통상의 기술자가 용이하게 발명할 수 있는 것이므로 거절결정합니다. 또한 신설된 항에 대

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001028

해서는 거절이유에 대한 판단을 실시하여 않았으나 보정시 상기의 거절이유가 그대로 적용 될 수 있어 그에 따라 보정하는 것이 바람직합니다. 끝.

2016.08.22.

특허청 특허심사3국

멀티미디어방송심사팀 심사관 박상철 

<< 재심사 청구, 거절결정 불복심판 청구 및 분할출원 안내 >>

1. 출원인은 이 거절결정서를 송달받은 날부터 30일 이내(심판청구기간)에 보정을 하여 특허청(출원과)에 재심사를 청구하거나 특허심판원에 거절결정불복심판 청구서를 제출하여 보정 없이 심판을 청구할 수 있습니다. 또한, 심판 청구기간에는 분할출원도 할 수 있습니다. 재심사 청구시에는 특허법 제47조제2항 및 제3항에 따른 범위 내에서 보정하실 수 있습니다.

2. 심판 청구기간(재심사 청구기간)은 특허법 제15조제1항에 따라 연장할 수 있습니다. 심판 청구기간을 연장하려는 경우에는 심판청구기간 만료일 7일 전까지 법정기간 연장신청서(특허법 시행규칙 별지 제10호서식)를 특허심판원으로 제출해 주시기 바랍니다.

3. 명세서 등의 보정은 반드시 특허법 시행규칙 별지 제9호서식을 이용해야 합니다.
(재심사 청구 시 반드시 '재심사청구 란'에 체크하시기 바랍니다.)

※ 이 통지서의 내용에 대해 문의사항이 있으시면 특허청 ☎ 042-481-8372(담당심사관 박상철)로, 서식 또는 절차에 대하여는 특허고객상담센터 ☎1544-8080로 문의하시기 바랍니다.

※ 우 35208 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001029

Attorney's Docket No. 042933/467264 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Mehmet Oguz Bici	Confirmation No.:	4782
Appl. No.:	13/666,680	Art Unit:	2488
Filed:	11/01/2012	Examiner:	Clifford Hilaire
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
CITATION UNDER 37 C.F.R. § 1.97

Attached is a list of documents on form SB08 along with a copy of any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2).

It is requested that the Examiner consider these documents and officially make them of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

Applicant notes that each item of information listed on form SB08 was cited in a communication from a foreign patent office in a counterpart foreign application. In addition, the communication from the foreign patent office was not received by any individual designated by 37 CFR 1.56(c) more than thirty (30) days prior to the filing of this Information Disclosure Statement.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

Customer No. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/666,680	Filing Date 11/01/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	09/01/2016	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 8	Minus	***8	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

SLIE
PATIENCE RESPER

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/666,680	Filing Date 11/01/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	09/01/2016	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
	Independent (37 CFR 1.16(h))	* 8	Minus	***8	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
STEFANIE BRYCE

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

10949 7590 09/30/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
AYNALEM, NATHNAEL B	
ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 09/30/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

TITLE OF INVENTION: METHOD FOR CODING AND AN APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	12/30/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001033

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 09/30/2016
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

TITLE OF INVENTION: METHOD FOR CODING AND AN APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	12/30/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
AYNALEM, NATHNAEL B	2488	375-240160

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29
  NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27
  NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status.
  NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001034

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 09/30/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
AYNALEM, NATHNAEL B	

ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 09/30/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001035

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	13/666,680	BICI ET AL.	
	Examiner	Art Unit	
	NATHNAEL AYNALEM	2488	

All participants (applicant, applicant's representative, PTO personnel):

(1) *NATHNAEL AYNALEM*. (3)_____.

(2) *GUY GOSNELL*. (4)_____.

Date of Interview: *23 September 2016*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☒112 ☐102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *19-32*.

Identification of prior art discussed: *N/A*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Examiner inquired the applicant's representative if there is any corresponding structure in the specification of the current application for a means plus function limitations as recited in claims 19 and 20. Applicant's representative indicated that he believes that there is a support in the specification for the means plus function, however, in order to advance the prosecution of this application, applicants will cancel claims 19 and 20 and will file a divisional application. Furthermore, applicant's representative indicated that applicants would like to add a new dependent claims 21-32 depended from independent claims 15 and 16 .

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/NATHNAEL AYNALEM/ Examiner, Art Unit 2488	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001037

Notice of Allowability	Application No. 13/666,680	Applicant(s) BICI ET AL.	
	Examiner NATHNAEL AYNALEM	Art Unit 2488	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed on 09/01/2016*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-18 and 21-32*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date *20160923* .
5. ☒ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/NATHNAEL AYNALEM/ Examiner, Art Unit 2488	/SATH V PERUNGAVOOR/ Supervisory Patent Examiner, Art Unit 2488

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001038

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 09/01/2016 has been entered.

Response to Amendment/Argument

3. Applicants' amendment/argument with respect to pending claims 1-20 filed on September 01, 2016 have been fully considered. In view of the amendment of the claims, in view of the applicants' argument, and an Examiner's Amendment appearing below, the rejection of all pending claims has been withdrawn. Thus, the current application is in condition for allowance.

EXAMINER'S AMENDMENT

4. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Guy Gosnell (Reg. No. 34, 610) on September 23, 2016.

Please amend claims 19-32 filed on 09/01/2016 as follows:

19. (Canceled)

20. (Canceled)

21. (New) The apparatus according to claim 15 wherein the apparatus is further caused to select spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order.

22. (New) The apparatus according to claim 15, wherein the apparatus is further caused to compare motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

23. (New) The apparatus according to claim 15 wherein the apparatus is further caused to examine whether the received block of pixels is divided into a first prediction unit and a second prediction unit; and if so, exclude the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

24. (New) The apparatus according to claim 15, wherein the apparatus is further caused to:

determine a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limit the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number .

25. (New) The apparatus according to claim 24 wherein the apparatus is further caused to:

examine, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examine whether the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, perform at least one of the following:

for a potential spatial motion vector prediction candidate on a left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit;
- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than a spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate, which is on a right side of the potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

26. (New) The apparatus according to claim 15 wherein the apparatus is further caused to include a temporal motion prediction candidate into the merge list.

27. (New) The apparatus according to claim 15 wherein the apparatus is further caused to select one motion vector prediction candidate from the merge list to represent a motion vector prediction for the block of pixels.

28. (New) The apparatus according to claim 16 wherein the apparatus is further caused to compare motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

29. (New) The apparatus according to claim 16 wherein the apparatus is further caused to examine whether the received encoded block of pixels is divided into a first prediction unit and a second prediction unit; and if so, exclude the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

30. (New) The apparatus according to claim 16 wherein the apparatus is further caused to:

determine a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limit the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number.

31. (New) The apparatus according to claim 30 wherein the apparatus is further caused to:

examine if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examine whether the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, perform at least one of the following:

for a potential spatial motion vector prediction candidate on a left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit;

– the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than a spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate, which is on a right side of the potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit; and

for a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– all the other potential spatial motion vector prediction candidates have been included in the merge list;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

32. (New) The apparatus according to claim 16 wherein the apparatus is further caused to select one motion vector prediction candidate from the merge list to represent a motion vector prediction for the received encoded block of pixels.

Allowable Subject Matter

5. Claims 1-18 and 21-32 are allowed.

6. The following is an examiner's statement of reasons for allowance: the amended claims are allowable due to applicants amending each of the independent claims 1, 9 and 15-18, and a persuasive argument by the applicants (Remarks dated 09/01/2016, pages 17-18). Specifically, the argument regarding the difference between the prior arts of record and the limitation "comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates," as recited the independent claims.

Dependent claims 2-8, 10-14 and 21-32 are allowed by virtue of their dependency from allowed claims 1, 9 and 15-18.

7. The following prior arts, Robertson et al. (US 2011/0176013 A1), Zhou (Pub. No. US 2012/0230408 A1), Zhou et al. (US 2012/0257678 A1), Chen et al. (Pub. No. US 2012/0269270 A1), Sugio et al. (Pub. No. US 2012/0300846 A1), Zhou (Pub. No. US 2012/0320984 A1), Sugio et al. (Pub. No. US 2013/0003850 A1), Sasai et al. (Pub. No. US 2013/0004092 A1), Zheng et al. (Pub. No. US 2013/0070855 A1), Coban et al. (Pub. No. 2013/0083853 A1) and Chen et al. (Pub. No. US 2013/0272408 A1) as a relevant prior arts. However, the pertinent prior arts do not teach the above patentable feature of the independent claims 1, 9 and 15-18.

8. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NATHNAEL AYNALEM whose telephone number is (571)270-1482. The examiner can normally be reached on Monday-Friday 7:30 to 5:00 EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sath V. Perungavoor can be reached on (571)272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/NATHNAEL AYNALEM/
Examiner, Art Unit 2488

/SATH V PERUNGAVOOR/

Supervisory Patent Examiner, Art Unit 2488

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	13/666,680	BICI ET AL.	
	Examiner	Art Unit	
	NATHNAEL AYNALEM	2488	

All participants (applicant, applicant's representative, PTO personnel):

(1) *NATHNAEL AYNALEM*. (3)_____.

(2) *GUY GOSNELL*. (4)_____.

Date of Interview: *23 September 2016*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☒112 ☐102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *19-32*.

Identification of prior art discussed: *N/A*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Examiner inquired the applicant's representative if there is any corresponding structure in the specification of the current application for a means plus function limitations as recited in claims 19 and 20. Applicant's representative indicated that he believes that there is a support in the specification for the means plus function, however, in order to advance the prosecution of this application, applicants will cancel claims 19 and 20 and will file a divisional application. Furthermore, applicant's representative indicated that applicants would like to add a new dependent claims 21-32 depended from independent claims 15 and 16 .

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/NATHNAEL AYNALEM/ Examiner, Art Unit 2488	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001048

Notice of References Cited	Application/Control No. 13/666,680	Applicant(s)/Patent Under Reexamination BICI ET AL.	
	Examiner NATHNAEL AYNALEM	Art Unit 2488	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2011/0176013 A1	07-2011	Robertson; Mark	H04N5/145	348/208.4
*	B	US-2012/0230408 A1	09-2012	Zhou; Minhua	H04N19/105	375/240.15
*	C	US-2012/0269270 A1	10-2012	Chen; Ying	H04N19/597	375/240.16
*	D	US-2012/0257678 A1	10-2012	Zhou; Minhua	H04N19/436	375/240.16
*	E	US-2012/0300846 A1	11-2012	SUGIO; Toshiyasu	H04N19/521	375/240.16
*	F	US-2012/0320984 A1	12-2012	Zhou; Minhua	H04N19/50	375/240.16
*	G	US-2013/0003850 A1	01-2013	SUGIO; Toshiyasu	H04N19/105	375/240.16
*	H	US-2013/0004092 A1	01-2013	SASAI; Hisao	H04N19/70	382/233
*	I	US-2013/0070855 A1	03-2013	Zheng; Yunfei	H04N19/105	375/240.16
*	J	US-2013/0083853 A1	04-2013	Coban; Muhammed Zeyd	H04N19/563	375/240.16
*	K	US-2013/0272408 A1	10-2013	CHEN; Ying	H04N19/597	375/240.16
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001049

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13666680	BICI ET AL.
	Examiner	**Art Unit**
	NATHNAEL AYNALEM	2488

CPC						
Symbol					**Type**	**Version**
H04N		19	/	00703	F	2013-01-01
H04N		19	/	52	I	2014-11-01
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			
			/			

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

/NATHNAEL AYNALEM/ Examiner.Art Unit 2488		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	30	
/SATH V PERUNGAVOOR/ Supervisory Patent Examiner.Art Unit 2488	09/26/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001050

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13666680	BICI ET AL.
	Examiner	**Art Unit**
	NATHNAEL AYNALEM	2488

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
375	240.16	H	0	4	N	19 / 513 (2014.01.01)						
CROSS REFERENCE(S)		H	0	4	N	19 / 11 (2014.01.01)						

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
375	240.12				

/NATHNAEL AYNALEM/ Examiner.Art Unit 2488		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	30	
/SATH V PERUNGAVOOR/ Supervisory Patent Examiner.Art Unit 2488	09/26/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001051

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13666680	BICI ET AL.
	Examiner	**Art Unit**
	NATHNAEL AYNALEM	2488

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	17	17												
2	2	18	18												
3	3		19												
4	4		20												
5	5	19	21												
6	6	20	22												
7	7	21	23												
8	8	22	24												
9	9	23	25												
10	10	24	26												
11	11	25	27												
12	12	26	28												
13	13	27	29												
14	14	28	30												
15	15	29	31												
16	16	30	32												

/NATHNAEL AYNALEM/ Examiner.Art Unit 2488 (Assistant Examiner)	(Date)	**Total Claims Allowed:** 30	
/SATH V PERUNGAVOOR/ Supervisory Patent Examiner.Art Unit 2488 (Primary Examiner)	09/26/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001052

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13666680	BICI ET AL.
	Examiner	Art Unit
	NATHNAEL AYNALEM	2488

CPC- SEARCHED		
Symbol	Date	Examiner
H04N19/52; H04N19/513; H04N19/176; H04N19/61; H04N19/51; H04N19/597; H04N19/56; H04N19/139; H04N19/573; H04N19/521; H04N19/103; H04N19/30	9/7/2016	CH
H04N19/176 ; H04N19/52 ; H04N19/593 ; H04N19/105 ; H04N19/513 ; H04N19/139 ; H04N19/70 ; H04N19/503 ; H04N19/44 ; H04N19/463 ; H04N19/597 ; H04N19/61 ; H04N19/159 ; H04N19/51	9/20/2016	N.A.
H04N19/56 ; H04N19/107 ; H04N19/587 ; H04N19/174 ; H04N19/577; H04N19/00684 ; H04N19/00703 ; H04N19/147 ; H04N19/30 ; H04N19/105 ; H04N19/11 ; H04N19/119 ; H04N19/187 ; H04N19/58	9/20/2016	N.A.

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	240	9/7/2016	CH
375	240.01-240.29	9/27/2016	N.A.

SEARCH NOTES		
Search Notes	Date	Examiner
See Attached EAST Search History Document	9/7/2016	CH
IEEEXplore Search	9/7/2016	CH
Google Scholar	9/7/2016	CH
East keyword search	9/20/2016	N.A.
Assignee search	9/20/2016	N.A.
Inventor's name search	9/20/2016	N.A.

/NATHNAEL AYNALEM/ Examiner.Art Unit 2488	

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
375	*	9/7/2016	CH
	General Interference Search of the claims (USPGPUB,USPAT)	9/20/2016	N.A.

/NATHNAEL AYNALEM/ Examiner.Art Unit 2488	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001054

Aynalem, Nathnael

From: Gosnell, Guy <Guy.Gosnell@alston.com>
Sent: Saturday, September 24, 2016 10:50 AM
To: Aynalem, Nathnael
Subject: US Patent Application No. 13/666,680
Attachments: NC77198US Claims.docx

Hello Examiner Aynalem,

As we have not previously corresponded via email, please confirm receipt so that I know that the email was properly addressed.

To follow up on our conversation from yesterday evening, please find attached an amended set of claims. Claims 19 and 20 are canceled without prejudice to subsequent presentation in a divisional application. New dependent Claims 21-32 are added. The new dependent claims depend from one of independent apparatus Claims 15 or 16 and are mirror images to the dependent method claims. Applicant is amenable to the entry of the attached amendments via an Examiner's amendment so long as the amendments advance the application to allowance.

If you have any questions or need any further information, please let me know. I thank you for your attention to this matter.

Best regards,
Guy Gosnell
Reg. No. 34,610
(704) 444 1029

NOTICE: This e-mail message and all attachments may contain legally privileged and confidential information intended solely for the use of the addressee. If you are not the intended recipient, you are hereby notified that you may not read, copy, distribute or otherwise use this message or its attachments. If you have received this message in error, please notify the sender by email and delete all copies of the message immediately.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001055

1. (Previously Presented) A method comprising:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

determining a subset of spatial motion vector prediction candidates based on a location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

causing information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

2. (Original) The method according to claim 1 comprising selecting spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order.

3. (Original) The method according to claim 1, comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001056

of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

4. (Original) The method according to claim 1 comprising examining whether the received block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

5. (Original) The method according to claim 1, further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number .

6. (Previously Presented) The method according to claim 5 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

for a potential spatial motion vector prediction candidate on a left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit;
- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than a spatial motion vector prediction candidate above the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001057

for a potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate, which is on a right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001058

7. (Original) The method according to claim 1 further comprising including a temporal motion prediction candidate into the merge list.

8. (Original) The method according to claim 1 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the block of pixels.

9. (Previously Presented) A method comprising:

receiving an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is constructed based on the motion information of the spatial motion vector prediction candidates;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of another spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

selecting a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001059

selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

10. (Original) The method according to claim 9 comprising comparing motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

11. (Original) The method according to claim 9 comprising examining whether the received encoded block of pixels is divided into a first prediction unit and a second prediction unit; and if so, excluding the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

12. (Original) The method according to claim 9 further comprising

determining a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limiting the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number.

13. (Previously Presented) The method according to claim 12 comprising:

examining, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examining whether the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, performing at least one of the following:

for a potential spatial motion vector prediction candidate on a left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001060

– the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than a spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate, which is on a right side of the potential spatial motion vector prediction candidate above the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit; and

for a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, excluding the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

– all the other potential spatial motion vector prediction candidates have been included in the merge list;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001061

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

– the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

14. (Original) The method according to claim 9 comprising selecting one motion vector prediction candidate from the merge list to represent a motion vector prediction for the received encoded block of pixels.

15. (Previously Presented) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive a block of pixels including a prediction unit;

determine a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

determine a subset of spatial motion vector-prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001062

if at least one the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, exclude the first spatial motion vector prediction candidate from the merge list; and

cause information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

16. (Previously Presented) An apparatus comprising a processor and a memory including computer program code, the memory and the computer program code configured to, with the processor, cause the apparatus to:

receive an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

determine a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

select a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is constructed based on the motion information of the spatial motion vector prediction candidates;

determine a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

compare motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric;

exclude the first spatial motion vector prediction candidate from the merge list, if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other; and

select a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is selected

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001063

from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

17. (Previously Presented) A non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving a block of pixels including a prediction unit;

determining a set of spatial motion vector prediction candidates for the block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is constructed based on the motion information of the spatial motion vector prediction candidates and is utilized to identify motion vector prediction candidates of which one spatial motion vector prediction candidate from the merge list is signaled as the motion information for the prediction unit;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

causing information identifying the one spatial motion vector prediction candidate from the merge list to be transmitted to a decoder or to be stored.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001064

18. (Previously Presented) A non-transitory computer readable medium having stored thereon a computer executable program code for use by an encoder, said program codes comprise instructions for use by an encoder, said program code comprises instructions for:

receiving an encoded block of pixels including a prediction unit and information identifying a respective spatial motion vector prediction candidate from a merge list constructed by an encoder;

determining a set of spatial motion vector prediction candidates for the encoded block of pixels; the spatial motion vector prediction candidates being provided with motion information;

selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit, where the merge list is constructed based on the motion information of the spatial motion vector prediction candidates;

determining a subset of spatial motion vector prediction candidates based on the location of the block associated with the first spatial motion vector prediction candidate;

comparing motion information of the first spatial motion vector prediction candidate with motion information of the spatial motion vector prediction candidate in the determined subset of spatial motion vector prediction candidates without making a comparison of each possible candidate pair from the set of spatial motion vector prediction candidates, wherein comparing comprises performing an equivalence check or comparing a difference in motion information to a threshold or other similarity metric;

if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list; and

selecting a spatial motion vector prediction candidate from the merge list for use in decoding the encoded block of pixels, wherein the spatial motion vector prediction candidate is selected from the merge list using the information that was received identifying a respective spatial motion vector prediction candidate.

19. (Canceled)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001065

20. (Canceled)

21. (New) The apparatus according to claim 15 wherein the apparatus is further caused to select spatial motion vector prediction candidates from the set of spatial motion vector prediction candidates as the potential spatial motion vector prediction candidate in a predetermined order.

22. (New) The apparatus according to claim 15, wherein the apparatus is further caused to compare motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

23. (New) The apparatus according to claim 15 wherein the apparatus is further caused to examine whether the received block of pixels is divided into a first prediction unit and a second prediction unit; and if so, exclude the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

24. (New) The apparatus according to claim 15, wherein the apparatus is further caused to:

determine a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limit the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number .

25. (New) The apparatus according to claim 24 wherein the apparatus is further caused to:

examine, if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examine whether the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, perform at least one of the following:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001066

for a potential spatial motion vector prediction candidate on a left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is vertically divided into a first prediction unit and a second prediction unit;
- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than a spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

for a potential spatial motion vector prediction candidate, which is on a right side of the potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001067

for a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

26. (New) The apparatus according to claim 15 wherein the apparatus is further caused to include a temporal motion prediction candidate into the merge list.

27. (New) The apparatus according to claim 15 wherein the apparatus is further caused to select one motion vector prediction candidate from the merge list to represent a motion vector prediction for the block of pixels.

28. (New) The apparatus according to claim 16 wherein the apparatus is further caused to compare motion information of the potential spatial motion vector prediction candidate with motion information of at most one other spatial motion vector prediction candidate of the set of spatial motion vector prediction candidates.

29. (New) The apparatus according to claim 16 wherein the apparatus is further caused to examine whether the received encoded block of pixels is divided into a first prediction unit and a second prediction unit; and if so, exclude the potential spatial motion vector prediction candidate from the merge list if the prediction unit is the second prediction unit.

30. (New) The apparatus according to claim 16 wherein the apparatus is further caused to:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001068

determine a maximum number of spatial motion vector prediction candidates to be included in a merge list; and

limit the number of spatial motion vector prediction candidates in the merge list smaller or equal to the maximum number.

31. (New) The apparatus according to claim 30 wherein the apparatus is further caused to:

examine if the number of spatial motion vector prediction candidates in the merge list smaller than the maximum number;

if so, examine whether the prediction unit to which the potential spatial motion vector prediction candidate belongs is available for motion prediction;

if so, perform at least one of the following:

for a potential spatial motion vector prediction candidate on a left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is vertically divided into a first prediction unit and a second prediction unit;
- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and if the prediction unit is the second prediction unit, and the potential spatial motion vector prediction candidate has essentially similar motion information than a spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- the received encoded block of pixels is horizontally divided into a first prediction unit and a second prediction unit, and the prediction unit is the second prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001069

for a potential spatial motion vector prediction candidate, which is on a right side of the potential spatial motion vector prediction candidate above the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;

for a potential spatial motion vector prediction candidate, which is below the potential spatial motion vector prediction candidate on the left side of the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit; and

for a potential spatial motion vector prediction candidate cornerwise neighbouring the prediction unit, exclude the potential spatial motion vector prediction candidate from the merge list if any of the following conditions are fulfilled:

- all the other potential spatial motion vector prediction candidates have been included in the merge list;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate above the prediction unit;
- the potential spatial motion vector prediction candidate has essentially similar motion information than the spatial motion vector prediction candidate on the left side of the prediction unit.

32. (New) The apparatus according to claim 16 wherein the apparatus is further caused to select one motion vector prediction candidate from the merge list to represent a motion vector prediction for the received encoded block of pixels.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001070

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	2798	(spatial or intra) with predict$3 with candidate$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 17:53
L5	559	(spatial or intra) with predict$3 with candidate$1 with list	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 17:55
L6	15357	(subset or sub$set) with candidate$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 17:57
L7	5	5 same 6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 17:58
L8	33	(spatial or intra) with predict$3 with candidate$1 with list with (exclud$3 or without or eliminat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:02
L9	580	(compar$3 or evaluat$3 or verif$7 or check$3 or search$3) with (spatial or intra) with predict$3 with candidate$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:17
L10	48	(spatial or intra) with predict$3 with candidate$1 with list with (exclud$3 or without or eliminat$3 or skip$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:18
L11	8	9 same 10	US-PGPUB;	OR	ON	2016/09/20

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001071

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			18:18
L12	5	11 AND ((H04N19/52 OR H04N19/00684 OR H04N19/00703 OR H04N19/147 OR H04N19/30 OR H04N19/597 OR H04N19/105 OR H04N19/11 OR H04N19/119 OR H04N19/174 OR H04N19/176 OR H04N19/187 OR H04N19/513 OR H04N19/58 OR H04N19/70).CPC. OR (375/240.01-240.29).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:19
L13	7278	merg$3 near3 list	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:20
L14	292	5 and 13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:20
L15	280	14 AND ((H04N19/176 OR H04N19/52 OR H04N19/593 OR H04N19/105 OR H04N19/513 OR H04N19/139 OR H04N19/70 OR H04N19/503 OR H04N19/44 OR H04N19/463 OR H04N19/597 OR H04N19/61 OR H04N19/159 OR H04N19/51 OR H04N19/56 OR H04N19/107 OR H04N19/587 OR H04N19/174 OR H04N19/577).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:23
L16	722	(compar$3 or evaluat$3 or verif$7 or check$3 or search$3 or differenc$2) with (spatial or intra) with predict$3 with candidate$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:24
L17	8	10 same 16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:25
L18	44	10 AND ((H04N19/176 OR H04N19/52 OR H04N19/593 OR H04N19/105 OR H04N19/513 OR H04N19/139 OR H04N19/70 OR H04N19/503 OR H04N19/44 OR H04N19/463 OR H04N19/597 OR H04N19/61 OR H04N19/159 OR H04N19/51 OR H04N19/56 OR H04N19/107 OR H04N19/587 OR H04N19/174 OR	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:26

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001072

		H04N19/577).CPC.)				
L19	736	(compar$3 or evaluat$3 or verif$7 or check$3 or search$3 or differenc$2 or examin$3) with (spatial or intra) with predict$3 with candidate$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:28
L20	18	(spatial or intra) with predict$3 with candidate$1 with list with (exclud$3 or without or eliminat$3) with merg$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:29
L21	4	19 same 20	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:29
L22	4	19 and 20	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 18:29
L23	43381	(intra or spatial or spatio adj1 temporal or inter) near4 predict$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:14
L24	407	13 same 23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:14
L25	1072	(motion or vector$1 or mv) with merg$3 with list	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:16
L27	323	24 same 25	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:16
L28	3255	(compar$3 or evaluat$3 or verif$7 or check$3 or search$3 or differenc$2 or examin$3) with (spatial or intra) with predict$3 with (motion or vector or mv)	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2016/09/20 19:17

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001073

			JPO; DERWENT; IBM_TDB			
L29	74	27 and 28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:17
L30	73	29 AND ((H04N19/176 OR H04N19/52 OR H04N19/593 OR H04N19/105 OR H04N19/513 OR H04N19/139 OR H04N19/70 OR H04N19/503 OR H04N19/44 OR H04N19/463 OR H04N19/597 OR H04N19/61 OR H04N19/159 OR H04N19/51 OR H04N19/56 OR H04N19/107 OR H04N19/587 OR H04N19/174 OR H04N19/577).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:17
L31	73	30 AND ((H04N19/52 OR H04N19/00684 OR H04N19/00703 OR H04N19/147 OR H04N19/30 OR H04N19/597 OR H04N19/105 OR H04N19/11 OR H04N19/119 OR H04N19/174 OR H04N19/176 OR H04N19/187 OR H04N19/513 OR H04N19/58 OR H04N19/70).CPC. OR (375/240.01-240.29).CCLS.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:18
L32	29910	(motion or vector$1 or mv) with list	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:20
L33	112	28 same 32	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:20
L34	5698	candidate$1 with list with (exclud$3 or without or eliminat$3 or remov$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:59
L35	259	25 and 34	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 19:59
L36	152	25 same 34	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2016/09/20 20:00

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001074

			JPO; DERWENT; IBM_TDB			
L38	227453	(compar$3 or evaluat$3 or verif$7 or check$3 or search$3 or differenc$2 or examin$3) with predict$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:03
L39	6	36 same 38	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:03
L40	126	36 and 38	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:03
L42	40	(BICI near3 (Mehmet Oguz)).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:44
L44	36069	(intra or inter) near3 predict$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:45
L45	13	42 and 44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:46
L47	431	(LAINEMA near2 Jani).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:47
L48	88	44 and 47	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:47
L49	11	34 and 48	US-PGPUB; USPAT;	OR	ON	2016/09/20 20:47

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001075

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
L50	306	(UGUR near3 Kemal).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:48
L51	12	34 and 50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:49
L52	61847	(nokia).as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:50
L53	70	34 and 52	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:50
L55	15	44 and 53	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/09/20 20:50

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L57	21002	((block or macroblock or picture or image) with (predict$3 or pu)).clm.	US-PGPUB; USPAT	OR	ON	2016/09/20 20:54
L58	266	((spatial or intra) with (mv or motion adj1 vector$1) with candidate).clm.	US-PGPUB; USPAT	OR	ON	2016/09/20 20:55
L59	818	(candidat$1 with merg$3).clm.	US-PGPUB; USPAT	OR	ON	2016/09/20 20:56
L60	739	((compar$3 or evaluat$3 or verif$7 or check$3 or search$3 or differenc$2 or examin$3) with predict$3 with candidat$1).clm.	US-PGPUB; USPAT	OR	ON	2016/09/20 20:57
L61	668	(candidate$1 with list with (exclud$3 or without or eliminat$3 or remov$3)).clm.	US-PGPUB;	OR	ON	2016/09/20 20:58

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001076

			USPAT			
L62	200	57 and 58	US-PGPUB; USPAT	OR	ON	2016/09/20 20:58
L63	2	59 and 60 and 61	US-PGPUB; USPAT	OR	ON	2016/09/20 20:59
L64	11	60 and 61	US-PGPUB; USPAT	OR	ON	2016/09/20 21:02
L65	1	62 and 64	US-PGPUB; USPAT	OR	ON	2016/09/20 21:02

9/ 20/ 2016 9:04:11 PM
C:\ Users\ naynalem\ Documents\ EAST\ Workspaces\ 13666680.wsp

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001077

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Sep 30, 2016 05:45:10 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	NOA	09/30/2016	042933/467264
	INTV.SUM.EX	09/30/2016	042933/467264
	892	09/30/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Nathnael B. Aynalem
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action for Canadian Application No. 2,854,495 dated September 6, 2016	

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36702952v1

Submitted October 3, 2016

Office de la propriété intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An Agency of Industry Canada

6 September 2016 (06-09-2016)

SIM & MCBURNEY
100 Simcoe Street, Suite 200
TORONTO Ontario
M5H 3G2

RECEIVED
SEP - 9 2016
SIM & McBURNEY
SIM, ASHTON & McKAY LLP

Application No.	:	**2,854,495**
PCT No.	:	**FI2012051070**
Owner	:	NOKIA TECHNOLOGIES OY
Title	:	**METHOD FOR VIDEO CODING AND AN APPARATUS**
Classification	:	H04N 19/593 (2014.01)
Your File No.	:	**15083-3 DAR**
Examiner	:	Minghui Shi

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 30(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(*a*) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN THE **SIX (6)** MONTH PERIOD AFTER THE ABOVE DATE.

This application has been examined taking into account the applicant's correspondence received in this office on 7 April 2016 (07-04-2016).

The number of claims in this application is 22.

Documents Cited:

D1:* Han et al., "Improved Video Compression Efficiency Through Flexible Unit Representation and Corresponding Extension of Coding Tools", *IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY*, Vol. 20, No. 12, Pages 1709 - 1720, 31 December 2010 (31-12-2010)

D2:* Tai et al., "A Multi-Pass True Motion Estimation Scheme With Motion Vector Propagation for Frame Rate Up-Conversion Applications", *JOURNAL OF DISPLAY TECHNOLOGY*, Vol. 4, No. 2, Pages 188 - 197, 30 June 2009 (30-06-2009)

D3:* Huang et al., "A Multistage Motion Vector Processing Method for Motion-Compensated Frame Interpolation", *IEEE TRANSACTIONS ON IMAGE PROCESSING*, Vol. 17, No. 5, Pages 694 - 708, 31 May 2008 (31-05-2008)

* document cited by a foreign patent office

Additional prior art is cited due to change of claims and foreign prosecution

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001080

The examiner has identified the following defects in the application:

Obviousness

Claims 1 - 22 do not comply with section 28.3 of the *Patent Act.* These claims are directed to subject-matter that would have been obvious at the claim date to a person skilled in the art or science to which it pertains having regard to D1 in view of D2 and common general knowledge.

Regarding claims 1, 6, 11, 16, 21 - 22, D1 discloses a method comprising (abstract): receiving a block of pixels including a prediction (abstract) unit (fig. 1).

D1 does not explicitly disclose, but D2 discloses

> determining a set of spatial motion vector prediction candidates for the block of pixels (page 189, col. 2, par. 3: the search is confined to the vectors defined in the candidate vector set), the spatial motion vector prediction candidates being provided with motion information (page 189, col. 2, par. 3: the basic principle of the multi-pass ME strategy proposed in this study is to utilize the motion information relating to neighboring blocks generated in the previous pass to gradually refine the accuracy of the MV in the current block);
> selecting a first spatial motion vector prediction candidate from the set of spatial motion vector prediction candidates as a potential spatial motion vector prediction candidate to be included in a merge list for the prediction unit (page 190, col. 1, par. 3: every motion vector in the candidate vector set is comprised by a single PMV and a update vector selected from update vector set)
> determining a subset of spatial motion vector predictions based on the location of the block associated (fig. 2; page 190, col. 1, par. 3) with the first spatial motion vector prediction candidate (page 190, col. 1, par. 3; eq. 2);
> comparing motion information of the first spatial motion vector prediction candidate (page 190, col. 1, par. 5; eq. 1) with motion information of the spatial motion vector prediction candidates in the determined subset of spatial motion vector prediction candidates (fig. 3; page 190; col. 1, par. 5: Each pass in the proposed ME scheme is performed using one of the PMV predictor patterns, and then one MV in the selected PMV pattern which has minimal distortion is selected as the final PMV of this pass).

It would have been obvious to a person skilled in the art to combine the teachings of D1 and D2 to reduce the number of PMV predictors to be evaluated.

D1 and D2, as the Applicant argues in the latest correspondence, do not explicitly disclose where the merge list is selected based on the motion information; if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list.

D3 discloses

> where the merge list is selected based on the motion (Page 697, par. 2; eq. 2: reliability of MV) information (page 697, par. 10);
> if at least one of the comparisons indicates that the motion vector information of the spatial motion vector prediction candidates correspond with each other, excluding the first spatial motion vector prediction candidate from the merge list (page 697, par. 10: if MV's is reliable or possibly reliable will not be merged in a group), excluding the first spatial motion vector prediction candidate from the merge list (page 697, par. 10: only those MBs that have unreliable MVs connecting to each other in vertical, horizontal and diagonal directions will be merged).

It would have been obvious to a person skilled in the art to further incorporate the teachings of D3 to correct unreliable MVs by finding a best single MV.

Claims 2 - 5, 7 - 10, 12 - 15 and 17 - 20 do not introduce any additional features which patentably distinguish over the cited prior art in light of the common general knowledge in the art.

Claims

Claims 4, 9, 14 and 19 are indefinite and do not comply with subsection 27(4) of the *Patent Act*. It is not clear whether "prediction unit" in these claims is same or different from the introduced "prediction unit" in the independent claims 1, 6, 11 and 16 that these claims depend on, respectively, and, therefore, it is not clear how it applies to the conditions for "excluding the potential spatial motion vector prediction candidate from the merge list".

In view of the foregoing defects, the applicant is requisitioned, under subsection 30(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 34 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the nature thereof, and how it corrects each of the above identified defects.

Minghui Shi
Patent Examiner
819-639-8308

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, Leah Smith, can be reached at 819-639-9981.

CIPO values your feedback and invites you to complete a short and anonymous ongoing survey on patent examination products and services. You can access the survey at the following link: http://ic.sondages-surveys.ca/s/SCB-OPS/langeng.

2854495B_MSH.docm

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001082

The Examination Search Report is provided for reference only and is not part of any requisition made by the examiner in accordance with the *Patent Act* or *Rules*. The applicant is not required to respond to the information contained in the Examination Search Report.

Examination Search Report

Box I: General Information			
Application No.	2,854,495	Search Report Date	2016-08-29
Title	METHOD FOR VIDEO CODING AND AN APPARATUS		
Examiner	Minghui Shi	Search Conducted?	No
No search was conducted for the following reasons :			
- Search deferred - see report for reasoning (lack of unity, excluded subject matter etc.)			N/A
- Relied on previous search results (CIPO and/or by Foreign Office)			Yes

Box II: Family Prosecution		
Family Member	File Wrapper Reviewed	Status of Prosecution
WO2013064749A1	2015-09-28	Completed
US2013114723A1	2015-09-28	In Progress
EP2774375A1	2015-09-28	In opposition

Box III: Search History			
Claims Searched		Date of Search	
Type of Search Conducted (select all that apply):			
Canadian first to file search	☐	Supplemental/top up search	☐
Inventor/applicant search	☐	Non laid open search	☐
Comprehensive search	☐	In-house searcher	☐
Search History from Databases Consulted:			
No Search Conducted			

Version 8

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001083

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	27105559
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/467264
Receipt Date:	03-OCT-2016
Filing Date:	01-NOV-2012
Time Stamp:	15:37:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$180
RAM confirmation Number	100416INTEFSW00002032160605
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		467264-IDS.pdf	134631 9e00d74392be2af6e529f8b7a6f01d521f2bfdd2	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
2	Non Patent Literature	467264-CA_OA-9-6-2016.pdf	1555512 026af6deaa910c802d0a6ec18e2093aa844cb910	no	4
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30676 67dba1ce2c4a20026c45c1fa1126ad60f5133300	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1720819		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Mehmet Oguz Bici	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	11/01/2012	Examiner:	Nathnael B. Aynalem
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Final Office Action under 37 C.F.R. § 1.113 or a Notice of Allowance under 37 C.F.R. § 1.311, but before payment of the Issue Fee. The Final Office Action or Notice of Allowance was mailed on September 30, 2016.

Attached is a list of documents on form PTO-1449 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement. In this regard, Applicant notes that the communication from the foreign patent office was not received by any individual designated by 37 CFR 1.56(c) more than thirty (30) days prior to the filing of this Information Disclosure Statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

PRINTER RUSH
(PTO ASSISTANCE)

Application: 13666680	Examiner: AYNALEM	GAU: 2488
From: Bernice Crittenden	Location: RTFM	Creation Date: 10/07/2016

Week Date: 10/3/2016

DOC CODE	DOC DATE	MISCELLANEOUS
[ ] 1449		[ ] Continuing Data
[X] IDS	10/03/2016	[ ] Foreign Priority
[ ] CLM		[ ] Document Legibility
[ ] IIFW/FWCLM		[ ] Fees
[ ] SRFW		[ ] Petition (TC)
[ ] DRW		[ ] Other
[ ] OATH		
[ ] 312		
[ ] SPEC		

[RUSH] Message:

Please respond to the 10-03-2016 IDS.

Thank you,
BC

[XRUSH] Response:

Initials: _____

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001090

PRINTER RUSH
(PTO ASSISTANCE)

Application: 13666680	Examiner: Aynalem	GAU: 2488
From: Nran Hem	Location: IDC	Creation Date: 10/11/2016

Week Date: 10/3/2016

DOC CODE	DOC DATE	MISCELLANEOUS
[ ] 1449		[ ] Continuing Data
[X] IDS	02/26/2016	[ ] Foreign Priority
[ ] CLM		[ ] Document Legibility
[ ] IIFW/FWCLM		[ ] Fees
[ ] SRFW		[ ] Petition (TC)
[ ] DRW		[ ] Other
[ ] OATH		
[ ] 312		
[ ] SPEC		

[RUSH] Message:

Please initial/line through citations on (IDS 02/26/2016), (IDS 04/25/2016) and (IDS 09/02/2016).

thank you

[XRUSH] Response:

Initials: _____

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001091

PRINTER RUSH
(PTO ASSISTANCE)

Application: 13666680	Examiner: AYNALEM	GAU: 2488
From: Bernice Crittenden	Location: RTFM	Creation Date: 10/07/2016

Week Date: 10/3/2016

DOC CODE	DOC DATE	MISCELLANEOUS
[ ] 1449		[ ] Continuing Data
[X] IDS	10/03/2016	[ ] Foreign Priority
[ ] CLM		[ ] Document Legibility
[ ] IIFW/FWCLM		[ ] Fees
[ ] SRFW		[ ] Petition (TC)
[ ] DRW		[ ] Other
[ ] OATH		
[ ] 312		
[ ] SPEC		

[RUSH] Message:

Please respond to the 10-03-2016 IDS.

Thank you,
BC

[XRUSH] Response:

The IDS filed on 10/03/2016 has been considered.

Initials: /N.A./

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001092

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 10/19/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
AYNALEM, NATHNAEL B

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
10/19/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001093

Supplemental Notice of Allowability	Application No. 13/666,680	Applicant(s) BICI ET AL.	
	Examiner NATHNAEL AYNALEM	Art Unit 2488	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *Information Disclosure Statement filed on 10/03/2016*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-18 and 21-32*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 10/03/2016
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/NATHNAEL AYNALEM/ Examiner, Art Unit 2488	/SATH V PERUNGAVOOR/ Supervisory Patent Examiner, Art Unit 2488

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001094

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Nathnael B. Aynalem
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
/N.A./	1	Office Action for Canadian Application No. 2,854,495 dated September 6, 2016	

Examiner Signature	/Nathnael Aynalem/	Date Considered	10/08/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36702952v1

Submitted October 3, 2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.A./

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Oct 19, 2016 05:27:01 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	NOA	10/19/2016	042933/467264
	1449	10/19/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Filing Date	November 1, 2012
				First Named Inventor	Bici et al.
				Art Unit	2488
				Examiner Name	N. B. Aynalem
Sheet	1	of	1	Attorney Docket Number	042933/467264

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document Country Code - Number Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	English Language Translation Attached
	1	WO 2011 115659 A1	09-22-2011	Thomson Licensing		

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	2	Office Action for Chinese Application No. 2012800657775 dated October 9, 2016	Yes

Examiner Signature		Date Considered	

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. LEGAL02/36819290v1

Submitted November 23, 2016

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 September 2011 (22.09.2011)

PCT

(10) International Publication Number
WO 2011/115659 A1

(51) International Patent Classification:
H04N 7/26 (2006.01) *H04N 7/50* (2006.01)
H04N 7/36 (2006.01)

(21) International Application Number:
PCT/US2011/000421

(22) International Filing Date:
3 March 2011 (03.03.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/314,506 16 March 2010 (16.03.2010) US

(71) Applicant *(for all designated States except US)*: **THOMSON LICENSING** [FR/FR]; 1-5 rue Jeanne d'Arc, F-92443 Issy-Les Moulineaux (FR).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **ZHENG, Yunfei** [CN/US]; 4615 Torrey Circle, Apt. S205, San Diego, California 92130 (US). **YIN, Peng** [CN/US]; 6 John Street, Ithaca, New York 14850 (US). **SOLE, Joel** [ES/US]; 8722 Villa La Jolla Drive, Unit 106, La Jolla, California 92037 (US). **LU, Xiaoan** [CN/US]; 30 Kennedy Court, Princeton, New Jersey 08540 (US). **XU, Qian** [CN/US]; 240 Natoma Station Drive, Apt. 220, Folsom, California 95630 (US).

(74) Agents: **SHEDD, Robert, D.** et al.; Thomson Licensing LLC, 2 Independence Way, Suite #200, Princeton, New Jersey 08540 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ,

[Continued on next page]

(54) Title: METHODS AND APPARATUS FOR IMPLICIT ADAPTIVE MOTION VECTOR PREDICTOR SELECTION FOR VIDEO ENCODING AND DECODING

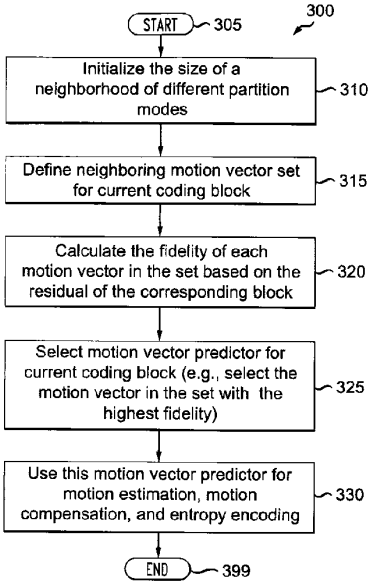


FIG. 3

(57) Abstract: Methods and apparatus are provided for implicit adaptive motion vector predictor selection for video encoding and decoding. The method encodes an image block using implicit adaptive motion vector predictor selection. The motion vector for encoding the block is predicted by defining (315) a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors; and then selecting (325) from the set a particular motion vector predictor candidate as the motion vector for encoding the bloc. The selection is made responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors (320).

WO 2011/115659 A1

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001098

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001099

METHODS AND APPARATUS FOR IMPLICIT ADAPTIVE MOTION VECTOR PREDICTOR SELECTION FOR VIDEO ENCODING AND DECODING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Serial No. 61/314,506, filed March 16, 2010, which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present principles relate generally to video encoding and decoding and, more particularly, to methods and apparatus for implicit adaptive motion vector predictor selection for video encoding and decoding.

BACKGROUND

Motion estimation and compensation are widely used in video compression to leverage and make use of the temporal redundancy inherent between images of a video sequence. Motion information is usually represented by a displacement format with a motion vector and corresponding reference frame index to indicate the correspondence of a current coding block in the reference frame buffer. Such motion information is transmitted or otherwise conveyed to a decoder as overhead. Obviously, the goal in compression is to convey information for as little cost as possible, while still maintaining a desired objective and subjective quality of images.

In the state of the art video coding standard, namely the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Moving Picture Experts Group-4 (MPEG-4) Part 10 Advanced Video Coding (AVC) Standard/International Telecommunication Union, Telecommunication Sector (ITU-T) H.264 Recommendation (hereinafter the "MPEG-4 AVC Standard"), a motion vector is predicted by the median of its spatial causal neighboring motion vectors. This approach is very simple and effective when the motion field is relatively smooth and the neighboring motion vectors have high fidelities. However, when the motion field tends to be complicated, this approach may not work well by only selecting the median value of the neighboring motion vectors. Furthermore, there could be many low fidelity motion vectors surrounding a current coding block. These factors may cause a degradation of the quality of a motion vector predictor.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001100

A technique known as motion vector competition (MVComp) is described in a first prior art approach. In MVComp, the procedure for motion vector predictor selection is incorporated within the rate-distortion optimization of a coding block. As a resulting output, MVComp explicitly transmits (or otherwise conveys, e.g., embedded on a media) the best motion vector predictor index to the decoder. In MVComp, a coding block has a set of motion vector predictors. The best motion vector predictor will be selected based on the rate-distortion (RD) optimization. The index of the motion vector predictor in the set will be explicitly transmitted to the decoder if the set has more than one candidate. The process is highly optimized because each of the motion vector predictors will be checked and compared with other motion vector predictors. The set can include motion vectors which come from both spatial and temporal causal neighboring blocks. Given a motion vector predictor set, this approach can also find the best predictor in the set in the rate-distortion sense. However, the complexity is very high at the encoder as it will take each predictor into the mode decision loop for each coding block. Another shortcoming is the overhead (e.g., the index of the motion vector predictor in the set) and can make this approach costly and inefficient especially for the low bitrate applications.

SUMMARY

These and other drawbacks and disadvantages of the prior art are addressed by the present principles, which are directed to methods and apparatus for implicit adaptive motion vector predictor selection for video encoding and decoding.

According to an aspect of the present principles, there is provided an apparatus. The apparatus includes a video encoder for encoding at least a block in a picture using implicit adaptive motion vector predictor selection. A motion vector for encoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for encoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

According to another aspect of the present principles, there is provided a method in a video encoder. The method includes encoding at least a block in a picture using implicit adaptive motion vector predictor selection. A motion vector for encoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001101

plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for encoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

According to yet another aspect of the present principles, there is provided an apparatus. The apparatus includes a video decoder for decoding at least a block in a picture using implicit adaptive motion vector predictor selection. A motion vector for decoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for decoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

According to still another aspect of the present principles, there is provided a method in a video decoder. The method includes decoding at least a block in a picture using implicit adaptive motion vector predictor selection. A motion vector for decoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for decoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

These and other aspects, features and advantages of the present principles will become apparent from the following detailed description of exemplary embodiments, which is to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present principles may be better understood in accordance with the following exemplary figures, in which:

FIG. 1 is a block diagram showing an exemplary video encoder to which the present principles may be applied, in accordance with an embodiment of the present principles;

FIG. 2 is a block diagram showing an exemplary video decoder to which the present principles may be applied, in accordance with an embodiment of the present principles;

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001102

FIG. 3 is a flow diagram showing an exemplary method for implicit adaptive motion vector prediction selection in a video encoder, in accordance with an embodiment of the present principles;

FIG. 4 is a flow diagram showing an exemplary method for implicit adaptive motion vector prediction selection in a video decoder, in accordance with an embodiment of the present principles;

FIG. 5 is a flow diagram showing another exemplary method for implicit adaptive motion vector predictor selection in a video encoder, in accordance with an embodiment of the present principles;

FIG. 6 is a flow diagram showing another exemplary method for implicit adaptive motion vector predictor selection in a video decoder, in accordance with an embodiment of the present principles;

FIG. 7 is a flow diagram showing yet another exemplary method for implicit adaptive motion vector predictor selection in a video encoder, in accordance with an embodiment of the present principles; and

FIG. 8 is a flow diagram showing yet another exemplary method for implicit adaptive motion vector predictor selection in a video decoder, in accordance with an embodiment of the present principles.

DETAILED DESCRIPTION

The present principles are directed to methods and apparatus for implicit adaptive motion vector predictor selection for video encoding and decoding.

The present description illustrates the present principles. It will thus be appreciated that those skilled in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the present principles and are included within its spirit and scope.

All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the present principles and the concepts contributed by the inventor(s) to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions.

Moreover, all statements herein reciting principles, aspects, and embodiments of the present principles, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof. Additionally, it is intended that such

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001103

equivalents include both currently known equivalents as well as equivalents developed in the future, i.e., any elements developed that perform the same function, regardless of structure.

Thus, for example, it will be appreciated by those skilled in the art that the block diagrams presented herein represent conceptual views of illustrative circuitry embodying the present principles. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudocode, and the like represent various processes which may be substantially represented in computer readable media and so executed by a computer or processor, whether or not such computer or processor is explicitly shown.

The functions of the various elements shown in the figures may be provided through the use of dedicated hardware as well as hardware capable of executing software in association with appropriate software. When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which may be shared. Moreover, explicit use of the term "processor" or "controller" should not be construed to refer exclusively to hardware capable of executing software, and may implicitly include, without limitation, digital signal processor ("DSP") hardware, read-only memory ("ROM") for storing software, random access memory ("RAM"), and non-volatile storage.

Other hardware, conventional and/or custom, may also be included. Similarly, any switches shown in the figures are conceptual only. Their function may be carried out through the operation of program logic, through dedicated logic, through the interaction of program control and dedicated logic, or even manually, the particular technique being selectable by the implementer as more specifically understood from the context.

In the claims hereof, any element expressed as a means for performing a specified function is intended to encompass any way of performing that function including, for example, a) a combination of circuit elements that performs that function or b) software in any form, including, therefore, firmware, microcode or the like, combined with appropriate circuitry for executing that software to perform the function. The present principles as defined by such claims reside in the fact that the functionalities provided by the various recited means are combined and brought together in the manner which the claims call for. It is thus regarded that any means that can provide those functionalities are equivalent to those shown herein.

Reference in the specification to "one embodiment" or "an embodiment" of the present principles, as well as other variations thereof, means that a particular feature,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001104

structure, characteristic, and so forth described in connection with the embodiment is included in at least one embodiment of the present principles. Thus, the appearances of the phrase "in one embodiment" or "in an embodiment", as well any other variations, appearing in various places throughout the specification are not necessarily all referring to the same embodiment.

It is to be appreciated that the use of any of the following "/", "and/or", and "at least one of", for example, in the cases of "A/B", "A and/or B" and "at least one of A and B", is intended to encompass the selection of the first listed option (A) only, or the selection of the second listed option (B) only, or the selection of both options (A and B). As a further example, in the cases of "A, B, and/or C" and "at least one of A, B, and C", such phrasing is intended to encompass the selection of the first listed option (A) only, or the selection of the second listed option (B) only, or the selection of the third listed option (C) only, or the selection of the first and the second listed options (A and B) only, or the selection of the first and third listed options (A and C) only, or the selection of the second and third listed options (B and C) only, or the selection of all three options (A and B and C). This may be extended, as readily apparent by one of ordinary skill in this and related arts, for as many items listed.

Moreover, for purposes of illustration and description, examples are described herein in the context of improvements over the MPEG-4 AVC Standard, using the MPEG-4 AVC Standard as the baseline for our description and explaining the improvements and extensions beyond the MPEG-4 AVC Standard. However, it is to be appreciated that the present principles are not limited solely to the MPEG-4 AVC Standard and/or extensions thereof. Given the teachings of the present principles provided herein, one of ordinary skill in this and related arts would readily understand that the present principles are equally applicable and would provide at least similar benefits when applied to extensions of other standards, or when applied and/or incorporated within standards not yet developed. It is to be further appreciated that the present principles also apply to video encoders and video decoders that do not conform to standards, but rather confirm to proprietary definitions.

Also, as used herein, the words "picture" and "image" are used interchangeably and refer to a still image or a picture from a video sequence. As is known, a picture may be a frame or a field.

Turning to FIG. 1, an exemplary video encoder to which the present principles may be applied is indicated generally by the reference numeral 100. The video encoder 100 includes a frame ordering buffer 110 having an output in signal communication with a non-

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001105

inverting input of a combiner 185. An output of the combiner 185 is connected in signal communication with a first input of a transformer and quantizer 125. An output of the transformer and quantizer 125 is connected in signal communication with a first input of an entropy coder 145 and a first input of an inverse transformer and inverse quantizer 150. An output of the entropy coder 145 is connected in signal communication with a first non-inverting input of a combiner 190. An output of the combiner 190 is connected in signal communication with a first input of an output buffer 135.

A first output of an encoder controller 105 is connected in signal communication with a second input of the frame ordering buffer 110, a second input of the inverse transformer and inverse quantizer 150, an input of a picture-type decision module 115, a first input of a macroblock-type (MB-type) decision module 120, a second input of an intra prediction module 160, a second input of a deblocking filter 165, a first input of a motion compensator 170, a first input of a motion estimator 175, and a second input of a reference picture buffer 180.

A second output of the encoder controller 105 is connected in signal communication with a first input of a Supplemental Enhancement Information (SEI) inserter 130, a second input of the transformer and quantizer 125, a second input of the entropy coder 145, a second input of the output buffer 135, and an input of the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) inserter 140.

An output of the SEI inserter 130 is connected in signal communication with a second non-inverting input of the combiner 190.

A first output of the picture-type decision module 115 is connected in signal communication with a third input of the frame ordering buffer 110. A second output of the picture-type decision module 115 is connected in signal communication with a second input of a macroblock-type decision module 120.

An output of the Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) inserter 140 is connected in signal communication with a third non-inverting input of the combiner 190.

An output of the inverse quantizer and inverse transformer 150 is connected in signal communication with a first non-inverting input of a combiner 119. An output of the combiner 119 is connected in signal communication with a first input of the intra prediction module 160 and a first input of the deblocking filter 165. An output of the deblocking filter 165 is connected in signal communication with a first input of a reference picture buffer 180.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001106

An output of the reference picture buffer 180 is connected in signal communication with a second input of the motion estimator 175 and a third input of the motion compensator 170. A first output of the motion estimator 175 is connected in signal communication with a second input of the motion compensator 170. A second output of the motion estimator 175 is connected in signal communication with a third input of the entropy coder 145.

An output of the motion compensator 170 is connected in signal communication with a first input of a switch 197. An output of the intra prediction module 160 is connected in signal communication with a second input of the switch 197. An output of the macroblock-type decision module 120 is connected in signal communication with a third input of the switch 197. The third input of the switch 197 determines whether or not the "data" input of the switch (as compared to the control input, i.e., the third input) is to be provided by the motion compensator 170 or the intra prediction module 160. The output of the switch 197 is connected in signal communication with a second non-inverting input of the combiner 119 and an inverting input of the combiner 185.

A first input of the frame ordering buffer 110 and an input of the encoder controller 105 are available as inputs of the encoder 100, for receiving an input picture. Moreover, a second input of the Supplemental Enhancement Information (SEI) inserter 130 is available as an input of the encoder 100, for receiving metadata. An output of the output buffer 135 is available as an output of the encoder 100, for outputting a bitstream.

Turning to FIG. 2, an exemplary video decoder to which the present principles may be applied is indicated generally by the reference numeral 200. The video decoder 200 includes an input buffer 210 having an output connected in signal communication with a first input of an entropy decoder 245. A first output of the entropy decoder 245 is connected in signal communication with a first input of an inverse transformer and inverse quantizer 250. An output of the inverse transformer and inverse quantizer 250 is connected in signal communication with a second non-inverting input of a combiner 225. An output of the combiner 225 is connected in signal communication with a second input of a deblocking filter 265 and a first input of an intra prediction module 260. A second output of the deblocking filter 265 is connected in signal communication with a first input of a reference picture buffer 280. An output of the reference picture buffer 280 is connected in signal communication with a second input of a motion compensator 270.

A second output of the entropy decoder 245 is connected in signal communication with a third input of the motion compensator 270, a first input of the deblocking filter 265,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001107

and a third input of the intra predictor 260. A third output of the entropy decoder 245 is connected in signal communication with an input of a decoder controller 205. A first output of the decoder controller 205 is connected in signal communication with a second input of the entropy decoder 245. A second output of the decoder controller 205 is connected in signal communication with a second input of the inverse transformer and inverse quantizer 250. A third output of the decoder controller 205 is connected in signal communication with a third input of the deblocking filter 265. A fourth output of the decoder controller 205 is connected in signal communication with a second input of the intra prediction module 260, a first input of the motion compensator 270, and a second input of the reference picture buffer 280.

An output of the motion compensator 270 is connected in signal communication with a first input of a switch 297. An output of the intra prediction module 260 is connected in signal communication with a second input of the switch 297. An output of the switch 297 is connected in signal communication with a first non-inverting input of the combiner 225.

An input of the input buffer 210 is available as an input of the decoder 200, for receiving an input bitstream. A first output of the deblocking filter 265 is available as an output of the decoder 200, for outputting an output picture.

As noted above, the present principles are directed to methods and apparatus for implicit adaptive motion vector predictor selection for video encoding and decoding. In accordance with an embodiment of the present principles, a motion vector is predicted by one of its spatio-temporal neighboring motion vector. The selection is based on the motion compensation error of the corresponding motion vector candidate, which is available at both the encoder and decoder. Therefore, the selection is based on implicit (derived) data already available at the encoder and decoder without the need for side or additional information being sent from the encoder to the decoder. Therefore, using the present principles, there is no additional cost or overhead for motion vector predictor selection and, yet, the present principles still achieve very accurate prediction performance. A motion vector is derived at the decoder by exploiting the correlation among its spatio-temporal neighboring motion vectors and their prediction confidence. The prediction confidence can be a function of an estimated motion compensation error, motion vector magnitude, reference index, or other parameter available and related to motion information.

In accordance with the present principles, we exploit the correlation among neighboring motion vectors by defining a causal local neighborhood for each coding block.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001108

The neighborhood includes causal spatio-temporal neighboring blocks that are coded as inter-coded blocks. Since these blocks are already decoded, the motion vectors are known at both the encoder and decoder. These motion vectors form the motion vector candidate set. The next question is how to select motion vector predictors for the coding block within the candidate set.

In accordance with the present principles, we consider the fidelity of each candidate in the set. The fidelity is defined as the motion compensation error caused by using the motion vector to compensate the corresponding block. For example, considering a block B_i in the neighborhood, block B_i has motion vector MV_i available at both the encoder and decoder. The motion compensation error E_i of B_i caused by using MV_i can be estimated by the residual information of B_i. Thus, the fidelity of MV_i can be defined as a function of E_i as follows:

$$F(i) = f(E_i)$$

The function should be a decreasing function of E_i, which means that a large motion compensation error results in a low fidelity. Each motion vector in the candidate set has a fidelity value, which implicitly provides side information for our motion vector predictor selection.

After obtaining the fidelity values of the candidates, the selection process is made. The actual parameter or parameters used to make the selection can be from a variety of parameters. For example, in an embodiment, we can select the motion vector in the set which has the highest fidelity as the motion vector predictor. In another embodiment, we can use the weighted median value of the motion vectors in the set as the motion vector predictor. In an embodiment, the weights can be a function of the fidelity value. In an embodiment, we can also use weighted averaging or other functions that take into account the fidelity information in order to derive the motion vector predictor. Embodiments are presented which illustrate these varieties.

Since all information used in the selection and the calculation of the fidelity value is available at both the encoder and decoder, no overhead needs to be sent, which makes the present principles promising in both low and high bit rate applications. Compared to the median approach in the MPEG-4 AVC Standard, the present principles take into account the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001109

fidelity of the neighboring motion vectors, which may be suitable for the relatively complicated motion field cases with only a very minor increase in complexity.

Embodiment 1:

In Embodiment 1, the motion vector predictor selection is based on the prior information provided by the fidelity values of the neighboring candidates. The motion vector predictor of the current coding block is the motion vector in the set which has the highest fidelity.

Turning to FIG. 3, an exemplary method for implicit adaptive motion vector prediction selection in a video encoder is indicated generally by the reference numeral 300. The method 300 includes a start block 305 that passes control to a function block 310. The function block 310 initializes the size of a neighborhood of different partition modes, and passes control to a function block 315. The function block 315 defines the neighboring motion vector set for the current coding block, and passes control to a function block 320. The function block 320 calculates the fidelity of each motion vector in the set based on the residual of the corresponding block, and passes control to a function block 325. The function block 325 selects the motion vector predictor for the current coding block (e.g., selecting the motion vector in the set with the highest fidelity), and passes control to a function block 330. The function block 330 uses this motion vector predictor for motion estimation, motion compensation, and entropy encoding, and passes control to an end block 399.

Turning to FIG. 4, an exemplary method for implicit adaptive motion vector prediction selection in a video decoder is indicated generally by the reference numeral 400. The method 400 includes a start block 405 that passes control to a function block 410. The function block 410 parses an input bitstream, and passes control to a function block 415. The function block 415 initializes the size of a neighborhood of different partition modes, and passes control to a function block 420. The function block 420 defines the neighboring motion vector set for the current coding block, and passes control to a function block 425. The function block 425 calculates the fidelity of each motion vector in the set based on the residual of the corresponding block, and passes control to a function block 430. The function block 430 selects the motion vector predictor for the current coding block (e.g., selecting the motion vector in the set with the highest fidelity), and passes control to a function block 435. The function block 435 decodes the motion vector difference, calculates the motion vector by using the motion vector predictor, and passes control to an end block 499.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001110

Embodiment 2:

In Embodiment 2, the fidelity values of the motion vector candidates are used for a weighted median filter to derive the motion vector predictor. The weights in the weighted median filter indicate the number of repetitions of a value within the filter support. The filter support here is the neighborhood that includes all the motion vector candidates of a block. If the weight of a motion vector is n, then the motion vector will be duplicated n times when being filtered by a median filter. In Embodiment 2, the weights are linked with the fidelity by a mapping function, which maps the fidelity to the number of repetitions of a motion vector. Then the output of the weighted median filter is taken as the motion vector predictor of the current coding block.

Turning to FIG. 5, another exemplary method for implicit adaptive motion vector predictor selection in a video encoder is indicated generally by the reference numeral 500. The method 500 includes a start block 505 that passes control to a function block 510. The function block 510 initializes the size of a neighborhood of different partition modes, and passes control to a function block 515. The function block 515 defines the neighboring motion vector set for the current coding block, and passes control to a function block 520. The function block 520 calculates the fidelity of each motion vector in the set based on the residual of the corresponding block, and passes control to a function block 525. The function block 525 maps the fidelity to the weight of the median filter, and passes control to a function block 530. The function block 530 applies the weighted median filter to the motion vector predictor candidate set to obtain the motion vector predictor of the current coding block, and passes control to a function block 535. The function block 535 uses the motion vector predictor for motion estimation, motion compensation, and entropy encoding, and passes control to an end block 599.

Turning to FIG. 6, another exemplary method for implicit adaptive motion vector predictor selection in a video decoder is indicated generally by the reference numeral 600. The method 600 includes a start block 605 that passes control to a function block 610. The function block 610 parses an input bitstream, and passes control to a function block 615. The function block 615 initializes the size of a neighborhood of different partition modes, and passes control to a function block 620. The function block 620 defines the neighboring motion vector set for the current coding block, and passes control to a function block 625. The function block 625 calculates the fidelity of each motion vector in the set based on the

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001111

residual of the corresponding block, and passes control to a function block 630. The function block 630 maps the fidelity to the weight of the median filter, and passes control to a function block 635. The function block 635 applies the weighted median filter to the motion vector predictor candidate set to obtain the motion vector predictor of the current coding block, and passes control to a function block 640. The function block 640 decodes the motion vector difference, calculates the motion vector by using the motion vector predictor, and passes control to an end block 699.

Embodiment 3:

In Embodiment 3, the implicit motion vector predictor selection can be combined with the explicit approach. The fidelities of neighboring motion vectors are generated and compared with a pre-defined threshold. If all fidelities are lower than the threshold, the explicit signaling approach is used for selecting the motion vector predictors based on the rate distortion optimization. Otherwise, the implicit signaling approach is used.

Turning to FIG. 7, yet another exemplary method for implicit adaptive motion vector predictor selection in a video encoder is indicated generally by the reference numeral 700. The method 700 includes a start block 705 that passes control to a function block 710. The function block 710 initializes the size of a neighborhood of different partition modes, and passes control to a function block 715. The function block 715 defines the neighboring motion vector set for the current coding block, and passes control to a function block 720. The function block 720 calculates the fidelity of each motion vector in the set based on the residual of the corresponding block, and passes control to a decision block 725. The decision block 725 determines whether or not all fidelities are smaller than a threshold. If so, then control is passed to a function block 730. Otherwise, control is passed to a function block 740. The function block 730 uses the explicit motion vector predictor signaling approach based on rate distortion optimization, and passes control to a function block 735. The function block 740 uses the implicit motion vector predictor selection approach based on fidelity, and passes control to the function block 735. The function block 735 uses this motion vector predictor for motion estimation, motion compensation, and entropy encoding, and passes control to an end block 799.

Turning to FIG. 8, yet another exemplary method for implicit adaptive motion vector predictor selection in a video decoder is indicated generally by the reference numeral 800. The method 800 includes a start block 805 that passes control to a function block 810. The

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001112

function block 810 parses an input bitstream, and passes control to a function block 815. The function block 815 initializes the size of a neighborhood of different partition modes, and passes control to a function block 820. The function block 820 defines the neighboring motion vector set for the current coding block, and passes control to a function block 825. The function block 825 calculates the fidelity of each motion vector in the set based on the residual of the corresponding block, and passes control to a decision block 830. The decision block 830 determines whether or not all fidelities are smaller than a threshold. If so, then control is passed to a function block 835. Otherwise, control is passed to a function block 840. The function block 835 decodes the motion vector index, and passes control to a function block 840. The function block 845 uses the implicit motion vector predictor selection approach based on fidelity, and passes control to the function block 840. The function block 840 decodes the motion vector difference, calculates the motion vector by using the motion vector predictor, and passes control to an end block 899.

Syntax

TABLE 1 shows exemplary slice header syntax, in accordance with an embodiment of the present principles.

TABLE 1

slice_header( ) {	**Descriptor**
...	
use_implicit_mvp_signaling	u(1)
...	
}	
macroblock(){	
if (use_implicit_mvp_signaling){	
...	
if (all fidelities < threshold){	
mvp_index	u(v)
}	
...	
}	
...	
}	

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001113

The semantics of the syntax elements of TABLE 1 are as follows:

use_implicit_mvp_signaling specifies whether the implicit motion vector predictor selection is used or not. use_implicit_mvp_signaling equal to 1 means the implicit motion vector prediction selection is used; use_implicit_mvp_signaling equal to 0 means it is not used.

mvp_index specifies the index of the motion vector that is selected as motion vector predictor in the candidate set.

A description will now be given of some of the many attendant advantages/features of the present invention, some of which have been mentioned above. For example, one advantage/feature is an apparatus having a video encoder for encoding at least a block in a picture using implicit adaptive motion vector predictor selection, wherein a motion vector for encoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for encoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

Another advantage/feature is the apparatus having the video encoder as described above, wherein the fidelity is a function of at least one of the motion compensation error, a motion vector magnitude, a reference index, and other motion related information which is available at both the encoder and the corresponding decoder.

Yet another advantage/feature is the apparatus having the video encoder as described above, wherein the particular motion vector predictor candidate selected as the motion vector for encoding the block has a highest fidelity from the motion vector predictor candidates in the set.

Still another advantage/feature is the apparatus having the video encoder as described above, wherein the respective values for the fidelity of the spatio-temporal neighboring motion vectors are used for a weighted median filter to derive the particular motion vector predictor candidate selected as the motion vector for encoding the block.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001114

Moreover, another advantage/feature is the apparatus having the video encoder as described above, wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario.

Further, another advantage/feature is the apparatus having the video encoder wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario as described above, wherein a decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is determined responsive to an evaluation of fidelity values.

Also, another advantage/feature is the apparatus having the video encoder wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario as described above, wherein the explicit signaling of motion vector predictors is used at a slice level, and the decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is made at a block level.

These and other features and advantages of the present principles may be readily ascertained by one of ordinary skill in the pertinent art based on the teachings herein. It is to be understood that the teachings of the present principles may be implemented in various forms of hardware, software, firmware, special purpose processors, or combinations thereof.

Most preferably, the teachings of the present principles are implemented as a combination of hardware and software. Moreover, the software may be implemented as an application program tangibly embodied on a program storage unit. The application program may be uploaded to, and executed by, a machine comprising any suitable architecture. Preferably, the machine is implemented on a computer platform having hardware such as one or more central processing units ("CPU"), a random access memory ("RAM"), and input/output ("I/O") interfaces. The computer platform may also include an operating system and microinstruction code. The various processes and functions described herein may be either part of the microinstruction code or part of the application program, or any combination thereof, which may be executed by a CPU. In addition, various other peripheral units may be connected to the computer platform such as an additional data storage unit and a printing unit.

It is to be further understood that, because some of the constituent system components and methods depicted in the accompanying drawings are preferably implemented in software,

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001115

the actual connections between the system components or the process function blocks may differ depending upon the manner in which the present principles are programmed. Given the teachings herein, one of ordinary skill in the pertinent art will be able to contemplate these and similar implementations or configurations of the present principles.

Although the illustrative embodiments have been described herein with reference to the accompanying drawings, it is to be understood that the present principles is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one of ordinary skill in the pertinent art without departing from the scope or spirit of the present principles. All such changes and modifications are intended to be included within the scope of the present principles as set forth in the appended claims.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001116

CLAIMS:

1. An apparatus, comprising:

a video encoder (100) for encoding an image block using implicit adaptive motion vector predictor selection, wherein a motion vector for encoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for encoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

2. The apparatus of claim 1, wherein the fidelity is a function of at least one of: motion compensation error, motion vector magnitude, and a reference index, which is available at both the encoder and corresponding decoder.

3. The apparatus of claim 1, wherein the particular motion vector predictor candidate selected as the motion vector for encoding the block has a highest fidelity from the motion vector predictor candidates in the set.

4. The apparatus of claim 1, wherein the respective values for the fidelity of the spatio-temporal neighboring motion vectors are used for a weighted median filter to derive the particular motion vector predictor candidate selected as the motion vector for encoding the block.

5. The apparatus of claim 1, wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario.

6. The apparatus of claim 5, wherein a decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is determined responsive to an evaluation of fidelity values.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001117

7. The apparatus of claim 5, wherein the explicit signaling of motion vector predictors is used at a slice level, and the decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is made at a block level.

8. In a video encoder, a method, comprising:

encoding an image block using implicit adaptive motion vector predictor selection, wherein a motion vector for encoding the block is predicted by defining (315, 515, 715) a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting (325, 530, 740) from the set a particular motion vector predictor candidate as the motion vector for encoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors (320, 520, 720).

9. The method of claim 8, wherein the fidelity is a function of at least one of: motion compensation error, motion vector magnitude, and a reference index, which is available at both the encoder and corresponding decoder (320, 520, 720).

10. The method of claim 8, wherein the particular motion vector predictor candidate selected as the motion vector for encoding the block has a highest fidelity from the motion vector predictor candidates in the set (325).

11. The method of claim 8, wherein the respective values for the fidelity of the spatio-temporal neighboring motion vectors are used for a weighted median filter to derive the particular motion vector predictor candidate selected as the motion vector for encoding the block (525, 530).

12. The method of claim 8, wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario (700).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001118

13. The method of claim 12, wherein a decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is determined responsive to an evaluation of fidelity values (725).

14. The method of claim 12, wherein the explicit signaling of motion vector predictors is used at a slice level, and the decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is made at a block level (700).

15. An apparatus, comprising:

a video decoder (200) for decoding an image block using implicit adaptive motion vector predictor selection, wherein a motion vector for decoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting from the set a particular motion vector predictor candidate as the motion vector for decoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors.

16. The apparatus of claim 15, wherein the fidelity is a function of at least one of: motion compensation error, motion vector magnitude, and a reference index, which is available at both the decoder and corresponding encoder.

17. The apparatus of claim 15, wherein the particular motion vector predictor candidate selected as the motion vector for decoding the block has a highest fidelity from the motion vector predictor candidates in the set.

18. The apparatus of claim 15, wherein the respective values for the fidelity of the spatio-temporal neighboring motion vectors are used for a weighted median filter to derive the particular motion vector predictor candidate selected as the motion vector for decoding the block.

19. The apparatus of claim 15, wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001119

20. The apparatus of claim 19, wherein a decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is determined responsive to an evaluation of fidelity values.

21. The apparatus of claim 19, wherein the explicit signaling of motion vector predictors is used at a slice level, and the decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is made at a block level.

22. In a video decoder, a method, comprising:

decoding an image block using implicit adaptive motion vector predictor selection, wherein a motion vector for decoding the block is predicted by defining (420, 620, 820) a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, and selecting (430, 635, 845) from the set a particular motion vector predictor candidate as the motion vector for decoding the block responsive to respective values for a fidelity of the spatio-temporal neighboring motion vectors (425, 625, 825).

23. The method of claim 22, wherein the fidelity is a function of at least one of: motion compensation error, motion vector magnitude, and a reference index, which is available at both the decoder and corresponding encoder (425, 625, 825).

24. The method of claim 22, wherein the particular motion vector predictor candidate selected as the motion vector for decoding the block has a highest fidelity from the motion vector predictor candidates in the set (430).

25. The method of claim 22, wherein the respective values for the fidelity of the spatio-temporal neighboring motion vectors are used for a weighted median filter to derive the particular motion vector predictor candidate selected as the motion vector for decoding the block (630, 635).

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001120

26. The method of claim 22, wherein the implicit adaptive motion vector predictor selection is combined with explicit signaling of motion vector predictors in a hybrid scenario (800).

27. The method of claim 26, wherein a decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is determined responsive to an evaluation of fidelity values (830).

28. The method of claim 26, wherein the explicit signaling of motion vector predictors is used at a slice level, and the decision of whether to use the implicit adaptive motion vector predictor selection or the explicit signaling of motion vector predictors for the block is made at a block level (800).

29. A computer readable non-transitory storage media having video signal data encoded thereupon, comprising:

compressed data for an image block encoded using implicit adaptive motion vector predictor selection, wherein a motion vector for encoding the block is predicted by defining a set of motion vector predictor candidates for the block based on a plurality of spatio-temporal neighboring motion vectors, selecting from the set a particular motion vector predictor candidate as the motion vector for encoding the block based on a motion compensation error of the particular motion vector predictor candidate, the motion compensation error being available at the video encoder and a corresponding decoder.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001121

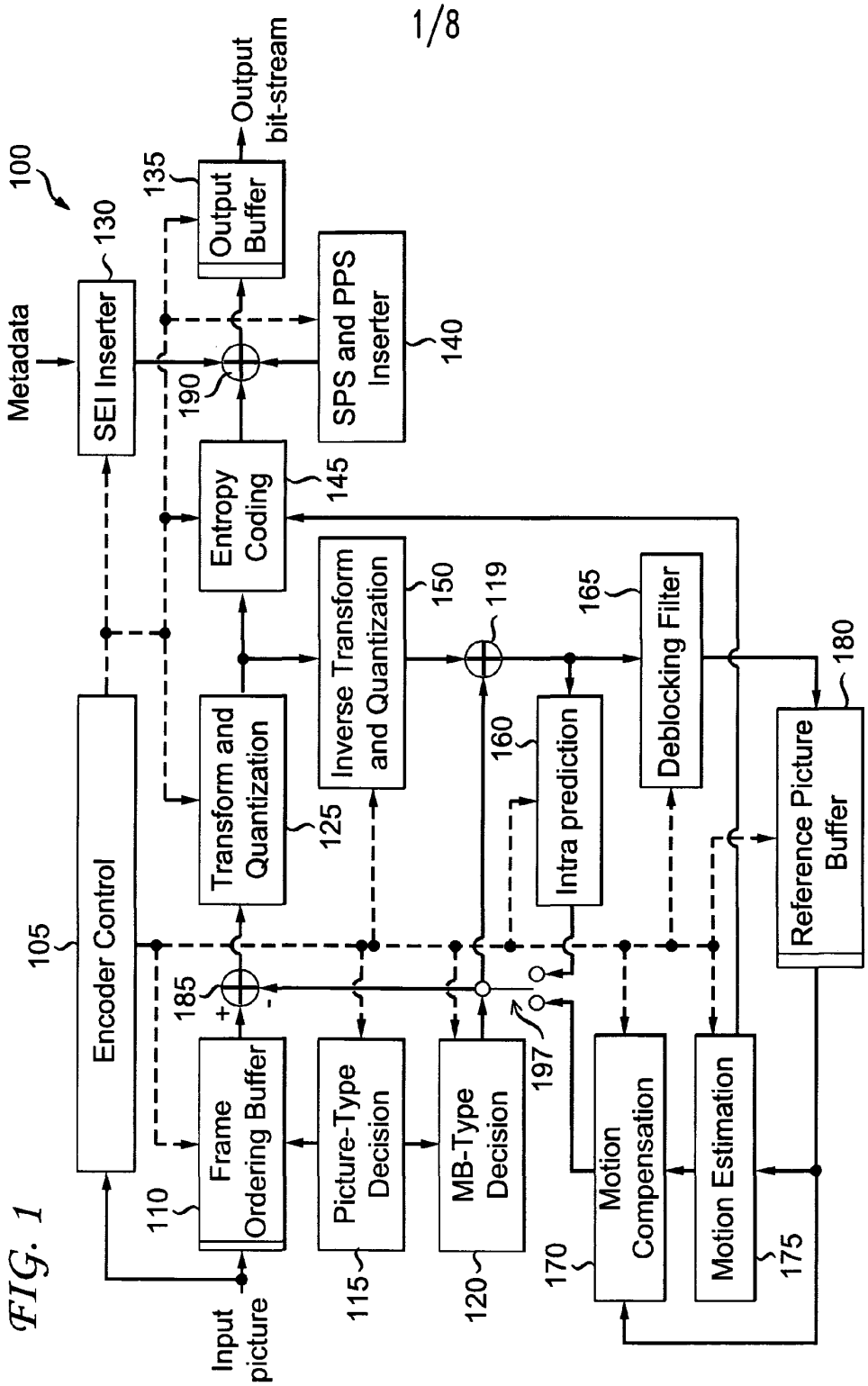

100
Metadata
SEI Inserter
130
135
Output Buffer
Output bit-stream
190
SPS and PPS Inserter
140
Entropy Coding
145
Inverse Transform and Quantization
150
119
165
Deblocking Filter
180
Reference Picture Buffer
Transform and Quantization
125
160
Intra prediction
105
Encoder Control
185
+
-
Frame Ordering Buffer
110
Picture-Type Decision
115
MB-Type Decision
120
197
170
Motion Compensation
Motion Estimation
175
Input picture

FIG. 1

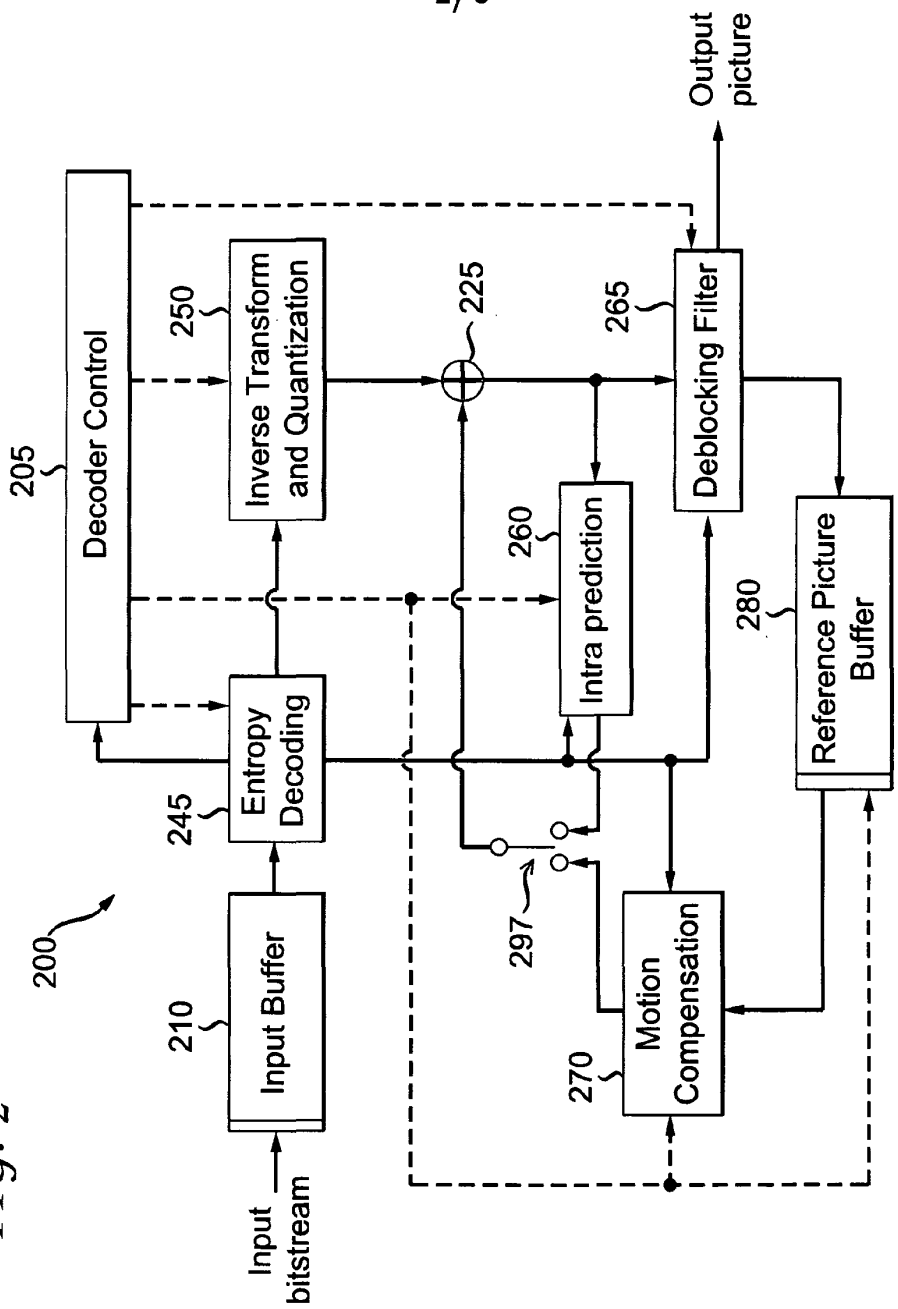

Output picture
Decoder Control
205
250
Inverse Transform and Quantization
225
265
Deblocking Filter
260
Intra prediction
280
Reference Picture Buffer
Entropy Decoding
245
297
Motion Compensation
270
200
210
Input Buffer
Input bitstream

FIG. 2

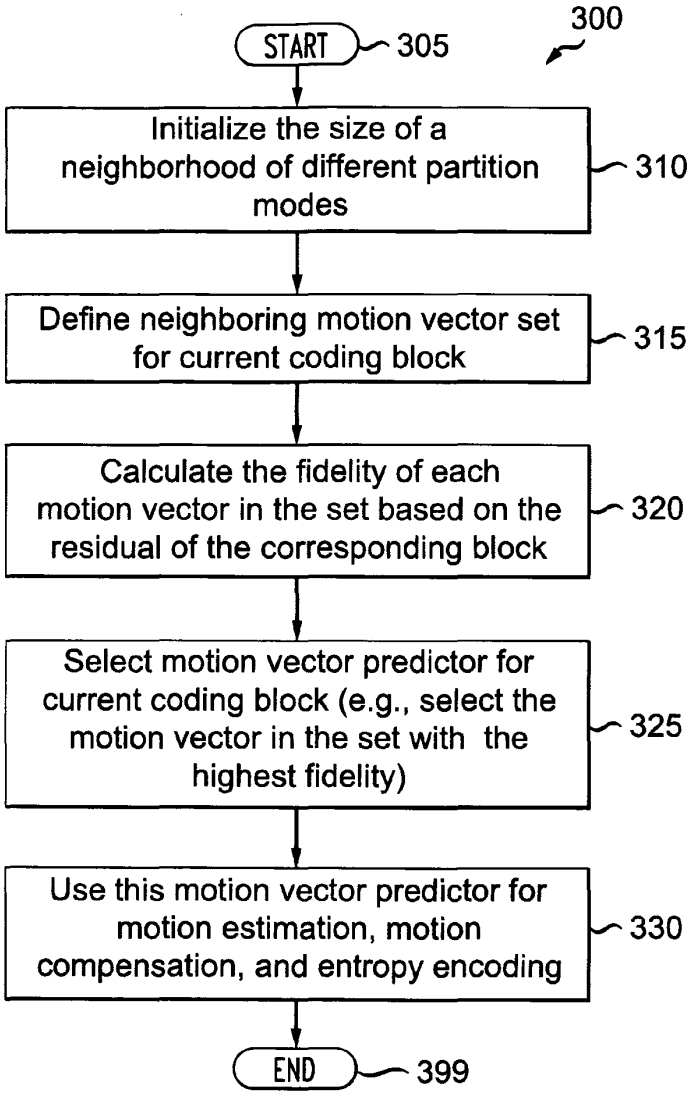

300
START
305
Initialize the size of a neighborhood of different partition modes
310
Define neighboring motion vector set for current coding block
315
Calculate the fidelity of each motion vector in the set based on the residual of the corresponding block
320
Select motion vector predictor for current coding block (e.g., select the motion vector in the set with the highest fidelity)
325
Use this motion vector predictor for motion estimation, motion compensation, and entropy encoding
330
END
399

FIG. 3

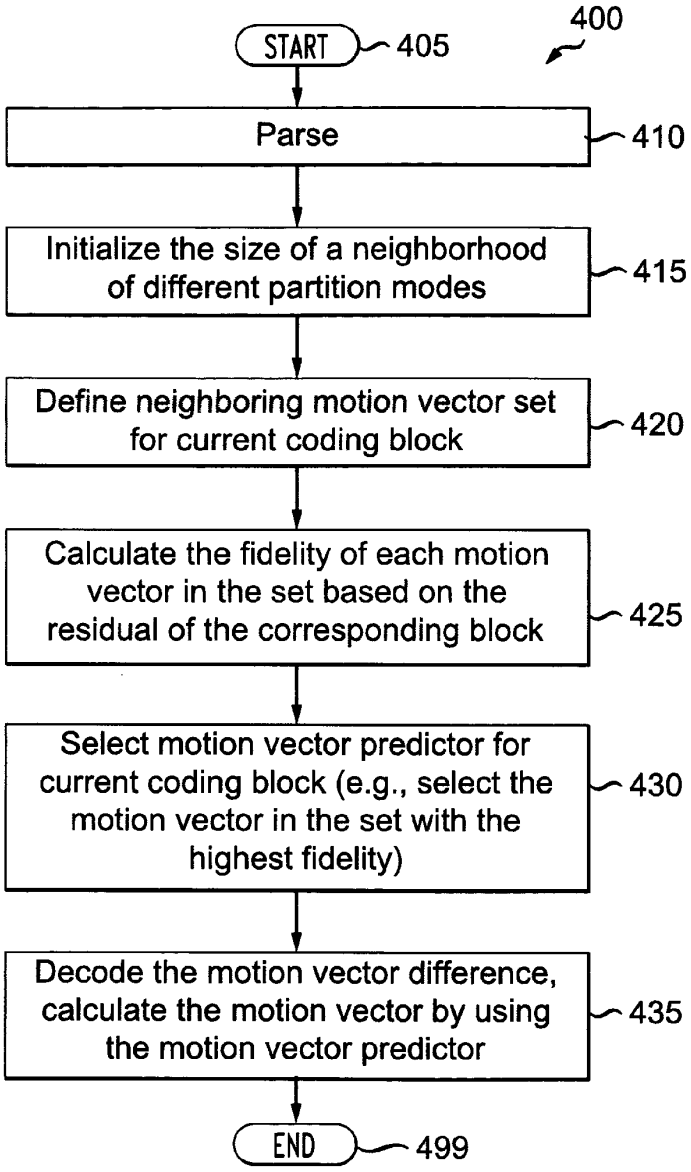

400
START
405
Parse
410
Initialize the size of a neighborhood of different partition modes
415
Define neighboring motion vector set for current coding block
420
Calculate the fidelity of each motion vector in the set based on the residual of the corresponding block
425
Select motion vector predictor for current coding block (e.g., select the motion vector in the set with the highest fidelity)
430
Decode the motion vector difference, calculate the motion vector by using the motion vector predictor
435
END
499

FIG. 4

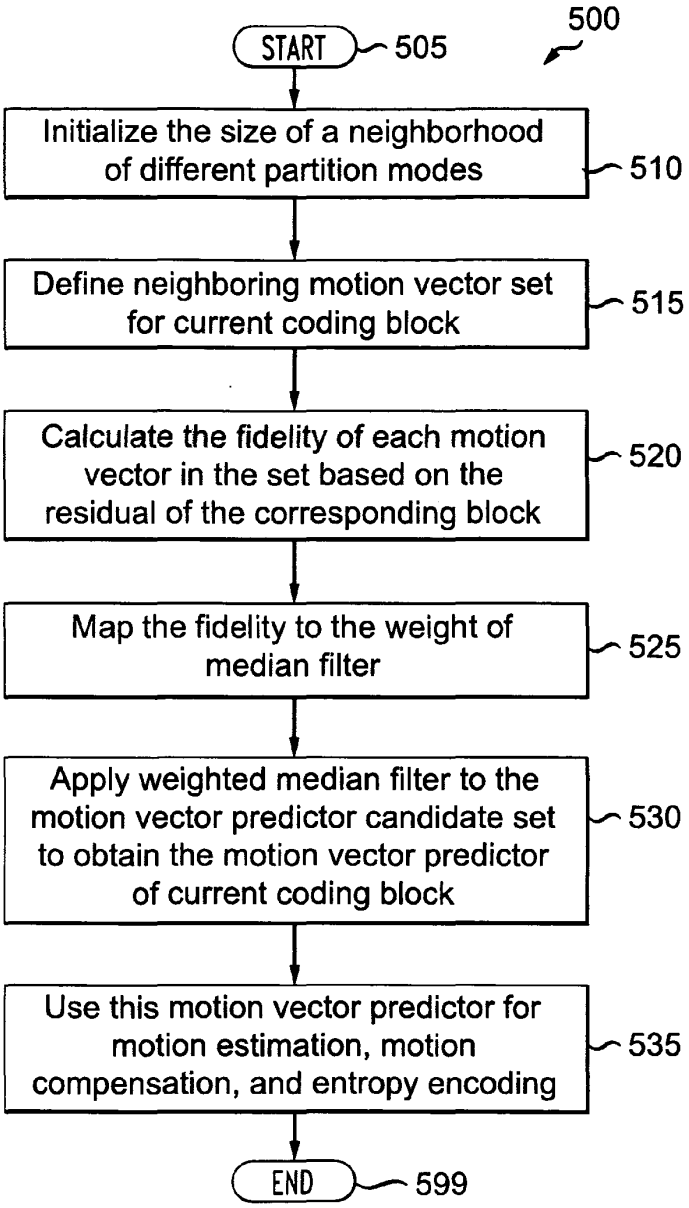

500
START
505
Initialize the size of a neighborhood of different partition modes
510
Define neighboring motion vector set for current coding block
515
Calculate the fidelity of each motion vector in the set based on the residual of the corresponding block
520
Map the fidelity to the weight of median filter
525
Apply weighted median filter to the motion vector predictor candidate set to obtain the motion vector predictor of current coding block
530
Use this motion vector predictor for motion estimation, motion compensation, and entropy encoding
535
END
599

FIG. 5

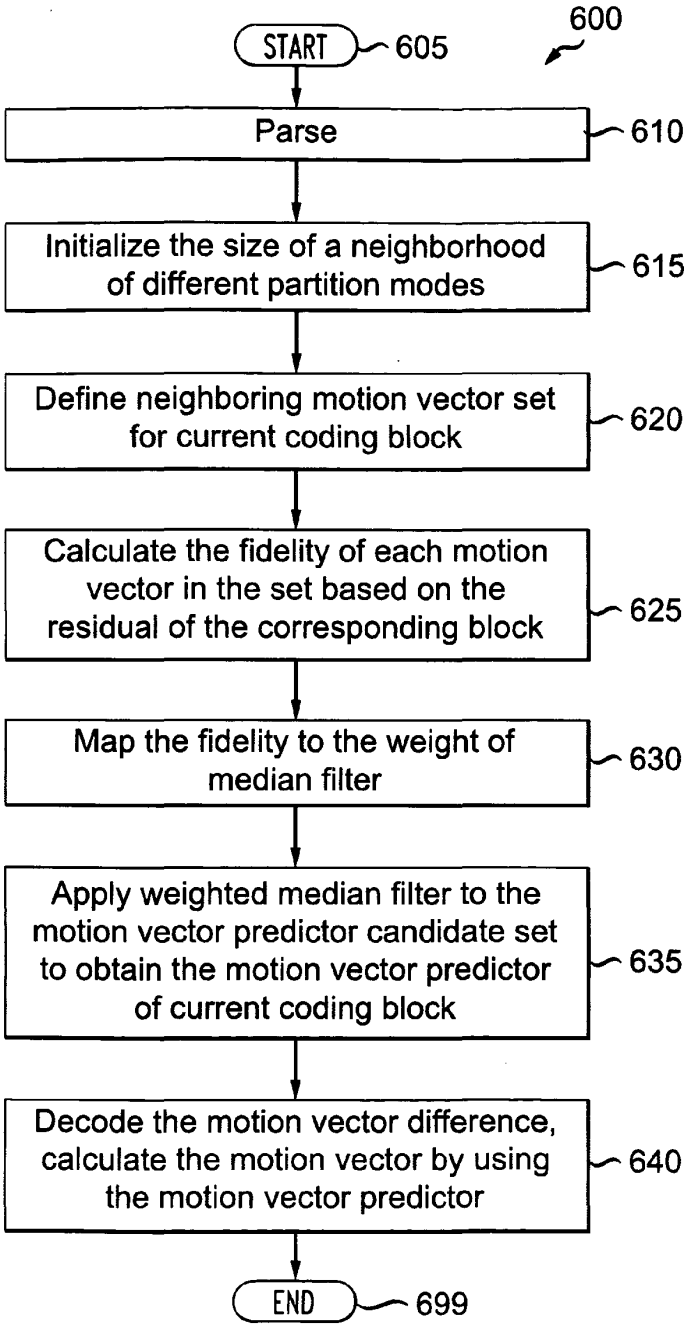

600
START
605
Parse
610
Initialize the size of a neighborhood of different partition modes
615
Define neighboring motion vector set for current coding block
620
Calculate the fidelity of each motion vector in the set based on the residual of the corresponding block
625
Map the fidelity to the weight of median filter
630
Apply weighted median filter to the motion vector predictor candidate set to obtain the motion vector predictor of current coding block
635
Decode the motion vector difference, calculate the motion vector by using the motion vector predictor
640
END
699

FIG. 6

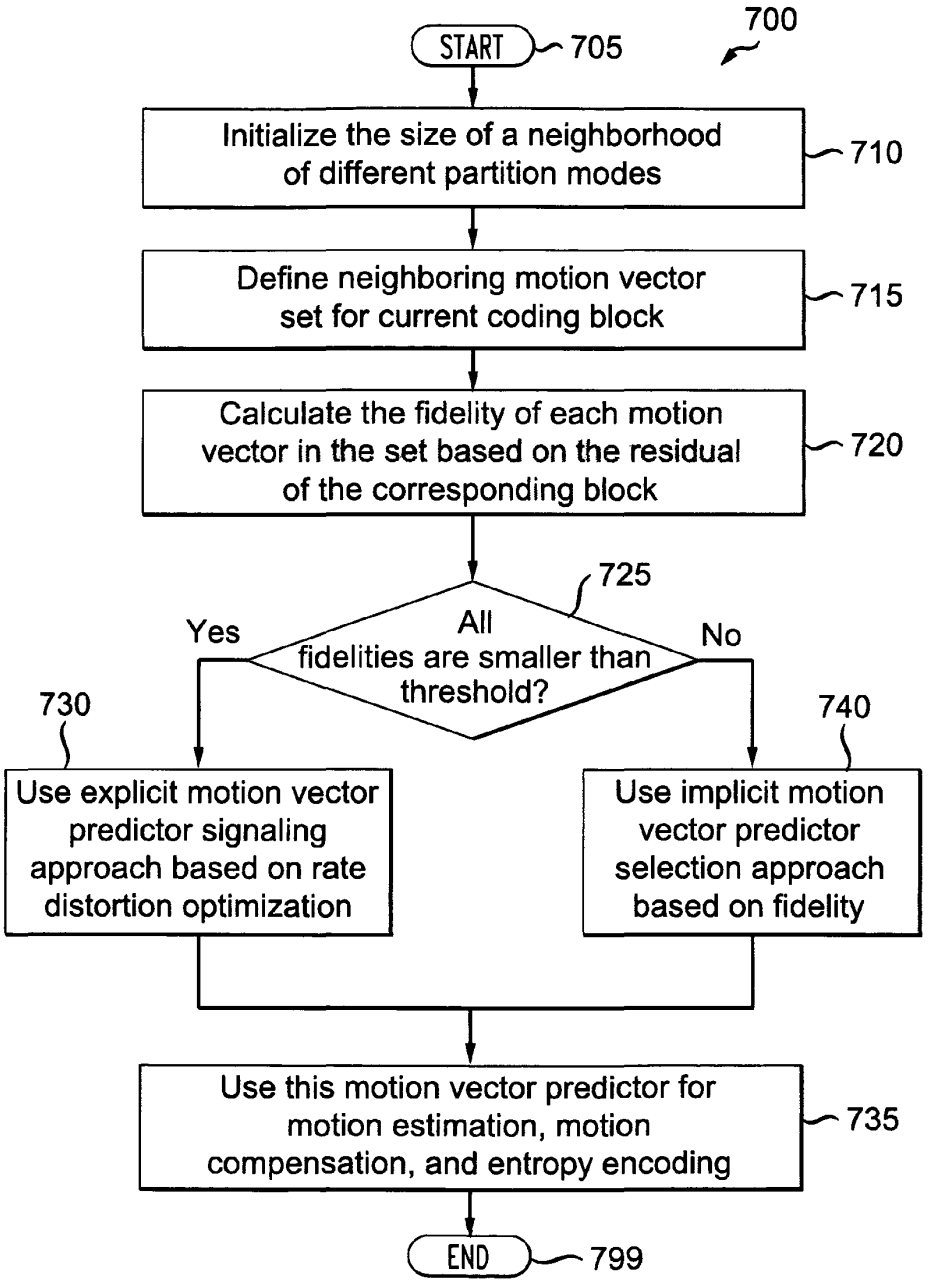

700
START
705
Initialize the size of a neighborhood of different partition modes
710
Define neighboring motion vector set for current coding block
715
Calculate the fidelity of each motion vector in the set based on the residual of the corresponding block
720
725
All fidelities are smaller than threshold?
Yes
No
730
Use explicit motion vector predictor signaling approach based on rate distortion optimization
740
Use implicit motion vector predictor selection approach based on fidelity
Use this motion vector predictor for motion estimation, motion compensation, and entropy encoding
735
END
799

FIG. 7

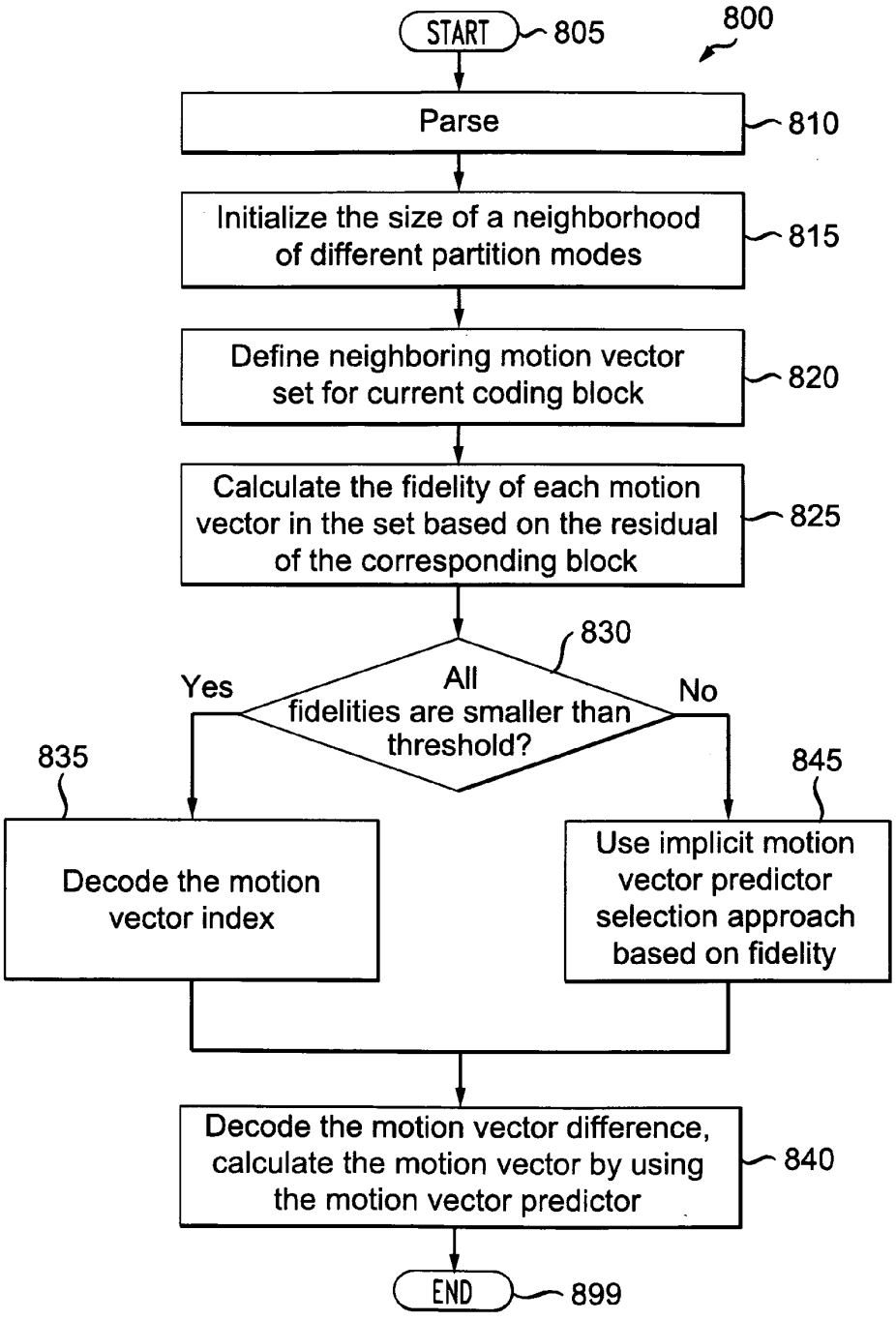

START
805
800
Parse
810
Initialize the size of a neighborhood of different partition modes
815
Define neighboring motion vector set for current coding block
820
Calculate the fidelity of each motion vector in the set based on the residual of the corresponding block
825
830
All fidelities are smaller than threshold?
Yes
No
835
Decode the motion vector index
845
Use implicit motion vector predictor selection approach based on fidelity
Decode the motion vector difference, calculate the motion vector by using the motion vector predictor
840
END
899

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/000421

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N7/26 H04N7/36 H04N7/50
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JINGJING DAI ET AL: "An efficient motion vector coding algorithm based on adaptive motion vector prediction", 90. MPEG MEETING; 26-10-2009 - 30-10-2009; XIAN; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, 23 October 2009 (2009-10-23), XP030045452, the whole document -----	1-3, 8-10, 15-17, 22-24,29
X	WO 2009/115901 A2 (NOKIA CORP [FI]; HALLAPURO ANTTI OLLI [FI]; UGUR KEMAI [FI]; LAINEMA J) 24 September 2009 (2009-09-24) abstract page 3, lines 12-18,33-34 page 8, lines 13-23 page 9, lines 10-22,31-32 -----	1,2,5-9, 12-16, 19-23, 26-28
	-/--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2011	24/08/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Santos Luque, Rocio

Form PCT/ISA/210 (second sheet) (April 2005)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001130

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/000421

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/247465 A1 (XIN ET AL) 9 October 2008 (2008-10-09) paragraphs [0017] - [0018], [0021], [0033] - [0039] -----	1,4,8, 11,15, 18,22,25
A	US 2004/252764 A1 (HUR ET AL) 16 December 2004 (2004-12-16) abstract paragraphs [0018] - [0025], [0082] - [0085] -----	1,4,8, 11,15, 18,22,25
A	LAROCHE G ET AL: "RD Optimized Coding for Motion Vector Predictor Selection", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 18, no. 9, 1 September 2008 (2008-09-01), pages 1247-1257, XP011231739, ISSN: 1051-8215, DOI: 10.1109/TCSVT.2008.928882 the whole document -----	1-29

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001131

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/000421

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009115901 A2	24-09-2009	EP 2266318 A2	29-12-2010
		US 2009304084 A1	10-12-2009
US 2008247465 A1	09-10-2008	JP 2008259174 A	23-10-2008
US 2004252764 A1	16-12-2004	JP 2005012798 A	13-01-2005
		KR 20040108053 A	23-12-2004

Form PCT/ISA/210 (patent family annex) (April 2005)

THE PATENT OFFICE OF THE PEOPLE'S REPUBLIC OF CHINA

Address: 6 Xi Tu Cheng Lu, Haidian, Beijing Post Code: 100088

Applicant:	**NOKIA TECHNOLOGIES OY**		Date of Notification:
Attorney:	**FRANK XUN FENG**		Date:**09** Month:**10**Year:**2016**
Application No.:	**2012800657775**	Serial No.	**2016092901544440**
Title of the Invention:	**METHOD FOR VIDEO CODING AND AN APPARATUS**		

Notification of the First Office Action
(PCT Application in the National Phase)

1.☒ Upon the request of the applicant, the Examiner has proceeded the substantive examination on the above-identified patent application for invention under Article 35(1) of the Patent Law of the People's Republic of China (hereinafter referred to as "the Patent Law").
☐ The Chinese Patent Office has decided to examine the application on its own initiative under Article 35(2) of the Patent Law.

2.☒ The applicant claimed priority/priorities based on the application(s):
filed in US on November 04, 2011

3.☐ The amendments made on __ are not acceptable under Rule 51 of the Implementing Regulations of the Patent Law.

4.☐ Examination was directed to the Chinese translation of the International Application as originally filed.
☒ Examination was directed to the application documents as specified below:
Claims 1-22 as submitted under Article 28/ 41 of the PCT.
Paragraphs 1-367 of the specification, the drawings, the abstract, and the figure in the abstract as submitted on July 01, 2014.

5.☒ Below is/are the reference(s) cited in this Office Action (the reference number(s) will be used throughout the examination procedure):

No.	Number(s) or Title(s) of Reference(s)	Date of Publication (or the filing date of conflicting application)
1	**"Unification of derivation process for merge mode and MVP", Hiroya Nakamura et al., "Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11" JCTVC-F419, Pages 1-10**	**July 22, 2011**
2	**"Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode" Yunfei Zheng et al., "Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11", JCTVC-F302, Pages 1-6**	**July 22, 2011**
3	**"On MVP list pruning process", Yongjoon Jeon et al., Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, JCTVC-F302, Pages 1-2**	**July 22, 2011**

6.Conclusions of the Action:

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001133

On the Specification:

☐ The subject matter contained in the application is not patentable under Article 5 of the Patent Law.
☐ The description does not comply with Article 26 paragraph 3 of the Patent Law.
☐ The amendments do not comply with Article 33 of the Patent Law.
☐ The draft of the description does not comply with Rule 17 of the Implementing Regulations.
☐ ___

On the Claims:

☐ Claim(s) __ does/do not comply with Article 2 paragraph 2 of the Patent Law.
☐ Claim(s) __ does/do not comply with Article 9 paragraph 1 of the Patent Law.
☒ Claim(s) 1-2 does/do not possess the novelty as required by Article 22 paragraph 2 of the Patent Law.
☒ Claim(s) 3-20 does/do not possess the inventiveness as required by Article 22 paragraph 3 of the Patent Law.
☐ Claim(s) __ does/do not possess the practical applicability as required by Article 22 paragraph 4 of the Patent Law.
☒ Claim(s) 21-22 is/are not patentable under Article 25 of the Patent Law.
☐ Claim(s) __ does/do not comply with Article 26 paragraph 4 of the Patent Law.
☐ Claim(s) __ does/do not comply with Article 29 paragraph 1 of the Patent Law.
☐ Claim(s) __ does/do not comply with Article 31 paragraph 1 of the Patent Law.
☐ Claim(s) __ does/do not comply with Article 33 of the Patent Law.
☐ Claim(s) __ does/do not comply with the provisions of Rule 19 of the Implementing Regulations.
☐ Claim(s) __ does/do not comply with the provisions of Rule 20 of the Implementing Regulations.
☐ Claim(s) __ does/do not comply with the provisions of Rule 21 of the Implementing Regulations.
☐ Claim(s) __ does/do not comply with the provisions of Rule 22 of the Implementing Regulations.
☐ ___

☐ The application does not comply with Article 26 paragraph 5 of the Patent Law or the provisions of Rule 26 of the Implementing Regulations.
☐ The application does not comply with Article 20 paragraph 1 of the Patent Law.
☐ The divisional application does not comply with the provisions of Rule 43 paragraph 1 of the Implementing Regulations.
The detailed explanation of the above conclusions is set forth in the text portion of the Notification.

7. In view of the conclusions set forth above, the Examiner is of the opinion that:

☐ The applicant should make amendments as directed in the text portion of the Notification.
☐ The applicant should expound in the response reasons why the application is patentable and make amendments to the application where there are deficiencies as pointed out in the text portion of the Notification, otherwise, the application will not be allowed.
☒ The application contains no allowable invention, and therefore, if the applicant fails to submit sufficient reasons to prove that the application does have merits, it will be rejected.
☐ __

8. The followings should be taken into consideration by the applicant in making the response:

(1) Under Article 37 of the Patent Law, the applicant should respond to the office action within **4** months counting from the date of receipt of the Notification. If, without any justified reason, the time limit is not met, the application shall be deemed to have been withdrawn.
(2) Any amendments to the application should be in conformity with the provisions of Article 33 of the Patent Law. Substitution pages should be in duplicate and the format of the substitution should be in conformity with the relevant provision contained in "The Examination Guidelines".
(3) The response to the Notification and/or revision of the application should be mailed to or handed over to the "Reception Division" of the Patent Office, and documents not mailed or handed over to the Reception Divisions have no legal effect.
(4) Without an appointment, the applicant and/or his agent shall not interview with the Examiner in the Patent Office.

9. This Notification contains a text portion of 4 page(s) and the following attachments:

☒ 3 cited reference(s), totaling 26 page(s).
☐ ___

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001134

Examination Dept. **The Patent Office** Examiner: **Meng Guiyu** Seal of the Examination Department

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001135

Summary of First Office Action

In the first Office Action, the Examiner has rejected Claims 1-2 under Article 22.2 of the Chinese Patent Law as lacking novelty over D1 (Unification of derivation process for merge mode and MVP), rejected Claims 3-20 under Article 22.3 of the Chinese Patent Law as lacking inventiveness over D1 in view of D2 (Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode), D3 (On MVP list pruning process), and/or alleged customary means in the art, and rejected Claims 21-22 under Article 25.1 of the Chinese Patent Law as reciting unpatentable subject matter. The specific examination opinions are as below.

1. D1 discloses (see its abstract, sections 2.1 and 2.2.1, and figs. 1(a) and 2(b)) all the features as recited in Claim 1. Therefore, Claim 1 does not possess novelty. In rejecting claim 1, the Examiner particularly copied and referenced the table 2 on page 4 of D1.

2. D1 discloses (see section 2 and the last line in table 2) the additional features as recited in Claim 2. Therefore, Claim 2 does not possess novelty.

3. D2 discloses (see part 1 and fig. 1) the additional features as recited in Claim 2. Therefore, Claim 3 does not possess inventiveness over D1 in view of D2.

4. The additional features of Claim 4 are either disclosed by D2 (see part 1 and fig. 1) or belong to customary means in the art. Therefore, Claim 3 does not possess inventiveness.

5. The additional features of Claim 5 belong to customary means in the art. Therefore, Claim 5 does not possess inventiveness.

6. Based on the similar reasons, Claims 6-20 do not possess inventiveness.

7. Claims 21 and 22 recite "a computer-readable media having computer-readable instructions" which belongs to unpatentable subject matter.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001136

中华人民共和国国家知识产权局

100020

北京市朝阳区东三环中路 1 号环球金融中心办公楼东楼 20 层 北京市
金杜律师事务所
鄢迅 赵林琳

发文日：

2016 年 10 月 09 日

申请号或专利号：**201280065777.5**　　发文序号：**2016092901544440**

申请人或专利权人：诺基亚技术有限公司

发明创造名称：用于视频编码的方法和装置

第一次审查意见通知书

（进入国家阶段的 PCT 申请）

1. ☒应申请人提出的实质审查请求，根据专利法第 35 条第 1 款的规定，国家知识产权局对上述发明专利申请进行实质审查。
   ☐根据专利法第 35 条第 2 款的规定，国家知识产权局决定自行对上述发明专利申请进行实质审查。
2. ☒申请人要求以其在：
   US 专利局的申请日 2011 年 11 月 04 日为优先权日。
3. ☐经审查，申请人于_____提交的修改文件，不符合专利法实施细则第 51 条第 1 款的规定，不予接受。
4. ☐审查是针对原始提交的国际申请的中文文本或中文译文进行的。
   ☒审查是针对下列申请文件进行的：
   依据专利合作条约第 28 条或者第 41 条提交的修改，权利要求第 1-22 项；
   2014 年 7 月 1 日提交的说明书第 1-367 段、说明书附图 1-12、说明书摘要、摘要附图。
5. ☒本通知书引用下列对比文献（其编号在今后的审查过程中继续沿用）

编号	文件号或名称	公开日期（或抵触申请的申请日）
1	“Unification of derivation process for merge mode and MVP”，Hiroya Nakamura 等，《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》，JCTVC-F419，第 1-10 页	20110722
2	“Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode”，Yunfei Zheng 等，《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》，JCTVC-F302，第 1-6 页	20110722
3	“On MVP list pruning process”，Yongjoon Jeon 等，《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》，JCTVC-F105，第 1-2 页	20110722

纸件申请，回函请寄：100088 北京市海淀区蓟门桥西土城路 6 号　国家知识产权局专利局受理处收
电子申请，应当通过电子专利申请系统以电子文件形式提交相关文件。除另有规定外，以纸件等其他形式提交的文件视为未提交。

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001137

6. 审查的结论性意见：

关于说明书：

□申请的内容属于专利法第 5 条规定的不授予专利权的范围。
□说明书不符合专利法第 26 条第 3 款的规定。
□说明书不符合专利法第 33 条的规定。
□说明书的撰写不符合专利法实施细则第 17 条的规定。
□_____

关于权利要求书：

□权利要求_____不符合专利法第 2 条第 2 款的规定。
□权利要求_____不符合专利法第 9 条第 1 款的规定。
☒权利要求 1-2 不具备专利法第 22 条第 2 款规定的新颖性。
☒权利要求 3-20 不具备专利法第 22 条第 3 款规定的创造性。
□权利要求_____不具备专利法第 22 条第 4 款规定的实用性。
☒权利要求 21-22 属于专利法第 25 条规定的不授予专利权的范围。
□权利要求_____不符合专利法第 26 条第 4 款的规定。
□权利要求_____不符合专利法第 31 条第 1 款的规定。
□权利要求_____不符合专利法第 33 条的规定。
□权利要求_____不符合专利法实施细则第 19 条的规定。
□权利要求_____不符合专利法实施细则第 20 条的规定。
□权利要求_____不符合专利法实施细则第 21 条的规定。
□权利要求_____不符合专利法实施细则第 22 条的规定。
□_____

□申请不符合专利法第 26 条第 5 款或者实施细则第 26 条的规定。
□申请不符合专利法第 20 条第 1 款的规定。
□分案申请不符合专利法实施细则第 43 条第 1 款的规定。

上述结论性意见的具体分析见本通知书的正文部分。

7. 基于上述结论性意见，审查员认为：

□申请人应当按照通知书正文部分提出的要求，对申请文件进行修改。

□申请人应当在意见陈述书中论述其专利申请可以被授予专利权的理由，并对通知书正文部分中指出的不符合规定之处进行修改，否则将不能授予专利权。

☒专利申请中没有可以被授予专利权的实质性内容，如果申请人没有陈述理由或者陈述理由不充分，其申请将被驳回。

□_____

8. 申请人应注意下列事项：

（1）根据专利法第 37 条的规定，申请人应当在收到本通知书之日起的 4 个月内陈述意见，如果申请人无正当理由逾期不答复，其申请将被视为撤回。

（2）申请人对其申请的修改应当符合专利法第 33 条的规定，不得超出原说明书和权利要求书记载的范围，同时申请人对专利申请文件进行的修改应当符合专利法实施细则第 51 条第 3 款的规定，按照本通知书的要求进行修改。

（3）申请人的意见陈述书和 / 或修改文本应当邮寄或递交国家知识产权局专利局受理处，凡未邮寄或递交给受理处的文件不具备法律效力。

（4）未经预约，申请人和 / 或代理人不得前来国家知识产权局与审查员举行会晤。

9. 本通知书正文部分共有 4 页，并附有下列附件：

☒引用的对比文件的复印件共 3 份 26 页。

□_____

审查员：孟贵宇　　联系电话：022-84868235　　审查部门：专利审查协作天津中心通信发明审查部

纸件申请，回函请寄：100088 北京市海淀区蓟门桥西土城路 6 号　国家知识产权局专利局受理处收

电子申请，应当通过电子专利申请系统以电子文件形式提交相关文件。除另有规定外，以纸件等其他形式提交的文件视为未提交。

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001138

第一次审查意见通知书

（进入国家阶段的 PCT 申请）

申请号:2012800657775

经审查，现提出如下审查意见。

1. 权利要求 1 要求保护一种用于编码视频图像的方法，对比文件 1（"Unification of derivation process for merge mode and MVP", Hiroya Nakamura 等，JCTVC-F419）是最接近的现有技术，公开了一种合并模式和运动矢量预测的导出处理的统一的方法，并具体公开如下技术内容（参见摘要，正文第 2.1，2.2.1 节，图 1(a)，图 2(b)）：可用作为合并候选的空间相邻块的位置与空间运动矢量预测（MVP）候选的位置相同。这是合并模式和 MVP 的空间相邻的位置的统一。本文试图减少空间导出处理中候选数量，以减少移除过程中比较的次数。本文对合并模式与 HM3.0 不同之处在于：可以用于合并候选的空间相邻的位置，是与空间运动矢量预测（MVP）候选的位置相同；在空间导出处理中导出两个空间合并候选；合并候选列表由两个空间合并候选和一个临时合并候选组成。两个空间候选和一个临时候选被导出。在空间导出处理中候选的数量减少了，为了减少在移除处理中比较的次数。如表 1，不同的候选数目下，移除过程中比较次数不同，在 HM3.0 中，比较次数为 10 次，在本文中比较次数为 3 次。如表 2，在合并模式下，HM3.0 和本文算法 1 的比较：

	HM3.0	Proposal 1
The number of spatial candidates	4 in 4 [positions]	2 in 5 [positions]
Spatial derivation order	A, B, C, D	A, B, C, D, E
The number of times of comparison of redundant candidates in the spatial derivation process	0 [time]	0 [time]
The number of temporal candidates	1	1
Merging candidate list order	A, B, Col, C, D	S_0, S_1, Col
The number of times of comparison in the removal process	10 [times] (A vs B, Col, C, D, B vs Col, C, D, Col vs C, D, and C vs D)	3 [times] (S_0 vs S_1, S_0 vs Col, and S_1 vs Col)

表 2

其中，s0 表示在空间导出处理中选择的第一空间候选（相当于从空间运动矢量预测候选集合中选择第一空间运动矢量候选作为所述预测单元的合并列表中的潜在空间运动矢量候选，其中表 2 中的（A,B,C,D,E）为确定用于所述像素块的空间矢量预测候选集合，空间矢量预测候选提供有运动信息）；s1 表示在空间导出处理中选择的第二空间候选。表 2 中（S_0, S_1, Col）为基于与第一空间运动矢量预测候选关联的块的位置确定空间运动矢量预测候选子集。

纸件申请，回函请寄：100088 北京市海淀区蓟门桥西土城路 6 号 国家知识产权局专利局受理处收
电子申请，应当通过电子专利申请系统以电子文件形式提交相关文件。除另有规定外，以纸件等其他形式提交的文件视为未提交。

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001139

图 1(a)示出，第一步，空间导出处理，导出空间合并候选；第二步，临时导出处理，导出一个临时合并候选；第三步，列表生成处理，构建合并候选列表；第 4 步，移除处理，移除有相同运动信息的候选（相当于比较所述第一空间运动矢量预测候选的运动信息与在确定的所述空间运动矢量预测候选子集中的所述空间运动矢量预测候选的运动信息，如果所述比较中的至少一个比较指示所述空间运动矢量预测候选的所述运动矢量信息相互对应，则从所述合并列表排除所述第一空间运动矢量预测候选）。在实现上述过程之前，必然存在接收包括预测单元的像素块。

由此可见，对比文件 1 公开了权利要求 1 的全部技术特征，该权利要求请求保护的技术方案与对比文件 1 公开的技术方案实质上是相同的，且两者属于相同的视频编码技术领域，解决相同的在候选中比较有限数目的运动信息以除去冗余的技术问题，并能产生相同的较少复杂性的预期效果，因此权利要求 1 所要求保护的技术方案不符合专利法第 22 条第 2 款有关新颖性的规定。

2. 权利要求 1 引用权利要求 1。对比文件 1 还公开了（参见第 2 节，表 2 最后一行）：在移除处理中比较次数的数目，HM3.0 为将 A, B, Col, C, D 每两两均比较一次，对比文件 1 的算法 1 比较(S_0 vs S_1, S_0 vs Col, and S_1 vs Col)，即相当于比较潜在空间运动矢量预测候选的运动矢量信息与所述空间运动矢量预测候选集合中至多一个其他空间运动矢量预测候选的运动信息。因此，在其引用的权利要求不具备新颖性时，该权利要求不具备专利法第 22 条第 2 款规定的新颖性。

3. 权利要求 3 引用权利要求 1 或 2，其附加技术特征构成与对比文件 1 的区别特征，由此确定该权利要求实际解决的技术问题是，从合并列表排除潜在空间运动矢量预测候选时考虑何种因素。

对比文件 2（“Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode”，Yunfei Zheng 等，JCTVC-F302）公开了一种在 2NxN, Nx2N, and NxN 模式下合并候选的选择方法，并具体公开如下技术内容（参见第 1 部分，图 1）：根据当前的 HM3.0，位于 PU 相邻的左侧和上侧的候选的运动信息通常是不被用的。任何其他与上述候选分享相同的运动信息的候选也不被用。如图 1，在 Nx2N 和 2NxN 模式下，当编码第二编码单元（PU_1）时，每个合并候选（L,A,T,RA 和 BL）的运动信息将与第一编码单元 PU（PU_0）相比较。如果某个候选与 PU_0 有相同的运动信息，该候选将设为无效且被避免的。在 NxN 模式下，当编码最后编码单元（PU_3）时，每个合并候选（L,A,T,RA 和 BL）的运动信息将与第一编码单元 PU（PU_1）和第二编码单元 PU_2 相比较，避免形成冗余的 2Nx2N, Nx2N 或 2NxN 模式。这么做的原因是避免获得这样的合并模

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001140

式，这个合并模式已经在一个更大尺寸的部分下，如2Nx2N，是可用的。且上述特征在对比文件2中的作用与该权利要求的附加技术特征在该权利要求中的作用相同，均是考虑第一第二预测单元的因素排除潜在空间运动矢量预测候选，也即对比文件2给出了将上述特征应用到对比文件1中以解决其技术问题的启示。因此，在对比文件1的基础上结合对比文件2得到该权利要求的技术方案对本领域技术人员来说是显而易见的。因此，该权利要求不具有突出的实质性特点和显著的进步，不具备专利法第22条第3款规定的创造性。

4. 权利要求4引用权利要求1或2。对比文件2公开了（参见第1部分，图1）：根据当前的HM3.0，位于PU相邻的左侧和上侧的候选的运动信息通常是不被用的。任何其他与上述候选分享相同的运动信息的候选也不被用。如图1，在Nx2N和2NxN模式下，当编码第二编码单元（PU_1）时，每个合并候选（L,A,T,RA和BL）的运动信息将与第一编码单元PU（PU_0）相比较。如果某个候选与PU_0有相同的运动信息，该候选将设为无效且被避免的。在NxN模式下，当编码最后编码单元（PU_3）时，每个合并候选（L,A,T,RA和BL）的运动信息将与第一编码单元PU（PU_1）和第二编码单元PU_2相比较，避免形成冗余的2Nx2N, Nx2N 或2NxN模式。这么做的原因是避免获得合并模式，这个合并模式已经在一个更大尺寸的部分下，如2Nx2N，是可用的。对比文件2公开的上述内容实质与权利要求4的附加技术特征相同，均是对于预测单元的相邻的潜在空间运动矢量预测候选是否要从合并列表中排除，包括对预测单元相邻的，之上，左侧，之上右侧，左侧之下，对角邻近这几种情况进行判断。具体判断过程，对比文件2公开的是比较的两者的运动信息是否“相同”，而该权利要求中比较两者运动信息是否“基本上相似”。对比文件3（“On MVP list pruning process”，Yongjoon Jeon等，JCTVC-F105）公开了一种MVP列表的移除处理，并具体公开如下技术内容（参见摘要，第1节，第2节）：如果运动矢量之间的差别小于等于一个阈值时，允许“不同的”运动矢量预测（MVP）候选从MVP列表中移除（相当于基本相似的运动矢量）。且上述特征在对比文件3中与“基本相似的运动矢量”在该权利要求中的作用相同，均是作为是否将该运动矢量预测候选移除的条件，即对比文件3给出了将上述特征应用到该权利要求中的启示。

对于技术特征“检查在所述合并列表中的空间运动矢量预测候选的数目是否小于所述最大数目。如果是这样，则检查所述潜在空间运动矢量预测候选所属的预测单元是否可用于运动预测”，对于本领域技术人员来说，当对潜在空间运动矢量预测候选进一步判断时，要考虑合并列表中的空间运动矢量预测候选的数目是否小于最大数目，若大于等于最大数目，则无需进一步检查潜在的空间运动矢量预测候选所属的预测单元是否可用于运动预测，若小于最大数目，则进一步检查潜在的空间运动矢量预测候选所属的预测单元是否可用于运动预测，这属于本领域

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001141

的惯用手段。

因此，在对比文件 1 的基础上结合对比文件 2、对比文件 3 及本领域的惯用手段得到该权利要求的技术方案对本领域技术人员来说是显而易见的，因此，该权利要求不具有突出的实质性特点和显著的进步，不具备专利法第 22 条第 3 款规定的创造性。

5. 权利要求 5 引用权利要求 1 或 2。对于本领域技术人员来说，合并列表中的运动矢量预测候选就是为了用于对像素块的运动矢量预测，因此，从所述合并列表选择一个运动矢量预测候选以表示用于所述像素块的运动矢量预测是本领域的惯用手段。因此，在其引用的权利要求不具备新颖性时，该权利要求不具备专利法第 22 条第 3 款规定的创造性。

6. 权利要求 6-10 是与权利要求 1-5 用于编码视频图像的方法相逆过程的用于解码编码的视频图像的方法，采用与编码方法相逆的过程用于解码编码的视频图像是本领域的惯用手段，基于权利要求 1-5 不具备新颖性或创造性的理由，权利要求 6-10 也不具备专利法第 22 条第 3 款规定的创造性。

7. 权利要求 11-15，16-20 是与权利要求 1-5，6-10 编码和解码的方法权利要求相对应的产品权利要求，编码装置和解码装置，均包括处理器和存储器，存储器包括计算机程序代码，存储器和计算机程序代码被配置为与处理器一起使装置实现权利要求 1-5 和 6-10 的编码方法及解码方法。对于本领域技术人员来说，相应的装置包括处理器及存储器以实现相应的方法是本领域的惯用手段。因此，基于权利要求 1-10 不具备新颖性或创造性的理由，权利要求 11-20 也不具备专利法第 22 条第 3 款规定的创造性。

8. 权利要求 21 和 22 均要求保护一种在其上具有计算机可读指令的计算机可读介质，其要求保护的实质是计算机可读介质上记录的计算机程序本身，而不是一种利用自然规律和自然力的技术方案，属于专利法第 25 条第 1 款第（2）项所述的智力活动的规则和方法的范围，因此不能被授予专利权。

基于上述理由，本申请的权利要求不具备新颖性或创造性或属于不授予专利权的客体，同时说明书中也没有记载其他任何可以授予专利权的实质性内容，因而即使申请人对权利要求进行重新组合和 / 或根据说明书记载的内容作进一步的限定，本申请也不具有被授予专利权的前景。如果申请人不能在本通知书规定的答复期限内提出表明本申请具有创造性的充分理由，本申请将被驳回。如修改申请文件，请提交修改对照页及替换页。

审查员姓名:孟贵宇
审查员代码:657730

纸件申请，回函请寄：100088 北京市海淀区蓟门桥西土城路 6 号 国家知识产权局专利局受理处收
电子申请，应当通过电子专利申请系统以电子文件形式提交相关文件。除另有规定外，以纸件等其他形式提交的文件视为未提交。

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001142

检索报告

申请号：2012800657775	申请日：20121102	首次检索
申请人：诺基亚技术有限公司	最早的优先权日：20111104	
权利要求项数：22	说明书段数：367+18	
审查员确定的 IPC 分类号：H04N19/513,H04N19/52		
检索记录信息：CNABS,CNTXT,VEN,USTXT,IEEE: 运动矢量，候选，预测，空间，列表，编码，移除，排除，相邻，郑云飞/in, MVP, motion, vector, candidate?, merge, remov+, deriv+, predict+, IPC 分类号：H04N19/513, H04N19/52		

相关专利文献

类型	国别以及代码[11]给出的文献号	代码[43]或[45]给出的日期	IPC 分类号	相关的段落和/或图号	涉及的权利要求
A	WO2011115659A1	20110922	H04N7/26	全文	1-20

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001143

相关非专利文献					
类型	书名（包括版本号和卷号）	出版日期	作者姓名和出版者名称	相关页数	涉及的权利要求
类型	期刊或文摘名称（包括卷号和期号）	发行日期	作者姓名和文章标题	相关页数	涉及的权利要求
X	《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》	20110722	Hiroya Nakamura 等 Unification of derivation process for merge mode and MVP	第 1-10 页	1-2，5，6-7，10，11-12，15，16-17，20
Y	《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》	20110722	Hiroya Nakamura 等 Unification of derivation process for merge mode and MVP	第 1-10 页	3-4，8-9，13-14，18-19
Y	《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》	20110722	Yunfei Zheng 等 Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode	第 1-6 页	3-4，8-9，13-14，18-19
Y	《Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11》	20110722	Yongjoon Jeon 等 On MVP list pruning process	第 1-2 页	4，9，14，19

表格填写说明事项：

1．审查员实际检索领域的 IPC 分类号应当填写到大组和 / 或小组所在的分类位置。

2．期刊或其它定期出版物的名称可以使用符合一般公认的国际惯例的缩写名称。

3．相关文件的类型说明：

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001144

X：一篇文件影响新颖性或创造性；

Y：与本报告中的另外的Y类文件组合而影响创造性；

A：背景技术文件；

R：任何单位或个人在申请日向专利局提交的、属于同样的发明创造的专利或专利申请文件。

P：中间文件，其公开日在申请的申请日与所要求的优先权日之间的文件；

E：抵触申请。

审 查 员：孟贵宇　　审查部门：专利审查协作天津中心通信发明审查部

2016年09月22日

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001145

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Christopher Jason Gegg/Joyce Smith
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	27608249
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Christopher Jason Gegg/Joyce Smith
Filer Authorized By:	Christopher Jason Gegg
Attorney Docket Number:	042933/467264
Receipt Date:	23-NOV-2016
Filing Date:	01-NOV-2012
Time Stamp:	17:20:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$180
RAM confirmation Number	112516INTEFSW00006268160605
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		IDS467264.PDF	120349 b845ae209454b044d9859450981370 7f2049057f	yes	2
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
2	Foreign Reference	467264_WO2011115659A1.pdf	2509710 d4823bdcdd669fa523163e7b121a7c735a7273fe	no	35
Warnings:					
Information:					
3	Non Patent Literature	467264_CNOA.PDF	808176 c1c45dbc009990c5360d598d0cc49f2d4bb59439	no	13
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30777 055efd02c01f163e02f2bc505e958676c3b5611c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3469012		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/467264

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Bici et al.	Confirmation No.:	4782
Appl. No.:	13/666,680	Group Art Unit:	2488
Filed:	November 1, 2012	Examiner:	N. B. Aynalem
For:	METHOD FOR CODING AND AN APPARATUS		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Notice of Allowance under 37 C.F.R. § 1.311, but before payment of the Issue Fee. The Notice of Allowance was mailed on October 19, 2016.

Attached is a list of documents on form SB08 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

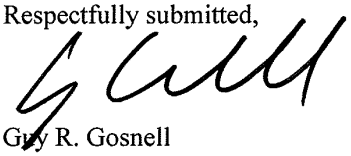
By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,



Guy R. Gosnell
Registration No. 34,610

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
#36819315v1

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001151

PRINTER RUSH
(PTO ASSISTANCE)

Application: 13666680	Examiner: AYNALEM	GAU: 2488
From: Bernice Crittenden	Location: RTFM	Creation Date: 12/01/2016

Week Date: 10/3/2016

DOC CODE	DOC DATE	MISCELLANEOUS
[ ] 1449		[ ] Continuing Data
[X] IDS	11/23/2016	[ ] Foreign Priority
[ ] CLM		[ ] Document Legibility
[ ] IIFW/FWCLM		[ ] Fees
[ ] SRFW		[ ] Petition (TC)
[ ] DRW		[ ] Other
[ ] OATH		
[ ] 312		
[ ] SPEC		

[RUSH] Message:

Please respond to the 11-23-2016 IDS.

Thank you,
BC

[XRUSH] Response:

Initials: _____

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001152

PRINTER RUSH
(PTO ASSISTANCE)

Application: 13666680	Examiner: AYNALEM	GAU: 2488
From: Bernice Crittenden	Location: RTFM	Creation Date: 12/01/2016

Week Date: 10/3/2016

DOC CODE	DOC DATE	MISCELLANEOUS
[ ] 1449		[ ] Continuing Data
[X] IDS	11/23/2016	[ ] Foreign Priority
[ ] CLM		[ ] Document Legibility
[ ] IIFW/FWCLM		[ ] Fees
[ ] SRFW		[ ] Petition (TC)
[ ] DRW		[ ] Other
[ ] OATH		
[ ] 312		
[ ] SPEC		

[RUSH] Message:

Please respond to the 11-23-2016 IDS.

Thank you,
BC

[XRUSH] Response:

The IDS filed on 11/23/2016 has
been considered.

Initials: /N.B.A/

Examiner: PUBS contact - James Leija, (703) 756-1197
NOTE: This form will be included as part of the official USPTO record with the response document coded as XRUSH.
REV: AUG 16

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001153

Substitute for form SB08 (Revised 07/09)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/666,680
				Filing Date	November 1, 2012
				First Named Inventor	Bici et al.
				Art Unit	2488
				Examiner Name	N. B. Aynalem
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document Country Code - Number Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	English Language Translation Attached
/N.B.A/	1	WO 2011 115659 A1	09-22-2011	Thomson Licensing		

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
/N.B.A/	2	Office Action for Chinese Application No. 2012800657775 dated October 9, 2016	Yes

Examiner Signature	/NATHNAEL B AYNALEM/	Date Considered	12/12/2016

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. LEGAL02/36819290v1

Submitted November 23, 2016

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 12/20/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
AYNALEM, NATHNAEL B

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
12/20/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001155

Supplemental Notice of Allowability	Application No. 13/666,680	Applicant(s) BICI ET AL.	
	Examiner NATHNAEL AYNALEM	Art Unit 2488	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *Information Disclosure Statement filed on 11/23/2016*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-18 and 21-32*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 11/23/2016
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/NATHNAEL AYNALEM/
Examiner, Art Unit 2488

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001156

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Dec 20, 2016 03:30:34 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	1449	12/20/2016	042933/467264
	NOA	12/20/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

10949 7590 12/27/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER
AYNALEM, NATHNAEL B

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
12/27/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001158

Supplemental Notice of Allowability	**Application No.** 13/666,680	**Applicant(s)** BICI ET AL.	
	Examiner NATHNAEL AYNALEM	**Art Unit** 2488	**AIA (First Inventor to File) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *application filed on 11/01/2012*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-18 and 21-32*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date See Continuation Sheet
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/NATHNAEL AYNALEM/
Examiner, Art Unit 2488

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001159

Continuation of Attachment(s) 2. Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date: 2/26/2016;4/25/2016;9/2/2016.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001160

Substitute for form SB08 (Revised 07/09)				Complete if Known	
				Application Number	13/666,680
				Filing Date	11/01/2012
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
(Use as many sheets as necessary)				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
/N.B.A/	1	Office Action from corresponding Canadian Patent Application No. 2,854,495, dated October 7, 2015	YES

Examiner Signature	/NATHNAEL B AYNALEM/	Date Considered	12/21/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36219768v1

Submitted February 26, 2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.H/

Substitute for form SB08 (Revised 07/09)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/666,680
				Filing Date	11/01/2012
				First Named Inventor	Mehmet Oguz Bici
				Art Unit	2488
				Examiner Name	Clifford Hilaire
Sheet	*1*	of	1	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
/N.B.A/	1	Office Action from Korean Patent Application No. 2014-7015093 dated August 22, 2016	YES

Examiner Signature	/NATHNAEL B AYNALEM/	Date Considered	12/21/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36636444v1

Submitted September 2, 2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.H/

Substitute for form SB08 (Revised 07/09)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/666,680
				Filing Date	November 1, 2012
				First Named Inventor	Bici et al.
				Art Unit	2488
				Examiner Name	Clifford Hilaire
Sheet	*1*	of	*1*	Attorney Docket Number	042933/467264

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
/N.B.A/	1	Extended European Search Report for corresponding European Application No. 12845839.5 dated March 21, 2016, 10 pages	
/N.B.A/	2	**Nakamura, H. et al.**, *Unification of derivation process for merge mode and MVP*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting; Torino, IT, 14-22 July, 2011; Document JCTVC-F419; URL: http://wftp3.itu.int/AV-ARCH/JCTVC-SITE/2011_07_F_Torino/, 10 pages	
/N.B.A/	3	**Zheng, Y. et al.**, *Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting, Torino, IT, 14-22 July, 2011; Document JCTVC-F302, 6 pages	
/N.B.A/	4	**Bross, B. et al.**, *Core Experiment 9: MV Coding and Skip/Merge Operations*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting, Torino, IT, 14-22 July, 2011; Document JCTVC-F909, 13 pages	
/N.B.A/	5	**Jeon, Y. et al.**, *On MVP list pruning process*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 6th Meeting, Torino, IT, 14-22 July, 2011, Document JCTVC-F105, 7 pages	
/N.B.A/	6	**Bici, O. et al.**, *Non-CE13: Simplification of merge mode*, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 7th Meeting: Geneva, CH, 21-30 November, 2011, Document JCTVC-G593; URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, 13 pages	

Examiner Signature	/NATHNAEL B AYNALEM/	Date Considered	12/21/2016

*Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. LEGAL02/32811780v3

Submitted April 25, 2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /C.H/

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Dec 27, 2016 03:38:12 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	NOA	12/27/2016	042933/467264
	1449	12/27/2016	042933/467264
	1449	12/27/2016	042933/467264
	1449	12/27/2016	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 09/30/2016
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	11/01/2012	Mehmet Oguz BICI	042933/467264	4782

TITLE OF INVENTION: METHOD FOR CODING AND AN APPARATUS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	12/30/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
AYNALEM, NATHNAEL B	2488	375-240160

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 Alston & Bird LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Nokia Technologies Oy
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Espoo, Finland

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
☒ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 16-0605 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
☐ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
☐ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date December 29, 2016

Typed or printed name Guy R. Gosnell Registration No. 34,610

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001165

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Christopher Jason Gegg/Joyce Smith
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt

EFS ID:	27927497
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Christopher Jason Gegg/Joyce Smith
Filer Authorized By:	Christopher Jason Gegg
Attorney Docket Number:	042933/467264
Receipt Date:	29-DEC-2016
Filing Date:	01-NOV-2012
Time Stamp:	13:11:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$960
RAM confirmation Number	122916INTEFSW00014176160605
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	ISSUEFEE467264.PDF	102442 652827919 46e16d72d1808df53bc83dd3a33c817	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30855 f76e07a1b0914739f7d9ba2745db1d44e95681de	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	133297		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13666680
Filing Date	2012-11-01
First Named Inventor	Mehmet Oguz BICI
Art Unit	2631
Examiner Name	TBD
Attorney Docket Number	NC77198US-NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
Change(s) applied to document, /L.H./ 1/3/2017	1	20120307905	A1	2012-12-06	~~Sunycon et al.~~ Kim et al.	
	2	20110170602	A1	2011-07-14	~~Tammy et al.~~ Lee et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2011062392	WO	A2	2011-05-26	SK Telecom Co. Ltd. et al.		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /CH/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/666,680	02/14/2017	9571833	042933/467264	4782

10949 7590 01/25/2017

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 711 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Mehmet Oguz BICI, Tampere, FINLAND;
Nokia Technologies Oy, Espoo, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Kemal UGUR, Tampere, FINLAND;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1002, 001171

To: usptomail@alston.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 10949

Jan 26, 2017 03:31:13 AM

Dear PAIR Customer:

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 10949 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
13666680	ISSUE.NTF	01/25/2017	042933/467264

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	REQUEST ID
13/666,680	9571833	2488	46786

PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 00197 on 09/06/2017 via Private PAIR in view of the certification copied below that authorized the change.

- Maintenance Fee Address

The address for Customer Number 00197 is:
00197
CPA GLOBAL LIMITED
2318 Mill Road 12th Floor
ALEXANDRIA, VA 22314

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/Guy R. Gosnell/
Name:	Guy R. Gosnell
Registration Number:	34610

Attorney's Docket No. 042933/467264 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Mehmet Oguz Bici	Confirmation No. 4782
Appl. No.:	13/666,680	Patent No.: 9,571,833
Filed:	November 1, 2012	Issue Date: February 14, 2017
For:	METHOD FOR CODING AND AN APPARATUS	

Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CERTIFICATE OF CORRECTION

On behalf of the Applicant and Assignee of the above-referenced patent, Nokia Technologies Oy, it is hereby requested that the Office issue a Certificate of Correction in order to make a correction to Claim 9 as set forth in the attached Certificate of Correction. Specifically, the requested correction brings the wording of Claim 9 consistent with corresponding independent Claims 1, 15, 16, 17 and 18.

The required Certificate of Correction fee of $150 is being paid during e-filing concurrently herewith.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111
LEGAL02/38421324v1

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,571,833 B2 Page 1 of 1

APPLICATION NO. : 13/666,680

ISSUE DATE : February 14, 2017

INVENTOR(S) : Bici et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims:

Column 33,
Line 56, "set" should read --subset--.

MAILING ADDRESS OF SENDER

ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000

Electronic Patent Application Fee Transmittal

Application Number:	13666680
Filing Date:	01-Nov-2012
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Filer:	Guy Randall Gosnell/Kim Shaul
Attorney Docket Number:	042933/467264

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
CERTIFICATE OF CORRECTION	1811	1	150	150

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**150**

Electronic Acknowledgement Receipt

EFS ID:	33854474
Application Number:	13666680
International Application Number:	
Confirmation Number:	4782
Title of Invention:	METHOD FOR CODING AND AN APPARATUS
First Named Inventor/Applicant Name:	Mehmet Oguz BICI
Customer Number:	10949
Filer:	Guy Randall Gosnell/Kim Shaul
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/467264
Receipt Date:	27-SEP-2018
Filing Date:	01-NOV-2012
Time Stamp:	18:13:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$150
RAM confirmation Number	092818INTEFSW00005658160605
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	467264CertCorr.pdf	25125 37a5125c542e55e231a2bdd4cf3cb8e97558576c	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30382 8f7054e7fe1d5735f8fa94c5479a75400dab72e6	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	55507		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,571,833 B2
APPLICATION NO. : 13/666680
DATED : February 14, 2017
INVENTOR(S) : Bici et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 33,
Line 56, "set" should read --subset--.

Signed and Sealed this
Twenty-third Day of October, 2018

Andrei Iancu
Director of the United States Patent and Trademark Office