PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Yunfei Zheng		
Filed:	Herewith	Customer No.:	15150
Docket No.:	1010-939US01/120072		
Title:	**PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING**		

REQUEST FOR PATENT APPLICATION UNDER 37 C.F.R. § 1.53(b)

Commissioner for Patents
Alexandria, VA 22313-1450

Sir:

This application claims the benefit of U.S. Provisional Application No. 61/499,112, filed June 20, 2011, U.S. Provisional Application No. 61/543,043, filed October 4, 2011, U.S. Provisional Application No. 61/543,059, filed October 4, 2011, U.S. Provisional Application No. 61/556,761, filed November 7, 2011, U.S. Provisional Application No. 61/562,387, filed November 21, 2011, and U.S. Provisional Application No. 61/562,953, filed November 22, 2011.

We are transmitting herewith the attached correspondence relating to this application:

☒ Transmittal sheet.
☒ Utility Patent Application: Spec. 34 pp.; Claims 9 pp.; Abstract 1 p.
The fee has been calculated as shown below in the "Claims as Filed" table.
☒ Ten (10) sheets of formal drawings.
☒ Application Data Sheet (5 pp.).

CLAIMS AS FILED

Number of Claims Filed		In Excess of:		Extra		Rate		Fee
Basic Filing Fee								$380.00
Total Claims								
40		20		20	x	$60.00	=	$1,200.00
Independent Claims								
4		3		1	x	$250.00	=	$ 250.00
MULTIPLE DEPENDENT CLAIM FEE								
EXAMINATION FEE								$250.00
SEARCH FEE								$620.00
APPLICATION SIZE FEE (if applicable)								$
TOTAL FILING FEE								$2,700.00

Under 37 CFR §1.53(f), no filing fee is being paid at this time.

If this application is found to be incomplete, or if a telephone conference would otherwise be helpful, please call the undersigned at (651) 286-8320.

Please send all correspondence to Practitioners at Customer Number 15150.

Date: June 18, 2012
By: /Matthew J. Evans/
Name: Matthew J. Evans, Reg No. 56,530

SHUMAKER & SIEFFERT, P.A.
1625 Radio Drive, Suite 300
Woodbury, Minnesota 55125
Telephone: 651.286.8320
Facsimile: 651.735.1102

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PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

[0001] This application claims the benefit of U.S. Provisional Application No. 61/499,112, filed June 20, 2011, U.S. Provisional Application No. 61/543,043, filed October 4, 2011, U.S. Provisional Application No. 61/543,059, filed October 4, 2011, U.S. Provisional Application No. 61/556,761, filed November 7, 2011, U.S. Provisional Application No. 61/562,387, filed November 21, 2011, and U.S. Provisional Application No. 61/562,953, filed November 22, 2011, all of which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

[0002] This disclosure relates to video coding, and more particularly to techniques for determining a set of motion vector prediction candidates in a motion vector prediction process.

BACKGROUND

[0003] Digital video capabilities can be incorporated into a wide range of devices, including digital televisions, digital direct broadcast systems, wireless broadcast systems, personal digital assistants (PDAs), laptop or desktop computers, digital cameras, digital recording devices, digital media players, video gaming devices, video game consoles, cellular or satellite radio telephones, video teleconferencing devices, and the like. Digital video devices implement video compression techniques, such as those described in the standards defined by MPEG-2, MPEG-4, ITU-T H.263, ITU-T H.264/MPEG-4, Part 10, Advanced Video Coding (AVC), the High Efficiency Video Coding (HEVC) standard presently under development, and extensions of such standards, to transmit, receive and store digital video information more efficiently.

[0004] Video compression techniques include spatial prediction and/or temporal prediction to reduce or remove redundancy inherent in video sequences. For block-based video coding, a video frame or slice may be partitioned into blocks. Each block can be further partitioned. Blocks in an intra-coded (I) frame or slice are encoded using spatial prediction with respect to reference samples in neighboring blocks in the same frame or slice. Blocks in an inter-coded (P or B) frame or slice may use spatial

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prediction with respect to reference samples in neighboring blocks in the same frame or slice or temporal prediction with respect to reference samples in other reference frames. Spatial or temporal prediction results in a predictive block for a block to be coded. Residual data represents pixel differences between the original block to be coded and the predictive block.

[0005] An inter-coded block is encoded according to a motion vector that points to a block of reference samples forming the predictive block, and the residual data indicating the difference between pixel values in the coded block and reference samples in the predictive block. An intra-coded block is encoded according to an intra-coding mode and the residual data. For further compression, the residual data may be transformed from the pixel domain to a transform domain, resulting in residual transform coefficients, which then may be quantized. The quantized transform coefficients, initially arranged in a two-dimensional array, may be scanned in a particular order to produce a one-dimensional vector of transform coefficients for entropy coding.

SUMMARY

[0006] In general, this disclosure describes techniques for coding video data. This disclosure describes techniques for determining a set of merge candidates in a merge mode motion vector prediction process.

[0007] In some examples, this disclosure proposes generating a merge candidate set for a current prediction unit of a coding unit without comparing the motion information of any merge candidates with the motion information of any other prediction units in the same coding unit. In this way, merge candidate sets for multiple prediction units of coding unit may be generated in parallel, as the generation of specific merge candidate does not rely on a comparison to motion vector information in other prediction units that may or may not have been already determined.

[0008] This disclosure further proposes to remove merge candidates from a merge candidate set for a current prediction unit that are contained within another prediction unit of the same coding unit. In this way, the likelihood that all prediction units of one coding unit will use the same motion vector information is limited, thus preserving the advantage of partitioning a coding unit into multiple prediction units.

[0009] In one example of the disclosure, a method of coding video data comprises determining a merge candidate set for a current prediction unit of a current coding unit,

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wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and performing a merge motion vector prediction process for the current prediction unit using the merge candidate set. The method may further comprise excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

[0010] In another example of the disclosure, an apparatus configured to code video data comprises a video coder configured to determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and to perform a merge motion vector prediction process for the current prediction unit using the merge candidate set. The video coder may be further configured to remove merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

[0011] In another example of the disclosure, an apparatus configured to code video data comprises means for determining a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and means for performing a merge motion vector prediction process for the current prediction unit using the merge candidate set. The apparatus may further comprise means for excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

[0012] In another example of the disclosure, a computer-readable storage medium having stored thereon instructions that when executed cause one or more processors configured to code video data is proposed. The instructions cause the one or more processors to determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and to perform a merge motion vector prediction process for the current prediction unit using the merge candidate set. The instructions may further cause the one or more processors to remove merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

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[0013] The details of one or more examples are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

[0014] FIG. 1 is a conceptual drawing illustrating candidate blocks for motion vector prediction according to merge mode.

[0015] FIG. 2 is a conceptual drawing illustrating example partition types.

[0016] FIG. 3A is a conceptual diagram illustrating candidate blocks for merge mode motion vector prediction for an Nx2N partition of a coding unit.

[0017] FIG. 3B is a conceptual diagram illustrating candidate blocks for merge mode motion vector prediction for a 2NxN partition of a coding unit.

[0018] FIG. 4A is a conceptual diagram illustrating candidate blocks for merge mode motion vector prediction for an NxN partition of a coding unit.

[0019] FIG. 4B is a conceptual diagram illustrating another example of candidate blocks for merge mode motion vector prediction for an NxN partition of a coding unit.

[0020] FIG. 5 is a block diagram illustrating an example video coding system.

[0021] FIG. 6 is a block diagram illustrating an example video encoder.

[0022] FIG. 7 is a block diagram illustrating an example video decoder.

[0023] FIG. 8 is a flowchart illustrating an example method of encoding video according to the techniques of this disclosure.

[0024] FIG. 9 is a flowchart illustrating an example method of decoding video according to the techniques of this disclosure.

DETAILED DESCRIPTION

[0025] In general, this disclosure describes techniques for coding video data. This disclosure describes techniques for determining a merge candidate set in a merge mode motion vector prediction process.

[0026] Digital video devices implement video compression techniques to encode and decode digital video information more efficiently. Video compression may apply spatial (intra-frame) prediction and/or temporal (inter-frame) prediction techniques to reduce or remove redundancy inherent in video sequences.

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[0027] There is a new video coding standard, namely High-Efficiency Video Coding (HEVC), being developed by the Joint Collaboration Team on Video Coding (JCT-VC) of ITU-T Video Coding Experts Group (VCEG) and ISO/IEC Motion Picture Experts Group (MPEG). A recent draft of the HEVC standard, referred to as "HEVC Working Draft 6" or "WD6," is described in document JCTVC-H1003, Bross et al., "High efficiency video coding (HEVC) text specification draft 6," Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 8th Meeting: San Jose, California, USA, February, 2012, which, as of June 1, 2012, is downloadable from http://phenix.int-evry.fr/jct/doc_end_user/documents/8_San%20Jose/wg11/JCTVC-H1003-v22.zip.

[0028] For video coding according to the high efficiency video coding (HEVC) standard currently under development by the Joint Cooperative Team for Video Coding (JCT-VC), a video frame may be partitioned into coding units. A coding unit (CU) generally refers to an image region that serves as a basic unit to which various coding tools are applied for video compression. A CU usually has a luminance component, which may be denoted as Y, and two chroma components, which may be denoted as U and V. Depending on the video sampling format, the size of the U and V components, in terms of number of samples, may be the same as or different from the size of the Y component. A CU is typically square, and may be considered to be similar to a so-called macroblock, e.g., under other video coding standards such as ITU-T H.264.

[0029] To achieve better coding efficiency, a coding unit may have variable sizes depending on video content. In addition, a coding unit may be split into smaller blocks for prediction or transform. In particular, each coding unit may be further partitioned into prediction units (PUs) and transform units (TUs). Prediction units may be considered to be similar to so-called partitions under other video coding standards, such as H.264. Transform units (TUs) refer to blocks of residual data to which a transform is applied to produce transform coefficients.

[0030] Coding according to some of the presently proposed aspects of the developing HEVC standard will be described in this application for purposes of illustration. However, the techniques described in this disclosure may be useful for other video coding processes, such as those defined according to H.264 or other standard or proprietary video coding processes.

[0031] HEVC standardization efforts are based on a model of a video coding device referred to as the HEVC Test Model (HM). The HM presumes several capabilities of

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video coding devices over devices according to, e.g., ITU-T H.264/AVC. For example, whereas H.264 provides nine intra-prediction encoding modes, HM provides as many as thirty-four intra-prediction encoding modes.

[0032] According to the HM, a CU may include one or more prediction units (PUs) and/or one or more transform units (TUs). Syntax data within a bitstream may define a largest coding unit (LCU), which is a largest CU in terms of the number of pixels. In general, a CU has a similar purpose to a macroblock of H.264, except that a CU does not have a size distinction. Thus, a CU may be split into sub-CUs. In general, references in this disclosure to a CU may refer to a largest coding unit of a picture or a sub-CU of an LCU. An LCU may be split into sub-CUs, and each sub-CU may be further split into sub-CUs. Syntax data for a bitstream may define a maximum number of times an LCU may be split, referred to as CU depth. Accordingly, a bitstream may also define a smallest coding unit (SCU). This disclosure also uses the term "block" or "portion" to refer to any of a CU, PU, or TU. In general, "portion" may refer to any sub-set of a video frame.

[0033] An LCU may be associated with a quadtree data structure. In general, a quadtree data structure includes one node per CU, where a root node corresponds to the LCU. If a CU is split into four sub-CUs, the node corresponding to the CU includes four leaf nodes, each of which corresponds to one of the sub-CUs. Each node of the quadtree data structure may provide syntax data for the corresponding CU. For example, a node in the quadtree may include a split flag, indicating whether the CU corresponding to the node is split into sub-CUs. Syntax elements for a CU may be defined recursively, and may depend on whether the CU is split into sub-CUs. If a CU is not split further, it is referred as a leaf-CU.

[0034] Moreover, TUs of leaf-CUs may also be associated with respective quadtree data structures. That is, a leaf-CU may include a quadtree indicating how the leaf-CU is partitioned into TUs. This disclosure refers to the quadtree indicating how an LCU is partitioned as a CU quadtree and the quadtree indicating how a leaf-CU is partitioned into TUs as a TU quadtree. The root node of a TU quadtree generally corresponds to a leaf-CU, while the root node of a CU quadtree generally corresponds to an LCU. TUs of the TU quadtree that are not split are referred to as leaf-TUs.

[0035] A leaf-CU may include one or more prediction units (PUs). In general, a PU represents all or a portion of the corresponding CU, and may include data for retrieving a reference sample for the PU. For example, when the PU is inter-mode encoded, the

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PU may include data defining a motion vector for the PU. The data defining the motion vector may describe, for example, a horizontal component of the motion vector, a vertical component of the motion vector, a resolution for the motion vector (e.g., one-quarter pixel precision or one-eighth pixel precision), a reference frame to which the motion vector points, and/or a reference list (e.g., list 0 or list 1) for the motion vector. Data for the leaf-CU defining the PU(s) may also describe, for example, partitioning of the CU into one or more PUs. Partitioning modes may differ depending on whether the CU is not predictively coded, intra-prediction mode encoded, or inter-prediction mode encoded. For intra coding, a PU may be treated the same as a leaf transform unit described below.

[0036] To code a block (e.g., a prediction unit (PU) of video data), a predictor for the block is first derived. The predictor can be derived either through intra (I) prediction (i.e. spatial prediction) or inter (P or B) prediction (i.e. temporal prediction). Hence, some prediction units may be intra-coded (I) using spatial prediction with respect to neighbouring reference blocks in the same frame, and other prediction units may be inter-coded (P or B) with respect to reference blocks in other frames.

[0037] Upon identification of a predictor, the difference between the original video data block and its predictor is calculated. This difference is also called the prediction residual, and refers to the pixel differences between the pixels of the block to be coded and corresponding reference samples (which may be integer-precision pixels or interpolated fractional-precision pixels) of the reference block, i.e., predictor. To achieve better compression, the prediction residual (i.e., the array of pixel difference values) is generally transformed, e.g., using a discrete cosine transform (DCT), integer transform, Karhunen-Loeve (K-L) transform, or other transform.

[0038] Coding a PU using inter-prediction involves calculating a motion vector between a current block and a block in a reference frame. Motion vectors are calculated through a process called motion estimation (or motion search). A motion vector, for example, may indicate the displacement of a prediction unit in a current frame relative to a reference sample of a reference frame. A reference sample may be a block that is found to closely match the portion of the CU including the PU being coded in terms of pixel difference, which may be determined by sum of absolute difference (SAD), sum of squared difference (SSD), or other difference metrics. The reference sample may occur anywhere within a reference frame or reference slice. In some examples, the reference sample may be interpolated, in whole or in part, and occur at a fractional pixel position.

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Upon finding a portion of the reference frame that best matches the current portion, the encoder determines the current motion vector for the current portion as the difference in the location from the current portion to the matching portion in the reference frame (e.g., from the center of the current portion to the center of the matching portion).

[0039] In some examples, an encoder may signal the motion vector for each portion in the encoded video bitstream. The signaled motion vector is used by the decoder to perform motion compensation in order to decode the video data. However, signaling the original motion vector directly may result in less efficient coding, as a large number of bits are typically needed to convey the information.

[0040] In some instances, rather than directly signaling the original motion vector, the encoder may predict a motion vector for each PU. In this disclosure, the term "block" may be used generically to refer to a CU, PU or a TU. In performing a motion vector prediction process, the encoder may select a set of candidate motion vectors determined for spatially neighboring blocks in the same frame as the current PU or a candidate motion vector determined for a co-located PU in a reference frame. The encoder may perform motion vector prediction to select a particular candidate motion vector, and if needed, signal a syntax element indicating a selected motion vector candidate to reduce bit rate in signaling. The candidate motion vectors from the spatially neighboring blocks may be referred to as spatial MVP candidates, whereas the candidate motion vector from the co-located block in another reference frame may be referred to as a temporal MVP candidate.

[0041] The techniques of this disclosure are directed to the "merge" mode of motion vector prediction. In merge mode, a video encoder instructs a decoder, through bitstream signaling of prediction syntax, to copy a motion vector, reference index (identifying a reference frame, in a given reference picture list, to which the motion vector points) and the motion prediction direction (which identifies the reference picture list (List 0 or List 1), i.e., in terms of whether the reference frame temporally precedes or follows the currently frame) from a selected candidate motion vector for a current portion of the frame. This is accomplished by signaling in the bitstream an index into a candidate motion vector set identifying the selected candidate motion vector (i.e., the particular spatial MVP candidate or temporal MVP candidate). The candidate motion vector set may be derived through default settings or inferred from certain coding parameters. Thus, for merge mode, the prediction syntax may include a flag identifying the mode (in this case "merge" mode) and an index identifying the selected candidate

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motion vector. In some instances, the candidate motion vector will be in a causal PU in reference to the current PU. That is, the candidate motion vector will have already been decoded by the decoder. As such, the decoder has already received and/or determined the motion vector, reference index, and motion prediction direction for the causal PU. As such, the decoder may simply retrieve the motion vector, reference index, and motion prediction direction associated with the causal PU from memory and copy these values for the current PU. To decode a block in merge mode, the decoder obtains the predictor block using the motion vector prediction, and adds the residual data to the predictor block to reconstruct the coded block.

[0042] Once motion estimation is performed to determine a motion vector for a current portion, the encoder compares the matching portion in the reference frame to the current portion. This comparison typically involves subtracting the portion (which is commonly referred to as a "reference sample") in the reference frame from the current portion and results in so-called residual data, as mentioned above. The residual data indicates pixel difference values between the current portion and the reference sample. The encoder then transforms this residual data from the spatial domain to a transform domain, such as the frequency domain. Usually, the encoder applies a discrete cosine transform (DCT) to the residual data to accomplish this transformation. The encoder performs this transformation in order to facilitate the compression of the residual data because the resulting transform coefficients represent different frequencies, wherein the majority of energy is usually concentrated on a few low frequency coefficients.

[0043] Typically, the resulting transform coefficients are grouped together in a manner that enables run-length encoding, especially if the transform coefficients are first quantized (rounded). The encoder performs this run-length encoding of the quantized transform coefficients and then performs statistical lossless (or so-called "entropy") encoding to further compress the run-length coded quantized transform coefficients.

[0044] After performing lossless entropy coding, the encoder generates a bitstream that includes the encoded video data. This bitstream also includes a number of prediction syntax elements in certain instances that specify whether, for example, motion vector prediction was performed, the motion vector mode, and a motion vector predictor (MVP) index (i.e., the index of the candidate portion with the selected motion vector). The MVP index may also be referred to as its syntax element variable name "mvp_idx."

[0045] FIG. 1 shows a candidate motion vector set 90 currently proposed in the HEVC standard for use in merge mode. Merge mode uses six merge candidates from the

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following spatial and temporal blocks: the below left (BL) block 91, the left (L) block 92, the right above (RA) block 93, the above (A) block 94, the left above (LA) block 95, and the temporal block (T) 96. The candidate motion vectors associated with these blocks are used for determining a motion vector predictor in merge mode.

[0046] Temporal block 96 may be within a co-located block in a different frame than current PU (e.g., T_2) or adjacent to a co-located block in a different frame than the current PU 108 (e.g., T_1). The locations of the spatial candidate blocks (i.e., BL, L, LA, A, and RA) depicted in FIG. 1 are not absolute positions, but rather are relative positions to current PU 98 based on the following general definitions. It should be noted that the candidate blocks need not be the nearest possible block that meets the following definitions, but may be any PU that meets the definitions. The LA candidate block 95 is located above a top line defining the current PU and to the left of a left line defining the current PU. The L candidate block 92 is located to the left of a left line defining the current PU, but also above a bottom line defining the current PU and below a top line defining the current PU. The BL candidate block 91 is located below a bottom line defining the current PU and to the left of a left line defining the current PU. The A candidate block 94 is located above a top line defining the current PU, but also to the right of a left line defining the current PU and to the left of a right line defining the current PU. The RA candidate block 93 is located to the right of a right line defining the current PU and above a top line defining the current PU.

[0047] Merge candidates are generated per PU. That is, each PU has its own set of merge candidates. This includes PUs that are partitioned from a larger CU. The example of FIG. 1 is for a 2Nx2N partitioned PU (e.g., a square PU). FIG. 2 shows further examples of prediction units with different partition types. As shown in FIG. 2, a 2Nx2N partition is a square-shaped partition. Essentially, it is a PU from an unpartitioned CU. A 2NxN partition is made by dividing a square CU into two horizontally oriented PUs, where PU 0 is on top of PU 1. An Nx2N partition is made by dividing a square CU into two vertically oriented PUs, where PU 0 is to the left of PU 1. An NxN partition is made by dividing a square CU into four equally sized PUs. In an NxN partition, PU 0 is at the upper left of the CU, PU 1 is at the upper right of the CU, PU 2 is at the lower left of the CU, and PU 3 is a the lower right of the CU.

[0048] FIG. 2 shows additional types of "non-square" partitions. A 2NxnD partition is a horizontally oriented non-square partition type, where the lower PU (PU 1) is of a smaller size (i.e. a quarter size of the CU size) than the upper PU (PU 0). A 2NxnU

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partition is a horizontally oriented non-square partition type, where the lower PU (PU 1) is of a larger size (i.e. three quarters of the CU size) than the upper PU (PU 0). An nLx2N partition is a vertically oriented non-square partition type, where the left PU (PU 0) is of a smaller size (i.e. a quarter size of the CU size) than the right PU (PU 1). An nRx2N partition is a vertically oriented non-square partition type, where the left PU (PU 0) is of a larger size (i.e., three quarters of the CU size) than the right PU (PU 1). These partitioning examples are sometimes called an asymmetric motion partition (AMP).

[0049] CUs are partitioned according to one of the partition types to provide for more accurate inter prediction (temporal prediction). Motion information is signaled separately for each partition. With a finer partition (e.g., a 2NxN partition is finer than a 2Nx2N partition), a better quality of predictor can potentially be derived for each partition. On the other hand, since motion information is signaled separately for each partition, signaling overhead of a CU with a finer partition is also relatively higher. In practice, determining a partition type for a current CU is often based on rate-distortion optimization. The selected partition type is a tradeoff between accuracy of prediction and signaling overhead. Current proposals for the HEVC standard implement techniques to avoid using redundant merge candidates for PUs of the same CU. A redundant merge candidate is a merge candidate that has the same motion information as another PU in the same CU. For a particular partition type, each of the merge candidates for PU 1 (or PUs 1, 2 and 3 for an NxN partition) are compared with the motion information of PU 0 (or PUs 0, 1 and 2 for an NxN partition) to avoid the whole CU using the same motion information. If every PU in a CU used the same motion information, the result would be duplicative of the 2Nx2N partition type (i.e., no partitioning). Thus the advantage of partitioning a CU for more accurate inter prediction would be negated.

[0050] In order to avoid using redundant merge candidates, one proposal for HEVC proposes comparing the motion information for each merge candidate in a merge candidate set with the motion information of other PUs of the same CU. Any merge candidates with the same motion information as a previously coded PU is removed from the merge candidate set to avoid the whole CU using same motion information.

[0051] According to this technique, the process for generating a merge candidate set for a PU is as follows:

1. Check the motion information for the next candidate block

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2. Compare the candidate motion information with the motion information for previously coded PUs in the same CU
3. If the candidate motion information for the candidate block is the same as the motion information for a previously coded PU, go to step 1; otherwise, go to step 4
4. Add the candidate block into the merge candidate set
5. If all the candidate blocks are checked, finish; otherwise, go to step 1

[0052] In general, the restriction on merge candidates with this process produces the following results for 2NxN, Nx2N and NxN partition types:

1) 2NxN/Nx2N cases: if a merge candidate for the second PU (PU 1) has the same motion information as that of the first PU (PU 0), that merge candidate will be set as not available.
2) NxN case:
    a. PU 0 and PU 1 have the same motion information. If a merge candidate of PU 3 has the same motion information as PU 2, the merge candidate is set to unavailable;
    b. PU 0 and PU 2 have the same motion information. If a merge candidate of PU 3 has the same motion information as PU 1, the merge candidate is set to unavailable.

[0053] While this process does eliminate redundant merge candidates, this process requires that all PUs have been encoded/decoded prior to developing the merge candidate set for subsequent PUs. As such, the ability to process multiple PUs of one CU in parallel is limited. The encoder/decoder must determine the final motion information of all previous PUs in the same CU before constructing the merge candidate set for a current PU. Furthermore, the comparison operation for each candidate block may increase the computational complexity for the encoder/decoder.

[0054] In one example, this disclosure proposes to remove the comparison checking operation during generation of a merge candidate set, thus making merge candidate generation parallelization friendly. The disclosed technique eliminates the need for comparing motion information between candidate blocks and other PUs of a CU. As such, the merge candidate sets for all PUs of a CU may be generated in parallel. The disclosed process may also reduce the computational complexity of encoding and decoding.

[0055] The proposed process for each PU is

1. Check next candidate block

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2. Add the candidate block into the candidate set
3. If all the neighboring blocks are checked, finish; otherwise, go to step 1

[0056] This process provides a unified solution for all PUs without considering the prediction unit's index (e.g., PU 0, PU 1) and without making a comparison of the motion information of the candidate block to the motion information of previously coded PUs. The motion information comparison steps illustrated above can be removed. Although described iteratively, the steps of this method can be performed in parallel. For example, a first thread of a parallel process can include instructions to perform a first instance of steps 1 and 2, and a second, different thread of the parallel process can include instructions to perform a second instance of steps 1 and 2. Additional threads can also be provided.

[0057] Based on the proposed technique, a merge candidate that is inside a previous PU can be included into the merge candidate set. However this may cause the whole CU to use the same motion information. As such, a partitioned CU may end up with the same coded motion vectors as a 2Nx2N partition, and the benefits of partitioning for inter-prediction may be limited. In addition, including such redundant candidate blocks in the merge candidate set may cause some performance drops because extra bits are used to signal the redundant merge candidates. As such, this disclosure also proposes to remove merge candidates from the merge candidate set if the merge candidate is located inside another PU of the same CU.

[0058] FIG. 3A is a conceptual diagram illustrating candidate blocks for merge mode for an Nx2N partition of a CU. Note that the techniques shown in FIG. 3A are equally applicable for nLx2N or nRx2N asymmetric partition types. Merge candidate set 100 shows the merge candidates for PU 0 of an Nx2N partitioned CU. Since no merge candidate in merge candidate set 100 is within another PU of the same CU, all merge candidates may remain in the merge candidate set 100. Merge candidate set 102 shows the merge candidates for PU 1 of an Nx2N partitioned CU. As can be seen for merge set 102 for PU 1, merge candidate L is from PU 0 of the same CU. As such, merge candidate L may be removed/excluded from merge candidate set 102. In this context, a removed merge candidate may be thought of a candidate that is removed from a pre-defined list of merge candidates. An excluded merge candidate may be a merge candidate that is excluded from a merge candidate list as the merge candidate list is being derived, whether or not such list is pre-defined. In general, a removed/excluded merge candidate is any merge candidate that is not used in a final merge candidate list.

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[0059] It should be noted that merge candidate L need not be located in the exact position in PU 0 (e.g., in the case that PU 0 is further partitioned), but may be excluded if merge candidate L is located in any portion of PU 0. Note, also, that each of merge candidate sets 100 and 102 also have the temporal merge candidate T, as shown in FIG. 1.

[0060] FIG. 3B is a conceptual diagram illustrating candidate blocks for merge mode for a 2NxN partition of a CU. Note that the techniques shown in FIG. 3B are equally applicable for 2NxnU or 2NxnD asymmetric partition types. Merge candidate set 104 shows the merge candidates for PU 0 of a 2NxN partitioned CU. Since no merge candidate in merge candidate set 104 is within another PU of the same CU, all merge candidates may remain in the merge candidate set 104. Merge candidate set 106 shows the merge candidates for PU 1 of a 2NxN partitioned CU. As can be seen for merge set 106 for PU 1, merge candidate A is from PU 0 of the same CU. As such, merge candidate A may be removed/excluded from merge candidate set 106. It should be noted that merge candidate A need not be located in the exact position in PU 0 as shown (e.g., in the case that PU 0 is further partitioned), but may be excluded if merge candidate A is located in any portion of PU 0. Note, also, that each of merge candidate sets 104 and 106 also have the temporal merge candidate T, as shown in FIG. 1.

[0061] FIG. 4A is a conceptual diagram illustrating candidate blocks for merge mode for an NxN partition of a CU. Merge candidate set 108 shows the merge candidates for PU 0 of an NxN partitioned CU. Since no merge candidate in merge candidate set 108 is within another PU of the same CU, all merge candidates may remain in the merge candidate set 108.

[0062] Merge candidate set 110 shows the merge candidates for PU 1 of an NxN partitioned CU. As can be seen for merge set 110 for PU 1, merge candidates L and BL are from PU 0 and PU 2, respectively, of the same CU. As such, merge candidates L and BL may be removed/excluded from merge candidate set 110. It should be noted that merge candidates L and BL need not be located in the exact position in PU 0 and PU 2 as shown (e.g., in the case that PU 0 or PU 2 are further partitioned), but may be excluded if merge candidates L and/or BL are located in any portion of PU 0 and/or PU 2.

[0063] Merge candidate set 112 shows the merge candidates for PU 2 of an NxN partitioned CU. As can be seen for merge set 112 for PU 2, merge candidates A and RA are from PU 0 and PU 1, respectively, of the same CU. As such, merge candidates A

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and RA may be removed/excluded from merge candidate set 112. It should be noted that merge candidates A and RA need not be located in the exact position in PU 0 and PU 1 as shown (e.g., in the case that PU 0 or PU 1 are further partitioned), but may be excluded if merge candidates A and/or RA are located in any portion of PU 0 and/or PU 1.

[0064] Merge candidate set 114 shows the merge candidates for PU 3 of an NxN partitioned CU. As can be seen for merge set 114 for PU 3, merge candidates LA, A and L are from PU 0, PU 1 and PU2 respectively, of the same CU. As such, merge candidates LA, A and L may be removed/excluded from merge candidate set 114. It should be noted that merge candidates LA, A and L need not be located in the exact position in PU 0, PU 1 and PU 2 as shown (e.g., in the case that PU 0, PU1 or PU 2 are further partitioned), but may be excluded if merge candidates LA, A and/or L are located in any portion of PU 0, PU 1 and/or PU 2.

[0065] Note, that each of merge candidate sets 108, 110, 112 and 114 also have the temporal merge candidate T, as shown in FIG. 1.

[0066] Although the examples described above consider only the 2NxN, Nx2N, and NxN partition types, other partition types (e.g. AMP, geometric motion partition (GMP), etc.) can also benefit from the disclosed techniques. In general, the proposed techniques determine a merge candidate set without comparing the motion information of the merge candidates with the motion information of any other prediction units. Furthermore, merge candidates within the merge candidate set for a current prediction unit may be removed/excluded if they are within another prediction unit of the same coding unit.

[0067] In another example, for the NxN partition mode, all merge candidates of each prediction unit are used regardless of any use by another prediction unit. FIG. 4B is a conceptual diagram illustrating example candidate blocks for merge mode for an NxN partition of a coding unit where no merge candidates are removed/excluded, regardless of their position in another PU. As shown in FIG. 4B, all candidates (including temporal candidate T), are used for each of PUs 116, 118, 120 and 122. For other partition modes, such as 2NxN, Nx2N, and asymmetric modes such as 2NxnD, 2NxnU, nLx2N and nRx2N, exclusion of a certain candidates for a current PU that are located inside another PU of the same CU is applied according to the process described above.

[0068] In another example of the disclosure, a merge candidate set is generate that utilizes all potential merge candidates in the set shown in FIG. 1 for prediction unit 1 in

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the Nx2N and 2NxN partition modes, in the case prediction unit 0 in the particular partition mode uses a merge candidate (i.e., the actually selected candidate in the motion vector prediction) that is not duplicative of a merge candidate that would be used in the 2Nx2N partition mode. In another example, for the NxN partition mode, all merge candidates are used regardless of any use by another prediction unit.

[0069] The rules for generating a merge candidate set according to this example are as follows:

1. Nx2N partition mode: The left (L) merge candidate of PU 1 is used if the merge index (i.e., the actually selected merged candidate) used for PU 0 is RA, A or T; otherwise L is not used (contrasted with the previous example of the disclosure, where L is never used for PU 1)

2. 2NxN partition mode: The above (A) merge candidate of PU 1 is used if the merge index used for PU 0 is BL, L or T; otherwise A is not used (contrasted with the previous example of the disclosure, where A is never used for PU 1).

3. NxN partition mode: All prediction candidates of all PUs are considered as valid

[0070] In the Nx2N example, utilizing merge candidate L for PU 1 does not become duplicative of the 2Nx2N partition mode, because merge candidate locations RA, A or T for PU 0 in the Nx2N partition mode would not necessarily be used for the 2Nx2N partition. Likewise, in the 2NxN example, utilizing merge candidate A for PU 1 does not become duplicative of the 2Nx2N partition mode, because merge candidates BL, L or T for PU 0 would not necessarily be used for the 2Nx2N partition.

[0071] FIG. 5 is a block diagram illustrating an example video encoding and decoding system 10 that may be configured to utilize techniques for generating candidate motion vectors in a merge mode in accordance with examples of this disclosure. As shown in FIG. 5, the system 10 includes a source device 12 that transmits encoded video to a destination device 14 via a communication channel 16. Encoded video data may also be stored on a storage medium 34 or a file server 36 and may be accessed by the destination device 14 as desired. When stored to a storage medium or file server, video encoder 20 may provide coded video data to another device, such as a network interface, a compact disc (CD), Blu-ray or digital video disc (DVD) burner or stamping facility device, or other devices, for storing the coded video data to the storage medium.

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Likewise, a device separate from video decoder 30, such as a network interface, CD or DVD reader, or the like, may retrieve coded video data from a storage medium and provided the retrieved data to video decoder 30.

[0072] The source device 12 and the destination device 14 may comprise any of a wide variety of devices, including mobile devices, desktop computers, notebook (i.e., laptop) computers, tablet computers, set-top boxes, telephone handsets such as so-called smartphones, televisions, cameras, display devices, digital media players, video gaming consoles, or the like. In many cases, such devices may be equipped for wireless communication. Hence, the communication channel 16 may comprise a wireless channel, a wired channel, or a combination of wireless and wired channels suitable for transmission of encoded video data. Similarly, the file server 36 may be accessed by the destination device 14 through any standard data connection, including an Internet connection. This may include a wireless channel (e.g., a Wi-Fi connection), a wired connection (e.g., DSL, cable modem, etc.), or a combination of both that is suitable for accessing encoded video data stored on a file server.

[0073] Techniques for generating candidate motion vectors in a merge mode, in accordance with examples of this disclosure, may be applied to video coding in support of any of a variety of multimedia applications, such as over-the-air television broadcasts, cable television transmissions, satellite television transmissions, streaming video transmissions, e.g., via the Internet, encoding of digital video for storage on a data storage medium, decoding of digital video stored on a data storage medium, or other applications. In some examples, the system 10 may be configured to support one-way or two-way video transmission to support applications such as video streaming, video playback, video broadcasting, and/or video telephony.

[0074] In the example of FIG. 5, the source device 12 includes a video source 18, a video encoder 20, a modulator/demodulator 22 and a transmitter 24. In the source device 12, the video source 18 may include a source such as a video capture device, such as a video camera, a video archive containing previously captured video, a video feed interface to receive video from a video content provider, and/or a computer graphics system for generating computer graphics data as the source video, or a combination of such sources. As one example, if the video source 18 is a video camera, the source device 12 and the destination device 14 may form so-called camera phones or video phones. However, the techniques described in this disclosure may be applicable

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to video coding in general, and may be applied to wireless and/or wired applications, or application in which encoded video data is stored on a local disk.

[0075] The captured, pre-captured, or computer-generated video may be encoded by the video encoder 20. The encoded video information may be modulated by the modem 22 according to a communication standard, such as a wireless communication protocol, and transmitted to the destination device 14 via the transmitter 24. The modem 22 may include various mixers, filters, amplifiers or other components designed for signal modulation. The transmitter 24 may include circuits designed for transmitting data, including amplifiers, filters, and one or more antennas.

[0076] The captured, pre-captured, or computer-generated video that is encoded by the video encoder 20 may also be stored onto a storage medium 34 or a file server 36 for later consumption. The storage medium 34 may include Blu-ray discs, DVDs, CD-ROMs, flash memory, or any other suitable digital storage media for storing encoded video. The encoded video stored on the storage medium 34 may then be accessed by the destination device 14 for decoding and playback.

[0077] The file server 36 may be any type of server capable of storing encoded video and transmitting that encoded video to the destination device 14. Example file servers include a web server (e.g., for a website), an FTP server, network attached storage (NAS) devices, a local disk drive, or any other type of device capable of storing encoded video data and transmitting it to a destination device. The transmission of encoded video data from the file server 36 may be a streaming transmission, a download transmission, or a combination of both. The file server 36 may be accessed by the destination device 14 through any standard data connection, including an Internet connection. This may include a wireless channel (e.g., a Wi-Fi connection), a wired connection (e.g., DSL, cable modem, Ethernet, USB, etc.), or a combination of both that is suitable for accessing encoded video data stored on a file server.

[0078] The destination device 14, in the example of FIG. 5, includes a receiver 26, a modem 28, a video decoder 30, and a display device 32. The receiver 26 of the destination device 14 receives information over the channel 16, and the modem 28 demodulates the information to produce a demodulated bitstream for the video decoder 30. The information communicated over the channel 16 may include a variety of syntax information generated by the video encoder 20 for use by the video decoder 30 in decoding video data. Such syntax may also be included with the encoded video data stored on the storage medium 34 or the file server 36. Each of the video encoder 20 and

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the video decoder 30 may form part of a respective encoder-decoder (CODEC) that is capable of encoding or decoding video data.

[0079] The display device 32 may be integrated with, or external to, the destination device 14. In some examples, the destination device 14 may include an integrated display device and also be configured to interface with an external display device. In other examples, the destination device 14 may be a display device. In general, the display device 32 displays the decoded video data to a user, and may comprise any of a variety of display devices such as a liquid crystal display (LCD), a plasma display, an organic light emitting diode (OLED) display, or another type of display device.

[0080] In the example of FIG. 5, the communication channel 16 may comprise any wireless or wired communication medium, such as a radio frequency (RF) spectrum or one or more physical transmission lines, or any combination of wireless and wired media. The communication channel 16 may form part of a packet-based network, such as a local area network, a wide-area network, or a global network such as the Internet. The communication channel 16 generally represents any suitable communication medium, or collection of different communication media, for transmitting video data from the source device 12 to the destination device 14, including any suitable combination of wired or wireless media. The communication channel 16 may include routers, switches, base stations, or any other equipment that may be useful to facilitate communication from the source device 12 to the destination device 14.

[0081] The video encoder 20 and the video decoder 30 may operate according to a video compression standard, such as the High Efficiency Video Coding (HEVC) standard presently under development, and may conform to the HEVC Test Model (HM). Alternatively, the video encoder 20 and the video decoder 30 may operate according to other proprietary or industry standards, such as the ITU-T H.264 standard, alternatively referred to as MPEG-4, Part 10, Advanced Video Coding (AVC), or extensions of such standards. The techniques of this disclosure, however, are not limited to any particular coding standard. Other examples include MPEG-2 and ITU-T H.263.

[0082] Although not shown in FIG. 5, in some aspects, the video encoder 20 and the video decoder 30 may each be integrated with an audio encoder and decoder, and may include appropriate MUX-DEMUX units, or other hardware and software, to handle encoding of both audio and video in a common data stream or separate data streams. If

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applicable, in some examples, MUX-DEMUX units may conform to the ITU H.223 multiplexer protocol, or other protocols such as the user datagram protocol (UDP).

[0083] The video encoder 20 and the video decoder 30 each may be implemented as any of a variety of suitable encoder circuitry, such as one or more microprocessors, digital signal processors (DSPs), application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), discrete logic, software, hardware, firmware or any combinations thereof. When the techniques are implemented partially in software, a device may store instructions for the software in a suitable, non-transitory computer-readable medium and execute the instructions in hardware using one or more processors to perform the techniques of this disclosure. Each of the video encoder 20 and the video decoder 30 may be included in one or more encoders or decoders, either of which may be integrated as part of a combined encoder/decoder (CODEC) in a respective device.

[0084] The video encoder 20 may implement any or all of the techniques of this disclosure for generating candidate motion vectors in a merge mode in a video encoding process. Likewise, the video decoder 30 may implement any or all of these techniques for generating candidate motion vectors in a merge mode in a video decoding process. A video coder, as described in this disclosure, may refer to a video encoder or a video decoder. Similarly, a video coding unit may refer to a video encoder or a video decoder. Likewise, video coding may refer to video encoding or video decoding.

[0085] In one example of the disclosure, the video encoder 20 of the source device 12 may be configured to determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and to perform a merge motion vector prediction process for the current prediction unit using the merge candidate set. The video encoder 20 may be further configured to remove merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

[0086] In another example of the disclosure, the video decoder 30 of the source device 12 may be configured to determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and to perform a merge motion vector prediction process for the current prediction unit using the merge candidate set. The

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video decoder 30 may be further configured to remove merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

[0087] FIG. 6 is a block diagram illustrating an example of a video encoder 20 that may use techniques for generating candidate motion vectors in a merge mode as described in this disclosure. The video encoder 20 will be described in the context of HEVC coding for purposes of illustration, but without limitation of this disclosure as to other coding standards or methods.

[0088] The video encoder 20 may perform intra- and inter-coding of CUs within video frames. Intra-coding relies on spatial prediction to reduce or remove spatial redundancy in video data within a given video frame. Inter-coding relies on temporal prediction to reduce or remove temporal redundancy between a current frame and previously coded frames of a video sequence. Intra-mode (I-mode) may refer to any of several spatial-based video compression modes. Inter-modes such as uni-directional prediction (P-mode) or bi-directional prediction (B-mode) may refer to any of several temporal-based video compression modes.

[0089] As shown in FIG. 6, the video encoder 20 receives a current video block within a video frame to be encoded. In the example of FIG. 6, the video encoder 20 includes a motion compensation unit 44, a motion estimation unit 42, an intra-prediction unit 46, a reference frame buffer 64, a summer 50, a transform module 52, a quantization unit 54, and an entropy encoding unit 56. The transform module 52 illustrated in FIG. 6 is the structure or apparatus that applies the actual transform or combinations of transform to a block of residual data, and is not to be confused with block of transform coefficients, which may be referred to as a transform unit (TU) of a CU. For video block reconstruction, the video encoder 20 also includes an inverse quantization unit 58, an inverse transform module 60, and a summer 62. A deblocking filter (not shown in FIG. 6) may also be included to filter block boundaries to remove blockiness artifacts from reconstructed video. If desired, the deblocking filter would typically filter the output of the summer 62.

[0090] During the encoding process, the video encoder 20 receives a video frame or slice to be coded. The frame or slice may be divided into multiple video blocks, e.g., largest coding units (LCUs). The motion estimation unit 42 and the motion compensation unit 44 perform inter-predictive coding of the received video block relative to one or more blocks in one or more reference frames to provide temporal compression. The intra-prediction unit 46 may perform intra-predictive coding of the

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received video block relative to one or more neighboring blocks in the same frame or slice as the block to be coded to provide spatial compression.

[0091] The mode select unit 40 may select one of the coding modes, intra or inter, e.g., based on error (i.e., distortion) results for each mode, and provides the resulting intra- or inter-predicted block (e.g., a prediction unit (PU)) to the summer 50 to generate residual block data and to the summer 62 to reconstruct the encoded block for use in a reference frame. Summer 62 combines the predicted block with inverse quantized, inverse transformed data from inverse transform module 60 for the block to reconstruct the encoded block, as described in greater detail below. Some video frames may be designated as I-frames, where all blocks in an I-frame are encoded in an intra-prediction mode. In some cases, the intra-prediction unit 46 may perform intra-prediction encoding of a block in a P- or B-frame, e.g., when motion search performed by the motion estimation unit 42 does not result in a sufficient prediction of the block.

[0092] The motion estimation unit 42 and the motion compensation unit 44 may be highly integrated, but are illustrated separately for conceptual purposes. Motion estimation (or motion search) is the process of generating motion vectors, which estimate motion for video blocks. A motion vector, for example, may indicate the displacement of a prediction unit in a current frame relative to a reference sample of a reference frame. The motion estimation unit 42 calculates a motion vector for a prediction unit of an inter-coded frame by comparing the prediction unit to reference samples of a reference frame stored in the reference frame buffer 64. A reference sample may be a block that is found to closely match the portion of the CU including the PU being coded in terms of pixel difference, which may be determined by sum of absolute difference (SAD), sum of squared difference (SSD), or other difference metrics. The reference sample may occur anywhere within a reference frame or reference slice.

[0093] The portion of the reference frame identified by a motion vector may be referred to as a reference sample. The motion compensation unit 44 may calculate a prediction value for a prediction unit of a current CU, e.g., by retrieving the reference sample identified by a motion vector for the PU. In some video encoding techniques, the motion estimation unit 42 sends the calculated motion vector, reference frame, and prediction direction (e.g., the direction in terms of whether the reference frame temporally precedes or follows the current frame) to the entropy encoding unit 56 and the motion compensation unit 44. Other video encoding techniques utilize a motion

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vector prediction process to encode the motion vector. The motion vector prediction process may be chosen from among a plurality of modes, including a merge mode.

[0094] In merge mode, the encoder considers a set of merge candidate blocks and selects a block that has the same (or most closely matches) motion vector, reference frame, and prediction direction as the current block to be coded. This is accomplished, for example, by checking each candidate block in turn and choosing the one that yields the best rate-distortion performance once its motion vector, reference frame, and prediction direction are copied to the current block. Then, rather than signaling this motion vector information (i.e., the motion vector, reference frame, and prediction direction) in the encoded video bitstream, the encoder signals an index number for the selected motion vector candidate. The index number identifies the selected candidate motion vector among a set of candidate motion vectors. A decoder may copy the motion vector information from the motion vector candidate to use for a current block.

[0095] In the examples described above, signaling the motion vector information in the encoded bitstream does not necessarily require real-time transmission of such elements from the encoder to a decoder, but rather means that such information is encoded into the bitstream and are made accessible to the decoder in any fashion. This may include real-time transmission (e.g., in video conferencing) as well as storing the encoded bitstream on a computer-readable medium for future use by a decoder (e.g., in streaming, downloading, disk access, card access, DVD, Blu-ray, etc.).

[0096] In accordance with examples of this disclosure described above, for merge mode, a merge candidate set may be generated without comparing the motion information of any merge candidates with the motion information of other PUs within the same CU as the current PU. In addition, this disclosure also proposes to remove merge candidates from the merge candidate set if the merge candidate is located inside another PU of the same CU. The generation of merge candidates may be handled by motion compensation unit 44, motion compensation unit 42, or by any other fixed function or programmable hardware structure of video encoder 20.

[0097] As one example, for an Nx2N partition of a CU, all merge candidates (e.g., the merge candidates shown in FIG. 1) may be used for PU 0. For PU 1, merge candidate L is removed/excluded from the merge candidate list (see FIG. 3A) as it is within PU 0. As another example, for a 2NxN partition of a CU, all merge candidates (e.g., the merge candidate shown in FIG. 1) may be used for PU 0. For PU 1, merge candidate A is removed from the merge candidate list (see FIG. 3B) as it is within PU 0.

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[0098] As another example, for an NxN partition of a CU, all merge candidates (e.g., the merge candidates shown in FIG. 1) may be used for PU 0. For PU 1, merge candidates L and BL are removed/excluded from the merge candidate list (see FIG. 4A) as they are within PU 0 and PU 2, respectively. For PU 2, merge candidates A and RA are removed/excluded from the merge candidate list (see FIG. 4A) as they are within PU 0 and PU 1, respectively. For PU 3, merge candidates LA, A and L are removed/excluded from the merge candidate list (see FIG. 4A) as they are within PU 0, PU 1 and PU 2, respectively. As such, PU 0 may use merge candidates BL, L, LA, A, RA and T. PU 1 may use merge candidates LA, A, RA and T. PU 2 may use merge candidates BL, L, LA and T. PU 3 may use merge candidates BL, RA and T.

[0099] As yet another example, for the NxN partition mode, all merge candidates of each prediction unit are used regardless of any use by another prediction unit (see FIG. 4B). For other partition modes, such as 2NxN, Nx2N and asymmetric modes such as 2NxnD, 2NxnU, nLx2N and nRx2N, exclusion of a certain candidates for a current PU that are located inside another PU of the same CU is applied according to the process described above.

[0100] Returning to FIG. 6, the intra-prediction unit 46 may perform intra-prediction on the received block, as an alternative to inter-prediction performed by the motion estimation unit 42 and the motion compensation unit 44. The intra-prediction unit 46 may predict the received block relative to neighboring, previously coded blocks, e.g., blocks above, above and to the right, above and to the left, or to the left of the current block, assuming a left-to-right, top-to-bottom encoding order for blocks. The intra-prediction unit 46 may be configured with a variety of different intra-prediction modes. For example, the intra-prediction unit 46 may be configured with a certain number of directional prediction modes, e.g., thirty-four directional prediction modes, based on the size of the CU being encoded.

[0101] The intra-prediction unit 46 may select an intra-prediction mode by, for example, calculating prediction error values for various intra-prediction modes and selecting a mode that yields the lowest error value. Directional prediction modes may include functions for combining values of spatially neighboring pixels and applying the combined values to one or more pixel positions in a PU. Once values for all pixel positions in the PU have been calculated, the intra-prediction unit 46 may calculate an error value for the prediction mode based on pixel differences between the calculated or predicted values of the PU and the received original block to be encoded. The intra-

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prediction unit 46 may continue testing intra-prediction modes until an intra-prediction mode that yields an acceptable error value is discovered. The intra-prediction unit 46 may then send the PU to the summer 50.

[0102] The video encoder 20 forms a residual block, which may include one luma block and two chroma blocks, by subtracting the prediction data calculated by the motion compensation unit 44 or the intra-prediction unit 46 from the original video block being coded. The summer 50 represents the component or components that perform this subtraction operation. The residual block may correspond to a two-dimensional matrix of pixel difference values, where the number of values in the residual block is the same as the number of pixels in the PU corresponding to the residual block. The values in the residual block may correspond to the differences, i.e., error, between values of co-located pixels in the PU and in the original block to be coded. Such an operation is applied to both luma and chroma components, so the differences may be chroma or luma differences depending on the type of block that is coded.

[0103] The transform module 52 may form one or more transform units (TUs) from the residual block. The transform module 52 selects a transform from among a plurality of transforms. The transform may be selected based on one or more coding characteristics, such as block size, coding mode, or the like. The transform module 52 then applies the selected transform to the TU, producing a video block comprising a two-dimensional array of transform coefficients.

[0104] The transform module 52 may send the resulting transform coefficients to the quantization unit 54. The quantization unit 54 may then quantize the transform coefficients. The entropy encoding unit 56 may then perform a scan of the quantized transform coefficients in the matrix according to a scanning mode. This disclosure describes the entropy encoding unit 56 as performing the scan. However, it should be understood that, in other examples, other processing units, such as the quantization unit 54, could perform the scan.

[0105] Once the transform coefficients are scanned into the one-dimensional array, the entropy encoding unit 56 may apply entropy coding such as context adaptive variable length coding (CAVLC), context adaptive binary arithmetic coding (CABAC), syntax-based context-adaptive binary arithmetic coding (SBAC), or another entropy coding methodology to the coefficients. Entropy coding may also be applied to syntax elements, such as syntax elements used in merge mode.

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[0106] To perform CAVLC, the entropy encoding unit 56 may select a variable length code for a symbol to be transmitted. Codewords in VLC may be constructed such that relatively shorter codes correspond to more likely symbols, while longer codes correspond to less likely symbols. In this way, the use of VLC may achieve a bit savings over, for example, using equal-length codewords for each symbol to be transmitted.

[0107] To perform CABAC, the entropy encoding unit 56 may select a context model to apply to a certain context to encode symbols to be transmitted. In the case of transform coefficients, the context may relate to, for example, whether neighboring values are non-zero or not. The entropy encoding unit 56 may also entropy encode syntax elements, such as the signal representative of the selected transform. In accordance with the techniques of this disclosure, the entropy encoding unit 56 may select the context model used to encode these syntax elements based on, for example, an intra-prediction direction for intra-prediction modes, a scan position of the coefficient corresponding to the syntax elements, block type, and/or transform type, among other factors used for context model selection.

[0108] Following the entropy coding by the entropy encoding unit 56, the resulting encoded video may be transmitted to another device, such as the video decoder 30, or archived for later transmission or retrieval.

[0109] In some cases, the entropy encoding unit 56 or another unit of the video encoder 20 may be configured to perform other coding functions, in addition to entropy coding. For example, the entropy encoding unit 56 may be configured to determine coded block pattern (CBP) values for CU's and PU's. Also, in some cases, the entropy encoding unit 56 may perform run length coding of coefficients.

[0110] The inverse quantization unit 58 and the inverse transform module 60 apply inverse quantization and inverse transformation, respectively, to reconstruct the residual block in the pixel domain, e.g., for later use in reconstructing a reference block. The motion compensation unit 44 may calculate a reference block by adding the residual block to a predictive block formed from one of the frames of the reference frame buffer 64, which may also be referred to as a decoded picture buffer. The motion compensation unit 44 may also apply one or more interpolation filters to the reconstructed reference block to calculate sub-integer pixel values for use in motion estimation. The summer 62 adds the reconstructed residual block to the motion compensated prediction block produced by the motion compensation unit 44 to produce

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a reconstructed video block for storage in the reference frame buffer 64. The reconstructed video block may be used by the motion estimation unit 42 and the motion compensation unit 44 as a reference block to inter-code a block in another, subsequently coded video frame.

[0111] FIG. 7 is a block diagram illustrating an example of a video decoder 30, which decodes an encoded video sequence. In the example of FIG. 7, the video decoder 30 includes an entropy decoding unit 70, a motion compensation unit 72, an intra-prediction unit 74, an inverse quantization unit 76, an inverse transform module 78, a reference frame buffer 82 and a summer 80. The video decoder 30 may, in some examples, perform a decoding pass generally reciprocal to the encoding pass described with respect to the video encoder 20 (see FIG. 6).

[0112] The entropy decoding unit 70 performs an entropy decoding process on the encoded bitstream to retrieve a one-dimensional array of transform coefficients. The entropy decoding process used depends on the entropy coding used by the video encoder 20 (e.g., CABAC, CAVLC, etc.). The entropy coding process used by the encoder may be signaled in the encoded bitstream or may be a predetermined process.

[0113] In some examples, the entropy decoding unit 70 (or the inverse quantization unit 76) may scan the received values using a scan mirroring the scanning mode used by the entropy encoding unit 56 (or the quantization unit 54) of the video encoder 20. Although the scanning of coefficients alternatively may be performed in the inverse quantization unit 76, scanning will be described for purposes of illustration as being performed by the entropy decoding unit 70. In addition, although shown as separate functional units for ease of illustration, the structure and functionality of the entropy decoding unit 70, the inverse quantization unit 76, and other units of the video decoder 30 may be highly integrated with one another.

[0114] The inverse quantization unit 76 inverse quantizes, i.e., de-quantizes, the quantized transform coefficients provided in the bitstream and decoded by the entropy decoding unit 70. The inverse quantization process may include a conventional process, e.g., similar to the processes proposed for HEVC or defined by the H.264 decoding standard. The inverse quantization process may include use of a quantization parameter QP calculated by the video encoder 20 for the CU to determine a degree of quantization and, likewise, a degree of inverse quantization that should be applied. The inverse quantization unit 76 may inverse quantize the transform coefficients either before or

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after the coefficients are converted from a one-dimensional array to a two-dimensional array.

[0115] The inverse transform module 78 applies an inverse transform to the inverse quantized transform coefficients. In some examples, the inverse transform module 78 may determine an inverse transform based on signaling from the video encoder 20, or by inferring the transform from one or more coding characteristics such as block size, coding mode, or the like. In some examples, the inverse transform module 78 may determine a transform to apply to the current block based on a signaled transform at the root node of a quadtree for an LCU including the current block. Alternatively, the transform may be signaled at the root of a TU quadtree for a leaf-node CU in the LCU quadtree. In some examples, the inverse transform module 78 may apply a cascaded inverse transform, in which inverse transform module 78 applies two or more inverse transforms to the transform coefficients of the current block being decoded.

[0116] The intra-prediction unit 74 may generate prediction data for a current block of a current frame based on a signaled intra-prediction mode and data from previously decoded blocks of the current frame.

[0117] According to examples of this disclosure, the video decoder 30 may receive, from the encoded bitstream, prediction syntax that indicates an index of a selected merge candidate block from a set of merge candidate blocks for use in a motion vector prediction process. The video decoder is further configured to retrieve a motion vector, a reference frame, and a prediction direction associated with the merge candidate block identified by the received index, and to perform inter-prediction decoding for the current block using the retrieved motion vector, reference frame, and prediction direction.

[0118] In accordance with examples of this disclosure described above, for merge mode, a merge candidate set may be generated by video decoder 30 without comparing the motion information of any merge candidates with the motion information of other PUs within the same CU as the current PU. In addition, this disclosure also proposes to remove merge candidates from the merge candidate set if the merge candidate is located inside another PU of the same CU. The generation of merge candidates may be handled by motion compensation unit 72 or by any other fixed function or programmable hardware structure of video decoder 30. Once video decoder 30 has determined the final merge candidate set, it may retrieve the motion information from the merge candidate indicated by the received index.

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[0119] As one example, for an Nx2N partition of a CU, all merge candidates (e.g., the merge candidates shown in FIG. 1) may be used for PU 0. For PU 1, merge candidate L is removed/excluded from the merge candidate list (see FIG. 3A) as it is within PU 0. As another example, for a 2NxN partition of a CU, all merge candidates (e.g., the merge candidate shown in FIG. 1) may be used for PU 0. For PU 1, merge candidate A is removed/excluded from the merge candidate list (see FIG. 3B) as it is within PU 0.

[0120] As another example, for an NxN partition of a CU, all merge candidates (e.g., the merge candidates shown in FIG. 1 may be used for PU 0. For PU 1, merge candidates L and BL are removed/excluded from the merge candidate list (see FIG. 4A) as they are within PU 0 and PU 2, respectively. For PU 2, merge candidates A and RA are removed/excluded from the merge candidate list (see FIG. 4A) as they are within PU 0 and PU 1, respectively. For PU 3, merge candidates LA, A and L are removed/excluded from the merge candidate list (see FIG. 4A) as they are within PU 0, PU 1 and PU 2, respectively.

[0121] As yet another example, for the NxN partition mode, all merge candidates of each prediction unit are used regardless of any use by another prediction unit (see FIG. 4B). For other partition modes, such as 2NxN, Nx2N and asymmetric modes such as 2NxnD, 2NxnU, nLx2N and nRx2N, exclusion of a certain candidates for a current PU that are located inside PU of the same CU is applied according to the process described above.

[0122] Returning to FIG. 7, the motion compensation unit 72 may produce the motion compensated blocks, possibly performing interpolation based on interpolation filters. Identifiers for interpolation filters to be used for motion estimation with sub-pixel precision may be included in the syntax elements. The motion compensation unit 72 may use interpolation filters as used by the video encoder 20 during encoding of the video block to calculate interpolated values for sub-integer pixels of a reference block. The motion compensation unit 72 may determine the interpolation filters used by the video encoder 20 according to received syntax information and use the interpolation filters to produce predictive blocks.

[0123] Additionally, the motion compensation unit 72 and the intra-prediction unit 74, in an HEVC example, may use some of the syntax information (e.g., provided by a quadtree) to determine sizes of LCUs used to encode frame(s) of the encoded video sequence. The motion compensation unit 72 and the intra-prediction unit 74 may also use syntax information to determine split information that describes how each CU of a

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frame of the encoded video sequence is split (and likewise, how sub-CUs are split). The syntax information may also include modes indicating how each CU is encoded (e.g., intra- or inter-prediction, and for intra-prediction an intra-prediction encoding mode), one or more reference frames (and/or reference lists containing identifiers for the reference frames) for each inter-encoded PU, and other information to decode the encoded video sequence.

[0124] The summer 80 combines the residual blocks with the corresponding prediction blocks generated by the motion compensation unit 72 or the intra-prediction unit 74 to form decoded blocks. The decoded blocks, in effect, reconstruct the originally coded blocks, subject to loss due to quantization or other coding aspects. If desired, a deblocking filter may also be applied to filter the decoded blocks in order to remove blockiness artifacts. The decoded video blocks are then stored in the reference frame buffer 82, which provides reference blocks for subsequent motion compensation and also produces decoded video for presentation on a display device (such as the display device 32 of FIG. 5).

[0125] FIG. 8 is a flowchart illustrating an example method of encoding video according to the techniques of this disclosure. The method of FIG. 8 may be carried out by video encoder 20 of FIG. 6. Video encoder 20 may be configured to determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of another prediction unit (200), and remove merge candidates from the merge candidate set that are within another prediction unit of the current coding unit (202). The merge candidate set may include a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge candidate, and a temporal merge candidate.

[0126] In the case that the current coding unit has a 2NxN partition type, including a prediction unit 0 positioned above a prediction unit 1, video encoder 20 may remove the above merge candidate from the merge candidate set for prediction unit 1. In the case that the current coding unit has an Nx2N partition type including a prediction unit 0 positioned to the left of a prediction unit 1, video encoder 20 may remove the left merge candidate from the merge candidate set for prediction unit 1.

[0127] In the case that the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction

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unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit, video encoder 20 may remove the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1. In this case, video encoder 20 may further remove the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2. Video encoder 20, in this case, may still further remove the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

[0128] In other examples, excluding merge candidates comprises excluding merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode. In this case, no merge candidates are removed/excluded from prediction units from the coding unit having the NxN partition mode.

[0129] Video encoder 20 may be further configured to perform a merge motion vector prediction process for the current prediction unit using the merge candidate set to determine a selected merge candidate for the current prediction unit (204), and signal a syntax element indicating the selected merge candidate in an encoded video bitstream (206).

[0130] FIG. 9 is a flowchart illustrating an example method of decoding video according to the techniques of this disclosure. The methods of FIG. 9 may be carried about by video decoder 30 of FIG. 7. Video decoder 30 may be configured to receive a syntax element indicating a selected merge candidate for a current prediction unit (220), and determine a merge candidate set for the current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units (222). Video decoder 30 may be further configured to remove merge candidates from the merge candidate set that are within another prediction unit of the current coding unit (224). The merge candidate set may include a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge candidate, and a temporal merge candidate.

[0131] In the case that the current coding unit has a 2NxN partition type, including a prediction unit 0 positioned above a prediction unit 1, video decoder 30 may remove the above merge candidate from the merge candidate set for prediction unit 1. In the case

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that the current coding unit has an Nx2N partition type including a prediction unit 0 positioned to the left of a prediction unit 1, video decoder 30 may remove the left merge candidate from the merge candidate set for prediction unit 1.

[0132] In the case that the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit, video decoder 30 may remove the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1. In this case, video decoder 30 may further remove the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2. Video decoder 30, in this case, may still further remove the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

[0133] In other examples, excluding merge candidates comprises excluding merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode. In this case, no merge candidates are removed/excluded from prediction units from the coding unit having the NxN partition mode.

[0134] Video decoder 30 may be further configured to perform a merge motion vector prediction process for the current prediction unit using the merge candidate set and the received syntax element to determine a motion vector for the current prediction unit (226), and decode the current prediction unit using the determined motion vector (228).

[0135] In one or more examples, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over, as one or more instructions or code, a computer-readable medium and executed by a hardware-based processing unit. Computer-readable media may include computer-readable storage media, which corresponds to a tangible medium such as data storage media, or communication media including any medium that facilitates transfer of a computer program from one place to another, e.g., according to a communication protocol. In this manner, computer-readable media generally may correspond to (1) tangible computer-readable storage media which is non-transitory or (2) a communication medium such as a signal or carrier wave. Data storage media may be any available media that can be accessed by

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one or more computers or one or more processors to retrieve instructions, code and/or data structures for implementation of the techniques described in this disclosure. A computer program product may include a computer-readable medium.

[0136] By way of example, and not limitation, such computer-readable storage media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage, or other magnetic storage devices, flash memory, or any other medium that can be used to store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if instructions are transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. It should be understood, however, that computer-readable storage media and data storage media do not include connections, carrier waves, signals, or other transient media, but are instead directed to non-transient, tangible storage media. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc, where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

[0137] Instructions may be executed by one or more processors, such as one or more digital signal processors (DSPs), general purpose microprocessors, application specific integrated circuits (ASICs), field programmable logic arrays (FPGAs), or other equivalent integrated or discrete logic circuitry. Accordingly, the term "processor," as used herein may refer to any of the foregoing structure or any other structure suitable for implementation of the techniques described herein. In addition, in some aspects, the functionality described herein may be provided within dedicated hardware and/or software modules configured for encoding and decoding, or incorporated in a combined codec. Also, the techniques could be fully implemented in one or more circuits or logic elements.

[0138] The techniques of this disclosure may be implemented in a wide variety of devices or apparatuses, including a wireless handset, an integrated circuit (IC) or a set of ICs (e.g., a chip set). Various components, modules, or units are described in this disclosure to emphasize functional aspects of devices configured to perform the

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disclosed techniques, but do not necessarily require realization by different hardware units. Rather, as described above, various units may be combined in a codec hardware unit or provided by a collection of interoperative hardware units, including one or more processors as described above, in conjunction with suitable software and/or firmware.

[0139] Various examples have been described. These and other examples are within the scope of the following claims.

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WHAT IS CLAIMED IS:

1. A method of coding video data comprising:

determining a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units; and

performing a merge motion vector prediction process for the current prediction unit using the merge candidate set.

2. The method of claim 1, further comprising:

excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

3. The method of claim 2, wherein excluding merge candidates comprises excluding merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode.

4. The method of claim 3, further comprising:

not excluding merge candidates from prediction units from the coding unit having the NxN partition mode.

5. The method of claim 2, wherein the merge candidate set includes a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge candidate, and a temporal merge candidate.

6. The method of claim 5, wherein the current coding unit has a 2NxN, a 2NxnU or a 2NxnD partition type, including a prediction unit 0 positioned above a prediction unit 1, and wherein excluding merge candidates from the merge candidate set comprises excluding the above merge candidate from the merge candidate set for prediction unit 1.

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7. The method of claim 5, wherein the current coding unit has an Nx2N, an nLx2N or an nRx2N partition type, including a prediction unit 0 positioned to the left of a prediction unit 1, and wherein excluding merge candidates from the merge candidate set comprises excluding the left merge candidate from the merge candidate set for prediction unit 1.

8. The method of claim 2, wherein the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit,

wherein excluding merge candidates from the merge candidate set comprises excluding the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1,

wherein excluding merge candidates from the merge candidate set comprises excluding the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2, and

wherein excluding merge candidates from the merge candidate set comprises excluding the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

9. The method of claim 2, wherein coding video comprises decoding video, and wherein the method further comprises:

receiving a syntax element indicating a selected merge candidate for the current prediction unit;

performing the merge motion vector prediction process for the current prediction unit using the merge candidate set and the received syntax element to determine a motion vector for the current prediction unit; and

decoding the current prediction unit using the determined motion vector.

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10. The method of claim 2, wherein coding video comprises encoding video, and wherein the method further comprises:

performing the motion vector prediction process for the current prediction unit using the merge candidate set to determine a selected merge candidate for the current prediction unit; and

signaling a syntax element indicating the selected merge candidate in an encoded video bitstream.

11. An apparatus configured to code video data comprising:

a video coder configured to:

determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units; and

perform a merge motion vector prediction process for the current prediction unit using the merge candidate set.

12. The apparatus of claim 11, wherein the video coder is further configured to:

exclude merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

13. The apparatus of claim 12, wherein the video coder is further configured to:

exclude merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode.

14. The apparatus of claim 13, wherein the video coder is further configured to:

not exclude merge candidates from prediction units from the coding unit having the NxN partition mode.

15. The apparatus of claim 12, wherein the merge candidate set includes a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge candidate, and a temporal merge candidate.

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16. The apparatus of claim 15, wherein the current coding unit has a 2NxN, a 2NxnU or a 2NxnD partition type, including a prediction unit 0 positioned above a prediction unit 1, and wherein the video coder is further configured to exclude the above merge candidate from the merge candidate set for prediction unit 1.

17. The apparatus of claim 15, wherein the current coding unit has an Nx2N, an nLx2N or an nRx2N partition type, including a prediction unit 0 positioned to the left of a prediction unit 1, and wherein the video coder is further configured to exclude the left merge candidate from the merge candidate set for prediction unit 1.

18. The apparatus of claim 15, wherein the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit,

wherein the video coder is further configured to exclude the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1,

wherein the video coder is further configured to exclude the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2, and

wherein the video coder is further configured to exclude the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

19. The apparatus of claim 12, wherein the video coder is a video decoder, and wherein the video decoder is further configured to:

receive a syntax element indicating a selected merge candidate for the current prediction unit;

perform the merge motion vector prediction process for the current prediction unit using the merge candidate set and the received syntax element to determine a motion vector for the current prediction unit; and

decode the current prediction unit using the determined motion vector.

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20. The apparatus of claim 12, wherein the video coder is a video encoder, and wherein the video encoder is further configured to:

perform the motion vector prediction process for the current prediction unit using the merge candidate set to determine a selected merge candidate for the current prediction unit; and

signal a syntax element indicating the selected merge candidate in an encoded video bitstream.

21. The apparatus of claim 11, wherein the video coder is part of a mobile device.

22. An apparatus configured to code video data comprising:

means for determining a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units; and

means for performing a merge motion vector prediction process for the current prediction unit using the merge candidate set.

23. The apparatus of claim 22, further comprising:

means for excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

24. The apparatus of claim 23, wherein the means for excluding merge candidates comprises means for excluding merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode.

25. The apparatus of claim 23, further comprising:

means for not excluding merge candidates from prediction units from the coding unit having the NxN partition mode.

26. The apparatus of claim 23, wherein the merge candidate set includes a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge candidate, and a temporal merge candidate.

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27. The apparatus of claim 26, wherein the current coding unit has a 2NxN, a 2NxnU or a 2NxnD partition type, including a prediction unit 0 positioned above a prediction unit 1, and wherein the means for excluding merge candidates from the merge candidate set comprises means for excluding the above merge candidate from the merge candidate set for prediction unit 1.

28. The apparatus of claim 26, wherein the current coding unit has an Nx2N, an nLx2N or an nRx2N partition type, including a prediction unit 0 positioned to the left of a prediction unit 1, and wherein the means for excluding merge candidates from the merge candidate set comprises means for excluding the left merge candidate from the merge candidate set for prediction unit 1.

29. The apparatus of claim 26, wherein the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit,

wherein the means for excluding merge candidates from the merge candidate set comprises means for excluding the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1,

wherein the means for excluding merge candidates from the merge candidate set comprises means for excluding the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2, and

wherein the means for excluding merge candidates from the merge candidate set comprises means for excluding the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

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30. The apparatus of claim 23, wherein the apparatus is configured to decode video, and wherein the apparatus further comprises:

means for receiving a syntax element indicating a selected merge candidate for the current prediction unit;

means for performing the merge motion vector prediction process for the current prediction unit using the merge candidate set and the received syntax element to determine a motion vector for the current prediction unit; and

means for decoding the current prediction unit using the determined motion vector.

31. The apparatus of claim 23, wherein the apparatus is configured to encode video, and wherein the apparatus further comprises:

means for performing the motion vector prediction process for the current prediction unit using the merge candidate set to determine a selected merge candidate for the current prediction unit; and

means for signaling a syntax element indicating the selected merge candidate in an encoded video bitstream.

32. The apparatus of claim 22, wherein the apparatus is part of a mobile device.

33. A computer-readable storage medium having stored thereon instructions that when executed cause one or more processors configured to code video data to:

determine a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units; and

perform a merge motion vector prediction process for the current prediction unit using the merge candidate set.

34. The computer-readable storage medium of claim 33, wherein the instructions further cause the one or more processors to:

exclude merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

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35. The computer-readable storage medium of claim 34, wherein the instructions further cause the one or more processors to:

exclude merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode.

36. The computer-readable storage medium of claim 35, wherein the instructions further cause the one or more processors to:

not exclude merge candidates from prediction units from the coding unit having the NxN partition mode.

37. The computer-readable storage medium of claim 34, wherein the merge candidate set includes a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge candidate, and a temporal merge candidate.

38. The computer-readable storage medium of claim 37, wherein the current coding unit has a 2NxN, a 2NxnU or a 2NxnD partition type, including a prediction unit 0 positioned above a prediction unit 1, and wherein the instructions further cause the one or more processors to exclude the above merge candidate from the merge candidate set for prediction unit 1.

39. The computer-readable storage medium of claim 37, wherein the current coding unit has an Nx2N, an nLx2N or an nRx2N partition type, including a prediction unit 0 positioned to the left of a prediction unit 1, and wherein the instructions further cause the one or more processors to exclude the left merge candidate from the merge candidate set for prediction unit 1.

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40. The computer-readable storage medium of claim 37, wherein the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit,

wherein the instructions further cause the one or more processors to exclude the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1, wherein the instructions further cause the one or more processors to exclude the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2, and

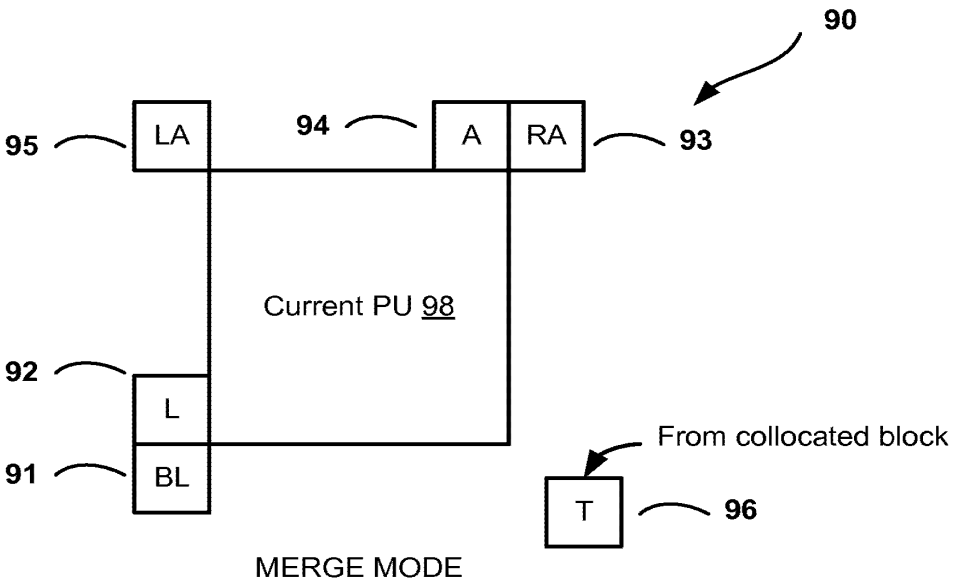
wherein the instructions further cause the one or more processors to exclude the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

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ABSTRACT

This disclosure presents methods and systems for coding video in merge mode of a motion vector prediction process. A method of coding video data may determining a merge candidate set for a current prediction unit of a current coding unit, wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units, and performing a merge motion vector prediction process for the current prediction unit using the merge candidate set. The method may further comprise excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit.

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90
95
LA
94
A
RA
93
Current PU 98
92
L
91
BL
From collocated block
T
96
MERGE MODE

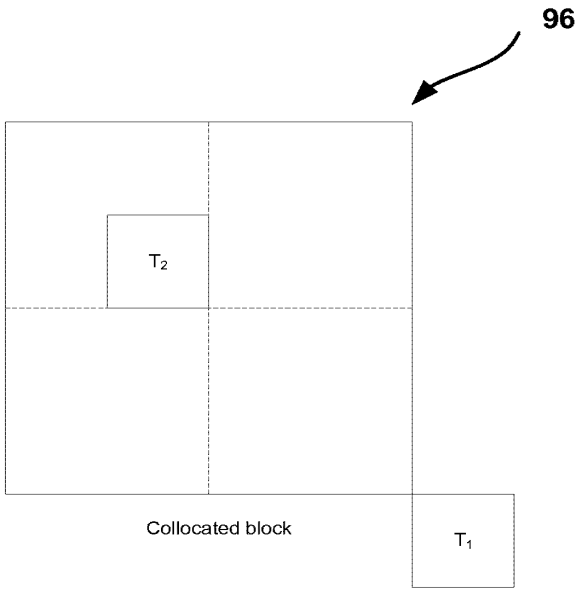

96
T2
Collocated block
T1

FIG. 1

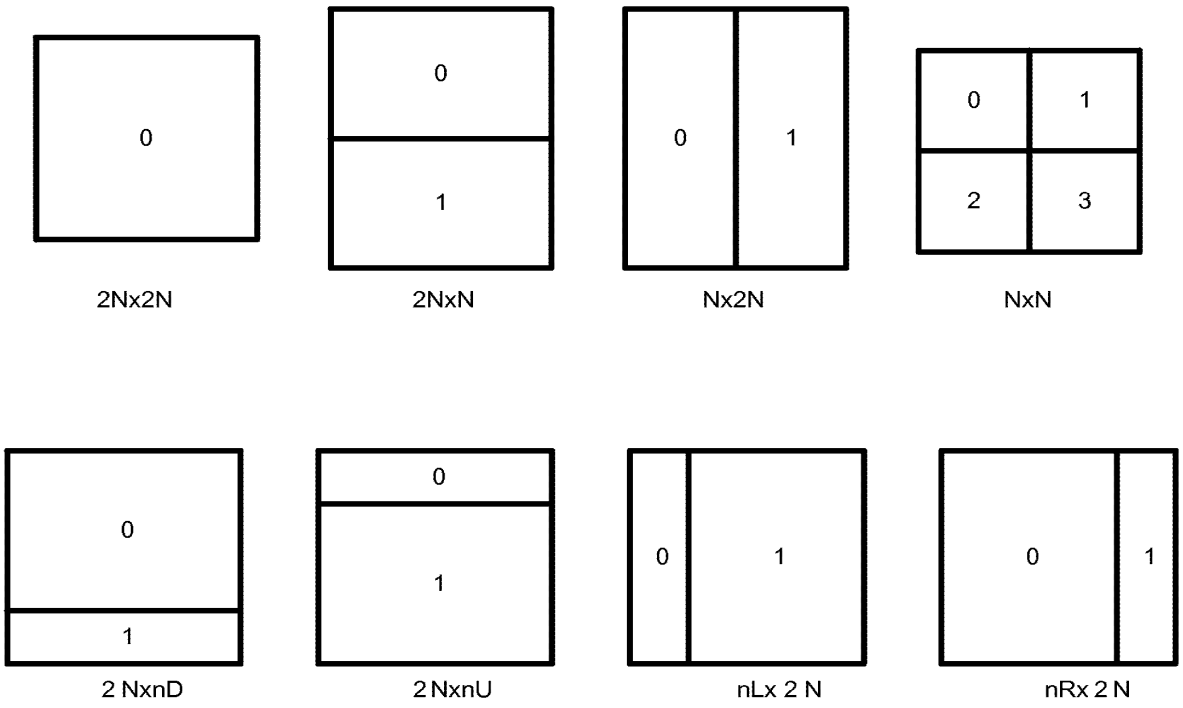

0
2Nx2N
0
1
2NxN
0
1
Nx2N
0
1
2
3
NxN
0
1
2 NxnD
0
1
2 NxnU
0
1
nLx 2 N
0
1
nRx 2 N

FIG. 2

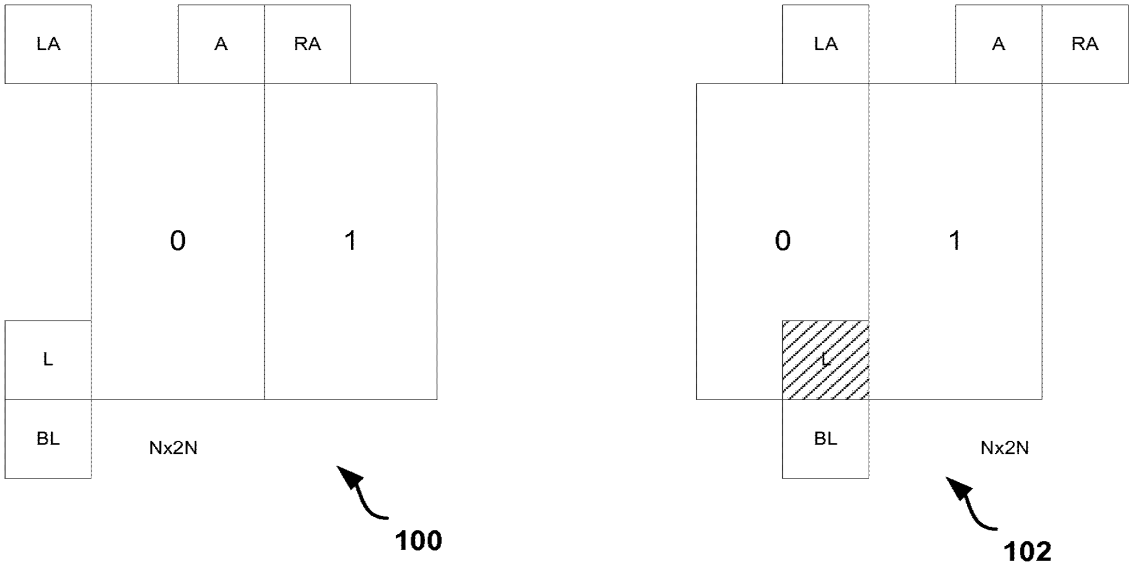

LA
A
RA
0
1
L
BL
Nx2N
100
LA
A
RA
0
1
L
BL
Nx2N
102

FIG. 3A

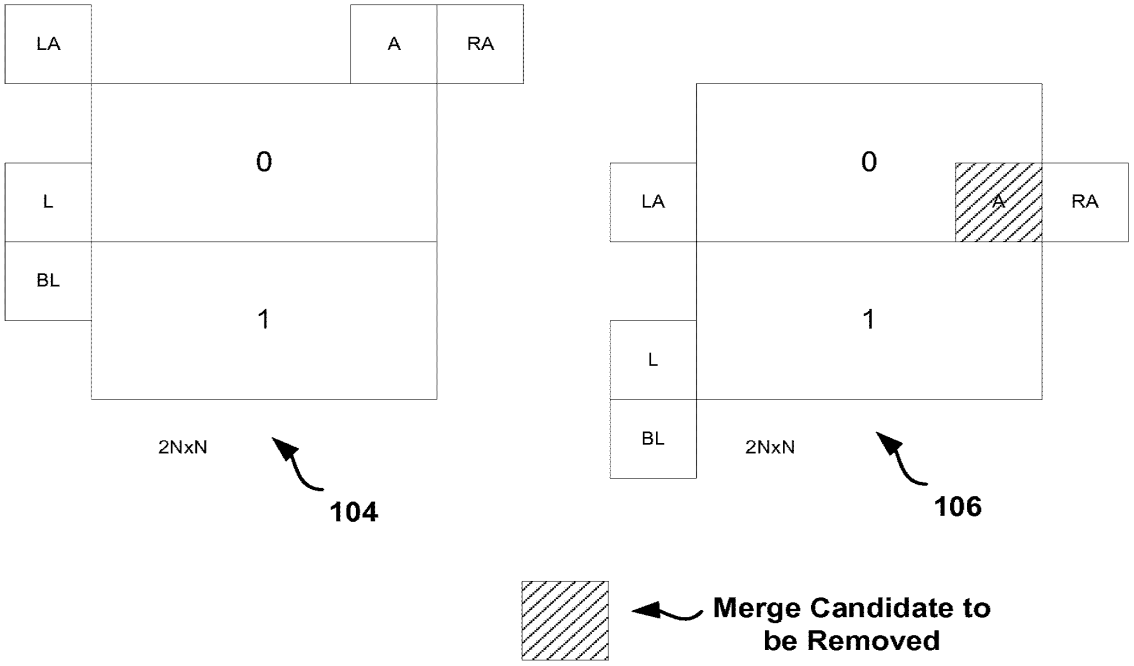

LA
A
RA
0
L
BL
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2NxN
104
0
LA
A
RA
1
L
BL
2NxN
106
Merge Candidate to be Removed

FIG. 3B

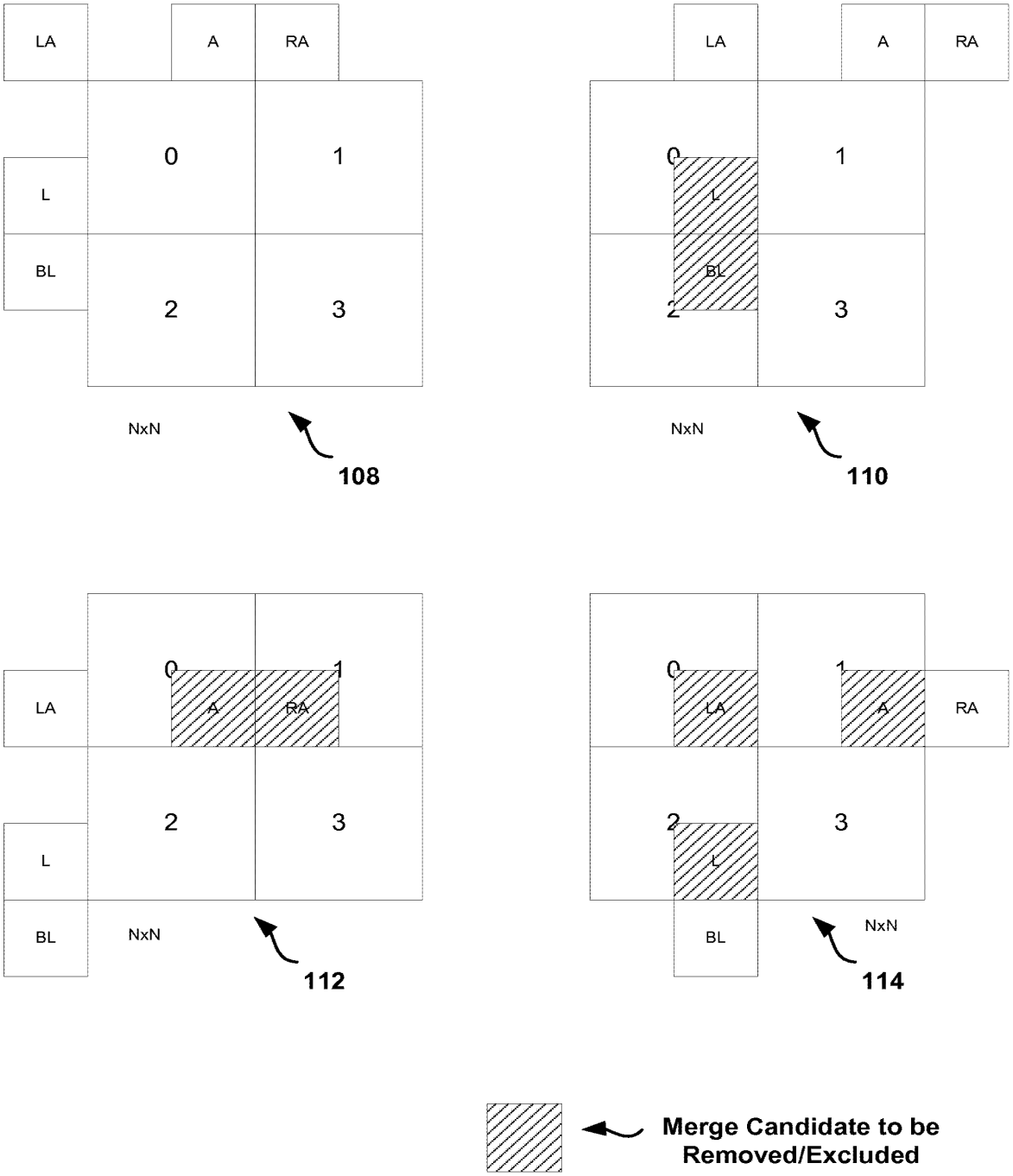
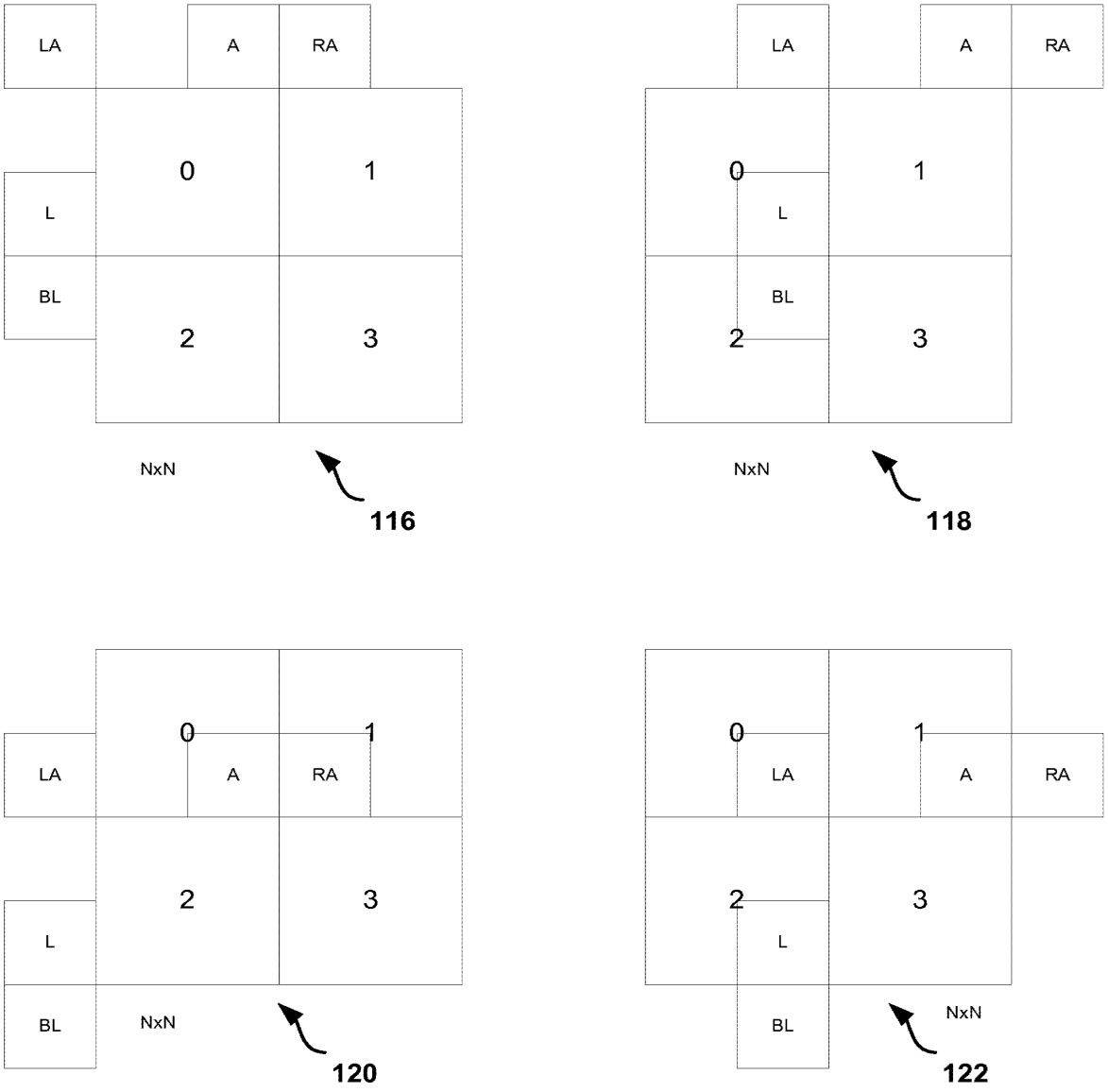

LA
A
RA
L
BL
0
1
2
3
NxN
108
110
112
114
Merge Candidate to be Removed/Excluded

FIG. 4A



No Merge Candidates Are Removed/Excluded

FIG. 4B

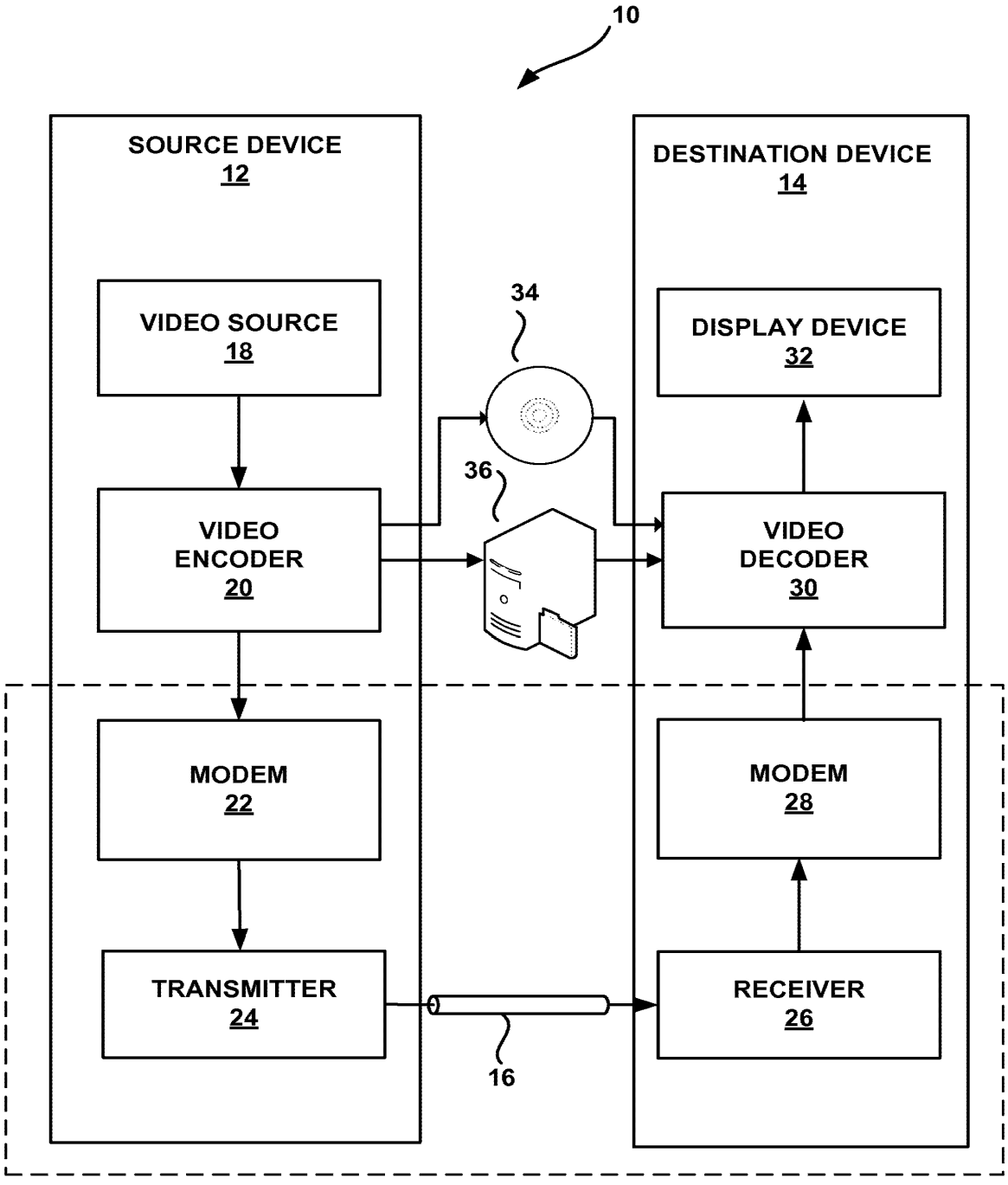

10
SOURCE DEVICE
12
DESTINATION DEVICE
14
VIDEO SOURCE
18
34
DISPLAY DEVICE
32
36
VIDEO
ENCODER
20
VIDEO
DECODER
30
MODEM
22
MODEM
28
TRANSMITTER
24
RECEIVER
26
16

FIG. 5

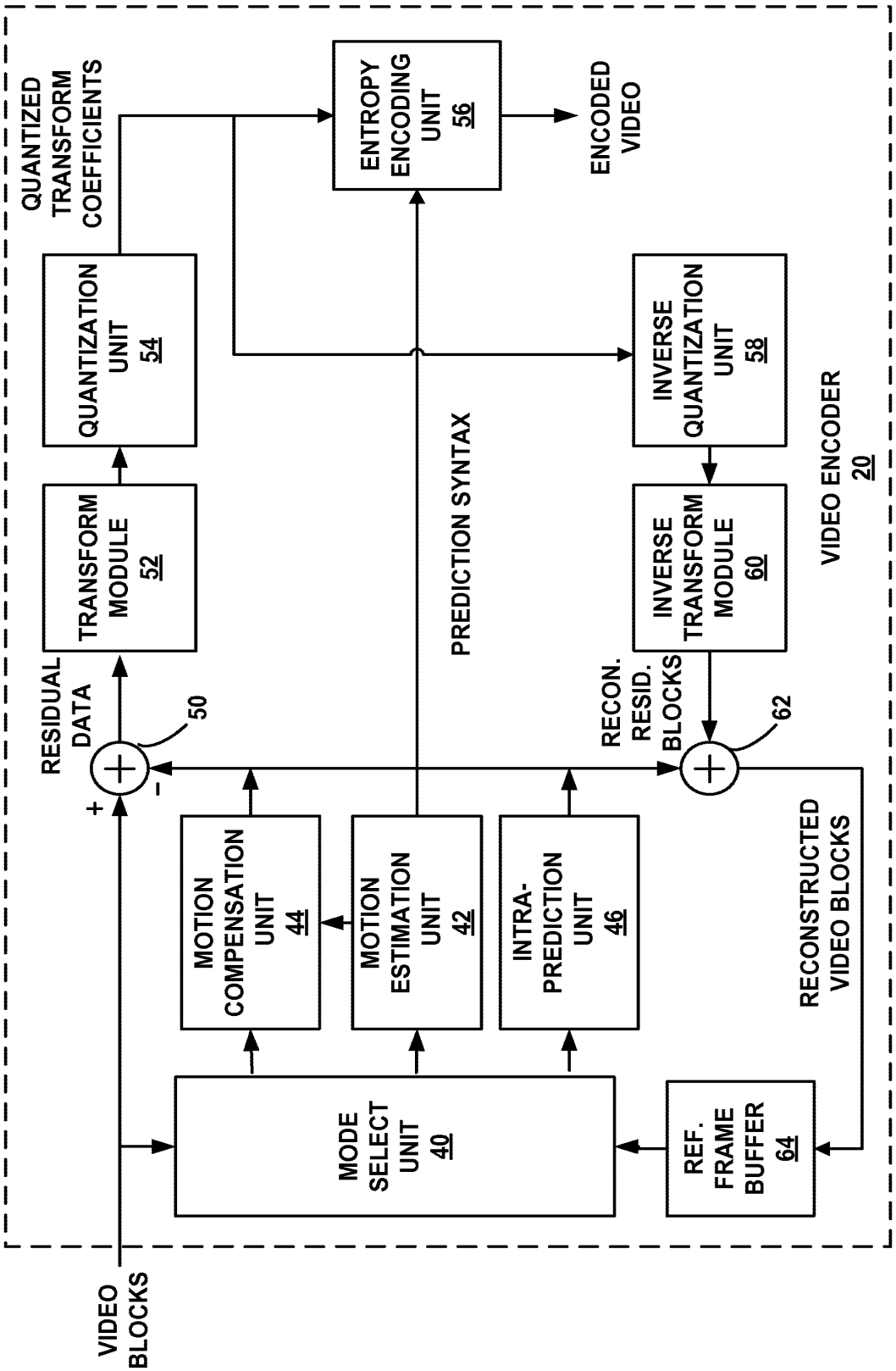

VIDEO BLOCKS
VIDEO ENCODER 20
MODE SELECT UNIT 40
REF. FRAME BUFFER 64
MOTION COMPENSATION UNIT 44
MOTION ESTIMATION UNIT 42
INTRA-PREDICTION UNIT 46
RESIDUAL DATA
50
+
-
TRANSFORM MODULE 52
QUANTIZATION UNIT 54
QUANTIZED TRANSFORM COEFFICIENTS
ENTROPY ENCODING UNIT 56
ENCODED VIDEO
PREDICTION SYNTAX
INVERSE QUANTIZATION UNIT 58
INVERSE TRANSFORM MODULE 60
RECON. RESID. BLOCKS
62
RECONSTRUCTED VIDEO BLOCKS

FIG. 6

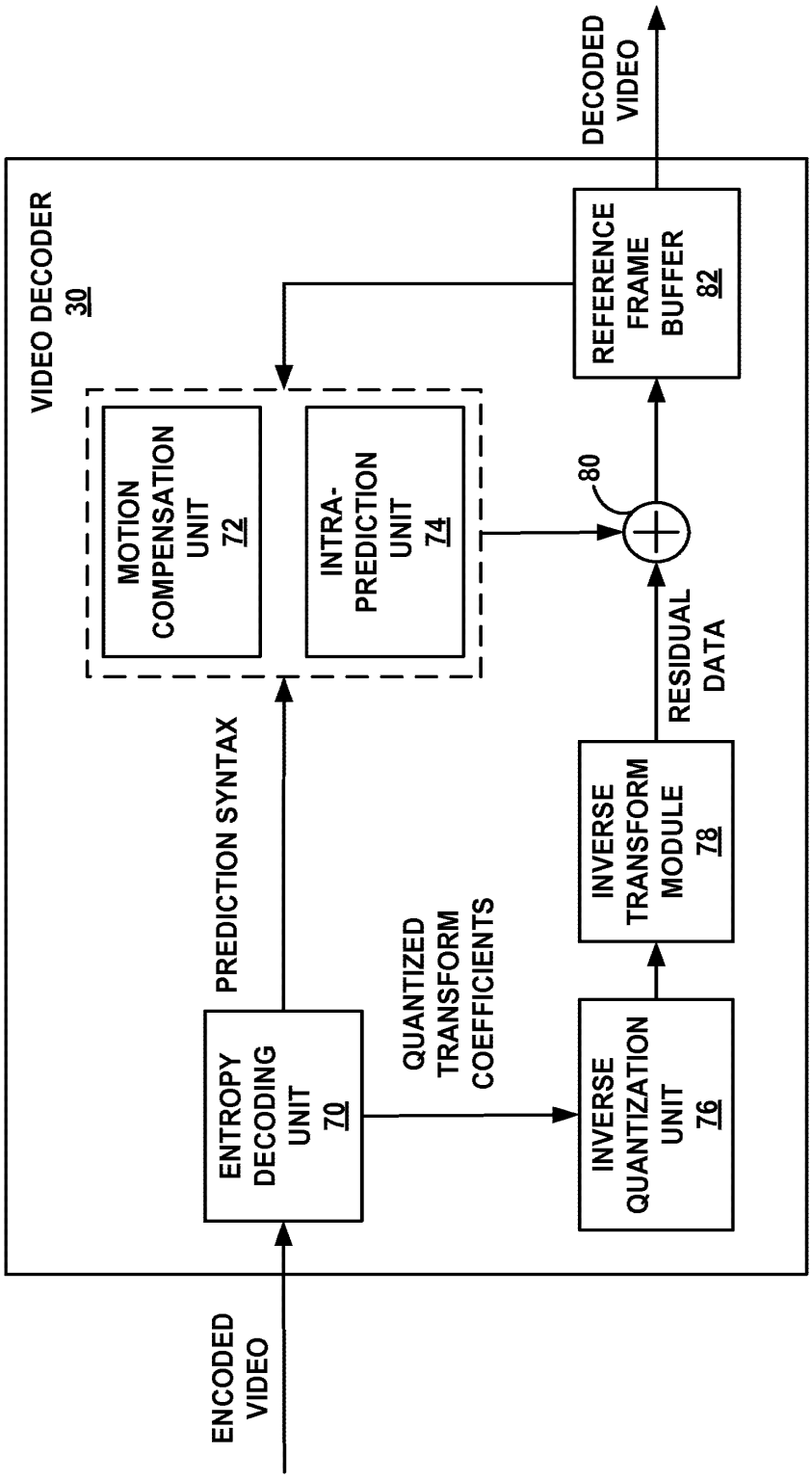

ENCODED VIDEO
VIDEO DECODER 30
ENTROPY DECODING UNIT 70
PREDICTION SYNTAX
QUANTIZED TRANSFORM COEFFICIENTS
MOTION COMPENSATION UNIT 72
INTRA-PREDICTION UNIT 74
INVERSE QUANTIZATION UNIT 76
INVERSE TRANSFORM MODULE 78
RESIDUAL DATA
80
REFERENCE FRAME BUFFER 82
DECODED VIDEO

FIG. 7

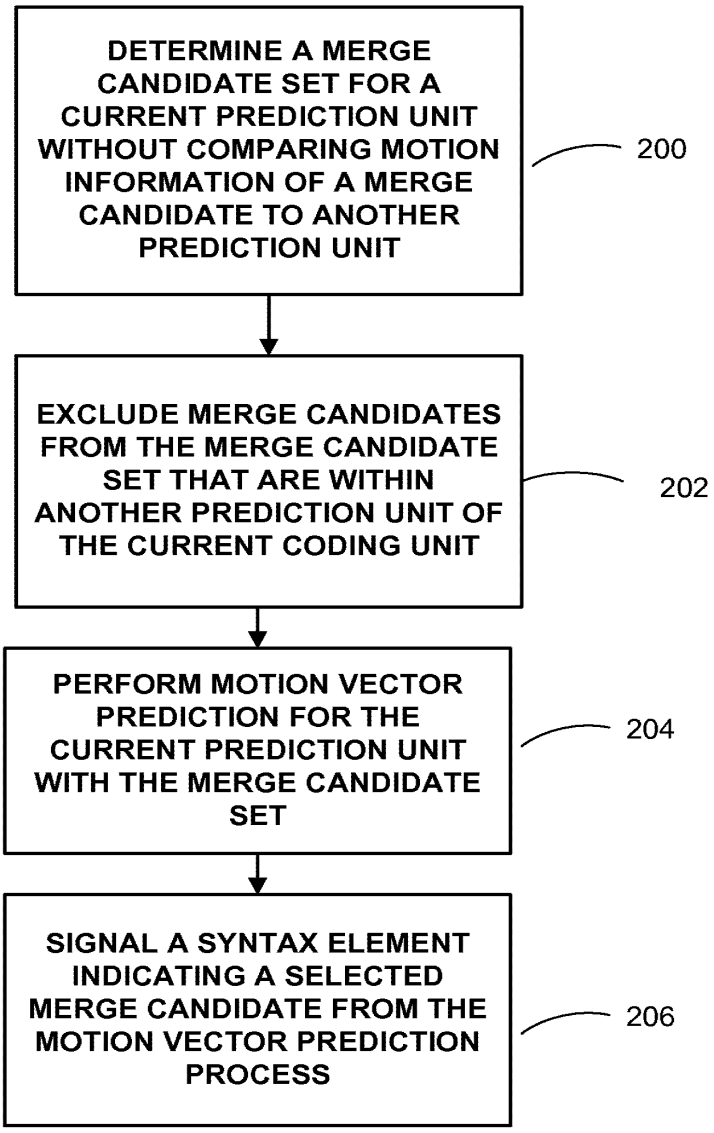

DETERMINE A MERGE CANDIDATE SET FOR A CURRENT PREDICTION UNIT WITHOUT COMPARING MOTION INFORMATION OF A MERGE CANDIDATE TO ANOTHER PREDICTION UNIT
200
EXCLUDE MERGE CANDIDATES FROM THE MERGE CANDIDATE SET THAT ARE WITHIN ANOTHER PREDICTION UNIT OF THE CURRENT CODING UNIT
202
PERFORM MOTION VECTOR PREDICTION FOR THE CURRENT PREDICTION UNIT WITH THE MERGE CANDIDATE SET
204
SIGNAL A SYNTAX ELEMENT INDICATING A SELECTED MERGE CANDIDATE FROM THE MOTION VECTOR PREDICTION PROCESS
206

FIG. 8

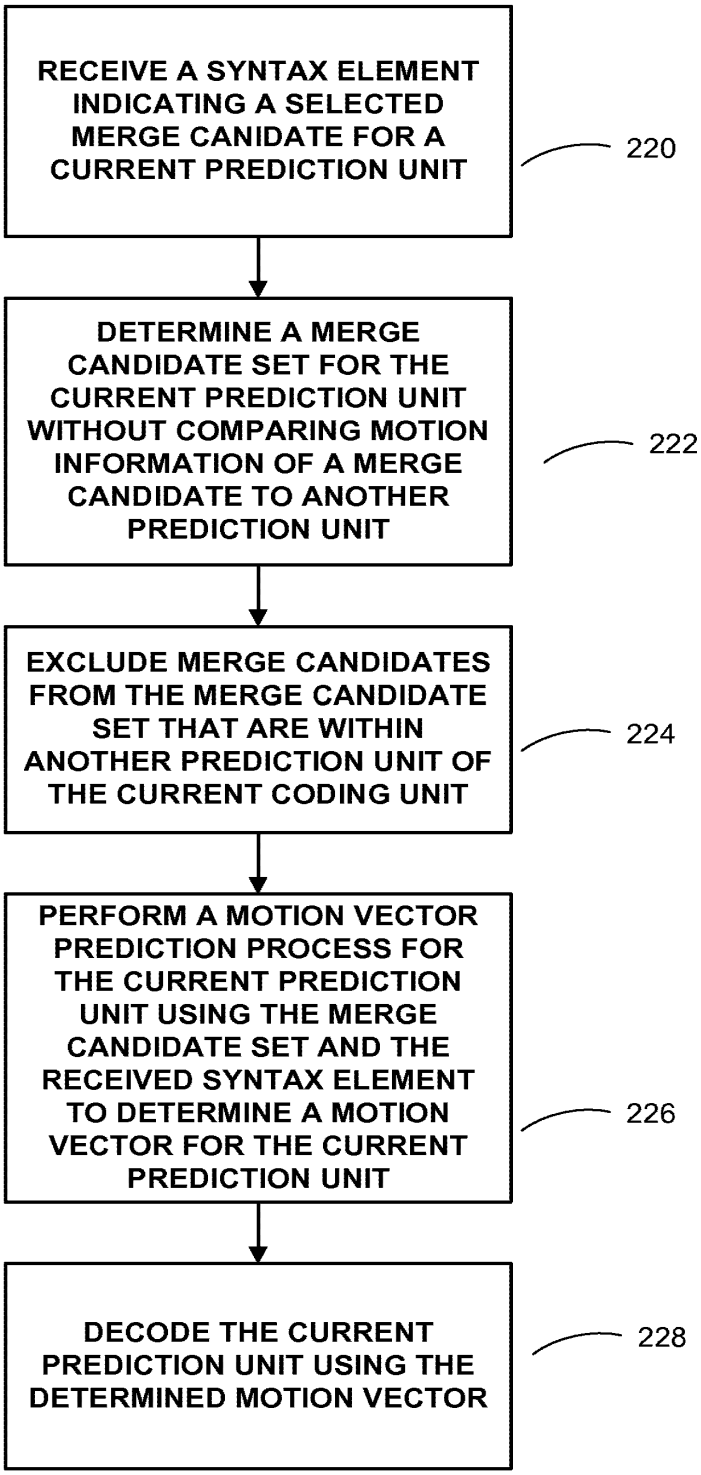

RECEIVE A SYNTAX ELEMENT INDICATING A SELECTED MERGE CANIDATE FOR A CURRENT PREDICTION UNIT
220
DETERMINE A MERGE CANDIDATE SET FOR THE CURRENT PREDICTION UNIT WITHOUT COMPARING MOTION INFORMATION OF A MERGE CANDIDATE TO ANOTHER PREDICTION UNIT
222
EXCLUDE MERGE CANDIDATES FROM THE MERGE CANDIDATE SET THAT ARE WITHIN ANOTHER PREDICTION UNIT OF THE CURRENT CODING UNIT
224
PERFORM A MOTION VECTOR PREDICTION PROCESS FOR THE CURRENT PREDICTION UNIT USING THE MERGE CANDIDATE SET AND THE RECEIVED SYNTAX ELEMENT TO DETERMINE A MOTION VECTOR FOR THE CURRENT PREDICTION UNIT
226
DECODE THE CURRENT PREDICTION UNIT USING THE DETERMINED MOTION VECTOR
228

FIG. 9

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1010-939US01/120072
	Application Number	
Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Yunfei		Zheng	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Cupertino	State/Province	CA	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i] CN

Mailing Address of Applicant:

Address 1	20631 Forge Way, Suite 279		
Address 2			
City	Cupertino	State/Province	CA
Postal Code	95014	Country [i]	US

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xianglin		Wang	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	San Diego	State/Province	CA	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i] US

Mailing Address of Applicant:

Address 1	5775 Morehouse Drive		
Address 2			
City	San Diego	State/Province	CA
Postal Code	92121	Country [i]	US

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Marta		Karczewicz	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	San Diego	State/Province	CA	Country of Residence [i]	US

PTO/SB/14 (07-07)
Approved for use through 06/30/2010. 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 contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1010-939US01/120072
	Application Number	
Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING	

Citizenship under 37 CFR 1.41(b) [i]	US		
Mailing Address of Applicant:			
Address 1	5775 Morehouse Drive		
Address 2			
City	San Diego	**State/Province**	CA
Postal Code	92121	**Country**[i]	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	15150		
Email Address	pairdocketing@ssiplaw.com	Add Email	Remove Email

Application Information:

Title of the Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING		
Attorney Docket Number	1010-939US01/120072	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1010-939US01/120072
	Application Number	
Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING	

Customer Number	15150

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/499112	2011-06-20
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/543043	2011-10-04
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/543059	2011-10-04
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/556761	2011-11-07
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/562387	2011-11-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61/562953	2011-11-22

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			○ Yes ◉ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1062, Page 000059

PTO/SB/14 (07-07)
Approved for use through 06/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1010-939US01/120072
	Application Number	
Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING	

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee [1] Remove

If the Assignee is an Organization check here. ☒

Organization Name	QUALCOMM Incorporated		
Mailing Address Information:			
Address 1	5775 Morehouse Drive		
Address 2			
City	San Diego	**State/Province**	CA
Country [i]	US	Postal Code	92121
Phone Number	858-845-4265	Fax Number	
Email Address	patent.docketing.us@qualcomm.com		

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Matthew J. Evans/			Date (YYYY-MM-DD)	2012-06-18
First Name	Matthew J.	Last Name	Evans	Registration Number	56530

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.**

Privacy Act Statement

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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 the Freedom of Information Act requires disclosure of these records.

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 inspections 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.

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Filer:	Matthew J. Evans/Susan Daly
Attorney Docket Number:	1010-939US01/120072

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Late filing fee for oath or declaration	1051	1	130	130
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**130**

Electronic Acknowledgement Receipt

EFS ID:	13043791
Application Number:	13526261
International Application Number:	
Confirmation Number:	8560
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Customer Number:	15150
Filer:	Matthew J. Evans/Susan Daly
Filer Authorized By:	Matthew J. Evans
Attorney Docket Number:	1010-939US01/120072
Receipt Date:	18-JUN-2012
Filing Date:	
Time Stamp:	18:19:53
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	Transmittal of New Application	Transmittal.pdf	67232 ea8bbfca84816f9d40689f2931ae8969d201a0e4	no	2
Warnings:					
Information:					

2		Application.pdf	183247 48bbd8ff8c91c9e1d2559469a248652b480c86ac	yes	44

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	34
	Claims	35	43
	Abstract	44	44

Warnings:					
Information:					
3	Drawings-only black and white line drawings	Figures.pdf	68534 713e7aba8937cbbab49bf0936a46cab501f11749	no	10
Warnings:					
Information:					
4	Application Data Sheet	ADS.pdf	837223 5b8543f20205b387ef7180ab3691ae7f422ca81e	no	5
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	29749 07a07dec7edc7374e9aab00beb577a330c5ce8cb	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1185985		

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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.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/526,261

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	40 minus 20 =	* 20			OR	x 60 =	1200
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 250 =	250
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).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2700

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	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 found in the appropriate box in column 1.

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
13/526,261	06/18/2012	2626	0.00	1010-939US01/120072	40	4

CONFIRMATION NO. 8560

15150
Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

FILING RECEIPT

OC000000055078397

Date Mailed: 06/29/2012

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**

Applicant(s)

Yunfei Zheng, Cupertino, CA;
Xianglin Wang, San Diego, CA;
Marta Karczewicz, San Diego, CA;

Assignment For Published Patent Application

QUALCOMM INCORPORATED, San Diego, CA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/499,112 06/20/2011
and claims benefit of 61/543,043 10/04/2011
and claims benefit of 61/543,059 10/04/2011
and claims benefit of 61/556,761 11/07/2011
and claims benefit of 61/562,387 11/21/2011
and claims benefit of 61/562,953 11/22/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 06/27/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/526,261**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

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Title

PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

Preliminary Class

704

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 (1-866-999-4158).

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

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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).

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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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
13/526,261	06/18/2012	Yunfei Zheng	1010-939US01/120072

CONFIRMATION NO. 8560

15150
Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

FORMALITIES LETTER

OC000000055078398

Date Mailed: 06/29/2012

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  *Applicant must submit $**380** to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of $**1450** as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- A surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $**130** for a non-small entity, must be submitted.

SUMMARY OF FEES DUE:

Total fee(s) required within **TWO MONTHS** from the date of this Notice is $**2830** for a non-small entity

- $**380** Statutory basic filing fee.
- $**130** Surcharge.
- The application search fee has not been paid. Applicant must submit $**620** to complete the search fee.

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- The application examination fee has not been paid. Applicant must submit $**250** to complete the examination fee for a non-small entity.
- Total additional claim fee(s) for this application is $**1450**
  - $**250** for **1** independent claims over 3.
  - $**1200** for **20** total claims over 20.

Replies should be mailed to:

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Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/nhassani/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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PTO/SB/80 (11-08)
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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.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 15150

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 15150

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Qualcomm Incorporated
5775 Morehouse Drive
San Diego, CA 92121

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	MAY 23, 2011
Name	Katherine Umpleby	Telephone	(858) 651-7170
Title	Vice President, Chief Patent Counsel		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. 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 3 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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Yunfei Zheng	Confirmation No.	8560
Serial No.:	13/526,261		
Filed:	June 18, 2012	Customer No.:	15150
Examiner:	Unknown		
Group Art Unit:	2626		
Docket No.:	1010-939US01/120072		
Title:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING		

CERTIFICATE UNDER 37 CFR 1.8 I hereby certify that this correspondence is being transmitted via the United States Patent and Trademark Office electronic filing system on August 14, 2012.

By: / Tiffany J. Schuna /
Name: Tiffany J. Schuna

Mail Stop Missing Parts
Commissioner for Patents
Alexandria, VA 22313-1450

Dear Commissioner:

We are transmitting herewith the attached correspondence relating to this application:

☒ Transmittal sheet containing Certificate of Electronic Filing
☒ Signed Declaration with Application (4 pgs.)
☒ Statement Under 3.73(b) with executed Assignment (6 pgs.)
☒ Signed Power of Attorney (1 pg.)

Number of Claims Filed		In Excess of:		Extra		Rate		Fee
Basic Filing Fee								$380.00
Total Claims								
40		20		20	x	$60.00	=	$1,200.00
Independent Claims								
4		3		1	x	$250.00	=	$ 250.00
MULTIPLE DEPENDENT CLAIM FEE								
EXAMINATION FEE								$250.00
SEARCH FEE								$620.00
APPLICATION SIZE FEE (if applicable)								$
TOTAL FILING FEE								$2,700.00

Please charge credit card in the amount of $2,830.00 ($2,700.00 for deferred filing fee and $130.00 for missing parts surcharge). Additionally, apply any charges not covered, or any credits, to Deposit Account No. 50-1778.

Date: August 14, 2012

By: /Matthew J. Evans/

Name: Matthew J. Evans, Reg No. 56,530

SHUMAKER & SIEFFERT, P.A.
1625 Radio Drive, Suite 300
Woodbury, Minnesota 55125
Telephone: 651.286.8036
Facsimile: 651.735.1102

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Electronic Patent Application Fee Transmittal

Application Number:	13526261
Filing Date:	18-Jun-2012
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Filer:	Matthew J. Evans/Tiffany Schuna
Attorney Docket Number:	1010-939US01/120072

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	380	380
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Claims in excess of 20	1202	20	60	1200
Independent claims in excess of 3	1201	1	250	250
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Late filing fee for oath or declaration	1051	1	130	130
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2830**

Electronic Acknowledgement Receipt

EFS ID:	13491661
Application Number:	13526261
International Application Number:	
Confirmation Number:	8560
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Customer Number:	15150
Filer:	Matthew J. Evans/Tiffany Schuna
Filer Authorized By:	Matthew J. Evans
Attorney Docket Number:	1010-939US01/120072
Receipt Date:	14-AUG-2012
Filing Date:	18-JUN-2012
Time Stamp:	13:48:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$2830
RAM confirmation Number	11796
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Assignee showing of ownership per 37 CFR 3.73(b).	373b_PTO.pdf	3021716 bd2bc1dec8ba242d82a05a185179239032965a35	no	6
Warnings:					
Information:					
2	Oath or Declaration filed	Declaration.pdf	3422199 5c241caa4e4b1d004a7f8ef8675c54c0af4236f3	no	4
Warnings:					
Information:					
3	Power of Attorney	POA.pdf	543662 d7e96b8a2e33619deffa51f40d968997419ec9f3	no	1
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	Transmittal.pdf	57074 66deadc9a052e6d02719ccb92f0722eb18552eef	no	2
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	40177 3111f4f3f31d02db667c150fb67ec987fd6aec1b9	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	7084828		

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.

<u>New Applications Under 35 U.S.C. 111</u>
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.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
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/96 (07-09)
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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.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: QUALCOMM Incorporated

Application No./Patent No.: 13/526,261 Filed/Issue Date: June 18, 2012

Titled: PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

QUALCOMM Incorporated , a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [X] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy therefore is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[X] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Matthew J. Evans/ August 14, 2012

Signature Date

Matthew J. Evans, Reg. No. 56,530 Patent Attorney

Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). 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: 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.

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.

ASSIGNMENT

WHEREAS, WE,

1. **Yunfei Zheng,** a citizen of **China,** having a mailing address located at 20631 Forge Way, Suite 279, Cupertino, California 95014, and a resident of **Cupertino, CA,**

2. **Xianglin Wang,** a citizen of **The United States of America,** having a mailing address located at 5775 Morehouse Drive, San Diego, California 92121-1714, and a resident of **San Diego, CA,**

3. **Marta Karczewicz,** a citizen of **The United States of America,** having a mailing address located at 5775 Morehouse Drive, San Diego, California 92121-1714, and a resident of **San Diego, CA,**

have conceived of one or more processes, methods, machines, articles of manufacture, designs, compositions of matter, inventions, discoveries or new or useful improvements relating to **PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING** (collectively the "**INVENTIONS**") for which WE have executed and/or may execute one or more patent applications therefor; and

WHEREAS, QUALCOMM Incorporated (hereinafter "**ASSIGNEE**"), a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, U.S.A., desires to acquire or otherwise obtain the entire right, title, and interest in and to said INVENTIONS, including all inventions related thereto or thereof, all patent applications therefor, and all patents that have granted or may be granted hereafter thereon, including but not limited to those identified below.

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, WE do hereby acknowledge that WE have sold, assigned, conveyed, and transferred, and by these presents do hereby sell, assign, convey, and transfer, unto ASSIGNEE, its successors, its legal representatives, and its assigns, the entire right, title, and interest throughout the world in and to said INVENTIONS, including all patent applications therefor that may have been filed or may be filed hereafter for said INVENTIONS in the United States, including but not limited to U.S. Application No(s). **13/526,261**, filed **June 18, 2012**, Qualcomm Reference No. **120072**, and all provisional applications relating thereto, together with U.S. Provisional Application No(s). **61/499,112**, filed **June 20, 2011**, Qualcomm Reference No. **112573P1**, and together with U.S. Provisional Application No(s). **61/543,043**, filed **October 4, 2011**, Qualcomm Reference No. **120072P1**, together with U.S. Provisional Application No(s). **61/543,059**, filed **October 4, 2011**, Qualcomm Reference No. **112573P2**, together with U.S. Provisional Application No(s). **61/556,761**, filed **November 7, 2011**, Qualcomm Reference No. **120469P1**, together with U.S. Provisional Application No(s). **61/562,387**, filed **November 21, 2011**, Qualcomm Reference No. **120469P2**, together with U.S. Provisional Application No(s). **61/562,953**, filed **November 22, 2011**, Qualcomm Reference No. **120469P3**, (and do hereby authorize ASSIGNEE and its representative to hereafter add herein such application number(s) and/or filing date(s) when known), and all divisional applications, renewal applications, continuation applications, continuation-in-part applications, and design applications thereof, and all issued patents of the United States which may have granted or may be granted hereafter thereon and all reissues, renewals, reexaminations, and extensions to any of the foregoing and all patents issuing thereon in the United States;

AND WE further do acknowledge and agree that WE have sold, assigned, conveyed, and transferred, and by these presents do hereby sell, assign, convey, and transfer, unto ASSIGNEE, its successors, its legal representatives, and its assigns, all rights of priority under International Conventions, Treaties, or Agreements, and the entire right, title, and interest throughout the world in said INVENTIONS, including all inventions related thereto or thereof, and all patent applications therefor that may have been filed or may be filed hereafter for said INVENTIONS in any foreign country, countries, or treaty/union organizations, and all divisional applications, renewal applications, continuation applications, continuation-in-part applications, patent of addition applications, confirmation applications, validation applications, utility model applications, and design applications thereof, and all issued patents which may have granted or may be granted hereafter for said INVENTIONS in any country or countries foreign to the United States, and all reissues, renewals, reexaminations, and extensions thereof;

AND WE DO HEREBY authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications or registrations, to issue all patents for said INVENTIONS to said ASSIGNEE, its successors, its legal representatives and its assigns, in accordance with the terms of this instrument;

AND WE DO HEREBY sell, assign, transfer, and convey to said ASSIGNEE, its successors, its legal representatives, and its assigns all claims for damages and all remedies arising out of or relating to any violation(s) of any of the rights assigned hereby that have or may have accrued prior to the date of assignment to said ASSIGNEE, or may accrue hereafter, including, but not limited to the right to sue for, seek, obtain, collect, recover, and retain damages and any ongoing or prospective royalties to which WE may be entitled, or that WE may collect for any infringement or from any settlement or agreement related to any of said patents before or after issuance;

AND WE HEREBY covenant and agree that WE will communicate promptly to said ASSIGNEE, its successors, its legal representatives, and its assigns, any facts known to us respecting said INVENTIONS, and will testify in any legal proceeding, sign all lawful papers, execute all applications and certificates, make all rightful declarations and/or oaths, and provide all lawful assistance to said ASSIGNEE, its successors, its legal representatives and its assigns, to obtain and enforce patent protection for said INVENTIONS in all countries;

AND WE HEREBY represent that WE have full and exclusive, unencumbered right to sell, assign, convey and transfer all subject matter herein, and hereby covenant that WE have not and will not execute any writing or do any act whatsoever conflicting with these presents.

Done at Cupertino, CA (LOCATION), on 08/01/2012 (DATE) _____
Yunfei Zheng

Done at _____ (LOCATION), on _____ (DATE) _____
Xianglin Wang

Done at _____ (LOCATION), on _____ (DATE) _____
Marta Karczewicz

ASSIGNMENT

WHEREAS, WE,

1. **Yunfei Zheng**, a citizen of **China**, having a mailing address located at 20631 Forge Way, Suite 279, Cupertino, California 95014, and a resident of **Cupertino, CA**,

2. **Xianglin Wang**, a citizen of **The United States of America**, having a mailing address located at 5775 Morehouse Drive, San Diego, California 92121-1714, and a resident of **San Diego, CA**,

3. **Marta Karczewicz**, a citizen of **The United States of America**, having a mailing address located at 5775 Morehouse Drive, San Diego, California 92121-1714, and a resident of **San Diego, CA**,

have conceived of one or more processes, methods, machines, articles of manufacture, designs, compositions of matter, inventions, discoveries or new or useful improvements relating to **PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING** (collectively the "**INVENTIONS**") for which WE have executed and/or may execute one or more patent applications therefor; and

WHEREAS, QUALCOMM Incorporated (hereinafter "**ASSIGNEE**"), a Delaware corporation, having a place of business at 5775 Morehouse Drive, San Diego, California 92121-1714, U.S.A., desires to acquire or otherwise obtain the entire right, title, and interest in and to said INVENTIONS, including all inventions related thereto or thereof, all patent applications therefor, and all patents that have granted or may be granted hereafter thereon, including but not limited to those identified below.

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, WE do hereby acknowledge that WE have sold, assigned, conveyed, and transferred, and by these presents do hereby sell, assign, convey, and transfer, unto ASSIGNEE, its successors, its legal representatives, and its assigns, the entire right, title, and interest throughout the world in and to said INVENTIONS, including all patent applications therefor that may have been filed or may be filed hereafter for said INVENTIONS in the United States, including but not limited to U.S. Application No(s). **13/526,261**, filed **June 18, 2012**, Qualcomm Reference No. **120072**, and all provisional applications relating thereto, together with U.S. Provisional Application No(s). **61/499,112**, filed **June 20, 2011**, Qualcomm Reference No. **112573P1**, and together with U.S. Provisional Application No(s). **61/543,043**, filed **October 4, 2011**, Qualcomm Reference No. **120072P1**, together with U.S. Provisional Application No(s). **61/543,059**, filed **October 4, 2011**, Qualcomm Reference No. **112573P2**, together with U.S. Provisional Application No(s). **61/556,761**, filed **November 7, 2011**, Qualcomm Reference No. **120469P1**, together with U.S. Provisional Application No(s). **61/562,387**, filed **November 21, 2011**, Qualcomm Reference No. **120469P2**, together with U.S. Provisional Application No(s). **61/562,953**, filed **November 22, 2011**, Qualcomm Reference No. **120469P3**, (and do hereby authorize ASSIGNEE and its representative to hereafter add herein such application number(s) and/or filing date(s) when known), and all divisional applications, renewal applications, continuation applications, continuation-in-part applications, and design applications thereof, and all issued patents of the United States which may have granted or may be granted hereafter thereon and all reissues, renewals, reexaminations, and extensions to any of the foregoing and all patents issuing thereon in the United States;

AND WE further do acknowledge and agree that WE have sold, assigned, conveyed, and transferred, and by these presents do hereby sell, assign, convey, and transfer, unto ASSIGNEE, its successors, its legal representatives, and its assigns, all rights of priority under International Conventions, Treaties, or Agreements, and the entire right, title, and interest throughout the world in said INVENTIONS, including all inventions related thereto or thereof, and all patent applications therefor that may have been filed or may be filed hereafter for said INVENTIONS in any foreign country, countries, or treaty/union organizations, and all divisional applications, renewal applications, continuation applications, continuation-in-part applications, patent of addition applications, confirmation applications, validation applications, utility model applications, and design applications thereof, and all issued patents which may have granted or may be granted hereafter for said INVENTIONS in any country or countries foreign to the United States, and all reissues, renewals, reexaminations, and extensions thereof;

AND WE DO HEREBY authorize and request the Commissioner of Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications or registrations, to issue all patents for said INVENTIONS to said ASSIGNEE, its successors, its legal representatives and its assigns, in accordance with the terms of this instrument;

AND WE DO HEREBY sell, assign, transfer, and convey to said ASSIGNEE, its successors, its legal representatives, and its assigns all claims for damages and all remedies arising out of or relating to any violation(s) of any of the rights assigned hereby that have or may have accrued prior to the date of assignment to said ASSIGNEE, or may accrue hereafter, including, but not limited to the right to sue for, seek, obtain, collect, recover, and retain damages and any ongoing or prospective royalties to which WE may be entitled, or that WE may collect for any infringement or from any settlement or agreement related to any of said patents before or after issuance;

AND WE HEREBY covenant and agree that WE will communicate promptly to said ASSIGNEE, its successors, its legal representatives, and its assigns, any facts known to us respecting said INVENTIONS, and will testify in any legal proceeding, sign all lawful papers, execute all applications and certificates, make all rightful declarations and/or oaths, and provide all lawful assistance to said ASSIGNEE, its successors, its legal representatives and its assigns, to obtain and enforce patent protection for said INVENTIONS in all countries;

AND WE HEREBY represent that WE have full and exclusive, unencumbered right to sell, assign, convey and transfer all subject matter herein, and hereby covenant that WE have not and will not execute any writing or do any act whatsoever conflicting with these presents.

Done at _____, on _____ _____
LOCATION DATE **Yunfei Zheng**

Done at San Diego, CA, on 07/30/12 _____
LOCATION DATE **Xianglin Wang**

Done at San Diego, on 07/30/12 _____
LOCATION DATE **Marta Karczewicz**

Qualcomm Ref. No. 120072

Approved for use through 06/30/2010. 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.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☑ Application No. 13/526,261 filed on June 18, 2012

☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Yunfei Zheng Date: 08/01/2012

Signature: _____ Citizen of: CN

Inventor two: Xianglin Wang Date: _____

Signature: _____ Citizen of: US

☑ Additional inventors or a legal representative are being named on 1 of 2 additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.

Qualcomm Ref. No. 120072

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☑ Application No. 13/526,261 filed on June 18, 2012

☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

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All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Yunfei Zheng Date: _____

Signature: _____ Citizen of: CN

Inventor two: Xianglin Wang Date: 07/30/12

Signature: _____ Citizen of: US

☑ Additional inventors or a legal representative are being named on 1 of 2 additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.**

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Title of Invention	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☑ Application No. 13/526,261 filed on June 18, 2012

☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

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All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Marta Karczewicz Date: 07/30/12

Signature: [signature] Citizen of: US

Inventor two: _____ Date: _____

Signature: _____ Citizen of: _____

☑ Additional inventors or a legal representative are being named on 2 of 2 additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.

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.

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	13/526,261
Filing Date	06-18-2012
First Named Inventor	Yunfei Zheng
Art Unit	2626
Examiner Name	Unknown

Sheet	**1**	**of**	**2**	**Attorney Docket No:** 1010-939US01/120072

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2](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
	001	US7940844	05-10-2011	LAI et al.	
	002	US20060120455	06-08-2006	PARK et al.	
	003	US20060140275	06-29-2006	LEE et al.	
	004	US20080043843	02-21-2008	NAKAISHI	
	005	US20090129472	05-21-2009	PANUSOPONE et al.	
	006	US20110176615	07-21-2011	LEE et al.	
	007	US20120008676	01-12-2012	LEE et al.	
	008	US20120008688	01-12-2012	TSAI et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5](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	T[6]
	009	WO2011047994A1	04-28-2011	THOMSON LICENSING [FR]		☐

NON PATENT LITERATURE 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.	T2
	010	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, December 2010, 12 pp.	☐

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(Use as many sheets as necessary)

Sheet	**2**	**of**	**2**

Complete if Known

Application Number	13/526,261
Filing Date	06-18-2012
First Named Inventor	Yunfei Zheng
Art Unit	2626
Examiner Name	Unknown

Attorney Docket No: 1010-939US01/120072

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 April 2011 (28.04.2011)

PCT

(10) International Publication Number
WO 2011/047994 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/EP2010/065316

(22) International Filing Date:
13 October 2010 (13.10.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0957342 20 October 2009 (20.10.2009) FR

(71) Applicant *(for all designated States except US)*: **THOMSON LICENSING** [FR/FR]; 1-5 rue Jeanne d'Arc, F-92130 Issy-les-Moulineaux (FR).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **FRANCOIS, Edouard** [FR/FR]; 18 Allee du Locar, F-35890 Bourg des-Comptes (FR). **THOREAU, Dominique** [FR/FR]; 39 rue du Réage, F-35510 Cesson Sevigne (FR). **VIERON, Jérôme** [FR/FR]; 5 allee Jeanne Malivel, F-35000 Rennes (FR). **MARTIN, Aurélie** [FR/FR]; 5 rue Jeanne Malivel, F-35000 Rennes (FR).

(74) Agents: **LORETTE, Anne** et al.; 1-5 rue Jeanne d'Arc, F-92130 Issy-Les-Moulineaux (FR).

(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: MOTION VECTOR PREDICTION AND REFINEMENT

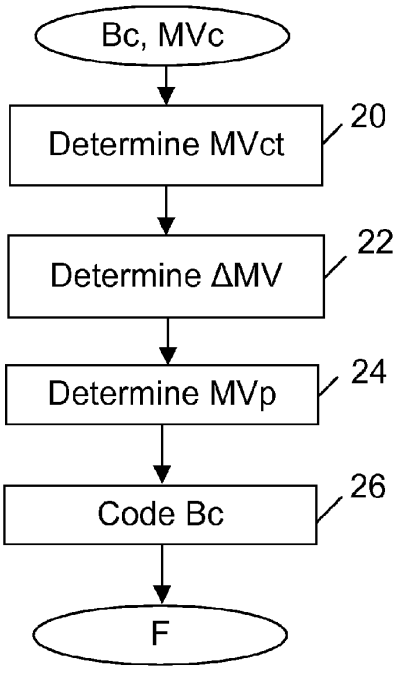


FIGURE 3

(57) Abstract: The invention relates to a method for coding a current block of a sequence of images comprising the following steps: - determining (20, 30) at least one candidate motion vector associated with a neighbouring block of said current block, - determining (24, 34) a prediction motion vector from the candidate motion vector, and - coding (26, 36) the current block from the prediction motion vector. Advantageously, the prediction motion vector is determined according to the following steps: - determining (22, 32), for the candidate motion vector, a corrective motion vector so as to minimise a distortion calculated between the neighbouring block successively coded and reconstructed and a prediction block motion compensated by the at least one candidate motion vector modified by the corrective motion vector, and - determining (24, 34) the prediction motion vector from the candidate motion vector modified by the corrective motion vector.

WO 2011/047994 A1

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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))*

MOTION VECTOR PREDICTION AND REFINEMENT

1. Scope of the invention

The invention relates to the general domain of image coding. More specifically, the invention relates to a method for coding a block of pixels of a sequence of images and a method for reconstructing such a block.

2. Prior art

It is known in the prior art to efficiently code a sequence of images to use a method for coding by temporal prediction or inter-image coding (mode INTER) as shown in **figure 1**. A current block Bc of an image Ic is coded by temporal prediction from a block Bp possibly interpolated from a previously coded and reconstructed reference image Iref, with which it is specifically correlated. The block of the reference image Bp is called the prediction block. It is identified using a motion vector MVc associated with the current block Bc. The motion vector MVc is determined by a method for motion estimation, for example by a block pairing method. According to the known methods for coding by temporal prediction, the motion vector MVc and the residual data are coded in a stream F for the current block Bc. The residual data are obtained by subtracting from the current block Bc, the prediction block Bp. Using this residual data, of the reconstructed reference image Iref and the motion vector MVc associated with the current block Bc, it is possible to reconstruct the current block Bc.

It is, moreover, known in the art to code the motion vector MVc associated with the current block Bc by prediction using motion vectors associated with blocks A, B and C adjacent to the current block Bc. In reference to **figure 2**, during a step 10, one or more candidate motion vectors MV_{ct} are determined from among the motion vectors associated with the adjacent blocks A, B and C. In general, three candidate motion vectors are used. Exceptions exist when one of the blocks A, B and/or C is outside the image or one of the blocks is not coded by temporal prediction (for example in INTRA mode). In fact, in the latter case no motion vector is associated with the block in question. During a step 12 a prediction motion vector MVp is

determined from candidate motion vectors MV_{ct}. It is known that the prediction motion vector MVp has as coordinates the abscissa median value of candidate motion vectors and the ordinate median value of candidate motion vectors. During a step 14, the current block Bc is coded taking into account the prediction motion vector MVp. It is known to code for the block Bc, residual data obtained by subtracting from the current block Bc, the prediction block Bp and a motion vector differential MVdiff. The motion vector differential MVdiff calculated from MVc and MVp is coded in the stream F. MVdiff has as coordinates (MVx-MVpx ; MVy-MVpy) where (MVx ; MVy) are the coordinates of Mvc and (MVy-MVpy) are the coordinates of MVp. The residual data are generally transformed then quantized. The residual data transformed then quantized and the motion vector differential MVdiff are coded by VLC (Variable Length Coding) type entropy coding into coded data.

The method for coding the motion vector MVc described in reference to figures 1 and 2 is not always efficient in terms of coding cost.

3. Summary of the invention

The purpose of the invention is to overcome at least one of the disadvantages of the prior art. For this purpose, the invention relates to a method for coding a current block of a sequence of images comprising the following steps:

- determining at least one candidate motion vector associated with a neighbouring block of the current block,
- determining a prediction motion vector from at least one candidate motion vector, and
- coding the current block from the prediction motion vector.

Advantageously, the prediction motion vector is determined according to the following steps:

- Determining, for the at least one candidate motion vector, a corrective motion vector so as to minimise a distortion calculated between the neighbouring block successively coded and reconstructed and a prediction block motion compensated by the at least one candidate motion vector modified by the corrective motion vector, and

- determining the prediction motion vector from at least the one candidate motion vector modified by the corrective motion vector.

According to a particular characteristic of the invention, the coding method comprises the determination of a motion vector differential calculated from the current motion vector associated with the current block Bc and the prediction motion vector and the step of coding of the current block comprises the coding of the motion vector differential.

According to a particular aspect of the invention, the amplitude of each of the coordinates of the corrective motion vector is limited by a first threshold value.

According to another aspect of the invention, the threshold value is less than a second threshold value representative of the coding precision of motion vectors.

According to a particular aspect of the invention, the first threshold value is equal to 1/8 and the second threshold value is equal to 1/4.

According to another particular aspect of the invention, the first threshold value is equal to 1/4 and the second threshold value is equal to 1/2.

According to another particular aspect of the invention, each of the coordinates of said corrective motion vector is determined in a defined interval around said candidate motion vector with a precision greater than the coding precision of the motion vectors.

According to a first embodiment of the invention, the step of determination of at least one candidate motion vector comprises the following steps of:

- determining at least two candidate motion vectors,
- merging the at least two candidate motion vectors into a merged motion vector, and
- selecting among the at least two candidate motion vectors, the motion vector closest to the merged motion vector.

According to a second embodiment of the invention, at least two candidate motion vectors being determined, the step of determination of a corrective motion vector comprises the determination of a corrective motion vector for each of the at least two candidate motion vectors and the step of

determination of the prediction motion vector comprises the merge of candidate motion vectors modified by their respective corrective motion vectors into a single prediction motion vector.

The invention relates in addition to a method for reconstructing a current block comprising the following steps for:

- determining at least one candidate motion vector associated with a neighbouring block of the current block,
- determining a prediction motion vector from at least one candidate motion vector, and
- reconstructing the current block from the prediction motion vector.

The prediction motion vector is determined according to the following steps for:

- determining a corrective motion vector so as to minimise a distortion calculated between the reconstructed neighbouring block and a prediction block motion compensated by the at least one candidate motion vector modified by the corrective motion vector, and
- determining the prediction motion vector from the candidate motion vector modified by the corrective motion vector.

According to a particular aspect of the invention, the reconstruction method also comprises steps of:

- decoding a motion vector differential for the current block,
- determining at least one current motion vector for the current block from the motion vector differential and the prediction motion vector, and
- reconstructing the current block from the current motion vector.

The methods for coding and reconstruction according to the invention advantageously enable the coding efficiency to be increased, i.e. to reduce the coding cost of a sequence of images at a constant quality or to increase the quality of the reconstructed sequence of images for a given coding cost.

4. List of figures

The invention will be better understood and illustrated by means of embodiments and advantageous implementations, by no means limiting, with reference to the figures in the appendix, wherein:

- figure 1 shows a coding method via temporal prediction according to the prior art,
- figure 2 shows a flowchart of a method for coding a current block according to the prior art,
- figure 3 shows a flowchart of a method for coding a current block according to a first embodiment of the invention,
- figure 4 illustrates a step of the coding method for a current block according to the first embodiment of the invention,
- figure 5 shows a flowchart of a method for coding a current block according to a variant of the first embodiment of the invention,
- figure 6 shows a flowchart of a method for coding a current block according to a second embodiment of the invention,
- figure 7 shows a flowchart of a method for reconstructing a current block according to a first embodiment of the invention,
- figure 8 shows a flowchart of a method for reconstructing a current block according to a variant of the first embodiment of the invention,
- figure 9 shows a flowchart of a method for reconstructing a current block according to a second embodiment of the invention,
- figure 10 shows a coding device according to the invention, and
- figure 11 shows a decoding device according to the invention.

5. Detailed description of the invention

An image sequence is a series of several pictures. Each image comprises pixels or image points, with each of which is associated at least one item of image data. An item of image data is for example an item of luminance data or an item of chrominance data.

The term "motion data" is to be understood in the widest sense. It comprises the motion vectors and possibly the reference image indexes enabling a reference image to be identified in the image sequence. It can also comprise an item of information indicating the interpolation type used to determine the

prediction block. In fact, in the case where the motion vector MVc associated with a block Bc does not have integer coordinates, the image data must be interpolated in the reference image Iref to determine the prediction block Bp. The motion data associated to a block are generally calculated by a motion estimation method, for example by block pairing. However, the invention is in no way limited by the method enable a motion vector to be associated with a block.

The term “residual data” signifies data obtained after extraction of other data. The extraction is generally a subtraction pixel by pixel of prediction data from source data. However, the extraction is more general and comprises notably a weighted subtraction. The term “residual data” is synonymous with the term “residue”. A residual block is a block of pixels with which residual data is associated.

The term "transformed residual data" signifies residual data to which a transform has been applied. A DCT (Discrete Cosine Transform) is an example of such a transform described in chapter 3.4.2.2 of the book by I.E. Richardson entitled “H.264 and MPEG-4 video compression“, published by J. Wiley & Sons in September 2003. The wavelet transforms described in chapter 3.4.2.3 of the book by I. E. Richardson and the Hadamard transform are other examples. Such transforms “transform" a block of image data, for example residual luminance and/or chrominance data, into a “block of transformed data" also called a “block of frequency data” or a “block of coefficients”.

The term “prediction data” signifies data used to predict other data. A prediction block is a block of pixels with which prediction data is associated.

A prediction block is obtained from a block or several blocks of the same image as the image to which belongs the block that it predicts (spatial prediction or intra-image prediction) or from one (mono-directional prediction) or several blocks (bi-directional prediction) of a different image (temporal prediction or inter-image prediction) of the image to which the block that it predicts belongs.

The term “reconstructed data” signifies data obtained after merging of residual data with prediction data. The merging is generally a sum pixel by pixel of prediction data to residual data. However, the merging is more general and

comprises notably the weighted sum. A reconstructed block is a block of pixels with which reconstructed data is associated.

In reference to figure 3, the invention relates to a method for coding a current block of a sequence of images.

During a step 20, a candidate motion vector MV_{ct} of coordinates (vx, vy) is determined from among motion vectors associated with spatially neighbouring blocks of the current block Bc. The block Bc belongs to the image Ic. For example, the candidate motion vector MV_{ct} is determined as being one of the motion vectors of blocks A, B and/or C adjacent to the current block Bc as shown in figure 1. According to a variant, the candidate motion vector MV_{ct} is determined as being the motion vector of a block spatially neighbouring the block Bc but not necessarily adjacent. The block neighbouring the current block Bc with which is associated the candidate motion vector MV_{ct} determined is noted as Bv. The motion vector retained by default is for example the motion vector associated with the neighbouring block situated to the left of the current block Bc. According to a variant, the motion vector retained by default is for example the motion vector associated with the neighbouring block situated above the current block Bc as shown in **figure 4**.

During a step 22, a corrective motion vector ΔMV of coordinates (dx, dy) is determined. The corrective motion vector ΔMV is determined in such a way as to minimise a distortion calculated between neighbouring block successively coded and reconstructed, noted as $B_v^{rec}(x,y)$, and a prediction block motion compensated by the candidate motion vector MV_{ct} modified by the corrective motion vector ΔMV. The prediction block belongs to a reference image I_{ref}. For example, the following function is used:

$$\begin{aligned} E(dx,dy) &= \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - MC_{MV_{ct}+\Delta MV}(x,y)\right)^2 \\ &= \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - I_{ref}^{rec}(x-vx-dx, y-vy-dy)\right)^2 \end{aligned}$$

where: - $MC_{MV_{ct}-\Delta MV}(.,.)$ is the prediction block motion compensated by MV_{ct} + ΔMV:

- $I_c^{rec}(x,y)$ is the value of the item of image data coded and reconstructed of the pixel (x,y) in the image Ic:
- I_{ref}^{rec}(x,y) is the value of the item of image data coded and reconstructed of the pixel (x,y) of the reference image.

According to a variant, $E(dx,dy)=\sum_{(x,y)\in B_y^{rec}}\left|I_c^{rec}(x,y)-MC_{MV_{ct}+\Delta MV}(x,y)\right|$. According to another variant, $E(dx,dy)=\max_{(x,y)\in B_y^{rec}}\left|I_c^{rec}(x,y)-MC_{MV_{ct}+\Delta MV}(x,y)\right|$.

During step 22, the motion vector ΔMV is thus sought that minimises E(.,.). For example, for each possible value (dx, dy) the value of E(dx, dy) is calculated and the values (dx, dy) are retained for which the value of E(dx, dy) is smallest.

According to a variant of step 22, the corrective motion vector ΔMV is that that minimises E(.,.) with an additional constraint that the amplitude of each of its coordinates dx and dy is less than a first threshold value a_{enh}, where a_{enh} is the precision authorised for the motion compensation. For example, if the motion vectors are coded then decoded with a precision of ¼ pixel then a_{enh}=1/8. This variant enables the complexity of the calculation for the determination of the corrective motion vector ΔMV to be limited. In fact, according to this variant ΔMV is only sought in a restricted interval around the candidate vector MV_{ct}, this interval being for each of the horizontal and vertical components defined as follows $[-a_{cod} + a_{enh}, a_{cod} - a_{enh}]$. In a version more exhaustive and thus more costly in calculation, the search can be done in a larger interval defined as follows [-R, R], R> a_{enh} representing the search range. A value of R=2.25 can for example be used. In this latter case, the coordinates of the corrective motion vector ΔMV are sought in the interval [-R, R] around the candidate vector MV_{ct} with a precision of a_{enh}.

During a step 24, a prediction motion vector MVp is determined from the candidate motion vector MV_{ct} modified by the corrective motion vector ΔMV. $MVp= MV_{ct} + \Delta MV$.

During a step 26, the current block Bc is coded taking into account the prediction motion vector MVp. It is known to code for the block Bc, residual data obtained by subtracting from the current block Bc, the prediction block Bp and a motion vector differential MVdiff. The motion vector differential MVdiff

calculated from MVc and MVp is coded in the stream F. MVdiff has as coordinates (MVx-MVpx ; MVy-MVpy) where (MVx ; MVy) are the coordinates of Mvc and (MVpx ; MVpy) are the coordinates of MVp. The residual data are generally transformed then quantized. The residual data transformed then quantized and the motion vector differential MVdiff are coded by VLC (Variable Length Coding) type entropy coding or CABAC (Context-Adaptive Binary Arithmetic Coding) type coding into coded data. The maximum coding precision authorized for MVdiff is a_{cod}. Examples of entropy coding methods are described in chapter 6.5.4 of the book by I.E. Richardson or in section 9.3 of the document ISO/IEC 14496-10 entitled "Information technology - Coding of audio-visual objects – Part 10: Advanced Video Coding". According to another variant, a CAVLC (Context-based Adaptive Variable Length Coding) type method can be used like that described in section 9.2 of the ISO/IEC 14496-10 document entitled "Information technology - Coding of audio-visual objects – Part 10: Advanced Video Coding" as well as in chapter 6.4.13.2 of the book by I. E. Richardson.

According to a variant, the current block Bc is coded according to the SKIP coding mode. In this case, no residual data and no motion data is coded in the stream F for the current block Bc. In fact, the "skip" coding mode is retained to code the current block Bc when the residual block obtained by extracting from the current block the prediction block determined from the prediction motion MVp determined in step 24 has all its coefficients null.

According to a variant of the first embodiment shown in **figure 5**, the step 20 of determination of a candidate motion vector MV_{ct} comprises a step 200 of determination of at least two candidate motion vectors, a step 202 of merging of candidate motion vectors determined in step 200 into a merged motion vector and a step 204 of selection of the candidate motion vector MV_{ct} from among the motion vectors determined in step 200 according to the merged motion vector. Steps identical to those of figure 3 are identified in figure 5 using the same numerical references and are not further described.

During step 200, at least two candidate motion vectors MV_{ct1} and MV_{ct2} are determined from among the motion vectors associated with blocks spatially neighbouring the current block Bc. For example, the candidate motion vectors

MV_{ct} and MV_{ct2} are determined as being motion vectors of blocks A, B and/or C adjacent to the current block Bc as shown in figure 1. According to a variant, the candidate motion vectors MV_{ct} and MV_{ct2} are determined as being motion vectors of blocks spatially neighbouring the block Bc but not necessarily adjacent. The neighbouring block of the current block Bc with which is associated the candidate motion vector MV_{ct1} is noted as Bv1 and the current block Bc with which is associated the candidate motion vector MV_{ct2} is noted as Bv2. The candidate motion vector MV_{ct1} has as coordinates (vx1, vy1) and the candidate motion vector MV_{ct2} has as coordinates (vx2, vy2).

During a step 202, the candidate motion vectors determined in step 200 are merged into a single motion vector MV_{fus} of coordinates ($MV_{fus}(x)$, $MV_{fus}(y)$). For example, $MV_{fus}(x)$=median(vx1, vx2, 0) and $MV_{fus}(y)$=median (vy1, vy2,0). According to a variant, $MV_{fus}(x)$ =0.5*(vx1+ vx2) and $MV_{fus}(y)$=0.5*(vy1+ vy2).

During a step 204, the candidate motion vector determined in step 200 closest to MV_{fus} in the sense of a certain standard is selected to be the candidate motion vector MV_{ct}. For example, MV_{ct} =MV_{ct2} if $||MV_{ct2}-MV_{fus}||<||MV_{ct1}-MV_{fus}||$ and MV_{ct} =MV_{ct1} otherwise. The standard is, for example, the standard L2. The standard can also be the absolute value.

This variant described with two candidate motion vectors MV_{ct1} and MV_{ct2} can be applied in the same way to any number of candidate motion vectors.

A second embodiment is shown in **figure 6**.

During a step 30, at least two candidate motion vectors MV_{ct1} and MV_{ct2} are determined from among the motion vectors associated with blocks spatially neighbouring the current block Bc. For example, the candidate motion vectors MV_{ct} and MV_{ct2} are determined as being motion vectors of blocks A, B and/or C adjacent to the current block Bc as shown in figure 1. According to a variant, the candidate motion vectors MV_{ct} and MV_{ct2} are determined as being motion vectors of blocks spatially neighbouring the block Bc but not necessarily adjacent. The neighbouring block of the current block Bc with which is associated the candidate motion vector MV_{ct1} is noted as Bv1 and the current block Bc with which is associated the candidate motion vector MV_{ct2} is noted as Bv2.

During a step 32, a corrective motion vector ΔMV1 of coordinates (dx1, dy1) is determined for the candidate motion vector MV_{ct1} and a corrective motion vector ΔMV2 of coordinates (dx2, dy2) is determined for the candidate motion vector MV_{ct2}. The motion vector ΔMV1 is determined so as to minimise a distortion calculated between the neighbouring block with which is associated the candidate motion vector MV_{ct1} successively coded and reconstructed and a prediction block motion compensated by the candidate motion vector MV_{ct1} modified by the corrective motion vector ΔMV1. Likewise, the motion vector ΔMV2 is determined so as to minimise a distortion calculated between the neighbouring block with which is associated the candidate motion vector MV_{ct2} successively coded and reconstructed and a prediction block motion compensated by the candidate motion vector MV_{ct2} modified by the corrective motion vector ΔMV2. For example, the following function is used:

$$\begin{aligned} E1(dx1, dy1) &= \sum_{(x,y)\in B_{v1}^{rec}} \left(I_c^{rec}(x,y) - MC_{MV_{ct1}+\Delta MV1}(x,y)\right)^2 \\ &= \sum_{(x,y)\in B_{v1}^{rec}} \left(I_c^{rec}(x,y) - I_{ref}^{rec}(x - vx1 - dx1, y - vy1 - dy1)\right)^2 \end{aligned}$$

$$\begin{aligned} E2(dx2, dy2) &= \sum_{(x,y)\in B_{v2}^{rec}} \left(I_c^{rec}(x,y) - MC_{MV_{ct2}+\Delta MV2}(x,y)\right)^2 \\ &= \sum_{(x,y)\in B_{v2}^{rec}} \left(I_c^{rec}(x,y) - I_{ref}^{rec}(x - vx2 - dx2, y - vy2 - dy2)\right)^2 \end{aligned}$$

According to a variant, $E1(dx, dy) = \sum_{(x,y)\in B_{v1}^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct1}+\Delta MV1}(x,y)\right|$ and $E2(dx, dy) = \sum_{(x,y)\in B_{v1}^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct2}+\Delta MV2}(x,y)\right|$. According to another variant, $E1(dx, dy) = \max_{(x,y)\in B_{v2}^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct1}+\Delta MV1}(x,y)\right|$ and $E2(dx, dy) = \max_{(x,y)\in B_{v2}^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct2}+\Delta MV2}(x,y)\right|$

During step 32, the corrective motion vector ΔMV1 is thus sought that minimises E1(.,.) and ΔMV2 that minimises E2(.,.). For example, for each possible value (dx1, dy1) the value of E1(dx1 dy1) is calculated and the values (dx1, dy1) are retained for which the value of E1(dx1, dy1) is smallest. Likewise, for each possible value (dx2, dy2) the value of E2(dx2, dy2) is calculated and the value (dx2n dy2) are retained for which the value of E2(dx2, dy2) is smallest.

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According to a variant of step 32, the corrective motion vectors ΔMV1 and ΔMV2 are those that minimise E1(.,.) respectively E2(.,.) under the additional constraint that the amplitudes of each or their coordinates dx1, dx2, dy1 and dy2 are less than a_{enh}, where a_{enh} is the precision authorised for the motion compensation. For example, if the motion vectors are coded then decoded with a precision of ¼ pixel then a_{enh}=1/8. This variant enables the complexity of the calculation for the determination of the corrective motion vectors ΔMV1 and ΔMV2 to be limited. In fact, according to this variant ΔMV1 and ΔMV2 are only sought in a restricted interval around the candidate vectors MV_{ct}, respectively MV_{ct2}, this interval being for each of the horizontal and vertical components defined as follows $[-a_{cod} + a_{enh}, a_{cod} - a_{enh}]$. In a version more exhaustive and thus more costly in calculation, the search can be done in a larger interval defined as follows [-R, R], R> a_{enh} representing the search range. A value of R=2 can for example be used. In this latter case, the coordinates of the corrective motion vectors are sought in the interval [-R, R] around the candidate vectors with a precision of a_{enh}.

During a step 34, a prediction motion vector MVp is determined by merging of candidate motion vectors MV_{ct1} and MV_{ct2} modified respectively by the corrective motion vectors ΔMV1 and ΔMV2. For example, MVpx=median (vx1+ dx1, vx2+ dx2, 0) and MVpy=median (vy1+ dy1, vy2+ dy2, 0). According to a variant, MVpx =min(vx1+ dx1, vx2+ dx2, 0) and MVpy=min (vy1+ dy1, vy2+ dy2, 0). According to another variant, MVpx =0.5*(vx1+ dx1+vx2+ dx2) and MVpy=0.5*(vy1+ dy1+ vy2+ dy2).

During a step 36, the current block Bc is coded taking into account the prediction motion vector MVp. It is known to code for the block Bc, residual data obtained by subtracting from the current block Bc, the prediction block Bp and a motion vector differential MVdiff. The motion vector differential MVdiff calculated from MVc and MVp is coded in the stream F. MVdiff has as coordinates (MVx-MVpx ; MVy-MVpy) where (MVx ; MVy) are the coordinates of Mvc and (MVpx ; MVpy) are the coordinates of MVp. The residual data are generally transformed then quantized. The residual data transformed then quantized and the motion vector differential MVdiff are coded by VLC (Variable Length Coding) type entropy coding or CABAC (Context-Adaptive Binary Arithmetic Coding) type coding into coded data. The maximum coding

precision authorized for MVdiff is a_{cod}. Examples of entropy coding methods are described in chapter 6.5.4 of the book by I.E. Richardson or in section 9.3 of the document ISO/IEC 14496-10 entitled "Information technology - Coding of audio-visual objects – Part 10: Advanced Video Coding". According to another variant, a CAVLC (Context-based Adaptive Variable Length Coding) type method can be used like that described in section 9.2 of the ISO/IEC 14496-10 document entitled "Information technology - Coding of audio-visual objects – Part 10: Advanced Video Coding" as well as in chapter 6.4.13.2 of the book by I. E. Richardson.

According to a variant, the current block Bc is coded according to the SKIP coding mode. In this case, no residual data and no motion data is coded in the stream F for the current block Bc. In fact, the "skip" coding mode is retained to code the current block Bc when the residual block obtained by extracting from the current block the prediction block determined from the prediction motion MVp determined in step 24 has all its coefficients null.

The embodiment is described in reference to figure 5 with two candidate motion vectors MV_{ct1} and MV_{ct2}, however it can be applied to any number of candidate motion vectors. In this case, during step 32, for each candidate motion vector a corrective motion vector is determined. During a step 34, a prediction motion vector MVp is determined from the candidate motion vectors modified by their respective corrective motion vectors.

In reference to **figure 7**, the invention also relates to a method for reconstructing a current block of a sequence of images.

During a step 52, a candidate motion vector MV_{ct} of coordinates (vx, vy) is determined from among motion vectors associated with spatially neighbouring blocks of the current block Bc. For example, the candidate motion vector MV_{ct} is determined as being one of the motion vectors of blocks A, B and/or C adjacent to the current block Bc as shown in figure 1. According to a variant, the candidate motion vector MV_{ct} is determined as being the motion vector of a block spatially neighbouring the block Bc but not necessarily adjacent. The block neighbouring the current block Bc with which is associated the candidate motion vector MV_{ct} determined is noted as Bv. The motion vector

retained by default is for example the motion vector associated with the neighbouring block situated to the left of the current block Bc. According to a variant, the motion vector retained by default is for example the motion vector associated with the neighbouring block situated above the current block Bc as shown in **figure 4**. Step 52 is identical to step 20 of the coding method.

During a step 54, a corrective motion vector ΔMV of coordinates (dx, dy) is determined. The corrective motion vector ΔMV is determined in such a way as to minimise a distortion calculated between neighbouring block successively coded and reconstructed, noted as $B_v^{rec}(x,y)$, and a prediction block motion compensated by the candidate motion vector MV_{ct} modified by the corrective motion vector ΔMV. The prediction block belongs to a reference image I_{ref}. For example, the following function is used:

$$\begin{aligned} E(dx,dy) &= \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - MC_{MV_{ct}+\Delta MV}(x,y)\right)^2 \\ &= \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - I_{ref}^{rec}(x-vx-dx, y-vy-dy)\right)^2 \end{aligned}$$

where: - $MC_{MV_{ct}-\Delta MV}(.,.)$ is the prediction block motion compensated by MV_{ct} + ΔMV:

- $I_c^{rec}(x,y)$ is the value of the item of image data coded and reconstructed of the pixel (x,y) in the image Ic:
- I_{ref}^{rec}(x,y) is the value of the item of image data coded and reconstructed of the pixel (x,y) of the reference image.

According to a variant, $E(dx,dy) = \sum_{(x,y)\in B_v^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct}+\Delta MV}(x,y)\right|$. According to another variant, $E(dx,dy) = \max_{(x,y)\in B_v^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct}+\Delta MV}(x,y)\right|$.

During step 54, the motion vector ΔMV is thus sought that minimises E(.,.). For example, for each possible value (dx, dy) the value of E(dx, dy) is calculated and the values (dx, dy) are retained for which the value of E(dx, dy) is smallest. Step 54 is identical to step 22 of the coding method.

According to a variant of step 54, the corrective motion vector ΔMV is that that minimises E(.,.) with an additional constraint that the amplitude of each of its coordinates dx and dy is less than a first threshold value a_{enh}, where a_{enh} is the precision authorised for the motion compensation. For example, if the

motion vectors are coded then decoded with a precision of ¼ pixel then a_{enh}=1/8. This variant enables the complexity of the calculation for the determination of the corrective motion vector ΔMV to be limited. In fact, according to this variant the vector ΔMV is only sought in a restricted interval around the candidate motion vector MV_{ct}, this interval being for each of the horizontal and vertical components defined as follows [$-a_{cod} + a_{enh}$, $a_{cod} - a_{enh}$]. In a version more exhaustive and thus more costly in calculation, the search can be done in a larger interval defined as follows [-R, R], R> a_{enh} representing the search range. A value of R=2 can for example be used. In this latter case, the coordinates of the corrective motion vector ΔMV are sought in the interval [-R, R] around the candidate vector MV_{ct} with a precision of a_{enh}.

During a step 56, a prediction motion vector MVp is determined from the candidate motion vector MV_{ct} modified by the corrective motion vector ΔMV. MVp= MV_{ct} + ΔMV. Step 56 is identical to step 24 of the coding method.

During a step 58, the current block Bc is reconstructed taking into account the prediction motion vector MVp. More specifically, the residual data transformed/quantized and a motion vector differential MVdiff are decoded from the stream F by VLC (Variable Length Coding) type entropy coding or CABAC (Context-Adaptive Binary Arithmetic Coding) type coding. The transformed/quantized residual data are dequantized then transformed by an inverse transform to that used in step 26 of the coding method. A motion vector MVc is reconstructed for the current block Bc from the motion vector differential MVdiff and the prediction motion vector MVp determined in step 56. MVc has as coordinates (MVdiffx+MVpx ; MVdiffx+MVpy) where (MVdiffx ; MVdiffy) are the coordinates of MVdiff and (MVpx ; MVpy) are the coordinates of MVp. A prediction block is determined in the reference image reconstructed from the motion vector MVc, it relates to a prediction block motion compensated by the motion vector MVc. The prediction block is then merged, for example added pixel by pixel, to the block of residual data reconstructed for the current block from the stream F.

According to a variant, the current block Bc is reconstructed according to the SKIP coding mode. In this case, no residual data and no motion data is coded in the stream F for the current block Bc. In this case, the block Bc

reconstructed is the prediction block motion compensated by the prediction motion vector MVp determined in step 56.

According to a variant shown in **figure 8**, the step 52 of determination of a candidate motion vector MV_{ct} comprises a step 520 of determination of at least two candidate motion vectors, a step 522 of merging of candidate motion vectors determined in step 520 into a merged motion vector and a step 524 of selection of the candidate motion vector MV_{ct} from among the motion vectors determined in step 520 according to the merged motion vector. Step 520 is identical to step 200 of figure 5, step 522 is identical to step 202 of figure 5 and step 524 is identical to step 204 of figure 5.

Another embodiment is shown in **figure 9**.

During a step 62, at least two candidate motion vectors MV_{ct1} and MV_{ct2} are determined from among the motion vectors associated with blocks spatially neighbouring the current block Bc. For example, the candidate motion vectors MV_{ct} and MV_{ct2} are determined as being motion vectors of blocks A, B and/or C adjacent to the current block Bc as shown in figure 1. According to a variant, the candidate motion vectors MV_{ct} and MV_{ct2} are determined as being motion vectors of blocks spatially neighbouring the block Bc but not necessarily adjacent. The neighbouring block of the current block Bc with which is associated the candidate motion vector MV_{ct1} is noted as Bv1 and the current block Bc with which is associated the candidate motion vector MV_{ct2} is noted as Bv2. This step 62 is identical to step 30 of figure 6.

During a step 64, a corrective motion vector ΔMV1 of coordinates (dx1, dy1) is determined for the candidate motion vector MV_{ct1} and a corrective motion vector ΔMV2 of coordinates (dx2, dy2) is determined for the candidate motion vector MV_{ct2}. The motion vector ΔMV1 is determined so as to minimise a distortion calculated between the neighbouring block with which is associated the candidate motion vector MV_{ct1} successively coded and reconstructed and a prediction block motion compensated by the candidate motion vector MV_{ct1} modified by the corrective motion vector ΔMV1. Likewise, the motion vector ΔMV2 is determined so as to minimise a distortion calculated between the neighbouring block with which is associated the candidate motion vector MV_{ct2}

successively coded and reconstructed and a prediction block motion compensated by the candidate motion vector MV_{ct2} modified by the corrective motion vector ΔMV2. For example, the following function is used:

$$E1(dx1,dy1) = \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - MC_{MV_{ct1}+\Delta MV1}(x,y)\right)^2$$
$$= \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - I_{ref}^{rec}(x-vx1-dx1, y-vy1-dy1)\right)^2$$

$$E2(dx2,dy2) = \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - MC_{MV_{ct2}+\Delta MV2}(x,y)\right)^2$$
$$= \sum_{(x,y)\in B_v^{rec}} \left(I_c^{rec}(x,y) - I_{ref}^{rec}(x-vx2-dx2, y-vy2-dy2)\right)^2$$

According to a variant, $E1(dx,dy) = \sum_{(x,y)\in B_v^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct1}+\Delta MV1}(x,y)\right|$ and $E2(dx,dy) = \sum_{(x,y)\in B_v^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct2}+\Delta MV2}(x,y)\right|$. According to another variant, $E1(dx,dy) = \max_{(x,y)\in B_{v2}^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct1}+\Delta MV1}(x,y)\right|$ and $E2(dx,dy) = \max_{(x,y)\in B_{v2}^{rec}} \left|I_c^{rec}(x,y) - MC_{MV_{ct2}+\Delta MV2}(x,y)\right|$.

During step 64, the corrective motion vector ΔMV1 is thus sought that minimises E1(.,.) and ΔMV2 that minimises E2(.,.). For example, for each possible value (dx1, dy1) the value of E1(dx1 dy1) is calculated and the values (dx1, dy1) are retained for which the value of E1(dx1, dy1) is smallest. Likewise, for each possible value (dx2, dy2) the value of E2(dx2, dy2) is calculated and the value (dx2, dy2) are retained for which the value of E2(dx2, dy2) is smallest. This step 64 is identical to step 32 of figure 6.

According to a variant of step 64, the corrective motion vectors ΔMV1 and ΔMV2 are those that minimise E1(.,.) respectively E2(.,.) under the additional constraint that the amplitudes of each or their coordinates dx1, dx2, dy1 and dy2 are less than a_{enh}, where a_{enh} is the precision authorised for the motion compensation. For example, if the motion vectors are coded then decoded with a precision of ¼ pixel then a_{enh}=1/8. This variant enables the complexity of the calculation for the determination of the corrective motion vectors ΔMV1 and ΔMV2 to be limited. In fact, according to this variant ΔMV1 and ΔMV2 are only sought in a restricted interval around the candidate vectors MV_{ct}, respectively MV_{ct2}, this interval being for each of the horizontal and vertical

components defined as follows [-a_{cod} + a_{enh}, a_{cod} - a_{enh}]. In a version more exhaustive and thus more costly in calculation, the search can be done in a larger interval defined as follows [-R, R], R> a_{enh} representing the search range. A value of R=2 can for example be used. In this latter case, the coordinates of the corrective motion vector ΔMV are sought in the interval [-R, R] around the candidate vector MV_{ct} with a precision of a_{enh}.

During a step 66, a prediction motion vector MVp is determined by merging of candidate motion vectors MV_{ct1} and MV_{ct2} modified respectively by the corrective motion vectors ΔMV1 and ΔMV2. For example, MVpx=median (vx1+ dx1, vx2+ dx2, 0) and MVpy=median (vy1+ dy1, vy2+ dy2, 0). According to a variant, MVpx =min(vx1+ dx1, vx2+ dx2, 0) and MVpy=min (vy1+ dy1, vy2+ dy2, 0). According to another variant, MVpx =0.5*(vx1+ dx1+vx2+ dx2) and MVpy=0.5*(vy1+ dy1+ vy2+ dy2). This step 66 is identical to step 34 of figure 6.

During a step 68, the current block Bc is reconstructed taking into account the prediction motion vector MVp. More specifically, the residual data transformed/quantized and a motion vector differential MVdiff are decoded from the stream F by VLC (Variable Length Coding) type entropy coding or CABAC (Context-Adaptive Binary Arithmetic Coding) type coding. The transformed/quantized residual data are dequantized then transformed by an inverse transform to that used in step 26 of the coding method. A motion vector MVc is reconstructed for the current block Bc from the motion vector differential MVdiff and the prediction motion vector MVp determined in step 56. MVc has as coordinates (MVdiffx+MVpx ; MVdiffx+MVpy) where (MVdiffx ; MVdiffy) are the coordinates of MVdiff and (MVpx ; MVpy) are the coordinates of MVp. A prediction block is determined in the reference image reconstructed from the motion vector MVc, it relates to a prediction block motion compensated by the motion vector MVc. The prediction block is then merged, for example added pixel by pixel, to the block of residual data reconstructed for the current block from the stream F.

According to a variant, the current block Bc is reconstructed according to the SKIP coding mode. In this case, no residual data and no motion data is coded in the stream F for the current block Bc. In this case, the block Bc

reconstructed is the prediction block motion compensated by the prediction motion vector MVp determined in step 66.

The invention that is described in the case where a single motion vector is associated with a (mono-directional prediction) block is directly extended to the case where two or more motion vectors are associated with a block (e.g. bidirectional prediction). In this case, each motion vector is associated with a list of reference images. For example, in H.264, a bidirectional type block will use two lists L0 and L1, and a motion vector is defined for each list. In the bidirectional case, the steps 20 to 24 or 30 to 34 are applied independently for each list. During each step 20 (respectively 30), the candidate motion vector or vectors is/are determined from among the motion vectors of the same list as the current list and associated with blocks spatially neighbouring the current block Bc. The current block Bc is coded during step 26 (respectively 36) from motion vectors of each list from step 24 (respectively 34).

The methods for motion vector coding and reconstruction according to the invention have the advantage of improving the method for prediction of motion vectors using corrective motion vectors. They therefore have the advantage of improving the coding efficiency in terms of quality and/or coding cost. The method according to the invention notably enables the selection of the "skip" coding mode to be favoured. It enables, in addition, to reduce in the case of temporal prediction the coding cost of motion data or to improve the precision of motion vectors and thus the quality of the motion compensation at a constant cost. In fact, the prediction motion vector MVp has a precision a_{enh}, the coded vector differential MVdiff has a precision a_{cod}, and thus, the reconstructed vector MVc, resulting from the sum of the prediction motion vector and the coded vector differential, then has a precision a_{enh}. The methods for coding and reconstruction according to the invention thus enable motion vectors to be coded according to a certain precision a_{cod}, then carry out a motion compensation with motion vectors of greater precision equal to a_{enh}.

The invention also relates to a coding device 12 described in reference to figure 10 and a decoding device 13 described in reference to figure 11. In figures 10 and 11, the modules shown are functional units, that may correspond or not to physically distinguishable units. For example, these modules or some of them can be grouped together in a single component, or constitute functions of the same software. Conversely, some modules may be composed of separate physical entities.

In reference to **figure 10**, the coding device 12 receives at input images belonging to a sequence of images. Each image is divided into blocks of pixels each of which is associated with at least one item of image data. The coding device 12 notably implements a coding with temporal prediction. Only the modules of the coding device 12 relating to the coding by temporal prediction or INTER coding are shown in figure 12. Other modules not shown and known by those skilled in the art of video coders implement the INTRA coding with or without spatial prediction. The coding device 12 notably comprises a calculation module 1200 able to extract, for example by subtraction pixel by pixel, from a current block Bc a prediction block Bp to generate a block of residual image data or residual block Bres. It further comprises a module 1202 able to transform then quantize the residual block Bres into quantized data. The transform T is for example a discrete cosine transform (or DCT). The coding device 12 further comprises an entropy coding module 1204 able to code the quantized data into a stream F of coded data. It further comprises a module 1206 performing the inverse operation of the module 1202. The module 1206 performs an inverse quantization Q^{-1} followed by an inverse transformation T^{-1}. The module 1206 is connected to a calculation module 1208 capable of merging, for example by addition pixel by pixel, the block of data from the module 1206 and the prediction block Bp to generate a block of reconstructed image data that is stored in a memory 1210. The coding device 12 further comprises a motion estimation module 1212 capable of estimating at least one motion vector MVc between the block Bc and a block of a reference image Iref stored in the memory 1210, this image having previously been coded then reconstructed. According to a variant, the motion estimation can be carried out between the current block Bc and the original reference image Ic in which case the memory 1210 is not connected

to the motion estimation module 1212. According to a method well known to those skilled in the art, the motion estimation module searches the reference image Iref for an item of motion data, notably a motion vector in such a manner as to minimize an error calculated between the current block Bc and a block in the reference image Iref identified by means of the item of motion data.

The motion data determined are transmitted by the motion estimation module 1212 to a decision module 1214 able to select a coding mode for the block Bc in a predefined set of coding modes. The coding mode retained is for example that which minimizes a bitrate-distortion type criterion. However, the invention is not restricted to this selection method and the mode retained can be selected according to another criterion for example an a priori type criterion. The coding mode selected by the decision module 1214 as well as the motion data, for example the item or items of motion data in the case of the temporal prediction mode or INTER mode are transmitted to a prediction module 1216. The prediction module 1216 is able to implement the steps 20 to 24 or 30 to 34 of the coding method. The steps 26 and 36 are implemented via the set of modules of the coding device 12. The coding mode selected and in the contrary case the item or items of motion data are in addition transmitted to the entropy coding module 1204 to be coded in the stream F. The prediction module 1216 determines the prediction block Bp from the coding mode determined by the decision module 1214 and possibly from motion data determined by the motion estimation module 1212 (inter-images prediction).

In reference to **figure 11**, the decoding module 13 receives at input a stream F of coded data representative of a sequence of images. The stream F is for example transmitted by a coding device 12 via a channel. The decoding device 13 comprises an entropy decoding module 1300 able to generate decoded data, for example coding modes and decoded data relating to the content of the images.

The decoding device 13 also comprises a motion data reconstruction module. According to a first embodiment, the motion data reconstruction module is the entropy decoding module 1300 that decodes a part of the stream F representative of said motion data. According to a variant not shown in figure

13, the motion data reconstruction module is a motion estimation module. This solution for reconstructing motion data via the decoding device 13 is known as "template matching".

The decoded data relating to the content of the images is then transmitted to a module 1302 able to carry out an inverse quantization followed by an inverse transform. The module 1303 is identical to the module 1206 of the coding device 12 having generated the coded stream F. The module 1302 is connected to a calculation module 1304 able to merge, for example by addition pixel by pixel, the block from the module 1302 and a prediction module Bp to generate a reconstructed current block Bc that is stored in a memory 1306. The decoding device 13 also comprises a prediction module 1308. The prediction module 1308 determines the prediction block Bp from the coding mode decoded for the current block by the entropy decoding module 1300 and possibly from motion data determined by the motion data reconstruction module. The prediction module 1308 is able to implement steps 52 to 56 or 62 to 66 of the decoding method according to the invention. The steps 58 and 68 are implemented by the set of modules of the decoding device 12.

Naturally, the invention is not limited to the embodiment examples mentioned above.

In particular, those skilled in the art may apply any variant to the stated embodiments and combine them to benefit from their various advantages. Notably the invention is in no way limited by the candidate motion vector types that are not necessarily adjacent to the current block. In addition, the invention described in the in the case where a motion vector is associated with a (mono-directional prediction) block is directly extended to the case where two or more motion vectors are associated with a block (e.g. bidirectional prediction).

Claims

1. Method for coding a current block of a sequence of images comprising the following steps:

- determining (20, 30) at least one candidate motion vector associated with a neighbouring block of said current block,
- determining (24, 34) a prediction motion vector from said at least one candidate motion vector,
- coding (26, 36) said current block from said prediction motion vector

said method being characterized in that said prediction motion vector is determined according to the following steps:

- determining (22, 32), for said at least one candidate motion vector, a corrective motion vector (ΔMV) so as to minimise a distortion calculated between the neighbouring block successively coded and reconstructed and a prediction block motion compensated by said at least one candidate motion vector modified by said corrective motion vector (ΔMV), and
- determining (24, 34) said prediction motion vector from at least said one candidate motion vector modified by said corrective motion vector.

2. Method for coding according to claim 1, which comprises the determination (26, 36) of a motion vector differential calculated from a current motion vector associated with said current block Bc and said prediction motion vector and wherein the step of coding of said current block comprises the coding of said motion vector differential.

3. Method for coding according to claims 1 or 2, wherein during the step of determination of said corrective motion vector, the amplitude of each of the coordinates of said corrective motion vector (dx, dy) is limited by a first threshold value.

4. Method for coding according to claim 3, wherein said threshold value is less than a second threshold value representative of the coding precision of motion vectors.

5. Method for coding according to claim 4, wherein said first threshold value is equal to 1/8 and the second threshold value is equal to 1/4.

6. Method for coding according to claim 4, wherein said first threshold value is equal to 1/4 and the second threshold value is equal to 1/2.

7. Method for coding according to one of claims 1 or 2, wherein each of the coordinates (dx, dy) of said corrective motion vector is determined in a defined interval around said candidate motion vector with a precision greater than the coding precision of the motion vectors.

8. Method for coding according to one of claims 1 to 7, wherein the step of determination (20) of at least one candidate motion vector comprises the following steps of:
- determining (200) at least two candidate motion vectors,
- merging (202) said at least two candidate motion vectors into a merged motion vector, and
- selecting (204) among said at least two candidate motion vectors, the motion vector closest to said merged motion vector.

9. Method for coding according to one of claims 1 to 7, wherein at least two candidate motion vectors being determined (30), the step of determination (32) of a corrective motion vector comprises the determination of a corrective motion vector for each of said at least two candidate motion vectors and wherein said step of determination (34) of said prediction motion vector comprises the merge of said candidate motion vectors modified by their respective corrective motion vectors into a single prediction motion vector.

10. Method for reconstructing a current block comprising the following steps:

- determining (52) at least one candidate motion vector associated with a neighbouring block of said current block,
- determining (56) a prediction motion vector from said at least one candidate motion vector,
- reconstructing (58) said current block from said prediction motion vector,

said method being characterized in that said prediction motion vector is determined according to the following steps:

- determining (54) a corrective motion vector (dx, dy) so as to minimise a distortion calculated between the reconstructed neighbouring block and a prediction block motion compensated by said at least one candidate motion vector modified by said corrective motion vector (dx, dy), and
- determining (56) said prediction motion vector from said candidate motion vector modified by said corrective motion vector.

11. Method for reconstruction according to claim 10, which further comprises the steps of:

- decoding a motion vector differential for said current block,
- determining at least one current motion vector for said current block from said motion vector differential and said prediction motion vector,

said current block being reconstructed (58) from said current motion vector.

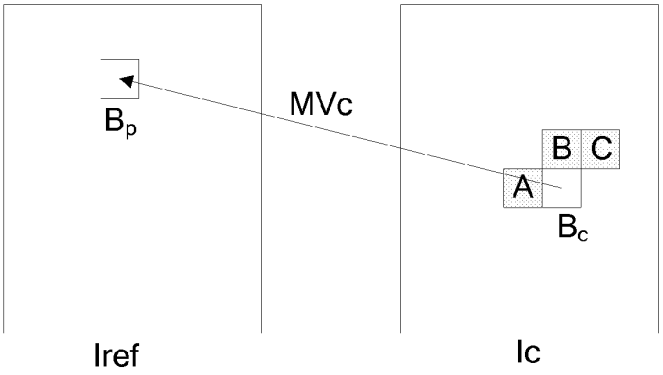


FIGURE 1 – PRIOR ART

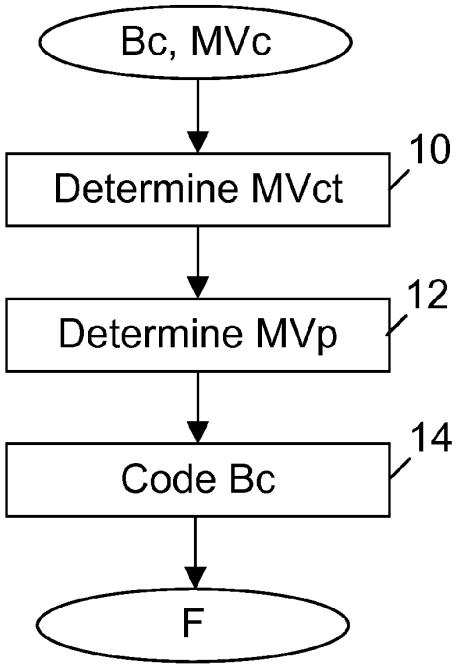


FIGURE 2 – PRIOR ART

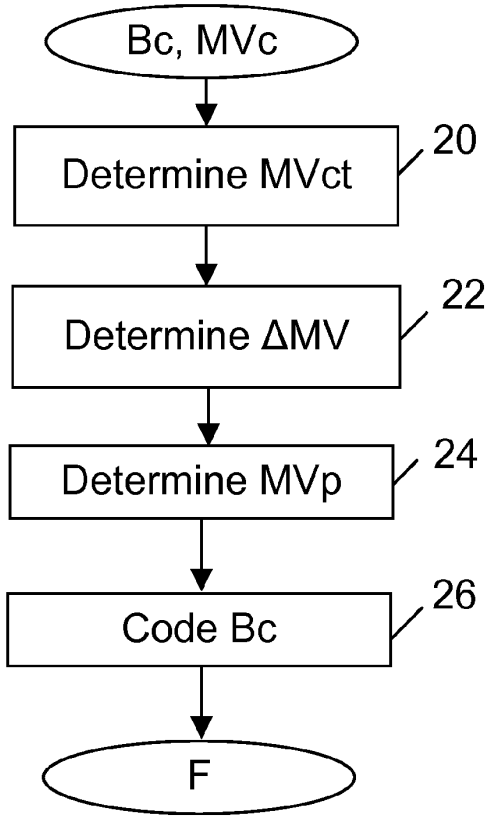


FIGURE 3

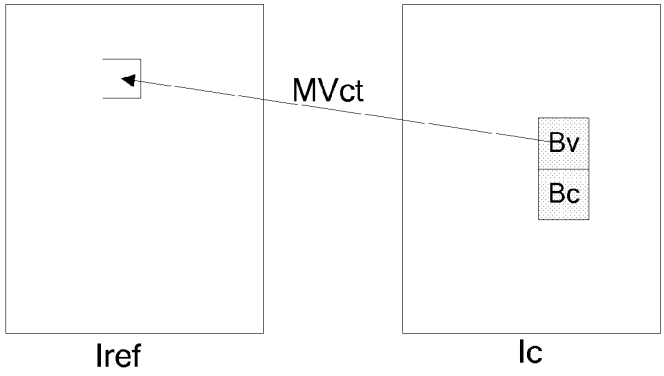


FIGURE 4

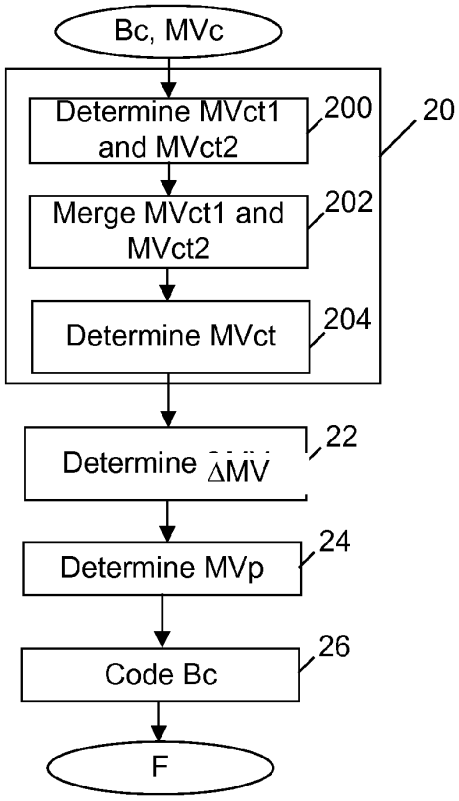

Bc, MVc
Determine MVct1 and MVct2
200
Merge MVct1 and MVct2
202
Determine MVct
204
20
Determine ΔMV
22
Determine MVp
24
Code Bc
26
F

FIGURE 5

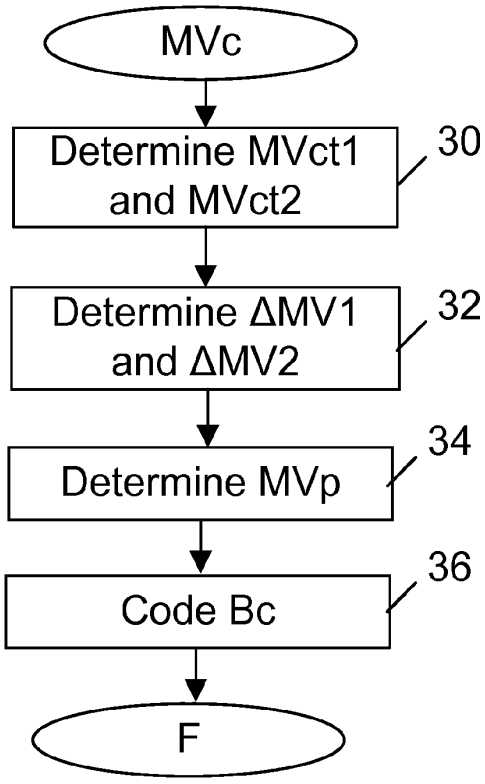

MVc
Determine MVct1 and MVct2
30
Determine ΔMV1 and ΔMV2
32
Determine MVp
34
Code Bc
36
F

FIGURE 6

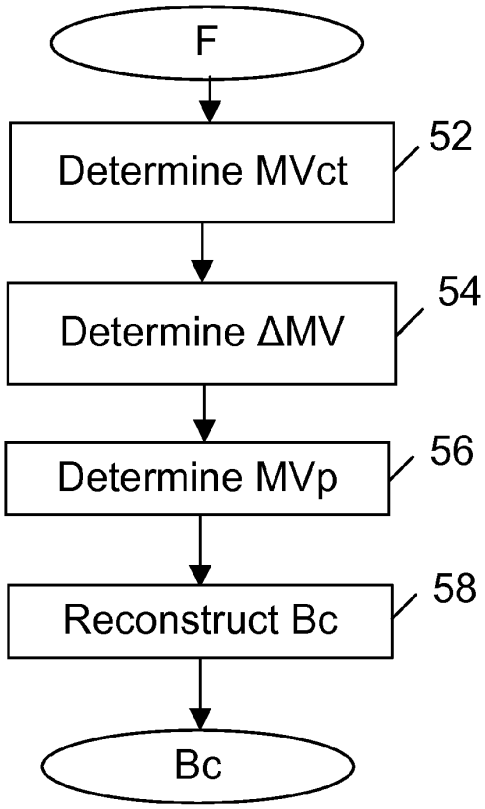

F
Determine MVct
52
Determine ΔMV
54
Determine MVp
56
Reconstruct Bc
58
Bc

FIGURE 7

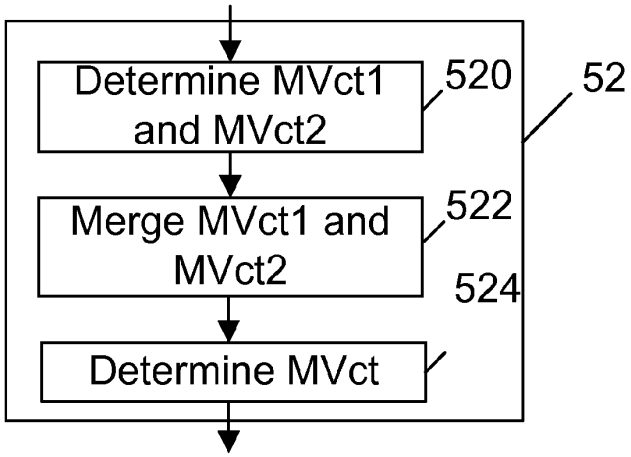


FIGURE 8

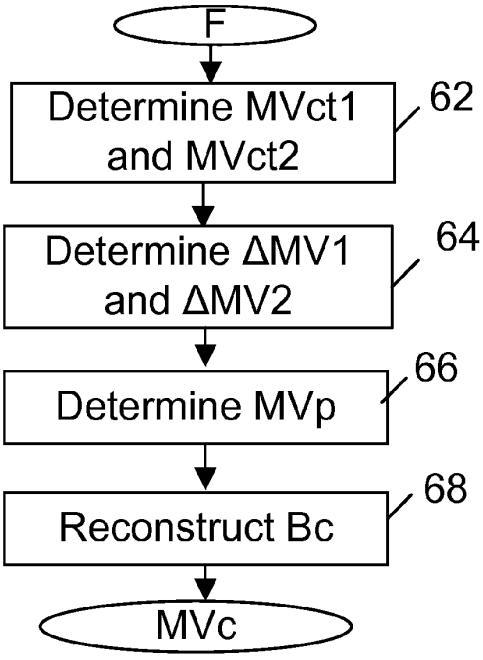


FIGURE 9

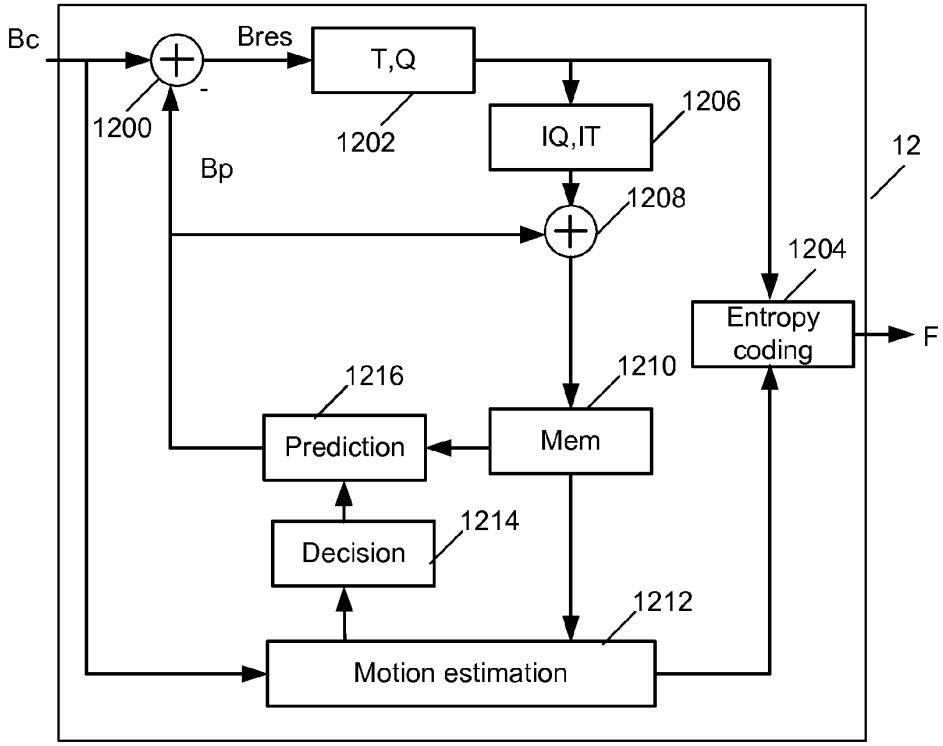


FIGURE 10

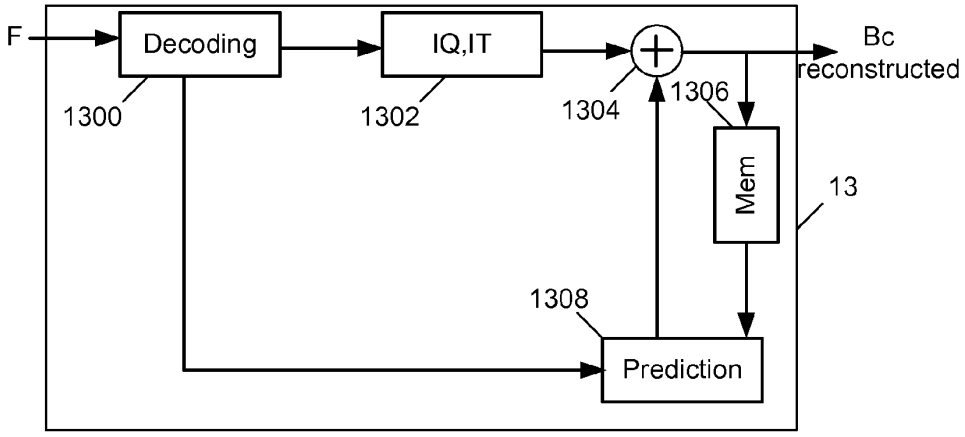


FIGURE 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/065316

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, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/253457 A1 (MOORE DARNELL J [US]) 16 October 2008 (2008-10-16)	1-6,8-11
A	* abstract paragraph [0030]; figure 3 paragraph [0037] - paragraph [0059]; figures 5,7	7
	----- -/--	

[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
11 January 2011	18/01/2011

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	Colesanti, Carlo

Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/065316

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LIBO YANG ET AL: "Prediction-Based Directional Fractional Pixel Motion Estimation for H.264 Video Coding", 2005 IEEE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING (IEEE CAT. NO.05CH37625) IEEE PISCATAWAY, NJ, USA, IEEE, PISCATAWAY, NJ LNKD-DOI:10.1109/ICASSP.2005.1415551, vol. 2, 18 March 2005 (2005-03-18), pages 901-904, XP010790786, ISBN: 978-0-7803-8874-1 the whole document	1-6,10, 11
X	ZHIBO CHEN ET AL: "Fast integer pel and fractional pel motion estimation", ITU STUDY GROUP 16 - VIDEO CODING EXPERTS GROUP -ISO/IEC MPEG & ITU-T VCEG(ISO/IEC JTC1/SC29/WG11 AND ITU-T SG16 Q6), XX, XX, no. M9117, 30 November 2002 (2002-11-30), XP030038051, Section 1 Section 3 (avec sous-sections)	1-6,10, 11
A	EP 2 101 504 A2 (LG ELECTRONICS INC [KR]) 16 September 2009 (2009-09-16) paragraph [0059] - paragraph [0091]; figures 4-8	1-11
A	JOEL JUNG ET AL: "Competition-Based Scheme for Motion Vector Selection and Coding", ITU STUDY GROUP 16 - VIDEO CODING EXPERTS GROUP -ISO/IEC MPEG & ITU-T VCEG(ISO/IEC JTC1/SC29/WG11 AND ITU-T SG16 Q6), XX, XX, no. VCEG-AC06r1, 2 August 2006 (2006-08-02), XP030003490, the whole document	1-11
A	YAO NIE ET AL: "Adaptive Rood Pattern Search for Fast Block-Matching Motion Estimation", IEEE TRANSACTIONS ON IMAGE PROCESSING, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 11, no. 12, 1 December 2002 (2002-12-01), XP011074339, ISSN: 1057-7149 Section I. Introduction	1-11

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2010/065316

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008253457 A1	16-10-2008	NONE	
EP 2101504 A2	16-09-2009	WO 2009113787 A2	17-09-2009
		US 2009232215 A1	17-09-2009

Form PCT/ISA/210 (patent family annex) (April 2005)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1062, Page 000128

Electronic Acknowledgement Receipt

EFS ID:	13777749
Application Number:	13526261
International Application Number:	
Confirmation Number:	8560
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Customer Number:	15150
Filer:	Matthew J. Evans/Kayla Tahti
Filer Authorized By:	Matthew J. Evans
Attorney Docket Number:	1010-939US01/120072
Receipt Date:	18-SEP-2012
Filing Date:	18-JUN-2012
Time Stamp:	16:57:37
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	Information Disclosure Statement (IDS) Form (SB08)	120072_IDS.pdf	123571 b3d10ad37cb895a26c90e75f792d320f1e888a38	no	2

Warnings:	
Information:	

This is not an USPTO supplied IDS fillable form					
2	Non Patent Literature	HAN.pdf	4868941 b6c4e89f0e061a089f1c4a2c447f99361504841e	no	12
Warnings:					
Information:					
3	Foreign Reference	WO2011047994.pdf	3873743 6c478fdbe222a9c917148359877d62946defa2de	no	37
Warnings:					
Information:					
			Total Files Size (in bytes):	8866255	

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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.

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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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
13/526,261	06/18/2012	2626	0.00	1010-939US01/120072	40	4

CONFIRMATION NO. 8560

15150
Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

FILING RECEIPT

OC000000055078397

Date Mailed: 06/29/2012

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**

Applicant(s)

Yunfei Zheng, Cupertino, CA;
Xianglin Wang, San Diego, CA;
Marta Karczewicz, San Diego, CA;

Assignment For Published Patent Application

QUALCOMM INCORPORATED, San Diego, CA

Power of Attorney: ~~None~~ The patent practitioners associated with Customer Number 15150

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/499,112 06/20/2011
and claims benefit of 61/543,043 10/04/2011
and claims benefit of 61/543,059 10/04/2011
and claims benefit of 61/556,761 11/07/2011
and claims benefit of 61/562,387 11/21/2011
and claims benefit of 61/562,953 11/22/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 06/27/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/526,261**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1062, Page 000131

Title

PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

Preliminary Class

704

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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.

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Yunfei Zheng	Confirmation No.	8560
Serial No.:	13/526,261		
Filed:	18 June 2012	Customer No.:	15150
Examiner:	Unknown		
Group Art Unit:	2626		
Docket No.:	1010-939US01/120072		
Title:	**PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING**		

CERTIFICATE UNDER 37 CFR 1.8 I hereby certify that this correspondence is being transmitted via the United States Patent and Trademark Office electronic filing system on 10 December 2012.

By: /Susan J. Daly/
Name: Susan J. Daly

REQUEST FOR NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY AND AN UPDATED FILING RECEIPT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Please issue a "Notice of Acceptance of Power of Attorney" for the above-referenced application. A Statement under 37 CFR 3.73(b) and a Power of Attorney were filed on August 14, 2012, and Applicant has not yet received the Notice of Acceptance.

Please also issue an updated filing receipt to reflect that the Power of Attorney for Serial No. 13/526,261 is associated with Customer Number 15150. Attached is a copy of the filing receipt showing the requested update.

Issuance of both an updated filing receipt and a Notice of Acceptance of Power of Attorney is respectfully solicited.

Date: __December 10, 2012_____
By: __/Matthew J. Evans/_____
Name: Matthew J. Evans, Reg No. 56,530

SHUMAKER & SIEFFERT, P.A.
1625 Radio Drive, Suite 300
Woodbury, Minnesota 55125
Telephone: 651.286.8036
Facsimile: 651.735.1102

Electronic Acknowledgement Receipt

EFS ID:	14428459
Application Number:	13526261
International Application Number:	
Confirmation Number:	8560
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Customer Number:	15150
Filer:	Matthew J. Evans
Filer Authorized By:	
Attorney Docket Number:	1010-939US01/120072
Receipt Date:	10-DEC-2012
Filing Date:	18-JUN-2012
Time Stamp:	17:18:39
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	Miscellaneous Incoming Letter	Updated_Filing_Receipt.pdf	189832 3ca4326205892182 33bdbe0f1c1358913e156147	no	3
Warnings:					
Information:					

2	Miscellaneous Incoming Letter	Request_UpdatedFilingReceipt.pdf	61265 53d813c1a4dfdb2925b82992abd20d7eb58ad448	no	1
Warnings:					
Information:					
			Total Files Size (in bytes):	251097	

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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.

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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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
13/526,261	06/18/2012	2626	2830	1010-939US01/120072	40	4

CONFIRMATION NO. 8560

15150
Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

UPDATED FILING RECEIPT

OC000000058121610

Date Mailed: 12/17/2012

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)

Yunfei Zheng, Cupertino, CA;
Xianglin Wang, San Diego, CA;
Marta Karczewicz, San Diego, CA;

Applicant(s)

Yunfei Zheng, Cupertino, CA;
Xianglin Wang, San Diego, CA;
Marta Karczewicz, San Diego, CA;

Assignment For Published Patent Application

QUALCOMM INCORPORATED, San Diego, CA

Power of Attorney: The patent practitioners associated with Customer Number 15150

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/499,112 06/20/2011
and claims benefit of 61/543,043 10/04/2011
and claims benefit of 61/543,059 10/04/2011
and claims benefit of 61/556,761 11/07/2011
and claims benefit of 61/562,387 11/21/2011
and claims benefit of 61/562,953 11/22/2011

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.

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If Required, Foreign Filing License Granted: 06/27/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/526,261**

Projected Publication Date: 03/28/2013

Non-Publication Request: No

Early Publication Request: No
Title

PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

Preliminary Class

704

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 (1-866-999-4158).

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LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/526,261

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	390
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	40 minus 20 =	* 20			OR	x 62 =	1240
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 250 =	250
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).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2750

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	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 found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/526,261	06/18/2012	Yunfei Zheng	1010-939US01/120072

CONFIRMATION NO. 8560

15150
Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

POA ACCEPTANCE LETTER

OC000000058121487

Date Mailed: 12/17/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/14/2012.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/twoldeyes/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/526,261	06/18/2012	Yunfei Zheng	1010-939US01/120072

CONFIRMATION NO. 8560

15150
Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

PUBLICATION NOTICE



Title:PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

Publication No.US-2013-0077691-A1
Publication Date:03/28/2013

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13526261
	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

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	1	2012030193	WO	A2	2012-03-08	LG ELECTRONICS INC [KR], et al.	Abstract Only	☒
	2	2012059577	WO	A1	2012-05-10	FRAUNHOFER GES FORSCHUNG [DE], et al.		☐

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	First Named Inventor	ZHENG; Yunfei
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	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Zheng et al., "Simplification and improvement of additional merge candidate," JCT-VC MEETING; MPEG MEETING; 21-11-2011 - 30-11-2011; GENEVA, CH; (JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG.16 WP3 AND ISO/IEC JTC1/SC29/WG11); URL:http://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, no.JCTVC-G683, XP030110667, pp 1-8, 8 pp.	☐
	2	BROSS et al., "High efficiency video coding (HEVC) text specification draft 7," 9th Meeting: Geneva, CH, 27 April - 7 May 2012, JCTVC-I1003_d2, 290 pp.	☐
	3	BROSS et al., "High efficiency video coding (HEVC) text specification draft 8," 10th Meeting: Stockholm, SE, 11-20 July 2012, JCTVC-J1003_d7, 261 pp.	☐
	4	BROSS et al., "High efficiency video coding (HEVC) text specification draft 6," 8th Meeting: San Jose, CA, USA, 1-10 February, 2012, JCTVC-H1003, 259 pp.	☐
	5	BROSS et al., "WD4: Working Draft 4 of High-Efficiency Video Coding," 6th Meeting: JCTVC-F803_d2, Torino, IT, 14-22 July, 2011, 226 pp.	☐
	6	BROSS et al., "WD5: Working Draft 5 of High-Efficiency Video Coding," 7th Meeting: Geneva, CH, 12-30 November, 2011, JCTVC-G1103_d2, 214 pp.	☐
	7	INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY -PCT/US2012/043155, THE INTERNATIONAL BUREAU OF WIPO - GENEVA, SWITZERLAND, 2013-09-24 (1010-939WO01/120072WO), 11 pp.	☐
	8	INTERNATIONAL SEARCH REPORT AND WRITTEN OPINION - PCT/US2012/043155- ISA/EPO - 2012-09-27 (1010-939WO01/120072WO), 15 pp.	☐
	9	ITU-T H.264, Series H: Audiovisual and Multimedia Systems, Infrastructure of audiovisual services - Coding of moving video, Advanced video coding for generic audiovisual services, The International Telecommunication Union. June 2011, 674 pp.	☐
	10	KIM H Y. et al., "CU-based Merge Candidate List Construction," Document: JCTVC-G416, 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, Date Saved: 2011-11-09, XP030110400, pp 1-13	☐

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	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

	11	LIU et al., "Method and syntax for partial CU merge", MPEG MEETING; 5th Meeting, 16-23 March 2011, GENEVA, CH; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11), no. m19599, XP030048166, pp. 1-5	☐
	12	MATHEW et al., "Quad-Tree Motion Modeling With Leaf Merging," IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, Vol. 20, No. 10, October 2010, XP011318748, ISSN: 1051-8215, pp. 1331-1345, 15 pp.	☐
	13	MCCANN et al., "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description," 20110128, no. JCTVC-D502, 28 January 2011, XP002679641, Retrieved from the Internet: URL: http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11], 26 pp.	☐
	14	WIEGAND et al., "WD1: Working Draft 1 of High-Efficiency Video Coding," JCTVC-C403, 3rd Meeting: Guangzhou, CN, 7-15 October, 2010, 137 pp.	☐
	15	WIEGAND et al., "WD2: Working Draft 2 of High-Efficiency Video Coding," JCTVC-D503, 4th Meeting: Daegu, KR, 20-28 January 2011, 153 pp.	☐
	16	WIEGAND et al., "WD3: Working Draft 3 of High-Efficiency Video Coding," Document JCTVC-E603, 5th Meeting: Geneva, CH, 16-23 March 2011, 193 pp.	☐
	17	ZHENG et al., "CE9: Unified Merge and AMVP candidates selection (UNI03)", JCT-VC MEETING; MPEG MEETING; 14-7-2011 - 22-7-2011; Torino, IT; (Joint Collaborative Team on Video Coding of ITU-T SG.16 WP3 and ISO/IEC JTC1/SC29/WG11) URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/ no. JCTVC-F297, XP030009320, 12 pp.	☐
	18	ZHENG et al., "Simplified Merge candidate derivation," JCT-VC MEETING; MPEG MEETING; 21-30 November 2011; GENEVA, CH; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11; URL:http://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, No. JCTVC-G681, XP030110665, 5 pp.	☐
	19	ZHENG et al., "Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode," MPEG MEETING; 6th Meeting, TORINO, IT, 14-22 July 2011; (MOTION PICTURE EXPERT GROUP OR ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11), JCTVC-F302, no.m20723, date saved: 2011-07-07, XP030049286, 6 pp.	☐
	20	ZHENG et al., "Unified Motion Vector Predictor Selection for Merge and AMVP", MPEG Meeting; 5th Meeting, 16-23 March 2011; Geneva, CH; (Motion Picture Expert Group or ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11), no. m19932, JCTVC-E396, XP030048499, 5 pp.	☐
	21	BROSS et al., "High Efficiency Video Coding (HEVC) text specification draft 9," 11th Meeting: Shanghai, CN, 10-19 October 2012, JCTVC-K1003_v7, 290 pp.	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	2488
	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

	22	BROSS et al., "High Efficiency Video Coding (HEVC) text specification draft 10 (for FDIS & Last Call)," 12th Meeting: Geneva, CH, 14-23 January 2013, JCTVC-L1003_v34, 310 pp.	☐
	23	ITU-T H.265, Series H: Audiovisual and Multimedia Systems, Infrastructure of audiovisual services - Coding of moving video, Advanced video coding for generic audiovisual services, The International Telecommunication Union. April 2013, 317 pp.	☐
	24	Second Written Opinion from International Application number PCT/US2012/043155, dated June 6, 2013, 9 pp. (Atty docket no. 1010-939WO01/120072WO)	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew J. Evans/	Date (YYYY-MM-DD)	2014-09-04
Name/Print	Matthew J. Evans	Registration Number	56,530

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

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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.

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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.

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(PCT Rule 71.1)

Date of mailing *(day/month/year)*	24.09.2013
Applicant's or agent's file reference 1010-939WO01	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/043155	19.06.2012	20.06.2011

Applicant
Qualcomm Incorporated

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	Ipiñazar, Paula Tel. +49 89 2399-8131

Form PCT/IPEA/416 (January 2004)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 1010-939WO01	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/US2012/043155	International filing date *(day/month/year)* 19.06.2012	Priority date *(day/month/year)* 20.06.2011
International Patent Classification (IPC) or national classification and IPC INV. H04N7/26		
Applicant Qualcomm Incorporated		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 10 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 12 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3*bis* of Annex C of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☒	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☒	Box No. VI	Certain documents cited
☒	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
05.02.2013	24.09.2013
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	Authorized officer Kuhn, Peter Telephone No. +49 89 2399-7630

Form PCT/IPEA/409 (Cover Sheet) (July 2010)

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-34 as originally filed

Claims, Numbers

1-36 filed with telefax on 05-02-2013

Drawings, Sheets

1/10-10/10 as originally filed

☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

5. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 70.2 (e)).

6. ☐ Supplementary international search report(s) from Authority(ies) have been received and taken into account in drawing up this report (Rule 45bis.8(b) and (c)).

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Box No. II Priority

1. ☐ This report has been established as if no priority had been claimed due to the failure to furnish within the prescribed time limit the requested:
   ☐ copy of the earlier application whose priority has been claimed (Rule 66.7(a)).
   ☐ translation of the earlier application whose priority has been claimed (Rule 66.7(b)).

2. ☐ This report has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rule 64.1). Thus for the purposes of this report, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

   see separate sheet

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-36
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-36
Industrial applicability (IA)	Yes:	Claims	1-36
	No:	Claims	

2. Citations and explanations (Rule 70.7):

   see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

   and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

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Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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Re Item II Priority

1 The application claims priority of

U.S. Provisional Application No. 61/499,112, filed June 20, 2011,

U.S. Provisional Application No. 61/543,043, filed October 4, 2011,

U.S. Provisional Application No. 61/543,059, filed October 4, 2011,

U.S. Provisional Application No. 61/556,761, filed November 7, 2011,

U.S. Provisional Application No. 61/562,387, filed November 21, 2011,

U.S. Provisional Application No. 61/562,953, filed November 22, 2011, and

U.S. Provisional Application No. 13/526,261, filed June 18, 2012.

2 The claims and description should contain only subject-matter of the priority documents. In view of the number of priority documents and the number of P documents in the search report, the applicant is asked to state the origin (page, lines within the originally submitted description or claims) of this application (claims, drawings and description) within the priority documents.

3 Furthermore, the application cites on page 5 / paragraph [0027] a document called "HEVC Working Draft" or "WD 6" which is an output document of a JCT-VC meeting in February 2012, which is after the claimed priority dates. Thus, on page 5 / paragraph [0027] the reference to this document should be deleted.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

4 Reference is made to the following document(s):

D1 MATHEW R ET AL: "Quad-Tree Motion Modeling With Leaf Merging", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 20, no. 10, 1 October 2010 (2010-10-01), pages 1331-1345, XP011318748, ISSN: 1051-8215

D2 LIU S ET AL: "Method and Syntax for Partial CU Merge", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19599, 20 March 2011 (2011-03-20), XP030048166

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1062, Page 000154

D3 MCCANN K ET AL: "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 3RD MEETING: GUANGZHOU, CN, 7-15 OCTOBER, 2010, vol. JCTVC-D502, no. WG11 Number: N11818 28 January 2011 (2011-01-28), pages 1-26, XP002679641, Retrieved from the Internet: URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11]

D4 WIEGAND T ET AL: "WD2: Working Draft 2 of High-Efficiency Video Coding", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 4TH MEETING: KR, 20-28 JANUARY, 2011, vol. JCTVC-D503 28 January 2011 (2011-01-28), pages 1-154, XP002679642, Retrieved from the Internet: URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11]

D5 ZHENG Y ET AL: "Unified Motion Vector Predictor Selection for Merge and AMVP", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19932, 19 March 2011 (2011-03-19), XP030048499

Independent Claims: Lack of inventive step

5 The subject matter of independent claim 1 does not involve an inventive step over the disclosure of D1 combined with the common knowledge of the skilled person, Article 33(3) PCT.

6 D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses:

A method of coding video (D1/I:"Introduction") data comprising:

determining a merge candidate set (D1/p.1334/left column/"B. Merging Principle", Figs. 2,3) for a current prediction unit of a current coding unit,

wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units (D1/p.1334/left column/lines 26-34: Merging is performed using Lagrange based Rate/Distortion optimization without comparing motion information);

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~~excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit~~;

performing a merge motion vector prediction (Fig.1, D1/p.1332/right column/ last paragraph - D1/p.1333/left column/line 23, D1/p.1334/right column/"C. Motion Signalling") process for the current prediction unit using the merge candidate set.

7 The subject-matter of claim 1 differs from that of document D1 in that it additionally comprises

excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit; and

8 The problem to be solved by the present invention may therefore be regarded as that of how to effectively encode a prediction unit.

The feature: "excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit" seems to be an arbitrary design choice and thus obvious to the person skilled in the art.

Furthermore, in the unclear (see section on clarity below) framework of claim 1, the skilled person would only use merge candidates from the merge candidate set of the same prediction unit of the current coding unit, as these candidates often have similar predictive characteristics (i.e. based on similar motion) while other prediction units of the current coding unit have a high probability of different predictive characteristics (that's why they are in a different prediction unit) and are thus less suitable to be merged. Therefore, it is considered common design practice to exclude other prediction units from the merge candidate list.

9 The subject-matter of claim 1 does not appear to contain any feature that involves an inventive step (Article 33(3) PCT) because this claim concerns commonplace features which appear to be obvious to a person skilled in the art.

10 Furthermore, the present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of claim 1 does not involve an inventive step based on D2 (Fig.1-6, para 1-2) combined with D3 (para 5.4.1, para 6.6.2.1, Fig. 5-7, 5-8).

11 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 10, 20 and 30, which therefore are also considered not inventive.

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Arguments of the Applicant

12 The applicant argues that excluding merge candidates are not an arbitrary design choice, because:

"By excluding merge candidates from a merge candidate set that are within another prediction unit of the current coding unit, a motion vector candidate list may be determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units (i.e., to identify candidates with redundant motion information), and without any drawbacks that may be associated with not comparing motion information (i.e., having candidates with redundant motion information).

As such, the candidate blocks that would most likely be excluded from the merge candidate set (i.e., candidates within the same coding unit) based on a motion information comparison are simply excluded without performing such a comparison. As a result, the determination of a merge candidate set is simplified, while still eliminating candidate blocks most likely to contain redundant motion information. The prior art fails to suggest such a feature, and does not support the characterization oft his feature as a mere design choice." (emphasis added)

13 The IPEA replies that claim 1 does not refer to "determination of a merge candidate set is simplified, while still eliminating candidate blocks most likely to contain redundant motion information" as stated in the applicant's letter. Also, it is unclear how this might work in the unclear framework of claim 1. Given the clarity objections as reiterated below, the feature "excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit" are still considered an arbitrary design choice, and are thus obvious to the person skilled in the art.

14 Further, the applicant argues that:

"Furthermore, the Second Written Opinion contended that the exclusion feature of the Applicants independent claims would have been an obvious design feature given the preferred use of merge candidates from the same prediction unit. Such a contention is not readily understood by the Applicant. It is unclear how a merge candidate can be from the same prediction unit as the currently coded prediction unit, as merge candidates, by definition, are from other, i.e., different, prediction units. It appears that this contention may be based on a misunderstanding of the merge mode process used in video coding. As such, the Second Written Opinion's conclusion that Applicant's claimed exclusion technique is an obvious design feature is based upon an

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unsupported, and unsound interpretation of the video coding process. Accordingly, in view of the above remarks, the feature of excluding merge candidates from a merge candidate set that are within another prediction unit of the current coding unit provides for a solution to a specific problem, and is not an arbitrary design choice." (emphasis added)

15 The IPEA refers to "It is unclear how a merge candidate can be from the same prediction unit as the currently coded prediction unit". as written in the applicant's letter. The feature of unclear claim 1: "*excluding* merge candidates from the merge candidate set that are within *another prediction unit* of the current coding unit" only leaves "merge candidates from the *same prediction unit* as the currently coded prediction unit".

16 The IPEA refers to claim 1 which is silent about "merge candidates, by definition, are from other, i.e., different, prediction units" and claim 1 lacks a reference to "merge mode process" as referred to in the applicant's letter and - given the clarity objections as reiterated below - the IPEA still considers the feature of "excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit" an arbitrary design choice which is obvious to the person skilled in the art.

Dependent claims

17 Dependent claims 2-9, 11-19, 21-29, 31-36 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step.

18 Dependent claims 2-9, 11-19, 21-29, 31-36 (Inventive Step, closest prior art: D1) do not appear to contain any additional features which, in combination with the features of any claim to which they refer, involve an inventive step because these claims concern commonplace features which appear to be obvious to a person skilled in the art.

19 Claim 2-9, 11-19, 21-29, 31-36 (Inventive Step): D2 (Fig.1-6, para 1-2) combined with D3 (para 5.4.1, para 6.6.2.1, Fig. 5-7, 5-8) discloses square (D2/Fig.1: e.g.: NxN) and non-square (D2/Fig.1: e.g. NxN) coding units and prediction units positioned in left, top and bottom locations (D2/Fig.2-6) and syntax elements (claims 9,10, 19, 20, 30, 31) indicating selected merge candidates (D2/para. 2).

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Re Item VI Certain Documents

20 Please refer to section on "Priority".

Re Item VII Certain defects in the international application (Form or Content)

Disclosure

21 The description shall disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art (Article 5 PCT). Thus, on page 1 / paragraph [0001] the phrase "incorporated by reference" should be deleted.

Re Item VIII Certain observations on the international application

Clarity - Results to be achieved

22 The application does not meet the requirements of Article 6 PCT, because claims 1-36 are not clear.

23 Claim 1 does not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

24 Specifically, in claim 1 it is still unclear how "the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units", how "a merge motion vector prediction process" is to be performed and how "coding video data" with these merge candidates is to be performed.

25 The foregoing objections apply also to closely related claims 10, 20 and 30.

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PATENT COOPERATION TREATY

RECEIVED
OCT 4 2012
By

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
Gage, Matthew K.
SHUMAKER & SIEFFERT, P.A.
1625 Radio Drive
Suite 300
Woodbury, Minnesota 55125
ETATS-UNIS D'AMERIQUE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 27 September 2012 (27-09-2012)
Applicant's or agent's file reference 1010-939WO01	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2012/043155	International filing date *(day/month/year)* 19 June 2012 (19-06-2012)
Applicant QUALCOMM INCORPORATED	

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 - 9.011.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	EXNER, Karin Tel: +49 (0)89 2399-7826

Form PCT/ISA/220 (July 2010)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
1010-939WO01		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2012/043155	19/06/2012	20/06/2011
Applicant		
QUALCOMM INCORPORATED		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language,** the international search was carried out on the basis of:
      [X] the international application in the language in which it was filed
      [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. [ ] **Certain claims were found unsearchable** (See Box No. II)

3. [ ] **Unity of invention is lacking** (see Box No III)

4. With regard to the **title,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings,**
   a. the figure of the **drawings** to be published with the abstract is Figure No. 3A
      [X] as suggested by the applicant
      [ ] as selected by this Authority, because the applicant failed to suggest a figure
      [ ] as selected by this Authority, because this figure better characterizes the invention
   b. [ ] none of the figures is to be published with the abstract

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/043155

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N7/26 H04N7/34 H04N7/36 H04N7/46 H04N19/00
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 practicable, search terms used)
EPO-Internal, COMPENDEX, 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	MATHEW R ET AL: "Quad-Tree Motion Modeling With Leaf Merging", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 20, no. 10, 1 October 2010 (2010-10-01), pages 1331-1345, XP011318748, ISSN: 1051-8215 page 1332, paragraph III - page 1335, paragraph IV; figures 1-3 ----- -/--	1-40

[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 application or patent 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
20 September 2012	27/09/2012

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	Kuhn, Peter

3

Form PCT/ISA/210 (second sheet) (April 2005)

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1062, Page 000162

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LIU S ET AL: "Method and Syntax for Partial CU Merge", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19599, 20 March 2011 (2011-03-20), XP030048166, paragraph [0001] - paragraph [0002]; figures 1-6	1-40
Y	MCCANN K ET AL: "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 3RD MEETING: GUANGZHOU, CN, 7-15 OCTOBER, 2010, , vol. JCTVC-D502, no. WG11 Number: N11818 28 January 2011 (2011-01-28), pages 1-26, XP002679641, Retrieved from the Internet: URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11] paragraph [5.4.1] paragraph [6.6.2.1] figures 5-7, 5-8	1-40
A	WIEGAND T ET AL: "WD2: Working Draft 2 of High-Efficiency Video Coding", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 4TH MEETING: KR, 20-28 JANUARY, 2011, , vol. JCTVC-D503 28 January 2011 (2011-01-28), pages 1-154, XP002679642, Retrieved from the Internet: URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11] paragraph [8.4.2.1.1] - paragraph [8.4.2.1.7]	1-40
A	ZHENG Y ET AL: "Unified Motion Vector Predictor Selection for Merge and AMVP", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19932, 19 March 2011 (2011-03-19), XP030048499, the whole document	1-40

-/--

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/043155

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	KIM (ETRI) H Y ET AL: "CU-based Merge Candidate List Construction", 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-G416, 8 November 2011 (2011-11-08), XP030110400, the whole document --- ZHENG Y ET AL: "CE9: Unified Merge and AMVP candidates selection (UNI03)", 97. MPEG MEETING; 18-7-2011 - 22-7-2011; TORINO; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m20718, 6 June 2012 (2012-06-06), XP030049281, the whole document --- 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, 6 June 2012 (2012-06-06), XP030049286, the whole document --- ZHENG Y ET AL: "Simplified Merge candidate derivation", 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-G681, 9 November 2011 (2011-11-09), XP030110665, the whole document --- ZHENG Y ET AL: "Simplification and improvement of additional merge candidate", 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-G683, 9 November 2011 (2011-11-09), XP030110667, the whole document --- -/--	X,P: 1-40 X,P: 1-40 X,P: 1-40 X,P: 1-40

3

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/043155

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 2012/059577 A1 (FRAUNHOFER GES FORSCHUNG [DE]; SCHWARZ HEIKO [DE]; KIRCHHOFFER HEINER) 10 May 2012 (2012-05-10) the whole document	1-40
A,P	WO 2012/030193 A2 (LG ELECTRONICS INC [KR]; LIM JAEHYUN [KR]; KIM JUNGSUN [KR]; PARK SEUN) 8 March 2012 (2012-03-08) the whole document	1-40

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/043155

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2012059577 A1	10-05-2012	NONE	
WO 2012030193 A2	08-03-2012	NONE	

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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/043155	19.06.2012	20.06.2011

International Patent Classification (IPC) or both national classification and IPC
INV. H04N7/26 H04N7/34 H04N7/36 H04N7/46 H04N19/00

Applicant
QUALCOMM INCORPORATED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Kuhn, Peter Telephone No. +49 89 2399-7630

Form PCT/ISA/237 (Cover Sheet) (July 2009)

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant date (Rules 43*bis*.1 and 64.1) is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

   see separate sheet

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Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2-10, 12-21, 23-32, 34-40
	No:	Claims	1, 11, 22, 33
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-40
Industrial applicability (IA)	Yes:	Claims	1-40
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rules 43*bis*.1 and 70.10)

and / or

2. Non-written disclosures (Rules 43*bis*.1 and 70.9)

see form 210

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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Re Item II

Priority

1 The application claims priority (among others) of USP201161499112 filed 20-06-2011, which is not yet available to the ISA. However, the application cites on page 5 / paragraph [0027] a document called "HEVC Working Draft" or "WD 6" which is an output document of a JCT-VC meeting in February 2012, which is after the claimed priority date. Thus, on page 5 / paragraph [0027] the reference to this document should be deleted.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

2 Reference is made to the following document(s):

D1 MATHEW R ET AL: "Quad-Tree Motion Modeling With Leaf Merging", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 20, no. 10, 1 October 2010 (2010-10-01), pages 1331-1345, XP011318748, ISSN: 1051-8215

D2 LIU S ET AL: "Method and Syntax for Partial CU Merge", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19599, 20 March 2011 (2011-03-20), XP030048166

D3 MCCANN K ET AL: "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 3RD MEETING: GUANGZHOU, CN, 7-15 OCTOBER, 2010, vol. JCTVC-D502, no. WG11 Number: N11818 28 January 2011 (2011-01-28), pages 1-26, XP002679641, Retrieved from the Internet: URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11]

D4 WIEGAND T ET AL: "WD2: Working Draft 2 of High-Efficiency Video Coding", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 4TH MEETING: KR, 20-28 JANUARY, 2011, vol. JCTVC-D503 28 January 2011

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(2011-01-28), pages 1-154, XP002679642, Retrieved from the Internet: URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11]

D5 ZHENG Y ET AL: "Unified Motion Vector Predictor Selection for Merge and AMVP", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19932, 19 March 2011 (2011-03-19), XP030048499

Independent claims

3 The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of claim 1 is not new.

D1 discloses:

A method of coding video (D1/I:"Introduction") data comprising:

determining a merge candidate set (D1/p.1334/left column/"B. Merging Principle", Figs. 2,3) for a current prediction unit of a current coding unit,

wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units (D1/p.1334/left column/lines 26-34: Merging is performed using Lagrange based Rate/Distortion optimization without comparing motion information); and

performing a merge motion vector prediction (Fig.1, D1/p.1332/right column/ last paragraph - D1/p.1333/left column/line 23, D1/p.1334/right column/"C. Motion Signalling") process for the current prediction unit using the merge candidate set.

4 The present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of claim 1 does not involve an inventive step based on D2 (Fig.1-6, para 1-2) combined with D3 (para 5.4.1, para 6.6.2.1, Fig. 5-7, 5-8).

5 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 11, 22 and 33, which therefore are also considered not new/inventive.

Dependent claims

6 Dependent claims 2-10, 12-21, 23-32, 34-40 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step.

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7 Dependent claims 2-10, 12-21, 23-32, 34-40 (Inventive Step, closest prior art: D1) do not appear to contain any additional features which, in combination with the features of any claim to which they refer, involve an inventive step because these claims concern commonplace features which appear to be obvious to a person skilled in the art.

8 Claim 2-10, 12-21, 23-32, 34-40 (Inventive Step): D2 (Fig.1-6, para 1-2) combined with D3 (para 5.4.1, para 6.6.2.1, Fig. 5-7, 5-8) discloses square (D2/Fig.1: e.g.: NxN) and non-square (D2/Fig.1: e.g. NxN) coding units and prediction units positioned in left, top and bottom locations (D2/Fig.2-6) and syntax elements (claims 9,10, 19, 20, 30, 31) indicating selected merge candidates (D2/para. 2).

Re Item VII Certain defects in the international application (Form or Content)

Disclosure

9 The description shall disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art (Article 5 PCT). Thus, on page 1 / paragraph [0001] the phrase "incorporated by reference" should be deleted.

Re Item VIII Certain observations on the international application

Clarity - Results to be achieved

10 The application does not meet the requirements of Article 6 PCT, because claims 1-40 are not clear.

11 Claim 1 does not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

12 Specifically, in claim 1 it is unclear how "the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units" and how "a merge motion vector prediction process" is to be performed.

13 The foregoing objections apply also to closely related claims 11, 22 and 33.

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Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO-ISA)

General information	For all international applications filed on or after 01/01/2004 the competent ISA will establish an ISR. It is accompanied by the WO-ISA. Unlike the former written opinion of the IPEA (Rule 66.2 PCT), the WO-ISA is not meant to be responded to, but to be taken into consideration for further procedural steps. This document explains about the possibilities.
Amending claims under Art. 19 PCT	Within 2 months after the date of mailing of the ISR and the WO-ISA the applicant may file amended claims under Art. 19 PCT directly with the International Bureau of WIPO. The PCT reform of 2004 did not change this procedure. For further information please see Rule 46 PCT as well as form PCT/ISA/220 and the corresponding Notes to form PCT/ISA/220.
Filing a demand for international preliminary examination	In principle, the WO-ISA will be considered as the written opinion of the IPEA. This should, in many cases, make it unnecessary to file a demand for international preliminary examination. If the applicant nevertheless wishes to file a demand this must be done before expiry of 3 months after the date of mailing of the ISR/WO-ISA or 22 months after priority date, whichever expires later (Rule 54bis PCT). Amendments under Art. 34 PCT can be filed with the IPEA as before, normally at the same time as filing the demand (Rule 66.1 (b) PCT). If a demand for international preliminary examination is filed and no comments/amendments have been received the WO-ISA will be transformed by the IPEA into an IPRP (International Preliminary Report on Patentability) which would merely reflect the content of the WO-ISA. The demand can still be withdrawn (Art. 37 PCT).
Filing informal comments	After receipt of the ISR/WO-ISA the applicant may file informal comments on the WO-ISA directly with the International Bureau of WIPO. These will be communicated to the designated Offices together with the IPRP (International Preliminary Report on Patentability) at 30 months from the priority date. Please also refer to the next box.
End of the international phase	At the end of the international phase the International Bureau of WIPO will transform the WO-ISA or, if a demand was filed, the written opinion of the IPEA into the IPRP, which will then be transmitted together with possible informal comments to the designated Offices. The IPRP replaces the former IPER (international preliminary examination report).
Relevant PCT Rules and more information	Rule 43 PCT, Rule 43bis PCT, Rule 44 PCT, Rule 44bis PCT, PCT Newsletter 12/2003, OJ 11/2003, OJ 12/2003

Bitte beachten Sie, dass angeführte Nichtpatentliteratur (wie z. B. wissenschaftliche oder technische Dokumente) je nach geltendem Recht dem Urheberrechtsschutz und/oder anderen Schutzarten für schriftliche Werke unterliegen könnte. Die Vervielfältigung urheberrechtlich geschützter Texte, ihre Verwendung in anderen elektronischen oder gedruckten Publikationen und ihre Weitergabe an Dritte ist ohne ausdrückliche Zustimmung des Rechtsinhabers nicht gestattet.

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Please be aware that cited works of non-patent literature such as scientific or technical documents or the like may be subject to copyright protection and/or any other protection of written works as appropriate based on applicable laws. Copyrighted texts may not be copied or used in other electronic or printed publications or re-distributed without the express permission of the copyright holder.

XS CPRTENFRDE

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

SHUMAKER, Steven, J.
Shumaker & Sieffert, P.A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125
ETATS-UNIS D'AMERIQUE

ALSO FAXED TO 001 651-735-1102

PCT

WRITTEN OPINION OF THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rule 66)

Date of mailing *(day/month/year)*	06.06.2013
Applicant's or agent's file reference: 1010-939WO01	**REPLY DUE** within 2 month(s) from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/043155	19.06.2012	20.06.2011

International Patent Classification (IPC) or both national classification and IPC
INV. H04N7/26

Applicant
Qualcomm Incorporated

1. ☒ The written opinion established by the International Searching Authority:
   ☒ is ☐ is not
   considered to be a written opinion of the International Preliminary Examining Authority.
2. This second opinion contains indications relating to the following items:
   - ☒ Box No. I Basis of the opinion
   - ☒ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☒ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☒ Box No. VIII Certain observations on the international application
3. The applicant is hereby **invited to reply** to this opinion.

   When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(e).
   How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 55.3 and 66.8.
   Also: For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4*bis*. For an informal communication with the examiner, see Rule 66.6. For an additional opportunity to submit amendments, see Rule 66.4.
   If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.
4. The final date by which the international preliminary report on patentability (Chapter II of the PCT) must be established according to Rule 69.2 is: 20.10.2013

Name and mailing address of the international preliminary examining authority:	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	Kuhn, Peter Telephone No. +49 89 2399-7630

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WRITTEN OPINION OF THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

International application No.
PCT/US2012/043155

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into ,
   which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3(a) and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4(a))
   - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))

2. With regard to the elements of the international application, this opinion has been established on the basis of *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed")*:

Description, Pages

1-34 as originally filed

Claims, Numbers

1-36 filed with telefax on 05-02-2013

Drawings, Sheets

1/10-10/10 as originally filed

☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

4. ☐ This opinion has been established as if (some of) the amendments listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:

5. ☐ This opinion has been established:
   - ☐ taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 66.1(d-bis)).
   - ☐ without taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 66.4bis).

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WRITTEN OPINION OF THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

International application No.
PCT/US2012/043155

6. ☐ Supplementary international search report(s) from Authority(ies) have been received and taken into account in drawing up this opinion (Rule 45bis.8(b) and (c)).

Box No. II Priority

1. ☐ This opinion has been established as if no priority had been claimed due to the failure to furnish within the prescribed time limit the requested:
   ☐ copy of the earlier application whose priority has been claimed (Rule 66.7(a)).
   ☐ translation of the earlier application whose priority has been claimed (Rule 66.7(b)).
2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rule 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.
3. Additional observations, if necessary:

   see separate sheet

Box No. V Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	No:	Claims
Inventive step (IS)	No:	Claims 1-36
Industrial applicability (IA)	No:	Claims

2. Citations and explanations:

   see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

   and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

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WRITTEN OPINION OF THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

International application No.
PCT/US2012/043155

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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WRITTEN OPINION OF THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY (SEPARATE SHEET)

International application No. PCT/US2012/043155

Re Item II Priority

1 The application claims priority of

U.S. Provisional Application No. 61/499,112, filed June 20, 2011,

U.S. Provisional Application No. 61/543,043, filed October 4, 2011,

U.S. Provisional Application No. 61/543,059, filed October 4, 2011,

U.S. Provisional Application No. 61/556,761, filed November 7, 2011,

U.S. Provisional Application No. 61/562,387, filed November 21, 2011,

U.S. Provisional Application No. 61/562,953, filed November 22, 2011, and

U.S. Provisional Application No. 13/526,261, filed June 18, 2012.

2 The description should contain only subject-matter of the priority documents. In view of the number of priority documents and the number of P documents in the search report, the applicant is asked to state the origin (page, lines within the originally submitted description or claims) of this application within the priority documents.

3 Furthermore, the application cites on page 5 / paragraph [0027] a document called "HEVC Working Draft" or "WD 6" which is an output document of a JCT-VC meeting in February 2012, which is after the claimed priority dates. Thus, on page 5 / paragraph [0027] the reference to this document should be deleted.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

4 Reference is made to the following document(s):

D1 MATHEW R ET AL: "Quad-Tree Motion Modeling With Leaf Merging", IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 20, no. 10, 1 October 2010 (2010-10-01), pages 1331-1345, XP011318748, ISSN: 1051-8215

D2 LIU S ET AL: "Method and Syntax for Partial CU Merge", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. m19599, 20 March 2011 (2011-03-20), XP030048166

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D3 MCCANN K ET AL: "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description",
JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 3RD MEETING: GUANGZHOU, CN, 7-15 OCTOBER, 2010, vol. JCTVC-D502, no. WG11 Number: N11818 28 January 2011 (2011-01-28), pages 1-26, XP002679641, Retrieved from the Internet:
URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/
[retrieved on 2012-07-11]

D4 WIEGAND T ET AL: "WD2: Working Draft 2 of High-Efficiency Video Coding", JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG16 WP3 AND ISO/IEC JTC1/SC29/WG11, 4TH MEETING: KR, 20-28 JANUARY, 2011, vol. JCTVC-D503 28 January 2011 (2011-01-28), pages 1-154, XP002679642, Retrieved from the Internet:
URL:http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/
[retrieved on 2012-07-11]

D5 ZHENG Y ET AL: "Unified Motion Vector Predictor Selection for Merge and AMVP", 96. MPEG MEETING; 21-3-2011 - 25-3-2011; GENEVA; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),,
no. m19932, 19 March 2011 (2011-03-19), XP030048499

Independent Claims: Lack of inventive step

5 The subject matter of independent claim 1 does not involve an inventive step over the disclosure of D1 combined with the common knowledge of the skilled person, Article 33(3) PCT.

6 D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses:

A method of coding video (D1/I:"Introduction") data comprising:

determining a merge candidate set (D1/p.1334/left column/"B. Merging Principle", Figs. 2,3) for a current prediction unit of a current coding unit,

wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units (D1/p.1334/left column/lines 26-34: Merging is performed using Lagrange based Rate/Distortion optimization without comparing motion information);

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~~excluding merge candidates from the merge candidate set that are within another prediction unit of the coding unit~~;

performing a merge motion vector prediction (Fig.1, D1/p.1332/right column/ last paragraph - D1/p.1333/left column/line 23, D1/p.1334/right column/"C. Motion Signalling") process for the current prediction unit using the merge candidate set.

7 The subject-matter of claim 1 differs from that of document D1 in that it additionally comprises

excluding merge candidates from the merge candidate set that are within another prediction unit of the coding unit; and

8 The problem to be solved by the present invention may therefore be regarded as that of how to effectively encode a prediction unit.

The feature: "excluding merge candidates from the merge candidate set that are within another prediction unit of the coding unit" seems to be an arbitrary design choice and thus obvious to the person skilled in the art.

Furthermore, the skilled person would only use merge candidates from the merge candidate set of the same prediction unit, as these candidates have similar predictive characteristics (i.e. based on similar motion) while other prediction units of the current coding unit have a high probability of different predictive characteristics (that's why they are in a different prediction unit) and are thus less suitable to be merged with the current prediction unit. Therefore, it is considered common design practice to exclude other prediction units from the merge candidate list.

9 The subject-matter of claim 1 does not appear to contain any feature that involves an inventive step (Article 33(3) PCT) because this claim concerns commonplace features which appear to be obvious to a person skilled in the art.

10 Furthermore, the present application does not meet the criteria of Article 33(3) PCT, because the subject-matter of claim 1 does not involve an inventive step based on D2 (Fig.1-6, para 1-2) combined with D3 (para 5.4.1, para 6.6.2.1, Fig. 5-7, 5-8).

11 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 10, 20 and 30, which therefore are also considered not inventive.

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Dependent claims

12 Dependent claims 2-9, 11-19, 21-29, 31-36 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step.

13 Dependent claims 2-9, 11-19, 21-29, 31-36 (Inventive Step, closest prior art: D1) do not appear to contain any additional features which, in combination with the features of any claim to which they refer, involve an inventive step because these claims concern commonplace features which appear to be obvious to a person skilled in the art.

14 Claim 2-9, 11-19, 21-29, 31-36 (Inventive Step): D2 (Fig.1-6, para 1-2) combined with D3 (para 5.4.1, para 6.6.2.1, Fig. 5-7, 5-8) discloses square (D2/Fig.1: e.g.: NxN) and non-square (D2/Fig.1: e.g. NxN) coding units and prediction units positioned in left, top and bottom locations (D2/Fig.2-6) and syntax elements (claims 9,10, 19, 20, 30, 31) indicating selected merge candidates (D2/para. 2).

Re Item VI Certain Documents

15 Please refer to section on "Priority".

Re Item VII Certain defects in the international application (Form or Content)

Disclosure

16 The description shall disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art (Article 5 PCT). Thus, on page 1 / paragraph [0001] the phrase "incorporated by reference" should be deleted.

Re Item VIII Certain observations on the international application

Clarity - Results to be achieved

17 The application does not meet the requirements of Article 6 PCT, because claims 1-36 are not clear.

18 Claim 1 does not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claim attempts to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

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19 Specifically, in claim 1 it is still unclear how "the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units", how "a merge motion vector prediction process" is to be performed and how "coding video data" with these merge candidates is to be performed.

20 The foregoing objections apply also to closely related claims 10, 20 and 30.

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(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
2012 년 3 월 8 일 (08.03.2012)

PCT

(10) 국제공개번호
WO 2012/030193 A2

(51) 국제특허분류:
H04N 7/32 (2006.01) *H04N 7/34* (2006.01)

(21) 국제출원번호: PCT/KR2011/006530

(22) 국제출원일: 2011 년 9 월 2 일 (02.09.2011)

(25) 출원언어: 한국어

(26) 공개언어: 한국어

(30) 우선권정보:
61/379,708 2010 년 9 월 2 일 (02.09.2010) US
61/410,939 2010 년 11 월 8 일 (08.11.2010) US
61/412,805 2010 년 11 월 12 일 (12.11.2010) US

(71) 출원인 (US 을(를) 제외한 모든 지정국에 대하여): **엘지전자 주식회사 (LG ELECTRONICS INC.)** [KR/KR]; 서울시 영등포구 여의도동 20, 150-721 Seoul (KR).

(72) 발명자; 겸

(75) 발명자/출원인 (US 에 한하여): **임재현 (LIM, Jaehyun)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **김정선 (KIM, Jungsun)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **박승욱 (PARK, Seungwook)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **성재원 (SUNG, Jaewon)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **전병문 (JEON, Byeongmoon)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **박준영 (PARK, Joonyoung)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **전용준 (JEON, Yongjoon)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR). **최영희 (CHOI, Younghee)** [KR/KR]; 서울시 서초구 양재동 221 엘지전자 Convergence R&D 연구소, 137-130 Seoul (KR).

(74) 대리인: **양문옥 (YANG, Moon Ock)**; 서울시 강남구 역삼동 735-10 삼흥역삼빌딩 2 층 에센특허법률사무소, 135-080 Seoul (KR).

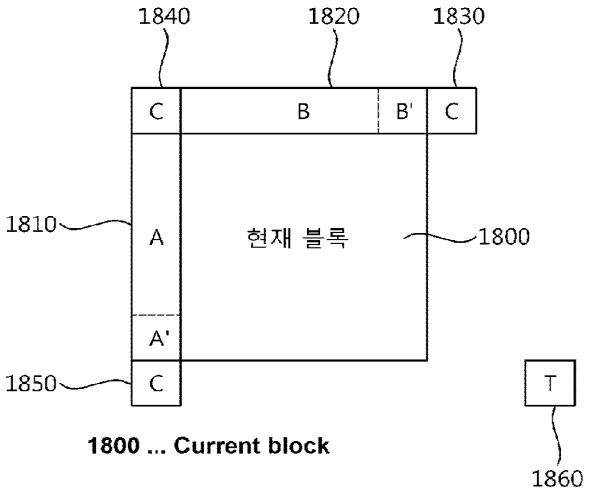
(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,

[다음 쪽 계속]

(54) Title: METHOD FOR ENCODING AND DECODING VIDEO, AND APPARATUS USING SAME

(54) 발명의 명칭 : 영상 부호화 및 복호화 방법과 이를 이용한 장치

[Fig. 18]



1800 ... Current block

에서 제시하는 영상 정보 복호화

(57) Abstract: The present invention relates to a technique for encoding and decoding video data, and more particularly, to a method for performing inter-prediction in an effective manner. The present invention combines an inter-prediction method using an AMVP mode and an inter-prediction method using a merge mode so as to propose a method for using the same candidate. The method for encoding video data proposed by the present invention comprises the following steps: receiving mode information on an inter-prediction method of a current block; determining, on the basis of the received mode information, whether the inter-prediction method to be applied to the current block is an AMVP mode or a merge mode; and selecting a candidate to derive motion information of the current block, wherein the candidate is selected in a left region, top region and corner region of the current block and in the same position block as the current block, and the AMVP mode and the merge mode are applied on the basis of the selected candidate.

(57) 요약서: 본 발명은 영상 정보 부호화 및 복호화 기술에 관한 것으로서, 더 구체적으로는 화면 간 예측을 효과적으로 수행하는 방법에 관한 것이다. 본 발명에서는 AMVP 를 이용하는 화면 간 예측 방법과 머지 모드를 이용한 화면 간 예측 방법을 통합하여 동일한 후보를 이용하는 방법을 제시한다. 본 발명

[다음 쪽 계속]

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TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 유럽 (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).

공개:

— 국제조사보고서 없이 공개하며 보고서 접수 후 이를 별도 공개함 (규칙 48.2(g))

방법은 현재 블록의 화면 간 예측 방법에 관한 모드 정보를 수신하는 단계, 상기 수신한 모드 정보에 따라 현재 블록에 적용할 화면 간 예측 방법이 AMVP 모드인지 머지 모드인지를 판단하는 단계 및 상기 현재 블록의 움직임 정보를 유도할 후보를 선택하는 단계를 포함하며, 상기 후보는, 상기 현재 블록의 좌측 영역, 상단 영역, 코너 영역 및 상기 현재 블록에 대한 동일 위치 블록에서 선택되고, 상기 AMVP 모드와 상기 머지 모드는 상기 선택된 부호를 기반으로 적용된다.

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명세서

발명의 명칭: 영상 부호화 및 복호화 방법과 이를 이용한 장치

기술분야

[0001] 본 발명은 영상 압축 기술에 관한 것으로서, 구체적으로는 화면 간 예측(inter picture prediction) 방법 및 장치에 관한 것이다.

배경기술

[0002] 최근 고해상도, 고품질의 영상에 대한 요구가 다양한 응용 분야에서 증가하고 있다. 하지만, 영상의 고해상도, 고품질이 될수록 해당 영상에 관한 정보량도 함께 증가한다. 따라서 기존의 유무선 광대역 회선과 같은 매체를 이용하여 영상 정보를 전송하거나 기존의 저장 매체를 이용해 영상 정보를 저장하는 경우, 정보의 진송 비용과 저장 비용이 증가하게 된다.

[0003] 고해상도, 고품질 영상의 정보를 효과적으로 전송하거나 저장하고, 재생하기 위해 고효율의 영상 압축 기술을 이용할 수 있다.

[0004] 영상 압축의 효율을 높이기 위해, 화면 간 예측(inter prediction)과 화면 내 예측(intra prediction)을 이용할 수 있다. 화면 간 예측 방법에서는 다른 픽처의 정보를 참조하여 현재 픽처(picture)의 화소값을 예측하며, 화면 내 예측 방법에서는 동일한 픽처 내에서 화소 간 연관 관계를 이용하여 화소값을 예측한다.

발명의 요약

기술적 과제

[0005] 본 발명은 영상 압축의 효율을 높이기 위한 예측 방법을 제공하는 것을 일 목적으로 한다.

[0006] 본 발명은 화면 간 예측을 효과적으로 하기 위한 방법을 제공하는 것을 일 목적으로 한다.

[0007] 본 발명은 영상 정보의 압축 효율을 높이면서 영상 품질을 유지하는 방법을 제공하는 것을 일 목적으로 한다.

[0008] 본 발명은 영상 정보의 부호화/복호화 시에 처리하는 정보량을 줄이는 방법을 제공하는 것을 일 목적으로 한다.

[0009] 본 발명은 영상 정보 부호화/복호화의 복잡도를 줄이는 방법을 제공하는 것을 일 목적으로 한다.

과제 해결 수단

[0010] 본 발명의 일 실시형태는 현재 블록의 예측 모드(prediction mode)를 결정하는 단계 및 상기 결정된 예측 모드가 스킵 모드인 경우에는, 순방향, 역방향 또는 양방향 중 하나의 예측 방향을 지정하는 정보를 전송하는 단계를 포함하는 영상 정보 부호화 방법이다.

[0011] 본 발명의 다른 실시형태는 현재 블록의 예측 모드를 판단하는 단계 및 상기

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현재 블록의 예측 모드가 스킵 모드인 경우에는, 예측 방향을 지시하는 정보에 따라서, 스킵 모드의 예측 방향을 단방향 또는 양방향으로 설정하는 단계를 포함하는 영상 정보 복호화 방법이다.

[0012] 본 발명의 또 다른 실시형태는, AMVP 후보에 대하여, 각 후보를 이용하는 경우에 대한 비용을 체크하는 단계, 머지 후보와 상기 AMVP 후보의 동일성을 비교하는 단계, 상기 AMVP 후보와 동일하지 않은 머지 후보에 대하여, 비용을 체크하는 단계 및 상기 체크한 비용들을 기반으로 현재 블록에 적용할 화면 간 예측 모드를 결정하는 단계를 포함하는 영상 정보 부호화 방법이다.

[0013] 본 발명의 또 다른 실시형태는, 현재 블록의 주변 영역에서 AMVP 후보를 선택하는 단계, 상기 AMVP 후보와 머지 후보의 동일성을 판단하는 단계 및 상기 동일성 판단 결과, 상기 AMVP 후보와 동일하지 않은 머지 후보에 현재 블록을 머지하는 단계를 포함하는 영상 정보 복호화 방법이다.

[0014] 본 발명의 또 다른 실시형태는, 현재 블록의 주변 영역에서 AMVP 후보를 선택하고 AMVP 후보 리스트를 구성하는 단계, 상기 AMVP 후보 리스트의 후보에 속하지 않는 머지 후보가 존재하는지를 판단하는 단계 및 상기 AMVP 후보 리스트에 속하지 않는 머지 후보가 있는 경우, 상기 AMVP 후보 리스트에 상기 머지 후보를 추가하거나 상기 AMVP 후보 리스트의 후보 중 소정의 후보를 상기 머지 후보로 변경하도록 시그널링하는 단계를 포함하는 영상 정보 부호화 방법이다.

[0015] 본 발명의 또 다른 실시형태는, 현재 블록의 주변 영역에서 AMVP 후보를 선택하고 AMVP 후보 리스트를 구성하는 단계, 상기 AMVP 후보 리스트에 속하지 않는 머지 후보가 있는 경우, 상기 AMVP 후보 리스트에 상기 머지 후보를 추가하거나 상기 AMVP 후보 리스트의 후보 중 소정의 후보를 상기 머지 후보로 변경하는 단계 및 상기 변경된 AMVP 후보 리스트를 기반으로 현재 블록을 예측하는 단계를 포함하는 것을 특징으로 하는 영상 정보 복호화 방법이다.

[0016] 본 발명의 또 다른 실시형태는, AMVP를 이용하는 화면 간 예측 방법과 머지 모드를 이용하는 화면 간 예측 방법 중 현재 블록에 적용되는 예측 방법을 결정하는 단계 및 상기 결정된 예측 방법에 관한 정보를 전송하는 단계를 포함하며, 상기 AMVP의 후보와 상기 머지 모드의 후보를 통합하여 이용하는 영상 정보 부호화 방법이다.

[0017] 본 발명의 또 다른 실시형태는 현재 블록의 화면 간 예측 방법에 관한 모드 정보를 수신하는 단계 및 상기 현재 블록의 움직임 정보를 유도할 후보를 선택하는 단계를 포함하며, 상기 후보는, 상기 현재 블록의 좌측 영역, 상단 영역, 코너 영역 및 상기 현재 블록에 대한 동일 위치 블록에서 선택되는 영상 정보 복호화 방법이다.

[0018] 이때, 상기 후보는 상기 현재 블록의 좌측 영역, 상단 영역 및 코너 영역에 있어서 특정 위치의 블록으로서, 화면 간 예측 모드의 블록일 수 있다. 또한, 상기

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후보는,

[0019] 상기 현재 블록의 좌측 영역의 최하단 블록, 상기 현재 블록의 상단 영역에서 최우측 블록 및 상기 현재 블록에 대한 좌하(Left Below), 좌상(Left Top) 그리고 우상(Right Top) 코너 블록일 수도 있다.

발명의 효과

[0020] 본 발명에 의하면, 영상 정보의 압축 효율을 높이면서 영상 품질을 유지할 수 있다.

[0021] 본 발명에 의하면, 영상 정보의 인코딩/디코딩 시에 처리하는 정보량을 줄이고 영상 정보 처리의 효율을 높일 수 있다.

[0022] 본 발명에 의하면, 영상 정보 인코딩/디코딩의 복잡도를 줄이고 영상 정보 처리의 효율을 높일 수 있다.

도면의 간단한 설명

[0023] 도 1은 본 발명의 일 실시예에 따른 영상 부호화 장치를 개략적으로 도시한 블록도이다.

[0024] 도 2는 본 발명의 일 실시예에 따른 예측부를 개략적으로 도시한 개념도이다.

[0025] 도 3은 본 발명이 적용되는 시스템에서 처리 유닛의 쿼드 트리 구조에 관한 일 예를 개략적으로 설명하는 도면이다.

[0026] 도 4는 본 발명의 일 실시예에 따른 영상 복호화기를 개략적으로 나타낸 블록도이다.

[0027] 도 5는 본 발명의 일 실시예에 따른 영상 복호화기의 예측부를 개략적으로 나타낸 개념도이다.

[0028] 도 6은 본 발명이 적용되는 시스템에서 적용되는 AMVP 모드의 일 예를 개략적으로 설명하는 도면이다.

[0029] 도 7은 본 발명이 적용되는 시스템에서 머지 모드를 적용하는 일 예를 개략적으로 설명하는 도면이다.

[0030] 도 8은 본 발명이 적용되는 부호화기에서 예측 모드 정보를 구성해서 전송하는 방법을 개략적으로 설명하는 도면이다.

[0031] 도 9는 본 발명이 적용되는 부호화기에서 예측 후보들의 비용을 산출하는 방법을 개략적으로 설명하는 순서도이다.

[0032] 도 10은 본 발명이 적용되는 복호화기에서 머지가 수행되는 방법을 개략적으로 설명하는 순서도이다.

[0033] 도 11은 본 발명이 적용되는 부호화기에서 상술한 바와 같이 AMVP 후보 리스트를 변경하는 동작을 개략적으로 설명하는 순서도이다.

[0034] 도 12는 본 발명이 적용되는 복호화기에서 변경된 AMVP 리스트를 기반으로 예측을 수행하는 방법을 개략적으로 설명하는 도면이다.

[0035] 도 13은 다이렉트 모드와 머지 모드를 선택하는 시그널링 방법을 개략적으로 설명하는 순서도이다.

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[0036] 도 14는 다이렉트 모드와 머지 모드를 통합하여 시그널링을 수행하는 일 예를 개략적으로 나타낸 것이다.

[0037] 도 15는 플래그를 사용하여 다이렉트 모드를 적용할지 코딩 블록 머지를 적용할지를 시그널링 하는 예를 개략적으로 도시한 것이다.

[0038] 도 16은 다이렉트 모드가 적용될지 코딩 블록 머지가 적용될지를 유도해내는 방법을 개략적으로 도시한 것이다.

[0039] 도 17은 본 발명에 따라서 통합 모드를 적용하는 경우에 대한 시그널링의 일 예를 개략적으로 나타내는 순서도이다.

[0040] 도 18은 통합 모드의 후보 블록들이 선택되는 영역을 개략적으로 설명하는 도면이다.

[0041] 도 19는 본 발명이 적용되는 부호화기에서 통합 모드를 적용하여 예측 후보를 생성하고 해당 정보를 전송하는 방법을 개략적으로 설명하는 순서도이다.

[0042] 도 20은 본 발명이 적용되는 복호화기에서 통합 모드를 적용하여 예측을 수행하는 방법을 개략적으로 설명하는 순서도이다.

발명의 실시를 위한 형태

[0043] 본 발명은 다양한 변경을 가할 수 있고 여러 가지 실시예를 가질 수 있는 바, 특정 실시예들을 도면에 예시하고 상세하게 설명하고자 한다. 그러나, 이는 본 발명을 특정한 실시 형태에 대해 한정하려는 것이 아니다. 본 명세서에서 사용하는 용어는 단지 특정한 실시예를 설명하기 위해 사용된 것으로, 본 발명의 기술적 사상을 한정하려는 의도로 사용되는 것은 아니다. 단수의 표현은 문맥상 명백하게 다르게 뜻하지 않는 한, 복수의 표현을 포함한다. 본 명세서에서, "포함하다" 또는 "가지다" 등의 용어는 명세서상에 기재된 특징, 숫자, 단계, 동작, 구성 요소, 부품 또는 이들을 조합한 것이 존재함을 지정하려는 것이지, 하나 또는 그 이상의 다른 특징들이나 숫자, 단계, 동작, 구성 요소, 부품 또는 이들을 조합한 것들의 존재 또는 부가 가능성을 미리 배제하지 않는 것으로 이해되어야 한다.

[0044] 한편, 본 발명에서 설명되는 도면상의 각 구성들은 영상 부호화/복호화 장치에서 서로 다른 특징적인 기능들에 관한 설명의 편의를 위해 독립적으로 도시된 것으로서, 각 구성들이 서로 별개의 하드웨어나 별개의 소프트웨어로 구현된다는 것을 의미하지는 않는다. 예컨대, 각 구성 중 두 개 이상의 구성이 합쳐져 하나의 구성을 이룰 수도 있고, 하나의 구성이 복수의 구성으로 나뉘어질 수도 있다. 각 구성이 통합 및/또는 분리된 실시예도 본 발명의 본질에서 벗어나지 않는 한 본 발명의 권리범위에 포함된다.

[0045] 이하, 첨부한 도면들을 참조하여, 본 발명의 바람직한 실시예를 보다 상세하게 설명하고자 한다. 이하, 도면상의 동일한 구성 요소에 대해서는 동일한 참조 부호를 사용하고 동일한 구성 요소에 대해서 중복된 설명은 생략한다.

[0046] 도 1은 본 발명의 일 실시예에 따른 영상 부호화(encoding) 장치를 개략적으로

도시한 블록도이다. 도 1을 참조하면, 영상 부호화 장치(100)는 픽처 분할부(105), 예측부(110), 변환부(115), 양자화부(120), 재정렬부(125), 엔트로피 부호화부(130), 역양자화부(135), 역변환부(140), 필터부(145) 및 메모리(150)를 구비한다.

[0047] 픽처 분할부(105)는 입력된 픽처를 적어도 하나의 처리 단위로 분할할 수 있다. 이때, 처리 단위는 예측 유닛(Prediction Unit: PU)일 수도 있고, 변환 유닛(Transform Unit: TU)일 수도 있으며, 부호화 유닛(Coding Unit: CU)일 수도 있다.

[0048] 예측부(110)는 후술하는 바와 같이, 화면 간 예측(inter prediction)을 수행하는 화면 간 예측부와 화면 내 예측(intra predicition)을 수행하는 화면 내 예측부를 포함한다. 예측부(110)는, 픽처 분할부(105)에서 픽처의 처리 단위에 대하여 예측을 수행하여 예측 블록을 생성한다. 예측부(110)에서 픽처의 처리 단위는 부호화 유닛일 수도 있고, 변환 유닛일 수도 있고, 예측 유닛일 수도 있다. 또한, 해당 처리 단위에 대하여 실시되는 예측이 화면 간 예측인지 화면 내 예측인지를 결정하고, 각 예측 방법의 구체적인 내용(예컨대, 예측 모드 등)를 정할 수 있다. 이때, 예측이 수행되는 처리 단위와 예측 방법 및 구체적인 내용이 정해지는 처리 단위는 다를 수 있다. 예컨대, 예측의 방법과 예측 모드 등은 예측 유닛 단위로 결정되고, 예측의 수행은 변환 유닛 단위로 수행될 수도 있다. 생성된 예측 블록과 원본 블록 사이의 잔차값(residual)(잔차 블록(residual block) 또는 잔차 신호(residual siganal))은 변환부(115)로 입력된다. 또한, 예측을 위해 사용한 예측 모드(predicition mode) 정보, 움직임 벡터(motion vector) 정보 등은 잔차값과 함께 엔트로피 부호화부(130)에서 부호화되어 복호화기에 전달된다.

[0049] 변환부(115)는 변환 단위로 잔차 블록에 대한 변환을 수행하고 변환 계수를 생성한다. 변환부(115)에서의 변환 단위는 변환 유닛일 수 있으며, 쿼드 트리(quad tree) 구조를 가질 수 있다. 이때, 변환 단위의 크기는 소정의 최대 및 최소 크기의 범위 내에서 정해질 수 있다. 변환부(115)는 잔차 블록을 DCT(Discrete Cosine Transform) 및/또는 DST(Discrete Sine Transform)를 이용하여 변환할 수 있다.

[0050] 양자화부(120)는 변환부(115)에서 변환된 잔차값들을 양자화하여 양자화 계수를 생성할 수 있다. 양자화부(120)에서 산출된 값은 역양자화부(135)와 재정렬부(125)에 제공된다.

[0051] 재정렬부(125)는 양자화부(120)로부터 제공된 양자화 계수를 재정렬한다. 양자화 계수를 재정렬함으로써 엔트로피 부호화부(130)에서의 부호화의 효율을 높일 수 있다. 재정렬부(125)는 계수 스캐닝(Coefficient Scanning) 방법을 통해 2차원 블록 형태의 양자화 계수들을 1차원의 벡터 형태로 재정렬할 수 있다. 재정렬부(125)에서는 양자화부에서 전달된 계수들의 확률적인 통계를 기반으로 계수 스캔닝의 순서를 변경함으로써 엔트로피 부호화부(130)에서의 엔트로피 부호화 효율을 높일 수도 있다.

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[0052] 엔트로피 부호화부(130)는 재정렬부(125)에 의해 재정렬된 양자화 계수들에 대한 엔트로피 부호화를 수행할 수 있다. 엔트로피 부호화에는 예를 들어, 지수 골롬(Exponential Golomb), CAVLC(Context-Adaptive Variable Length Coding), CABAC(Context-Adaptive Binary Arithmetic Coding)과 같은 부호화 방법을 사용할 수 있다. 엔트로피 부호화부(130)는 재정렬부(125) 및 예측부(110)로부터 전달받은 부호화 유닛의 양자화 계수 정보 및 블록 타입 정보, 예측 모드 정보, 분할 단위 정보, 예측 유닛 정보 및 전송 단위 정보, 움직임 벡터 정보, 참조 픽처(reference picture) 정보, 블록의 보간(interpolation) 정보, 필터링 정보 등 다양한 정보를 부호화할 수 있다.

[0053] 역양자화부(135)는 양자화부(120)에서 양자화된 값들을 역양자화하고, 역변환부(140)는 역양자화부(135)에서 역양자화된 값들을 역변환한다. 역양자화부(135) 및 역변환부(140)에서 생성된 잔차값(Residual)은 예측부(110)에서 예측된 예측 블록과 합쳐져 복원 블록(Reconstructed Block)이 생성될 수 있다.

[0054] 필터부(145)는 디블록킹 필터 및/또는 ALF(Adaptive Loop Filter)를 복원된 픽처에 적용할 수 있다.

[0055] 디블록킹 필터는 복원된 픽처에서 블록 간의 경계에 생긴 블록 왜곡을 제거할 수 있다. ALF(Adaptive Loop Filter)는 디블록킹 필터를 통해 블록이 필터링된 후 복원된 영상과 원래의 영상을 비교한 값을 기초로 필터링을 수행할 수 있다. ALF는 고효율을 적용하는 경우에만 수행될 수도 있다.

[0056] 한편, 화면 간 예측에 사용되는 복원 블록에 대해서 필터부(145)는 필터링을 적용하지 않을 수 있다.

[0057] 메모리(150)는 필터부(145)를 통해 산출된 복원 블록 또는 픽처를 저장할 수 있다. 메모리(150)에 저장된 복원 블록 또는 픽처는 화면 간 예측을 수행하는 예측부(110)에 제공될 수 있다.

[0058] 부호화 유닛(Coding Unit: CU)은 픽처의 부호화/복호화가 수행되는 단위로서, 쿼드 트리 구조(Quad Tree Structure)를 기반으로 깊이(Depth)를 가지며 분할될 수 있다. 부호화 유닛은 64x64, 32x32, 16x16, 8x8 등의 여러 크기를 가질 수 있다.

[0059] 부호화기는 최대 부호화 유닛(Largest Coding Unit: LCU)과 최소 부호화 유닛(Smallest Coding Unit: SCU)에 관한 정보를 복호화기에 전송할 수도 있다. 최대 부호화 유닛 및/또는 최소 부호화 유닛에 관한 정보와 함께 분할 가능한 회수에 관한 정보(깊이 정보)가 복호화기에 전송될 수 있다. 부호화 유닛이 쿼드 트리 구조를 기반으로 분할되는지에 관한 정보는 분할 플래그(Split Flag)와 같은 플래그 정보를 통해 부호화기로부터 복호화기로 전송될 수 있다. 이하, 특별한 설명이 없는 한, 본 명세서에서 '전송'은 부호화기로부터 복호화기로의 정보 전달을 나타낸다.

[0060] 도 2는 본 발명의 일 실시예에 따른 예측부를 개략적으로 도시한 개념도이다.

[0061] 도 2를 참조하면 예측부(200)는 화면 간 예측부(210) 및 화면 내 예측부(220) 를

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포함할 수 있다.

[0062] 화면 간 예측부(210)는 현재 픽처의 이전 픽처 및/또는 이후 픽처 중 적어도 하나의 픽처의 정보를 기초로 예측을 수행하여 예측 블록을 생성할 수 있다. 또한, 화면 내 예측부(220)는 현재 픽처 내의 화소 정보를 기초로 예측을 수행하여 예측 블록을 생성할 수 있다. 화면 간 예측부(210)는 예측 유닛에 대하여, 참조 픽처(reference picture)를 선택하고 예측 유닛과 동일한 크기의 참조 블록을 정수 화소 샘플 단위로 선택할 수 있다. 이어서, 화면 간 예측부(210)는 현재 예측 유닛과의 잔차 신호가 최소화되며 움직임 벡터 크기 역시 최소가 되는 예측 블록을 생성한다. 예측 블록은 1/2 화소 샘플 단위와 1/4 화소 샘플 단위와 같이 정수 이하 샘플 단위로 생성될 수 있다.

[0063] 이때, 움직임 벡터는 정수 화소 이하의 단위로 표현될 수 있으며, 예컨대 휘도(luma) 화소에 대해서는 1/4 화소 단위로, 색차(chroma) 화소에 대해서는 1/8 화소 단위로 표현될 수 있다.

[0064] 화면 간 예측부(210)가 선택한 참조 픽처의 인덱스, 움직임 벡터(ex. Motion Vector Predictor), 잔차 신호 등의 정보는 부호화되어 복호화기에 전달된다.

[0065] 도 3은 본 발명이 적용되는 시스템에서 처리 유닛의 쿼드 트리 구조에 관한 일 예를 개략적으로 설명하는 도면이다.

[0066] 최대 부호화 유닛(LCU, 300)은 분할을 통해서 더 작은 부호화 유닛(310)들로 이루어진 계층적 구조(hierarchical structure)를 가질 수 있으며, 부호화 유닛의 계층적 구조는 크기 정보, 깊이 정보, 분할 플래그 정보 등을 기반으로 특정될 수 있다. 최대 부호화 유닛의 크기 정보, 분할 깊이 정보 및 현재 부호화 유닛의 분할 여부 정보는 비트 스트림 상의 시퀀스 파라미터 셋(SPS)에 포함되어 영상 복호화기에 전송될 수 있다. 다만, 최소 부호화 유닛은 더 이상 작은 부호화 유닛으로 분할되지 않으므로, 최소 부호화 유닛에 대해서는 부호화 유닛의 분할 플래그가 전송되지 않을 수 있다.

[0067] 한편, 화면 간 예측과 화면 내 예측 중 어떤 예측이 수행될 것인지는 부호화 유닛 단위로 결정될 수 있다. 화면 간 예측을 수행하는 경우에는 예측 유닛 단위로 화면 간 예측이 수행될 수 있다. 화면 내 예측을 수행하는 경우에는, 예측 유닛 단위로 예측 모드가 정해져서 예측 유닛 단위로 예측이 수행될 수 있다. 이때, 예측 유닛 단위로 예측 모드가 정해지고 변환 유닛 단위로 화면 내 예측이 수행될 수도 있다.

[0068] 도 3을 참조하면, 화면 내 예측의 경우에 예측 유닛(320)은 2N×2N 또는 N×N (N은 정수)의 크기일 수 있고, 화면 간 예측의 경우에 예측 유닛(330)은 2N×2N, 2N×N, N×2N, 또는 N×N의 크기일 수 있다. 이때, N×N를 특정한 경우, 예컨대 최소 크기 부호화 유닛에 대해서만 적용하도록 정하거나 화면 내 예측에 대해서만 적용하도록 정할 수도 있다. 또한, 도시된 예측 블록의 사이즈 외에, N×mN, mN×N, 2N×mN 또는 mN×2N (m<1)을 더 정의하여 사용할 수도 있다.

[0069] 도 4는 본 발명의 일 실시예에 따른 영상 복호화기를 개략적으로 나타낸

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블록도이다. 도 4를 참조하면, 영상 복호화기(400)는 엔트로피 복호화부(410), 재정렬부(415), 역양자화부(420), 역변환부(425), 예측부(430), 필터부(435) 메모리(440)를 포함할 수 있다.

[0070] 영상 부호화기에서 영상 비트 스트림이 입력된 경우, 입력된 비트 스트림은 영상 부호화기에서 영상 정보가 처리된 절차에 따라서 복호화될 수 있다.

[0071] 예컨대, 영상 부호화기에서 엔트로피 부호화를 수행하기 위해 CAVLC 등의 가변 길이 부호화(Variable Length Coding: VLC, 이하 'VLC' 라 함)가 사용된 경우에는 엔트로피 복호화부(410)도 부호화기에서 사용한 VLC 테이블과 동일한 VLC 테이블로 구현하여 엔트로피 복호화를 수행할 수 있다. 영상 부호화기에서 엔트로피 부호화를 수행하기 위해, CABAC을 이용한 경우에도, 엔트로피 복호화부(410)는 이에 대응하여 CABAC을 이용한 엔트로피 복호화를 수행할 수 있다.

[0072] 엔트로피 복호화부(410)는 엔트로피 부호화되어 전송된 비트스트림 내의 정보를 엔트로피 복호화한다. 엔트로피 복호화부(410)에서 복호화된 정보 중 예측 블록을 생성하기 위한 정보는 예측부(430)로 제공되고 엔트로피 복호화부에서 엔트로피 복호화가 수행된 잔차값은 재정렬부(415)로 입력될 수 있다.

[0073] 재정렬부(415)는 엔트로피 복호화부(410)에서 엔트로피 복호화된 비트 스트림을 영상 부호화기에서 재정렬한 방법을 기초로 재정렬할 수 있다. 재정렬부(415)는 1차원 벡터 형태로 표현된 계수들을 다시 2차원의 블록 형태의 계수로 복원하여 재정렬할 수 있다. 재정렬부(415)는 부호화기에서 수행된 계수 스캐닝에 관련된 정보를 제공받고 해당 부호화부에서 수행된 스캐닝 순서에 기초하여 역으로 스캐닝하는 방법을 통해 재정렬을 수행할 수 있다.

[0074] 역양자화부(420)는 부호화기에서 제공된 양자화 파라미터와 재정렬된 블록의 계수값을 기초로 역양자화를 수행할 수 있다.

[0075] 역변환부(425)는 영상 부호화기에서 수행된 양자화 결과에 대해, 부호화기의 변환부가 수행한 DCT 및 DST에 대해 역DCT 및/또는 역DST를 수행할 수 있다. 역변환은 부호화기에서 결정된 전송 단위 또는 영상의 분할 단위를 기초로 수행될 수 있다. 부호화기의 변환부에서 DCT 및/또는 DST는 예측 방법, 현재 블록의 크기 및 예측 방향 등 복수의 정보에 따라 선택적으로 수행될 수 있고, 복호화기의 역변환부(425)는 부호화기의 변환부에서 수행된 변환 정보를 기초로 역변환을 수행할 수 있다.

[0076] 예측부(430)는 엔트로피 복호화부(410)에서 제공된 예측 블록 생성 관련 정보와 메모리(440)에서 제공된 이전에 복호화된 블록 및/또는 픽처 정보를 기초로 예측 블록을 생성할 수 있다. 복원 블록(reconstructed block)은 예측부(430)에서 생성된 예측 블록과 역변환부(425)에서 제공된 잔차 블록을 이용해 생성될 수 있다.

[0077] 복원된 블록 및/또는 픽처는 필터부(435)로 제공될 수 있다. 필터부(435)는

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복원된 블록 및/또는 픽처에 디블록킹 필터링, SAO(Sample Adaptive Offset) 및/또는 적응적(adaptive) 루프 필터링 등을 적용한다.

[0078] 메모리(440)는 복원된 픽처 또는 블록을 저장하여 참조 픽처 또는 참조 블록으로 사용할 수 있도록 할 수 있고 또한 복원된 픽처를 출력부로 제공할 수 있다.

[0079] 도 5는 본 발명의 일 실시예에 따른 영상 복호화기의 예측부를 개략적으로 나타낸 개념도이다.

[0080] 도 5를 참조하면, 예측부(500)는 화면 내 예측부(510) 및 화면 간 예측부(520)를 포함할 수 있다.

[0081] 화면 내 예측부(510)는 해당 예측 유닛에 대한 예측 모드가 인트라 예측(intra prediction) 모드(화면 내 예측 모드)인 경우에, 현재 픽처(current block) 내의 화소 정보를 기초로 예측 블록을 생성할 수 있다.

[0082] 화면 간 예측부(520)는 해당 예측 유닛에 대한 예측 모드가 인터 예측(inter prediction) 모드(화면 간 예측 모드)인 경우에, 영상 부호화기에서 제공된 현재 예측 유닛의 화면 간 예측에 필요한 움직임 정보, 예컨대 움직임 벡터, 참조 픽처 인덱스 등에 관한 정보를 이용해 현재 예측 유닛이 포함된 현재 픽처의 이전 픽처 또는 이후 픽처 중 적어도 하나의 픽처에 포함된 정보를 기초로 현재 예측 유닛에 대한 화면 간 예측을 수행할 수 있다. 이때, 움직임 정보는 수신되는 부호화 유닛의 스킵 플래그, 머지 플래그 등을 확인하고, 이에 대응하여 유도될 수 있다.

[0083] 도 5에서는 설명의 편의를 위해, 예측부(500)가 각 기능별 구성을 포함하는 것으로 설명하였으나, 본 발명은 이에 한정되지 않으며, 예측부는 상술한 기능을 수행하는 단일 구성으로 구현될 수도 있다.

[0084] 인터 예측 모드의 경우에 부호화기 및 복호화기에서 움직임 정보를 유도하는 방법으로는 스킵(skip) 모드, 다이렉트(direct) 모드, 머지(merge) 모드 등이 있다.

[0085] 스킵 모드와 다이렉트 모드에서는 AMVP(Advanced Motion Vector Predictor)의 후보 MVP(Motion Vector Predictor)로부터 유도되는 움직임 정보를 사용한다. 설명의 편의를 위해, 이하 스킵 모드와 다이렉트 모드를 함께 지칭하여 'AMVP 모드'라 한다. 예컨대, AMVP 모드에서는 참조 픽처에 대한 현재 블록과 주변 블록의 움직임 벡터 차이(Motion Vector difference: MVD)와 참조 픽처에 대한 주변 블록의 움직임 벡터(Motion Vector Predictor: MVP)의 합으로 참조 픽처에 대한 현재 블록의 움직임 벡터를 유도할 수 있다.

[0086] 다이렉트 모드가 적용된 블록에 대해서는, 상기 블록의 움직임 벡터가 지시하는 참조 블록을 기반으로 생성된 예측 블록과 현재 블록의 차이값에 해당하는 잔차 블록이 전송될 수 있다. 스킵 모드가 적용된 블록(ex. 예측 유닛)에 대해서는 부호화기로부터 복호화기로 잔차 신호가 전송되지 않을 수 있다. 스킵 모드의 경우에는 예측 블록의 값을 현재 블록의 값으로 사용할 수 있다.

[0087] 머지 모드가 적용되는 경우에는, 현재 블록(예측 대상 블록)의 주변 블록들

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중에서 머지 후보(candidate)를 정하고, 머지 후보들 중 어느 한 후보의 움직임 정보를 현재 블록의 움직임 정보로 이용할 수 있다. 머지 모드가 적용된 현재 블록에 대해서는 잔차 신호가 전송될 수 있다.

[0088] 도 6은 본 발명이 적용되는 시스템에서 적용되는 AMVP 모드의 일 예를 개략적으로 설명하는 도면이다.

[0089] AMVP를 적용하는 경우에는, 현재 블록 주변의 이용 가능한(available) 후보 블록 및/또는 현재 블록과 동일 위치에 있는(co-located) 각 참조 픽처(대상 픽처라고도 함)의 파티션들 중에서 이용 가능한(available) 블록(이하, 설명의 편의를 위해 '동일 위치 블록(co-located block)'이라 함)의 MVP에 대해 움직임 벡터 경쟁(Motion Vector Competition: MVC, 이하 'MVC'라 함)을 적용하여 최적의 MVP를 선택할 수 있다. 현재 블록의 움직임 벡터는 상기 최적의 MVP를 기반으로 유도될 수 있다. 한편, 현재 블록의 주변 블록이 화면 간 예측 모드인 경우에는 이용 가능한 블록이 아니라고 할 수 있다.

[0090] 도 6의 예를 참조하면, 현재 블록의 좌측 영역(610)에서 화살표 방향으로 검색을 하면서 참조 픽처를 지시하는 참조 인덱스(reference index)가 현재 블록과 동일하고 이용 가능한 첫 번째 블록(A)의 MVP를 AMVP의 후보 중 하나로 선택할 수 있다.

[0091] 도 6에서는 화살표 방향을 따라 위에서 아래로 검색하는 것을 설명하였으나, 이는 현재 블록의 좌측 영역에서 AMVP 후보를 선택하는 방법의 일 예로서, 도 6과 달리 아래에서 위로 검색을 수행할 수도 있다.

[0092] 또한, 현재 블록의 좌측(left) 영역 전체를 순서대로 검색하는 대신에, 좌측 영역에서 특정 블록을 AMVP의 후보로서 고정적으로 사용할 수도 있다. 예컨대, 코너 블록(C, 630)와 맞닿는 좌측 영역 최하단 블록의 MVP를 좌측 영역의 AMVP 후보로서 이용할 수도 있다.

[0093] 현재 블록의 상단(top)에서도 AMVP의 후보를 선택할 수 있다. 도 6의 예를 참조하면, 현재 블록의 상단 영역(620)에서 화살표 방향을 따라서 왼쪽에서 오른쪽으로 검색하면서 현재 블록과 참조 인덱스가 동일하고 이용 가능한 첫 번째 블록(B)의 MVP를 상단 영역에 대한 AMVP 후보로서 선택할 수 있다.

[0094] 도 6에서는 현재 블록의 상단을 왼쪽에서 오른쪽으로 검색하는 것을 설명하였으나, 이는 현재 블록의 상단 영역에서 AMVP 후보를 선택하는 방법의 일 예로서, 도 6과 달리 오른쪽에서 왼쪽으로 검색할 수도 있다.

[0095] 또한, 현재 블록의 상단 영역 전체를 순서대로 검색하는 대신에, 특정 블록을 현재 블록의 상단 영역에 대한 AMVP 후보로서 고정적으로 사용할 수도 있다. 예컨대, 코너 블록(C, 640)와 맞닿는 상단 영역 최우측 블록의 MVP를 현재 블록의 상단 영역에 대한 AMVP 후보로서 이용할 수도 있다.

[0096] 현재 블록의 각 코너 블록(630, 640, 650) 중에서도 AMVP의 후보를 선택할 수 있다. 도 6의 예를 참조하면, 코너 블록들(C)에 대하여, 우상단 코너 블록(640) → 좌상단 코너 블록(650) → 좌하단 코너 블록(630)의 순서로 검색하면서 현재

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블록과 참조 인덱스가 동일하고 이용 가능한 첫 번째 블록의 MVP를 선택할 수도 있다.

[0097] 도 6에서는 우상단 → 좌상단 → 좌하단의 순서로 코너 블록을 검색하는 것을 설명하였으나, 이는 코너 블록들에서 AMVP 후보를 선택하는 방법의 일 예로서, 도 6과 달리 좌하단 → 좌상단 → 우상단의 순서로 검색할 수도 있고, 좌상단 → 우상단 → 좌하단 혹은 좌상단 → 좌하단 → 우상단의 순서로 검색할 수도 있다.

[0098] 또한, 각 코너 블록을 순서대로 검색하는 대신에, 각 코너 블록의 MVP를 모두 AMVP의 후보로 선택할 수도 있다.

[0099] 상술한 각 영역 별(현재 블록의 좌측/상단/코너 영역) AMVP 후보들 외에, 각 영역별 AMVP 후보들의 조합을 AMVP 후보 중 하나로 선택할 수도 있다. 예컨대, 현재 블록의 좌측 영역, 상단 영역, 코너 영역에서 선택된 MVP에 대하여 각 움직임 정보들의 미디언 값을 AMVP의 후보 중 하나로 취할 수도 있다.

[0100] 현재 블록에 대하여 공간적으로 이웃하는 블록들로부터 AMVP 후보를 선택하는 방법 외에, 동일 위치 블록(co-located block)의 MVP를 AMVP 후보로 선택할 수 있다.

[0101] 이렇게 선택된 AMVP 후보들에 대하여 MVC에 의해 최적의 MVP를 선택하고, 선택한 최적의 MVP를 이용하여 현재 블록의 움직임 정보를 나타낼 수 있다.

[0102] 예컨대, 부호화기/복호화기의 예측부에서는 AMVP의 후보들이 선택되면, 중복성(redundancy)을 줄이기 위해 중복되는 MVP를 배제하고, AMVP 후보 리스트를 작성할 수 있다. 예컨대, 중복되는 n개의 MVP들 중에서 한 MVP만을 남기고, 나머지 n-1 개의 MVP는 AMVP 후보 리스트 작성에서 배제할 수 있다.

[0103] AVMP 후보 리스트를 구성하는 MVP들의 개수와 순서는 특정될 수 있다. 예컨대, 현재 블록 주변의 후보들 중에서 소정 개수의 후보를 선택하고, 동일 위치 블록으로부터 하나의 후보를 선택하여 AMVP 후보 리스트를 구성할 수도 있다. 이때, AMVP 후보 리스트를 구성할 후보들의 이용 가능성을 판단하는 순서를 특정하고, 이 순서에 따라서 먼저 이용 가능한 것으로 판단된 후보들로 리스트를 구성할 수도 있다. 후보 블록이 화면 내 예측 모드인 경우에는 이용 가능한 MVP가 아닌 것으로 보고, AMVP 후보에서 제외할 수 있다.

[0104] 예측부에서는 AMVP 후보 리스트 내의 후보들에 대한 비용(cost)을 산출하여 최적의 MVP(best MVP)를 선택할 수 있다. 이 경우에, AMVP 후보 리스트에서 선택된 MVP에 대한 비용과 특정 위치의 MVP 혹은 특정 연산 결과 얻어지는 MVP에 대한 비용을 추가로 비교하여 하나의 MVP를 정할 수도 있다.

[0105] 상술한 바와 같이, AMVP에 의해 최적의 MVP가 유도(derivation)되면, 이 MVP를 이용하여 스킵 모드 또는 다이렉트 모드를 적용할 수 있다.

[0106] 도 7은 본 발명이 적용되는 시스템에서 머지 모드를 적용하는 일 예를 개략적으로 설명하는 도면이다.

[0107] 머지 모드가 적용되는 경우에는 현재 블록 주변의 블록들 중 어느 하나의 움직임 정보를 이용하여 현재 블록의 움직임 정보를 나타낼 수 있다. 예컨대,

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현재 블록 주변의 블록들 중 어느 하나의 참조 블록(픽처)에 대한 움직임 벡터를 현재 블록의 움직임 벡터로 이용할 수 있다. 이때, 움직임 정보와 함께 잔차 신호를 전송할 수도 있고, 예측 블록의 화소값을 현재 블록의 화소값으로 사용하는 경우에는 잔차 신호를 전송하지 않을 수도 있다. 여기서, 현재 블록 주변의 블록들은 동일 위치 블록을 포함한다.

[0108] 예를 들어 도 7의 경우에, 현재 블록의 좌측 영역에서 선택된 블록(710)과 현재 블록의 상단 영역에서 선택된 블록(720)을 머지의 후보로 이용할 수 있다. 이때, 도시된 바와 같이, 현재 블록의 좌측 영역에서 선택되는 블록은 좌측 상단의 블록일 수 있고, 현재 블록의 상단 영역에서 선택되는 블록은 상단 좌측의 블록일 수 있다.

[0109] 또한, 머지 모드를 적용하는 경우에도, AMVP 모드의 경우와 유사하게 동일 위치(co-located) 블록을 후보 중의 하나로 할 수도 있고, 현재 블록의 코너에 있는 블록들을 후보로 할 수도 있다.

[0110] 이렇게 선택된 머지 후보들 중에서 하나의 후보를 선택하고, 선택한 후보의 움직임 벡터를 이용하여 현재 블록의 움직임 정보를 나타낼 수 있다. 예컨대, 부호화기/복호화기의 예측부에서는 머지 후보들이 선택되면, 중복성(redundancy)을 줄이기 위해 중복되는 후보들을 배제하고, 머지 후보 리스트를 작성할 수 있다.

[0111] 머지 후보 리스트를 구성하는 후보들의 개수와 순서는 특정될 수 있다. 예컨대, 현재 블록 주변의 블록들 중에서 소정 개수의 후보를 선택하고, 동일 위치 블록으로부터 하나의 후보를 선택할 수도 있다. 이때, 후보의 이용 가능성을 판단하는 순서를 특정하고, 이 순서대로 후보들의 이용 가능성을 판단해서, 이용 가능한 것으로 먼저 판단된 후보들로 머지 후보 리스트를 구성할 수도 있다. 화면 내 예측 모드의 블록은 이용 가능한(unavailable) 블록이 아니라고 판단될 수 있다.

[0112] 예측부에서는 머지 후보 리스트 내의 후보들에 대한 비용을 산출하여 최적의 후보 블록을 선택할 수 있다. 상술한 바와 같이, 머지 후보들 중에서 하나의 후보 블록이 선택되면, 현재 블록을 이 블록에 머지할 수 있다. 현재 블록이 선택된 후보 블록에 머지되면, 선택된 후보 블록의 움직임 정보를 현재 블록의 움직임 정보로 이용할 수 있다.

[0113] 한편, 부호화기에서는 AMVP에 의해 선택된 MVP를 이용하는 경우의 비용과 머지 모드를 적용하는 경우의 비용을 비교하여, AMVP 모드와 머지 모드 중 어느 하나를 이용하여 현재 블록의 화면 간 예측을 수행할 수도 있다.

[0114]

[0115] **<u>< 예측 모드의 방향성 지시 ></u>**

[0116] 상술한 움직임 정보의 유도 방법들이 부호화기에서 사용된 경우에, 부호화기는 현재 블록의 움직임 정보를 유도하기 위한 정보를 복호화기에 전송할 수 있다.

[0117] 전송되는 정보는 잔차 신호의 존부에 따라서, 우선 스킵 모드가 적용되는지를

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알려주고, 스킵 모드가 적용되는 경우에는 그에 따라서 예측이 이루어지도록 할 수 있다. 스킵 모드가 적용되는지에 관한 정보는 스킵 모드 적용에 관한 플래그(이하, '스킵 플래그(skip_flag)'라 함)를 통해 전달될 수도 있다.

[0118] 스킵 모드가 적용되지 않는다는 것을 스킵 플래그가 지시한 경우에는 다이렉트 모드가 적용되는지를 지시할 수 있다. 이때, 예측 모드에 관한 인덱스를 지정하고, 다이렉트 모드를 지정하는 인덱스(ex. pred-mode==0)를 전송함으로써, 현재 블록에 다이렉트 모드가 적용된다는 정보를 전달할 수 있다.

[0119] 머지 모드가 적용되는 경우에, 부호화기는 머지 모드에 관한 정보를 복호화기에 전송할 수 있다. 예컨대, 머지 모드가 적용되는지에 관한 정보를 나타내는 플래그(이하, '머지 플래그'라 함)를 사용하여 해당 블록에 머지 모드가 적용되는지를 복호화기에 알려줄 수 있다.

[0120] 표 1은 움직임 정보를 유도하는 방법에 관한 정보를 전송하는데 이용되는 신택스 구조의 일 예를 개략적으로 나타낸 것이다.

[0121] [Table 1]

```
prediction_unit()
{
  ...
    skip_flag
    if ( skip_flag==1 )
    {
        스킵 모드로 디코딩
    }
    else
    {
        pred_mode
        if (pred_mode==0)
        {
            다이렉트 모드로 디코딩
        }
        if (pred_mode==MODE_INTER)
        {
            merge_flag
            if (merge_flag==1)
                merge_left_flag
                머지 모드로 디코딩
         }
    }
...
}
```

[0122] 여기서, skip_flag는 스킵 모드가 적용되는지를 나타내는 플래그로서, skip_flag의 값이 1인 경우에는 스킵 모드가 적용되는 것을 나타내고 있다. 또한, merge_flag는 머지 모드가 적용되는지를 나타내는 플래그로서, merge_flag의 값이 1인 경우에는 머지 모드가 적용되는 것을 나타낸다. 다만, 표 1은 상술한

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내용을 적용하는 일 예로서, skip_flag의 값이 0인 경우에 스킵 모드를 적용하거나 merge_flag의 값이 0인 경우에 머지 모드를 적용하도록 정할 수도 있다.

[0123] 상술한 표에서 pred_mode는 어떤 예측 모드가 적용되는지를 지시하는 신택스로서, pred_mode==0은 다이렉트 모드가 적용되었다는 것을 지시하는 값이다.

[0124] merge_left_flag는 현재 블록이 어느 쪽의 머지 후보에 머지(merge)되는지를 지시하는 플래그이다. 예를 들어, merge_left_flag==1인 경우에는 현재 블록의 좌측에서 선택된 머지 후보에 머지하는 것을 지시하고, merge_left_flag==0인 경우에는 현재 블록의 상단에서 선택된 머지 후보에 머지하는 것을 지시하도록 할 수 있다.

[0125] 여기서는 다이렉트 모드의 적용 여부를 지시하는 예측 모드 (pred_mode)를 먼저 확인한 후에, 머지 플래그를 확인하는 것으로 설명하였으나, 머지 플래그를 먼저 확인하고 예측 모드를 확인할 수도 있다.

[0126] 또한, 상술한 표 1과 달리, 잔차 신호의 전송 여부와 관련하여, 잔차 신호가 전송되지 않는 스킵 모드가 적용되거나 혹은 잔차 신호의 전송 없이 머지 모드가 적용되는 경우에는, 예측 유닛 레벨의 파라미터 셋이 아닌 상위단의 파라미터 셋에서 관련 정보를 알려줄 수도 있다.

[0127] 한편, 스킵 모드가 적용되는 경우에, 예측 방향을 알려주는 신택스를 파라미터 셋에 추가하여 단방향(uni-directional) 예측과 양방향(bi-directional) 예측이 모두 효과적으로 수행될 수 있도록 할 수 있다.

[0128] 예컨대, 복수의 참조 인덱스와 복수의 움직임 벡터를 이용하는 화면 간 예측 또는 화면 내 예측을 통해 복호화되는 B 슬라이스(slice)에 스킵 모드를 적용하면서 예측 방향을 지시함으로써, B 슬라이스에서도 효과적으로 단방향 예측, 예컨대, L0 방향 예측 또는 L1 방향 예측이 수행될 수 있도록 할 수 있다. 여기서, L0과 L1은 참조 픽처의 리스트로서, L0은 현재 픽처에 순방향(시간축상에서 과거 방향)으로 가까운 참조 픽처일수록 더 낮은 인덱스가 부여된 리스트이고, L1은 현재 픽처에 역방향(시간축상에서 미래 방향)으로 가까운 참조 픽처일수록 더 낮은 인덱스가 부여된 리스트이다. 따라서, B 슬라이스의 경우에도 스킵 모드를 적용하면서, 세 예측 방향(L0 방향, L1방향, 양방향) 중 어느 한 방향을 예측 방향으로 지정할 수 있다.

[0129] 스킵 모드가 적용되는 경우에 예측 방향을 알려주는 신택스로서는 예측의 방향을 지시하는 예측 방향 지시자(예컨대, inter_pred_idc)를 도입할 수 있다.

[0130] 표 2는 예측 방향 지시자(inter_pred_idc)를 사용하는 경우에 관한 신택스의 일 예를 개략적으로 나타낸 것이다.

[0131]

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[Table 2]

prediction_unit(x0, y0, currPredUnitSize){
if (slice_type!=I)
skip_flag
if(skip_flag){
if (slice_type==B)
inter_pred_idc
if(mv_competition_flag){
if(inter_pred_idc!=Pred_L1 && NumMVPCand(L0)>1)
mvp_idx_l0
if(inter_pred_idc!=Pred_L0 && NumMVPCand(L1)>1)
mvp_idx_l1
}
}
else{

[0132] 표 2의 예에 있어서, 스킵 모드가 적용되는 경우(skip_flag=1)에 예측 방향 지시자(inter_pred_idc)는 상술한 바와 같이, 세 예측 방향(L0방향, L1방향, 양 방향) 중 어느 한 방향을 지시할 수 있다. 예컨대, (1) inter_pred_idc==0인 경우에는 L0 방향의 예측, (2) inter_pred_idc==1인 경우에는 L1 방향의 예측, (3) inter_pred_idc==2인 경우에는 양 방향 예측을지시하도록 할 수 있다.

[0133] 도 8은 본 발명이 적용되는 부호화기에서 예측 모드 정보를 구성해서 전송하는 방법을 개략적으로 설명하는 도면이다.

[0134] 도 8을 참조하면, 부호화기는 우선 파라미터 셋을 구성한다(S810). 파라미터 셋은 소정의 신택스 구조에 따라서 구성되며, 복호화기에 전송할 특징 정보를 포함한다. 파라미터 셋을 해당 정보에 대한 '신택스'라 할 수도 있다. 스킵 모드를 적용하는 경우에, 부호화기는 스킵 모드를 적용하여 움직임 벡터를 이용할 참조 픽처의 리스트를 지시하는 지시자를 포함하도록 파라미터를 구성할 수 있다.

[0135] 이때, 부호화기는 단순히 참조 픽처 리스트를 지시하는 것이 아니라, 구체적인 참조 픽처 또는 참조 블록을 지시하는 지시자가 포함되도록 파라미터 셋을 구성할 수도 있다. 참조 픽처는 참조 픽처 리스트 내의 특정 픽처일 수 있고, 참조 블록은 현재 블록의 주변 블록 중 어느 하나 혹은 동일 위치 블록(collocated block)일 수 있다.

[0136] 부호화기는 구성한 파라미터 셋을 복호화기로 전송한다(S820). 파라미터 셋에

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포함된 정보는 부호화되어 비트스트림으로 복호화기에 전달될 수 있다.

[0137] 파라미터 셋을 수신한 복호화기는 현재 블록을 복호화하기 위한 정보를 획득할 수 있다. 수신한 파라미터 셋은 스킵 모드에서 예측 방향을 지시하는 정보를 포함할 수 있다. 복호화기는 스킵 모드를 적용하는 경우에는 지시된 예측 방향, 즉 지시된 참조 픽처 리스트 중에서 지시되는 움직임 벡터 예측자(Motion Vector Predictor: MVP)를 이용하여 현재 블록의 움직임 정보를 얻을 수 있다.

[0138] 전송된 정보에서 구체적으로 스킵 모드를 적용할 참조 블록이 직접 지시되는 경우에는, 해당 참조 블록의 움직임 벡터를 이용하여 현재 블록의 움직임 벡터를 유도할 수 있다. 스킵 모드가 적용되는 경우이므로, 해당 움직임 벡터가 지시하는 참조 블록을 통해 생성된 예측 블록을 현재 블록의 화소값 블록으로 이용할 수 있다.

[0139]

[0140] **<u><AMVP모드와 머지 모드의 통합 - 비용 산출 및 AMVP 후보 리스트 변경></u>**

[0141] 한편, 움직임 정보의 두 유도 방법(AMVP 모드, 머지 모드)은, 현재 블록의 주변 블록으로부터 유도된 움직임 정보와 잔차 신호(잔차가 없어 잔차 신호를 전달되지 않는 경우도 포함) 를 통해서, 현재 블록의 화소 정보를 구한다는 점에서 유사하다. 따라서, AMVP모드와 머지 모드를 통합하여 이용하는 것을 고려할 수 있다.

[0142] AMVP모드와 머지 모드에서는 현재 블록의 움직임 정보를 유도하기 위해 사용하는 후보 블록들이 상이할 수 있다. 예컨대, AMVP모드에서는 여러 후보 블록의 움직임 벡터를 후보 MVP로 하고, 이 후보 MVP들 중 하나를 이용하여 현재 블록의 움직임 정보를 유도할 수 있다. 머지 모드에서는 현재 블록 좌측의 후보 블록과 현재 블록 상단의 후보 블록 중 선택된 후보 블록의 움직임 벡터를 이용하여 현재 블록의 움직임 정보를 유도할 수 있다.

[0143] 다만, AMVP 모드와 머지 모드의 후보 블록들이 서로 다르다고 해도, AMVP 모드에서 후보 블록(후보 MVP)을 선택하기 위해 검색하는 영역에는 머지 후보가 포함되어 있다. 예컨대, AMVP 모드를 적용하는 도 6의 경우에, 후보 블록 A와 B를 선택하기 위해 검색하는 영역(610, 620)에, 머지 모드를 적용하는 도 7에서 선택된 후보 블록(710, 720)이 포함되어 있다.

[0144] 또한, 현재 블록의 움직임 정보를 유도하는 방법으로서 AMVP 모드와 머지 모드를 순차적으로 적용할 수도 있는데, 먼저 적용하는 모드로부터 나중에 사용하는 모드에 필요한 정보를 유도해서 정보 전달량을 줄일 수도 있다. 가령, AMVP 모드를 먼저 적용하고, AMVP 모드를 이용하지 않는 경우에 머지 모드를 이용한다고 가정하면, AMVP 모드에서 사용되는 정보들(예컨대, 후보 블록(후보 MVP)의 정보)을 조합하여 머지 모드를 적용하는데 필요한 정보를 유도하도록 할 수 있다. 예컨대, AMVP 모드에서 사용하는 스킵 플래그, 예측 모드를 나타내는 신택스, AMVP 후보 등에 관한 정보들을 조합하여 머지 모드를 나타내기 위한 정보의 양을 줄일 수 있다.

[0145] 구체적으로, AMVP의 후보들 중에서 최선의 후보를 선택하기 위해 비용을 산출하는 과정에서 머지 모드의 후보를 고려할 수 있다.

[0146] 이하, 부호화기의 측면과 복호화기의 측면을 나누어 설명한다.

[0147]

[0148] (1) 부호화기 측면

[0149] 상술한 바와 같이, AMVP 후보들에 대한 비용을 산출하는 과정에서 머지 후보를 고려하면, 부호화기측에서는 AMVP모드와 머지 모드에 대한 비용을 계산하는 과정을 단순화할 수 있으므로, 부호화 복잡도(encoding complexity)를 감소시킬 수 있다.

[0150] 구체적으로, 부호화기에서는 우선 현재 블록에 대하여 AMVP모드를 적용할 때의 비용(cost)을 체크한다. 이때, 부호화기는 스킵 모드에 대한 비용과 다이렉트 모드에 대한 비용을 각각 체크할 수 있다.

[0151] 스킵 모드에 대한 비용이 다이렉트 모드에 대한 비용보다 적은 경우에는 아래와 같은 두 조건 중 일부 또는 전부를 사용하여 머지 모드에 대한 비용을 산출하는 과정을 패스(pass)할 수 있다. 스킵 모드에 대한 비용이 다이렉트 모드에 대한 비용보다 적은 경우라면, 스킵 모드에 대한 후보와 다이렉트 모드에 대한 후보에 대한 비용을 비교한 후에 스킵 모드를 적용하는 쪽으로 결정이 될 것이다. 다이렉트 모드와 유사한 방식으로 주변 블록의 움직임 벡터를 이용하되 잔치 신호를 전송하는 머지 모드의 비용은 다이렉트 모드의 비용과 유사할 수 있다. AMVP의 후보 블록과 동일해서 스킵 모드와 다이렉트 모드의 비용을 비교할 때 이미 검토된 후보 블록이라면, 해당 후보 블록에 대해서는 머지 모드의 비용을 산출하는 것을 패스할 수 있다.

[0152]

[0153] 1) 현재 블록의 상단 영역과 좌측 영역에서 선택된 AMVP 후보 블록 또는 후보 MVP가 머지 모드의 후보 블록 또는 후보 움직임 벡터와 동일한지 여부. (이하, 설명의 편의를 위해, AMVP 후보 블록 또는 후보 MVP를 'AMVP 후보'로, 머지 모드의 후보 블록 또는 후보 움직임 벡터를 '머지 후보'로 표현한다.)

[0154] 2) AMVP를 통해 결정된 최적의 MVP(best MVP)가 머지 후보와 동일한지 여부

[0155]

[0156] 1)의 조건만을 이용할 때,

[0157] (a) 현재 블록의 좌측 영역(예컨대, 도 6의 610)에서 선택된 AMVP 후보가 현재 블록의 좌측 영역에서 선택된 머지 후보와 동일한 경우 - 머지 모드에 대한 비용을 산출하는 과정 중 현재 블록의 좌측 영역에서 선택된 머지 후보에 머지(merge)하는 경우에 대해서는 비용 산출을 패스한다.

[0158] (b) 현재 블록의 상단 영역(예컨대, 도 6의 620)에서 선택된 AMVP 후보가 현재 블록의 상단 영역에서 선택된 머지 후보와 동일한 경우 - 머지 모드에 대한 비용을 산출하는 과정 중 현재 블록의 상단 영역에서 선택된 머지 후보에 머지하는 경우에 대해서는 비용 산출을 패스한다.

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[0159] (c) 필요에 따라서는 (a)와 (b)의 경우를 조합하여 적용할 수 있다. 예를 들어, (a)와 (b)를 동시에 만족하는 경우에는 머지 모드에 대한 비용을 구하는 과정 중 현재 블록의 좌측 또는 상단 영역에서 선택된 머지 후보에 대한 비용을 구하는 것을 패스하거나, 머지 모드에 대한 비용을 구하는 과정 전체를 패스할 수 있다.

[0160]

[0161] 1)과 2)의 조건을 모두 이용할 때,

[0162] (a) AMVP를 통해 결정된 최적의 MVP가 현재 블록의 좌측 영역(예컨대, 도 6의 610)에 존재하고, 최적의 MVP가 현재 블록의 좌측 영역에서 선택된 머지 후보와 동일한 경우 - 머지 모드에 대한 비용을 산출하는 과정 중에서 현재 블록의 좌측 영역에서 선택된 머지 후보에 머지하는 경우에 대해서는 비용 산출을 패스한다.

[0163] (b) AMVP를 통해 결정된 최적의 MVP가 현재 블록의 상단 영역(예컨대, 도 6의 B 영역)에 존재하고, 최적의 MVP가 현재 블록의 상단 영역에서 선택된 머지 후보와 동일한 경우 - 머지 모드에 대한 비용을 산출하는 과정 중에서 현재 블록의 상단 영역에서 선택된 머지 후보에 머지하는 경우에 대해서는 비용 산출을 패스한다.

[0164] (c) 필요에 따라서는 (a)와 (b)의 경우를 조합하여 적용할 수 있다. 예를 들어, (a)와 (b)를 동시에 만족하는 경우에는 머지 모드에 대한 코스트를 구하는 과정 중 현재 블록의 좌측 또는 상단 영역에서 선택된 머지 후보에 대한 비용을 산출하는 것을 패스하거나, 머지 모드에 대한 비용을 산출하는 과정 전체를 패스할 수 있다.

[0165] 도 9는 본 발명이 적용되는 부호화기에서 상술한 바와 같이 예측 후보들의 비용을 산출하는 방법을 개략적으로 설명하는 순서도이다.

[0166] 도 9를 참조하면, 부호화기(예컨대, 예측부)는 AMVP후보에 대한 비용을 산출한다(S910). 부호화기는 머지 후보가 AMVP 후보에 포함되는지를 판단할 수 있다(S920). 이때, 머지 후보가 AMVP 후보에 포함되는지는, 전체 AMVP 후보 중에 머지 후보와 동일한 것이 있는지 판단하는 경우와 최적의 AMVP 후보가 머지 후보와 동일한지를 판단하는 경우를 모두 포함한다. 각각의 경우에 대한 상세한 내용은 앞서 설명한 바와 같다.

[0167] 머지 후보가 AMVP 후보에 포함되는 경우, 즉, 머지 후보가 AMVP 후보 중 어느 하나와 동일한 경우에는, 해당 머지 후보에 머지하는 경우에 대한 비용은 산출하지 않는다(S930). AMVP 후보에 포함되지 않는 머지 후보에 대해서는, 해당 머지 후보에 머지하는 경우에 대한 비용을 산출한다(S940).

[0168]

[0169] (2) 복호화기 측면

[0170] 스킵 모드가 적용되지 않고(skip_flag==0), 화면 간 예측이 적용되는(pred_mode==MODE_INTER) 경우에, 머지 플래그(예컨대, merge_flage) 및/또는 머지 방향/대상을 지시하는 플래그(예컨대, merge_left_flag)가 모두 전송되지 않아도 복호화기는 현재 블록의 움직임 정보를 유도할 수 있다. 이때,

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아래와 같은 조건을 이용할 수 있다.

[0171]

[0172] 현재 블록의 좌측 영역과 상단 영역(예컨대, 도 6의 A와 B 영역)에 대해 선택된 AMVP 후보와 머지 후보가 동일한지 여부

[0173]

[0174] 상기 조건을 적용하는 경우,

[0175] (a) 현재 블록의 좌측 영역(예컨대, 도 6의 A 영역)에서 선택된 AMVP 후보가 현재 블록의 좌측 영역에서 선택된 머지 후보와 동일한 경우 - 머지 모드를 적용하는 경우(merge_flag==1)라면, 현재 블록의 상단 영역에서 선택된 머지 후보에 머지(merge)할 수 있다. 따라서, 부호화기로부터 어느 쪽의 머지 후보에 머지할 것인지를 나타내는 플래그(예컨대, merge_left_flag)가 전송되지 않을 수 있다.

[0176] (b) 현재 블록의 상단 영역(예컨대, 도 6의 B 영역)에서 선택된 AMVP 후보가 현재 블록의 상단 영역에서 선택된 머지 후보와 동일한 경우 - 머지 모드를 적용하는 경우(merge_flag==1)라면, 현재 블록의 좌측 영역에서 선택된 머지 후보에 머지할 수 있다. 따라서, 부호화기로부터 어느 쪽의 머지 후보에 머지할 것인지를 나타내는 플래그(예컨대, merge_left_flag)가 전송되지 않을 수 있다.

[0177] (c) 필요에 따라서는 (a)와 (b)의 경우를 조합하여 적용할 수 있다. 예를 들어, 현재 블록의 좌측 영역에서 선택된MVP 후보 및 현재 블록의 상단 영역에서 선택된 AMVP 후보가 각각 현재 블록의 좌측 영역에서 선택된 머지 후보 및 현재 블록의 상단 영역에서 선택된 머지 후보와 동일한 경우에는, 머지 모드를 적용하지 않을 수 있다. 따라서, 머지 모드를 적용할지를 나타내는 플래그(예컨대, merge_flag)와 현재 블록의 어느 쪽 머지 후보에 머지할 것인지를 지시하는 플래그(예컨대, merge_left_flag)가 부호화기로부터 전송되지 않을 수 있다.

[0178]

[0179] 도 10은 본 발명이 적용되는 복호화기에서 상술한 바와 같은 머지가 수행되는 방법을 개략적으로 설명하는 순서도이다. 도 10을 참조하면, 복호화기는 머지가 적용되는지를 판단한다(S1010).

[0180] 머지가 적용되는 경우에는, 머지 후보 중에 AMVP 후보에 포함되는 것이 있는지를 판단한다(S1020). 이때, 머지 후보가 AMVP 후보에 포함되는지는, 전체 AMVP 후보 중에 머지 후보와 동일한 것이 있는지 판단하는 경우와 최적의 AMVP 후보가 머지 후보와 동일한지를 판단하는 경우를 모두 포함한다. 각각의 경우에 대한 상세한 내용은 앞서 설명한 바와 같다.

[0181] 머지 후보가 AMVP 후보와 동일하지 않다면, 어느 쪽의 머지 후보에 머지할 것인지를 지시하는 플래그를 복호화하고(S1030), 상기 플래그에 따라서 머지를 수행한다(S1050). 머지 후보가 AMVP 후보와 동일하다면, 어느 쪽의 머지 후보에 머지할 것인지를 지시하는 플래그를 복호화하지 않고(S1040), AMVP 후보와

동일하지 않은 머지 후보에 머지한다(S1050). 여기서, 어느 쪽의 머지 후보에 머지할 것인지를 지시하는 플래그를 복호화하지 않는 것은 해당 플래그가 부호화기로부터 전송되지 않아서, 복호화하지 않는 것을 포함한다.

[0182]

[0183] 한편, AMVP를 이용하는 방법과 머지 모드를 통합하는 또 다른 방법으로서, AMVP후보를 생성하는 과정에서 머지 후보를 고려할 수 있다. 즉, AMVP후보와 머지 후보가 서로 다른 경우에는, 머지 후보를 AMVP 후보로서 추가하여 AMVP를 적용할 수 있다. 이때, AMVP모드와 머지 모드 사이의 유사성을 고려하여, 부호화기는 AMVP모드와 머지 모드 중 어느 하나만을 사용하도록 복호화기에 시그널링 할 수도 있다. 여기서, 시그널링한다는 것은 관련된 정보 및/또는 지시를 전송한다는 것을 의미한다.

[0184] 먼저, 부호화기는 AMVP 후보 리스트와 머지 후보 리스트를 비교하여, 현재 블록의 주변 영역(예컨대, 도 6의 610, 620과 같은 현재 블록의 좌측 및/또는 상단 영역)에 대한 AMVP 후보와 머지 후보가 동일한지를 확인(check)할 수 있다.

[0185] 현재 블록의 주변 영역에 대하여, 머지 후보 중 일부 또는 전부가 AMVP 후보 리스트에 존재하지 않는 경우(AMVP 후보에 포함되지 않는 머지 후보가 존재하는 경우)에는, AMVP 후보가 아닌 머지 후보를 AMVP 후보 리스트에 추가할 수 있다. 따라서, AMVP 후보가 확장될 수 있다.

[0186] 이때, 머지 모드에 대해서는 시그널링 하지 않고, 확장된 AMVP 후보들의 리스트와 함께 AMVP모드를 적용하도록 하는 시그널링이 이루어질 수도 있다. 예컨대, 잔차 신호를 전송하는 경우에는 확장된 AMVP 후보를 이용한 다이렉트 모드가 수행되도록 시그널링 할 수 있다.

[0187] 또한, 상술한 바와 같이, AMVP 후보 리스트에 머지 후보를 추가하여 AMVP 후보를 확장하는 방법 외에도, AMVP 후보의 일부 또는 전부와 머지 후보를 경쟁시켜 AMVP 후보들 중 일부 또는 전부를 머지 후보로 대체/변경시킬 수도 있다. 이 경우에는 변경된 AMVP 후보 리스트를 기반으로 AMVP모드를 적용하도록 부호화기로부터 복호화기로 시그널링이 이루어질 수 있다.

[0188] 도 11은 본 발명이 적용되는 부호화기에서 상술한 바와 같이 AMVP 후보 리스트를 변경하는 동작을 개략적으로 설명하는 순서도이다.

[0189] 도 11을 참조하면, 부호화기(예컨대, 예측부)에서는 현재 블록에 대한 AMVP 후보 리스트와 머지 후보 리스트를 작성한다(S1110).

[0190] 부호화기는 상기 AMVP 후보 리스트와 머지 후보 리스트를 기반으로, AMVP 후보와 머지 후보의 동일성을 판단한다(S1120). 예컨대, 부호화기는 머지 후보 중에 AMVP 후보에 포함되지 않는 후보가 있는지를 확인할 수 있다.

[0191] 부호화기는 AMVP 후보 리스트에 속하지 않는 머지 후보를 이용하여 AMVP 후보 리스트를 변경할 수 있다(S1130). 이때, 부호화기는 AMVP 후보 리스트에 속하지 않는 머지 후보를 AMVP 후보 리스트에 추가할 수도 있고, AMVP 후보 리스트의 일부를 머지 후보로 변경할 수도 있다.

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[0192] 부호화기는 변경된 AMVP 후보 리스트를 복호화기에 시그널링 할 수 있다(S1140). 이때, 부호화기의 시그널링은 변경된 AMVP 후보 리스트를 전송하는 시그널링일 수도 있고, AMVP 후보 리스트를 변경하도록 하는 시그널링일 수도 있다.

[0193] 도 12는 본 발명이 적용되는 복호화기에서 변경된 AMVP 리스트를 기반으로 예측을 수행하는 방법을 개략적으로 설명하는 도면이다. 도 12를 참조하면, 복호화기는 부호화기로부터 시그널링을 수신한다(S1210).

[0194] 부호화기로부터의 시그널링은 AMVP 후보 리스트를 포함한다. 또한, 부호화기로부터의 시그널링은 AMVP 후보 리스트를 변경하도록 하는 시그널링일 수도 있다.

[0195] 복호화기는 변경된 AMVP 후보 리스트를 수신한 경우에는 기존의 AMVP 후보 리스트를 대체하며, AMVP 후보 리스트를 변경하는 시그널링을 수신한 경우에는 시그널링에 따라서 AMVP 후보 리스트를 변경한다.

[0196] 복호화기는 변경된 AMVP 후보 리스트를 기반으로 최적의 MVP를 선택하여 예측을 수행할 수 있다(S1220).

[0197]

[0198] **<u><AMVP를 이용하는 방법과 머지 모드의 통합 - 통합 모드 및 시그널링 ></u>**

[0199] 머지 모드의 경우, 주변 블록으로부터 현재 블록의 움직임 정보를 유도한다. 잔차 신호를 전송하는 머지 모드는 상술한 다이렉트 모드와 유사하다. 따라서, 잔차 신호를 전송하는 머지 모드와 다이렉트 모드를 통합하여 적용하는 것을 고려할 수 있다.

[0200] 예컨대, 다이렉트 모드가 코딩 블록(코딩 유닛) 단위로 적용되는 경우에, 머지 모드가 코딩 블록 단위 및 코딩 블록을 분할한 파티션 단위로 적용될 수 있다면, 다이렉트 모드와 동일한 단위에서 머지 모드를 다이렉트 모드와 통합하여 적용할 수 있다.

[0201] 동일하게, 코딩 블록, 예측 블록 또는 변환 블록과 같은 처리 단위들 중에 다이렉트 모드가 적용되는 단위와 머지 모드가 적용되는 처리 단위가 동일한 경우가 있다면, 해당 처리 단위에 대하여 다이렉트 모드와 머지 모드를 통합하여 적용할 수 있다.

[0202] 여기서는 잔차 신호가 전달되는 머지 모드와 AMVP를 이용하되 역시 잔차 신호를 전송하는 다이렉트 모드의 병합을 예로서 설명하였지만, 서로 유사한 모드, 예컨대 잔차 신호를 전송하지 않는 머지 모드나 AMVP를 이용하되 역시 잔차 신호를 전송하지 않는 스킵 모드를 동일한 방법으로 병합할 수 있다.

[0203] 따라서, 이하 설명하는 방법에 의해, 머지 모드와 AMVP모드를 통합하여 적용할 수 있다. 통합의 구체적인 방법은 현재 블록의 움직임 정보를 유도할 수 있는 주변의 후보 블록 또는 후보 움직임 벡터(이하, 설명의 편의를 위해 후보 블록과 후보 움직임 벡터를 '후보'라 함)들을 동일하게 생성/도출해서 이용하는 방법을 생각할 수 있다. 이에 관해서는 후술하도록 한다.

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[0204] 우선, AMVP모드와 머지 모드를 통합하여 적용하는 방법에 있어서, 필요한 신택스 구조에 대하여 설명한다. 아래에서는 AMVP모드 중 다이렉트 모드와 머지 모드의 통합을 예로서 설명한다.

[0205] 코딩 블록(코딩 유닛)을 더 분할한 파티션 단위로 머지가 수행될 수 있는 경우에, 해당 파티션에 대해서는 머지 모드와 다이렉트 모드를 선택하여 적용하도록 시그널링할 수 있다.

[0206] 도 13은 다이렉트 모드와 머지 모드를 선택하는 시그널링 방법을 개략적으로 설명하는 순서도이다.

[0207] 도 13을 참조하면, 스킵 모드와 다이렉트 모드의 적용 여부가 먼저 결정된 뒤에, 화면 간 예측(인터 모드)과 화면 내 예측(인트라 모드)의 분류가 이루어진다. 화면 간 예측 모드(INTER MODR)일 경우에는 머지 플래그(merge_falg)에 따라서 머지 모드를 적용할 수 있다.

[0208] 먼저, 상술한 바와 같이 스킵 플래그(skip_flag)가 지시하는 바에 따라 스킵 모드가 적용될 것인지가 결정된다(S1310). 스킵 플래그가 스킵 모드를 지시한 경우에는 스킵 모드를 적용하고(S1320), 스킵 플래그가 스킵 모드를 지시하지 않은 경우에는, 어떤 예측 모드가 적용될 것인지를 다시 판단한다(S1330). 이때, 예측 모드를 지시하는 신택스(예컨대, Pred_mode)가 전송될 수 있다.

[0209] S1330 단계에서 다이렉트 모드가 지시된 경우에는, 다이렉트 모드가 적용되고(S1340), 다이렉트 모드가 지시되지 않은 경우에는, 다시 예측 모드를 지시(pred_mode)할 수 있다(S1350). S1350 단계에서는, 예측 모드가 화면 내 예측 모드인지 화면 간 예측 모드인지를 지시할 수 있다.

[0210] S1350 단계에서 화면 내 예측 모드(intra mode)가 지시된 경우에는, 현재 블록에 화면 내 예측이 적용(S1370)되지만, 화면 간 예측 모드(inter modr)가 지시된 경우(S1360)에는 현재 블록에 머지 모드가 적용될 것인지를 판단할 수 있다(S1380). 이때, 머지 모드 적용 여부를 지시/판단하기 위해 머지 플래그(merge_flag)가 이용될 수 있다. 머지 플래그가 머지 모드를 지시하는 경우에는, 현재 블록의 움직임 정보를 유도하기 위해 머지 모드가 적용된다(S1390).

[0211] 머지 모드의 적용 여부는 각 파티션(partition)별로 결정될 수 있다. 예컨대, 코딩 블록(즉, 코딩 유닛) 전체가 하나의 파티션인 경우에는 코딩 블록 전체에 대하여 머지 모드의 적용 여부를 결정하고, 코딩 블록이 복수 개의 파티션으로 분할된 경우에는 각 파티션 단위로 머지 모드의 적용 여부를 결정할 수 있다. 코딩 블록이 분할된 파티션은 코딩 블록일 수도 있고, 예측 블록 또는 변환 블록일 수 있다.

[0212] 코딩 블록이 하나의 파티션으로 결정되는 경우, 해당 코딩 블록에 대하여 다이렉트 모드 혹은 머지 모드의 적용이 가능하다. 다만, 종래에는 다이렉트 모드와 머지 모드에 관한 정보를 서로 다른 시그널링 파트, 즉 서로 다른 파라미터 셋으로 전송하고 있기 때문에, 상술한 바와 같이, 두 모드 사이의

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유사성에도 불구하고, 정보가 중복해서 전달되는 경향이 있었다(중복성(redundancy)의 발생).

[0213] 하지만, 파티션 단위로 머지 모드 적용 여부를 결정하는 경우에는, 동일한 파티션 단위에 대하여 머지 모드와 AMVP모드(예컨대, 다이렉트 모드)가 적용될 수 있다. 따라서, AMVP모드(예컨대, 다이렉트 모드)과 머지 모드에 관한 정보를 동일한 시그널링 파트, 즉 동일한 파라미터 셋으로 전송할 수도 있다.

[0214] 예를 들어, 도 13의 인터 모드에 관한 시그널링 부분(S1360 이하의 단계)에서 다루어지고 있는 머지 모드 중 코딩 블록 전체가 하나의 파티션인 경우에 적용되고 있던 머지 모드(a)와 도 13의 다이렉트 모드에 관한 시그널링 부분(S1340)에서 다루어지고 있던 다이렉트 모드(b)를 통합(a와 b의 통합)하는 방법을 생각할 수 있다. 이때, 다이렉트 모드의 후보, 즉 AMVP 후보와 머지 후보를 통합하고, 통합된 후보들 중에서 선택된 후보를 이용하여 AMVP 모드(예컨대, 다이렉트 모드) 또는 머지 모드를 적용하도록 할 수 있다.

[0215] 도 14는 다이렉트 모드와 머지 모드를 통합하여 시그널링을 수행하는 일 예를 개략적으로 나타낸 것이다. 이하, 설명의 편의를 위해 코딩 블록 전체가 하나의 파티션으로 결정됐을 때 적용되는 머지를 '코딩 블록 머지'라 하고, 코딩 블록이 복수의 파티션으로 나뉘었을 때 파티션 단위로 적용되는 머지를 '파티션 머지'라 한다.

[0216] 도14에서는 다이렉트 모드가 코딩 블록 단위로 적용되는 경우를 예로서 설명한다. 따라서, 도 14의 예에서는 코딩 블록 전체를 하나의 파티션으로 하는 단계에서 파티션 단위로 적용될 수 있는 머지 모드와 다이렉트 모드의 병합을 설명한다.

[0217] 도 14를 참조하면, 스킵 플래그(skip_flag)가 지시하는 바에 따라 스킵 모드가 적용될 것인지가 결정된다(S1410). 스킵 플래그가 스킵 모드를 지시하는 경우에는 스킵 모드가 적용되고(S1420), 스킵 플래그가 스킵 모드를 지시하지 않은 경우에는, 어떤 예측 모드가 적용될 것인지를 다시 판단한다(S1430). 이때, 예측 모드를 지시하는 신택스(예컨대, Pred_mode)가 전송될 수 있다.

[0218] 도 13의 경우와 달리, 신택스(Pred_mode)는 다이렉트 모드와 머지 모드를 통합하여 시그널링(S1440)할 수 있다. 코딩 블록 단위에서, 상술한 바와 같이 다이렉트 모드와 머지 모드 사이의 유사성을 감안하여, S1040 단계에서는 코딩 블록 머지와 다이렉트 모드를 통합한 모드를 적용하는 것을 시그널링 할 수 있다.

[0219] 코딩 블록 단위로 머지 모드와 다이렉트 모드를 병합하여 적용하지 않는 경우에는 다시 예측 모드가 지시(pred_mode)될 수 있다(S1450). 이때, 예측 모드가 화면 내 예측 모드인지 화면 간 예측 모드인지가 지시될 수 있다.

[0220] S1450 단계에서 화면 내 예측 모드가 지시된 경우에는, 현재 블록에 화면 내 모드가 적용(S1470)되지만, 화면 간 예측 모드가 지시된 경우(S1460)에는 현재 블록에 머지 모드가 적용될 것인지를 판단할 수 있다(S1480). 이때, 머지 모드

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적용 여부를 지시/판단하기 위해 머지 플래그가 이용될 수 있다. 머지 플래그가 머지 모드를 지시하는 경우에는, 현재 블록에 머지 모드가 적용된다(S1490). 도 14를 참조하면, 코딩 블록 머지는 S1440 단계에서 적용될 수 있고, S1490 단계에서는 파티션 머지가 적용될 수 있다.

[0221] 한편, 도 14를 참조할 때, S1440 단계에서, 플래그(flag)를 사용하여 다이렉트 모드와 머지 모드 중에서 어떤 모드를 사용할 것인지를 지시할 수도 있다. 플래그에 의해 두 모드 중 어느 한 모드가 지시된 경우의 구체적인 처리 방법에 관해서는 다이렉트 모드와 코딩 블록 머지를 통합한 경우의 후보에 관한 설명과 함께 후술한다.

[0222] 도 15는 플래그를 사용하여 다이렉트 모드를 적용할지 코딩 블록 머지를 적용할지를 시그널링 하는 예를 개략적으로 도시한 것이다.

[0223] 도 15를 참조하면, 플래그를 사용하는 경우에는 플래그가 지시하는 바에 따라서 다이렉트 모드를 적용할지 코딩 블록 머지를 적용할지를 결정할 수 있다(S1500). 예컨대, 플래그 값이 0인 경우에는 다이렉트 모드를 적용하고(S1510), 플래그 값이 1인 경우에는 코딩 블록 머지를 적용할 수 있다(S1520).

[0224] 또한, 도 14의 S1440 단계에서 다이렉트 모드를 적용할지 코딩 블록 머지를 적용할지를 시그널링하는 경우에, 플래그를 사용하여 명시적으로 지시를 하지 않고, 다이렉트 모드가 적용될지 코딩 블록 머지가 적용될지 여부가 유도되도록 할 수도 있다.

[0225] 도 16은 다이렉트 모드가 적용될지 코딩 블록 머지가 적용될지를 유도해내는 방법을 개략적으로 도시한 것이다.

[0226] 도 16을 참조하면, 명시적인 지시 또는 시그널링 대신 유도(derivation)을 통해, 다이렉트 모드가 적용될지 코딩 블록 머지가 적용될지가 결정될 수 있다(S1600). 어떤 모드가 적용될지를 복호화기가 유도해 내기 위해, 주변 코딩 블록 예컨대 공간적 인접 블록(spatial neighbor block) 및/또는 시간적 인접 블록(temporal neighborblock)의 정보가 이용될 수 있다. 또한, 현재 코딩 블록이 속한 픽처의 통계 정보나 현재 코딩 블록이 속한 픽처보다 먼저 복호화된 픽처의 통계 정보 등이 사용될 수 있다.

[0227] 유도된 결과에 따라서, 다이렉트 모드가 적용(S1610)되거나 코딩 블록 머지가 적용(S1620)될 수 있다.

[0228]

[0229] 한편, 도 6과 도 7을 참조하여 설명한 바와 같이, 다이렉트 모드와 머지 모드는 후보(candidate)를 구하는 방법에서 차이가 있다. 하지만, 두 모드를 통합하고 통합 모드에서 현재 블록의 움직임 정보를 결정할 수 있다.

[0230] 통합 모드에서 현재 블록의 움직임 정보는 아래와 같은 다섯 후보 블록으로부터 결정될 수 있다. 즉, 다이렉트 모드에 사용되는 AMVP의 후보 블록과 머지 모드의 후보 블록을 통합할 수 있다.

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[0231]

[0232] 통합된 모드의 후보 블록들

[0233] (1) 현재 블록의 좌측 영역에서 선택되는 블록 - 예컨대, 도 6의 610에서 선택되는 블록을 통합된 모드의 후보 블록으로 선택할 수 있다.

[0234] 현재 블록의 좌측 영역에서 후보 블록을 선택하는 방법은 AMVP에 의해 후보를 선택하는 방법이 사용될 수 있다. 예컨대, 현재 블록의 좌측 영역에서 아래쪽 방향으로 혹은 위쪽 방향으로 검색하면서 첫 번째 가용(available) 블록을 선택할 수 있다.화면 내 예측 모드인 블록은 가용 블록이 아닌 것으로 보고, AMVP 후보에서 제외할 수 있다.

[0235] 현재 블록의 좌측 영역에 있는 블록들 중에서 특정 블록을 통합 모드의 후보 블록으로 선택할 수도 있다. 예컨대, 좌측 하단의 코너 블록에 맞닿은 블록을 현재 블록의 좌측 영역에서 선택되는 통합 모드의 후보로 특정하여 사용할 수도 있다.

[0236] (2) 현재 블록의 상단 영역에서 선택되는 블록 - 예컨대, 도 6의 620에서 선택되는 블록을 통합 모드의 후보 블록으로 선택할 수 있다.

[0237] 현재 블록의 상단 영역에서 후보 블록을 선택하는 방법은 AMVP에 의해 후보를 선택하는 방법이 사용될 수 있다. 예컨대, 현재 블록의 상단 영역에서 좌측 방향으로 혹은 우측 방향으로 검색하면서 첫 번째 가용 블록을 선택할 수 있다. 화면 내 예측 모드인 블록은 가용한 블록이 아닌 것으로 보고, AMVP 후보에서 제외할 수 있다.

[0238] 현재 블록의 상단 영역에 있는 블록들 중에서 특정 블록을 통합 모드의 후보 블록으로 선택할 수도 있다. 예컨대, 상단 우측의 코너 블록에 맞닿은 블록을 현재 블록의 상단 영역에서 선택되는 통합 모드의 후보로 특정하여 사용할 수도 있다.

[0239] (3) 현재 블록의 코너 영역에서 선택되는 블록 - 예컨대, 도 6의 630, 640, 650에서 선택되는 블록을 통합된 모드의 후보 블록으로 선택할 수 있다.

[0240] 현재 블록의 코너 영역에서 후보 블록을 선택하는 방법은 AMVP에 의해 후보를 선택하는 방법이 사용될 수 있다. 예컨대, 현재 블록의 코너 영역의 블록을 검색하면서 첫 번째 가용 블록을 선택할 수 있다. 화면 내 예측 모드인 블록은 가용한 블록이 아닌 것으로 보고, AMVP 후보에서 제외할 수 있다.

[0241] 현재 블록의 코너 영역에 위치하는 특정 블록을 통합 모드의 후보 블록으로 선택할 수 있다. 예컨대, 현재 블록의 각 코너에 위치한 블록(예컨대, 도 6의 630, 640, 650)을 현재 블록의 좌측 영역에서 선택되는 통합 모드의 후보로 특정하여 사용할 수도 있다.

[0242] (4) 현재 블록의 동일 위치(co-located) 블록 - 현재 블록에 대한 공간적인 주변 블록뿐만 아니라, 시간적인 주변 블록을 후보로서 사용할 수도 있다. 예컨대, 현재 블록에 대한 동일 위치(co-located) 블록을 통합 모드의 후보로 사용할 수 있다. 동일 위치 블록에 대해서도 AMVP 후보를 선택하는 방법을 동일하게

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적용하거나, 특정 참조 영상의 동일 위치 블록을 후보로서 사용할 수 있다.

[0243] (5) 상술한 후보들의 조합을 통해 유도되는 후보 - 예컨대, (1), (2) 및 (3)에서 유도된 후보들의 미디언(median) 값을 통합 모드의 후보로 사용할 수도 있다. 또한, 동일 위치 블록과 동일 리스트(L0 또는 L1)상의 동일하거나 상이한 참조 프레임에서 선택되는 움직임 벡터를 후보로서 유도할 수도 있고, 동일 위치 블록과 상이한 리스트상의 동일하기나 상이한 참조 프레임에서 선택되는 움직임 벡터를 추가적인 후보로 유도할 수도 있다.

[0244] 상술한 통합 모드에 대한 후보들의 움직임 정보를 이용하여 예측을 하는 경우에, 예측의 방향에 관한 조건을 함께 적용하여, 이에 관한 정보를 전송할 수도 있다.

[0245] (1) L0 방향의 움직임 정보를 사용

[0246] (2) L1 방향의 움직임 정보를 사용

[0247] (3) L0과 L1을 조합한 리스트의 움직임 정보를 이용(예컨대, L0과 L1을 조합한 리스트를 이용하거나 L0 및 L1 움직임을 평균한 정보를 사용)

[0248]

[0249] 또한, 예를 들면, 다이렉트 모드와 머지 모드의 두 가지 특징을 모두 반영하기 위해, 다이렉트 모드를 결정하는데 사용하는 후보 블록의 수보다는 적고, 코딩 블록 머지를 결정하는데 사용하는 후보 블록의 수보다는 많은 수의 후보 블록 집합으로부터 현재 블록의 움직임 정보를 결정할 수도 있다. 이때, 현재 블록은 코딩 블록일 수도 있고, 예측 블록일 수도 있으며, 변환 블록일 수도 있다.

[0250] 도 17은 본 발명에 따라서 통합 모드를 적용하는 경우에 대한 시그널링의 일 예를 개략적으로 나타내는 순서도이다. 도 17을 참조하면, 통합 모드를 적용하기 위해서, 먼저 AMVP/머지 플래그(merge_flag)를 통해 머지 모드를 적용할 것인지가 결정된다(S1710). AMV/머지 플래그는 머지 모드를 적용할 것인지 AMVP 모드를 적용할 것인지를 지시하는 플래그이다. 부호화기가 전송한 AMVP/머지 플래그에 기반해서, 복호화기에서 머지 모드를 적용할 것인지 AMVP 모드를 적용할 것인지가 결정될 수 있다. 예컨대, 플래그의 값이 0인 경우에는 AMVP 모드를 적용하고, 플래그의 값이 1인 경우에는 머지 모드를 적용하도록 할 수 있다. 이때, AMVP/머지 플래그 대신, 종래의 머지 플래그를 전송할 수도 있다. 이 경우에도, 머지 플래그의 값이 1인 경우에는 머지 모드를 적용하고, 머지 플래그의 값이 0인 경우에는 AMVP 모드를 적용하도록 할 수 있다.

[0251] 이어서 통합 모드 후보 인덱스가 전송된다(S1710). 복호화기는 부호화기로부터 전송된 통합 모드 후보 인덱스를 통해, 앞서 AMVP/머지 플래그 또는 머지 플래그에 의해 지시된 모드(머지 모드 또는 AMVP모드)에 대한 최적의 후보를 확인할 수 있다.

[0252] 머지 모드가 적용되는 경우에도, 통합 모드 후보 인덱스는 현재 블록의 좌측과 상단 영역에 있는 머지 후보뿐만 아니라 코너에 위치하는 후보와 참조 픽처에서

현재 블록과 동일한 위치의 블록까지 포함하는 통합 모드의 후보들 중에서, 어느 후보에 머지할 것인지를 지시할 수 있다. 따라서, 더 다양한 후보들의 움직임 정보를 활용할 수 있다.

[0253] 복호화기는 통합 모드 후보 인덱스가 지시하는 후보에 대하여 AMVP/머지 플래그 또는 머지 플래그가 지시하는 모드를 적용해서 현재 블록의 움직임 정보를 유도할 수 있다.

[0254] 한편, AMVP/머지 플래그 또는 머지 플래그(merge_flag)를 통해 머지 모드를 적용하는 것이 결정되면, 머지 후보와 예측 방향이 결정될 수 있다. 머지 후보와 예측 방향은 후보/방향 인덱스로 전송될 수 있다. 후보/방향 인덱스는 어떤 후보에 머지할 것인지를 지시하는 것 외에도, 예측이 단방향(L0 방향, L1)으로 이루어질지 양방향(bi-direction)으로 이루어질지를 지시할 수 있다. 이때, 후보/방향 인덱스가 지시하는 후보는 앞서 설명한 통합 모드의 후보들 중 하나일 수 있다.

[0255] 또한, 머지 후보와 예측 방향 중 적어도 하나는 소정의 방식에 따라서 유도되거나, 미리 정해진 룰에 따라서 결정될 수도 있다. 유도되지 않거나 미리 정해지지 않는 정보는 부호화기로부터 복호화기로 전송될 수도 있다.

[0256] 이때, 어떤 후보를 이용하여 머지 모드를 적용할 것인지를 지시하는 인덱스와 예측의 방향을 지시하는 인덱스를 별도로 전송할 수도 있다. 어떤 후보를 이용하여 미지 모드/다이렉트 모드를 적용할 것인지를 지시하는 경우에도, 상술한 바와 같이 현재 영역의 좌측과 상단 영역에 위치하는 후보들 중에서 어느 하나를 지시하지 않고, 현재 블록의 코너에 위치하는 후보와 동일 위치 블록의 후보까지 포함하는 후보들 중에서 어느 후보를 선택할 것인지를 지시할 수도 있다.

[0257] 또한, 예측의 방향을 지시하는 경우에도, 단방향(uni-direction) 또는 양방향(bi-direction)인지 뿐만 아니라, 단방향인 경우에는 L0과 L1 중 어느 방향인지까지 지시할 수도 있다.

[0258] 통합 모드의 후보뿐만 아니라 예측의 방향까지 지시할 수 있으므로, 더 세분화된 움직임 정보를 이용하여 현재 블록에 대한 예측을 수행할 수 있다.

[0259] 여기서는 통합 모드 중 머지 모드를 사용하는 방법에 대해서 설명하였으나, 상술한 설명의 내용은 통합 모드 중 AMVP 모드를 사용하는 경우에도 동일하게 적용될 수 있다.

[0260] 이하, 통합 모드에서 최적의 후보를 선택하는 방법에 대해서 설명한다.

[0261] 도 18은 통합 모드의 후보 블록들이 선택되는 영역을 개략적으로 설명하는 도면이다.

[0262] 상술한 바와 같이, 통합 모드의 후보 블록들은 (1) 현재 블록(1800)의 좌측 영역 A(1810), (2) 현재 블록(2000)의 상단 영역 B(1820), (3) 현재 블록(1800)의 코너 영역 C(1830, 1840, 1850), (4) 상기 (1) 내지 (3)의 조합, (5) 현재 블록에 대한 동일 위치(co-located) 블록 T(1860) 중에서 각각 선택될 수 있다.

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[0263] 머지 플래그를 통해서 머지 모드를 적용하는 것이 결정되면, (1) 내지 (5)의 통합 모드 후보 블록들 중에서 머지 모드를 적용할 후보 블록을 선택할 수 있다. 또한, 머지 플래그를 통해서 AMVP 모드(스킵 모드/다이렉트 모드)을 적용하는 것이 결정되면, (1) 내지 (5)의 통합 모드 후보 블록들 중에서 AMVP모드에서 현재 블록의 움직임 정보를 유도하는데 이용할 후보 블록을 선택할 수 있다.

[0264] 이때, 통합 모드 후보를 이용하여 머지 모드를 적용하는 경우에는,

[0265] 1) 종래의 머지 모드에서처럼 2개의 후보를 선택하고, 2개의 후보 블록을 MVC하여 하나의 후보에 현재 블록을 머지할 수 있다. MVC의 방법으로는 각 후보 블록의 움직임 벡터에 머지하는 경우에 대한 비용을 산출해서, 이를 기반으로 하나의 후보 블록을 선택하는 방법을 사용할 수도 있다. 이때, 2개의 후보 블록은 도 7의 경우와 같이, 현재 블록의 좌측 상단의 후보 블록과 상단 좌측의 후보 블록일 수도 있다. 이때, 현재 블록에 대한 공간적 주변 블록들뿐만 아니라, 시간적 주변 블록, 예컨대 동일 위치 블록 T(1860)가 후보로서 이용될 수 있다.

[0266] 2) 2개의 후보 블록은 앞서 통합 모드의 후보 블록에 관한 설명 (1) 및 (2)에서 언급한 바와 같이 선택될 수도 있다. 예컨대, 현재 블록의 좌측 영역(1810)과 상단 영역(1820)에서 각각 AMVP 후보를 검색하는 방법으로 선택한 두 블록일 수 있다. 또한, 현재 블록의 좌측 영역(1810)과 우측 영역(1820)에 위치하는 특정 블록으로서, 좌측 하단의 블록(A')과 상단 우측의 블록(B')일 수도 있다. 현재 블록에 대한 동일 위치 블록 T(1860)도 함께 후보로서 이용될 수도 있다.

[0267] 3) 또한, 종래의 머지 모드와 달리 현재 블록 주위에 공간적으로 위치하는 블록들을 모두 후보 블록으로 사용할 수 있다. 예컨대, 상술한 통합 모드의 후보 블록 (1)~(3)을 모두 후보 블록으로 사용할 수 있다. 아울러, 현재 블록에 대한 동일 위치 블록 역시 함께 후보로 이용될 수 있다. 이때, 이용하는 후보 블록의 개수에 제한을 두고, 해당 개수 내의 후보 블록들 중에서 하나의 후보 블록이 선택되도록 할 수도 있다. 이 경우에는, 이용 가능성 판단에 순서를 두고, 이 순서대로 판단하여 이용 가능하다고 판단된 순서대로 후보 리스트를 구성할 수도 있다. 예컨대, 상기 순서에 따라서 판단한 결과, 가장 먼저 이용 가능한 것으로 판단된 후보에게 후보 리스트의 가장 낮은 인덱스를 부여하고, 늦게 판단된 후보일수록 높은 인덱스를 부여하도록 할 수 있다.

[0268] 구성된 후보 리스트를 기반으로, 앞서 설명한 바와 같이 최적의 후보를 선택하는 과정을 통해 머지 대상 후보를 골라낼 수 있다.

[0269] 예컨대, 현재 블록 주위에 공간적으로 배치된 통합 모드의 후보 블록들을 앞서 설명한 통합 모드 후보 블록의 순서((1) 내지 (3))대로, 현재 블록(1800)의 좌측 영역(1810) → 현재 블록(1800)의 상단 영역(1820) → 현재 블록의 코너 영역(1830, 1840, 1850)의 순서로 이용 가능한 후보 블록을 찾을 수 있다. 이때, 현재 블록(1800)의 좌측 영역(1810)과 상단 영역(1820)에서 특정한 블록을 지정하여 사용하는 경우에는 A' → B' → 코너 블록(1830, 1840, 1850)의 순서로

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이용가능성을 판단해서 후보 리스트를 구성할 수 있다. 또한, 코너 블록들의 경우에도 순서를 정하여 이용 가능성을 판단할 수 있다. 예컨대, 상단 영역이 검색된 뒤 인접한 코너 블록이 검색되도록 코너 블록(1830)부터 검색을 시작하여, 코너 블록(1830) → 코너 블록(1840) → 코너 블록(1850) 또는 코너 블록(1830) → 코너 블록(1850) → 코너 블록(1840)의 순서로 이용 가능성을 판단할 수도 있다.

[0270] 상술한 순서대로 이용 가능한 후보 블록을 검색하였으나, 검색의 결과 이용할 수 없는(unavailable) 후보 블록이 있는 경우에는, 앞서 설명한 바와 같이 검색한 각 후보 블록을 이용하여 새로운 후보 블록을 선택하거나 생성할 수도 있다. 또한, 후보 리스트를 구성하여 최적의 후보를 선택하기 위한 후보 블록의 개수를 정하였으나, 이용 가능한 후보 블록의 개수가 후보 리스트를 구성하기 위한 후보 블록의 개수에 미치지 못하는 경우에도, 앞서 설명한 바와 같이 새로운 후보 블록을 선택하거나 생성할 수 있다.

[0271] 한편, 통합 모드 후보를 이용하여 AMVP 모드를 적용하는 경우에도,

[0272] 1) 머지 모드를 적용하는 경우처럼 현재 블록 주위에 공간적으로 위치하는 후보 블록들 중에서 2개의 후보를 선택하고, 2개의 후보 블록을 MVC하여 하나의 후보에 최적의 후보로 선택할 수 있다. MVC의 방법으로는 각 후보 블록의 MVP를 이용하는 경우에 대한 비용을 산출하고, 이를 기반으로 최적의 후보 블록을 선택하는 방법을 이용할 수도 있다. 이때, 현재 블록에 대한공간적 주변 블록들뿐만 아니라, 시간적 주변 블록, 예컨대 동일 위치 블록 T(1860)가 후보로서 이용될 수 있다.

[0273] 2) 2개의 후보 블록은 앞서 통합 모드의 후보 블록에 관한 설명 (1) 및 (2)에서 언급한 바와 같이 선택될 수도 있다. 예컨대, 현재 블록의 좌측 영역(1810)과 상단 영역(1820)에서 각각 AMVP 후보를 검색하는 방법으로 선택한 두 블록일 수 있다. 또한, 현재 블록의 좌측 영역(1810)과 우측 영역(1820)에 위치하는 특정 블록으로서, 좌측 하단의 블록(A')과 상단 우측의 블록(B')일 수도 있다. 현재 블록에 대한 동일 위치 블록 T(1860)도 함께 후보로서 이용될 수 있다.

[0274] 종래 2개의 후보 블록을 사용하던 머지 모드와 달리, 더 많은 후보 블록을 이용하던 AMVP모드의 경우에는 2개의 이용 가능한 후보 블록을 선택하기 위해 검색의 순서를 정할 수 있다. 예컨대, 코너 블록(1850)을 포함하는 현재 블록(1800)의 좌측 영역(1810)을 검색하여 하나의 후보 블록을 선택하고, 코너 블록(1830)을 포함하는 현재 블록(1800)의 상단 영역(1820)을 검색하여 하나의 후보 블록을 선택할 수 있다. 이때, 코너 블록(1840)을 현재 블록(1800)의 좌측 영역에 포함하여 검색할 수도 있고, 상단 영역에 포함하여 검색할 수도 있다. 따라서, 영역(1810, 1840, 1850)에서 하나의 후보 블록을 선택하고 영역(1820, 1830)에서 하나의 후보 블록을 선택할 수도 있고, 영역(1810, 1850)에서 하나의 후보 블록을 선택하고 영역(1820, 1830, 1840)에서 하나의 후보 블록을 선택할 수도 있다.

[0275] 현재 블록(1800)의 좌측 영역(1810)과 상단 영역(1820)에서 특정한 블록을 지정하여 사용하는 경우에는, 예컨대 블록 A'와 코너 블록(1840, 1850)에서 하나의 후보 블록을 선택하고 블록 B'와 코너 블록(1830)에서 하나의 후보 블록을 선택하거나, 블록 A'와 코너 블록(1850)에서 하나의 후보 블록을 선택하고 블록 B'와 코너 블록(1830, 1840)에서 하나의 후보 블록을 선택할 수도 있다.

[0276] 현재 블록을 기준으로 영역을 나누어 검색하지 않고, 영역 전체를 한 단위로 검색할 수도 있다. 예컨대, 코너 블록(1830)부터 코너 블록(1840)을 거쳐 코너 블록(1850)쪽으로 검색해 나갈 수 있다. 또한, 상단과 좌측의 코너 블록들부터 번갈아가며 검색해 나갈 수도 있다. 예컨대, 코너 블록(1830) → 코너 블록(1850) → 좌측 영역(1810) 또는 블록 A' → 상단 영역(1820) 또는 블록 B' → 코너 블록(1840)의 순서로 검색하면서 이용 가능한 블록 2개를 선착순으로 선택할 수 있다.

[0277] 3) 현재 블록 주위에 공간적으로 위치하는 블록들을 모두 후보 블록으로 사용할 수도 있다. 예컨대, 상술한 통합 모드의 (1) ~ (3)에서 설명한 후보 블록(즉, 현재 블록의 상단 영역에서 선택된 후보 블록, 좌측 영역에서 선택된 후보 블록, 코너 영역에서 선택되거나 코너 영역에 있는 후보 블록)을 모두 후보 블록으로 사용할 수 있다. 아울러, 현재 블록에 대한 동일 위치 블록 역시 함께 후보로 이용될 수 있다.

[0278] 이때, 이용하는 후보 블록의 개수에 제한을 두고, 해당 개수 내의 후보 블록들 중에서 하나의 후보 블록이 선택되도록 할 수도 있다. 이 경우에는, 이용 가능성 판단에 순서를 두고, 이용 가능한 것으로 판단된 순서대로 후보 리스트를 구성할 수도 있다. 후보 리스트를 기반으로 앞서 설명한 바와 같이 최적의 후보를 선택할 수 있다.

[0279] 예컨대, 현재 블록 주위에 공간적으로 배치된 통합 모드의 후보 블록들을 앞서 설명한 통합 모드 후보 블록의 순서((1) 내지 (3))대로, 현재 블록(1800)의 좌측 영역(1810) → 현재 블록(1800)의 상단 영역(1820) → 현재 블록의 코너 영역(1830, 1840, 1850)의 순서로 이용 가능한 후보 블록을 찾을 수 있다. 현재 블록(1800)의 좌측 영역(1810)과 상단 영역(1820)에서 특징한 블록을 지징하여 사용하는 경우에는 A' → B' → 코너 블록(1830, 1840, 1850)의 순서로 이용가능성을 판단해서 선택될 수 있다. 또한, 코너 블록들의 경우에도 순서를 정하여 이용 가능성을 판단할 수 있다. 예컨대, 상단 영역이 검색된 뒤 인접한 코너 블록이 검색되도록 코너 블록(1830)부터 검색을 시작하여, 코너 블록(1830) → 코너 블록(1840) → 코너 블록(1850) 또는 코너 블록(1830) → 코너 블록(1850) → 코너 블록(1840)의 순서로 검색할 수 있다.

[0280] 상술한 순서대로 후보 블록을 검색하였으나, 검색의 결과 이용할 수 없는(unavailable) 후보 블록이 있는 경우에는, 앞서 설명한 바와 같이 검색한 각 후보 블록을 이용하여 새로운 후보 블록을 선택하거나 생성할 수도 있다. 또한,

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후보 리스트를 구성하여 최적의 후보를 선택하기 위한 후보 블록의 개수를 정하였으나, 이용 가능한 후보 블록의 개수가 후보 리스트를 구성하기 위한 후보 블록의 개수에 미치지 못하는 경우에도, 앞서 설명한 바와 같이 새로운 후보 블록을 선택하거나 생성할 수 있다.

[0281] 도 19는 본 발명이 적용되는 부호화기에서 통합 모드를 적용하여 예측 후보를 생성하고 해당 정보를 전송하는 방법을 개략적으로 설명하는 순서도이다.

[0282] 도 19를 참조하면, 부호화기는 현재 블록에 적용할 모드를 정하고 해당 모드를 통해 예측을 수행할 때 이용할 수 있는 후보들을 결정한다(S1910).

[0283] 통합 모드의 후보들을 선택하는 방법은 상술한 바와 같다.

[0284] 이어서 부호화기는 파라미터 셋을 구성한다(S1920). 파라미터 셋은 해당 정보에 관한 신택스 구조에 따라서 구성될 수 있으며, 현재 블록의 예측에 사용되는 통합 모드에 관한 정보와 상기 결정된 통합 모드의 후보들에 관한 정보 등을 포함하도록 구성될 수 있다.

[0285] 부호화기는 구성된 파라미터 셋을 전송한다(S1930). 파라미터 셋의 정보는 부호화되어 비트스트림으로 복호화기에 전송될 수 있다.

[0286] 도 20은 본 발명이 적용되는 복호화기에서 통합 모드를 적용하여 예측을 수행하는 방법을 개략적으로 설명하는 순서도이다.

[0287] 도 20을 참조하면, 복호화기는 부호화기로부터 파라미터 셋을 수신한다(S2010). 파라미터 셋은 부호화되이 비트스트림으로 전송되며, 예측에 사용되는 통합 모드에 관한 정보와 통합 모드의 후보에 관한 정보 등을 포함한다.

[0288] 복호화기는 수신한 파라미터 셋 등으로부터 현재 블록의 예측에 관한 정보를 얻을 수 있다(S2020). 복호화기는 부호화기로부터 파라미터 셋 등을 통해 전송된 정보를 기반으로 현재 블록에 대한 예측 모드를 결정할 수 있다. 예측 모드는 머지 모드와 AMVP 모드의 통합 모드일 수 있다. 머지 모드와 AMVP 모드 중 어느 모드를 적용할 것인지는 파라미터 셋에 포함된 플래그 등을 통해서 결정될 수 있다. 복호화기는 파라미터 셋 등으로부터 획득한 통합 모드의 후보에 관한 정보를 기반으로 적용할 예측 모드에 대한 최적의 후보를 결정할 수 있다. 통합 모드의 후보를 결정하는 방법은 앞서 설명한 바와 같다.

[0289] 복호화기는 현재 블록에 대하여, 정해진 예측 모드, 예컨대 머지 모드 또는 AMVP 모드를 적용하고, 상기 결정된 최적 후보의 움직임 정보를 이용하여 현재 블록에 대한 예측을 수행할 수 있다(S2030).

[0290] 상술한 예시적인 시스템에서, 방법들은 일련의 단계 또는 블록으로써 순서도를 기초로 설명되고 있지만, 본 발명은 단계들의 순서에 한정되는 것은 아니며, 어떤 단계는 상술한 바와 다른 단계와 다른 순서로 또는 동시에 발생할 수 있다. 또한, 상술한 실시예들은 다양한 양태의 예시들을 포함한다. 따라서, 본 발명은 이하의 특허청구범위 내에 속하는 모든 다른 교체, 수정 및 변경을 포함한다고 할 것이다.

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[0291] 지금까지 본 발명에 관한 설명에서 일 구성 요소가 타 구성 요소에 "연결되어" 있다거나 "접속되어"있다고 언급된 때에는, 상기 일 다른 구성 요소가 상기 타 구성 요소에 직접적으로 연결되어 있거나 또는 접속되어 있을 수도 있지만, 상기 두 구성 요소 사이에 다른 구성 요소가 존재할 수도 있다고 이해되어야 한다. 반면에, 일 구성 요소가 타 구성 요소에 "직접 연결되어"있다거나 "직접 접속되이"있다고 언급된 때에는, 두 구성 요소 사이에 다른 구성요소가 존재하지 않는 것으로 이해되어야 한다.

청구범위

[청구항 1] 현재 블록의 예측 모드를 결정하는 단계; 및
상기 결정된 예측 모드가 스킵 모드인 경우에는, 순방향, 역방향 또는 양방향 중 하나의 예측 방향을 지정하는 정보를 전송하는 단계를 포함하는 것을 특징으로 하는 영상 정보 부호화 방법.

[청구항 2] 현재 블록의 예측 모드를 판단하는 단계; 및
상기 현재 블록의 예측 모드가 스킵 모드인 경우에는, 예측 방향을 지시하는 정보에 따라서, 스킵 모드의 예측 방향을 단방향 또는 양방향으로 설정하는 단계를 포함하는 것을 특징으로 하는 영상 정보 복호화 방법.

[청구항 3] AMVP 후보에 대하여, 각 후보를 이용하는 경우에 대한 비용을 체크하는 단계;
머지 후보와 상기 AMVP 후보의 동일성을 비교하는 단계;
상기 AMVP 후보와 동일하지 않은 머지 후보에 대하여, 비용을 체크하는 단계; 및
상기 체크한 비용들을 기반으로 현재 블록에 적용할 화면 간 예측 모드를 결정하는 단계를 포함하는 것을 특징으로 하는 영상 정보 부호화 방법.

[청구항 4] 현재 블록의 주변 영역에서 AMVP 후보를 선택하는 단계;
상기 AMVP 후보와 머지 후보의 동일성을 판단하는 단계; 및
상기 동일성 판단 결과, 상기 AMVP 후보와 동일하지 않은 머지 후보에 현재 블록을 머지하는 단계를 포함하는 것을 특징으로 하는 영상 정보 복호화 방법.

[청구항 5] 현재 블록의 주변 영역에서 AMVP 후보를 선택하고 AMVP 후보 리스트를 구성하는 단계;
상기 AMVP 후보 리스트의 후보에 속하지 않는 머지 후보가 존재하는지를 판단하는 단계; 및
상기 AMVP 후보 리스트에 속하지 않는 머지 후보가 있는 경우, 상기 AMVP 후보 리스트에 상기 머지 후보를 추가하거나 상기 AMVP 후보 리스트의 후보 중 소정의 후보를 상기 머지 후보로 변경하도록 시그널링하는 단계를 포함하는 것을 특징으로 하는 영상 정보 부호화 방법.

[청구항 6] 현재 블록의 주변 영역에서 AMVP 후보를 선택하고 AMVP 후보 리스트를 구성하는 단계;
상기 AMVP 후보 리스트에 속하지 않는 머지 후보가 있는 경우, 상기 AMVP 후보 리스트에 상기 머지 후보를 추가하거나 상기 AMVP 후보 리스트의 후보 중 소정의 후보를 상기 머지 후보로

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변경하는 단계; 및
상기 변경된 AMVP 후보 리스트를 기반으로 현재 블록을 예측하는 단계를 포함하는 것을 특징으로 하는 영상 정보 복호화 방법.

[청구항 7] AMVP를 이용하는 화면 간 예측 방법과 머지 모드를 이용하는 화면 간 예측 방법 중 현재 블록에 적용되는 예측 방법을 결정하는 단계; 및
상기 결정된 예측 방법에 관한 정보를 전송하는 단계를 포함하며,
상기 AMVP의 후보와 상기 머지 모드의 후보를 통합하여 이용하는 것을 특징으로 하는 영상 정보 부호화 방법.

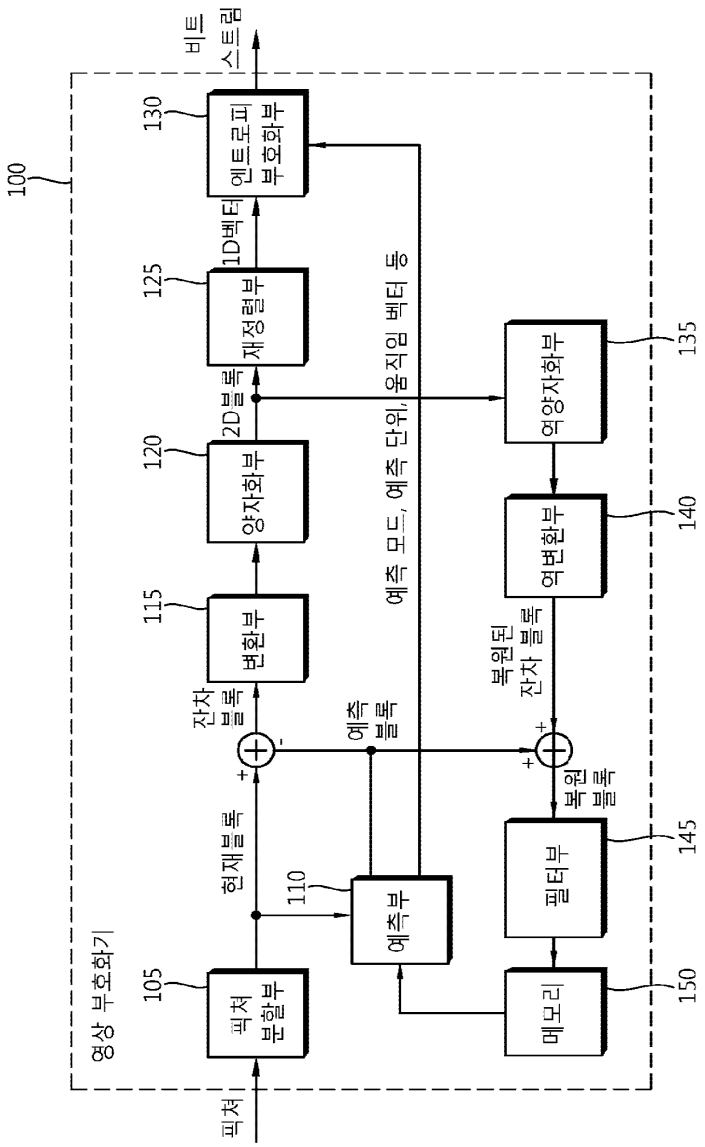
[청구항 8] 현재 블록의 화면 간 예측 방법에 관한 모드 정보를 수신하는 단계; 및
상기 현재 블록의 움직임 정보를 유도할 후보를 선택하는 단계를 포함하며,
상기 후보는, 상기 현재 블록의 좌측 영역, 상단 영역, 코너 영역 및 상기 현재 블록에 대한 동일 위치 블록에서 선택되는 것을 특징으로 하는 영상 정보 복호화 방법.

[청구항 9] 제8항에 있어서, 상기 후보는
상기 현재 블록의 좌측 영역, 상단 영역 및 코너 영역에 있이서 특정 위치의 블록으로서, 화면 간 예측 모드의 블록인 것을 특징으로 하는 영상 정보 복호화 방법.

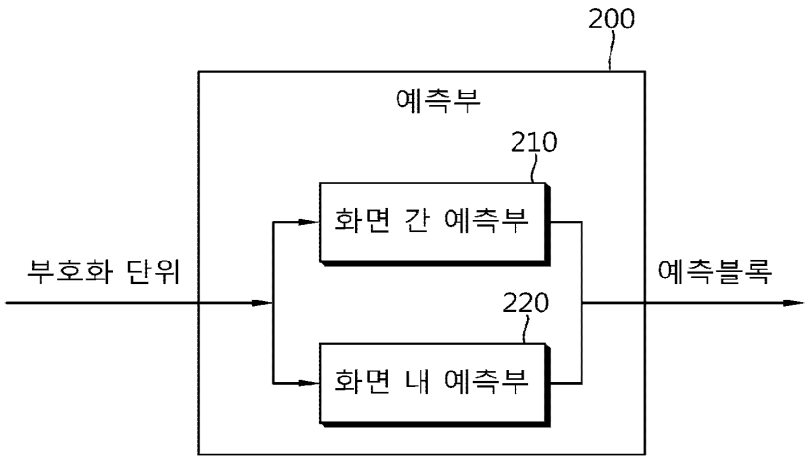
[청구항 10] 제8항에 있어서, 상기 후보는,
상기 현재 블록의 좌측 영역의 최하단 블록, 상기 현재 블록의 상단 영역에서 최우측 블록 및 상기 현재 블록에 대한 좌하(Left Below), 좌상(Left Top) 그리고 우상(Right Top) 코너 블록인 것을 특징으로 하는 영상 정보 복호화 방법.

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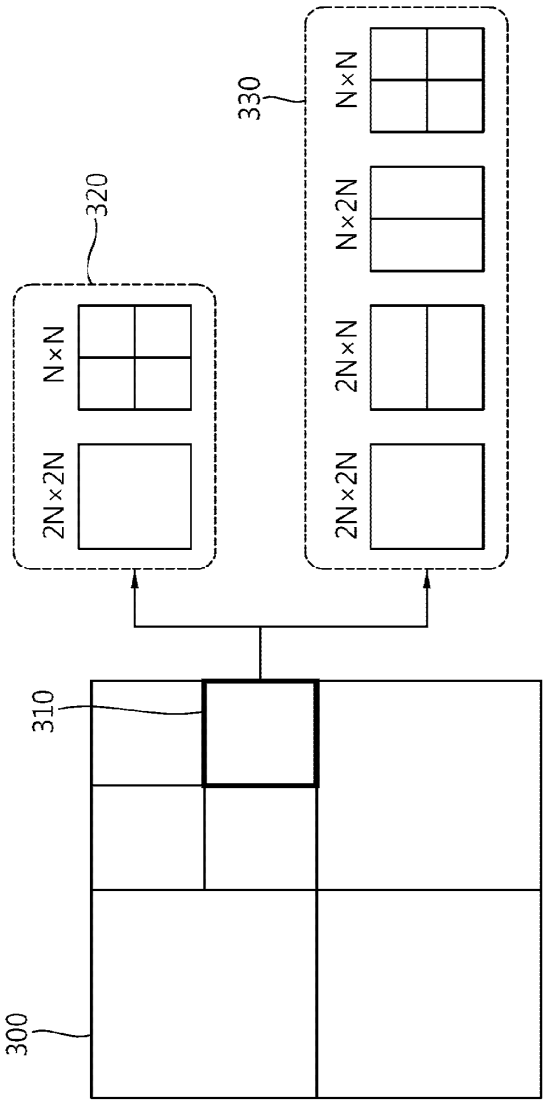
[Fig. 1]


비트 스트림
100
130
엔트로피 부호화부
1D벡터
125
재정렬부
2D블록
120
양자화부
115
변환부
잔차 블록
현재블록
105
픽처 분할부
픽처
영상 부호화기
110
예측부
예측 블록
예측 모드, 예측 단위, 움직임 벡터 등
135
역양자화부
140
역변환부
복원된 잔차 블록
복원 블록
145
필터부
150
메모리

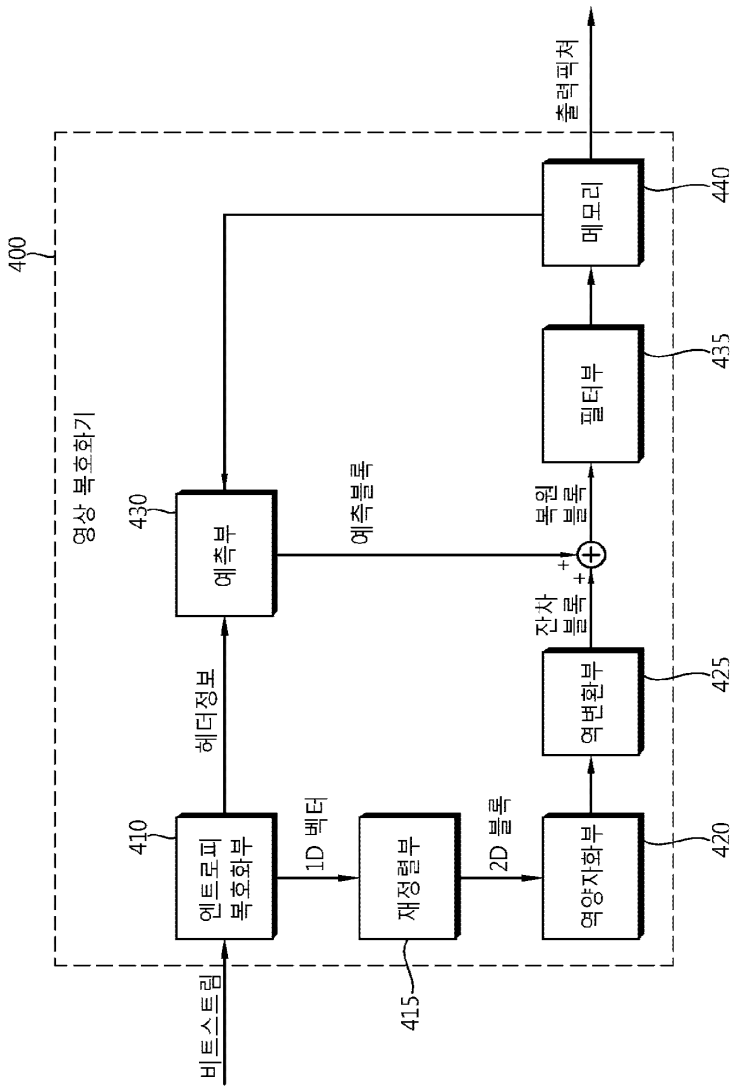
[Fig. 2]



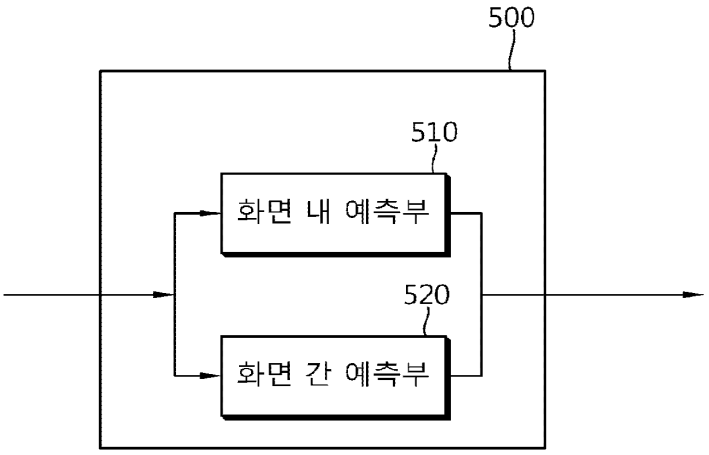
[Fig. 3]



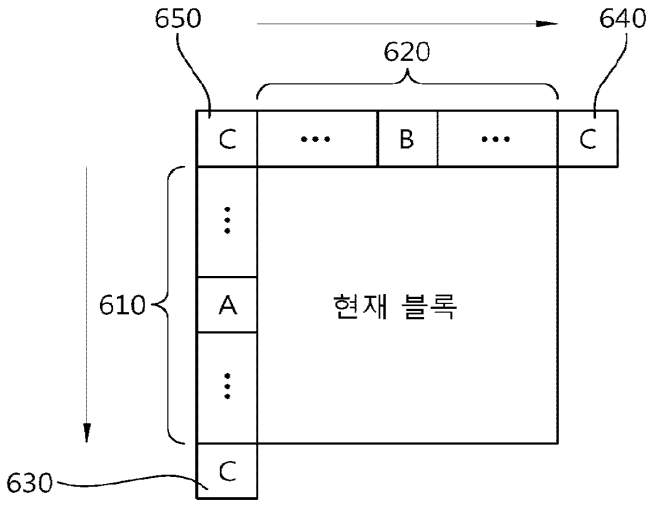
[Fig. 4]


400
영상 복호화기
비트스트림
410
엔트로피 복호화부
헤더정보
430
예측부
415
1D 벡터
재정렬부
2D 블록
역양자화부
420
잔사 블록
복원 블록
예측블록
역변환부
425
필터부
435
메모리
440
출력픽처

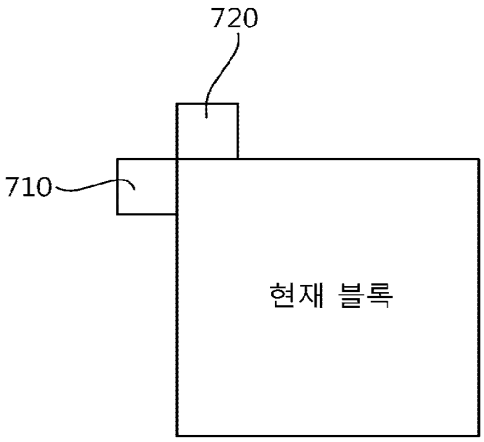
[Fig. 5]



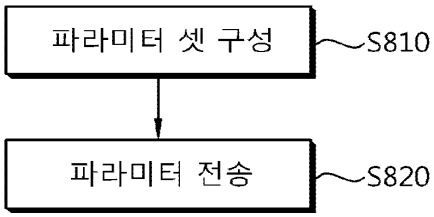
[Fig. 6]



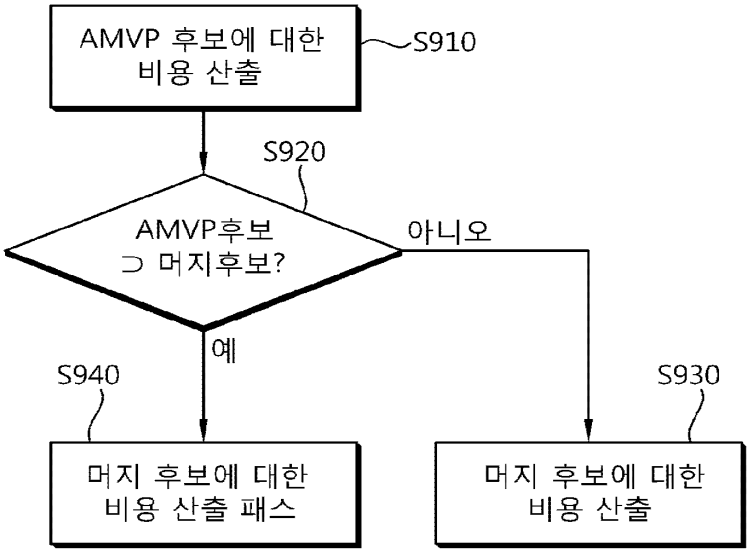
[Fig. 7]



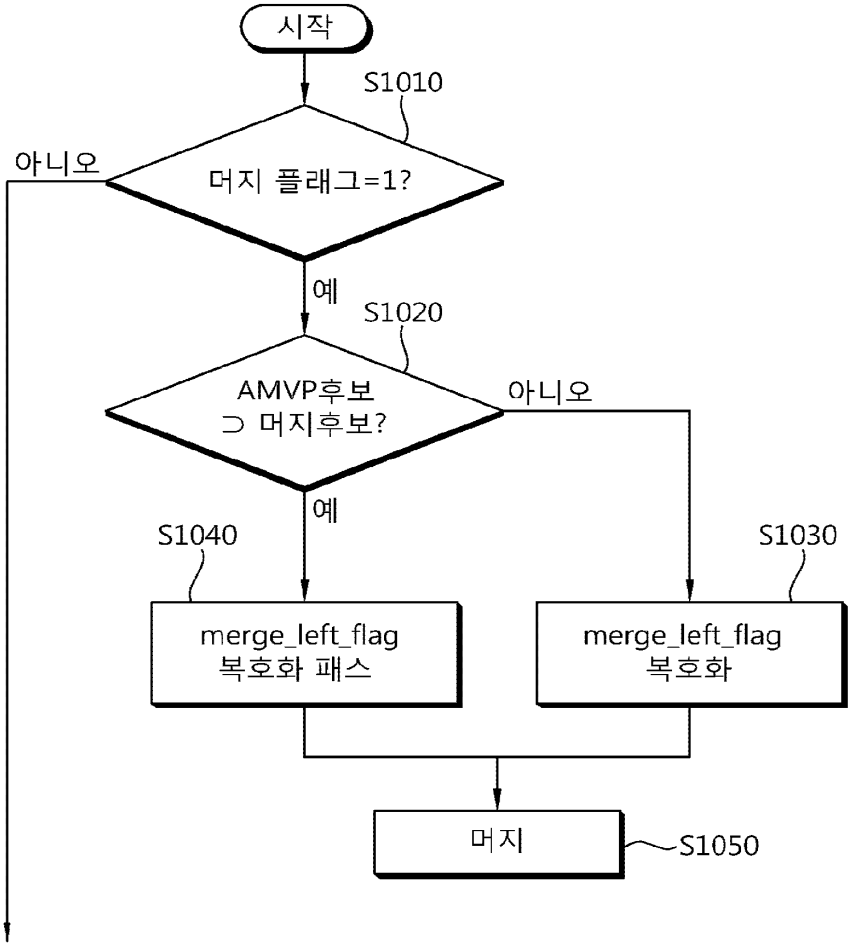
[Fig. 8]



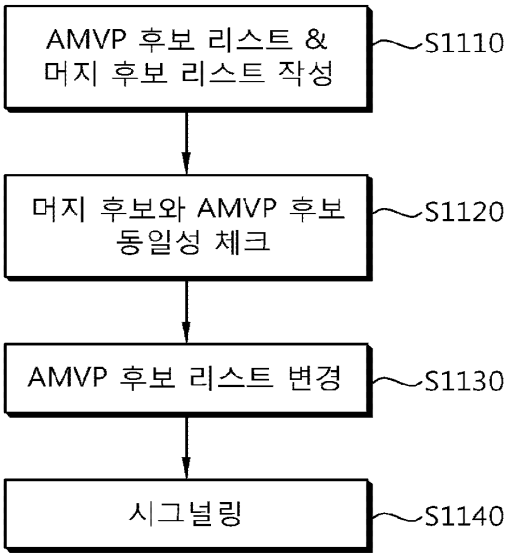
[Fig. 9]



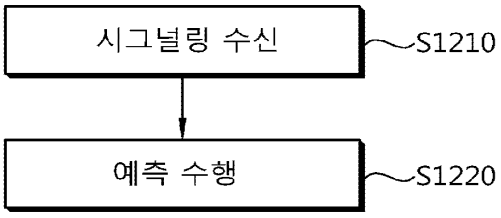
[Fig. 10]


시작
S1010
머지 플래그=1?
아니오
예
S1020
AMVP후보
⊃ 머지후보?
아니오
예
S1040
S1030
merge_left_flag
복호화 패스
merge_left_flag
복호화
머지
S1050

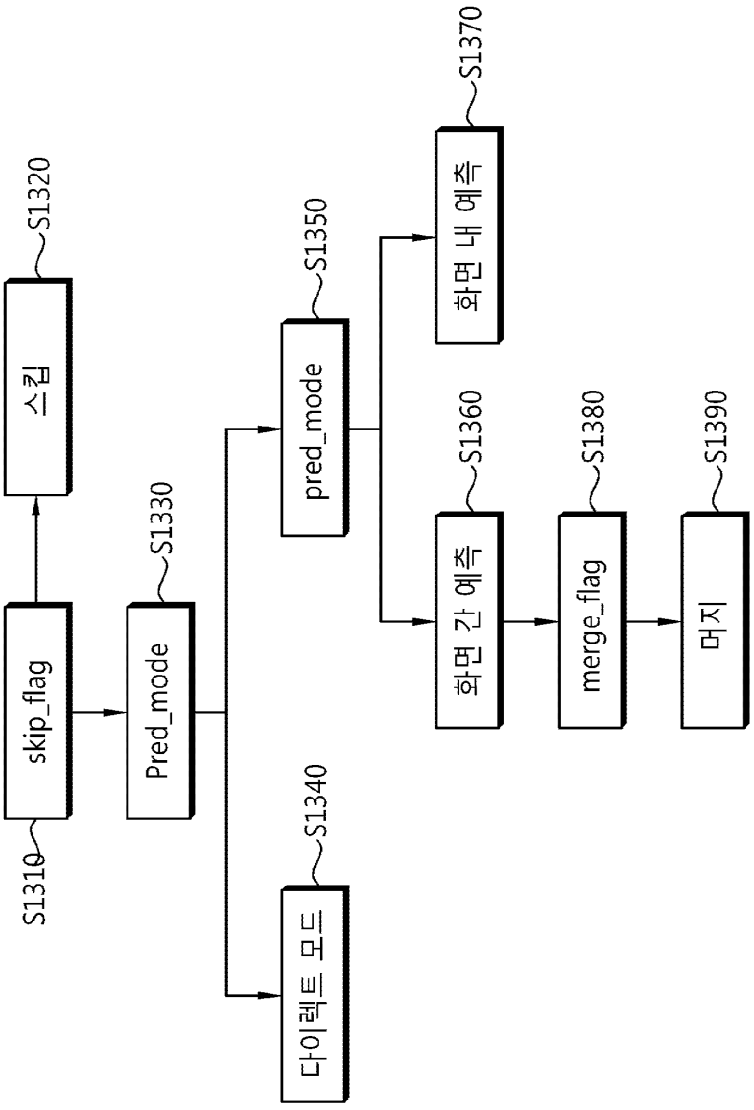
[Fig. 11]


AMVP 후보 리스트 &
머지 후보 리스트 작성
S1110
머지 후보와 AMVP 후보
동일성 체크
S1120
AMVP 후보 리스트 변경
S1130
시그널링
S1140

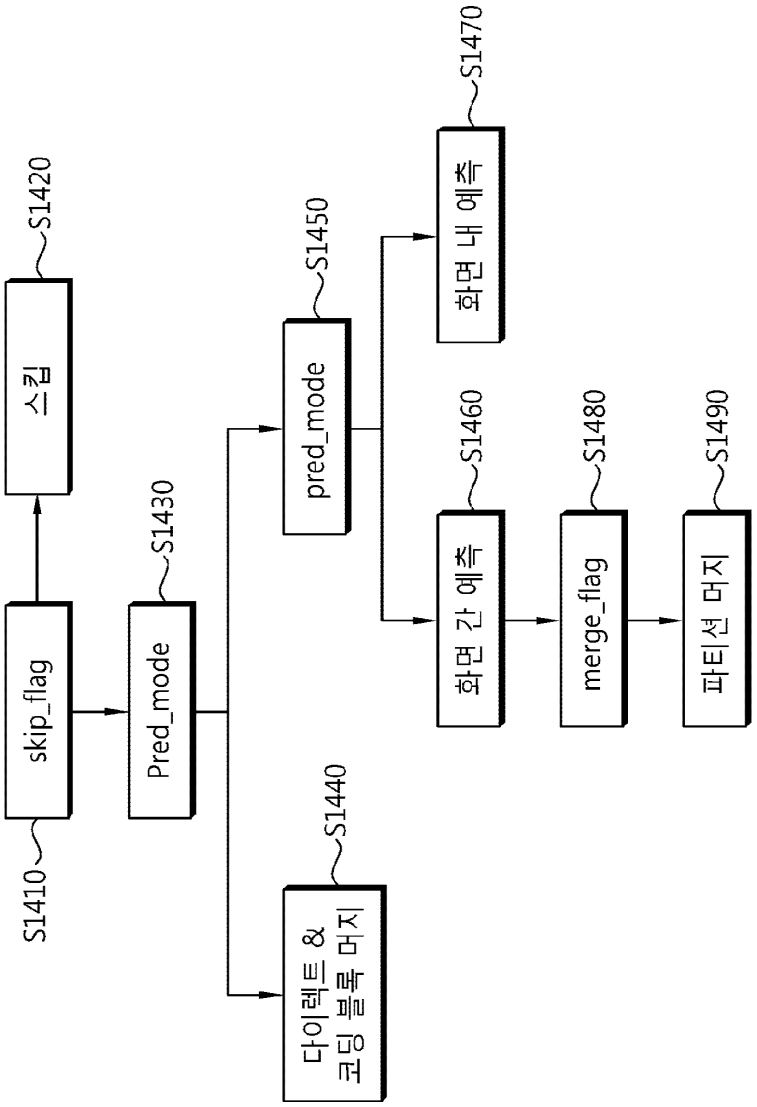
[Fig. 12]


시그널링 수신
S1210
예측 수행
S1220

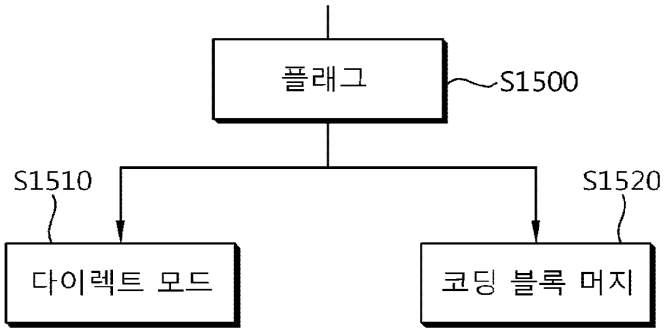
[Fig. 13]


S1310
skip_flag
S1320
스킵
S1330
Pred_mode
S1340
다이렉트 모드
S1350
pred_mode
S1360
화면 간 예측
S1370
화면 내 예측
S1380
merge_flag
S1390
머지

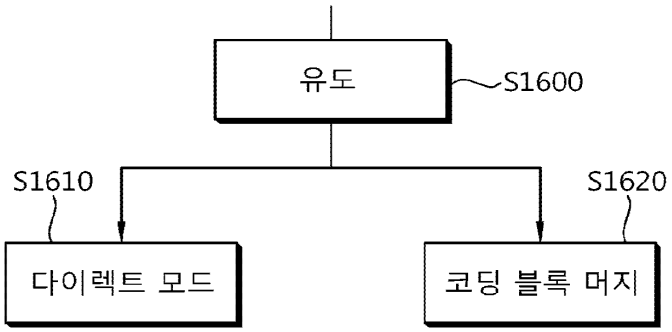
[Fig. 14]


S1410
skip_flag
S1420
스킵
S1430
Pred_mode
S1440
다이렉트 &
코딩 블록 머지
S1450
pred_mode
S1460
화면 간 예측
S1470
화면 내 예측
S1480
merge_flag
S1490
파티션 머지

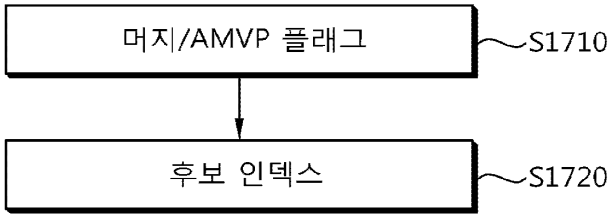
[Fig. 15]


플래그
S1500
S1510
S1520
다이렉트 모드
코딩 블록 머지

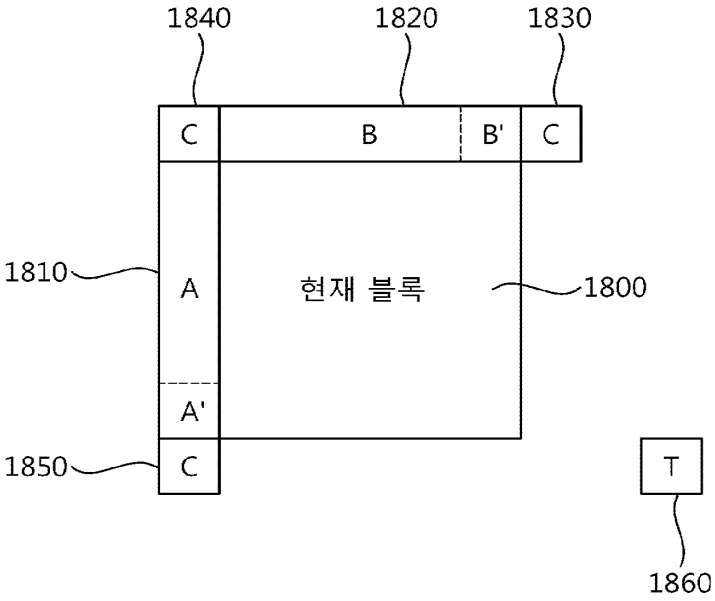
[Fig. 16]



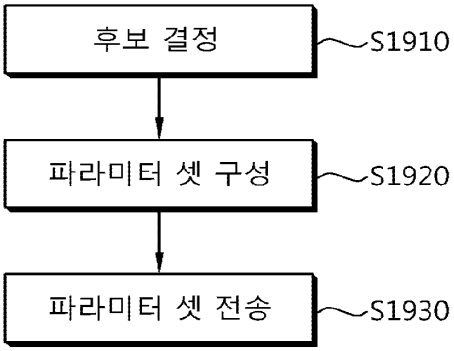
[Fig. 17]



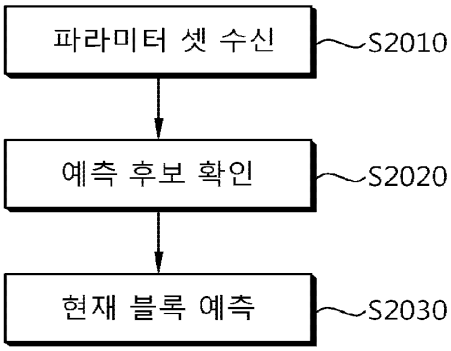
[Fig. 18]



[Fig. 19]


후보 결정
S1910
파라미터 셋 구성
S1920
파라미터 셋 전송
S1930

[Fig. 20]


파라미터 셋 수신
S2010
예측 후보 확인
S2020
현재 블록 예측
S2030

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 May 2012 (10.05.2012)

PCT

(10) International Publication Number
WO 2012/059577 A1

(51) International Patent Classification:
H04N 7/26 (2006.01)

(21) International Application Number:
PCT/EP2011/069408

(22) International Filing Date:
4 November 2011 (04.11.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/410,246 4 November 2010 (04.11.2010) US

(71) Applicant *(for all designated States except US)*: **FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V.** [DE/DE]; Hansastraße 27c, 80686 München (DE).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SCHWARZ, Heiko** [DE/DE]; Neue Schönholzer Straße 12, 13187 Berlin (DE). **KIRCHHOFFER, Heiner** [DE/DE]; Gotzkowskystraße 5, 10555 Berlin (DE). **HELLE, Philipp** [DE/DE]; Ahrenshopper Zeile 4, 14129 Berlin (DE). **OUDIN, Simon** [DE/DE]; Seumestraße 29, 10245 Berlin (DE). **STEGEMANN, Jan** [DE/DE]; Simplonstraße 55, 10245 Berlin (DE). **BROSS, Benjamin** [DE/DE]; Gabriel-Max-Straße 17, 10245 Berlin (DE). **MARPE, Detlev** [DE/DE]; Südwestkorso 70, 12161 Berlin (DE). **WIEGAND, Thomas** [DE/DE]; Otto-Appel-Straße 52, 14195 Berlin (DE).

(74) Agents: **SCHENK, Markus** et al.; Schoppe, Zimmermann, Stöckeler, Zinkler & Partner, P.O. Box 246, 82043 Pullach (DE).

(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, QA, RO, RS, RU, RW, 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, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, 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))*

(54) Title: PICTURE CODING SUPPORTING BLOCK MERGING AND SKIP MODE

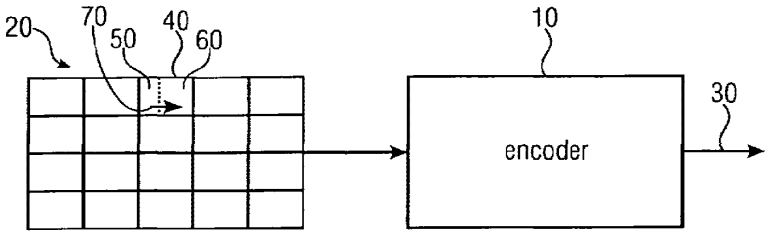


FIGURE 1

(57) Abstract: A coding efficiency increase is achieved by using a common signalization within the bitstream with regard to both activation of merging and activation of the skip mode. That is, one of the possible states of one or more syntax elements within the bitstream may signalize for a current sample set of a picture that the respective sample set is to be merged and has no prediction residual encoded and inserted into the bitstream. Alternatively speaking, a common flag may commonly signalize whether the coding parameters associated with a current sample set are to be set according to a merge candidate or to be retrieved from the bitstream, and whether the current sample set of the picture is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set, without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set by means of residual data within the bitstream.

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Picture Coding Supporting Block Merging and Skip Mode

Description

The present application concerns picture and/or video coding and in particular codecs supporting block partitioning and skip mode.

Many picture and/or video codecs treat the pictures in units of blocks. For example, predictive codecs use a block granularity in order to achieve a good compromise between very precisely set prediction parameters set at a high spatial resolution with, however, spending too much side information for the prediction parameters on the one hand and too coarsely set prediction parameters, causing the amount of bits necessary to encode the prediction residual to increase due to the lower spatial resolution of the prediction parameters, on the other hand. In effect, the optimum setting for the prediction parameters lies somewhere between both extremes.

Several attempts have been made in order to obtain the optimum solution for the above-outlined problem. For example, instead of using a regular subdivision of a picture into blocks regularly arranged in rows and columns, multi-tree partitioning subdivision seeks to increase the freedom of subdividing a picture into blocks at a reasonable demand for subdivision information. Nevertheless, even multi-tree subdivision necessitates the signalization of a remarkable amount of data and the freedom in subdividing a picture is quite restricted even in case of using such multi-tree subdivisioning.

In order to enable a better tradeoff between the amount of side information necessary in order to signalize the picture subdivision on the one hand and the freedom in subdividing the picture on the other hand, merging of blocks may be used in order to increase the number of possible picture subdivisionings at a reasonable amount of additional data necessary in order to signalize the merging information. For blocks being merged, the coding parameters need to be transmitted within the bitstream in full merely once, similarly as if the resulting merged group of blocks was a directly subdivided portion of the picture.

In order to additionally increase the efficiency in encoding the picture content, skip mode has been introduced into some block-based picture codecs, the skip mode enabling the encoder to refrain from transmitting the residual data of a certain block to the decoder. That is, the skip mode is a possibility to suppress residual data transmission for certain blocks. The ability to suppress the transmission of residual data for certain blocks results in

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a broader granularity interval for encoding the coding/prediction parameters within which an optimum tradeoff between coding quality on the one hand and total bit rate spent on the other hand may be expected: naturally, increasing the spatial resolution of the encoding of the coding/prediction parameters results in an increase of the side information rate while decreasing, however, the residuum thereby lowering the rate necessary to encode the residual data. However, due to the availability of the skip mode, it may be favorable to obtain an abrupt coding rate saving by merely moderately further increasing the granularity at which the coding/prediction parameters are transmitted so that the residuum is so small that a separate transmission of the residuum may be left away.

However, there is still a need for achieving better coding efficiency, due to remaining redundancies newly caused by the combination of block merging and skip mode usage.

Thus, the object of the present invention is to provide a coding concept having an increased coding efficiency. This object is achieved by the pending independent claims.

The idea underlying the present invention is that a further coding efficiency increase may be achieved if a common signalization is used within the bitstream with regard to both activation of merging and activation of the skip mode. That is, one of the possible states of one or more syntax elements within the bitstream may signalize for a current sample set of a picture that the respective sample set is to be merged and has no prediction residual encoded and inserted into the bitstream. Alternatively speaking, a common flag may commonly signalize whether the coding parameters associated with a current sample set are to be set according to a merge candidate or to be retrieved from the bitstream, and whether the current sample set of the picture is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set, without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set by means of residual data within the bitstream.

The inventors of the present invention found out that this introduction of a common signalization of the activation of the merging on the one hand and the activation of the skip mode on the other hand saves bit rate as additional overhead in order to signalize the activation of the merging and/or skip mode separately from each other may be reduced or may merely have to be spent in case of the merging and the skip mode not being activated concurrently.

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Advantageous implementations of the present invention are the subject of the attached dependent claims.

Preferred embodiments of the present application are described in the following in more detail with respect to the figures among which:

Fig. 1 shows a block diagram of an apparatus for encoding according to an embodiment;

Fig. 2 shows a block diagram of an apparatus for encoding according to a more detailed embodiment;

Fig. 3 shows a block diagram of an apparatus for decoding according to an embodiment;

Fig. 4 shows a block diagram of an apparatus for decoding according to a more detailed embodiment;

Fig. 5 shows a block diagram of a possible internal structure of the encoder of Fig. 1 or 2;

Fig. 6 shows a block diagram of a possible internal structure of the decoder of Fig. 3 or 4;

Fig. 7a shows schematically a possible subdivision of a picture into tree-root blocks, coding units (blocks) and prediction units (partitions);

Fig. 7b shows a subdivision tree of the tree-root block shown in Fig. 7a, down to the level of the partitions, in accordance with an illustrative example;

Fig. 8 shows an embodiment for a set of possible supported partitioning patterns in accordance with an embodiment;

Fig. 9 shows possible partitioning patterns which effectively result from combining block merging and block partitioning when using the block partitioning in accordance with Fig. 8;

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Fig. 10 schematically shows candidate blocks for a SKIP/DIRECT mode in accordance with an embodiment;

Fig. 11-13 show syntax portions of a syntax in accordance with an embodiment; and

Fig. 14 schematically shows the definition of neighboring partitions for a partition in accordance with an embodiment.

With respect to the following description, it is noted that whenever the same reference sign is used in connection with different figures, the explanations with regard to the respective element presented with respect to one of these figures shall equally apply to the other figures, provided that such transferring of explanations from one figure to the other does not conflict with the remaining description of this other figure.

Fig. 1 shows an apparatus 10 for encoding a picture 20 into a bitstream 30. Naturally, picture 20 could be part of a video, in which case the encoder 10 would be a video encoder.

The picture 20 is, although not explicitly shown in Fig. 1, represented as an array of samples. The sample array of picture 20 is partitioned into sample sets 40, which could be any set of samples such as sample sets covering non-overlapping single-connected areas of picture 20. For ease of understanding, the sample sets 40 are shown as, and are called in the following, blocks 40, wherein however, the following description shall not be regarded as being restricted to any special kind of sample sets 40. According to a concrete embodiment, the sample sets 40 are rectangular and/or quadratic blocks.

For example, the picture 20 may be subdivided into a regular arrangement of blocks 40 so that the blocks 40 are arranged in rows and columns as exemplarily shown in Fig. 1. However, any other subdivision of the picture 20 into blocks 40 may also be possible. In particular, subdivision of the picture 20 into blocks 40 may be fixed, i.e., known to the decoder by default or may be signaled within the bitstream 30 to the decoder. In particular, blocks 40 of picture 20 may vary in size. For example, a multi-tree subdivision such as a quad-tree subdivision may be applied to picture 20 or to a regular pre-subdivisioning of picture 20 into regularly arranged tree-root blocks so as to obtain blocks 40 which, in this case, form the leaf blocks of the multi-tree subdivision of the tree-root blocks.

In any case, the encoder 10 is configured to encode, for current sample set 40, a flag into the bitstream 30 commonly signaling whether the coding parameters associated with the current sample set 40 are to be set according to a merge candidate or to be retrieved from

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the bitstream 30, and whether the current sample set of the picture 20 is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set, without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set 40 by means of a residual data within the bitstream 30. For example, the encoder 10 is configured to encode, for current sample set 40, a flag into the bitstream 30 commonly signaling, if assuming a first state, that the coding parameters associated with the current sample set 40 are to be set according to a merge candidate rather than to be retrieved from the bitstream 30, and that the current sample set of the picture 20 is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set, without any residual data, and if assuming any other state that the coding parameters associated with the current sample set 40 are to be retrieved from the bitstream 30, or that the current sample set of the picture 20 is to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set 40 by means of a residual data within the bitstream 30. This means the following. The encoder 10 supports merging of blocks 40. The merging is facultative. That is, not every block 40 is subject to merging. For some blocks 40 it is, in some, for example, rate-distortion optimization sense favorable to merge the current block 40 with a merge candidate, but for others the opposite is true. In order to decide whether a certain block 40 should be made the subject of merging, the encoder 10 determines a set or list of merge candidates and checks, for each of these merge candidates, whether merging the current block 40 with that merge candidate forms the most preferred coding option in, for example, rate-distortion optimization sense. The encoder 10 is configured to determine the set or list of merge candidates for a current block 40 based on previously encoded portions of bitstream 30. For example, encoder 10 derives at least a portion of the set or list of merge candidates by adopting the coding parameters associated with locally and/or temporally neighboring blocks 40 which have been previously encoded in accordance with the encoding order applied by encoder 10. Temporal neighborhood denotes, for example, blocks of previously encoded pictures of a video to which picture 20 belongs, with the temporally neighboring blocks thereof being spatially located so as to spatially overlap the current block 40 of the current picture 20. Accordingly, for this portion of the set or list of merge candidates, there is a one to one association between each merge candidate and the spatially and/or temporally neighboring blocks. Each merge candidate has coding parameters associated therewith. If the current block 40 is merged with any of the merge candidates, encoder 10 sets the coding parameters of the current block 40 in accordance with the merge candidate. For example, encoder 10 may set the coding parameters of the current block 40 to be equal to the respective merge candidate, i.e. encoder 10 may copy the coding parameters of the current block 40 from the respective merge candidate. Thus,

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for this just-outlined portion of the set or list of merge candidates, the coding parameters of a merge candidate are directly adopted from a spatially and/or temporally neighboring block, or the coding parameters of the respective merge candidate is obtained from the coding parameters of such a spatially and/or temporally neighboring block by adopting same, i.e. setting the merge candidate equal thereto, while, however, taking domain changes into account by, for example, scaling the adopted coding parameters in accordance with the domain change. For example, at least a part of the coding parameters being subject to merging could encompass motion parameters. Motion parameters may, however, refer to different reference picture indices. To be more precise, motion parameters to be adopted may refer to a certain time interval between the current picture and the reference picture, and in merging the current block with the respective merge candidate having respective motion parameters, encoder 10 may be configured to scale the motion parameters of the respective merge candidate in order to adapt its time interval to the time interval selected for the current block.

In any case, the merge candidates described so far have in common that all of them have coding parameters associated therewith, and there is a one to one association between these merge candidates and neighboring blocks. Accordingly, merging blocks 40 with any of the just-outlined merge candidates may be thought of as a merging of these blocks into groups of one or more blocks 40 so that the coding parameters do not vary across the picture 20 within these groups of blocks 40, except for the scaling adaptions or the like. Effectively, the merging with any of the just-outlined merge candidates reduces the granularity at which the coding parameters vary over the picture 20. Beyond that, the merging with any of the just-outlined merge candidates results in an additional freedom in subdividing picture 20 into blocks 40 and groups of blocks 40, respectively. Thus, in this regard the merging of blocks 40 into such groups of blocks may be thought of causing the encoder 10 to encode the picture 20 using coding parameters which vary across the picture 20 in units of these groups of blocks 40.

Besides the just-mentioned merge candidates, encoder 10 may also add merge candidates to the set/list of merge candidates, which are a result of a combination of two or more neighboring blocks' coding parameters, such as an arithmetic mean, a geometric mean thereof or a median of the coding parameters of neighboring blocks and the like.

Thus, effectively, encoder 10 reduces the granularity at which coding parameters are explicitly transmitted within bitstream 30 compared to the granularity defined by the subdivision of picture 20 into blocks 40. Some of these blocks 40 form groups of blocks using one and the same coding parameters by use of the merging option outlined above.

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Some blocks are coupled to each other via merging, but use different coding parameters correlated among each other via respective scaling adaptations and/or combinational functions. Some blocks 40 are not subject to merging, and accordingly encoder 10 encodes the coding parameters into bitstream 30 directly.

The encoder 10 uses the coding parameters of blocks 40 thus defined in order to determine a prediction signal for picture 20. Encoder 10 performs this determination of the prediction signal block-wise in that the prediction signal depends on the coding parameters associated with the respective block 40.

Another decision performed by encoder 10 is whether the residuum, i.e. the difference between the prediction signal and the original picture content at the respective local area of the current block 40, is to be transmitted within bitstream 30 or not. That is, encoder 10 decides for blocks 40 whether skip mode shall be applied to the respective block or not. If skip mode is applied, the encoder 10 encodes picture 20 within the current portion 40 merely in the form of the prediction signal derived from, or depending on, the coding parameters associated with the respective block 40, and in case of the skip mode being deselected, encoder 10 encodes the picture 20 into bitstream 30 within block 40 using both, the prediction signal as well as the residual data.

In order to save bit rate for signaling the decision with regard to the merging on the one hand and the skip mode on the other hand, encoder 10 commonly signals both decisions using one flag for a block 40. To be more precise, the common signalization may be realized such that the activation of both the merging and the skip mode is commonly indicated by the flag of the respective block 40 within bitstream 30 assuming a first possible flag state, whereas the other flag state of the flag merely indicates to the decoder that either one of the merging or skip mode is not activated. For example, encoder 10 may decide for a certain block 40 to activate merging, but deactivate the skip mode. In that case, encoder 10 uses the other flag state in order to signal within bitstream 30 the deactivation of at least one of the merging and the skip mode, while subsequently signaling within bitstream 30 the activation of merging by use of another flag, for example. Accordingly, encoder 10 has to transmit this further flag merely in case a block 40 for which the merging and the skip mode is not activated concurrently. In embodiments further described below, the first flag is called mrg_cbf or skip_flag while the subsidiary merge indicator flag is called mrg or merge_flag. It has been found out by the inventors of the present application that this co-use of one signalization state in order to commonly signal the activation of merging and skip mode reduces the overall bit rate of bitstream 30.

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As to the signalization state just-mentioned, it should be noted that such a signalization state may be determined by the state of one bit of bitstream 30. However, encoder 10 may be configured to entropy encode bitstream 30, and accordingly the correspondence between the signalization state of the flag and the bitstream 30 may be more complicated. In that case, the state could correspond to one bit of bitstream 30 in the entropy-decoded domain. Even further, the signalization state may correspond to one of the two states of the flag for which code words are assigned in accordance with the variable length coding scheme. In case of arithmetic coding, the signalization state commonly signaling the activation of merging and skip mode, may correspond to one of the symbols of the symbol alphabet underlying the arithmetic encoding scheme.

As outlined above, the encoder 10 signals the concurrent activation of the merging and the skip mode using a flag within bitstream 30. As will be outlined in more detail below, this flag may be transmitted within a syntax element which has more than two possible states. This syntax element may, for example, signal other coding options as well. Details are described in more detail below. In that case, however, one of the possible states of the one or more syntax elements signalizes the concurrent activation. That is, whenever the just-mentioned syntax element of a current block 40 assumes this predetermined possible state, the encoder 10 signalizes thereby the activation of both the merging and the skip mode. The decoder thus needs no further signalization regarding the activation of merging and the activation of skip mode, respectively.

With regard to the description outlined above, it should be noted that the partitioning of picture 20 into blocks 40 may not represent the finest resolution at which coding parameters are determined for picture 20. Rather, encoder 10 may accompany each block 40 with further partitioning information in order to signal within the bitstream 30 one of supported partitioning patterns for partitioning the current block 40 into sub-blocks 50 and 60, respectively, i.e. sample subsets. In that case, the concurrent merging/skip decision is performed by encoder 10 in units of blocks 40, whereas coding parameters along with, for example, subsidiary merge decision and/or skip mode decision separated from each other, are defined for picture 20 in units of the sub-partitioning of blocks 40, i.e. in units of sub-blocks 50 and 60 in the exemplarily shown block 40 of Fig. 1. Naturally, a non-partitioning mode may represent one of the supported partitioning patterns, thereby resulting in encoder 10 merely determining one set of coding parameters for block 40. Irrespective of the number of sub-blocks 50 and 60 of the respective partitioning pattern, the merging decision may apply to all sub-blocks, i.e. the one or more sub-blocks. That is, if the merging is activated for block 40, this activation may be valid for all sub-blocks. In accordance with an embodiment outlined further below, the aforementioned common state commonly

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signaling the activation of the merging and the skip mode, may additionally concurrently signal the non-partitioning pattern among the supported partitioning patterns for the current block 40 so that in case of the flag or the syntax element assuming this state, no further transmission of partitioning information for the current block is necessary. Naturally, any other partitioning pattern among the supported partitioning pattern could alternatively be indicated concurrently in addition to the activation of the merging and the skip mode.

In accordance with some embodiments of the present application, the encoder 10 avoids bit efficiency penalties resulting from the co-use of the block partitioning of blocks 40 on the one hand and the merging of sub-blocks 50 and 60 on the other hand. To be more precise, the encoder 10 may decide as to whether it is in some, for example, rate-distortion optimization sense better to further partition block 40, and as to which of supported partitioning patterns should be used for a current block 40 in order to adapt the granularity at which certain coding parameters are set or defined within the current block 40 of picture 20. As will be outlined in more detail below, the coding parameters may, for example, represent prediction parameters such as inter prediction parameters. Such inter prediction parameters may, for example, comprise a reference picture index, a motion vector and the like. The supported partitioning patterns may, for example, comprise a non-partitioning mode, i.e., an option according to which the current block 40 is not further partitioned, a horizontally partitioning mode, i.e., an option according to which the current block 40 is subdivided along a horizontally extending line into an upper or top portion and a bottom or lower portion and a vertically partitioning mode, i.e., an option according to which the current block 40 is vertically subdivided along a vertically extending line into a left portion and a right portion. Beyond this, the supported partitioning patterns may also comprise an option according to which the current block 40 is further regularly subdivided into four further blocks each assuming one quarter of current block 40. Further, the partitioning may pertain all blocks 40 of the picture 20 or merely a proper subset thereof such as those having a certain coding mode associated therewith, such as the inter prediction mode. Similarly, it is noted that merging may, per se, merely be available for certain blocks, such as those coded in the inter prediction mode. In accordance with an embodiment further outlined below, the aforementioned commonly interpreted state also signals concurrently that the respective block is of the inter prediction mode rather than the intra prediction mode. Accordingly, one state of the aforementioned flag for block 40 may signal that this block is an inter prediction coded block which is not further partitioned and for which both the merging and the skip mode are activated. However, as a subsidiary decision in case of the flag assuming the other state, each partition or sample subset 50 and 60 may individually be accompanied by a further flag within bitstream 30 in order to signal whether merging shall be applied to the respective partition 50 and 60 or not. Further,

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different subsets of the supported partitioning modes may be available for blocks 40, depending, for example, on the block size, the subdivision level of the block 40 in case of the same being a multi-tree subdivision leaf block, in combination or individually.

That is, the subdivision of picture 20 into blocks so as to obtain, inter alia, block 40 may be fixed or signaled within the bitstream. Similarly, the partitioning pattern to be used for further partitioning current block 40 may be signaled within the bitstream 30 in the form of partitioning information. Accordingly, the partitioning information may, thus, be thought of as being a kind of extension of the subdivision of picture 20 into blocks 40. On the other hand, an additional relevance of the original granularity of subdivision of picture 20 into blocks 40 may still remain. For example, the encoder 10 may be configured to signalize within the bitstream 30 the coding mode to be used for the respective portion or block 40 of picture 20 at the granularity defined by block 40 while the encoder 10 may be configured to vary the coding parameters of the respective coding mode within the respective block 40 at an increased (finer) granularity defined by the respective partitioning pattern chosen for the respective block 40. For example, the coding mode signaled at the granularity of blocks 40 may distinguish between intra prediction mode, inter prediction mode and the like, such as temporal inter prediction mode, inter-view prediction mode etc. The sort of coding parameters associated with the one or more sub-blocks (partitions) resulting from the partitioning of the respective block 40, then depends on the coding mode assigned to the respective block 40. For example, for an intra-coded block 40, the coding parameters may comprise a spatial direction along which picture content of previously decoded portions of picture 20 are used to fill the respective block 40. In case of an inter-coded block 40, the coding parameters may comprise, inter alia, a motion vector for motion-compensated prediction.

Fig. 1 exemplarily shows the current block 40 as being subdivided into two sub-blocks 50 and 60. In particular, a vertically partitioning mode is exemplarily shown. The smaller blocks 50 and 60 may also be called sub-blocks 50 and 60 or partitions 50 and 60 or prediction units 50 and 60. In particular, the encoder 10 may be configured to remove, in such cases where the signaled one of the supported partitioning patterns specifies a subdivision of the current block 40 into two or more further blocks 50 and 60, for all further blocks except a first sub-block of the sub-blocks 50 and 60 in a coding order, from a set of coding parameter candidates for the respective sub-block, coding parameter candidates having coding parameters which are the same as coding parameters associated with any of the sub-blocks which would, when being merged with the respective sub-blocks, result in one of the supported partitioning patterns. To be more precise, for each of the supported partitioning patterns a coding order is defined among the resulting one or

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more partitions 50 and 60. In the case of Fig. 1, the coding order is exemplarily illustrated by an arrow 70, defining that the left partition 50 is coded prior to the right partition 60. In case of a horizontally partitioning mode, it could be defined that the upper partition is coded prior to the lower partition. In any case, the encoder 10 is configured to remove for the second partition 60 in coding order 70, from the set of coding parameter candidates for the respective second partition 60, coding parameter candidates having coding parameters which are the same as coding parameters associated with the first partition 50 in order to avoid the result of this merging, namely the fact that both partitions 50 and 60 would have the same coding parameters associated therewith which, in fact, could equally yield by choosing the non-partitioning mode for current block 40 at a lower coding rate.

To be more precise, encoder 10 may be configured to use block merging in an effective way along with block partitioning. As far as the block merging is concerned, encoder 10 may determine for each partition 50 and 60, a respective set of coding parameter candidates. The encoder may be configured to determine the sets of coding parameter candidates for each of the partitions 50 and 60 based on coding parameters associated with previously decoded blocks. In particular, at least some of the coding parameter candidates within the sets of coding parameter candidates may be equal to, i.e. may be adopted from, the coding parameters of previously decoded partitions. Additionally or alternatively, at least some of the coding parameter candidates may be derived from coding parameter candidates associated with more than one previously coded partition, by way of a suitable combination such as a median, mean or the like. However, since the encoder 10 is configured to perform the determination of the reduced set of coding parameter candidates and, if more than one such coding parameter candidate remains after removal, the choice among the remaining non-removed coding parameter candidates, for each of the non-first partitions 60 in order to set coding parameters associated with the respective partition depending on the one non-removed or chosen coding parameter candidate, the encoder 10 is configured to perform the removal such that coding parameter candidates which would lead, effectively, to a re-uniting of partitions 50 and 60, are removed. That is, syntax constellations are effectively avoided according to which an effective partitioning situation is coded more complex than in case of directly signaling this partitioning merely by use of the partitioning information alone.

Moreover, as the sets of coding parameter candidates gets smaller, the amount of side information necessary to encode the merging information into the bitstream 30 may decrease due to the lower number of elements in these candidate sets. In particular, as the decoder is able to determine and subsequently reduce the sets of coding parameter candidates in the same way as the encoder of Fig. 1 does, the encoder 10 of Fig. 1 is able to

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exploit the reduced sets of coding parameter candidates by, for example, using less bits in order to insert a syntax element into the bitstream 30, specifying which of the non-removed coding parameter candidates is to be employed for merging. Naturally, the introduction of the syntax element into bitstream 30 may be completely suppressed in case the number of non-removed coding parameter candidates for the respective partition is merely one. In any case, due to the merging, i.e., setting the coding parameters associated with the respective partition dependent on the remaining one, or chosen one, of the non-removed coding parameter candidates, the encoder 10 is able to suppress the completely anew insertion of coding parameters for the respective partition into bitstream 30, thereby reducing the side information as well. In accordance with some embodiments of the present application, the encoder 10 may be configured to signalize within the bitstream 30 refinement information for refining the remaining one, or chosen one of the coding parameter candidates for the respective partitions.

In accordance with the just-outlined possibility of reducing the merge candidate list, the encoder 10 may be configured to determine the merge candidates to be removed by way of a comparison of their coding parameters with the coding parameters of the partition, the merging with which would yield another supported partitioning pattern. This way of treating the coding parameter candidates would, effectively, remove at least one coding parameter candidate in the illustrative case of Fig. 1, for example, provided that the coding parameters of the left partition 50 form one element of the set of coding parameter candidates for the right partition 60. Further coding parameter candidates may, however, also be removed in case they are equal to the coding parameters of left partition 50. In accordance with another embodiment of the present invention, however, encoder 10 could be configured to determine a set of candidate blocks for each second and following partition in coding order, with removing that or those candidate blocks from this set of candidate blocks, which would, when being merged with the respective partition, result in one of the supported partitioning patterns. In some sense, this means the following. The encoder 10 may be configured to determine merge candidates for a respective partition 50 or 60 (i.e. the first and the following ones in coding order) such that each element of the candidate set has exactly one partition of the current block 40 or any of the blocks 40 previously coded, associated therewith in that the candidate adopts the respective coding parameters of the associated partition. For example, each element of the candidate set could be equal to, i.e. adopted from, one of such coding parameters of previously coded partitions, or could at least be derived from the coding parameters of merely one such previously coded partition such as by additionally scaling or refinement using additionally sent refinement information. The encoder 10 could, however, also be configured to accompany such candidate set with further elements or candidates, namely coding

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parameter candidates which have been derived from a combination of coding parameters of more than one previously coded partition, or which have been derived – by modification - from coding parameters of one previously coded partition such as by taking merely the coding parameters of one motion parameter list. For the "combined" elements, there is no 1:1 association between the coding parameters of the respective candidate element and a respective partition. In accordance with the first alternative of the description of Fig. 1, the encoder 10 could be configured to remove all candidates from the whole candidate set, the coding parameters of which equal the coding parameters of partition 50. In accordance with the latter alternative of the description of Fig. 1, the encoder 10 could be configured to remove merely the element of the candidate set which is associated with partition 50. Harmonizing both points of views, the encoder 10 could be configured to remove candidates from the portion of the candidate set, showing a 1:1 association to some (e.g. neighboring) previously coded partitions, with not extending the removal (and search for candidates having equal coding parameters) to the remaining portion of the candidate set having coding parameters being obtained by combination. But of course, if one combination also would lead to redundant representation, this could be solved by removing redundant coding parameters from the list or by performing the redundancy check for the combined candidates as well.

Before describing an embodiment of a decoder fitting to the just-outlined embodiment of Fig. 1, an apparatus for encoding, i.e. an encoder, according to Fig. 1 in a more detailed implementation is outlined in more detail below with respect to Fig. 2. Fig. 2 shows the encoder as comprising a subdivider 72 configured to subdivide the picture 20 into blocks 40, a merger 74 configured to merge the block 40 into groups of one or more sample sets as outlined above, an encoder or encoding stage 76, configured to encode the picture 20 using coding parameters varying across the picture 20 in units of the groups of sample sets, and a stream generator 78. The encoder 76 is configured to encode the picture 20 by predicting the picture 20 and encoding a prediction residual for predetermined blocks. That is, encoder 76 encodes, as described above, the prediction residual not for all blocks 40. Rather, some of them have the skip mode activated. The stream generator 78 is configured to insert the prediction residual and the coding parameters into the bitstream 30, along with one or more syntax elements for each of at least a subset of blocks 40, signaling whether the respective block 40 is merged into one of the groups along with another block or not and whether the respective block uses skip mode or not. As described above, the subdivision information underlying the subdivision of subdivider 72 may also be encoded into bitstream 30 for picture 20 by stream generator 78. This is indicated by a dashed line in Fig. 2. The merge decision by merger 74 and the skip mode decision performed by encoder 76 is, as outlined above, commonly encoded into bitstream 30 by stream generator

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78 such that one of the possible states of the one or more syntax elements of a current block 40 signalizes that the respective block is to be merged into one of the groups of blocks along with another block of picture 20 and has no prediction residual encoded and inserted into bitstream 30. The stream generator 78 may, for example, use entropy coding in order to perform the insertion. The subdivider 72 may be responsible for the subdivision of the picture 20 into the blocks 40 as well as the optional further partitioning into partitions 50 and 60, respectively. The merger 74 is responsible for the above-outlined merge decision while the encoder 76 may, for example, decide on the skip mode for the blocks 40. Naturally, all of these decisions influence the rate/distortion measure in combination, and accordingly apparatus 10 may be configured to try out several decision options in order to ascertain which option is to be preferred.

After having described an encoder according to an embodiment of the present invention with regard to Figs. 1 and 2, an apparatus for decoding, i.e. a decoder 80 according to an embodiment is described with respect to Fig. 3. The decoder 80 of Fig. 3 is configured to decode the bitstream 30 which, as described above, has picture 20 encoded therein. In particular, the decoder 80 is configured to be, for a current sample set or block 40, commonly responsive to the aforementioned flag within the bitstream 30 as to a first decision whether the coding parameters associated with the current block 40 are to be set according to a merge candidate or to be retrieved from the bitstream 30, and a second decision whether the current block 40 of the picture 20 is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current block 40, without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current block 40 by means of residual data within the bitstream 30.

That is, the decoder's functionality largely coincides with that of the encoder described with respect to Figs. 1 and 2. For example, the decoder 80 may be configured to perform the subdivision of picture 40 into blocks 40. This subdivision may be known to the decoder 80 by default, or decoder 80 may be configured to extract respective subdivision information from bitstream 30. Whenever a block 40 is merged, decoder 80 may be configured to obtain the coding parameters associated with that block 40 by setting the coding parameters thereof according to a merge candidate. In order to determine the merge candidate, the decoder 80 may perform the above-outlined determination of the set or list of merge candidates in exactly the same manner as the encoder did. This includes, in accordance with some embodiments of the present application, even the reduction of the preliminary set/list of merge candidates in order to avoid the above-outlined redundancy between block partitioning on the one hand and block merging on the other hand. The

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selection among the determined set or list of merge candidates may be performed by decoder 80 by extracting a respective merge index from the bitstream 30 whenever merging is activated. The merge index points to the merge candidate to be used out of the (reduced) set or list of merge candidates determined as described above. Further, as also described above, decoder 80 may also be configured to subject blocks 40 to a partitioning in accordance with one of the supported partitioning patterns. Naturally, one of these partitioning patterns may involve a non-partitioning mode according to which a block 40 is not further partitioned. In case of the thoroughly described flag assuming the commonly defined state indicating the activation of the merging and the skip mode for a certain block 40, decoder 80 may be configured to reconstruct the current block 40 merely based on the prediction signal rather than a combination thereof with any residual signal. In other words, decoder 80 suppresses in that case residual data extraction for the current block 40 and merely reconstructs the picture 20 within the current block 40 by use of the prediction signal derived from the coding parameters of the current block. As was also already described above, decoder 80 may interpret the common state of the flag also as a signalization for the current block 40 that this block is an inter predicted block and/or a block not further partitioned. That is, the decoder 80 may be configured such that same obtains the coding parameters associated with a current block 40 by setting these coding parameters according to a merge candidate, and reconstructs the current block 40 of the picture 20 merely based on a prediction signal depending on the coding parameters of the current block 40 without any residual data if the flag in question of the current block 40 within the bitstream 30 signals that the coding parameters associated with the current block 40 are to be set using merging. If the flag in question, however, signals that the current block 40 is not subject to merging or skip mode is not used, the decoder 80 may be responsive to another flag within the bitstream 30 such that the decoder 80, depending on this other flag, obtains the coding parameters associated with the current block by setting same according to a respective merge candidate, obtains residual data for the current block from the bitstream 30 and reconstructs the current block 40 of the picture 20 based on the prediction signal and the residual data, or extracts the coding parameters associated with the current block 40 from the bitstream 30, obtains residual data for the current block 40 from the bitstream 30 and reconstructs the current block 40 of the picture 20 based on the prediction signal and the residual data. As outlined above, the decoder 80 may be configured to expect the existence of the other flag within bitstream 30 only in case of the first flag not assuming the commonly signaling state concurrently signaling the activation of the merging and the skip mode. Only then, the decoder 80 extracts the other flag from the bitstream in order to ascertain whether merging shall take place without the skip mode. Naturally, the decoder 80 could alternatively be configured to await another third flag

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within bitstream 30 for the current block 40 in case of the second flag signaling the deactivation of merging, with this third flag signaling skip mode activation or deactivation.

Analogously to Fig. 2, Fig. 4 shows a possible implementation of the apparatus for decoding of Fig. 3. Accordingly, Fig. 4 shows an apparatus for decoding, i.e. a decoder 80, which comprises a subdivider 82 configured to subdivide the picture 20 encoded into bitstream 30 into blocks 40, a merger 84 configured to merge the blocks 40 into groups of one or more blocks each, a decoder 86 configured to decode or reconstruct the picture 20 using coding parameters varying across the picture 20 in units of the groups of sample sets and an extractor 88. The decoder 86 is also configured to decode the picture 20 by predicting the picture 20, decoding a prediction residual for predetermined blocks 40 and combining the prediction residual and a prediction resulting from predicting the picture 20, for the predetermined blocks 40, i.e. those having the skip mode switched off. The extractor 88 is configured to extract the prediction residual and the coding parameters from the bitstream 30, along with one or more syntax elements for each of at least a subset of the blocks 40, signaling whether the respective block 40 is to be merged into one of the groups along with another block 40 or not, wherein the merger 84 is configured to perform the merging responsive to the one or more syntax elements, wherein one of the possible states of the one or more syntax elements signalizes that the respective block 40 is to be merged into one of the groups of blocks along with another block 40 and has no prediction residual encoded and inserted into the bitstream 30.

Thus, comparing Fig. 4 with Fig. 2, the subdivider 82 acts like subdivider 72 in order to restore the subdivision generated by subdivider 72. Subdivider 82 knows about the subdivision of picture 20 either by default or extracts subdivision information from bitstream 30 via extractor 88. Similarly, merger 84 forms the merging of the blocks 40 and is activated with regard to blocks 40 and block portions via the above-outlined signaling within bitstream 30. Decoder 86 performs the generation of the prediction signal of picture 20 using the coding parameters within bitstream 30. In case of merging, decoder 86 copies the coding parameters of a current block 40 or a current block partition from neighboring blocks/partitions or otherwise sets the coding parameters thereof according to the merge candidate.

As already outlined above, the extractor 88 is configured to interpret one of the possible states of a flag or syntax element for a current block as a signal that concurrently signals the activation of the merging and the skip mode. Concurrently, extractor 88 may interpret the state to also signal a predetermined one among the supported partitioning patterns for the current block 40. For example, the predetermined partitioning pattern may be the non-

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partitioning mode according to which block 40 remains unpartitioned and thus forms a partition itself. Accordingly, extractor 88 expects bitstream 30 to comprise partitioning information signaling the partitioning of block 40 merely in case of the respective flag or syntax element not assuming the concurrently signaling state. As will be outlined in more detail below, the partitioning information may be conveyed within bitstream 30 via a syntax element which, concurrently, controls the coding mode of the current block 40, i.e. divide up blocks 40 into ones being inter coded and ones being intra coded. In that case, the commonly signaling state of the first flag/syntax element may also be interpreted as a signalization of the inter prediction coding mode. For each of the partitions resulting from the signaled partitioning information, extractor 88 may extract another merging flag from bitstream in case of the first flag/syntax element for block 40 not assuming the commonly signaling state concurrently signaling activation of the merging and the skip mode. In that case, the skip mode may inevitably be interpreted by extractor 88 to be switched off, and although merging may be activated by bitstream 30 individually for the partitions, the residual signal is extracted from bitstream 30 for this current block 40.

Thus, the decoder 80 of Fig. 3 or 4 is configured to decode the bitstream 30. As described above, bitstream 30 may signal one of supported partitioning patterns for a current block 40 of picture 20. The decoder 80 may be configured to, if the signaled one of the supported partitioning pattern specifies a subdivision of the current block 40 into two or more partitions 50 and 60, remove for all partitions except the first partition 50 of the partitions in coding order 70, i.e. for partition 60 in the illustrated example of Figs. 1 and 3, from a set of coding parameter candidates for the respective partition coding parameter candidates having coding parameters which are the same as, or equal to, coding parameters associated with any of the partitions, which would, when being merged with the respective partition, result in one of the supported partitioning patterns, namely one not having been signalized within the bitstream 30 but being, nevertheless, one of the supported partitioning patterns.

For example, the decoder 80 may be configured to, if a number of the non-removed coding parameter candidates is non-zero, set coding parameters associated with the respective partition 60 depending on one of the non-removed parameter candidates. For example, the decoder 80 sets the coding parameters of partition 60 so as to be equal to one of the non-removed coding parameter candidate, with or without additional refinement and/or with or without scaling in accordance with a temporal distance to which the coding parameters refer, respectively. For example, the coding parameter candidate to merge with out of the non-removed candidates, may have another reference picture index associated therewith than a reference picture index explicitly signaled within the bitstream 30 for partition 60. In that case, the coding parameters of the coding parameter candidates may define motion

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vectors, each related to a respective reference picture index, and the decoder 80 may be configured to scale the motion vector of the finally chosen non-removed coding parameter candidate in accordance with the ratio between both reference picture indices. Thus, in accordance with the just-mentioned alternative, the coding parameters being subject to merging, would encompass the motion parameters, whereas reference picture indices would be separate therefrom. However, as indicated above, in accordance with alternative embodiments, the reference picture indices could also be a part of the coding parameters being subject to merging.

It equally applies for the encoder of Fig. 1 and 2 and the decoder of Fig. 3 and 4 that the merge behavior may be restricted to inter-predicted blocks 40. Accordingly, the decoder 80 and the encoder 10 may be configured to support intra and inter prediction modes for the current block 40 and perform merging merely in case of the current block 40 being coded in inter prediction mode. Accordingly, merely the coding/prediction parameters of such inter-predicted previously coded partitions may be used to determine/construct the candidate list.

As already discussed above, the coding parameters may be prediction parameters and the decoder 80 may be configured to use the prediction parameters of the partitions 50 and 60 in order to derive a prediction signal for the respective partition. Naturally, the encoder 10 performs the derivation of the prediction signal in the same way, too. The encoder 10, however, additionally sets the prediction parameters along with all the other syntax elements within bitstream 30 in order to achieve some optimization in a suitable optimization sense.

Further, as already described above, the encoder may be configured to insert an index to a (non-removed) coding parameter candidate merely in case the number of (non-removed) coding parameter candidate for a respective partition is greater than one. Accordingly, the decoder 80 may be configured to, depending on the number of (non-removed) coding parameter candidates for, for example, partition 60, merely expect the bitstream 30 to comprise a syntax element specifying which of the (non-removed) coding parameter candidate is employed for merging, if the number of (non-removed) coding parameter candidates is greater than one. However, the case of the candidate set getting smaller in number than two, could be generally excluded from occurring by extending, as described above, the list/set of candidates using combined coding parameters, i.e. parameters having been derived by combination of the coding parameters of more than one – or more than two - previously coded partitions, with restricting the performance of the candidate set reduction to those candidates having been obtained by adopting, or derivation from, the

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coding parameters of exactly one previously coded partition. The opposite is possible as well, i.e. generally removing all coding parameter candidates having the same value as those of the partition resulting in another supported partitioning pattern.

Regarding the determination, the decoder 80 acts as encoder 10 does. That is, decoder 80 may be configured to determine the set of merge candidates for the partition or the partitions of a block 40 based on coding parameters associated with previously decoded partitions. That is, a coding order may not only be defined among the partitions 50 and 60 of a respective block 40, but also among blocks 40 of picture 20 itself. All the partitions having been coded prior to partition 60 may, thus, serve the basis for the determination of the set of merge candidates for any of the subsequent partitions, such as partition 60 in case of Fig. 3. As is also described above, the encoder and decoder may restrict the determination of the set of merge candidates to partitions in a certain spatial and/or temporal neighborhood. For example, the decoder 80 may be configured to determine the set of merge candidates based on the coding parameters associated with previously decoded partitions neighboring the current partition, wherein such partitions may lay outside and inside the current block 40. Naturally, the determination of merge candidates may also be performed for the first partition in coding order. Merely the removal may be left away.

Coinciding with the description of Fig. 1, the decoder 80 may be configured to determine the set of coding parameter candidates for the respective non-first partition 60 out of an initial set of previously decoded partitions, excluding ones being coded in an intra prediction mode.

Further, in case of the encoder introducing subdivision information into the bitstream in order to subdivide picture 20 into the blocks 40, the decoder 80 may be configured to recover the subdivision of picture 20 into such coding blocks 40 according to the subdivision information in the bitstream 30.

With regard to Figs. 1 to 4, it should be noted that the residual signal for current block 40 may be transmitted via bitstream 30 in a granularity which may differ from the granularity defined by the partitions with regard to the coding parameters. For example, for blocks for which the skip mode is deactivated, encoder 10 of Fig. 1 may be configured to subdivide the block 40 into one or more transform blocks in a way parallel to, or independent from, the partitioning into partitions 50 and 60. The encoder may signalize the respective transform block subdivision for block 40 by way of further subdivision information. The decoder 80, in turn, may be configured to recover this further subdivision of block 40 into

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one or more transform blocks according to the further subdivision information in the bitstream, and to derive a residual signal of the current block 40 from the bitstream in units of these transform blocks. The significance of the transform block partitioning may be that the transform, such as DCT, in the encoder and the corresponding inverse transform such as IDCT in the decoder are performed within each transform block of block 40 individually. In order to reconstruct picture 20 within block 40, the encoder 10 then combines, such as adds, the prediction signal derived by applying the coding parameters at the respective partitions 50 and 60, and the residual signal, respectively. However, it is noted that the residual coding may not involve any transform and inverse transform respectively, and that the prediction residuum is coded in the spatial domain instead, for example.

Before describing further possible details of further embodiments below, a possible internal structure of encoder and decoder of Figs. 1 to 4 shall be described with respect to Figs. 5 and 6, wherein, however the merger and the subdivider are not shown in these figures in order to concentrate on the hybrid coding nature. Fig. 5 shows exemplarily as to how encoder 10 may be constructed internally. As shown, encoder 10 may comprise a subtracter 108, a transformer 100, and a bitstream generator 102, which may, as indicated in Fig. 5, perform an entropy coding. Elements 108, 100 and 102 are serially connected between an input 112 receiving picture 20, and an output 114 outputting the aforementioned bitstream 30. In particular, subtractor 108 has its non-inverting input connected to input 112 and transformer 100 is connected between an output of subtractor 108 and a first input of bitstream generator 102 which, in turn, has an output connected to output 114. The encoder 10 of Fig. 5 further comprises an inverse transformer 104 and an adder 110 serially connected, in the order mentioned, to the output of transformer 100. Encoder 10 further comprises a predictor 106, which is connected between an output of adder 110 and a further input of adder 110 and the inverting input of subtractor 108.

The elements of Fig. 5 interact as follows: Predictor 106 predicts portions of picture 20 with the result of the prediction, i.e., the prediction signal, being applied to the inverting input of subtracter 108. The output of subtractor 108, in turn, represents the difference between the prediction signal and the respective portion of picture 20, i.e. a residual signal. The residual signal is subject to transform coding in transformer 100. That is, transformer 100 may perform a transformation, such as a DCT or the like, and a subsequent quantization on the transformed residual signal, i.e. the transform coefficients, so as to obtain transform coefficient levels. The inverse transformer 104 reconstructs the final residual signal output by transformer 100 to obtain a reconstructed residual signal which corresponds to the residual signal input into transformer 100 except for the information

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loss due to the quantization in transformer 100. The addition of the reconstructed residual signal and the prediction signal as output by predictor 106 results in a reconstruction of the respective portion of picture 20 and is forwarded from the output of adder 110 to the input of predictor 106. Predictor 106 operates in different modes as described above, such as an intra prediction mode, inter prediction mode and the like. Prediction mode and the corresponding coding or prediction parameters applied by predictor 106 in order to obtain the prediction signal, are forwarded by predictor 106 to entropy encoder 102 for insertion into the bitstream.

A possible implementation of the internal structure of decoder 80 of Figs. 3 and 4, corresponding to the possibility shown in Fig. 5 with respect to the encoder, is shown in Fig. 6. As shown therein, the decoder 80 may comprise a bitstream extractor 150 which may, as shown in Fig. 6, be implemented as an entropy decoder, an inverse transformer 152 and an adder 154, which are, in the order mentioned, connected between an input 158 and an output 160 of the decoder. Further, the decoder of Fig. 6 comprises a predictor 156 connected between an output of adder 154 and a further input thereof. The entropy decoder 150 is connected to a parameter input of predictor 156.

Briefly describing the functionality of the decoder of Fig. 6, the entropy decoder 150 is for extracting all the information contained in the bitstream 30. The entropy coding scheme used may be variable length coding or arithmetic coding. By this, entropy decoder 150 recovers from the bitstream transformation coefficient levels representing the residual signal and forwards same to the inverse transformer 152. Further, entropy decoder 150 acts as the above-mentioned extractor 88 and recovers from the bitstream all the coding modes and associated coding parameters and forwards same to predictor 156. Additionally, the partitioning information and merging information is extracted from the bitstream by extractor 150. The inversely transformed, i.e., reconstructed residual signal and the prediction signal as derived by predictor 156 are combined, such as added, by adder 154 which, in turn, outputs the thus-recovered reconstructed signal at output 160 and forwards same to the predictor 156.

As becomes clear from comparing Figs. 5 and 6, elements 152, 154 and 156 functionally correspond to elements 104, 110 and 106 of Fig. 5.

In the above description of Figs. 1 to 6, several different possibilities have been presented with regard to possible subdivisions of picture 20 and the corresponding granularity in varying some of the parameters involved in coding picture 20. One such possibility is again described with respect to Fig. 7a and Fig. 7b. Fig. 7a shows a portion out of a picture

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20. In accordance with the embodiment of Fig. 7a, encoder and decoder are configured to firstly subdivide picture 20 into tree-root blocks 200. One such tree-root block is shown in Fig. 7a. The subdivision of picture 20 into tree-root blocks is done regularly in rows and columns as illustrated by dotted lines. The size of the tree-root blocks 200 may be selected by the encoder and signaled to the decoder by bitstream 30. Alternatively, the size of these tree-root blocks 200 may be fixed by default. The tree-root blocks 200 are subdivided by use of quad-tree partitioning in order to yield the above-identified blocks 40 which may be called coding blocks or coding units. These coding blocks or coding units are drawn with thin solid lines in Fig. 7a. By this, the encoder accompanies each tree-root block 200 with subdivision information and inserts the subdivision information into the bitstream. This subdivision information indicates as to how the tree-root block 200 is to be subdivided into blocks 40. At a granularity of, and in units of, these blocks 40, the prediction mode varies within picture 20. As indicated above, each block 40 – or each block having a certain prediction mode such as inter prediction mode - is accompanied by partitioning information as to which supported partitioning pattern is used for the respective block 40. In this regard, it is recalled, however, that the aforementioned flag/syntax element may, when assuming the commonly signaling state, concurrently also signal one of the supported partitioning modes for the respective block 40 so that the explicit transmission of another partitioning information for this block 40 may be suppressed at the encoder side and not be expected, accordingly, at the decoder side. In the illustrative case of Fig. 7a, for many coding blocks 40, the non-partitioning mode has been chosen so that the coding block 40 spatially coincides with the corresponding partition. In other words, the coding block 40 is, concurrently, a partition having a respective set of prediction parameters associated therewith. The sort of prediction parameters, in turn, depends on the mode associated with the respective coding block 40. Other coding blocks, however, are exemplarily shown to be further partitioned. The coding block 40 at the top right-hand corner of the tree-root block 200, for example, is shown to be partitioned into four partitions, whereas the coding block at the bottom right-hand corner of the tree-root block 200 is exemplarily shown to be vertically subdivided into two partitions. The subdivision for partitioning into partitions is illustrated by dotted lines. Fig. 7a also shows the coding order among the partitions thus defined. As shown, a depth-first traversal order is used. Across the tree-root block borders, the coding order may be continued in a scan order according to which the rows of tree-root blocks 200 are scanned row-wise from top to bottom of picture 20. By this measure, it is possible to have a maximum chance that a certain partition has a previously coded partition adjacent to its top border and left-hand border. Each block 40 – or each block having a certain prediction mode such as inter prediction mode – may have a merge switch indicator within the bitstream indicating as to whether merging is activated for the corresponding partitions therein or not. It should be

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noted that the partitioning of the blocks into partitions/prediction units could be restricted to a partitioning of maximally two partitions, with merely an exception of this rule being only made for the smallest possible block size of blocks 40. This could, in case of using quad-tree subdivision in order to obtain blocks 40, avoid redundancy between subdivision information for subdividing picture 20 into block 40 and partitioning information for subdividing block 40 into partitions. Alternatively, merely partitionings into one or two partitions could be allowed, including or not including asymmetric ones.

Fig. 7b shows a subdivision tree. With solid lines, the subdivision of tree-root block 200 is illustrated, whereas dotted lines symbolize the partitioning of the leaf blocks of the quad-tree subdivisioning, which are the coding blocks 40. That is, the partitioning of the coding blocks represents a kind of extension of the quad-subdivision.

As already noted above, each coding block 40 may be parallely subdivided into transform blocks so that transform blocks may represent a different subdivision of the respective coding block 40. To each of these transform blocks, which are not shown in Figs. 7a and 7b, a transformation in order to transform the residual signal of the coding blocks may be performed separately.

In the following, further embodiments of the present invention are described. While the above embodiments concentrated on the relation between the block merging on the one hand and the block partitioning on the other hand, the following description also includes aspects of the present application relating to other coding principles known in present codecs, such as SKIP/DIRECT modes. Nevertheless, the subsequent description shall not be regarded as merely describing separate embodiments, i.e., embodiments separated from those described above. Rather, the description below also reveals possible implementation details for the embodiments described above. Accordingly, the description below uses reference signs of the figures already described above, so that a respective possible implementation described below, shall define possible variations of embodiments described above, too. Most of these variations may be individually transferred to the above embodiments.

In other words, embodiments of the present application describe methods for reducing the side information rate in image and video coding applications by combined signaling of merging and the absence of residual data for sets of samples. In other words, the side information rate in image and video coding applications is reduced by combining syntax elements indicating the usage of merging schemes and syntax elements indicating the absence of residual data.

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Further, before describing these variations and further details, an overview over picture and video codecs is presented.

In image and video coding applications, the sample arrays associated with a picture are usually partitioned into particular sets of samples (or sample sets), which may represent rectangular or quadratic blocks or any other collection of samples including arbitrarily shaped regions, triangles, or any other shapes. The subdivision of the samples arrays may be fixed by the syntax or the subdivision is (at least partly) signaled inside the bitstream. To keep the side information rate for signaling the subdivision information small, the syntax usually allows only a limited number of choices resulting in simple partitioning such as the subdivision of blocks into smaller blocks. An often used partitioning scheme is the partitioning of square block into four smaller square blocks, or into two rectangular blocks of the same size, or into two rectangular blocks of different sizes, where the actually employed partitioning is signaled inside the bitstream. The sample sets are associated with particular coding parameters, which may specify prediction information or residual coding modes, etc. In video coding applications, a partitioning is often done for the purpose of motion representation. All samples of a block (inside a partitioning pattern) are associated with the same set of motion parameters, which may include parameters specifying the type of prediction (e.g., list 0, list 1, or bi-prediction; and/or translational or affine prediction or a prediction with a different motion model), parameters specifying the employed reference pictures, parameters specifying the motion with respect to the reference pictures (e.g., displacement vectors, affine motion parameter vectors, or motion parameter vectors for any other motion model), which are usually transmitted as a difference to a predictor, parameters specifying the accuracy of motion parameters (e.g., half-sample or quarter-sample accuracy), parameters specifying the weighting of the reference sample signal (e.g., for the purpose of illumination compensation), or parameters specifying the interpolation filter that is employed for deriving the motion compensated prediction signal of the current block. It is assumed that for each sample set, individual coding parameters (e.g., for specifying the prediction and/or residual coding) are transmitted. In order to achieve an improved coding efficiency, this invention presents a method and particular embodiments for merging two or more sample sets into so-called groups of sample sets. All sample sets of such a group share the same coding parameters, which can be transmitted together with one of the sample sets in the group. By doing so, the coding parameters do not need to be transmitted for each sample set of the group of sample sets individually, but instead the coding parameters are transmitted only once for the whole group of sample sets.

As a result the side information rate for transmitting the coding parameters is reduced and the overall coding efficiency is improved. As an alternative approach, an additional

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refinement for one or more of the coding parameters can be transmitted for one or more of the sample sets of a group of sample sets. The refinement can be either applied to all sample sets of a group or only to the sample set for which it is transmitted.

Some embodiments of the present invention combine the merging process with a partitioning of a block into various sub-blocks 50, 60 (as mentioned above). Usually, image or video coding systems support various partitioning patterns for a block 40. As an example, a square block can be either not be partitioned or it can be partitioned into four square blocks of the same size, or into two rectangular blocks of the same size (where the square block can be vertically or horizontally divided), or into rectangular blocks of different sizes (horizontally or vertically). The described exemplary partition patterns are illustrated in Fig. 8. In addition to the above description, the partitioning may involve even more than one level of partitioning. For example, the square sub-blocks may optionally also be further partitioned using the same partitioning patterns. The issue that arises when such a partitioning process is combined with a merging process that allows the merging of a (square or rectangular) block with, for example, one of its neighbor blocks is that the same resulting partitioning can be achieved by different combinations of the partitioning patterns and merging signals. Hence, the same information can be transmitted in the bitstream using different codewords, which is clearly sub-optimal with respect to the coding efficiency. As a simple example, we consider a square block that is not further partitioned (as illustrated in the top-left corner of Fig. 8. This partitioning can be directly signaled by sending a syntax element that this block 40 is not subdivided. But, the same pattern can also be signaled by sending a syntax element that specifies that this block is, for example, subdivided into two vertically (or horizontally) aligned rectangular blocks 50, 60. Then we can transmit merging information that specify that the second of these rectangular blocks is merged with the first rectangular block, which results in exactly the same partitioning as when we signal that the block is not further divided. The same can also be achieved by first specifying that the block is subdivided in four square sub-blocks and then transmit merging information that effectively merges all these four blocks. This concept is clearly suboptimal (since we have different codewords for signaling the same thing).

Some embodiments of the present invention reduce the side information rate and thus increase the coding efficiency for a combination of the concept of merging with the concept of providing different partitioning patterns for a block. If we look at the example partitioning patterns in Fig. 8, the "simulation" of the not further divided block by any of the partitioning patterns with two rectangular blocks can be avoided when we forbid (i.e., exclude from the bitstream syntax specification) the case that a rectangular block is merged

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with a first rectangular block. When more deeply looking at the issue, it is also possible to "simulate" the not subdivided pattern by merging the second rectangular with any other neighbor (i.e., not the first rectangular block) that is associated with the same parameters (e.g., information for specifying the prediction) as the first rectangular block. By conditioning the sending of merging information in a way that the sending of particular merging parameters is excluded from the bitstream syntax when these merging parameters result in a pattern that can also be achieved by signaling one of the supported partitioning patterns redundancy may be avoided. As an example, if the current partitioning pattern specifies the subdivision into two rectangular blocks, as shown in Fig. 1 and 3, for example, before sending the merging information for the second block, i.e. 60 in case of Fig. 1 and 3, it can be checked which of the possible merge candidates has the same parameters (e.g., parameters for specifying the prediction signal) as the first rectangular block, i.e. 50 in case of Fig. 1 and 3. And all candidates that have the same motion parameters (including the first rectangular block itself) are removed from the set of merge candidates. The codewords or flags that are transmitted for signaling the merging information are adapted to the resulting candidate set. If the candidate set becomes empty due to the parameter checking, no merging information may be transmitted. If the candidate set consists of just one entry, it is only signaled whether the block is merged or not, but the candidate does not need to be signaled since it can be derived at the decoder side, etc. For the above example, the same concept is also employed to the partitioning pattern that divides a square block into four smaller square blocks. Here, the sending of merging flags is adapted in a way that neither the partitioning pattern that specifies no subdivision nor any of the two partitioning patterns specify a subdivision into two rectangular blocks of the same size can be achieved by a combination of merging flags. Although, we described the concept most on the above example with specific partitioning patterns, it should be clear that the same concept (avoiding the specification of a particular partitioning pattern by a combination of another partitioning pattern and corresponding merging information) can be employed for any other set of partitioning patterns.

Another aspect that needs to be considered is that the merging concept is in some sense similar to the SKIP or DIRECT modes that are found in video coding designs. In SKIP/DIRECT modes, basically no motion parameters are transmitted for a current block, but are inferred from a spatial and/or temporal neighborhood. In a particular efficient concept of the SKIP/DIRECT modes, a list of motion parameter candidates (reference frame indices, displacement vectors, etc.) is created from a spatial and/or temporal neighborhood and an index into this list is transmitted that specifies which of the candidate parameters is chosen. For bi-predicted blocks (or multi-hypothesis frames), a separate

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candidate can be signaled for each reference list. Possible candidates may include the block to the top of the current block, the block to the left of the current block, the block to the top-left of the current block, the block to the top-right of the current block, the median predictor of various of these candidates, the co-located block in one or more previous reference frames (or any other already coded block, or a combination obtained from already coded blocks).

Combining SKIP/DIRECT with the merge concept means that a block can be coded using either a SKIP/DIRECT or a merging mode. Although the SKIP/DIRECT and merging concepts are similar there are differences between the two concepts which are explained in more detail in section 1. The main difference between SKIP and DIRECT is that the SKIP mode further signals that no residual signal is transmitted. When the merging concept is used, usually a flag is transmitted that signals whether a block contains non-zero transform coefficient levels.

In order to achieve an improved coding efficiency, the embodiments described above and below combine the signaling whether a sample set uses the coding parameters of another sample set and the signaling whether no residual signal is transmitted for the block. The combined flag indicates that a sample set uses coding parameters of another sample set and that no residual data is transmitted. For this case only one flag, instead of two, needs to be transmitted.

As mentioned above, some embodiments of the present invention also provide an encoder with a greater freedom for creating a bitstream, since the merging approach significantly increases the number possibilities for selecting a partitioning for the sample arrays of a picture without introducing redundancy in the bitstream. Since the encoder can choose between more options, e.g., for minimizing a particular rate-distortion measure, the coding efficiency can be improved. As an example, some of the additional patterns that can be represented by a combination of sub-partitioning and merging (e.g., the patterns in Fig. 9) can be additionally tested (using the corresponding block sizes for motion estimation and mode decision) and the best of the patterns provided by purely partitioning (Fig. 8) and by partitioning and merging (Fig. 9) can be selected based on a particular rate-distortion measure. In addition for each block it can be tested whether a merging with any of the already coded candidate sets yields in decrease of a particular rate-distortion measure and then the corresponding merging flags are set during the encoding process. In summary, there are several possibilities to operate an encoder. In a simple approach, the encoder could first determine the best subdivision of the sample arrays (as in state-of-the-art coding schemes). And then it could check for each sample set, whether a merging with another

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sample set or another group of sample sets reduces a particular rate-distortion cost measure. At this, the prediction parameters associated with the merged group of sample sets can be re-estimated (e.g., by performing a new motion search) or the prediction parameters that have already be determined for the current sample set and the candidate sample set (or group of sample sets) for merging could be evaluated for the considered group of sample sets. In a more extensive approach, a particular rate-distortion cost measure could be evaluated for additional candidate groups of sample sets. As a particular example, when testing the various possible partitioning patterns (see Fig. 8 for example), some or all of the pattern that can be represented by a combination of partitioning and merging (see Fig. 9 for example) can be additionally tested. I.e., for all of the patterns a specific motion estimation and mode decision process is carried out and the pattern which yields the smallest rate-distortion measure is selected. This process can also be combined with the low complexity process described above, so that for the resulting blocks it is additionally tested whether a merging with already coded blocks (e.g., outside the patterns of Fig. 8 and Fig. 9) yields a decrease in a rate-distortion measure.

In the following, some possible detailed implementation for the embodiments outlined above are described, such as for the encoders in Figs. 1, 2 and 5 and the decoders of Figs. 3, 4 and 6. As already noted above, same are usable in image and video coding. As described above, the pictures or particular sets of sample arrays for the pictures may be decomposed into blocks, which are associated with particular coding parameters. The pictures usually consist of multiple sample arrays. In addition, a picture may also be associated with additional auxiliary samples arrays, which may, for example, specify transparency information or depth maps. The sample arrays of a picture (including auxiliary sample arrays) can be grouped into one or more so-called plane groups, where each plane group consists of one or more sample arrays. The plane groups of a picture can be coded independently or, if the picture is associated with more than one plane group, with prediction from other plane groups of the same picture. Each plane group is usually decomposed into blocks. The blocks (or the corresponding blocks of sample arrays) are predicted by either inter-picture prediction or intra-picture prediction. The blocks can have different sizes and can be either quadratic or rectangular. The partitioning of a picture into blocks can be either fixed by the syntax, or it can be (at least partly) signaled inside the bitstream. Often syntax elements are transmitted that signal the subdivision for blocks of predefined sizes. Such syntax elements may specify whether and how a block is subdivided into smaller blocks and being associated with coding parameters, e.g. for the purpose of prediction. An example of possible partitioning patterns is shown in Fig. 8. For all samples of a block (or the corresponding blocks of sample arrays) the decoding of the associated coding parameters is specified in a certain way. In the example, all samples in a block are

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predicted using the same set of prediction parameters, such as reference indices (identifying a reference picture in the set of already coded pictures), motion parameters (specifying a measure for the movement of a blocks between a reference picture and the current picture), parameters for specifying the interpolation filter, intra prediction modes, etc. The motion parameters can be represented by displacement vectors with a horizontal and vertical component or by higher order motion parameters such as affine motion parameters consisting of six components. It is also possible that more than one set of particular prediction parameters (such as reference indices and motion parameters) are associated with a single block. In that case, for each set of these particular prediction parameters, a single intermediate prediction signal for the block (or the corresponding blocks of sample arrays) is generated, and the final prediction signal is build by a combination including superimposing the intermediate prediction signals. The corresponding weighting parameters and potentially also a constant offset (which is added to the weighted sum) can either be fixed for a picture, or a reference picture, or a set of reference pictures, or they can be included in the set of prediction parameters for the corresponding block. The difference between the original blocks (or the corresponding blocks of sample arrays) and their prediction signals, also referred to as the residual signal, is usually transformed and quantized. Often, a two-dimensional transform is applied to the residual signal (or the corresponding sample arrays for the residual block). For transform coding, the blocks (or the corresponding blocks of sample arrays), for which a particular set of prediction parameters has been used, can be further split before applying the transform. The transform blocks can be equal to or smaller than the blocks that are used for prediction. It is also possible that a transform block includes more than one of the blocks that are used for prediction. Different transform blocks can have different sizes and the transform blocks can represent quadratic or rectangular blocks. In the above example for Figs. 1-7, it has been noted that it is possible that the leaf nodes of the first subdivision, i.e. the coding blocks 40, may parallely be further partitioned into the partition defining the granularity of coding parameters, on the one hand, and the transform blocks onto which the two-dimensional transform is applied individually, on the other hand. After transform, the resulting transform coefficients are quantized and so-called transform coefficient levels are obtained. The transform coefficient levels as well as the prediction parameters and, if present, the subdivision information is entropy coded. In particular, the coding parameters for the transform blocks are called residual parameters. The residual parameters as well as the prediction parameters and, if present, the subdivision information may be entropy coded. In state-of-the-art video coding standards as H.264, a flag called coded block flag (CBF) may signal that all transform coefficient levels are zero and thus, no residual parameters are coded. According to the present invention, this signaling is combined into the merge activation signaling.

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In state-of-the-art image and video coding standards, the possibilities for subdividing a picture (or a plane group) into blocks that are provided by the syntax are very limited. Usually, it can only be specified whether and (potentially how) a block of a predefined size can be subdivided into smaller blocks. As an example, the largest block size in H.264 is 16x16. The 16x16 blocks are also referred to as macroblocks and each picture is partitioned into macroblocks in a first step. For each 16x16 macroblock, it can be signaled whether it is coded as 16x16 block, or as two 16x8 blocks, or as two 8x16 blocks, or as four 8x8 blocks. If a 16x16 block is subdivided into four 8x8 block, each of these 8x8 blocks can be either coded as one 8x8 block, or as two 8x4 blocks, or as two 4x8 blocks, or as four 4x4 blocks. The small set of possibilities for specifying the partitioning into blocks in state-of-the-art image and video coding standards has the advantage that the side information rate for signaling the subdivision information can be kept small, but it has the disadvantage that the bit rate required for transmitting the prediction parameters for the blocks can become significant as explained in the following. The side information rate for signaling the prediction information does usually represent a significant amount of the overall bit rate for a block. And the coding efficiency could be increased when this side information is reduced, which, for instance, could be achieved by using larger block sizes. It is also possible to increase the set of supported partitioning patterns in comparison to H.264. For example, the partitioning patterns depicted in Fig. 8 can be provided for square blocks of all sizes (or selected sizes). Real images or pictures of a video sequence consist of arbitrarily shaped objects with specific properties. As an example, such objects or parts of the objects are characterized by a unique texture or a unique motion. And usually, the same set of prediction parameters can be applied for such an object or part of an object. But the object boundaries usually don't coincide with the possible block boundaries for large prediction blocks (e.g., 16x16 macroblocks in H.264). An encoder usually determines the subdivision (among the limited set of possibilities) that results in the minimum of a particular rate-distortion cost measure. For arbitrarily shaped objects this can result in a large number of small blocks. This statement remains also true when more partitioning patterns (as mentioned) above are provided. It should be noted that the amount of partitioning patterns should not become too large, since then a lot of side information and/or encoder/decoder complexity is required for signaling and processing these patterns. So, arbitrarily shaped objects often result in a large number of small blocks due to the partitioning. And since each of these small blocks is associated with a set of prediction parameters, which need to be transmitted, the side information rate can become a significant part of the overall bit rate. But since several of the small blocks still represent areas of the same object or part of an object, the prediction parameters for a number of the obtained blocks are the same or very similar. Intuitively, the coding efficiency could be

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increased when the syntax is extended in a way that it does not only allow to subdivide a block, but also to merge two or more of the blocks that are obtained after subdivision. As a result, one would obtain a group of blocks that are coded with the same prediction parameters. The prediction parameters for such a group of blocks need to be coded only once. In the above examples of Figs. 1-7, for example, the coding parameters for the current clock 40 are not transmitted provided that merging takes place. That is, the encoder does not transmit the coding parameters associated with the current block, and the decoder does not expect the bitstream 30 to contain coding parameters for the current block 40. Rather, in accordance with its specific embodiments, merely refinement information may be conveyed for the merged current block 40. As a determination of a candidate set and the reduction thereof as well as the merging and so forth is also performed for the other coding blocks 40 of picture 20. The coding blocks somehow form groups of coding blocks along a coding chain, wherein the coding parameters for these groups are transmitted within the bitstream in full merely once.

If the bit rate that is saved by reducing the number of coded prediction parameters is larger than the bit rate that is additionally spend for coding the merging information, the described merging does result in increased coding efficiency. It should further be mentioned that the described syntax extension (for the merging) provides the encoder with additional freedom in selecting the partitioning of a picture or plane group into blocks, without introducing redundancy. The encoder is not restricted to do the subdivision first and then to check whether some of the resulting blocks have the same set of prediction parameters. As one simple alternative, the encoder could first determine the subdivision as in state-of-the-art coding techniques. And then it could check for each block, whether a merging with one of its neighbor blocks (or the associated already determined group of blocks) reduces a rate-distortion cost measure. At this, the prediction parameters associated with the new group of blocks can be re-estimated (e.g., by performing a new motion search) or the prediction parameters that have already been determined for the current block and the neighboring block or group of blocks could be evaluated for the new group of blocks. An encoder can also directly check (a subset of) the patterns that are provided by a combination of splitting and merging; i.e., the motion estimation and mode decision can be done with the resulting shapes as already mentioned above. The merging information can be signaled on a block basis. Effectively, the merging could also be interpreted as inference of the prediction parameters for a current block, where the inferred prediction parameters are set equal to the prediction parameters of one of the neighboring blocks.

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For other modes than SKIP, additional flags, like the CBF, are needed to signal that no residual signal is transmitted. There are two variants of SKIP/DIRECT modes in the state-of-the-art video coding standard in H.264, which are selected on a picture level: the temporal direct mode and the spatial direct mode. Both direct modes are only applicable to B pictures. In temporal direct mode, the reference index for reference picture list 0 is set equal to 0 and the reference index for reference picture list 1 as well as the motion vectors for both reference lists are derived based on the motion data of the co-located macroblock in the first reference picture in reference picture list 1. The temporal DIRECT mode uses the motion vector from the temporal collocated block and scales the motion vector according to the temporal distance between the current and the collocated block. In spatial direct mode, the reference indexes and motion vectors for both reference picture lists are basically inferred based on the motion data in a spatial neighborhood. The reference indexes are chosen as the minimum of the corresponding reference indexes in the spatial neighborhood and each motion vector component is set equal to the median of the corresponding motion vector components in the spatial neighborhood. The SKIP mode can only be used for coding 16x16 macroblocks in H.264 (in P and B pictures) and the DIRECT mode can be used for coding 16x16 macroblocks or 8x8 sub-macroblocks. In contrast to the DIRECT mode, if merging is applied to a current block, all prediction parameters may be copied from the block the current block is merged with. Merging can also be applied to arbitrary block sizes resulting in the above-mentioned more flexible partitioning patterns where all samples of one pattern are predicting using the same prediction parameters.

The basic idea of the embodiments outlined above and below is to reduce the bit rate that is required for transmitting the CBF flags by combining the merge and CBF flags. If a sample set uses merging and no residual data is transmitted, one flag is transmitted signaling both.

In order to reduce the side information rate in image and video coding applications, particular sets of samples (which may represent rectangular or quadratic blocks or arbitrarily shaped regions or any other collection of samples) are usually associated with a particular set of coding parameters. For each of these sample sets, the coding parameters are included in the bitstream. The coding parameters may represent prediction parameters, which specify how the corresponding set of samples is predicted using already coded samples. The partitioning of the sample arrays of a picture into sample sets may be fixed by the syntax or may be signaled by corresponding subdivision information inside the bitstream. Multiple partitioning patterns for a block may be allowed. The coding parameters for the sample sets are transmitted in a predefined order, which is given by the syntax. It can be signaled for a current set of samples that it is merged (e.g., for the purpose

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of prediction) with one or more other sample sets into a group of sample sets. The possible set of values for the corresponding merging information may be adapted to the employed partitioning pattern, in a way that particular partitioning patterns cannot be represented by a combination of other partitioning patterns and corresponding merging data. The coding parameters for a group of sample sets need to be transmitted only once. Additional to the prediction parameters, residual parameters (such as transform and quantization side information and transform coefficient levels) may be transmitted. If the current sample set is merged, side information describing the merging process are transmitted. This side information will be further referred to as merging information. The embodiments described above and below describe a concept by which the signaling of the merging information is combined with the signaling of the coded block flag (specifying whether residual data is present for a block).

In a particular embodiment, the merging information contains a combined, so called mrg_cbf, flag that is equal to 1 if the current sample set is merged and no residual data is transmitted. In this case no further coding parameters and residual parameters are transmitted. If the combined mrg_cbf flag is equal to 0, another flag indicating whether merging is applied or not is coded. Furthermore flags indicating that no residual parameters are transmitted are coded. In CABAC and context adaptive VLC, the contexts for probability derivation (and VLC table switching) for syntax elements related to merging information can be chosen as a function of already transmitted syntax elements and/or decoded parameters (such as the combined mrg_cbf flag).

In a preferred embodiment, the merging information containing a combined mrg_cbf flag is coded before coding parameters (e.g. prediction information and subdivision information).

In a preferred embodiment, the merging information containing a combined mrg_cbf flag is coded after a subset of the coding parameters (e.g. prediction information and subdivision information). For every sample set, resulting from the subdivision information, merging information may be coded.

In embodiments described further below with respect to Figs. 11 to 13, mrg_cbf is called skip_flag. Generally. mrg_cbf could be called merge_skip in order to show that it is another version of skip related with block merging.

The following preferred embodiments are described for sets of samples that represent rectangular and quadratic blocks, but it can be extended to arbitrarily shaped regions or

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other collections of samples in a straightforward way. The preferred embodiments describe combinations of syntax elements related to the merging scheme and syntax elements indicating the absence of residual data. Residual data may include residual side information as well as transform coefficient levels. For all the preferred embodiments, the absence of residual data is specified by means of a coded block flag (CBF) but it can be expressed by other means or flags as well. A CBF equal to 0 relates to the case in which no residual data is transmitted.

1. Combination of the merging flag and the CBF flag

In the following, the subsidiary merging activating flag is called mrg whereas later on, with respect to Fig. 11 to 13, same is called merge_flag. Similarly the merge index is now called mrg_idx whereas later merge_idx is used.

A possible combination of the merging flag and the CBF flag by using one syntax element is described in this section. The description of this possible combination outlined below, may be transferred to any of the above described shown in Figs. 1 to 6.

In a preferred embodiment, up to three syntax elements are transmitted for specifying the merging information and the CBF.

The first syntax element, which is called mrg_cbf in the following, specifies whether the current set of samples is merged with another sample set and whether all corresponding CBFs are equal to 0. The mrg_cbf syntax element may only be coded if a derived set of candidate sample sets is not empty (after the potential removal of the candidates that would produce a partitioning that could be signaled by different partitioning pattern without merging). However, it may be guaranteed by default that the list of merge candidates never vanishes, that there is at least one or even at least two merge candidates available. In a preferred embodiment of the invention, if a derived set of candidate sample sets is not empty, the mrg_cbf syntax element is coded as follows.

- If the current block is merged and the CBF is equal to 0 for all components (e.g. a luma and two chroma components), the mrg_cbf syntax element is set to 1 and coded.
- Otherwise the mrg_cbf syntax element is set equal to 0 and coded.

The values 0 and 1 for the mrg_cbf syntax elements can also be switched.

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The second syntax element, further called mrg specifies whether the current set of samples is merged with another sample set. If the mrg_cbf syntax element is equal to 1 the mrg syntax element is not coded and inferred to be equal to 1 instead. If the mrg_cbf syntax element is not present (because the derived set of candidate samples is empty), the mrg syntax element is also not present, but inferred to be equal to 0. However, it may be guaranteed by default that the list of merge candidates never vanishes, that there is at least one or even at least two merge candidates available

The third syntax element, further called mrg_idx, which is only coded if the mrg syntax element is equal to 1 (or inferred to be equal to 1), specifies which of the sets of candidate sample sets is employed for merging. In a preferred embodiment, the mrg_idx syntax element is only coded if a derived set of candidate sample sets contains more than one candidate sample set. In a further preferred embodiment, the mrg_idx syntax element is only coded if at least two sample sets of a derived set of candidate sample sets are associated with different coding parameters.

It should be mentioned that the merge candidate list can even be fixed in order to decouple the parsing and the reconstruction to improve the parsing throughput and to be more robust in regard to information loss. To be more precise, the decoupling can be assured by using a fixed assignment of list entries and codewords. This would not necessitate to fix the length of the list. However, concurrently fixing the length of the list by adding additional candidates allows for compensating the coding efficiency loss of the fixed (longer) codewords. Thus, as described before, the merge index syntax element may only be transmitted if the list of candidates contains more than one candidate. This would require, however, to derive the list prior to parsing merge index, preventing to carry out these two processes in parallel. To allow for an increased parsing throughput and to make the parsing process more robust with regard to transmission errors, it is possible to remove this dependency by using a fixed codeword for each index value and a fixed number of candidates. If this number may not be reached by a candidate selection, it is possible to derive ancillary candidates to complete the list. These additional candidates may include so-called combined candidates, which are built from motion parameters of possibly different candidates already in the list, and zero motion vectors.

In a preferred embodiment, the merging information for a set of samples is coded after a subset of the prediction parameters (or, more generally, the particular coding parameters that are associated with the sample sets) has been transmitted. The subset of prediction parameters may consist of one or more reference picture indices or one or more

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components of a motion parameter vector or a reference picture index and one or more components of a motion parameter vector, etc.

In a preferred embodiment the mrg_cbf syntax element of the merging information is coded only for a reduced set of partitioning modes. A possible set of partitioning modes is presented in Fig. 8. In a preferred embodiment, this reduced set of partitioning modes is limited to one and corresponds to the first partitioning mode (the top-left of the list in Fig. 8). As an example, the mrg_cbf is coded only if a block is not further partitioned. As a further example, the mrg_cfb may be coded only for square blocks.

In another preferred embodiment the mrg_cbf syntax element of the merging information is coded only for one block of a partitioning where this partitioning is one of the possible partitioning modes shown in Fig. 8, e.g. the partitioning mode with four blocks bottom left. In a preferred embodiment, if there is more than one block that is merged in one of these partitioning modes, the merging information of the first merged block (in the decoding order) contains the mrg_cbf syntax element for the complete partition. For all the other blocks of the same partitioning mode that are decoded afterwards, the merging information only contains the mrg syntax element specifying whether the current set of samples is merged with another sample set or not. The information whether residual data are present or not is inferred from the mrg_cbf syntax element coded in the first block.

In a further preferred embodiment of the invention, the merging information for a set of samples is coded before the prediction parameters (or, more generally, the particular coding parameters that are associated with the sample sets). The merging information, containing the mrg_cbf, the mrg and the mrg_idx syntax element, is coded in a manner as described in the first preferred embodiment above. The prediction or coding parameters and the residual parameters are only transmitted if the merging information signals that the current set of samples is not merged with another set of samples and that the CBF, for at least one of the components, is equal to 1. In a preferred embodiment, if the mrg_cbf syntax element specifies that the current block is merged and the CBFs for all components are equal to 0, there will be no more signalization needed after the merging information, for this current block.

In another preferred embodiment of the invention, the syntax elements mrg_cbf, mrg, and mrg_idx are combined and coded as one or two syntax elements. In one preferred embodiment, mrg_cbf and mrg are combined into one syntax element, which specifies any of the following cases: (a) the block is merged and it doesn't contain residual data, (b) the block is merged and contains residual data (or may contain residual data), (c) the block is

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not merged. In another preferred embodiment, the syntax elements mrg and mrg_idx are combined into one syntax element. If N is being the number of merge candidates, the combined syntax element specifies one of the following cases: the block is not merged, the block is merged with candidate 1, the block is merged with candidate 2, ..., the block is merged with candidate N. In a further preferred embodiment of the invention, the syntax elements mrg_cfb, mrg, and mrg_idx are combined into one syntax element, which specifies one of the following cases (with N being the number of candidates): the block is not merged, the block is merged with candidate 1 and doesn't contain residual data, the block is merged with candidate 2 and doesn't contain residual data, ..., the block is merged with candidate N and doesn't contain residual data, the block is merged with candidate 1 and contains (or may contain) residual data, the block is merged with candidate 2 and contains (or may contain) residual data, ..., the block is merged with candidate N and contains (or may contain) residual data. The combined syntax elements may be transmitted with a variable length code or may be transmitted by arithmetic coding or may be transmitted by binary arithmetic coding using any particular binarization scheme.

2. Combination of the merging flag and the CBF flag and SKIP/DIRECT modes

The SKIP/DIRECT modes may be supported for all or only particular block sizes and/or block shapes. In an extension of the SKIP/DIRECT modes as specified in the state-of-the-art video coding standard H.264, a set of candidate blocks is used for the SKIP/DIRECT modes. The difference between SKIP and DIRECT is whether residual parameters are sent or not. The parameters (e.g., for prediction) of SKIP and DIRECT can be inferred from any of the corresponding candidates. A candidate index is coded, which signals which candidate is used to infer the coding parameters. If multiple predictions are combined to form the final prediction signal for the current block (as in bi-predictive blocks used in H.264 B-frames) every prediction can refer to a different candidate. Thus for every prediction a candidate index can be coded.

In a preferred embodiment of the invention, the candidate list for SKIP/DIRECT may contain different candidate blocks than the candidate list for merge modes. An example is illustrated in Figure 10. The candidate list may include the following blocks (the current block is denoted by Xi):

- Motion Vector (0,0)
- Median (between Left, Above, Corner)
- Left block (Li)
- Above block (Ai)
- Corner blocks (In order: Above Right (Ci1), Below Left (Ci2), Above Left (Ci3))

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- Collocated block in a different, but already coded picture

The following notation is used for describing following embodiments:

- set_mvp_ori is a set of candidates used for the SKIP/DIRECT mode. This set is composed of { Median, Left, Above, Corner, Collocated }, where Median is the median (middle value in an ordered set of Left, Above and Corner), and collocated is given by the nearest reference frame (or the first reference picture in one of the reference picture lists) and the corresponding motion vectors are scaled according to temporal distance. The Motion Vector with both components equal to 0 can be additionally inserted into the list of candidates, for example if there are no Left, no Above, no Corner blocks.
- set_mvp_comb is a subset of set_mvp_ori.

In a preferred embodiment, both SKIP/DIRECT modes and block merging modes are supported. SKIP/DIRECT modes use the original set of candidates, set_mvp_ori. The merging information related to the block merging mode may contain the combined mrg_cbf syntax element.

In another embodiment, both SKIP/DIRECT mode and block merging modes are supported, but the SKIP/DIRECT modes use a modified set of candidates, set_mvp_comb. This modified set of candidates can be a particular subset of the original set set_mvp_ori. In a preferred embodiment, the modified set of candidates is composed of Corner blocks and a Collocated block. In another embodiment, the modified set of candidates is only composed of the Collocated block. Further subsets are possible.

In another embodiment, the merging information containing the mrg_cbf syntax element is coded before the SKIP mode related parameters.

In another embodiment, the SKIP mode related parameters are coded before the merging information containing the mrg_cbf syntax element.

According to another embodiment, DIRECT mode may not be activated (is not even present) and block merging has an extended set of candidates with SKIP mode replaced by mrg_cbf.

In a preferred embodiment, the candidate list for block merging may contain different candidate blocks. An example is illustrated in Figure 10. The candidate list may include the following blocks (the current block is denoted by Xi):

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- Motion Vector (0,0)
- Left block (Li)
- Above block (Ai)
- Collocated block in a different, but already coded picture
- Corner blocks (In order: Above Right (Ci1), Below Left (Ci2), Above Left (Ci3)
- Combined bi-predictive candidates
- Non-scaled bi-predictive candidates

It should be mentioned that position of candidates for block merging can be the same than the list of MVP in inter-prediction in order to save memory access.

Further, the list can be "fixed" in the manner outlined above in order to decouple the parsing and the reconstruction to improve the parsing throughput & to be more robust in regard to information loss.

3. Coding of the CBF

In a preferred embodiment, if the mrg_cfb syntax element is equal to 0 (it signals that the block is either not merged or that it contains nonzero residual data), a flag is transmitted that signals whether or not all components (e.g., a luma and two chroma components) of the residual data are zero. This flag is not transmitted if mrg_cfb is equal to 1. In a particular configuration, this flag is not transmitted if mrg_cfb is equal to 0 and the syntax element mrg specifies that the block is merged.

In another preferred embodiment, if the mrg_cfb syntax element is equal to 0 (it signals that the block is either not merged or that it contains nonzero residual data), a separate syntax element for each component is transmitted that signals whether or not the residual data for the component are zero.

Different context models could be used for mrg_cbf.

Thus, above embodiments, inter alia, describe an apparatus for encoding a picture comprising

a subdivider configured to subdivide the picture into sample sets of samples;

a merger configured to merge the sample sets into disjoint sets of one or more sample sets each;

an encoder configured to encode the picture using coding parameters varying across the picture in units of the disjoint sets of sample sets, wherein the encoder is configured to encode the picture by predicting the picture and encoding a prediction residual for predetermined sample sets; and

a stream generator configured to insert the prediction residual and the coding parameters into a bitstream, along with one or more syntax elements for each of at least a subset of the sample sets, signaling as to whether the respective sample set is merged into one of the disjoint sets along with another sample set or not.

Further, an apparatus for decoding a bitstream having a picture encoded therein has been described, comprising

a subdivider configured to subdivide the picture into sample sets;

a merger configured to merge the sample sets into disjoint sets of one or more sample sets each;

a decoder configured to decode the picture using coding parameters varying across the picture in units of the disjoint sets of sample sets, wherein the decoder is configured to decode the picture by predicting the picture, decoding a prediction residual for predetermined sample sets and combining the prediction residual and a prediction resulting from predicting the picture, for the predetermined sample sets;

an extractor configured to extract the prediction residual and the coding parameters from the bitstream, along with one or more syntax elements for each of at least a subset of the sample sets, signaling as to whether the respective sample set is to be merged into one of the disjoint sets along with another sample set or not, wherein the merger is configured to perform the merging responsive to the syntax elements.

One of the possible states of the one or more syntax elements signalizes that the respective sample set is to be merged into one of the disjoint sets along with another sample set and has no prediction residual encoded and inserted into the bitstream.

The extractor may also be configured to extract subdivision information from the bitstream, and the subdivider is configured to subdivide the picture into sample sets responsive to the subdivision information.

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The extractor and the merger may, for example, be configured to sequentially step through the sample sets according to a sample set scan order, and to, for a current sample set,

extract a first binary syntax element (mrg_cbf) from the bitstream;

if the first binary syntax element assumes a first binary state, merge the current sample set into one of the disjoint sets by inferring the coding parameters for the current sample set to be equal to the coding parameters associated with this disjoint set, skip the extraction of the prediction residual for the current sample set and step to the next sample set in sample set scan order;

if the first binary syntax element assumes a second binary state, extract a second syntax element (mrg, mrg_idx) from the bitstream; and

depending on the second syntax element, merge the current sample set into one of the disjoint sets by inferring the coding parameters for the current sample set to be equal to the coding parameters associated with this disjoint set or perform the extraction of the coding parameters for the current sample set, with extracting at least one further syntax element concerning the prediction residual for the current sample set.

The one or more syntax elements for each of at least a subset of the sample sets may also signal with which of a set of predetermined candidate sample sets neighboring the respective sample set, the respective sample set is to be merged, if the respective sample set is to be merged into any one of the disjoint sets along with another sample set.

The extractor may be configured to, if the one or more syntax elements does not signal that the respective sample set is to be merged into any of the disjoint sets along with another sample set,

extract from the bitstream one or more further syntax elements (SKIP/DIRECT mode) signaling as to whether, and from which of a further set of predetermined candidate sample sets neighboring the respective sample set, at least a part of the coding parameters for the respective sample set is to be predicted.

In that case, the set of predetermined candidate sample sets and the further set of predetermined candidate sample sets may be disjoint or intersect each other with respect to a minority of the predetermined candidate sample sets of the set of predetermined

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candidate sample sets and the further set of predetermined candidate sample sets, respectively.

The extractor may also be configured to extract subdivision information from the bitstream, and the subdivider is configured to hierarchically subdivide the picture into sample sets responsive to the subdivision information, and the extractor is configured to sequentially step through child sample sets of a parent sample set, comprised by the sample sets into which the picture is sub-divided, and, for a current child sample set,

extract a first binary syntax element (mrg_cbf) from the bitstream;

if the first binary syntax element assumes a first binary state, merge the current child sample set into one of the disjoint sets by inferring the coding parameters for the current child sample set to be equal to the coding parameters associated with this disjoint set, skip the extraction of the prediction residual for the current child sample set and step to the next child sample sets;

if the first binary syntax element assumes a second binary state, extract a second syntax element (mrg, mrg_idx) from the bitstream; and

depending on the second syntax element, merge the current child sample set into one of the disjoint sets by inferring the coding parameters for the current child sample set to be equal to the coding parameters associated with this disjoint set or perform the extraction of the coding parameters for the current child sample set, with extracting at least one further syntax element concerning the prediction residual for the current child sample set, and then stepping to the next child sample sets,

with, for the next child sample sets, skipping extraction of the first binary syntax element if the first binary syntax element of the current child sample set assumes the first binary state and starting with extracting the second syntax element instead, and extracting the first binary syntax element if the first binary syntax element of the current child sample set assumes the second binary state.

Lets assume, for example, a parent sample set (CU) is split into two child sample sets (PU). If, then, for the first PU, the first binary syntax element (merge_cbf) has the first binary state 1) the first PU uses merge and the first and the second PU (the whole CU) do not have residual data in the bitstream, and 2) for the second PU second binary syntax element (merge_flag, merge_idx) is signaled. If, however, the first binary syntax element

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for the first PU has the second binary state, then 1) for the first PU, the second binary syntax element (merge_flag, merge_idx) is signaled, and residual data is in the bitstream as well, while 2) for the second PU, the first binary syntax element (merge_cbf) is signaled. Thus, it could be that the merge_cbf is also signaled on a PU level, i.e. for successive child sample sets, if merge_cbf is in a secondary binary state for all previous child sample sets. If merge_cbf is in a first binary state for a successive child sample set, all child sample sets following this child sample set do not have residual data in the bitstream. For example, for a CU split into, for example, 4 PUs, it is possible that merge_cbf is in a first binary state for the second PU meaning that the third and fourth PU in coding order do not have residual data in the bitstream but the first PU has or can have.

The first and second binary syntax elements may be coded using context-adaptive variable length coding or context-adaptive (binary) arithmetic coding and the contexts for coding the syntax elements are derived based on the values for these syntax elements in already coded blocks.

As described in other preferred embodiments, the syntax element merge_idx may only be transmitted if the list of candidates contains more than one candidate. This requires to derive the list prior to parsing merge index, preventing to carry out these two processes in parallel. To allow for an increased parsing throughput and to make the parsing process more robust with regard to transmission errors, it is possible to remove this dependency by using a fixed codeword for each index value and a fixed number of candidates. If this number may not be reached by a candidate selection, it is possible to derive ancillary candidates to complete the list. These additional candidates may include so-called combined candidates, which are built from motion parameters of possibly different candidates already in the list, and zero motion vectors

In another preferred embodiment, the syntax for signaling which of the blocks of the candidate set is simultaneously adapted at encoder and decoder. If for example, 3 choices of blocks for merging are given, those three choices are only present in the syntax and are considered for entropy coding. The probabilities for all other choices are considered to be 0 and the entropy codec is adjusted simultaneously at encoder and decoder.

The prediction parameters that are inferred as a consequence of the merging process may represent the complete set of the prediction parameters that are associated with a block or they may represent of subset of these prediction parameters (e.g., the prediction parameters for one hypothesis of a block for which multi-hypotheses prediction is used).

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In a preferred embodiment, the syntax elements related to the merging information are entropy coded using context modeling.

One way of transferring the above-outlined embodiments to a specific syntax is explained in the following with respect to the following figures. In particular, Figs. 11-13 show different portions of a syntax which takes advantage of the above-outlined embodiments. In particular, in accordance with the below-outlined embodiment, picture 20 is firstly up-divided into coding tree blocks the picture content of which is coded using the syntax coding_tree shown in Fig. 11. As shown therein, for entropy_coding_mode_flag=1, which relates to, for example, context adaptive binary arithmetic coding or another specific entropy coding mode, the quad-tree subdivision of the current coding tree block is signaled within syntax portion coding_tree by way of the flags called split_coding_unit_flag at mark 400. As shown in Fig. 11, in accordance with the embodiment described hereinafter, the tree-root block is subdivided as signaled by split_coding_unit_flag in a depth-first traversal order as shown in Fig. 7a. Whenever a leaf node is reached, same represents a coding unit which is coded right away using the syntax function coding_unit. This can be seen from Fig. 11 when looking at the if-clause at 402 which checks as to whether the current split_coding_unit_flag is set or not. If yes, function coding_tree is recursively called, leading to a further transmission/extraction of a further split_coding_unit_flag at the encoder and decoder, respectively. If not, i.e. if the split_coding_unit_flag=0, the current sub-block of the tree-root block 200 of Fig. 7a is a leaf block and in order to code this coding unit, the function coding_unit of Fig. 10 is called at 404.

In the currently described embodiment, the above-mentioned option is used according to which merging is merely usable for pictures for which the inter prediction mode is available. That is, intra-coded slices/pictures do not use merging anyway. This is visible from Fig. 12, where the flag skip_flag is transmitted at 406 merely in case of a slice type being unequal to the intra-picture slice type, i.e. if the current slice which the current coding unit belongs to allows partitions to be inter coded. Merging relates, in accordance with the present embodiment, merely to the prediction parameters related to inter prediction. In accordance with the present embodiment, the skip_flag is signaled for the whole coding unit 40 and if skip_flag equals 1, this flag value concurrently signals to the decoder

1) that the partitioning mode for the current coding unit is the non-partitioning mode according to which same is not partitioned and represents itself the only partition of that coding unit,

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2) that the current coding unit/partition is inter-coded, i.e. is assigned to the inter coding mode,

3) that the current coding unit/partition is subject to merging, and

4) that the current coding unit/partition is subject to the skip mode, i.e. has the skip mode activated.

Accordingly, if skip_flag is set, the function prediction_unit is called at 408 with denoting the current coding unit as being a prediction unit. This is, however, not the only possibility for switching on the merging option. Rather, if the skip_flag related to the whole coding unit is not set at 406, the prediction type of the coding unit of the non-intra-picture slice is signaled at 410 by syntax element pred_type with, depending thereon, calling function prediction_unit for any partition of the current coding unit at, for example, 412 in case of the current coding unit being not further partitioned. In Fig. 12, merely four different partitioning options are shown to be available, but the other partitioning options shown in Fig. 8 may be available as well. Another possibility would be that the partitioning option PART_NxN is not available, but the others. The association between the names for the partitioning modes used in Fig. 12 to the partitioning options shown in Fig. 8 is indicated in Fig. 8 by respective subscripts below the individual partitioning options. Please note that the prediction type syntax element pred_type not only signals the prediction mode, i.e. intra or inter coded, but also the partitioning in case of inter coding mode. The inter-coding mode case is discussed further. The function prediction_unit is called for each partition, such as partitions 50 and 60 in the coding order mentioned above. The function prediction_unit starts with checking the skip_flag at 414. If the skip_flag is set, a merge_idx inevitably follows at 416. The check at step 414, is for checking as to whether the skip_flag related to the whole coding unit as signalized at 406 has been set or not. If not, a merge_flag is signalized again at 418, and if the latter is set, a merge_idx follows at 420 which indicates the merge candidate for the current partition. Again, merge_flag is signalized for the current partition at 418 merely in case of the current prediction mode of the current coding unit is an inter prediction mode (see 422). That is, in case of skip_flag not being set, the prediction mode is signaled via pred_type at 410 whereupon, for each prediction unit, provided that pred_type signals that the inter coding mode is active (see 422), a merge specific flag, namely merge_flag, is individually transmitted for each partition followed, if merging is activated for the respective partition by a merge index merge_idx.

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As is visible from Fig. 13, the transmission of the prediction parameters in use for the current prediction unit at 424 is, in accordance with the present embodiment, performed merely in case of merging not being used for the present prediction unit, i.e. because merging is neither activated by skip_flag nor by the respective merge_flag of the respective partition.

As already indicated above, skip_flag = 1 concurrently signals that no residual data is to be transmitted. This is derivable from the fact that the transmission of the residual data at 426 in Fig. 12 for the current coding unit merely takes place in case of skip_flag being equal to 0, as derivable from the fact that this residual data transmission in within the else option of if-clause 428 which checks the state of skip_flag immediately after its transmission.

Up to now, the embodiment of Figs. 11 to 13 has only been described under the assumption that entropy_coding_mode_flag equals 1. However, the embodiments of Figs. 11 to 13 also comprises an embodiment of the above-outlined embodiments in case of entropy_coding_mode_flag = 0, in which case another entropy coding mode is used in order to entropy-encode the syntax elements, such as, for example, variable length coding and, in order to be more precise, context adaptive variable length coding, for example. In particular, the possibility of concurrently signaling the activation of merging on the one hand and the skip mode on the other hand follows the above-outlined alternative according to which the commonly signaling state is merely one state among more than two states of a respective syntax element. This is described in more detail now. However, it is emphasized that the possibility to switch between both entropy coding modes is optional, and thus, alternative embodiments may easily derived from Fig. 11 to 13 by merely allowing one of the two entropy coding modes.

See, for example, Fig. 11. If the entropy_coding_mode_flag equals 0 and the slice_type syntax element signals that the current tree-root block belongs to an inter coded slice, i.e. inter coding mode is available, then a syntax element cu_split_pred_part_mode is transmitted at 430, and this syntax element signals, as indicated via its name, information on the further subdivision of the current coding unit, the activation or deactivation of the skip mode, the activation or deactivation of merging and the prediction mode along with the respective partitioning information. See table 1:

Table 1

cu_split_pred_part_mode	split_coding_unit_flag	skip_flag	merge_flag	PredMode	PartMode
0	1	-	-	-	-

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1	0	1	-	MODE_SKIP	PART_2Nx2N
2	0	0	1	MODE_INTER	PART_2Nx2N
3	0	0	0	MODE_INTER	PART_2Nx2N
4	0	-	-	MODE_INTER	PART_2NxN
5	0	-	-	MODE_INTER	PART_Nx2N
6	0	-	-	MODE_INTRA	PART_2Nx2N

Table 1 specifies the significance of the possible states of the syntax elements cu_split_pred_part_mode in case of the current coding unit have a size which is not the smallest one in the quad-tree subdivisioning of the current tree-root block. The possible states are listed in at the outermost left-hand column of table 1. As table 1 refers to the case where the current coding unit does not have the smallest size, there is a state of cu_split_pred_part_mode, namely the state 0, which signals that the current coding unit is not an actual coding unit but has to be subdivided into further four units which are then traversed in depth-first traversal order as outlined by calling function coding_tree at 432 again. That is, cu_split_pred_part_mode = 0 signals that the current quad-tree subdivision unit of the current tree-root block is to be subdivided into four further smaller units again, i.e. split_coding_unit_flag = 1. However, if cu_split_pred_part_mode assumes any other possible state, then split_coding_unit_flag = 0 and the current unit forms a leaf block of the current tree-root block, i.e. a coding unit. In that case, one of the remaining possible states of cu_split_pred_part_mode represents the above-described commonly signaling state which concurrently signals that the current coding unit is subject to merging and has the skip mode activated, indicated by skip_flag equaling 1 in the third column of table 1, while concurrently signaling that no further partition of the current coding unit takes place, i.e. PART_2Nx2N is chosen as the partitioning mode. cu_split_pred_part_mode also has a possible state which signals the activation of merging with the skip mode being deactivated. This is the possible state 2, corresponding to skip_flag = 0 while merge_flag = 1 with the no partitioning mode being active, i.e. PART_2Nx2N. That is, in that case the merge_flag is signaled before hand rather than within the prediction_unit syntax. In the remaining possible states of cu_split_pred_part_mode, the inter prediction mode with other partitioning modes is signaled, with these partitioning modes partitioning the current coding unit into more than one partition.

Table 2

cu_split_pred_part_mode	**split_coding_unit_flag**	**skip_flag**	**merge_flag**	**PredMode**	**PartMode**
0	0	1	-	MODE_SKIP	PART_2Nx2N

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1	0	0	1	MODE_INTER	PART_2Nx2N
2	0	0	0	MODE_INTER	PART_2Nx2N
3	0	-	-	MODE_INTER	PART_2NxN
4	0	-	-	MODE_INTER	PART_Nx2N
5 (escape symbol)	0	-	-	MODE_INTRA	PART_2Nx2N
				MODE_INTRA	PART_NxN
				MODE_INTER	PART_NxN

Table 2 shows the significance or semantics of the possible states of cu_split_pred_part_mode in case of the current coding unit having the smallest size possible in accordance with the quad-tree subdivision of the current tree-root block. In that case, all possible states of cu_split_pred_part_mode corresponds to no further subdivision according to split_coding_unit_flag = 0. However, the possible state 0 signals that skip_flag = 1, i.e. concurrently signals that merging is activated and the skip mode is active. Moreover, same signals that no partitioning takes place, i.e. partitioning mode PART_2Nx2N. Possible state 1 corresponds to possible state 2 of table 1 and the same applies to possible state 2 of table 2, which corresponds to possible state 3 of table 1.

Although the above description of the embodiment of Figs. 11-13 already described most of the functionality and semantics, some further information is presented below.

skip_flag[x0][y0] equal to 1 specifies that for the current coding unit (see 40 in the figures), when decoding a P or B slice, no more syntax elements except the motion vector predictor indices (merge_idx) are parsed after skip_flag[x0][y0]. skip_flag[x0][y0] equal to 0 specifies that the coding unit is not skipped. The array indices x0, y0 specify the location (x0, y0) of the top-left luma sample of the considered coding unit relative to the top-left luma sample of the picture (see 20 in the figures).

When skip_flag[x0][y0] is not present, it shall be inferred to be equal to 0.

As described above if skip_flag[x0][y0] is equal to 1,

- PredMode is inferred to be equal to MODE_SKIP
- PartMode is inferred to be equal to PART_2Nx2N

cu_split_pred_part_mode[x0][y0] specifies split_coding_unit_flag and when the coding unit is not split the skip_flag[x0][y0], the merge_flag[x0][y0], PredMode and PartMode of a coding unit. The array indices x0 and y0 specify the location (x0, y0) of

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the top-left luma sample of the coding unit relative to the top-left luma sample of the picture.

merge_flag[x0][y0] specifies whether the inter prediction parameters for the current prediction unit (see 50 and 60 in the figures, i.e. the partition within coding unit 40) are inferred from a neighboring inter-predicted partition. The array indices x0, y0 specify the location (x0, y0) of the top-left luma sample of the considered prediction block relative to the top-left luma sample of the picture.

merge_idx[x0][y0] specifies the merging candidate index of the merging candidate list where x0, y0 specify the location (x0, y0) of the top-left luma sample of the considered prediction block relative to the top-left luma sample of the picture.

Although not specifically indicated in the above description of Figs. 11-13, the merging candidates or the list of merging candidates is determined in this embodiment exemplarily using not only coding parameters or prediction parameters of spatially neighboring prediction unit/partitions, but rather, a list of candidates is also formed by using prediction parameters of temporally neighboring partitions of temporally neighboring and previously coded pictures. Moreover, combinations of prediction parameters of spatially and/or temporally neighboring prediction units/partitions are used and included into the list of merging candidates. Naturally, merely a subset thereof may be used. In particular, Fig. 14 shows one possibility of determining spatial neighbors, i.e. spatially neighboring partitions or prediction units. Fig. 14 shows exemplarily a prediction unit or partition 60 and pixels B_0 to B_2 and A_0 and A_1 which are located directly adjacent the border 500 of partition 60, namely B_2 being diagonally adjacent the top left pixel of partition 60, B1 being located vertically above and adjacent the top right-hand pixel of partition 60, B0 being located diagonally to the top right-hand pixel of partition 60, A1 being located horizontally to the left of, and adjacent the bottom left-hand pixel of partition 60, and A0 being located diagonally to the bottom left-hand pixel of partition 60. A partition that includes at least one of pixels B_0 to B_2 and A_0 and A_1 forms a spatial neighbor and the prediction parameters thereof form a merge candidate.

In order to perform the above-mentioned optional removal of those candidates which would lead to another partitioning mode which would also have been available, the following functions could be used:

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In particular, the candidate N, i.e. the coding/prediction parameters stemming from the prediction unit/partition covering pixel N=(B_0, B_1, B_2, A_0, A_1), i.e. position (xN, yN), is removed from the candidate list if any of the following conditions is true (please see Fig. 8 for the partitioning mode PartMode and the corresponding partitioning index PartIdx indexing the respective partition inside the coding unit):

- 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) 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_Nx2N and PartIdx is equal to 1 and the prediction units covering luma location (xP – 1, yP) (PartIdx = 0) 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]

- 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:

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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]

In this regard, please note that position or location (xP, yP) denotes the uppermost pixel of the current partition/prediction unit. That is, in accordance with the first item, all coding parameter candidates are checked which have been derived by directly adopting the respective coding parameters of neighboring prediction units, namely prediction unit N. The other additional coding parameter candidates may, however, be checked in the same manner as to whether same are equal to the coding parameters of the respective prediction unit emerging with which would result in obtaining another partitioning pattern also supported by the syntax. In accordance with the embodiments just described, the equality of the coding parameters encompasses a check of the equality of the motion vector, i.e. mvLX, the reference index, i.e. refIxLX, and the prediction flag predFlagLX indicating that the parameters, i.e. motion vector and reference index, associated with reference list X, with X being 0 or 1, are used in inter prediction.

Please note that the just-described possibility for removal of coding parameter candidates of neighboring prediction units/partitions would also be applicable in case of supporting asymmetric partitioning modes shown in the right-hand half of Fig. 8. In that case, the

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mode PART_2NxN could represent all horizontally subdividing modes and PART_Nx2N could correspond to all vertically subdividing modes. Further, the mode PART_NxN could be excluded from the supported partitioning modes or partitioning patterns and in that case, merely the first two removal checks would have to be performed.

Regarding the embodiment Figs. 11-14, it should also be noted that it is possible to exclude the intra predicted partitions from the list of candidates, i.e. their coding parameters are, naturally, not included into the list of candidates.

Further, it is noted that three contexts could be used for the skip_flag, merge_flag and the merge_idx, respectively.

Although some aspects have been described in the context of an apparatus, it is clear that these aspects also represent a description of the corresponding method, where a block or device corresponds to a method step or a feature of a method step. Analogously, aspects described in the context of a method step also represent a description of a corresponding block or item or feature of a corresponding apparatus. Some or all of the method steps may be executed by (or using) a hardware apparatus, like for example, a microprocessor, a programmable computer or an electronic circuit. In some embodiments, some one or more of the most important method steps may be executed by such an apparatus.

Depending on certain implementation requirements, embodiments of the invention can be implemented in hardware or in software. The implementation can be performed using a digital storage medium, for example a floppy disk, a DVD, a Blue-Ray, a CD, a ROM, a PROM, an EPROM, an EEPROM or a FLASH memory, having electronically readable control signals stored thereon, which cooperate (or are capable of cooperating) with a programmable computer system such that the respective method is performed. Therefore, the digital storage medium may be computer readable.

Some embodiments according to the invention comprise a data carrier having electronically readable control signals, which are capable of cooperating with a programmable computer system, such that one of the methods described herein is performed.

Generally, embodiments of the present invention can be implemented as a computer program product with a program code, the program code being operative for performing one of the methods when the computer program product runs on a computer. The program code may for example be stored on a machine readable carrier.

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Other embodiments comprise the computer program for performing one of the methods described herein, stored on a machine readable carrier.

In other words, an embodiment of the inventive method is, therefore, a computer program having a program code for performing one of the methods described herein, when the computer program runs on a computer.

A further embodiment of the inventive methods is, therefore, a data carrier (or a digital storage medium, or a computer-readable medium) comprising, recorded thereon, the computer program for performing one of the methods described herein. The data carrier, the digital storage medium or the recorded medium are typically tangible and/or non–transitionary.

A further embodiment of the inventive method is, therefore, a data stream or a sequence of signals representing the computer program for performing one of the methods described herein. The data stream or the sequence of signals may for example be configured to be transferred via a data communication connection, for example via the Internet.

A further embodiment comprises a processing means, for example a computer, or a programmable logic device, configured to or adapted to perform one of the methods described herein.

A further embodiment comprises a computer having installed thereon the computer program for performing one of the methods described herein.

A further embodiment according to the invention comprises an apparatus or a system configured to transfer (for example, electronically or optically) a computer program for performing one of the methods described herein to a receiver. The receiver may, for example, be a computer, a mobile device, a memory device or the like. The apparatus or system may, for example, comprise a file server for transferring the computer program to the receiver .

In some embodiments, a programmable logic device (for example a field programmable gate array) may be used to perform some or all of the functionalities of the methods described herein. In some embodiments, a field programmable gate array may cooperate with a microprocessor in order to perform one of the methods described herein. Generally, the methods are preferably performed by any hardware apparatus.

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The above described embodiments are merely illustrative for the principles of the present invention. It is understood that modifications and variations of the arrangements and the details described herein will be apparent to others skilled in the art. It is the intent, therefore, to be limited only by the scope of the impending patent claims and not by the specific details presented by way of description and explanation of the embodiments herein.

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Claims

1. Apparatus configured to decode a bitstream (30) into which a picture (20) is coded, the sample array of the picture being partitioned into sample sets each of which is associated with respective coding parameters, the apparatus being configured to be, for a current sample set, commonly responsive to a flag within the bitstream (30) as to a first decision as to whether the coding parameters associated with the current sample set are to be set according to a merge candidate or to be retrieved from the bitstream (30), and a second decision as to whether the current sample set (40) of the picture (20) is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set (40), without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set (40) by means of residual data within the bitstream (30).

2. Apparatus according to claim 1, wherein the apparatus is configured such that the decoder

if the flag within the bitstream (30) signals that the coding parameters associated with the current sample set (40) are to be set according to a merge candidate,

obtains the coding parameters associated with the current sample set (40) by setting same according to a merge candidate, and reconstructs the current sample set (40) of the picture (20) merely based on a prediction signal depending on the coding parameters without any residual data, and

if the flag within the bitstream does not signal that the coding parameters associated with the current sample set (40) are to be set according to a merge candidate,

is responsive to another flag within the bitstream such that the apparatus, depending on the other flag,

obtains the coding parameters associated with the current sample set (40) by setting same according to a merge candidate, obtains residual data for the current sample set (40) from the bitstream (30) and reconstructs the current sample set (40) of the picture (20) based on the prediction signal and the residual data, or

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extracts the coding parameters associated with the current sample set (40) from the bitstream (30), obtains residual data for the current sample set (40) from the bitstream (30) and reconstructs the current sample set (40) of the picture (20) based on the prediction signal and the residual data.

3. Decoder according to claim 1 or 2 wherein the decoder is configured such that the decoder

if the flag within the bitstream signals that the coding parameters associated with the current sample set are to be set according to a merge candidate,

applies a predetermined one among supported partitioning patterns for the current to the current sample set, and

if the flag within the bitstream does not signal that the coding parameters associated with the current sample set are to be set according to a merge candidate,

is responsive to partitioning information within the bitstream signaling one of the supported partitioning patterns for the current sample set.

4. Decoder according to claim 3, wherein the predetermined one among the supported partitioning patterns is a non-partitioning mode and the decoder is configured such that the decoder

if the flag within the bitstream signals that the coding parameters associated with the current sample set are to be set according to a merge candidate,

obtains coding parameters associated with the current sample set by setting same according to a merge candidate, and reconstructs the current sample set of the picture merely based on a prediction signal depending on the coding parameters without any residual data, and

if the flag within the bitstream does not signal that the coding parameters associated with the current sample set are to be set according to a merge candidate,

is responsive to partitioning information within the bitstream signaling one of the supported partitioning patterns for the current sample set,

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obtains residual data for the current sample set from the bitstream,

for each sample subset of the signaled supported partitioning pattern of the current sample set, is responsive to another flag within the bitstream such that the decoder, depending on the other flag,

obtains coding parameters associated with the respective sample subset by setting same according to a merge candidate, or

extracts the coding parameters associated with the respective sample subset from the bitstream; and

reconstructs the current sample set of the picture based on a prediction signal depending on the coding parameters of each sample subset and the residual data.

5. Decoder according to claim 4, wherein the decoder is configured to

if the signaled supported partitioning patterns specifies a subdivision of the current sample set into two or more sample subsets,

remove

for all sample subsets except a first sample subset of the sample subsets in a coding order,

from a set of merge candidates for the respective sample subset,

merge candidates having coding parameters which are the same as coding parameters associated with any of the sample subsets, which would, when being merged with the respective sample subset result in one of the supported partitioning patterns.

6. Apparatus for decoding a bitstream having a picture (20) encoded therein, comprising

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a subdivider (82) configured to subdivide the picture (20) into sample sets of samples (40);

a merger (84) configured to merge the sample sets (40) into groups of one or more sample sets each;

a decoder (86) configured to decode the picture (20) using coding parameters varying across the picture (20) in units of the groups of sample sets, wherein the decoder (86) is configured to decode the picture by predicting the picture (20), decoding a prediction residual for predetermined sample sets and combining the prediction residual and a prediction resulting from predicting the picture (20), for the predetermined sample sets;

an extractor (88) configured to extract the prediction residual and the coding parameters from the bitstream (30), along with one or more syntax elements for each of at least a subset of the sample sets (40), signaling as to whether the respective sample set (40) is to be merged into one of the groups along with another sample set (40) or not, wherein the merger (84) is configured to perform the merging responsive to the one or more syntax elements,

wherein one of the possible states of the one or more syntax elements signalizes that the respective sample set (40) is to be merged into one of the groups along with another sample set (40) and has no prediction residual encoded and inserted into the bitstream (30).

7. Apparatus according to claim 6, wherein the extractor is also configured to extract subdivision information from the bitstream, and the subdivider is configured to subdivide the picture into sample sets responsive to the subdivision information.

8. Apparatus according to claim 6 or 7, wherein the extractor and the merger are configured to sequentially step through the sample sets according to a sample set scan order, and to, for a current sample set,

extract a first binary syntax element (mrg_cbf) from the bitstream;

if the first binary syntax element assumes a first binary state, merge the current sample set into one of the groups by inferring the coding parameters for the current sample set to be equal to the coding parameter associated with this group, skip the

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extraction of the prediction residual for the current sample set and step to the next sample set in sample set scan order;

if the first binary syntax element assumes a second binary state, extract a second syntax element (mrg, mrg_idx) from the bitstream; and

depending on the second syntax element, merge the current sample set into one of the groups by inferring the coding parameters for the current sample set to be equal to the coding parameters associated with this group or perform the extraction of the coding parameters for the current sample set, with extracting at least one further syntax element concerning the prediction residual for the current sample set.

9. Apparatus according to any of claims 6 to 8, wherein the one or more syntax elements for each of at least a subset of the sample sets also signals with which of a set of predetermined candidate sample sets neighboring the respective sample set, the respective sample set is to be merged, if the respective sample set is to be merged into any one of the disjoint sets along with another sample set.

10. Apparatus according to any of claims 6 to 9, wherein the extractor is also configured to extract subdivision information from the bitstream, and the subdivider is configured to hierarchically subdivide the picture into sample sets responsive to the subdivision information, and the extractor is configured to sequentially step through child sample sets of a parent sample set, comprised by the sample sets into which the picture is sub-divided, and, for a current child sample set,

extract a first binary syntax element (mrg_cbf) from the bitstream;

if the first binary syntax element assumes a first binary state, merge the current child sample set into one of the disjoint sets by inferring the coding parameters for the current child sample set to be equal to the coding parameters associated with this disjoint set, skip the extraction of the prediction residual for the current child sample set and step to the next child sample sets;

if the first binary syntax element assumes a second binary state, extract a second syntax element (mrg, mrg_idx) from the bitstream; and

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depending on the second syntax element, merge the current child sample set into one of the groups by inferring the coding parameters for the current child sample set to be equal to the coding parameters associated with this group or perform the extraction of the coding parameters for the current child sample set, with extracting at least one further syntax element concerning the prediction residual for the current child sample set, and then stepping to the next child sample sets,

with, for the next child sample sets, skipping extraction of the first binary syntax element if the first binary syntax element of the current child sample set assumes the first binary state and starting with extracting the second syntax element instead, and extracting the first binary syntax element if the first binary syntax element of the current child sample set assumes the second binary state.

11. Apparatus according to claim 10, wherein the first and second binary syntax elements are coded using context-adaptive variable length coding or context-adaptive (binary) arithmetic coding and the contexts for coding the syntax elements are derived based on the values for these syntax elements in already coded blocks.

12. Apparatus for encoding a picture (20) into a bitstream (30), the sample array of the picture (20) being partitioned into sample sets (40) each of which is associated with respective coding parameters, the apparatus being configured to encode, for a current sample set, a flag into the bitstream commonly signaling as to whether the coding parameters associated with the current sample set (40) are to be set according to a merge candidate or to be retrieved from the bitstream (30), and as to whether the current sample set (40) of the picture (20) is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set (40), without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set (40) by means of residual data within the bitstream (30).

13. Apparatus for encoding a picture comprising

a subdivider (72) configured to subdivide the picture into sample sets of samples;

a merger (74) configured to merge the sample sets into groups of one or more sample sets each;

an encoder (76) configured to encode the picture using coding parameters varying across the picture in units of the groups of sample sets, wherein the encoder (76) is configured to encode the picture by predicting the picture and encoding a prediction residual for predetermined sample sets;

a stream generator (78) configured to insert the prediction residual and the coding parameters into a bitstream, along with one or more syntax elements for each of at least a subset of the sample sets, signaling as to whether the respective sample set is merged into one of the groups along with another sample set or not,

wherein one of the possible states of the one or more syntax elements signalizes that the respective sample set is to be merged into one of the groups along with another sample set and has no prediction residual encoded and inserted into the bitstream.

14. Method for decoding a bitstream (30) into which a picture (20) is coded, the sample array of the picture being partitioned into sample sets each of which is associated with respective coding parameters, the method comprising, for a current sample set, commonly reacting to a flag within the bitstream (30) as to a first decision as to whether the coding parameters associated with the current sample set are to be set according to a merge candidate or to be retrieved from the bitstream (30), and a second decision as to whether the current sample set (40) of the picture (20) is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set (40), without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set (40) by means of residual data within the bitstream (30).

15. Method for decoding a bitstream having a picture (20) encoded therein, the method comprising

subdividing the picture (20) into sample sets of samples (40);

merging the sample sets (40) into groups of one or more sample sets each;

decoding the picture (20) using coding parameters varying across the picture (20) in units of the groups of sample sets, wherein the decoder (86) is configured to decode the picture by predicting the picture (20), decoding a prediction residual for

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predetermined sample sets and combining the prediction residual and a prediction resulting from predicting the picture (20), for the predetermined sample sets;

extracting the prediction residual and the coding parameters from the bitstream (30), along with one or more syntax elements for each of at least a subset of the sample sets (40), signaling as to whether the respective sample set (40) is to be merged into one of the groups along with another sample set (40) or not, wherein the merger (84) is configured to perform the merging responsive to the one or more syntax elements,

wherein one of the possible states of the one or more syntax elements signalizes that the respective sample set (40) is to be merged into one of the groups along with another sample set (40) and has no prediction residual encoded and inserted into the bitstream (30).

16. Method for encoding a picture (20) into a bitstream (30), the sample array of the picture (20) being partitioned into sample sets (40) each of which is associated with respective coding parameters, the method comprising encoding, for a current sample set, a flag into the bitstream commonly signaling as to whether the coding parameters associated with the current sample set (40) are to be set according to a merge candidate or to be retrieved from the bitstream (30), and as to whether the current sample set (40) of the picture (20) is to be reconstructed merely based on a prediction signal depending on the coding parameters associated with the current sample set (40), without any residual data, or to be reconstructed by refining the prediction signal depending on the coding parameters associated with the current sample set (40) by means of residual data within the bitstream (30).

17. Method for encoding a picture comprising

subdividing the picture into sample sets of samples;

merging the sample sets into groups of one or more sample sets each;

encoding the picture using coding parameters varying across the picture in units of the groups of sample sets, wherein the encoder (76) is configured to encode the picture by predicting the picture and encoding a prediction residual for predetermined sample sets;

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inserting the prediction residual and the coding parameters into a bitstream, along with one or more syntax elements for each of at least a subset of the sample sets, signaling as to whether the respective sample set is merged into one of the groups along with another sample set or not,

wherein one of the possible states of the one or more syntax elements signalizes that the respective sample set is to be merged into one of the groups along with another sample set and has no prediction residual encoded and inserted into the bitstream.

18. Computer program having a program code for performing, when running on a computer, a method according to claim 14 or 17.

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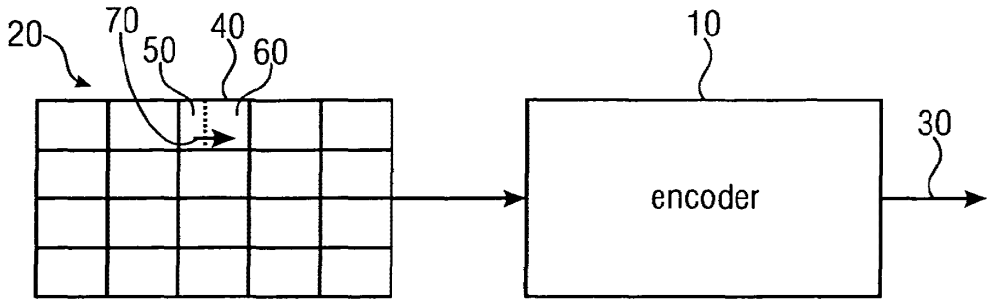


FIGURE 1

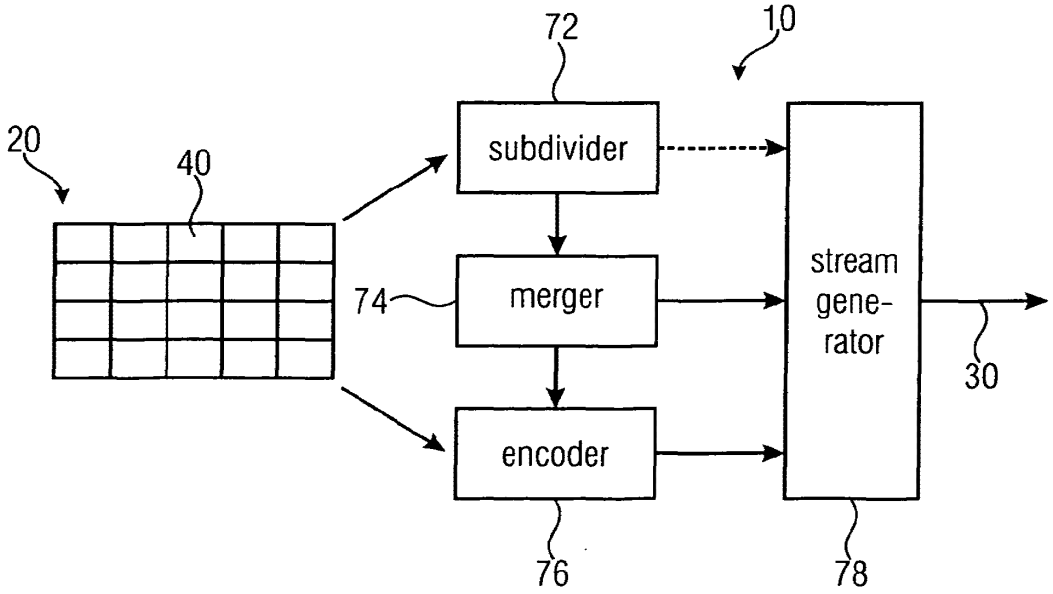


FIGURE 2

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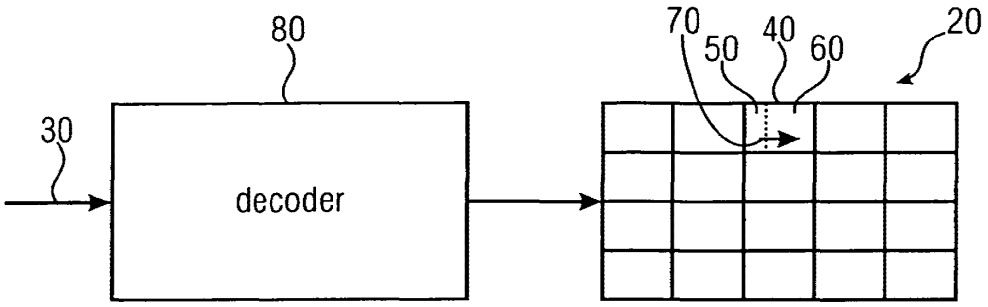


FIGURE 3

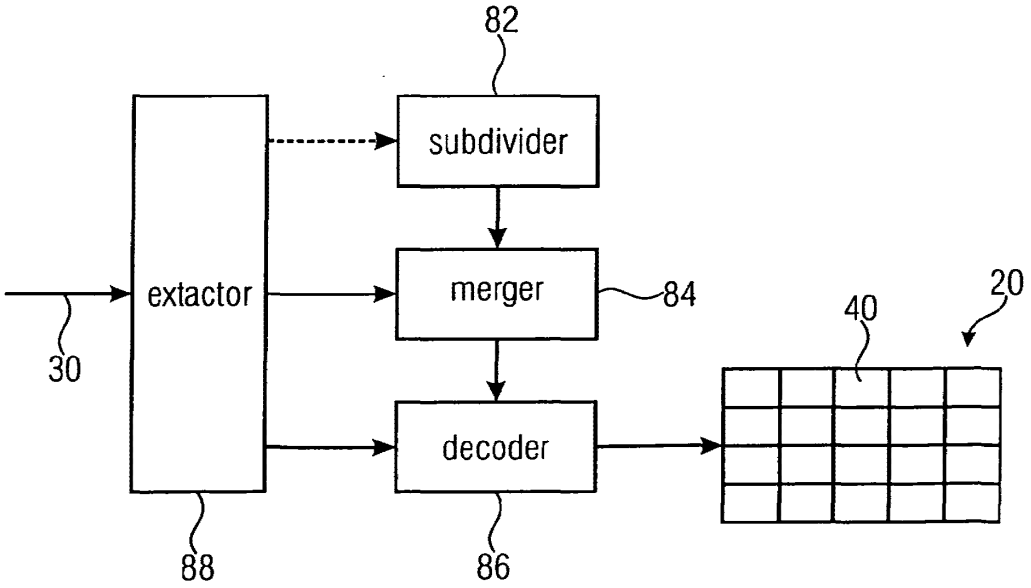


FIGURE 4

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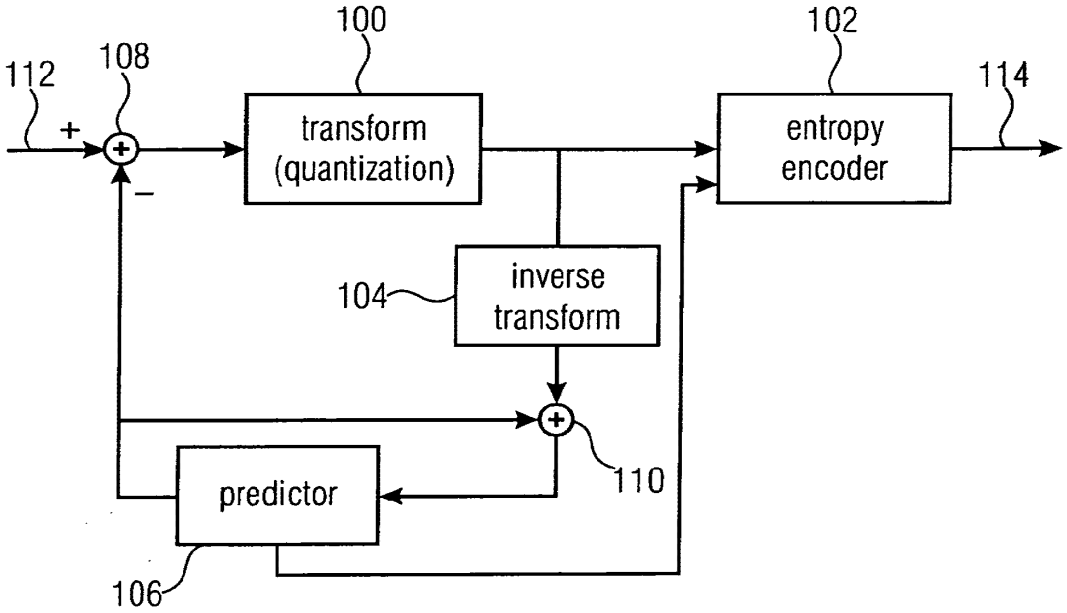


FIGURE 5

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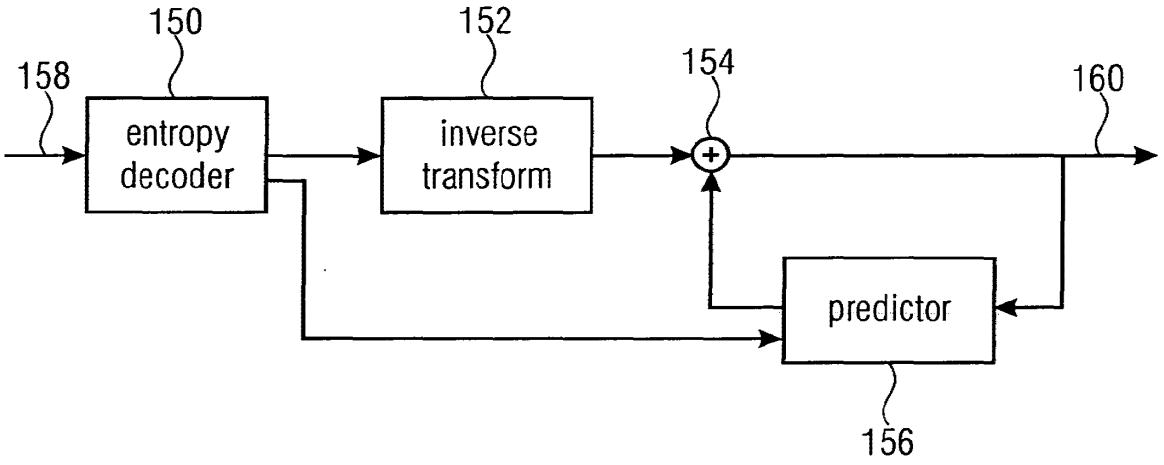


FIGURE 6

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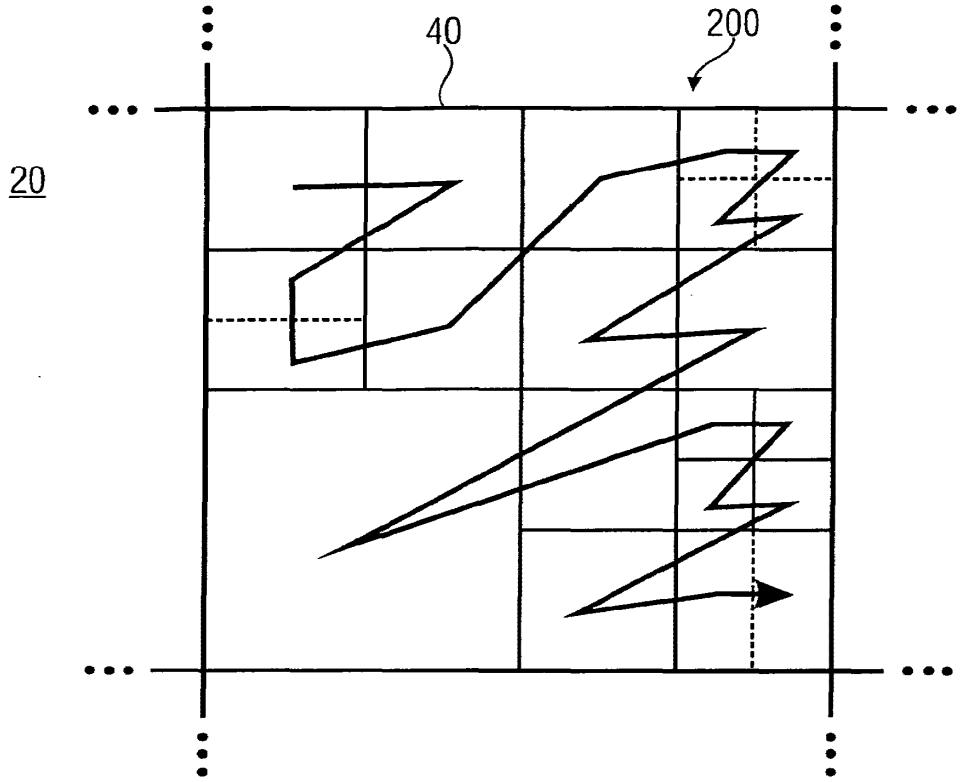


FIGURE 7A

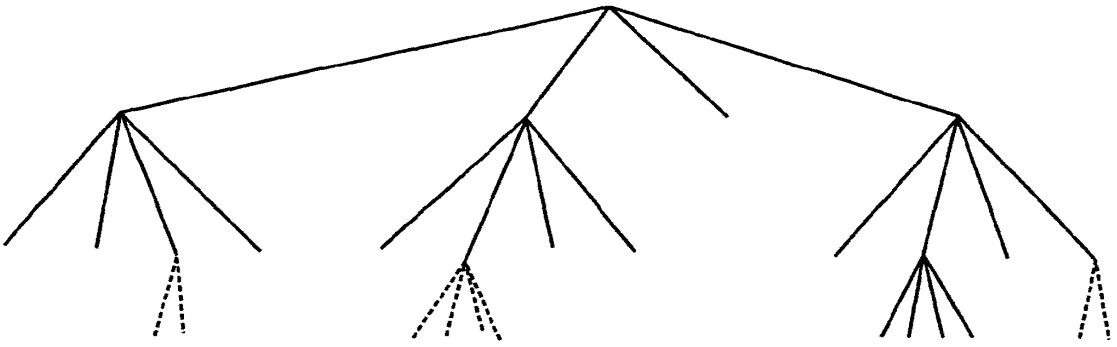


FIGURE 7B

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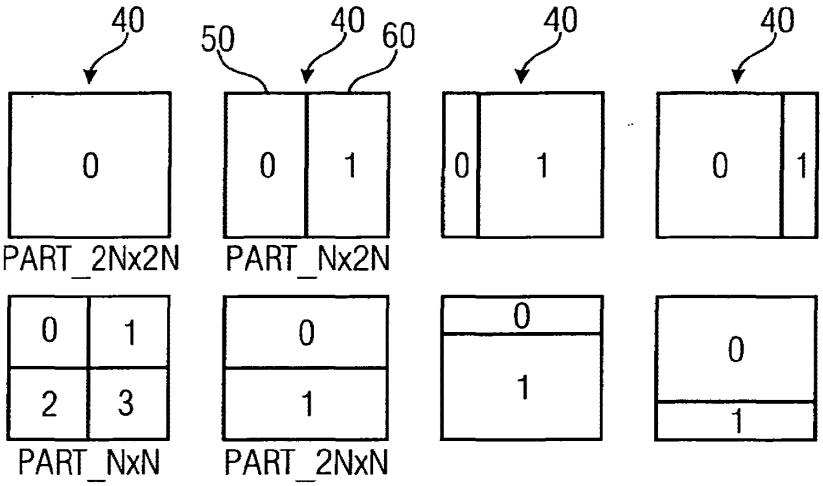


FIGURE 8

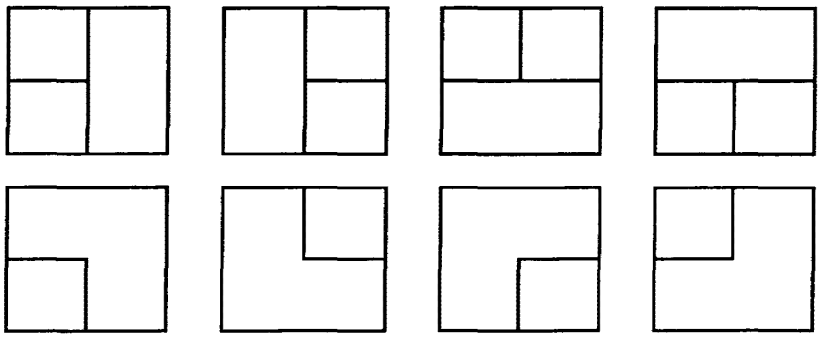


FIGURE 9

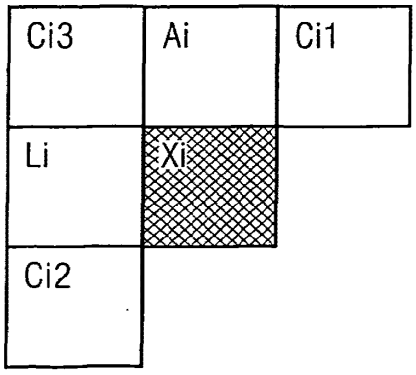


FIGURE 10

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coding_tree(x0, y0, log2CUSize) {	Descriptor
if(x0 + (1 << log2CUSize) <= PicWidthInSamplesL && y0 + (1 << log2CUSize) <= PicHeightInSamplesL && cuAddress(x0, y0) >= SliceAddress) {	
430 if(!entropy_coding_mode_flag && slice_type !=I) cu_split_pred_part_mode[x0][y0]	ce(v)
400 else if(log2CUSize > Log2MinCUSize) split_coding_unit_flag[x0][y0]	u(1)|ae(v)
} if(adaptive_loop_filter_flag && alf_cu_control_flag) { cuDepth = Log2MaxCUSize - log2CUSize if(cuDepth <= alf_cu_control_max_depth) if(cuDepth == alf_cu_control_max_depth || split_coding_unit_flag[x0][y0] == 0) 402 AlfCuFlagIdx++ } if(split_coding_unit_flag[x0][y0]) { if(cu_qp_depta_enabled_flag && log2CUSize == log2MinCUDQPSize) IsCuQpDeltaCoded = 0 x1 = x0 + ((1 << log2CUSize) >> 1) y1 = y0 + ((1 << log2CUSize) >> 1) if(cuAddress(x1, y0) > SliceAddress) moreDataFlag = coding_tree(x0, y0, log2CUSize - 1) if(cuAddress(x0, y1) > SliceAddress && moreDataFlag && x1 < PicWidthInSamplesL) moreDataFlag = coding_tree(x1, y0, log2CUSize - 1) 432 if(cuAddress(x1, y1) > SliceAddress && moreDataFlag && y1 < PicHeightInSamplesL) moreDataFlag = coding_tree(x0, y1, log2CUSize - 1) if(moreDataFlag && x1 < PicWidthInSamplesL && y1 < PicHeightInSamplesL) moreDataFlag = coding_tree(x1, y1, log2CUSize - 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) 404 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 }	

FIGURE 11

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coding_unit(x0, y0, log2CUSize) {	Descriptor
406 if(entropy_coding_mode_flag && slice_type != I) skip_flag[x0][y0]	u(1)|ae(v)

if(skip_flag[x0][y0])
428 prediction_unit(x0, y0, log2CUSize, log2CUSize, 0, 0)
408 else {
if(!entropy_coding_mode_flag) {
if(slice_type == I && log2CUSize == Log2MinCUSize)
intra_part_mode
	u(1)

410 } else if(slice-type !=I || log2CUSize == Log2MinCUSize) pred_type	u(v)|ae(v)

x1 = x0 + ((1 << log2CUSize) >> 1)
y1 = y0 + ((1 << log2CUSize) >> 1)
if(PartMode == PART_2Nx2N) {
prediction_unit(x0, y0, log2CUSize, log2CUSize, 0)
412 } else if(PartMode == PART_2NxN) {
prediction_unit(x0, y0, log2CUSize, log2CUSize - 1, 0)
prediction_unit(x0, y1, log2CUSize, log2CUSize - 1, 1)
} else if(partmode == PART_Nx2N) {
prediction_unit(x0, y0, log2CUSize - 1, log2CUSize, 0)
prediction_unit(x1, y0, log2CUSize - 1, log2CUSize, 1)
} else { /* PART_NxN */
prediction_unit(x0, y0, log2CUSize - 1, log2CUSize - 1, 0)
prediction_unit(x1, y0, log2CUSize - 1, log2CUSize - 1, 1)
prediction_unit(x0, y1, log2CUSize - 1, log2CUSize - 1, 2)
prediction_unit(x1, y1, log2CUSize - 1, log2CUSize - 1, 3)
}
if(!pcm_flag) {
426 transform_tree(x0, y0, log2CUSize, 0, 0)
transform_coeff(x0, y0, log2CUSize, 0, 0)
transform_coeff(x0, y0, log2CUSize, 0, 1)
transform_coeff(x0, y0, log2CUSize, 0, 2)
}
}
}	

FIGURE 12

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prediction_unit(x0, y0, log2PUWidth, log2PUHeight, PartIdx) {	Descriptor
if(skip_flag[x0][y0]) {	
414 merge_idx[x0][y0]	ue(v)|ae(v)
} else if(PredMode == MODE_INTRA) {	
416 if(PartMode == PART_2Nx2N && log2PUWidth >= Log2IPCMCUSize) 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]) if(NumMPMCand < 1) mpm_idx[x0][y0]	u(1)|ae(v)
else rem_intra_luma_pred_mode[x0][y0]	ce(v)|ae(v)
if(IntraPredMode[x0][y0] == 2) planar_flag_luma[x0][y0]	u(1)|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) if(IntraPredMode[x0][y0] != 2 && IntraPredMode[x0][y0]!=34 && SignaledAsChromaDC)	
422 planar_flag_chroma[x0][y0]	u(1)|ae(v)
}	
} else { /* MODE_INTER */	
if(entropy_coding_mode_flag||PartMode != PART_2Nx2N)	
418 merge_flag[x0][y0]	u(1)|ae(v)
if(merge_flag[x0][y0]) {	
420 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)

FIGURE 13A

FIGURE 13 FIGURE 13A FIGURE 13B

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} 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)
} mvd_lc[x0][y0][0]	se(v)|ae(v)
mvd_lc[x0][y0][1]	se(v)|ae(v)
mvp_idx_lc[x0][y0]	ue(v)|ae(v)

424 }
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)
} mvd_l0[x0][y0][0]	se(v)|ae(v)
mvd_l0[x0][y0][1]	se(v)|ae(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)
} mvd_l1[x0][y0][0]	se(v)|ae(v)
mvd_l1[x0][y0][1]	se(v)|ae(v)
mvp_idx_l1[x0][y0]	ue(v)|ae(v)
} } } }	

FIGURE 13B

FIGURE 13 FIGURE 13A FIGURE 13B

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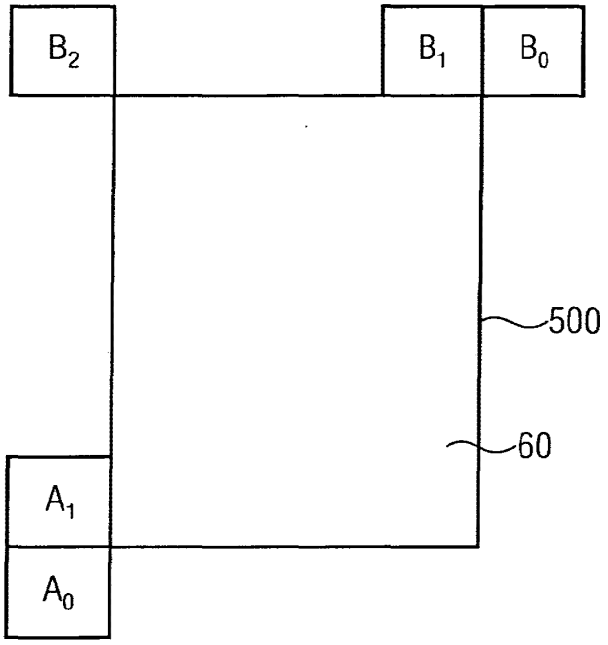


FIGURE 14

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/069408

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04N7/26
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ANONYMOUS: "Test Model under Consideration", 2. JCT-VC MEETING; 21-7-2010 - 28-7-2010; GENEVA; (JOINT COLLABORATIVETEAM 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-B205, 28 July 2010 (2010-07-28), XP030007704, ISSN: 0000-0046	1,6,7, 12-18
Y	point 3.1 point 4.2.10 point 5 last paragraph on page 125 -----	2-5,8-11
	-/--	

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 January 2012	06/02/2012

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	Regidor Arenales, R

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	I-K KIM ET AL: "TE11: Report on experiment 3.2.c: Check skip and merge together", 94. MPEG MEETING; 11-10-2010 - 15-10-2010; GUANGZHOU; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. M18237, 28 October 2010 (2010-10-28), XP030046827,	2-5,8-11
A	point 3	1,6,7, 12-18

Y	FULDSETH A ET AL: "Recent improvements of the low complexity entropy coder (LCEC) in TMuC", 94. MPEG MEETING; 11-10-2010 - 15-10-2010; GUANGZHOU; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11),, no. M18216, 28 October 2010 (2010-10-28), XP030046806,	11
A	point 2	1-10, 12-18

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Electronic Acknowledgement Receipt

EFS ID:	20068017
Application Number:	13526261
International Application Number:	
Confirmation Number:	8560
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Customer Number:	15150
Filer:	Matthew J. Evans/Kati Cheney
Filer Authorized By:	Matthew J. Evans
Attorney Docket Number:	1010-939US01/120072
Receipt Date:	08-SEP-2014
Filing Date:	18-JUN-2012
Time Stamp:	09:52:08
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	Information Disclosure Statement (IDS) Form (SB08)	120072_0_IDS.pdf	709288 f1eaa88244320d538acb7f158097b1914b82ac9a	no	6
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11	Non Patent Literature	NPL_10_KIM.pdf	190918 d635118a29531db37b649c07e910079bdcff5b81	no	13
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26	Foreign Reference	WO2012030193A2.pdf	2031776 fcb217bca1bdbb544e20e87f76819857b2744d75	no	47
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	Application Number	13526261
	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY, JANESE
	Attorney Docket Number	1010-939US01/120072

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13526261
	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY, JANESE
	Attorney Docket Number	1010-939US01/120072

	1	LIN, et al., "Parallel NxN merge mode", [online], 16 April 2012, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, Document: JCTVC-I0180 (version 1), 4 pp.	☐
	2	MCCANN, et al., "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description", [online], Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document: JCTVC-D502 (version 2), 7-15 October 2010, 28 pp.	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13526261
	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY, JANESE
	Attorney Docket Number	1010-939US01/120072

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SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew J. Evans/	Date (YYYY-MM-DD)	2015-02-24
Name/Print	Matthew J. Evans	Registration Number	56,530

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EFS ID:	21588329
Application Number:	13526261
International Application Number:	
Confirmation Number:	8560
Title of Invention:	PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING
First Named Inventor/Applicant Name:	Yunfei Zheng
Customer Number:	15150
Filer:	Matthew J. Evans/Kati Cheney
Filer Authorized By:	Matthew J. Evans
Attorney Docket Number:	1010-939US01/120072
Receipt Date:	24-FEB-2015
Filing Date:	18-JUN-2012
Time Stamp:	17:29:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	120072_0_IDS.pdf	707019 f847b5eb8b9af29b315632b8cd5357b5bf4f8bd6	no	4

Warnings:	
Information:	

A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

2	Non Patent Literature	LIN.pdf	1074291 742693471032c7b20fd8411ae1b7e5816e9d20a3c	no	4
Warnings:					
Information:					
3	Non Patent Literature	MCCANN.pdf	6300121 00abc3bb798004be7c4ede44beb41b066c2c9147	no	28
Warnings:					
Information:					
			Total Files Size (in bytes):	8081431	

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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/526,261	06/18/2012	Yunfei Zheng	1010-939US01/120072	8560

15150 7590 04/23/2015

Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125

EXAMINER	
DULEY, JANESE	

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
04/23/2015	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):

pairdocketing@ssiplaw.com
ocpat_uspto@qualcomm.com

Amazon.com, Inc., Amazon.com Services LLC - Ex. 1062, Page 000319

Office Action Summary	Application No. 13/526,261	Applicant(s) ZHENG ET AL.	
	Examiner JANESE DULEY	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 *06/18/2012*.

☐ 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) *1-40* 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) *1-7, 9-17, 19-28, 30-39* is/are rejected.

8)☒ Claim(s) *8,18,29,40* 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 *06/18/2012* 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 _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

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DETAILED ACTION

This Office Action is a response to an application filed June 18, 2012 in which claims 1-40 are pending and ready for examination.

Notice of Pre-AIA or AIA Status

1. The present application is being examined under the pre-AIA first to invent provisions.

Information Disclosure Statement

2. The information disclosure statements (IDS) submitted on September 18, 2012, September 8, 2014, and February 24, 2015 were filed before the mailing date of a first office action on the merits. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Priority

3. Receipt is acknowledged of domestic priority submitted under 35 U.S.C. 119 (e), claiming domestic priority to 61/499,112 filed on June 20, 2011, 61/543,043 on October 4, 2011,

61/543,0--59 on October 4, 2011, 61/556,761 November 7, 2011, 61/562,387 on November 21, 2011, and 61/562,953 on November 22, 2011.

Claim Interpretation - 35 USC § 112 6th Paragraph Invoked

4. Claim limitation 22-25, 27-31 has been interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, because it uses a generic placeholder "means for" coupled with functional language "determining", "performing", "excluding", "not excluding", "receiving", "decoding", "signaling" without reciting sufficient structure to achieve the function. Furthermore, the generic placeholder is not preceded by a structural modifier.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation: video encoder 20 [0140], video decoder 30 [0145].

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does not intend to have the claim limitation(s) treated under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112 , sixth paragraph, applicant may amend the claim(s) so that it/they will clearly not invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites/recite sufficient structure, material, or acts for

performing the claimed function to preclude application of 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 *et seq.* and *Supplementary Examination Guidelines for Determining Compliance With 35 U.S.C. 112 and for Treatment of Related Issues in Patent Applications*, 76 FR 7162, 7167 (Feb. 9, 2011).

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

35 U.S.C. 101 requires that a claimed invention must fall within one of the four eligible categories of invention (i.e. process, machine, manufacture, or composition of matter) *and* must not be directed to subject matter encompassing a judicially recognized exception as interpreted by the courts. MPEP 2106. The four eligible categories of invention include: (1) process which is an act, or a series of acts or steps, (2) machine which is an concrete thing, consisting of parts, or of certain devices and combination of devices, (3) manufacture which is an article produced from raw or prepared materials by giving to these materials new forms, qualities, properties, or combinations, whether by hand labor or by machinery, and (4) composition of matter which is all compositions of two or more substances and all composite articles, whether they be the results of

chemical union, or of mechanical mixture, or whether they be gases, fluids, powders or solids. MPEP 2106(I).

5. Claims 33-40 are rejected under 35 U.S.C. 101 as not falling within one of the four statutory categories of invention because the broadest reasonable interpretation of the instant claims in light of the specification encompasses transitory signals. But, transitory signals are not within one of the four statutory categories (i.e. non-statutory subject matter). *See* MPEP 2106(I). However, claims directed toward a non-transitory computer readable medium may qualify as a manufacture and make the claim patent-eligible subject matter. MPEP 2106(I). Therefore, amending the claims to recite a "*non-transitory computer-readable medium*" would resolve this issue.

Claim Rejections - 35 USC § 103

6. 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.

7. 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. 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.

9. Claims 1-4, 11-14, 22-25, 33-36 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over US 2014/0286395 A1 – Lee et al. in view of US 2011/0096826 A1- Han et al.

10. Regarding claim 1, Lee discloses **a method of coding video data** (Lee, Figure 17) **comprising:**

determining a merge candidate set for a current prediction unit of a current coding unit (Lee, [0055-56], data unit merging determinator 13 determines a merge candidate set**,…**

and

performing a merge motion vector prediction process for the current prediction unit using the merge candidate set (Lee, [0058], data unit merging determiner 13 determines candidate vector using motion vector prediction process)**.**

Lee fails to disclose adjacent coding unit not referred to encode current coding unit. However Han discloses:

wherein the merge candidate set is determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units (Han, [0208], [0212], coding unit determiner 1420 performs parallel encoding on coding units and therefore does not use comparing motion information to determine merge candidate set) **;**

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Lee to include determined without comparing motion information of a merge candidate in the merge candidate set to motion information of any other prediction units as taught by Han to implement a parallel processor architecture for faster execution.

11. Regarding claim 2, Lee in view of Hann discloses **the method of claim 1, further comprising:**

excluding merge candidates from the merge candidate set that are within another prediction unit of the current coding unit. (Lee, [0184], Figure 13, merge candidates excluded if same)

12. Regarding claim 3, Lee in view of Hann discloses **the method of claim 2, wherein excluding merge candidates comprises excluding merge candidates from the merge candidate set that are within another prediction unit for the current coding unit for all partition modes other than an NxN partition mode** (Lee, Fig. 15, [0175], geometric shapes are excluded from set)**.**

13. Regarding claim 4, Lee in view of Hann discloses **the method of claim 3, further comprising:**

not excluding merge candidates from prediction units from the coding unit having the NxN partition mode (Lee, [0193], merging when square mode)**.**

14. Regarding claims 11-14, apparatus claims 11-14 are drawn to the apparatus corresponding to the method of using same as claimed in claims 1-4. Therefore apparatus claims 11-14 correspond to method claims 1-4 and are rejected for the same reasons of obviousness as used above.

15. Regarding claims 22-25, apparatus claims 22-25 are drawn to the apparatus corresponding to the method of using same as claimed in claims 1-4. Therefore apparatus claims 22-25 correspond to method claims 1-4 and are rejected for the same reasons of obviousness as used above.

16. Regarding claims 33-36, computer readable storage medium claims 33-36 have limitations similar to those treated in the above claim 1-4 rejection(s), and are met by the references as discussed above. Claims 33-36 however also recites the following limitations **a computer-readable storage medium having stored thereon instructions that when executed cause one or more processors configured to code video data**…(Lee, [0013], encoding instructions stored on computer-readable storage medium).

17. Claims 5-7, 15-17, 26-28, 37-39 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over US 2014/0286395 A1 – Lee in view of US 2011/0096826 A1- Han further in view of US 2012/0134416 A1- Lin et al. (Lin)

18. Regarding claim 5**,** Lee in view of Hann discloses **the method of claim 2.**

Lee in view of Hann fails to disclose merge candidate set including left above, above, right above, left, below left, temporal merge candidates.

However in the same field of endeavor Lin discloses:

wherein the merge candidate set includes a left above merge candidate, an above merge candidate, a right above merge candidate, a left merge candidate, a below left merge

candidate, and a temporal merge candidate (Lin, Fig 1 & 2, merge candidate set includes left above, above, right above, left, below left, temporal) **.**

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Lee in view of Hann to include merge candidate set including left above, above, right above, left, below left, temporal merge candidates as taught by Lin to provide better coding efficiency [0004].

19. Regarding claim 6, Lee in view of Hann further in view of Lin discloses **the method of claim 5, wherein the current coding unit has a 2NxN, a 2NxnU or a 2NxnD partition type, including a prediction unit 0 positioned above a prediction unit 1, and wherein excluding merge candidates from the merge candidate set comprises excluding the above merge candidate from the merge candidate set for prediction unit 1** (Lee, Fig. 17, 26, 27, 31, [0062], as shown prediction unit 0 positioned above unit 1 in Fig 26, excluding above merge candidate using preset method)**.**

20. Regarding claim 7, Lee in view of Hann further in view of Lin discloses **the method of claim 5, wherein the current coding unit has an Nx2N, an nLx2N or an nRx2N partition type, including a prediction unit 0 positioned to the left of a prediction unit 1, and wherein excluding merge candidates from the merge candidate set comprises excluding the left merge candidate from the merge candidate set for prediction unit 1** (Lee, Fig. 17, 26, 27, 31, [0062], as shown prediction unit 0 positioned above unit 1 in Fig 26, excluding left merge candidate using preset method)**.**

21. Regarding claims 15-17, apparatus claims 15-17 are drawn to the apparatus corresponding to the method of using same as claimed in claims 5-7. Therefore apparatus claims 15-17 correspond to method claims 5-7 and are rejected for the same reasons of obviousness as used above.

22. Regarding claims 26-28, apparatus claims 26-28 are drawn to the apparatus corresponding to the method of using same as claimed in claims 5-7. Therefore apparatus claims 26-28 correspond to method claims 5-7 and are rejected for the same reasons of obviousness as used above.

23. Regarding claims 37-39, computer readable storage medium claims 37-39 have limitations similar to those treated in the above claim 5-7 rejection(s), and are met by the references as discussed above. Claims 37-39 however also recites the following limitations **a computer-readable storage medium having stored thereon instructions that when executed cause one or more processors configured to code video data**……(Lee, [0013], encoding instructions stored on computer-readable storage medium).

24. Claims 9-10, 19-20, 30-31 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over US 2014/0286395 A1 – Lee in view of US 2011/0096826 A1- Han further in view of US 2012/0189055 A1- Chien et al. (Chien).

25. Regarding claim 9, Lee in view of Hann discloses **the method of claim 2, wherein coding video comprises decoding video, and wherein the method further comprises:**

performing the merge motion vector prediction process for the current prediction unit using the merge candidate set and the received syntax element to determine a motion vector for the current prediction unit (Lee, [0058], motion vector prediction to determine motion vector for current unit)**; and**

decoding the current prediction unit using the determined motion vector (Lee, [0028], Fig 18, [0210], decoding using motion vector)**.**

Lee in view of Hann fails to disclose receiving a syntax element. However in the same field of endeavor Chien discloses:

receiving a syntax element indicating a selected merge candidate for the current prediction unit (Chien, [0033], an index identifying the candidate motion vector and location.)**;**

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Lee in view of Hann to include receiving a syntax element as taught by Chien to provide more flexibility and efficient coding [0021-23]).

26. Regarding claim 10, Lee in view of Hann discloses **the method of claim 2, wherein coding video comprises encoding video, and wherein the method further comprises:**

performing the motion vector prediction process for the current prediction unit using the merge candidate set to determine a selected merge candidate for the current prediction unit (Lee, [0058], motion vector prediction used to determine merge candidate)**; and**

Lee in view of Hann fails to disclose syntax element. However in the same field of endeavor Chien discloses:

signaling a syntax element indicating the selected merge candidate in an encoded video bitstream (Chien, [0033], [0037], encoder signals index in bitstream indicated the merge candidate).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Lee in view of Hann to include signaling a syntax element as taught by Chien to provide more flexibility and efficient coding [0021-23]).

27. Regarding claims 19-20, 30-31, apparatus claims 19-20, 30-31 are drawn to the apparatus corresponding to the method of using same as claimed in claims 9-10. Therefore apparatus claims 19-20, 30-31 correspond to method claims 9-10 and are rejected for the same reasons of obviousness as used above.

28. Claims 21 and 32 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over US 2014/0286395 A1 – Lee in view of US 2011/0096826 A1- Han further in view of US 2013/0287116 A1- Helle et al. (Helle).

29. Regarding claim 21**,** Lee in view of Hann discloses **the apparatus of claim 11.**

Lee in Hann fails to disclose a mobile device. However in the same field of endeavor Helle discloses:

wherein the video coder is part of a mobile device (Helle, [0178], encoding program is part of a mobile device)**.**

Therefore it would have been obvious to one of ordinary skill in art at the time the invention was made to modify the teachings of Lee in view of Hann to include a mobile device as taught by Helle to provide a flexible efficient platform.

30. Regarding claim 32, the apparatus claim 32 is similar to apparatus claim 21 and is rejected for the same reasons of obviousness as used above.

Allowable Subject Matter

31. Claims 8, 18, 29, 40 are objected to as being dependent upon a rejected base claim, but would be allowed if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The various claimed limitations mentioned in the claims are not taught or suggested by the prior art taken either singly or in combination, with emphasize that it is each claim, taken as a whole, including the interrelationships and interconnections between various claimed elements make them allowable over the prior art of record.

However, prior arts of record do not disclose, alone or in combination,

wherein the current coding unit has an NxN partition type, including a prediction unit 0 positioned in a top left portion of the current coding unit, a prediction unit 1 positioned in a top right portion of the current coding unit, a prediction unit 2 positioned in a bottom left portion of the current coding unit, and a prediction unit 3 positioned in a bottom right portion of the current coding unit,

wherein excluding merge candidates from the merge candidate set comprises excluding the left merge candidate and the below left merge candidate from the merge candidate set for prediction unit 1,

wherein excluding merge candidates from the merge candidate set comprises excluding the above merge candidate and the right above merge candidate from the merge candidate set for prediction unit 2, and

wherein excluding merge candidates from the merge candidate set comprises excluding the above merge candidate, the left merge candidate, and the left above merge candidate from the merge candidate set for prediction unit 3.

The prior art fails to teach or render obvious these limitations taken within the others in the claim.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JANESE DULEY whose telephone number is (571)272-5844. The examiner can normally be reached on 7:30-5; alt Fri off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sath 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.

/Janese Duley/

Examiner, Art Unit 2488

/SATH V PERUNGAVOOR/

Supervisory Patent Examiner, Art Unit 2488

Notice of References Cited	Application/Control No. 13/526,261	Applicant(s)/Patent Under Reexamination ZHENG ET AL.	
	Examiner JANESE DULEY	Art Unit 2488	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2014/0286395 A1	09-2014	LEE et al.	375/240.02
*	B	US-2011/0096826 A1	04-2011	HAN et al.	375/240.01
*	C	US-2012/0134416 A1	05-2012	Lin et al.	375/240.16
*	D	US-2012/0189055 A1	07-2012	Chien et al.	375/240.14
*	E	US-2013/0287116 A1	10-2013	HELLE et al.	375/240.24
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FOREIGN PATENT DOCUMENTS

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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*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.

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CONFIRMATION NO. 8560

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/526,261	06/18/2012 RULE	375	2488	1010-939US01/120072

APPLICANTS

INVENTORS

Yunfei Zheng, Cupertino, CA;
Xianglin Wang, San Diego, CA;
Marta Karczewicz, San Diego, CA;

**** CONTINUING DATA ***************************

This appln claims benefit of 61/499,112 06/20/2011
and claims benefit of 61/543,043 10/04/2011
and claims benefit of 61/543,059 10/04/2011
and claims benefit of 61/556,761 11/07/2011
and claims benefit of 61/562,387 11/21/2011
and claims benefit of 61/562,953 11/22/2011

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

06/27/2012

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /JANESE DULEY/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	10	40	4

ADDRESS

Shumaker & Sieffert, P. A.
1625 Radio Drive, Suite 300
Woodbury, MN 55125
UNITED STATES

TITLE

PARALLELIZATION FRIENDLY MERGE CANDIDATES FOR VIDEO CODING

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	13526261
Filing Date	2012-06-18
First Named Inventor	ZHENG; Yunfei
Art Unit	2488
Examiner Name	DULEY; JANESE
Attorney Docket Number	1010-939US01/120072

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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
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	1	2012030193	WO	A2	2012-03-08	LG ELECTRONICS INC [KR], et al.	Abstract Only	☒
	2	2012059577	WO	A1	2012-05-10	FRAUNHOFER GES FORSCHUNG [DE], et al.		☐

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Receipt date: 09/08/2014	Application Number	13526261 13526261 - GAU: 2488
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
(Not for submission under 37 CFR 1.99)	Art Unit	2488
	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	Zheng et al., "Simplification and improvement of additional merge candidate," JCT-VC MEETING; MPEG MEETING; 21-11-2011 - 30-11-2011; GENEVA, CH; (JOINT COLLABORATIVE TEAM ON VIDEO CODING (JCT-VC) OF ITU-T SG.16 WP3 AND ISO/IEC JTC1/SC29/WG11); URL:http://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, no.JCTVC-G683, XP030110667, pp 1-8, 8 pp.	☐
	2	BROSS et al., "High efficiency video coding (HEVC) text specification draft 7," 9th Meeting: Geneva, CH, 27 April - 7 May 2012, JCTVC-I1003_d2, 290 pp.	☐
	3	BROSS et al., "High efficiency video coding (HEVC) text specification draft 8," 10th Meeting: Stockholm, SE, 11-20 July 2012, JCTVC-J1003_d7, 261 pp.	☐
	4	BROSS et al., "High efficiency video coding (HEVC) text specification draft 6," 8th Meeting: San Jose, CA, USA, 1-10 February, 2012, JCTVC-H1003, 259 pp.	☐
	5	BROSS et al., "WD4: Working Draft 4 of High-Efficiency Video Coding," 6th Meeting: JCTVC-F803_d2, Torino, IT, 14-22 July, 2011, 226 pp.	☐
	6	BROSS et al., "WD5: Working Draft 5 of High-Efficiency Video Coding," 7th Meeting: Geneva, CH, 12-30 November, 2011, JCTVC-G1103_d2, 214 pp.	☐
	7	INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY -PCT/US2012/043155, THE INTERNATIONAL BUREAU OF WIPO - GENEVA, SWITZERLAND, 2013-09-24 (1010-939WO01/120072WO), 11 pp.	☐
	8	INTERNATIONAL SEARCH REPORT AND WRITTEN OPINION - PCT/US2012/043155- ISA/EPO - 2012-09-27 (1010-939WO01/120072WO), 15 pp.	☐
	9	ITU-T H.264, Series H: Audiovisual and Multimedia Systems, Infrastructure of audiovisual services - Coding of moving video, Advanced video coding for generic audiovisual services, The International Telecommunication Union. June 2011, 674 pp.	☐
	10	KIM H Y. et al., "CU-based Merge Candidate List Construction," Document: JCTVC-G416, 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, Date Saved: 2011-11-09, XP030110400, pp 1-13	☐

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(Not for submission under 37 CFR 1.99)	Art Unit	2488
	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

	11	LIU et al., "Method and syntax for partial CU merge", MPEG MEETING; 5th Meeting, 16-23 March 2011, GENEVA, CH; (MOTION PICTURE EXPERT GROUP OR ISO/IEC JTC1/SC29/WG11), no. m19599, XP030048166, pp. 1-5	☐
	12	MATHEW et al., "Quad-Tree Motion Modeling With Leaf Merging," IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, Vol. 20, No. 10, October 2010, XP011318748, ISSN: 1051-8215, pp. 1331-1345, 15 pp.	☐
	13	MCCANN et al., "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description," 20110128, no. JCTVC-D502, 28 January 2011, XP002679641, Retrieved from the Internet: URL: http://wftp3.itu.int/av-arch/jctvc-site/2011_01_D_Daegu/ [retrieved on 2012-07-11], 26 pp.	☐
	14	WIEGAND et al., "WD1: Working Draft 1 of High-Efficiency Video Coding," JCTVC-C403, 3rd Meeting: Guangzhou, CN, 7-15 October, 2010, 137 pp.	☐
	15	WIEGAND et al., "WD2: Working Draft 2 of High-Efficiency Video Coding," JCTVC-D503, 4th Meeting: Daegu, KR, 20-28 January 2011, 153 pp.	☐
	16	WIEGAND et al., "WD3: Working Draft 3 of High-Efficiency Video Coding," Document JCTVC-E603, 5th Meeting: Geneva, CH, 16-23 March 2011, 193 pp.	☐
	17	ZHENG et al., "CE9: Unified Merge and AMVP candidates selection (UNI03)", JCT-VC MEETING; MPEG MEETING; 14-7-2011 - 22-7-2011; Torino, IT; (Joint Collaborative Team on Video Coding of ITU-T SG.16 WP3 and ISO/IEC JTC1/SC29/WG11) URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/ no. JCTVC-F297, XP030009320, 12 pp.	☐
	18	ZHENG et al., "Simplified Merge candidate derivation," JCT-VC MEETING; MPEG MEETING; 21-30 November 2011; GENEVA, CH; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11; URL:http://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/, No. JCTVC-G681, XP030110665, 5 pp.	☐
	19	ZHENG et al., "Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode," MPEG MEETING; 6th Meeting, TORINO, IT, 14-22 July 2011; (MOTION PICTURE EXPERT GROUP OR ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11), JCTVC-F302, no.m20723, date saved: 2011-07-07, XP030049286, 6 pp.	☐
	20	ZHENG et al., "Unified Motion Vector Predictor Selection for Merge and AMVP", MPEG Meeting; 5th Meeting, 16-23 March 2011; Geneva, CH; (Motion Picture Expert Group or ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11), no. m19932, JCTVC-E396, XP030048499, 5 pp.	☐
	21	BROSS et al., "High Efficiency Video Coding (HEVC) text specification draft 9," 11th Meeting: Shanghai, CN, 10-19 October 2012, JCTVC-K1003_v7, 290 pp.	☐

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	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

	22	BROSS et al., "High Efficiency Video Coding (HEVC) text specification draft 10 (for FDIS & Last Call)," 12th Meeting: Geneva, CH, 14-23 January 2013, JCTVC-L1003_v34, 310 pp.	☐
	23	ITU-T H.265, Series H: Audiovisual and Multimedia Systems, Infrastructure of audiovisual services - Coding of moving video, Advanced video coding for generic audiovisual services, The International Telecommunication Union. April 2013, 317 pp.	☐
	24	Second Written Opinion from International Application number PCT/US2012/043155, dated June 6, 2013, 9 pp. (Atty docket no. 1010-939WO01/120072WO)	☐

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Examiner Signature	/Janese Duley/	Date Considered	03/04/2015

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	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY; JANESE
	Attorney Docket Number	1010-939US01/120072

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew J. Evans/	Date (YYYY-MM-DD)	2014-09-04
Name/Print	Matthew J. Evans	Registration Number	56,530

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	22	("20060120455" | "20060140275" | "20080043843" | "20090129742" | "20110176615" | "20120008676" | "20120008688" | "7940844").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/04 14:01
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S4	0	S2 and merge near3 candidate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/04 14:12
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S36	0	"32" and merge near3 candidate adj set	USPAT	OR	OFF	2015/03/19 12:28
S37	10	"32" and merge near3 candidate adj set	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 12:28
S38	32	(US-20110176615-$ or US-	US-PGPUB;	OR	OFF	2015/03/19

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		20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	USPAT; FPRS; DERWENT			13:48
S39	0	S38 and omit$3	USPAT	OR	OFF	2015/03/19 13:48
S40	0	S38 and ommit$4	USPAT	OR	OFF	2015/03/19 13:49
S41	10	"32" and merge near3 candidate adj set	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:49
S42	3	qualcomm.as. and (merge near3 candidate and motion near3 information and vector and prediction and candidate near3 set).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:49
S43	0	S42 and omit$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:49
S44	0	S42 and ommit$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:50
S45	74	((Yunfei) near2 (Zheng)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/03/19 13:50
S46	181	((Xianglin) near2 (Wang)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2015/03/19 13:50
S47	637	((Marta) near2 (Karczewicz)).INV.	US-PGPUB; USPAT;	OR	OFF	2015/03/19 13:50

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			USOCR			
S48	737	S45 S46 S47	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:50
S49	2	S48 and (merge near3 candidate and motion near3 information and vector and prediction and candidate near3 set).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:50
S50	0	S49 and ommit$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:50
S51	10	"32" and merge near3 candidate adj set	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:50
S52	0	S51 and ommit$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:50
S53	12697	prediction and merg$3 and (ommit$4 omit$4 exclud$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:51
S54	410	prediction and merg$3 near3 mode and (ommit$4 omit$4 exclud$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:51
S55	193	S54 and merge near3 (syntax flag)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:51
S56	137	S55 and partition	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2015/03/19 13:52

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			EPO; JPO; DERWENT; IBM_TDB			
S57	72	S56 and prediction near3 "0"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:53
S58	58	S57 and prediction near3 "1"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:53
S59	46	S57 and prediction near3 "3"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:53
S60	35	S57 and prediction near3 "2"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:53
S61	30	S59 and S60	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:54
S62	1072916	S61 and motion vector	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:54
S63	30	S61 and motion near3 vector	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:54
S64	10	S63 and encod$3 and decod$3 and (cell$4 mobile)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 13:55
S65	35	(US-20110176615-$ or US-20090129742-$ or US-20080043843-	US-PGPUB; USPAT;	OR	OFF	2015/03/19 14:26

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		$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	FPRS; DERWENT			
S66	0	S65 and merge near3 candidate	USPAT	OR	OFF	2015/03/19 14:26
S67	0	S65 and merg$3 near3 candidate	USPAT	OR	OFF	2015/03/19 14:27
S68	0	S65 and merg$3 near3 motion adj vector	USPAT	OR	OFF	2015/03/19 14:27
S69	8	S65 and merg$3 near3 motion adj vector	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/19 14:27
S70	1848	merg$3 near3 mode and (omit$4 eliminat$4 reduc$3 remov$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/21 18:18
S71	612	S70 and prediction and motion adj vector	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/03/21 18:19
S72	35	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/07 15:35

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		20120082210-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.				
S73	14	S72 and merge adj mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:35
S74	9	S72 and merge adj mode and prediction near3 unit with coding near3 unit	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:36
S75	219	merge adj mode and prediction near3 unit with coding near3 unit and HEVC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:37
S76	107	merge adj mode and prediction near3 unit with coding near3 unit and HEVC and parallel$7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:37
S77	45	merge adj mode and prediction near3 unit with coding near3 unit and HEVC and parallel$7 and merge near3 candidate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:41
S78	25	S77 not qualcomm.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:42
S79	25	S77 not (qualcomm.as.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:43
S80	25	S78 not (qualcomm.as.)	US-PGPUB;	OR	OFF	2015/04/07

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			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			15:43
S81	19	S78 not (qualcomm.aanm.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 15:45
S82	12	S77 and parallel near3 merge	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/07 16:23
S83	36	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/08 07:44
S84	17225	parallel with encod$3	USPAT	OR	OFF	2015/04/08 07:44
S85	787	parallel with merg$3 and encod$3	USPAT	OR	OFF	2015/04/08 07:56
S86	1700	parallel with merg$3 and encod$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/08 07:56
S87	2	parallel with merg$3 and encod$3 and (no without) near3 motion near5 compar$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/08 07:57

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S88	16	"2012005520"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/08 08:37
S89	92	"367952"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/08 08:38
S90	14	"367952".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/08 08:39
S91	5	"20100135387"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/08 08:50
S92	39	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$ or US-20100135387-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/08 10:52
S93	39	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/09 07:42

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		$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$ or US-20100135387-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.				
S94	0	S93 and merge adj candidate	USPAT	OR	OFF	2015/04/09 07:42
S95	0	S93 and merge near3 candidate	USPAT	OR	OFF	2015/04/09 07:43
S96	15	S93 and merge near3 candidate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 07:43
S97	9	S93 and merge adj candidate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 07:43
S98	39	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$ or US-20100135387-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/09 10:34

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S99	6	S98 and merge adj candidate and HEVC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 10:34
S100	39	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$ or US-20100135387-$).did. or (US-7940844-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/09 13:44
S101	1342	S100 and merge adj candidate with motion vector with prediction and HEVC and decod$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:45
S102	1342	S100 and merge adj candidate with motion vector with prediction and HEVC and decod$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:45
S103	1	S100 and merge adj candidate with motion adj vector with prediction and HEVC and decod$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:45
S104	1	S100 and merge adj candidate same motion adj vector with prediction and HEVC and decod$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:45
S105	5	S100 and merge adj candidate and	US-PGPUB;	OR	OFF	2015/04/09

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		motion adj vector with prediction and HEVC and decod$3	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			13:45
S106	0	nonsquare near6 (CU coding adj unit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:52
S107	1075	(non$square 2N$3) near6 (CU coding adj unit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:53
S108	630	(non$square 2N$3) near3 (CU coding adj unit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:53
S109	63	(non$square 2N$3) adj (CU coding adj unit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:54
S110	20	(non$square 2N$3) adj (CU coding adj unit) and (HEVC parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:54
S111	1	"61450720"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 13:57
S112	619	(non$square 2N$3 partition$3) adj (CU coding adj unit) and (HEVC parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 14:07
S113	47	(non$square 2N$3 partition$3 adj typ$2) adj (CU coding adj unit) and (HEVC parallel)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2015/04/09 14:08

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			IBM_TDB			
S114	27	S113 not S110	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 14:08
S115	11	S114 and merge	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 14:49
S116	133	HEVC near5 "6" and parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 14:55
S117	102	HEVC near5 draft near3 "6" and parallel	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 14:55
S118	221	HEVC and parallel and exclud$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 15:14
S119	134	HEVC and parallel and exclud$3 and (PU prediction adj unit) and (CU coding adj unit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 15:14
S120	5	HEVC and parallel and exclud$3 and (PU prediction adj unit) and (CU coding adj unit) and partition adj type	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 15:14
S121	5	HEVC and parallel and (exclud$3 not$available) and (PU prediction adj unit) and (CU coding adj unit) and partition adj type	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 15:19
S122	0	S121 not S120	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2015/04/09 15:19

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			EPO; JPO; DERWENT; IBM_TDB			
S123	5	HEVC and parallel and (exclud$3 not near3 available) and (PU prediction adj unit) and (CU coding adj unit) and partition adj type	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 15:19
S124	3	"20100124273".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/09 15:20
S125	42	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$ or US-20100135387-$ or US-20110096826-$ or US-20130016787-$).did. or (US-7940844-$ or US-8861616-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/13 10:32
S126	0	S125 and merge adj candidat$3	USPAT	OR	OFF	2015/04/13 11:07
S127	9	S125 and merge adj candidat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 11:07
S128	2	"20140286395".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 15:30
S129	0	"20140286395".pn. and	USPAT	OR	OFF	2015/04/13

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		interprediction				16:37
S130	0	"20140286395".pn. and intrapredíction	USPAT	OR	OFF	2015/04/13 16:37
S131	0	"20140286395".pn. and intrapredic$4	USPAT	OR	OFF	2015/04/13 16:37
S132	0	"20140286395".pn. and intrapredic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 16:37
S133	0	"20140286395".pn. and interpredic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 16:37
S134	0	"20140286395".pn. and interpredic$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 16:38
S135	0	"20140286395".pn. and intermode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 16:38
S136	1	"20140286395".pn. and inter adj mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/13 16:38
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S138	42	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/14 08:42

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		$ or US-20100135387-$ or US-20110096826-$ or US-20130016787-$).did. or (US-7940844-$ or US-8861616-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.				
S139	8	S138 and exclud$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 08:43
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S141	1	S138 and asymmetric$4 with (merg$3 exclud$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 09:41
S142	5	S138 and (symmetric$4 NxN square) with (merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 10:35
S143	1	"20140286395".pn. and above with (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 10:57
S144	1	"20140286395".pn. and (above upper) with (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 11:05
S145	1	"20140286395".pn. and (above) with (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2015/04/14 11:09

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			IBM_TDB			
S146	17	S138 and (above) with (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 11:09
S147	11	S138 and (above) near7 (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 11:09
S148	11	S138 and (above) near5 (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 11:09
S149	10	S138 and (above) near3 (exclud$3 merg$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 11:09
S150	3	S138 and (above) with(exclud$3 merg$3)with (right) with (left)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 12:08
S151	14	S138 and (mobile cellular cell phone)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 13:18
S152	7	S138 and (mobile cellular cell phone) and hevc	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 13:21
S153	7	S138 and (mobile cellular cell phone) and hevc and merg$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 13:22
S154	12	S138 and decod$3 and hevc and merg$3 and syntax	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2015/04/14 14:19

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			EPO; JPO; DERWENT; IBM_TDB			
S155	3	S138 and decod$3 and hevc and merg$3 and syntax near5 candidate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/14 14:19
S156	42	(US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or US-20140286395-$ or US-20130272404-$ or US-20130259129-$ or US-20120134416-$ or US-20120189055-$ or US-20120230411-$ or US-20120236941-$ or US-20120236942-$ or US-20120243609-$ or US-20120320969-$ or US-20130034157-$ or US-20130077691-$ or US-20130287116-$ or US-20120287988-$ or US-20120082210-$ or US-20120257678-$ or US-20100135387-$ or US-20110096826-$ or US-20130016787-$).did. or (US-7940844-$ or US-8861616-$).did. or (KR-20120008688-$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/14 17:58
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		$ or KR-20120008676-$ or KR-20090129742-$ or KR-20080043843-$ or KR-20060120455-$ or WO-2012005520-$).did. or (WO-2012005520-$ or US-20120008688-$ or US-20110176615-$ or US-20090129742-$ or US-20080043843-$ or US-20060140275-$ or US-20060120455-$ or WO-03107681-$).did.				
S159	1	S158 and mobile	USPAT	OR	OFF	2015/04/15 08:05
S160	8	S158 and mobile	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/04/15 08:06
S161	2	"20140286395".pn.	US-PGPUB; USPAT; FPRS; DERWENT	OR	OFF	2015/04/15 11:14

EAST Search History (Interference)

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4/15/2015 12:52:57 PM
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	13/526,261
Filing Date	06-18-2012
First Named Inventor	Yunfei Zheng
Art Unit	2626
Examiner Name	Unknown

Sheet	**1**	**of**	**2**	**Attorney Docket No:** 1010-939US01/120072

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2](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
	001	US7940844	05-10-2011	LAI et al.	
	002	US20060120455	06-08-2006	PARK et al.	
	003	US20060140275	06-29-2006	LEE et al.	
	004	US20080043843	02-21-2008	NAKAISHI	
	005	US20090129472	05-21-2009	PANUSOPONE et al.	
	006	US20110176615	07-21-2011	LEE et al.	
	007	US20120008676	01-12-2012	LEE et al.	
	008	US20120008688	01-12-2012	TSAI et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5](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	T[6]
	009	WO2011047994A1	04-28-2011	THOMSON LICENSING [FR]		☐

NON PATENT LITERATURE 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.	T2
	010	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, December 2010, 12 pp.	☐

EXAMINER SIGNATURE /Janese Duley/ **DATE CONSIDERED** 03/04/2015

*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. [1]Applicant's unique citation designation number (optional). [2]See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3]Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4]For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5]Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6]Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. 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 2 hours 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, 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.**

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	**2**	**of**	**2**

Complete if Known

Application Number	13/526,261
Filing Date	06-18-2012
First Named Inventor	Yunfei Zheng
Art Unit	2626
Examiner Name	Unknown

Attorney Docket No: 1010-939US01/120072

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew J. Evans/	Date (YYYY-MM-DD)	2012-09-18
Name/Print	Matthew J. Evans	Registration Number	56,530

This collection of information is required by 37 CFR 1.97 and 1.98. 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 CFR1.14. This collection is estimated to take 1 hour 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 SENDFEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13526261	ZHENG ET AL.
	Examiner	Art Unit
	JANESE DULEY	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	04/07/2015								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	O								
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	36	✓								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13526261	ZHENG ET AL.
	Examiner	**Art Unit**
	JANESE DULEY	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	04/07/2015								
	37	✓								
	38	✓								
	39	✓								
	40	O								

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13526261
	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY, JANESE
	Attorney Docket Number	1010-939US01/120072

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

Receipt date: 02/24/2015	Application Number	13526261 13526261 - GAU: 2488
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
(Not for submission under 37 CFR 1.99)	Art Unit	2488
	Examiner Name	DULEY, JANESE
	Attorney Docket Number	1010-939US01/120072

	1	LIN, et al., "Parallel NxN merge mode", [online], 16 April 2012, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, Document: JCTVC-I0180 (version 1), 4 pp.	☐
	2	MCCANN, et al., "High Efficiency Video Coding (HEVC) Test Model 2 (HM 2) Encoder Description", [online], Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Document: JCTVC-D502 (version 2), 7-15 October 2010, 28 pp.	☐

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EXAMINER SIGNATURE

Examiner Signature	/Janese Duley/	Date Considered	03/04/2015

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.D./

Receipt date: 02/24/2015	Application Number	13526261 13526261 - GAU: 2488
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date	2012-06-18
	First Named Inventor	ZHENG; Yunfei
	Art Unit	2488
	Examiner Name	DULEY, JANESE
	Attorney Docket Number	1010-939US01/120072

CERTIFICATION STATEMENT

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☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew J. Evans/	Date (YYYY-MM-DD)	2015-02-24
Name/Print	Matthew J. Evans	Registration Number	56,530

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13526261	ZHENG ET AL.
	Examiner	Art Unit
	JANESE DULEY	2488

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor search in EAST	03/05/2015	JD
Assignee search in EAST	03/19/2015	JD
Keyword search in EAST	03/19-21/2015, 04/07-09, 13-15/2015	JD
consultation for allowable content Kate Luo and Sath Perungavoor	04/14/2015	JD

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
