

(12) International Application Published under the Patent Cooperation Treaty

(19) World Intellectual Property
Organization

International Bureau

(43) International Publication Date
March 19, 2009 (03/09/2009)



PCT



(10) International Publication Number

WO 2009/033390 A1

(51) International Patent

Classification Number:

H04N 7/24 (01/2006)

(21) International Application No.: PCT/CN2008/072082

(22) International Filing Date: August 21, 2008
(08/21/2008)

(25) Language Used for Application: Chinese

(26) Language Used for Publication: Chinese

(30) Right of Priority:

200710149478.0

September 13, 2007 (09/13/2007) CN

(71) Applicant (for all designated countries except the United States):

Huawei Technologies Co., Ltd. [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN).

(72) Inventors; and

(75) Inventors/Applicants (for the United States only): FU, Jiali [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). ZHOU, Jiantong [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). HU, Changqi [CN/CN]; Huawei Headquarters Office Building,

Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). LIN, Sixin [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). GAO, Shan [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). LIU, Yingjia [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). XIE, Qingpeng [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). ZHANG, Xiaosen [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN). XIONG, Lianhuan [CN/CN]; Huawei Headquarters Office Building, Bantian, Longgang District, Shenzhen, Guangdong Province, 518129 (CN).

(74) Agent: Unitalen Attorneys at Law; 7/F, Scitech Plaza, No. 22 Jianguomenwai Avenue, Beijing 100004 (CN).

(81) Designated Countries (unless otherwise specified, every available country protection is required): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB,

[See Continuation]

(54) Title of Invention: METHOD AND DEVICE FOR ACQUIRING BLOCK BOUNDARY STRENGTH AND REDUCING BLOCK DISTORTION

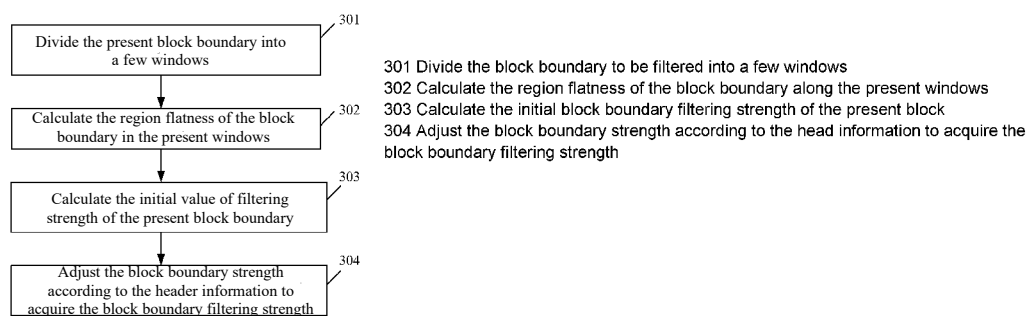


Figure 3

(57) Abstract: A method for acquiring block boundary filtering strength, comprises: deciding similar threshold, calculating region flatness with such similar threshold; deciding the initial value of the block boundary filtering strength according to the region flatness interval, which contains the region flatness; adjusting the initial value of the block boundary filtering strength with the head information of blocks along the boundary, to acquire the block boundary filtering strength; or using the head information of blocks such as mode information or coding block pattern (CBP), to decide whether to filter the pixels along the block boundary or not. A device for acquiring block boundary strength is also disclosed, moreover a method and a device for reducing block distortion are also provided. The advantage of the disclosed method and device can improve the accuracy of the block boundary filtering strength.

[See Following Page]

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,

INTEL-1022
9,641,841



MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated Countries (unless otherwise specified, every available region protection is required): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), EAPO (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), EPO (AT, BE, BG,

CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

This international publication:

— Includes international search report.

(57) Abstract:

A method for acquiring block boundary filtering strength, comprising determining a similarity threshold and calculating region flatness by using the similarity threshold; determining the initial value of block boundary filtering strength according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength; adjusting the initial value of filtering strength to acquire the block boundary filtering strength by using pre-acquired header information of blocks on both sides of the block boundary; or determining whether filtering of pixels of the blocks on both sides of the block boundary is required by using header information of the blocks, such as type information or coded block pattern information. The examples of the present disclosure further disclose a device for acquiring block boundary filtering strength, and the examples of the present disclosure separately disclose a method and a device for reducing block distortion. The application of the present disclosure is capable of improving accuracy in the acquisition of block boundary filtering strength.

**METHOD AND DEVICE FOR ACQUIRING BLOCK BOUNDARY STRENGTH AND
REDUCING BLOCK DISTORTION**

5 The present application requests priority for the Chinese patent application submitted to the China National Intellectual Property Administration on September 13, 2007, with application no. 200710149478.0, titled "METHOD AND DEVICE FOR ACQUIRING BLOCK BOUNDARY STRENGTH AND REDUCING BLOCK DISTORTION," the entire contents of which are incorporated herein by reference.

10 **Technical Field**

 The present disclosure relates to the field of image processing, and particularly to a method and device for acquiring block boundary strength and reducing block distortion.

15 **Background technologies**

 In video coding standards such as H.264 and digital audio and video codec technical standards, block processing is required for all images, for example, the basic processing unit of the H.264 standard is a 16×16 macroblock. After transformation and quantization of each block, block distortion of varying degrees appears, that is, a discontinuous visual mutation appears on the block boundary between blocks. Block distortion is caused by quantization error from block processing during quantization. According to the different content of the image within the block range, it appears in two different forms, the first as trapezoidal noise and the other as lattice noise. These two noises make the edges of the image so clear that a block-shaped region appears. Specifically, trapezoidal noise appears at the strong edge of the image. For example, when performing discrete cosine transform of the image to acquire the transform coefficient of each frequency point, many high frequency coefficients are quantized to zero. Hence, the strong edge of the image cannot be fully digitized within the transform domain, and because of the block processing of the image, the continuity at the strong edge crossing the block boundary cannot be guaranteed. Hence, there is jagged noise at the strong edge of the image, causing visually unnatural data block edges called trapezoidal noise. Lattice noise appears in the flat region of the image. In the flat region of the image, where luma increases or decreases, the direct current (DC) coefficient of the transform domain may cross the adjacent quantization level detection threshold due to rounding during quantization rounding, resulting in sudden changes in luma in two adjacent blocks in the reconstructed image, visually appearing as sheet-like contours called lattice noise.

 In order to avoid or reduce block distortion, after the quantization and encoding of the image is completed, before it is stored as the reference frame of the next frame, it is necessary to reduce the block distortion of the image. A specific method for reducing block distortion is introduced in detail below, using an 8×8 block boundary as an example, specifically illustrating the specific steps of the method for reducing block distortion:

Step 1: Using the interpolation of the actual pixels on both sides of the present block boundary, calculate the flatness of the image region where the present block boundary is located, expressing the flatness of the region with the number of similarity pairs around the block boundary. If there are many similarity pairs, the flatness of the image region where the present block boundary is located is considered to be relatively great. Refer to Figure 1 for the definition of similarities in this regard. Figure 1 is a schematic diagram of an example of a similarity discrimination sample in the prior art. The thick solid line refers to the main block boundary of two blocks, and the dashed line refers to the sub-block boundary that is within the two blocks, respectively. For the pixel sets R_x and L_x ($0 \leq x \leq 7$) on both sides of the main block boundary, R_x and L_x are considered a pair of similarities if the absolute value of their difference is less than threshold 1 (Th_1). For pixel sets L_x and M_x ($0 \leq x \leq 7$) and N_x and R_x ($0 \leq x \leq 7$) on both sides of the sub-block boundary, L_x and M_x or N_x and R_x are considered a pair of similarities if the absolute value of their difference is less than threshold 2 (Th_2).

The process of calculating the flatness of the image region is specifically illustrated below using an 8×8 block boundary as an example:

first, set the initial value for the region flatness to 0;

then, when the absolute value of the difference of 8 pairs of pixels on both sides of the main block boundary is less than the flatness threshold Th_1 , i.e., $Abs(Rx-Lx) < Th_1$, add 1 to the region flatness, or when the absolute value of the difference of 16 pairs of pixels on both sides of the sub-block boundary is less than the flatness threshold Th_2 , i.e., $Abs(Lx-Mx) < Th_2$ or $Abs(Nx-Rx) < Th_2$, add 1 to the region flatness to sum up to the region flatness. Here, $Abs(y)$ is the absolute value of y , which may be expressed as formula (1)

$$Abs(x) = \begin{cases} x & ; \quad x \geq 0 \\ -x & ; \quad x < 0 \end{cases} \quad (1)$$

The two flatness thresholds Th_1 and Th_2 may be obtained by table lookup, and the average QP_{av} may be first calculated based on the quantization parameters (QPs) of the two blocks. The QP here is the quantization step size used in the quantization process, and then QP_{av} is used to determine the table lookup index $IndexA$. The flatness thresholds Th_1 and Th_2 are finally obtained through table lookup. The values of Th_1 and Th_2 are obtained from Table 1 according to the correspondence relationship between $IndexA$ and thresholds Th_1 and Th_2 . Table 1 shows the relationship between the flatness thresholds Th_1 and Th_2 , and $IndexA$:

$IndexA$	Th_1	Th_2
----------	--------	--------

-3-

0	0	0
1	0	0
2	0	1
3	1	1
4	1	2
5	2	2
6	2	2
7	2	2
8	2	2
9	2	2
10	2	2
11	2	3
12	2	3

Table 1

The QP of each block is the data known when the block is quantized, and QP_{av} may be expressed as formula (2) with the following pseudocode:

$$QP_{av} = (QP_p + QP_q + 1) \gg 1 \quad (2)$$

5 wherein $\gg 1$ indicates shifting one place to the right, in the binary computer system, this means division by 2. Similarly, $\gg 2$ indicates shifting two places to the right and means division by 4, $\gg 3$ indicates shifting three places to the right, and means division by 8, and so on.

Index $IndexA$ is one-fifth of QP_{av} , i.e. $IndexA = QP_{av} / 5$. Flatness thresholds Th_1 and Th_2 may be determined from Table 1.

Step 2: Determine the filtering strength of the present block boundary based on the specific flatness. The specific method is as follows: determine the value of the block boundary filtering strength (BS) based on the macroblock type and region flatness, and the steps thereof are as follows:

first, obtain BS based on the determined region flatness, specifically as follows:

BS is equal to 0 when RegionFlatness is less than 4;

when RegionFlatness is greater than 4, determine whether the horizontal pixel scale (horizontal_size) is greater than 500:

BS is equal to 1 if horizontal_size is greater than 500 and RegionFlatness is less than 12, otherwise BS is equal to 2;

BS is equal to 1 if horizontal_size is less than 500 and RegionFlatness is less than 16; otherwise, BS is equal to 2.

Next, adjust the BS according to the macroblock type, specifically as follows:

determine whether one or both of the two 8×8 blocks on both sides of the block boundary belong to the intraframe prediction macroblock. If so, add 1 to BS, otherwise, do not change BS. The macroblock type here may be acquired from the header information of each macroblock, and may be divided into various types such as intraframe prediction macroblock, interframe prediction macroblock, and the like.

Step 3: After the BS value is determined, filter the pixels on both sides of the block boundary according to the flatness of different non-zero BS values.

Three levels of BS values may be obtained from Step 2, while this step determines three different filtering processes based on the BS values of different levels, so as to filter each row or column in the block accordingly. Below, the filtering process of p_0, p_1, p_2, q_0, q_1 and q_2 in Figure 2 is illustrated with a schematic diagram of the distribution of pixels of a row/column on both sides of the block boundary shown in Figure 2, and the filtered values of P_0 and Q_0 are expressed by P_0 and Q_0 , respectively. If $P_1(Q_1)$ is not assigned a value during filtering, $p_1(q_1)$ is not filtered; otherwise, P_1 or Q_1 is the filtered value of p_1 or q_1 . P_2 or Q_2 is the filtered value of p_2 or q_2 . The three different filtering processes determined by the BS values are as follows:

Process 1: filter the samples on both sides of the luma block boundary when $BS = 3$, and the filtering processes of p_0, p_1, p_2, q_0, q_1 and q_2 in Figure 2 may be expressed by pseudocode as follows:

-5-

$$P0 = ap ? (2 \times p1 + p2 + 2 \times (p0 + q0) + q1 + 4) \gg 3 : (2 \times p0 + p1 + q0 + 2) \gg 2;$$

$$P1 = ap ? (p0 + 2 \times p1 + q0 + 2) \gg 2 : p1;$$

$$P2 = ap ? (p0 + p1 + 4 \times p2 + 2 \times p3 + 4) \gg 3 : p2;$$

$$Q0 = aq ? (2 \times q1 + q2 + 2 \times (q0 + p0) + p1 + 4) \gg 3 : (2 \times q0 + q1 + p0 + 2) \gg 2;$$

$$Q1 = aq ? (q0 + 2 \times q1 + p0 + 2) \gg 2 : q1;$$

$$Q2 = (q0 + q1 + 4 \times q2 + 2 \times q3 + 4) \gg 3 : q2;$$

in the above filtering processes of $p0$, $p1$, $p2$, $q0$, $q1$ and $q2$, two sets of filters are used respectively.

For example, when filtering $p0$ and ap is greater than 0, a set of strong filters is used, i.e. $(2 \times p1 + p2 + 2 \times (p0 + q0) + q1 + 4) \gg 3$, and when ap is less than or equal to 0, a set of weak filters is used, i.e. $(2 \times p0 + p1 + q0 + 2) \gg 2$.

Moreover, during the above filtering processes of $p0$, $p1$, $p2$, $q0$, $q1$ and $q2$, ap may be obtained by the following formula (3), and aq may be obtained by the following formula (4):

$$ap = \text{Abs}(p2 - p0) < \beta \&\& \text{Abs}(p0 - q0) < ((\alpha \gg 2) + 2) \quad (3)$$

$$aq = \text{Abs}(q2 - q0) < \beta \&\& \text{Abs}(p0 - q0) < ((\alpha \gg 2) + 2) \quad (4)$$

The symbols “&&” in formula (3) and formula (4) indicate the “and” operation, while α and β in formula (3) and formula (4) are block boundary thresholds, and may be calculated according to the average QP, QP_{av} , of the two blocks, as well as AlphaCOffset and BetaOffset calculation table lookup indices IndexA and IndexB. The average QP, QP_{av} , of the two blocks is as follows: $QP_{av} = (QP_p + QP_q + 1) \gg 1$, while indices IndexA and IndexB are as follows:

$$\text{IndexA} = \text{Clip3}(0, 63, QP_{av} + \text{AlphaCOffset})$$

$$\text{IndexB} = \text{Clip3}(0, 63, QP_{av} + \text{BetaOffset})$$

According to the correspondence relationship between the indices IndexA and IndexB and the block boundary threshold a and the block boundary threshold P , the values of α and β are obtained from Table 2, α is obtained from the IndexA table lookup, and β is obtained from the IndexB table lookup.

Index	α	β	Index	α	β	Index	α	β	Index	α	β
-------	----------	---------	-------	----------	---------	-------	----------	---------	-------	----------	---------

-6-

0	0	0	16	4	2	32	22	6	48	46	15
1	0	0	17	4	2	33	24	7	49	48	16
2	0	0	18	5	3	34	26	7	50	50	17
3	0	0	19	5	3	35	28	7	51	52	18
4	0	0	20	6	3	36	30	8	52	53	19
5	0	0	21	7	3	37	33	8	53	54	20
6	1	1	22	8	4	38	33	8	54	55	21
7	1	1	23	9	4	39	35	9	55	56	22
8	1	1	24	10	4	40	35	9	56	57	23
9	1	1	25	11	4	41	36	10	57	58	23
10	1	1	26	12	5	42	37	10	58	59	24
11	2	1	27	13	5	43	37	11	59	60	24
12	2	1	28	15	5	44	39	11	60	61	25
13	2	2	29	16	5	45	39	12	61	62	25
14	3	2	30	18	6	46	42	13	62	63	26
15	3	2	31	20	6	47	44	14	63	64	27

Table 2

In process 1, the same method is used to filter samples p_0 and q_0 on both sides of the chroma block boundary. The meaning of “ $d = a ? b : c$ ” in the pseudocode is as follows: when a is greater than 0, $d = b$; otherwise $d = c$. The specific implementation procedures corresponding to the above pseudocodes are as follows:

```

5  if ( ap > 0 )
    {

```

```

        P0 = (2 × p1 + p2 + 2 × (p0 + q0) + q1 + 4) >> 3

```

```

        P1 = (p0 + 2 × p1 + q0 + 2) >> 2

```

```

10       P2 = (p0 + p1 + 4 × p2 + 2 × p3 + 4) >> 3

```

-7-

```

    }
    else
    {
5      P0 = (2 × p0 + p1 + q0 + 2 )>> 2
      P1 = p1
      P2 = p2
    }
    if ( aq > 0 )
    {
10     Q0 = (2 × q1 + q2 + 2 × (q0 + p0) + p1 + 4)>> 3
        Q1 = (q0 + 2 × q1 + p0 + 2)>>2
        Q2 = (q0 + q1 + 4 × q2 + 2 × q3 + 4)>> 3
    }
    else
15    {
        Q0 = (2 × q0 + q1 + p0 + 2 )>> 2
        Q1 = q1
        Q2 = q2
    }
20    Process 2: filter the samples on both sides of the luma block boundary when BS = 2, and only filter
the p0, p1, q0 and q1 in Figure 2, and expressed by pseudocode as follows:
    P0 = ap ? (2 × p1 + p2 + 2 × (p0 + q0) + q1 + 4)>>3:(2 × p0 + p1 + q0 + 2 )>>2;
    P1 = ap ? (p0 + 2 × p1 + q0 + 2) >>2 : p1;
    Q0 = aq ? (2 × q1 + q2 + 2 × (q0 + p0) + p1 + 4) >> 3 : (2 × q0 + q1 + p0 +2)>> 2;
25    Q2 = aq ? (q0 + 2 × q1 + p0 + 2) >> 2 : q1;

```

-8-

when filtering p_0 , p_1 , q_0 , and q_1 , a_p is obtained from formula (3) and a_q is obtained from formula (4). Moreover, a and P in formula (3) and formula (4) are the same as those in process 1.

Process 3: filter the samples on both sides of the luma block boundary when $BS = 1$, specifically as follows:

5 first, filter p_0 and q_0 (P_0 and Q_0 are respectively filtered values of p_0 and q_0), which may be expressed as follows:

$$\text{delta} = \text{Clip3}(-C, C, (((q_0 - p_0) \times 3 + (p_1 - q_1) + 4) \gg 3))$$

$$P_0 = \text{Clip1}(p_0 + \text{delta})$$

$$Q_0 = \text{Clip1}(q_0 - \text{delta}),$$

10 wherein $\text{Clip3}(a, b, c)$ is expressed as follows:

$$\text{Clip3}(a, b, c) = \begin{cases} a & ; \quad c < a \\ b & ; \quad c > b \\ c & ; \quad \text{Other} \end{cases}$$

$\text{Clip1}(a)$ is expressed as: $\text{Clip1}(x) = \text{Clip3}(0, 255, x)$

then, determine whether there is a need to filter p_1 and q_1 , and when there is a need to filter p_1 and q_1 , the calculation of P_0 and Q_0 may be divided into three cases:

first case: when the block boundary is a chroma block boundary, do not filter p_1 and q_1 .

15 second case: when a_p is greater than 0 at the luma block boundary, filter p_1 , and the filtered value is as follows:

$$P_1 = \text{Clip1}(p_1 + \text{Clip3}(-C, C, ((P_0 - p_1) \times 3 + (p_2 - Q_0) + 4) \gg 3))$$

third case: when a_q is greater than 0 at the luma block boundary, filter q_1 , and the filtered value is as follows:

$$20 \quad Q_1 = \text{Clip1}(q_1 - \text{Clip3}(-C, C, ((q_1 - Q_0) \times 3 + (P_0 - q_2) + 4) \gg 3))$$

During the filtering process of process 3, the definition of a_p and a_q is the same as that of process 1 and process 2, and a_p is obtained from formula (3) and a_q is obtained from formula (4). Moreover, a and P in formula (3) and formula (4) are also the same as in processes 1 and 2. C is called the filtering and clipping parameter, and the relationship between C and IndexA is as shown in Table 3. Table 3 shows the relationship between the filtering and clipping parameter C and IndexA :

25

Index	C	Index	C	Index	C	Index	C
0	0	16	1	32	2	48	5
1	0	17	1	33	2	49	5
2	0	18	1	34	2	50	5
3	0	19	1	35	2	51	6
4	0	20	1	36	2	52	6
5	0	21	1	37	2	53	6
6	0	22	1	38	3	54	7
7	0	23	1	39	3	55	7
8	0	24	1	40	3	56	7
9	0	25	1	41	3	57	7
10	0	26	1	42	3	58	8
11	0	27	1	43	3	59	8
12	0	28	1	44	3	60	8
13	0	29	1	45	4	61	9
14	0	30	2	46	4	62	9

-10-

15	0	31	2	47	4	63	9
----	---	----	---	----	---	----	---

Table 3

In the course of implementing the present disclosure, the inventors discovered during research that in the above existing method of reducing block distortion, when BS is acquired in order to determine the filtering process, similarity thresholds may only be obtained after two table lookups. Since the relationship and header information between the blocks on both sides of the block boundary are not fully used, the BS obtained is determined to be inaccurate, so the existing method of reducing block distortion does not use an effective filtering process to reduce block distortion. Hence, the performance of reducing block distortion is poor.

In summary, the BS obtained from the existing method of acquiring block boundary filtering strength is inaccurate, which in turn makes the existing method of reducing block distortion unable to effectively reduce block distortion.

Summary of the Invention

The examples of the present disclosure provide a method for acquiring block boundary filtering strength that is capable of improving the accuracy of the acquired block boundary filtering strength.

The examples of the present disclosure provide a method for acquiring block boundary filtering strength that is capable of improving the accuracy of the acquired block boundary filtering strength.

The examples of the present disclosure provide a method for reducing block distortion that is capable of improving the accuracy of the acquired block boundary filtering strength, thereby effectively reducing block distortion.

The examples of the present disclosure further provide a device for acquiring block boundary filtering strength that is capable of increasing the accuracy of the acquired block boundary filtering strength.

The examples of the present disclosure further provide a device for reducing block distortion that is capable of improving the accuracy of the acquired block boundary filtering strength, thereby effectively reducing block distortion.

In order to achieve the above objectives, the technical solution of the examples of the present disclosure is implemented as follows:

A method for acquiring block boundary filtering strength, comprising determining a similarity threshold, calculating region flatness of the block boundary in the present windows with the similarity threshold; determining the initial value of block boundary filtering strength in each window according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength; adjusting the initial value of block boundary filtering strength to acquire the block boundary filtering strength by using pre-acquired header information of blocks on both sides of the block boundary;

A method for acquiring block boundary filtering strength, comprising determining whether filtering of pixels of the blocks on both sides of the block boundary is required according to the header information of the blocks on both sides of the block boundary, if no, determining a similarity threshold and calculating region flatness by using the similarity threshold, wherein the header information of the blocks on both sides of the block boundary comprises type information or coded block pattern information; determining the initial value of block boundary filtering strength in each window according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength; adjusting the initial value of filtering strength to acquire the block boundary filtering strength by using pre-acquired header information of the blocks on both sides of the block boundary.

A method for reducing block distortion, comprising determining a similarity threshold and calculating region flatness by using the similarity threshold; acquiring block boundary filtering strength with the region flatness and using the first-order difference and second-order difference between various adjacent pixels in the blocks on both sides of the block boundary to determine whether the block boundary is a pseudo-boundary and once the block boundary is determined to be a pseudo-boundary, determining a corresponding filter combination based on the correspondence relationship pre-established between the block boundary filtering strength and the filter combination and the acquired block boundary filtering strength to filter the pixels of the blocks on both sides of the block boundary accordingly.

A device for acquiring block boundary filtering strength, comprising
a flatness calculation module, used to determine a similarity threshold and calculate region flatness of the block boundary in the present windows by using the similarity threshold;
an initial value determination module, used to determine the initial value of filtering strength of the block boundary in each window based on the region flatness calculated by the flatness calculation module, with each region flatness interval corresponding to an initial value of filtering strength;
an adjustment module, used to adjust the initial value of block boundary filtering strength determined by the initial value determination module to obtain the block boundary filtering strength by using the pre-acquired header information of the blocks on both sides of the block boundary.

A device for reducing block distortion, comprising
a block boundary filtering strength acquisition module, used to determine a similarity threshold and calculate region flatness by using the similarity threshold, and acquire block boundary filtering strength with the region flatness;
a boundary determination module, used to determine whether the block boundary is a pseudo-boundary;
a filter determination module, used to determine the corresponding filter combination based on the pre-established correspondence relationship between block boundary filtering strength and filter combination according to the block boundary filtering strength acquired by the block boundary filtering strength acquisition module when the determination results of the boundary determination module indicate that the block boundary is a pseudo-boundary;

a filter module, used to filter the pixels of the blocks on both sides of the block boundary accordingly by using the filter combination determined by the filter determination module.

It can be seen from the above technical solution that the method and device for acquiring block boundary filtering strength and reducing block distortion provided by the examples of the present disclosure determine a similarity threshold based on block boundary thresholds pre-obtained from table lookup, or determine a similarity threshold based on quantization parameters, macroblock modes, color spaces or frame types, and adjust the initial value of block boundary filtering strength by using header information of the block. Hence, they are capable of being unrestricted to the coding block unit and make full use of the relationship between the blocks on both sides and the header information, thereby improving the accuracy of the acquired block boundary filtering strength, thereby effectively reducing block distortion.

Description of Accompanying Drawings

Figure 1 is a schematic diagram of an example of a similarity discrimination sample in the prior art;

Figure 2 is a schematic diagram of the distribution of pixels of a row/column on both sides of a block boundary;

Figure 3 is a schematic diagram of a method for acquiring block boundary filtering strength according to an example of the present disclosure;

Figure 4 is a schematic diagram of an example of a sample with window size N of 4 according to an example of the present disclosure;

Figure 5 is a schematic diagram of an example of a sample with window size N of 2 according to an example of the present disclosure;

Figure 6 is a schematic diagram of the processes of a method for implementing the reduction of block distortion by using the block boundary filtering strength acquired according to another example of the present disclosure;

Figure 7 is a schematic diagram of the distribution of pixels of a row on both sides of a block boundary according to another example of the present disclosure;

Figure 8 is a schematic diagram of the structure of a device for acquiring block boundary filtering strength according to yet another example of the present disclosure;

Figure 9 is a schematic diagram of the structure of a device for reducing block distortion according to yet another example of the present disclosure;

Specific Embodiments

In order to make the purpose, technical solution and advantages of the present disclosure clearer and easier to understand, the disclosure will be illustrated in further detail below with reference to the accompanying drawings and examples.

The examples of the present disclosure provide a method for acquiring block boundary filtering strength by using pixels and header information, specifically as follows: determining a similarity threshold and calculating region flatness by using the similarity threshold; determining the initial value of block boundary filtering strength according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength; adjusting the initial value of filtering strength to acquire the block boundary filtering strength by using pre-acquired header information of blocks on both sides of the block boundary;

or, first determining whether filtering of pixels of the blocks on both sides of the block boundary is required according to the header information of the blocks on both sides of the block boundary, wherein header information of the blocks comprise type information or coded block pattern information, if so, ending the process; otherwise, determining a similarity threshold and calculating region flatness by using the similarity threshold; determining the initial value of block boundary filtering strength in each window according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength; using the header information of the blocks on both sides of the pre-acquired block boundary.

The examples of the present disclosure further provide a method for reducing block distortion, specifically as follows: determining a similarity threshold and calculating region flatness by using the similarity threshold; acquiring block boundary filtering strength with the region flatness and using the first-order difference and second-order difference between various adjacent pixels in the blocks on both sides of the block boundary to determine whether the block boundary is a pseudo-boundary and once the block boundary is determined to be a pseudo-boundary, determining a corresponding filter combination based on the correspondence relationship pre-established between the block boundary filtering strength and the filter combination and the acquired block boundary filtering strength to filter the pixels of the blocks on both sides of the block boundary accordingly.

Figure 3 is a schematic diagram of a method for acquiring block boundary filtering strength according to an example of the present disclosure. As shown in Figure 3, the method specifically comprises the following steps:

Steps 301 – 302 are processes for calculating the region flatness of the block boundary in the present windows.

Step 301: Divide the present block boundary into a few windows.

In the present example, the method of dividing the block boundary into windows is as follows: preset the window size and divide the blocks on both sides of the block boundary into more than one window according to the window size in the direction of the vertical block boundary. The window size is N, where N is adjustable. In the present example, assuming for an 8x8 transform block, the window size thereof is $N = 4$; as shown in Figure 4, Figure 4 is a schematic diagram of an example of a sample with window size N of 4 according to an example of the present disclosure. Of course, N may be $= 2$, as shown in Figure 5 or other values. Of course, the following steps may be performed using the block as a unit without dividing the block boundary into windows.

Step 302: Calculate the region flatness of the block boundary in the present windows.

In the present example, the process of calculating the region flatness comprises calculating the pixel flatness of the blocks on both sides of the block boundary in the present windows; summing up the pixel flatness of the blocks on both sides to obtain the region flatness in the windows. That is, the region flatness of the block boundary in the present windows is obtained by summing up the pixel flatness on both sides of the block boundary in the present windows. The region flatness of the block boundary in the present windows is determined by the number of similarities in the sub-block boundary in the present windows, and is calculated according to the following formula (5):

$$num = \sum_{n=0}^N ((abs(L_n - H_n) < T) ? 1 : 0) + \sum_{n=0}^N ((abs(R_n - K_n) < T) ? 1 : 0) \quad (5)$$

wherein the pixel flatness is obtained by comparing the first-order difference and threshold, where the similarity threshold T is adjustable, and for the present example $T = (\beta + 2) / 3$. See Table 1 for the β value. The index value IndexB is calculated according to the following formula (6):

$$IndexB = \sum_{m=1}^M QP_m / M + Offset_{\beta} \quad (6)$$

wherein, QP_m is the QP value of the blocks m on both sides of the block boundary in the present windows, and the Offset_β value is a preset offset value that is capable of adjusting the filtering strength, and the Offset_β value may be acquired from the transmitted video stream.

Steps 303 – 304 are processes for acquiring BS according to flatness and header information. BS may be divided into multiple levels. In the present example, BS is divided into four levels, that is, the BS value may be 0, 1, 2 or 3.

Step 303: Calculate the initial value of filtering strength of the present block boundary.

In the present example, the method for calculating the initial value of filtering strength bs of the present block boundary is specifically as follows:

if num < C0, bs = 0;

if num >= C0 and num < C1, bs = 1;

if num >= C1, bs = 2;

The C0 and C1 in the formula are the preset flatness thresholds according to the statistical rules. In the present example, C0 is set to 2 and C1 is set to 7.

Step 304: Adjust the block boundary strength according to the header information to acquire the block boundary filtering strength.

In the present example, if the information in the header information indicates that two adjacent blocks are in skip mode, the present block is not filtered; if the information in the header information indicates that one block is an intra-frame block, add 1 to the initial value of the present block boundary filtering strength bs; if the information in the header information indicates that the difference in the motion vector of the blocks on both sides of the block boundary is greater than the preset threshold T_{mv}, in the present example, take 3 whole pixels as T_{mv}, and add 1 to the present bs, or if the information in the header information indicates that the regions on both sides of the block boundary are from different reference frames, add 1 to the bs; if the coded block pattern of the blocks on both sides of the block boundary is also 0, BS is 0.

In the present example, the method for acquiring BS only obtains the initial value of the present block boundary filtering strength bs based on the number of similarities num of the blocks on both sides of the block boundary in the windows, so it is only necessary to determine the similarity threshold T of flatness in one window and num may be obtained without performing the method of table lookup 1 in the prior art. Therefore, the method of obtaining BS in the present example is more convenient and flexible.

Figure 6 is a schematic diagram of the processes of a method for implementing the reduction of block distortion by using the block boundary filtering strength acquired according to another example of the present disclosure. As shown in Figure 6, the method specifically comprises the following steps:

Steps 601 – 604 are similar to steps 301 – 304, except that in step 602, the similarity threshold T of the flatness in the windows is determined by the header information, where T is defined as $= (x\alpha + y\beta) / z$. Here, x , y and z will be adapted according to the quantization parameters, macroblock mode, i.e. intraframe macroblock (Intra) and inter macroblock (Inter), color space, i.e. luma and chroma and frame type, i.e. intraframe prediction frame (I), bidirectional prediction frame (B) and unidirectional prediction frame (P). For example,

$$T = \begin{cases} \frac{\beta}{3} & 0 \leq QP < 20 \\ \frac{\beta+1}{3} & 20 \leq QP < 40 \\ \frac{\beta+2}{3} & 40 \leq QP < 64 \end{cases}$$

$$T = \begin{cases} \frac{\beta+2}{4} & \text{Inter} \\ \frac{\alpha+3}{6} & \text{Intra} \end{cases}$$

$$T = \begin{cases} \frac{\alpha+\beta+4}{8} & \text{Luma} \\ \frac{\alpha+\beta+1}{8} & \text{Chroma} \end{cases}$$

Step 605: determine whether the block boundary is a true block boundary, if so, filtering is not required and end the process; otherwise, perform step 606.

In the present example, the method for determining whether the block boundary is a true block boundary is as follows: determining whether the difference between each adjacent pixel in the blocks on both sides of the block boundary is greater than a set boundary threshold, if so, it is the true edge of the image and filtering is not required; if no, it is a pseudo-edge and needs to be filtered.

In the present example, assuming that the block boundary is a vertical block boundary, the distribution of one row image pixels on both sides of the block boundary is as shown in Figure 7. Of course, it may be a block boundary or a horizontal block boundary and it is necessary to determine whether the block boundary is a true block boundary based on one column of image pixels on both sides of the block boundary to obtain the difference between the pair of pixels R0 and L0 on both sides of the block boundary given in Figure 7, and two pairs of pixels L0 and L1, R0 and R1 within the sub-block. Subtract L0 and R0 from each other to obtain a difference M1; subtract R1 from R0 to obtain a difference M2; subtract L1 from L0 to obtain a difference M3; add M1 to M2 to obtain M4; add M1 to M3 to obtain M5.

In the final discrimination formula, if M1 is smaller than α and greater than 1, M2 is smaller than β and M3 is smaller than β , and either of M4 and M5 is greater than 0, the feature edge of the image is considered to not be at the edge of the block, that is, BS is not equal to 0, and filtering may be performed; otherwise, filtering is not performed. That is,

$$Bs \neq 0 \ \&\& \ Abs(R0 - L0) < \alpha \ \&\& \ Abs(R0 - L0) > 1 \ \&\& \ Abs(R0 - R1) < \beta \ \&\& \ Abs(L0 - L1) < \beta \ \&\& \ Abs(2R0 - R1 - L0) > 0 \ \parallel \ Abs(2L0 - L1 - R0) > 0$$

where the symbol " $\neq$ " indicates that not equal to, and the symbol " $\parallel$ " indicates the "or" operation.

Step 606: Determine the corresponding filtering process for the pseudo-block boundary based on the different levels of non-zero BS.

In the present example, BS is divided into four levels, wherein when BS = 0, filtering is not performed, and in the distribution of image pixels of a row/column on both sides of the block boundary as shown in Figure 7, the three filtering processes are specifically as follows:

Process 1: when BS = 1, use the mean filtering method for filtering:

$$R0 = aq ? (2 * R1 + R0 + L0 + 2) >> 2 : (R1 + 2 * R0 + L0 + 2) >> 2;$$

$$L0 = ap ? (2 * L1 + L0 + R0 + 2) >> 2 : (L1 + 2 * L0 + R0 + 2) >> 2;$$

Process 2: when BS = 2, use the mean filtering method for filtering;

$$R0 = aq ? (R2 + 2 * R1 + 2 * R0 + 2 * L0 + L1 + 4) >> 3 : (R2 + 2 * R1 + 3 * R0 + 2 * L0 + 4) >> 3;$$

$$L0 = ap ? (L2 + 2 * L1 + 2 * L0 + 2 * R0 + R1 + 4) >> 3 : (L2 + 2 * L1 + 3 * L0 + 2 * R0 + 4) >> 3;$$

-17-

$R1 = aq ? (2 * R2 + 4 * R1 + R0 + L0 + 4) >> 3 : R1;$

$L1 = ap ? (2 * L2 + 4 * L1 + L0 + R0 + 4) >> 3 : L1;$

Process 3: when $BS = 3$, use the mean filtering method for filtering;

$R0 = (3 * R2 + 3 * R1 + 4 * R0 + 3 * L0 + 3 * L1 + 8) >> 4;$

5 $L0 = (3 * L2 + 3 * L1 + 4 * L0 + 3 * R0 + 3 * R1 + 8) >> 4;$

$R1 = aq ? (3 * R2 + 4 * R1 + 4 * R0 + 3 * L0 + 2 * L1 + 8) >> 4 : (2 * R2 + 4 * R1 + R0 + L0 + 4) >> 3;$

$L1 = ap ? (3 * L2 + 4 * L1 + 4 * L0 + 3 * R0 + 2 * R1 + 8) >> 4 : (2 * L2 + 4 * L1 + L0 + R0 + 4) >> 3;$

$R2 = aq ? (2 * R3 + 3 * R2 + R1 + R0 + L0 + 4) >> 3 : R2;$

$L2 = ap ? (2 * L3 + 3 * L2 + L1 + L0 + R0 + 4) >> 3 : L2;$

10 wherein ap and aq in processes 2, 3, and 4 are as follows:

$ap = \text{Abs}(R_2 - R_0) < \beta \ \& \ \& \ \text{Abs}(R_0 - L_0) < ((\alpha >> 2) + 2)$

$aq = \text{Abs}(L_2 - L_0) < \beta \ \& \ \& \ \text{Abs}(R_0 - L_0) < ((\alpha >> 2) + 2).$

For chroma blocks, the same filtering method is only used for R_0 and L_0 pixels on both sides of the block boundary, and not for $R2$, $R1$, $L1$ and $L2$.

15 In the present example, the filtering process of a vertical block boundary is used as an example for illustration. For a horizontal block boundary, the filter window thereof is in a vertical state, but the filtering process on the horizontal block boundary is also the same, so it will not be described in detail.

In step 604 of the present example, the value of BS may also be adjusted according to skip mode or cbp, for example, when both the adjacent blocks are in skip mode or all cbp are 0, subtract 1 from BS .

20 In addition, before step 601, the header information of the block may be used to determine whether filtering is required. For example, determine whether filtering is required according to skip mode or cbp and when the adjacent blocks on both sides of the block boundary are in skip mode or all cbp are 0, determine filtering to not be required, and end the process.

The weight of each row of pixels during filtering may also be different in the present example. For example, determine the weight of each row of pixels of the block boundary according to the macroblock type, and use filters of different strengths for filtering based on the weight of each row of pixels. Stronger filtering may be used on the block boundary row of the block, and a weighted strategy with weaker filtering may be used to filter the middle of the block, especially in the case of Intra blocks. For example, the strongest combination of filters for the present BS value may be used for filtering when the image pixel row to be filtered is the block boundary row of the present block, for example, rows 0, 7, 8, or 15 of the macroblock.

The filter in the present example may be shared. In the specific process, a weak filter with a larger BS may be used as a strong filter with a smaller BS, or a strong filter with a smaller BS may be used as a weak filter with a larger BS, so that there are more filter options with different strengths for the same BS, increasing the accuracy of the filter without increasing the complexity of the operation. For example, a weak filter for a BS of 3 is considered a strong filter for a BS of 2, and a weak filter for a BS of 2 is considered a strong filter for a BS of 1. The block boundary in the present windows may then be divided into BS values of different levels according to the flatness value, and different combinations of filters of each level may also be selected. However, the overall principle is to use the mean filtering method and to use stronger filters the higher the BS level.

The present example uses the acquired BS to filter row/columns of pixels that are considered pseudo-boundaries in the windows to effectively reduce block distortion caused by transform quantization and motion compensation.

Figure 8 is a schematic diagram of the structure of a device for acquiring block boundary filtering strength according to yet another example of the present disclosure, the device comprising a flatness calculation module 810, an initial value determination module 820, and an adjustment module 830.

Specifically, the flatness calculation module 810 determines a similarity threshold and calculates region flatness by using the similarity threshold.

The initial value determination module 820 determines the initial value of block boundary filtering strength in each window according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength.

The adjustment module 830 adjusts the initial value of filtering strength to acquire the block boundary filtering strength by using pre-acquired header information of the blocks on both sides of the block boundary.

Figure 9 is a schematic diagram of the structure of a device for reducing block distortion according to yet another example of the present disclosure, the device comprising a block boundary filtering strength acquisition module 910, a boundary determination module 920, a filter determination module 930, and a filter module 940.

Specifically, the block boundary filtering strength acquisition module 910 is used to determine a similarity threshold and calculate region flatness by using the similarity threshold, and acquire block boundary filtering strength with the region flatness; the boundary determination module 920 is used to determine whether the block boundary is a pseudo-boundary and output the determination results to the filter determination module 930.

The filter determination module 930 determines the corresponding filter combination based on the pre-established correspondence relationship between block boundary filtering strength and filter combination according to the block boundary filtering strength acquired by the block boundary filtering strength acquisition module 910 when the determination results of the boundary determination module indicate that the block boundary is a pseudo-boundary.

The filter module 940 filters the pixels of the blocks on both sides of the block boundary in the windows by using the filter combination determined by the filter determination module 930.

Those skilled in the art will appreciate that all or part of the steps of the method according to the above examples may be completed through a program instructing the relevant hardware, and the program may be stored in a type of computer-readable storage medium. When the program is executed, it comprises one or a combination of the steps of the method according to the examples.

In addition, each functional unit in the various examples of the present disclosure may be integrated in a processing module, where each unit may exist physically alone, or two or more units may be integrated in a module. The above integrated modules may be implemented in the form of hardware or software functional modules. If the integrated module is implemented in the form of a software functional module and sold or used as a stand-alone product, it may be stored in a computer-readable storage medium.

The storage medium mentioned above may be a read-only memory, magnetic disk, optical disc, or the like.

The foregoing are merely preferred examples of the present disclosure and are not intended to limit the scope of protection of the present disclosure. Any modifications, equivalent substitutions, changes, and the like made within the spirit and principles of the present disclosure shall be included in the scope of protection of the present disclosure.

Claims

1. A method for acquiring block boundary filtering strength, characterized in that it comprises determining a similarity threshold and calculating region flatness of the block boundary in the present windows by using the similarity threshold;

determining the initial value of block boundary filtering strength in each window according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength.

adjusting the initial value of the block boundary filtering strength to acquire the block boundary filtering strength by using pre-acquired header information of the blocks on both sides of the block boundary.

2. The method according to Claim 1, characterized in that the process of calculating region flatness by using the similarity threshold comprises

respectively calculating the difference between pixels on both sides of the block boundary and adjacent pixels in the same block, the adjacent pixels being adjacent pixels in a direction perpendicular to the block boundary;

adding 1 to the flatness of the pixels on both sides of the block boundary when the absolute value of any of the differences is smaller than the preset similarity threshold;

summing up the pixel flatness to obtain the region flatness.

3. The method according to Claim 1, characterized in that the process of determining the similarity threshold comprises determining the similarity threshold based on block boundary thresholds pre-obtained from table lookup.

4. The method according to Claim 3, characterized in that the process of determining the similarity threshold based on block boundary thresholds pre-obtained from table lookup further comprises

presetting the weighting coefficient and increment of the block boundary thresholds, weighting the block boundary thresholds by using the weighting coefficient, then obtaining the sum thereof with the increment to determine the similarity threshold.

5. The method according to Claim 3, characterized in that the process of determining the similarity threshold based on block boundary thresholds pre-obtained from table lookup further comprises

determining the weighting coefficient for each of the block boundary thresholds based on quantization parameters, macroblock modes, color spaces or frame types, weighting each of the block boundary thresholds by using the weighting coefficient, and obtaining the sum of each of the weighted block boundary thresholds to determine the similarity threshold.

6. The method according to Claim 1, characterized in that the header information of the blocks on both sides of the block boundary comprises type information of the blocks on both sides of the block boundary;

the process of adjusting the initial value of the block boundary filtering strength further comprises when the blocks on both sides of the block boundary are in skip mode, subtracting any preset integer step size from the initial value of filtering strength and using the result as the adjusted block boundary filtering strength;

5 when any one of the blocks on both sides of the block boundary is an intra-frame block, adding any preset integer step size to the initial value of filtering strength and using the result as the adjusted block boundary filtering strength.

10 7. The method according to Claim 1, characterized in that the header information of the blocks on both sides of the block boundary comprises reference frame information of the blocks on both sides of the block boundary;

the process of adjusting the initial value of the block boundary filtering strength further comprises when the blocks on both sides of the block boundary come from different reference frames, adding any preset integer step size to the initial value of filtering strength and using the result as the adjusted block boundary filtering strength.

15 8. The method according to Claim 1, characterized in that the header information of the blocks on both sides of the block boundary comprises motion vector information of the blocks on both sides of the block boundary;

20 the process of adjusting the initial value of the block boundary filtering strength further comprises when the motion vector of the blocks on both sides of the block boundary is greater than the preset vector preset, adding any preset integer step size to the initial value of filtering strength and using the result as the adjusted block boundary filtering strength.

9. The method according to Claim 1, characterized in that the header information of the blocks on both sides of the block boundary comprises coded block pattern information of the blocks on both sides of the block boundary;

25 the process of adjusting the initial value of the block boundary filtering strength further comprises when the blocks on both sides of the block boundary have a coded block pattern of 0, subtracting any integer step size from the initial value of filtering strength and using the result as the adjusted block boundary filtering strength.

30 10. A method for acquiring block boundary filtering strength, characterized in that it comprises determining whether filtering of pixels of the blocks on both sides of the block boundary is required according to the header information of the blocks on both sides of the block boundary, if no, determining a similarity threshold and calculating region flatness by using the similarity threshold, wherein the header information of the blocks on both sides of the block boundary comprises type information or coded block pattern information;

35 determining the initial value of block boundary filtering strength in each window according to the region flatness interval where the region flatness is located, with each region flatness interval corresponding to an initial value of filtering strength.

40 adjusting the initial value of filtering strength to acquire the block boundary filtering strength by using the header information of the blocks on both sides of the block boundary.

11. The method according to Claim 10, characterized in that the header information of the blocks on both sides of the block boundary further comprises type information of the blocks on both sides of the block boundary;

the process of determining whether filtering of pixels of the blocks on both sides of the block boundary is required comprises

when the blocks on both sides of the block boundary are in skip mode, determining filtering to not be required; otherwise, filtering is required.

12. The method according to Claim 10, characterized in that the header information of the blocks on both sides of the block boundary further comprises coded block pattern information of the blocks on both sides of the block boundary;

the process of determining whether filtering of pixels of the blocks on both sides of the block boundary is required comprises

when the blocks on both sides of the block boundary have a coded block pattern of 0, determining filtering to not be required; otherwise, filtering is required.

13. A method for reducing block distortion, characterized in that it comprises determining a similarity threshold and calculating region flatness by using the similarity threshold; acquiring block boundary filtering strength with the region flatness and using the first-order difference and second-order difference between various adjacent pixels in the blocks on both sides of the block boundary to determine whether the block boundary is a pseudo-boundary;

once the block boundary is determined to be a pseudo-boundary, determining a corresponding filter combination based on the correspondence relationship pre-established between the block boundary filtering strength and the filter combination and the acquired block boundary filtering strength to filter the pixels of the blocks on both sides of the block boundary accordingly.

14. The method according to Claim 13, characterized in that the process of determining whether the block boundary is a pseudo-boundary comprises

calculating the first-order difference and second-order difference between various adjacent pixels in the blocks on both sides of the block boundary, and when each first-order difference and second-order difference are in the interval determined based on the preset boundary threshold, determining that the block boundary is a pseudo-boundary, otherwise, it is a true boundary.

15. The method according to Claim 13, characterized in that the filter combination comprises strong and weak filters;

the process of establishing the correspondence relationship between the block boundary filtering strength and filter combination comprises having different filters corresponding to different block boundary filtering strengths, where filters with smaller block boundary filtering strengths are used as corresponding strong filters and where filters with stronger block boundary filtering strengths are used as corresponding weak filters.

16. The method according to Claim 13, characterized in that the pixels on both sides of the block boundary are four pixels on the left and four pixels on the right of the block boundary, where the four pixels to the right of the block boundary are sequentially set as R0, R1, R2, and R3, the four pixels to the left of the block boundary are sequentially set as L0, L1, L2, and L3, and the filter combination is one or a combination of any plurality of mean filters:

$(2 \cdot R1 + R0 + L0 + 2) / 4$ 、 $(R1 + 2 \cdot R0 + L0 + 2) / 4$ 、 $(2 \cdot L1 + L0 + R0 + 2) / 4$ 、 $(L1 + 2 \cdot L0 + R0 + 2) / 4$ 、
 $(R2 + 2 \cdot R1 + 2 \cdot R0 + 2 \cdot L0 + L1 + 4) / 8$ 、 $(R2 + 2 \cdot R1 + 3 \cdot R0 + 2 \cdot L0 + 4) / 8$ 、 $(L2 + 2 \cdot L1 + 2 \cdot L0 + 2 \cdot R0 + R1 + 4) / 8$ 、
 $(L2 + 2 \cdot L1 + 3 \cdot L0 + 2 \cdot R0 + 4) / 8$ 、 $(2 \cdot R2 + 4 \cdot R1 + R0 + L0 + 4) / 8$ 、 $(2 \cdot L2 + 4 \cdot L1 + L0 + R0 + 4) / 8$ 、
 $(3 \cdot R2 + 3 \cdot R1 + 4 \cdot R0 + 3 \cdot L0 + 3 \cdot L1 + 8) / 16$ 、 $(3 \cdot L2 + 3 \cdot L1 + 4 \cdot L0 + 3 \cdot R0 + 3 \cdot R1 + 8) / 16$ 、 $(3 \cdot R2 + 4 \cdot R1 + 4 \cdot R0 + 3 \cdot L0 + 2 \cdot L1 + 8) / 16$ 、 $(2 \cdot R2 + 4 \cdot R1 + R0 + L0 + 4) / 8$ 、 $(3 \cdot L2 + 4 \cdot L1 + 4 \cdot L0 + 3 \cdot R0 + 2 \cdot R1 + 8) / 16$ 、
 $(2 \cdot L2 + 4 \cdot L1 + L0 + R0 + 4) / 8$ 、 $(2 \cdot R3 + 3 \cdot R2 + R1 + R0 + L0 + 4) / 8$ 、 或 $(2 \cdot L3 + 3 \cdot L2 + L1 + L0 + R0 + 4) / 8$ 。

17. The method according to Claim 13, characterized in that the process of filtering the pixels of the blocks on both sides of the block boundary comprises

selecting a filter from the determined filter combination based on the preset weight of each row of pixels in the blocks on both sides of the block boundary to filter the pixels in the blocks on both sides of the block boundary.

18. A device for acquiring block boundary filtering strength, characterized in that it comprises a flatness calculation module, used to determine a similarity threshold and calculate region flatness of the block boundary in the present windows by using the similarity threshold;

an initial value determination module, used to determine the initial value of filtering strength of the block boundary in each window based on the region flatness calculated by the flatness calculation module, with each region flatness interval corresponding to an initial value of filtering strength;

an adjustment module, used to adjust the initial value of block boundary filtering strength determined by the initial value determination module to obtain the block boundary filtering strength by using the pre-acquired header information of the blocks on both sides of the block boundary.

19. A device for reducing block distortion, characterized in that it comprises
a block boundary filtering strength acquisition module, used to determine a similarity threshold and
calculate region flatness by using the similarity threshold, and acquire block boundary filtering strength
with the region flatness;

5 a boundary determination module, used to determine whether the block boundary is a pseudo-
boundary;

10 a filter determination module, used to determine the corresponding filter combination based on the
pre-established correspondence relationship between block boundary filtering strength and filter
combination according to the block boundary filtering strength acquired by the block boundary filtering
strength acquisition module when the determination results of the boundary determination module indicate
that the block boundary is a pseudo-boundary;

a filter module, used to filter the pixels of the blocks on both sides of the block boundary accordingly
by using the filter combination determined by the filter determination module.

		N0	R0	L0	M0		
		N1	R1	L1	M1		
		N2	R2	L2	M2		
		N3	R3	L3	M3		
		N4	R4	L4	M4		
		N5	R5	L5	M5		
		N6	R6	L6	M6		
		N7	R7	L7	M7		

Figure 1

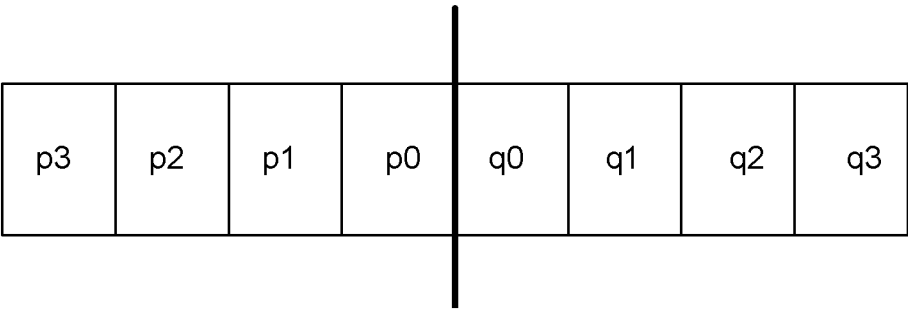
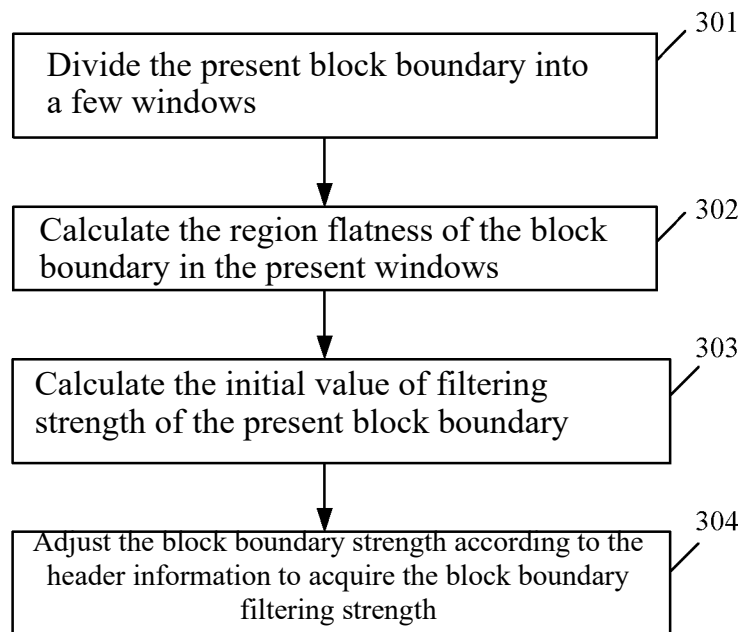
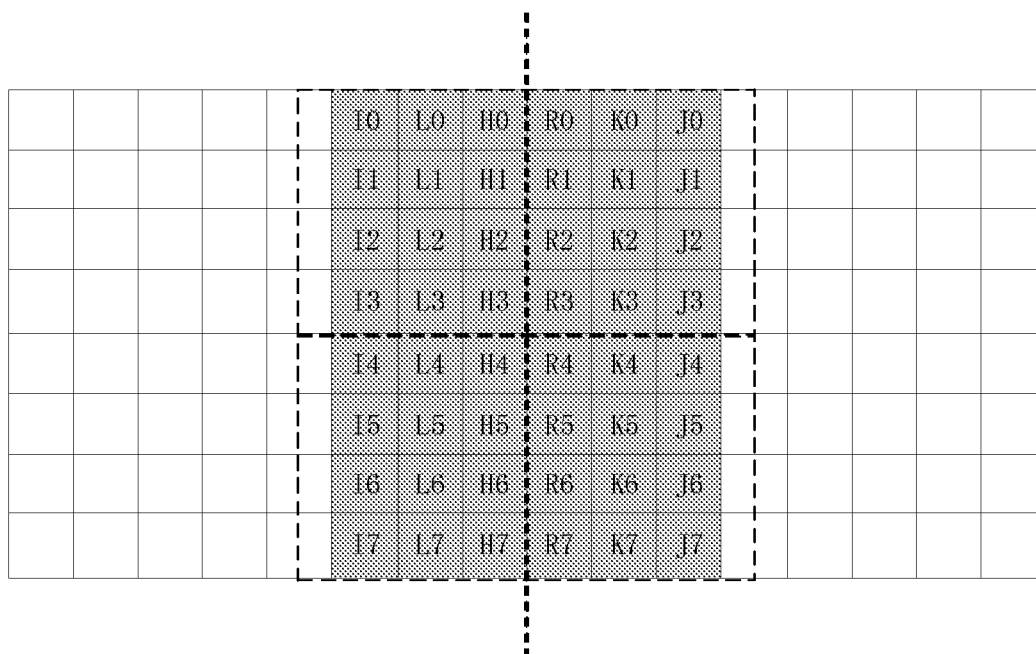
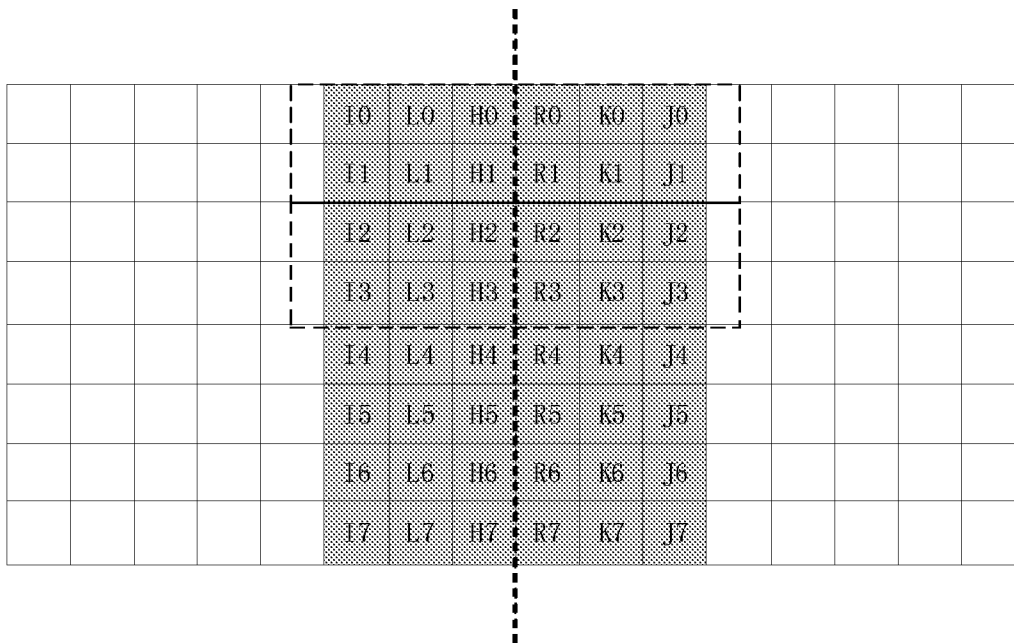
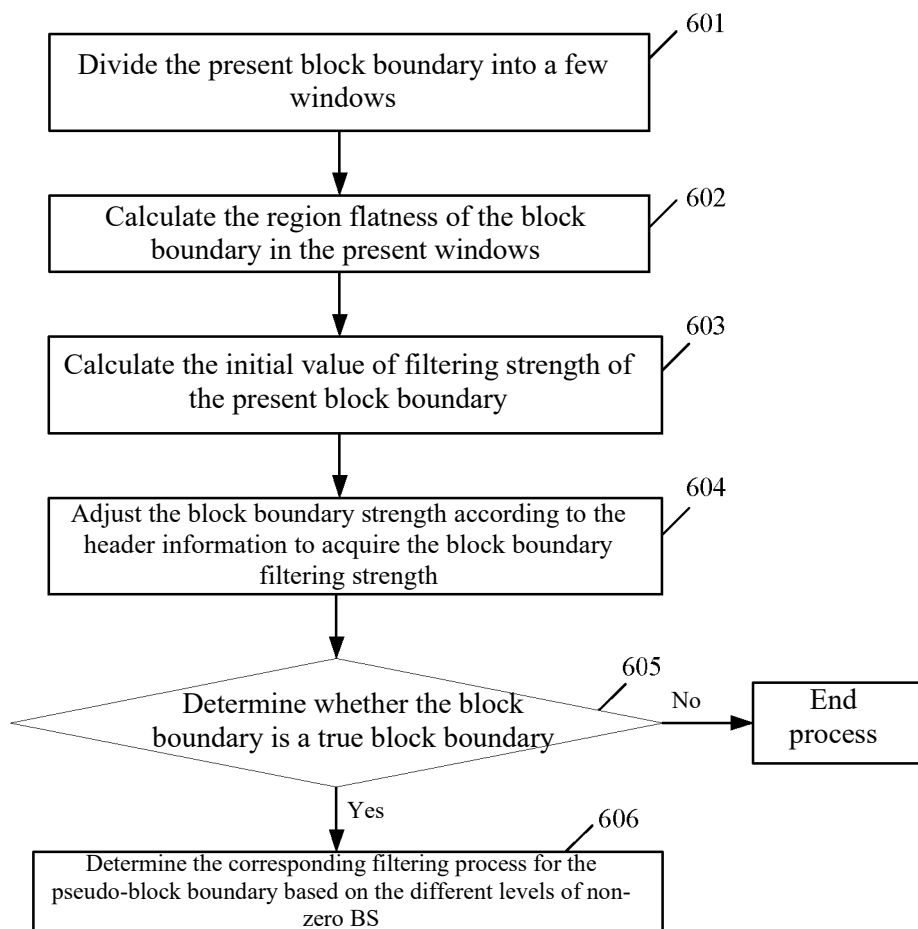


Figure 2

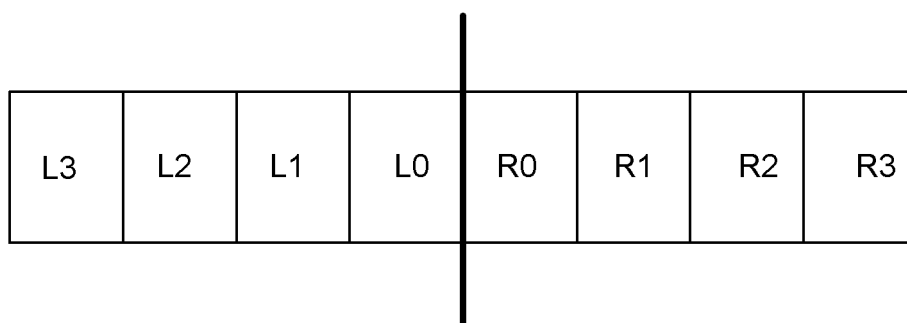
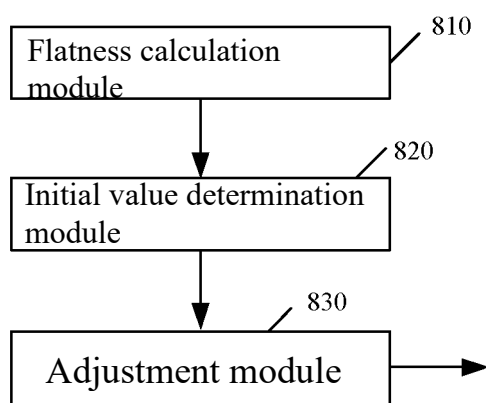
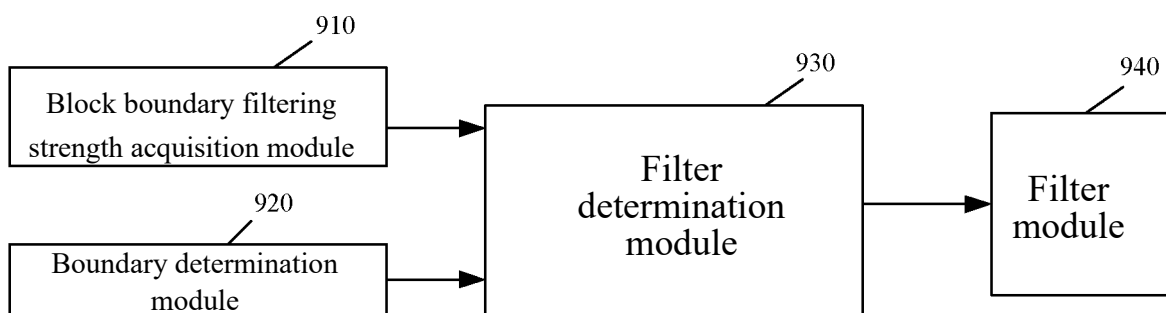
-2/4-

**Figure 3****Figure 4**

-3/4-

**Figure 5****Figure 6**

-4/4-

**Figure 7****Figure 8****Figure 9**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2008/072082

A. CLASSIFICATION OF SUBJECT MATTER		
H04N 7/24 (2006.01) i		
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)		
IPC: H04N7/-		
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)		
WPI,EPODOC, PAJ,CPRS, CNKI (boundary, strength, region, flatness, block, threshold, filter, similar)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1867075A (HUAWEI TECHNOLOGIES CO LTD) 22 November 2006 (22.11.2006) the whole document	1-19
A	US2003026337A1 (LG ELECTRONICS INC [US] et al.) 06 February 2003 (06.02.2003) the whole document	1-19
A	US2006126962A1 (SHARP LAB OF AMERICA INC) 15 June 2006 (15.06.2006) the whole document	1-19
A	CN1552161A (MATSUSHITA ELECTRIC IND CO LTD [JP]) 01 December 2004 (01.12.2004) the whole document	1-19
☐ Further documents are listed in the continuation of Box C. ☒ 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 November 2008 (20.11.2008)		11 Dec. 2008 (11.12.2008)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451		Authorized officer YU Xingzhou Telephone No. (86-10)62414411

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2008/072082

CN1867075A	22. 11.2006	W02007033551A1	29. .03.2007
US2003026337A1	06.02.2003	KR100525785B	03.11.2005
		KR20020095761A	28.12.2002
		KR100505319B	03.08.2005
		KR100505320B	03.08.2005
		KR100523551B	25.10.2005
		US7272186B2	18.09.2007
US2006126962A1	15.06.2006	W02006101682A2	28.09.2006
		W02007064347A2	07.06.2007
		EP1859389A2	28.11.2007
		EP1859534A2	28.11.2007
		W02007064347A3	17.01.2008
		KR20080005210A	10.01.2008
		KR20080003808A	08.01.2008
		JP2008533909T	21.08.2008
		W02004008773A1	22.01.2004
		JP2008187734A	14.08.2008
CN1552161A	01.12.2004	US2008130753A1	05.06.2008
		US7372905B2	13.05.2008
		CN100358366C	26.12.2007
		US2008069238A1	20.03.2008
		AU2007234501A1	06.12.2007
		AU2003244072B2	16.08.2007
		JP2006287974A	19.10.2006
		JP2006287973A	19.10.2006
		JP2006287972A	19.10.2006
		INCHENP200400526E	23.12.2005
		TW200402663A	16.02.2004
		MXPA04002265A	01.07.2004
		KR20050018730A	28.02.2005
		AU2003244072A1	02.02.2004
		US2004179620A1	16.09.2004
		BRPI0303901A	10.08.2004
		EP1408697A1	14.04.2004
		JP2004096719A	25.03.2004

A. Classification of Subject Matter		
H04N 7/24 (01/2006)i		
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)		
IPC: H04N7/-		
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)		
WPI, EPODOC, PAJ (boundary, strength, region, flatness, block, threshold, filter, similar)		
CPRS, CNKI (side, boundary, edge, strength, region, flat, block, threshold, filter, similar)		
C. Documents Considered to be Relevant		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim no.
A	CN1867075A (Huawei Technologies Co., Ltd.) November 22, 2006 (11/22/2006) the whole document	1-19
A	US2003026337A1 (LG ELECTRONICS INC [US] et al.) February 06, 2003 (02/06/2003) the whole document	1-19
A	US2006126962A1 (SHARP LAB OF AMERICA INC) June 15, 2006 (06/15/2006) the whole document	1-19
A	CN1552161A (Matsushita Electric Ind. Co., Ltd. [JP]) December 01, 2004 (12/01/2004) the whole document	1-19
☐ Further documents are listed in the continuation of Box C. ☒ 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 November 20, 2008 (11/20/2008)		Date of mailing of the international search report December 11, 2008 (12/11/2008)
China National Intellectual Property Administration (ISA/CN) 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China, 100088 Facsimile No.: (86-10)62019451		Authorized officer Yu Xingzhou Telephone No.: (86-10)62414411

International Search Report
Information on patent family members

International Application No.
PCT/CN2008/072082

Patent Document/s Cited in Search Report	Publication Date	Patent Family Member/s	Publication Date
CN1867075A	22.11.2006	W02007033551A1	29.03.2007
US2003026337A1	06.02.2003	KR100525785B	03.11.2005
		KR20020095761A	28.12.2002
		KR100505319B	03.08.2005
		KR100505320B	03.08.2005
		KR100523551B	25.10.2005
		US7272186B2	18.09.2007
US2006126962A1	15.06.2006	W02006101682A2	28.09.2006
		W02007064347A2	07.06.2007
		EP1859389A2	28.11.2007
		EP1859534A2	28.11.2007
		W02007064347A3	17.01.2008
		KR20080005210A	10.01.2008
		KR20080003808A	08.01.2008
		JP2008533909T	21.08.2008
CN1552161A	01.12.2004	W02004008773A1	22.01.2004
		JP2008187734A	14.08.2008
		US2008130753A1	05.06.2008
		US7372905B2	13.05.2008
		CN100358366C	26.12.2007
		US2008069238A1	20.03.2008
		AU2007234501A1	06.12.2007
		AU2003244072B2	16.08.2007
		JP2006287974A	19.10.2006
		JP2006287973A	19.10.2006
		JP2006287972A	19.10.2006
		INCHENP200400526E	23.12.2005
		TW200402663A	16.02.2004
		MXPA04002265A	01.07.2004
		KR20050018730A	28.02.2005
		AU2003244072A1	02.02.2004
		US2004179620A1	16.09.2004
		BRPI0303901A	10.08.2004
		EP1408697A1	14.04.2004
		JP2004096719A	25.03.2004



TRANSLATOR'S DECLARATION:

I, Lau Tsin Ning, hereby declare:

That I possess advanced knowledge of the Chinese and English languages. The attached Chinese into English translation has been translated by me and to the best of my knowledge and belief, it is a true and accurate translation of:

Fu WO2009033390A1

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willfully false statements and the like are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code.

Lau Tsin Ning

11 March 2024

[DATE]