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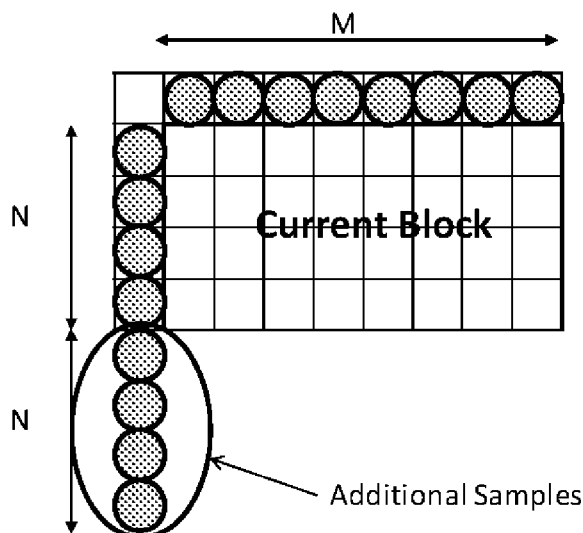
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(54) Title: METHODS FOR CHROMA CODING IN VIDEO CODEC



(a)

(57) Abstract: Methods for non-square intra chroma prediction in video coding are disclosed. With the proposed method, the chroma components can perform non-square intra prediction to achieve higher coding performance.

METHODS FOR CHROMA CODING IN VIDEO CODEC

TECHNICAL FIELD

[0001] The invention relates generally to video processing. In particular, the present invention relates to methods for specifying coding structures and prediction
5 methods for chroma component in video/picture.

BACKGROUND

[0002] The HEVC standard (a.k.a H.265) is based on the well-known block-based hybrid coding architecture, combining inter/intra prediction and transform coding with high-efficiency entropy coding. Below we will see the descriptions of the coding
10 structures and prediction in HEVC.

[0003] Coding unit (CU) and coding tree structure in HEVC

The coding unit (CU) is a square region, represented as the leaf node of a quadtree partitioning of the CTU, which shares the same prediction mode: intra, inter or skipped. The quad-tree partitioning structure allows recursive splitting into four
15 equally sized nodes, starting from the CTU as illustrated in Fig. 1. This process gives a content-adaptive coding tree structure comprised of CUs, each of which may be as large as the CTU or as small as 8x8. Each non-skipped CU is assigned to one of two prediction modes: intra prediction or inter prediction. A skipped CU is considered to be an inter prediction mode without coding of motion vector differences and residual
20 information.

[0004] Prediction unit (PU) structure in HEVC

The prediction unit (PU) is a region, defined by partitioning the CU, on which the same prediction is applied. In general, the PU is not restricted to being square in shape, in order to facilitate partitioning which matches the boundaries of real objects in the
25 picture.

Each CU contains one, two or four PUs depending on the partition mode. Fig. 2 illustrates the eight partition modes that may be used to define the PUs for an inter-coded CU. The PART_2Nx2N and PART_NxN partition modes are used for an intra-coded CU. The partition mode PART_NxN is allowed only when the corresponding

CU size is equal to the minimum CU size. In general, the HM supports PU sizes from 64x64 down to 4x4 samples. However, in order to reduce the memory bandwidth of motion compensation, the 4x4 block size is not allowed for an inter-coded PU.

[0005] Transform unit (TU) and transform tree structure in HEVC

- 5 The transform unit (TU) is a square region, defined by quad-tree partitioning of the CU, which shares the same transform and quantization processes. The TU shape is always square and it may take a size from 32x32 down to 4x4 samples. The maximum quad-tree depth is adjustable and is specified in the slice header syntax.

[0006] Intra Prediction in HEVC

10 Prediction modes

The decoded boundary samples of adjacent blocks are used as reference data for spatial prediction in regions where inter picture prediction is not performed. All TUs within a PU use the same associated intra prediction mode for the luma component and the chroma components. Note that the prediction process is performed at TU level,
 15 in other words, each TU uses its immediately adjacent reconstructed pixels to generate the predictors. The encoder selects the best luma intra prediction mode of each PU from 35 options: 33 directional prediction modes, a DC mode and a Planar mode. The mapping between the intra prediction direction and the intra prediction mode number is specified in Fig. 3.

- 20 For the chroma component of an intra PU, the encoder selects the best chroma prediction modes among five modes including Planar, DC, Horizontal, Vertical and a direct copy of the intra prediction mode for the luma component (also called derived mode, DM mode).

When the intra prediction mode number for the chroma component is not 4 and it is
 25 identical to the intra prediction mode number for the luma component, the intra prediction direction of 34 is used for the intra prediction sample generation for the chroma component.

Similar to DM mode, another mode called the luma-predict-chroma mode (LM mode) takes advantage of the inter-channel correlation but behaves differently (LM mode is
 30 not used in HEVC). As shown in Fig. 4, in LM mode, Chroma predictor is predicted from reconstructed luma using Eq. 1.

$$Pred_c[x, y] = \alpha \cdot Rec_L[x, y] + \beta \quad \text{Eq. 1}$$

where α and β are derived from causal reconstructed samples around the current block (Luma needs to be down-sampled for 4:2:0 which is the same as the chroma

down-sampling method in the normal YCbCr4:4:4 to YCbCr4:2:0 down-sampling) using the Eq. 2 and 3 (least square solution). Rec_c is the vector of reconstructed chroma samples around the current chroma block; Rec'_L is the vector of down-sampled reconstructed luma samples around the current luma block and I is the number of used neighboring samples around current block.

$$\alpha = \frac{I \cdot \sum_{i=0}^I Rec_c(i) \cdot Rec'_L(i) - \sum_{i=0}^I Rec_c(i) \cdot \sum_{i=0}^I Rec'_L(i)}{I \cdot \sum_{i=0}^I Rec'_L(i) \cdot Rec'_L(i) - \left(\sum_{i=0}^I Rec'_L(i) \right)^2} = \frac{A_1}{A_2} \quad \text{Eq. 2}$$

$$\beta = \frac{\sum_{i=0}^I Rec_c(i) - \alpha \cdot \sum_{i=0}^I Rec'_L(i)}{I} \quad \text{Eq. 3}$$

There are also some variant of LM mode. The LM parameters α and β can be selectively generated by different sets of neighboring reconstructed pixels.

[0007] Inter Prediction in HEVC

Prediction modes

Each inter coded PU has a set of motion parameters consisting of motion vector, reference picture index, reference picture list usage flag to be used for inter prediction sample generation, signalled in an explicit or implicit manner. When a CU is coded with skip mode, the CU is represented as one PU that has no significant transform coefficients and motion vectors, reference picture index and reference picture list usage flag obtained by merge mode. The merge mode is to find the neighbouring inter coded PU such that its motion parameters (motion vector, reference picture index, and reference picture list usage flag) can be inferred as the ones for the current PU. The encoder can select the best inferred motion parameters from multiple candidates formed by spatially neighbouring PUs and temporally neighbouring PUs, and transmit the corresponding index indicating the chosen candidate. The merge mode can be applied to any inter coded PU, not only for skip mode. In any inter coded PUs, the encoder can use merge mode or explicit transmission of motion parameters, where motion vector, corresponding reference picture index for each reference picture list and reference picture list usage flag are signalled explicitly per each PU. For inter coded PU, significant transform coefficients are sent to decoder. The details are presented in the following sections.

[0008] Please note that, in HEVC, luma component and two chroma components share the same CU split structure. PU structures, prediction modes and prediction parameters (e.g. motion vectors and reference index) are also shared between luma

and chroma when the current CU is coded in inter mode. However, when the current CU is coded in intra mode, PU and intra prediction modes can be different for luma and chroma components, respectively. To be specific, in a intra CU, the PU for luma component can be either $2N \times 2N$ or $N \times N$ but the PU for chroma component can only

5 be $2N \times 2N$.

[0009] In this invention, we mainly focus on improving the coding structure and prediction efficiency of chroma components by allowing flexible coding structure and prediction for chroma components.

SUMMARY

10 **[0010]** In light of the previously described problems, the sub-PU prediction restriction methods are proposed.

[0011] Other aspects and features of the invention will become apparent to those with ordinary skill in the art upon review of the following descriptions of specific embodiments.

15 BRIEF DESCRIPTION OF DRAWINGS

[0012] The invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

[0013] Fig. 1 is a diagram illustrating an example of coding tree structure.

20 **[0014]** Fig. 2 is a diagram illustrating 8 partition modes for inter PU.

[0015] Fig. 3 is a diagram illustrating mapping between intra prediction direction and intra prediction mode.

[0016] Fig. 4 is a diagram illustrating samples used to derive LM parameters.

[0017] Fig. 5 is a diagram illustrating quad-tree split, horizontal binary split and
25 vertical binary split.

[0018] Fig. 6 is a diagram illustrating additional samples for chroma prediction.

[0019] Fig. 7 is a diagram illustrating removed samples for chroma prediction.

DETAILED DESCRIPTION

[0020] The following description is of the best-contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is best determined by reference to the appended claims.

[0021] The main feature of this invention is to enable non-square intra prediction for chroma components for achieving higher coding performance. This idea can be realized in different ways as described below.

[0022] The non-square intra prediction can be realized by enabling various partition modes for chroma components in intra CU. The enabled partition modes are not limited to the 8 partition modes as shown in Fig. 2. Under this scheme, when the number of the supported partition mode is larger than 1, the partition mode needs to be signaled for each intra chroma CU.

[0023] In another embodiment, the non-square intra prediction can be realized by enabling non-square CU for intra chroma prediction. The non-square CU can be in any shape of rectangle with “width not equal to height” and “width and height are both power of 2”.

[0024] Yet in another embodiment, the non-square intra prediction can be realized by enabling non-square transform. The non-square transform unit can be in any shape of rectangle with “width not equal to height” and “width and height are both power of 2”.

[0025] In one example of the invention, each CTU or CU can be split into smaller CUs using either horizontal binary-tree split, vertical binary-tree split or quad-tree split as shown in Fig. 5. With the binary-tree split, CU can be in non-square shape. When PU and TU are both equal to CU, the chroma components prediction in intra CU can then be performed in a way of non-square intra prediction.

[0026] To support non-square intra prediction for chroma components, some modifications may need to be made for existed chroma intra modes. The modifications are illustrated as below.

[0027] When current intra chroma block is non-square ($M \times N$), intra DC prediction method is modified to make sure the number of the averaged samples will be power of 2 by taking additional samples or removing samples for DC calculation.

With the proposed modifications, the process of taking average can then be done by shift operation. To be specific, additional X (X is equal to the length of long side minus short side) samples along the short side of current block are used to calculate the DC value as shown in Fig. 6(a). In another embodiment, additional samples can be the second lines of the short side as shown in Fig. 6(b). Yet in another embodiment, X can be any number to make sure the number of the samples used to calculate the DC value will be power of 2 and the additional samples can be any subset of the neighbor reconstructed pixels.

[0028] Yet in another embodiment, we can remove the X samples from the neighboring samples around the current block (X is equal to the length of short side). As shown in Fig. 7(a), X samples are removed from the long side of current block. As shown in Fig. 7(b), X samples are removed from the long side of current block interleavingly. Yet in another embodiment, X can be any number to make sure the number of the samples used to calculate the DC value will be power of 2 and the removed samples can be any subset of the neighbor reconstructed pixels.

[0029] Yet in another embodiment, the DC is calculated as the average of the DC of above samples and the DC of the left samples.

[0030] When current intra chroma block is non-square ($M \times N$), the LM mode is modified to make sure the number of the samples used to derive the LM parameters α and β will be power of 2 by taking additional samples or removing samples for LM parameters derivation. With the proposed modifications, the process of LM parameter derivation can then be done by shift operation. To be specific, additional X (X is equal to the length of long side minus short side) samples along the short side of current block are used to derive the LM parameters as shown in Fig. 6 (a). In another embodiment, additional samples can be the second lines of the short side as shown in Fig. 6 (b). Yet in another embodiment, X can be any number to make sure the number of the samples used to derive the LM parameters will be power of 2 and the additional samples can be any subset of the neighbor reconstructed pixels.

[0031] Yet in another embodiment, we can remove the X samples from the neighboring samples around the current block (X is equal to the length of short side). As shown in Fig. 7(a), X samples are removed from the long side of current block. As shown in Fig. 7(b), X samples are removed from the long side of current block interleavingly. Yet in another embodiment, X can be any number to make sure the

number of the samples used to derive the LM parameters will be power of 2 and the removed samples can be any subset of the neighbor reconstructed pixels.

CLAIMS

1. A scheme of non-square intra prediction for chroma components in video coding.
2. The method as claimed in claim 1, wherein the intra chroma CU can have
5 non-square prediction unit (PU).
3. The method as claimed in claim 1, wherein the intra chroma CU can have the non-square prediction unit (PU) and the non-square transform unit (TU), and the size of non-square prediction unit is equal to the size of the no-square transform unit.
4. The method as claimed in claim 1, wherein the intra chroma processing unit
10 can have non-square coding unit, for the $2N \times N$ or $N \times 2N$ non-square coding unit, it will be further divided into two $N \times N$ transform units.
5. The method as claimed in claim 1, wherein the intra chroma processing unit can have non-square prediction unit, for the $2N \times N$ or $N \times 2N$ non-square prediction unit, it will be further divided into two $N \times N$ transform units.
6. The method as claimed in claim 1, wherein the intra chroma CU can be in
15 the shape of non-square.
7. The method as claimed in claim 3, wherein the intra chroma CTU or CU can be split using conventional quad-tree split, horizontal binary split or vertical binary split.
8. The method as claimed in claim 1, wherein non-square transform unit is
20 applied for intra chroma CU.
9. The method as claimed in claim 1, wherein the intra DC prediction method is modified for non-square intra chroma prediction to make sure the number of the averaged samples will be power of 2 by taking additional samples or removing
25 samples for DC calculation
10. The method as claimed in claim 1, wherein the LM mode is modified for non-square intra chroma prediction to make sure the number of the samples used to derive the LM parameters will be power of 2 by taking additional samples or removing samples for LM parameters derivation.
11. The method as claimed in claim 1, for the non-square, quad-tree split,
30 horizontal binary split or vertical binary split intra prediction unit (PU), the reconstructed pixels adjacent to current PU are used to derive the intra predictors.
12. The method as claimed in claim 1, for the non-square, quad-tree split,

horizontal binary split or vertical binary split intra prediction unit (PU), the reconstructed pixels adjacent to the CU coving current PU are used to derive the intra predictors.

13. The method as claimed in claim 1, wherein the partition of the chroma
5 prediction block is directly inherited from the partition of the luma prediction block. When the luma intra prediction unit is non-square block, quad-tree split, horizontal binary split or vertical binary split, the chroma intra prediction unit will also be non-square block, quad-tree split, horizontal binary split or vertical binary split.

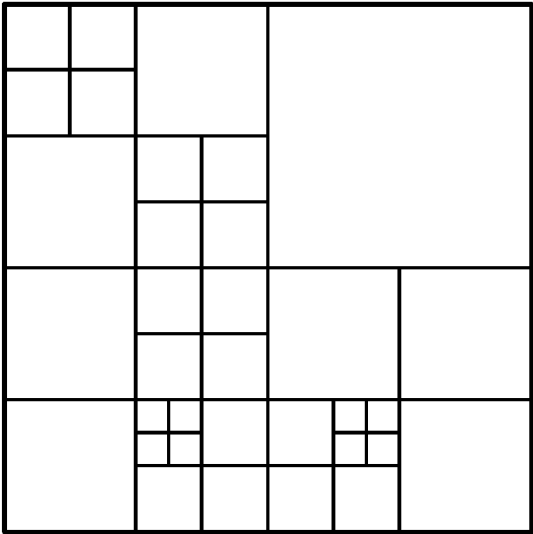


Fig. 1

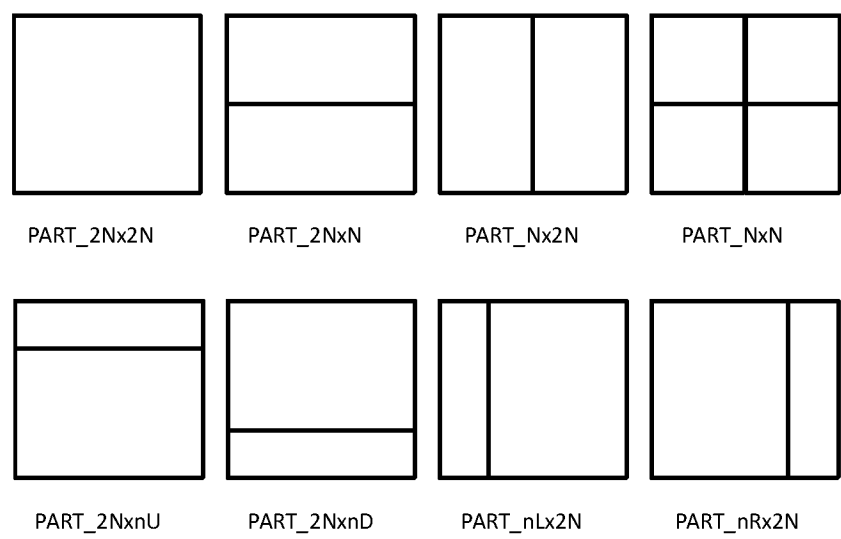


Fig. 2

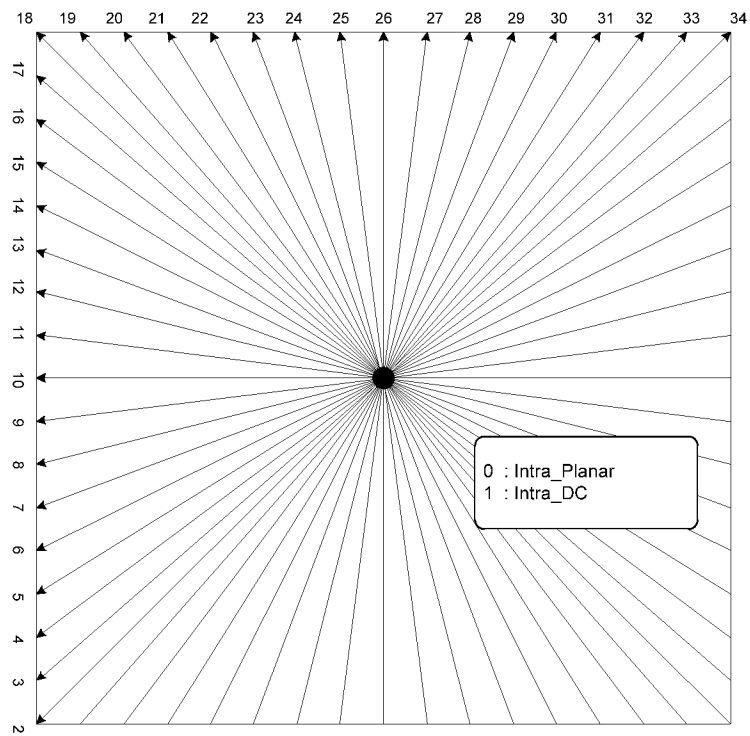


Fig. 3

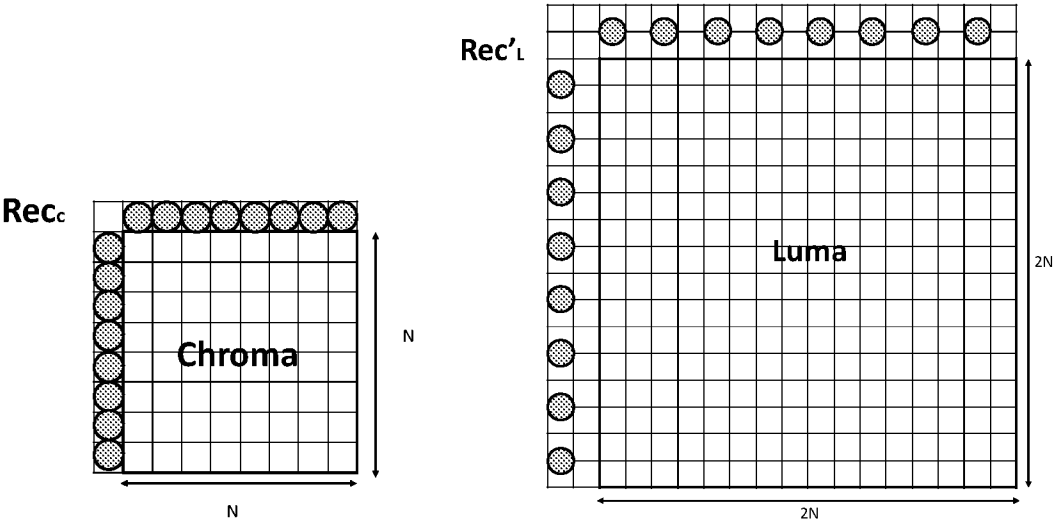


Fig. 4

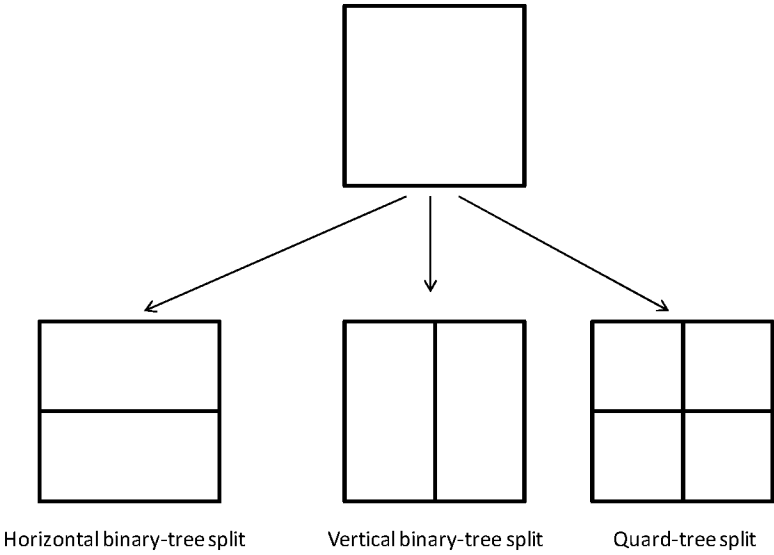


Fig. 5

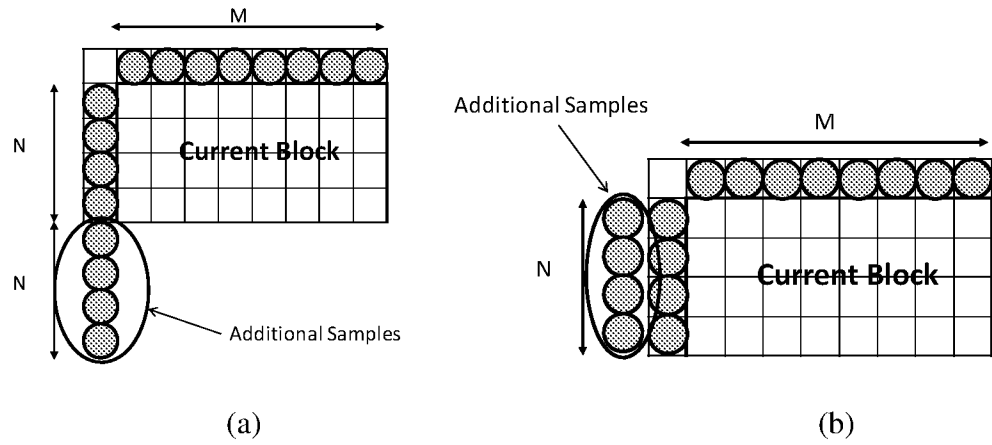


Fig. 6

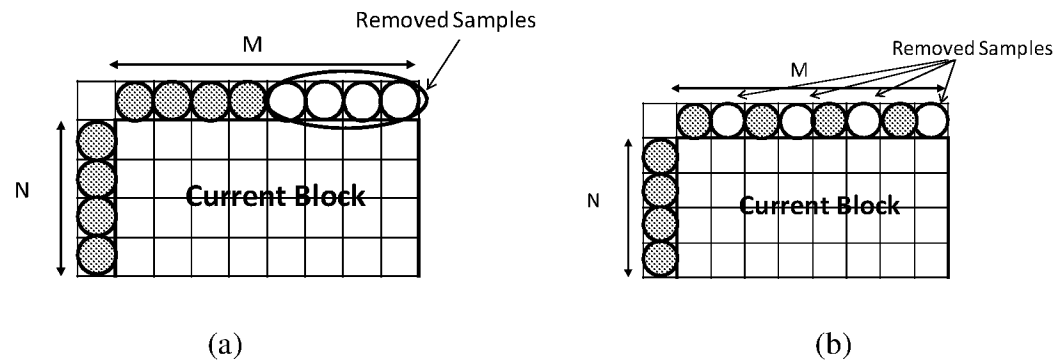


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/075672**A. CLASSIFICATION OF SUBJECT MATTER**

H04N 19/132(2014.01)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)

H04N 19/-, H04N 7/-

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)

CPRSABS,CNABS,VEN,CNKI,DWPI:non-square, intra prediction, inter prediction, chroma, code, video, prediction unit, transform unit,quad-tree, quadtree, horizontal, vertical, split,sample

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103636215 A (QUALCOMM INC) 12 March 2014 (2014-03-12) paragraphs [0026]-[0047] in the description)	1-3,6-13
Y	CN 103636215 A (QUALCOMM INC) 12 March 2014 (2014-03-12) paragraphs [0026]-[0047] in the description)	4-5
Y	CN 103748877 A (MEDIATEK SINGAPORE PTE LTD) 23 April 2014 (2014-04-23) claim 5	4-5
A	CN 103313055 A (UNIV CHINA ELECTRONIC SCI & TECHNOLOGY) 18 September 2013 (2013-09-18) see the whole document	1-13
A	CN 103596004 A (UNIV BEIJING POSTS & TELECOM) 19 February 2014 (2014-02-19) see the whole document	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

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04 January 2016

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2015/075672

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	103636215	A	12 March 2014	US	2013003824	A1	03 January 2013
				KR	20140033499	A	18 March 2014
				EP	2727348	A1	07 May 2014
				WO	2013006297	A9	07 March 2013
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CN	103748877	A	23 April 2014	EP	2745519	A4	25 March 2015
				US	2014140404	A1	22 May 2014
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CN	103596004	A	19 February 2014	None			