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(54) Title: METHODS FOR AFFINE MOTION COMPENSATION

(57) Abstract: Methods for using affine motion model for inter prediction are proposed.

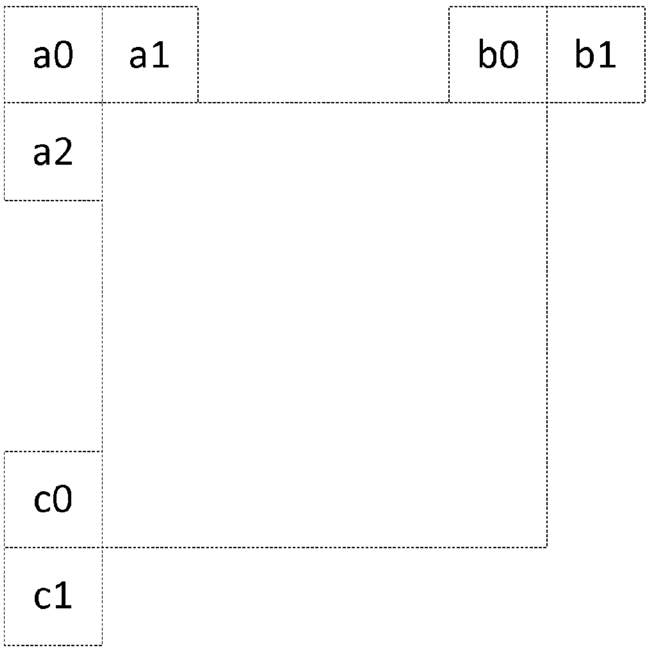

Fig.1

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METHODS FOR AFFINE MOTION COMPENSATION

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates generally to video processing. In particular, the present invention relates to methods for affine motion compensation in video coding and its extensions, 3D video coding, scalable video coding, screen content coding et al.

Description of the Related Art

[0002] In HEVC, the basic block for prediction is defined as a prediction unit (PU). In inter prediction mode, block matching is used. The displacement between the two blocks is defined as motion vector (MV). There're two types of inter prediction modes: one is inter AMVP (Advanced Motion Vector Prediction) mode, the other is merge mode.

[0003] In AMVP mode, the MV of current block is predicted from a motion vector predictor (MVP), and then only the MV difference (MVD) and the index of selected MVP (in the case of multiple MVPs) are signaled. In B slice, a syntax element *inter_pred_idc* is used to indicate the prediction direction. There are two lists of reference picture, namely list 0 and list 1. In bi-directional prediction, the MVD and index of MVP for both lists are signaled. Therefore, in total, there're two MVDs and two indices of MVP are signaled for a block in the bi-directional prediction mode. In the case of multiple reference pictures, the syntax element *ref_idx_l0* is signaled to indicate which reference picture in list 0 is used, and the syntax element *ref_idx_l1* is signaled to indicate which reference picture in list 1 is used.

[0004] In merge mode, the motion information (inter prediction direction, reference picture index and MV) is derived from a list of candidates. A merge index is signaled to indicate which candidate is used. The candidate list is formed by motion information of spatial or temporal neighboring coded blocks.

[0005] The assumption of block based motion compensation is that all the pixels within a block have the same MV. Therefore, it cannot capture complex motion, for example, rotation, zooming, and the deformation of moving objects. Affine motion model was introduced in the literature to provide more accurate motion-compensated prediction.

[0006] The affine transform model can be described as:

$$x' = a * x + b * y + e$$
$$y' = c * x + d * y + f$$

where (x, y) and (x', y') are a pair of corresponding locations in current and reference picture, respectively. And a, b, c, d, e, and f are the affine parameters. The motion (v_x, v_y) at location (x, y) is then derived as:

$$v_x = (1-a) * x - b * y - e$$
$$v_y = (1-c) * x - d * y - f$$

, termed as affine motion model. Given the affine parameters, if the affine motion model is applied to a block, then the motion in each pixel in the block can be derived by the affine motion model according to its location.

[0007] In order to better fit into the video codec, it was proposed to represent the affine parameters with MVs at 3 control points. Also, to reduce the complexity of affine motion compensation, sub-block based method was proposed. In which, when affine motion model is applied, a MV is derived for each sub-block (4x4 for example) instead of each pixel in the current block.

BRIEF SUMMARY OF THE INVENTION

[0008] Methods of using affine model for inter prediction are proposed. First, method of sub-block based affine motion derivation is proposed. Second, methods of deriving affine merge candidates are proposed. Third, methods of affine AMVP mode are proposed.

[0009] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

[0011] Fig.1 is a diagram illustrating the neighboring blocks that are used for deriving affine motion parameters predictor.

DETAILED DESCRIPTION OF THE INVENTION

[0012] 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.

[0013] Let *BlkWidth* denotes the width of a block; *BlkHeight* denotes the height of a block. The block is partitions into sub-blocks. The width of a sub-block is *SubWidth*, and the height is *SubHeight*. The number of sub-blocks in one row of the block is $M=BlkWidth/SubWidth$, the number of sub-blocks in one column of the block is $N=BlkHeight/SubHeight$.

[0014] In one embodiment, given the affine motion parameters represented by 3 MVs at control points denoted as $\boldsymbol{Mv0}=(Mvx0,Mvy0)$, $\boldsymbol{Mv1}=(Mvx1,Mvy1)$ and $\boldsymbol{Mv2}=$

(Mvx2,Mvy2), MV of a sub-block ***Mv(i,j)*** *=(Mvx(i,j), Mvy(i,j)) i=0,...,N-1, j=0,...,M-1* is derived as:

$$Mvx(i,j) = Mvx0 + (i+1)*deltaMvxVer + (j+1)*deltaMvxHor$$

$$Mvy(i,j) = Mvy0 + (i+1)*deltaMvyVer + (j+1)*deltaMvyHor\ .$$

Where, deltaMvxHor, deltaMvyHor, deltaMvxVer, deltaMvyVer are calculated as:

$$deltaMvxHor = (Mvx1-Mvx0)/M$$

$$deltaMvyHor = (Mvy1-Mvy0)/M$$

$$deltaMvxVer=(Mvx2-Mvx0)/N$$

$$deltaMvyVer=(Mvy2-Mvy0)/N$$

[0015] In another embodiment, MV of a sub-block ***Mv(i,j)*** *=(Mvx(i,j), Mvy(i,j)) i=0,...,N-1, j=0,...,M-1* is derived as:

$$Mvx(i,j) = Mvx0 + i*deltaMvxVer + j*deltaMvxHor$$

$$Mvy(i,j) = Mvy0 + i*deltaMvyVer + j*deltaMvyHor\ .$$

[0016] In another embodiment, affine merge candidate is derived and inserted into the merge candidate list. The affine motion parameters **Mv0**, **Mv1** and **Mv2** for the affine merge candidate are derived from neighboring coded blocks. **Mv0** is derived from the top-left neighboring sub-blocks, **Mv1** is derived from the top-right neighboring coded sub-blocks, and **Mv2** is derived from the bottom-left neighboring coded sub-blocks.

[0017] As shown in Fig. 3, **Mv0** can be the MV at sub-block a0, a1 or a2; **Mv1** can be the MV at sub-block b0 or b1; **Mv2** can be the MV at sub-block c0 or c1.

In one example, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c0.

In another example, **Mv0** is the first available MV at sub-block a0, a1 or a2, **Mv1** is the first available MV at sub-block b0, b1, **Mv2** is the first available MV at sub-block c0 and c1.

In still another example, multiple affine merge candidates are added into the merge candidate list.

For the first affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c0;

For the second affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0, and **Mv2** is the MV at sub-block c1;

For the third affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b1, and **Mv2** is the MV at sub-block c0.

For the fourth affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b1, and **Mv2** is the MV at sub-block c1.

[0018] In still another embodiment, if the inter prediction direction of **Mv0**, **Mv1** and **Mv2** are not all the same, then the affine merge candidate is denoted as not exist.

[0019] In still another embodiment, if **Mv0**, **Mv1** and **Mv2** are all available only in list 0, then the derived affine merge candidate's inter prediction is uni-direction, only using reference list 0.

[0020] In still another embodiment, if **Mv0**, **Mv1** and **Mv2** are all available only in list 1, then the derived affine merge candidate's inter prediction is uni-direction, only using reference list 1.

[0021] In still another embodiment, if the reference pictures of **Mv0**, **Mv1** and **Mv2** are not all the same, then the affine merge candidate is denoted as not exist.

[0022] In still another embodiment, if the reference pictures of **Mv0**, **Mv1** and **Mv2** are not all the same, then all the 3 MVs are scaled to a designated reference picture, for example, reference index 0.

[0023] In still another embodiment, if the reference pictures of **Mv0**, **Mv1** and **Mv2** are not all the same but two of them are the same, then the other is scaled to have the same reference picture.

[0024] In still another embodiment, for the AMVP affine mode, the affine motion parameters predictor is derived from neighboring coded blocks. Similar to the affine merge candidate derivation, the same neighboring coded blocks are used.

- In one example, only one predictor is used, therefore no need to signal MVP index. In this predictor, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c0. If the reference picture of neighboring coded block is not the same as current block, then the corresponding MV is scaled accordingly.
- In another example, only one predictor is used, therefore no need to signal MVP index. In this predictor, **Mv0** is the first available MV at sub-block a0, a1 or a2, **Mv1** is the first available MV at sub-block b0, b1, **Mv2** is the first available MV at sub-block c0 and c1. If the reference picture of neighboring coded block is not the same as current block, then the corresponding MV is scaled accordingly.

[0025] In still another embodiment, for the AMVP affine mode, only uni-prediction is allowed. Therefore, bi-prediction is disabled for AMVP affine mode. In the case of reference list 0 and reference list 1 are the same, only reference list 0 is used and no need to signal *inter_pred_idc*. In the case of reference list 0 and reference list 1 are not the same, one flag is signaled to indicate which list is used.

[0026] In still another embodiment, the above described methods can be applied to simplified affine motion model. For example, 2 control points are used instead of 3 control points, in which **Mv2** is derived by **Mv0** and **Mv1** or **Mv1** is derived by **Mv0** and **Mv2**.

[0027] The proposed methods described above can be used in a video encoder as well as in a video decoder. Embodiments of the proposed method according to the present invention as described above may be implemented in various hardware, software codes, or a combination of both. For example, an embodiment of the present invention can be a circuit integrated into a video compression chip or program codes integrated into video compression software to perform the processing described herein. An embodiment of the present invention may also be program codes to be executed on a Digital Signal Processor (DSP) to perform the processing described herein. The invention may also involve a number of functions to be performed by a computer processor, a digital signal processor, a microprocessor, or field programmable gate array (FPGA). These processors can be configured to perform particular tasks according to the invention, by executing machine-readable software code or firmware code that defines the particular methods embodied by the invention. The software code or firmware codes may be developed in different programming languages and different format or style. The software code may also be compiled for different target platform. However, different code formats, styles and languages of software codes and other means of configuring code to perform the tasks in accordance with the invention will not depart from the spirit and scope of the invention.

[0028] The invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described examples are to be considered in all respects only as illustrative and not restrictive. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is

1. A method of sub-block based affine motion derivation.

Given the affine motion parameters represented by 3 MVs at control points denoted as $\boldsymbol{Mv0} = (Mvx0,Mvy0)$, $\boldsymbol{Mv1} = (Mvx1,Mvy1)$ and $\boldsymbol{Mv2} = (Mvx2,Mvy2)$.

$$deltaMvxHor = (Mvx1-Mvx0)/M$$

$$deltaMvyHor = (Mvy1-Mvy0)/M$$

$$deltaMvxVer=(Mvx2-Mvx0)/N$$

$$deltaMvyVer=(Mvy2-Mvy0)/N$$

MV of a sub-block at location (i,j) i=0,…,N-1, j=0,…,M-1 is derived as **Mv**(i,j)= $(Mvx(i,j), Mvy(i,j))$

$$Mvx(i,j)= Mvx0+(i+1)*deltaMvxVer+(j+1)*deltaMvxHor$$

$$Mvy(i,j)= Mvy0+(i+1)*deltaMvyVer+(j+1)*deltaMvyHor .$$

Or **Mv**(i,j)= $(Mvx(i,j), Mvy(i,j))$ is derived as

$$Mvx(i,j)= Mvx0+i* deltaMvxVer+j*deltaMvxHor$$

$$Mvy(i,j)= Mvy0+i*deltaMvyVer+j*deltaMvyHor$$

2. A method of deriving affine merge candidate, the affine motion parameters **Mv0**, **Mv1** and **Mv2** for the affine merge candidate is derived from neighboring coded blocks.

3. The method as claimed in claim 2, **Mv0** is derived from the top-left neighboring sub-blocks, **Mv1** is derived from the top-right neighboring coded sub-blocks, and **Mv2** is derived from the bottom-left neighboring coded sub-blocks.

4. The method as claimed in claim 3, as shown in Fig. 1, **Mv0** can be the MV at sub-block a0, a1 or a2; **Mv1** can be the MV at sub-block b0 or b1; **Mv2** can

be the MV at sub-block c0 or c1.

5. The method as claimed in claim 3, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c0.

6. The method as claimed in claim 3, **Mv0** is the first available MV at sub-block a0, a1 and a2, **Mv1** is the first available MV at sub-block b0 and b1, **Mv2** is the first available MV at sub-block c0 and c1.

7. The method as claimed in claim 3, multiple affine merge candidates are added into the merge candidate list.

For the first affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c0;

For the second affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c1;

For the third affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b1 and **Mv2** is the MV at sub-block c0.

For the fourth affine merge candidate, **Mv0** is the MV at sub-block a0, **Mv1** is the MV at sub-block b1 and **Mv2** is the MV at sub-block c1.

8. The method as claimed in claim 2, if the inter prediction direction of **Mv0**, **Mv1** and **Mv2** are not all the same, then the affine merge candidate is denoted as not exist.

9. The method as claimed in claim 2, if **Mv0**, **Mv1** and **Mv2** are all available only in reference list 0, then the derived affine merge candidate's inter prediction is uni-direction, using reference list 0.

10. The method as claimed in claim 2, if **Mv0**, **Mv1** and **Mv2** are all available only in reference list 1, then the derived affine merge candidate's inter prediction is uni-direction, using reference list 1.

11. The method as claimed in claim 2, if the reference pictures of **Mv0**, **Mv1** and **Mv2** are not all the same, then the affine merge candidate is denoted as not exist.

12. The method as claimed in claim 2, if the reference pictures of **Mv0**, **Mv1** and **Mv2** are not all the same, then all the 3 MVs are scaled to a designated reference picture, for example, reference index 0 or the closest reference picture.

13. The method as claimed in claim 2, if the reference pictures of **Mv0**, **Mv1** and **Mv2** are not all the same but two of them are the same, then the other is scaled to have the same reference picture.

14. The method of AMVP affine mode, the affine motion parameters predictor is derived from neighboring coded blocks. Similar to the affine merge candidate derivation, the same neighboring coded blocks are used.

15. The method as claimed in claim 14, only one predictor is used, therefore no need to signal MVP index. In this predictor, **Mv0** is the **MV** at sub-block a0, **Mv1** is the MV at sub-block b0 and **Mv2** is the MV at sub-block c0. If the reference picture of neighboring coded block is not the same as current block, then the corresponding MV is scaled accordingly.

16. The method as claimed in claim 14, only one predictor is used, therefore no need to signal MVP index. In this predictor, **Mv0** is the first available MV at sub-block a0, a1 and a2, **Mv1** is the first available MV at sub-block b0 and b1, **Mv2** is the first available MV at sub-block c0 and c1. If the reference picture of neighboring coded block is not the same as current block, then the corresponding MV is scaled accordingly.

17. The method as claimed in claim 14, for the AMVP affine mode, only uni-prediction is allowed. Therefore, bi-prediction is disabled for AMVP affine mode. In the case of reference list 0 and reference list 1 are the same, only reference list 0 is used and no need to signal *inter_pred_idc*. In the case of reference list 0 and reference list 1 are not the same, a flag is signaled to indicate which list is used.

18. The method as claimed in claim 14-17, the described methods can be applied to simplified affine motion model. For example, 2 control points are used instead of 3 control points, in which, **Mv2** is derived by **Mv0** and **Mv1** or **Mv1** is derived by **Mv0** and **Mv2**.

FIGURES

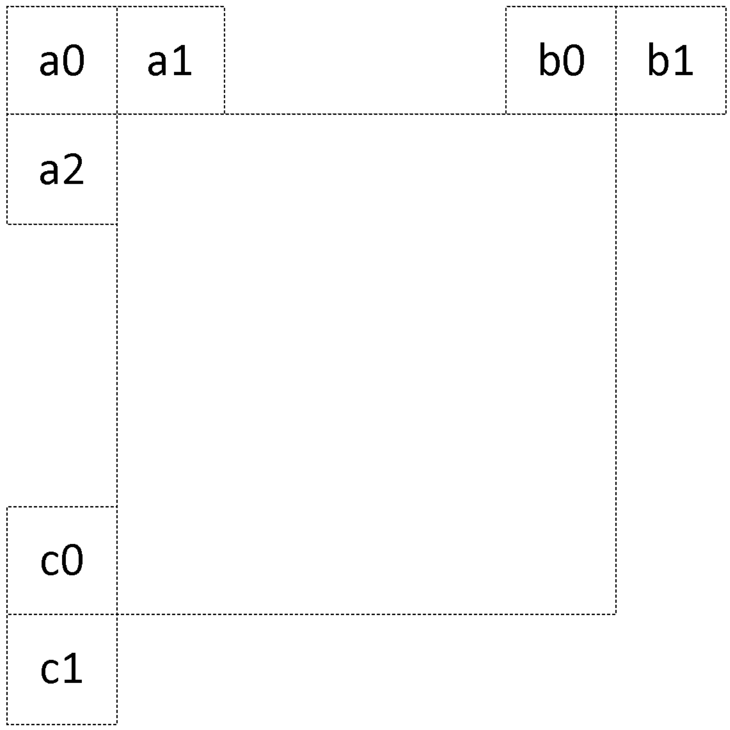

Fig.1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/075024

A. CLASSIFICATION OF SUBJECT MATTER

H04N 19/176(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

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)

CNABS;CNTXT;CNKI;VEN;DWPI;USTXT: video, affine, movement, move, code, motion, compensation, encode, merge, AMVP, MV

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2016008408 A1 (MEDIATEK SINGAPORE PTE LTD ET AL.) 21 January 2016 (2016-01-21) description, paragraphs [0013]-[0029]	1-18
X	WO 2016008157 A1 (MEDIATEK SINGAPORE PTE LTD ET AL.) 21 January 2016 (2016-01-21) description, paragraphs [0009]-[0024]	1-18
A	CN 105163116 A (HUAWEI TECHNOLOGIES CO., LTD. ET AL.) 16 December 2015 (2015-12-16) the whole document	1-18
A	US 2005141616 A1 (SAMSUNG ELECTRONICS CO., LTD.) 30 June 2005 (2005-06-30) the whole document	1-18

☐ 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
14 November 2016	**18 November 2016**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/075024

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2016008408 A1	21 January 2016	WO 2016008157 A1	21 January 2016
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		KR 20050068687 A	05 July 2005