

(51) International Patent Classification:
H04N 7/26 (2006.01)(21) International Application Number:
PCT/CN2012/076136(22) International Filing Date:
28 May 2012 (28.05.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD AND APPARATUS FOR LINE BUFFERS REDUCTION

**Fig. 5**

(57) Abstract: A method and apparatus for line buffer reduction in a video encoder or decoder are disclosed. In one embodiment according to the present invention, the method and apparatus for line buffer reduction determine a set of representative block information for every N first- blocks to achieve N:1 reduction. The set of representative block information corresponds to the set of block information selected from one of every N first-blocks and the selection may be according to positions or importance of every N first-blocks. In another embodiment of the present invention, the set of representative block information is derived by performing a mathematical operation on the sets of block information associated with two or more first- blocks of every N first-blocks. Another aspect of the present invention relates to control whether to turn on the line buffer reduction scheme.



METHOD AND APPARATUS FOR LINE BUFFERS REDUCTION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims priority to U.S. Provisional Patent
5 Application, Serial No. 61/498,952, filed June 20, 2011, entitled "Reduction of Line
Buffers for Motion Data". The U.S. Provisional Patent Applications is hereby
incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to video coding. In particular, the present
10 invention relates to reduction of line buffers for storing block information.

BACKGROUND

[0003] In video coding, block information of neighboring blocks are usually
utilized to predict motion data or related syntax elements of a current block. The
neighboring blocks usually correspond to blocks previously processed so that the
15 information of the neighboring blocks can be derived at the decoder side without side
information or with minimum side information. For example, the neighboring blocks
may be these blocks on the upper side or left side of the current block when the blocks
in a picture are processed in a raster scan order. The previously processed blocks may
also correspond to blocks in a previously processed frame (inter-frame prediction). In
20 order to use the motion data from previously processed blocks, the motion data has to
be buffered in memory. For example, motion data for a row of blocks at a slice
boundary may have to be buffered since they may be relied upon by blocks in the next
slice. The memory required to store data associated with pixel lines in a picture is
usually referred to as *line buffer*. The memory required for storing information
25 associated with a row of blocks is also termed as line buffer in a broader sense.
Furthermore, pixel lines involved may be a segment of pixel lines instead of whole

pixel lines. In order to reduce bandwidth associated with external memory access, the line buffer may be implemented using on-chip memory. Depending on the picture width or the segment size, the line buffer may be sizeable and consequently result in high chip cost. Accordingly, it is desirable to develop line buffer reduction scheme to
5 reduce the memory requirement for storing block information associated with the blocks for neighboring-block-dependent processing. However, line buffer reduction of the motion data may impact coding performance. It is also desirable to develop line buffer reduction scheme that will cause no performance degradation or minimum performance degradation.

10 SUMMARY

[0004] A method and apparatus for reduction of line buffer associated with neighboring-block-dependent processing in a video encoder or decoder are disclosed. In one embodiment according to the present invention, the method and apparatus for line buffer reduction comprise receiving the first-blocks at the outside boundary of the
15 second-block stripe consisting of second-blocks, wherein one or more of the first-blocks are used by a third-block at an inside boundary of the second-block stripe as neighboring blocks for neighboring-block-dependent processing, and wherein each of the first-blocks is associated with a set of block information, determining a set of representative block information for every N first-blocks, wherein N is a first integer
20 greater than 1; and storing the set of representative block information for every N first-blocks in memory, wherein the set of representative block information is used to derive the set of block information for every first-block in every N first-blocks. The set of block information includes one or a combination of the following: inter prediction direction, reference picture index, motion vector, motion vector difference,
25 motion vector predictor (MVP) candidate, and merge candidate, and said neighboring-block-dependent processing is motion vector predictor (MVP) candidate derivation, merge candidate derivation, or reference motion vector derivation.

[0005] An aspect of the present invention relates to determination of the set of representative block information. In one embodiment, the set of representative block
30 information corresponds to the set of block information selected from one of every N first-blocks. Said one of every N first-blocks can be selected according to positions or

importance of every N first-blocks. For example, the k-th position or the center position of every N first-blocks can be selected. In another embodiment, first position of one N first-blocks is selected for said one N first-blocks and last position of another N first-blocks is selected for said another N first-blocks, wherein said one N first-blocks are adjacent to said another N first-blocks. When said one of every N first-blocks is not Inter-coded, an Inter-coded neighboring first-block of every N first-blocks is selected to replace said one of every N first-blocks. In yet another embodiment, the set of representative block information is derived by performing a mathematical operation, such as median or weighted sum, on the sets of block information associated with two or more first-blocks of every N first-blocks.

[0006] Another aspect of the present invention relates to line buffer reduction control according to an indication explicitly incorporated in video bitstream or implicitly derived from the video bitstream. In one embodiment, the indication is related to whether minimum size or minimum width of the first-blocks is larger than a threshold. The threshold can be a predefined value or can be incorporated in a sequence, picture, or slice level of video bitstream such as sequence parameter set (SPS), picture parameter set (PPS), adaptive parameter set (APS) or a slice header. Alternatively, the indication can be a flag incorporated in a sequence, picture, or slice level of video bitstream such as SPS, PPS, APS or a slice header.

BRIEF DESCRIPTION OF DRAWINGS

[0007] Fig. 1 illustrates an example of dependency on neighboring blocks for motion vector predictor (MVP) candidate derivation in the High-Efficiency Video Coding (HEVC) coding system;

[0008] Fig. 2 illustrates an example of line buffers requirement for storing block information of blocks at an LCU row boundary in the HEVC coding system;

[0009] Fig. 3 illustrates an example of a 64x64 LCU divided into 4x4 blocks, where motion data associated with the bottom row of 4x4 blocks is buffered;

[0010] Fig. 4 illustrates neighboring block dependency of blocks on the upper side

of a current CU/PU at various sizes;

[0011] Fig. 5 illustrates an exemplary 2:1 line buffer reduction, where one set of representative block information determined from one of two blocks is shared by the two blocks;

5 [0012] Fig. 6 illustrates an exemplary 4:1 line buffer reduction, where one set of representative block information determined from one of four blocks is shared by the four blocks;

[0013] Fig. 7 illustrates an exemplary tile configuration, where a picture is partitioned into tiles containing multiple LCUs;

10 [0014] Fig. 8 illustrates an example of line buffers requirement for storing block information of blocks at a vertical tile boundary in the HEVC coding system.

DETAILED DESCRIPTION

[0015] In video coding, block information of neighboring blocks may be utilized to predict motion data or related syntax elements of a current block. For example, in
15 current High-Efficiency Video Coding (HEVC) Test Model version 4.0 (HM-4.0), inter prediction direction, reference picture index, and motion vector differences (MVDs) of upper and left blocks are used for coding the syntax element of inter prediction direction, reference picture index, and MVD of the current block in entropy coding. In another example, the inter prediction direction, reference picture index,
20 and MVs of upper-left (UL), upper (U), upper-right (UR0 and UR1), left (L), and bottom-left (BL0 and BL1) blocks are used to generate Merge and AMVP candidates of the current block as shown in Fig. 1. In Fig. 1, block T denotes a temporal co-located block.

[0016] In HM-4.0, the basic unit for storing the motion data of $N \times 2N$, $N \times N$,
25 $2N \times N$, and $2N \times 2N$ partitions is a 4×4 block. Each LCU (Largest Coding Unit) can be adaptively partitioned horizontally, vertically, or both vertically and horizontally into prediction units (PUs). Or the LCU is used as a PU (no partition). When a PU is

partitioned, a new PU is further partitioned until the new PU reaches a smallest size (4x4 in HM-4.0). Since LCUs are processed in a raster scan order, block information of bottom 4x4 blocks of an LCU row may be required to be stored in a line buffer for the processing of a next LCU row. Fig. 2 illustrates an example of line buffers for

5 block information associated with blocks at an LCU row boundary in the HEVC coding system, where a current CU/PU 210 within a current LCU 220 is being processed. Block information associated with upper blocks 230 and left blocks 240 is used by the current CU/PU 210 to generate Merge and AMVP candidates. In order to process the current row of LCUs 270, motion data for the row of blocks 250 on the

10 upper side of the LCU row boundary 252 has to be stored. Similarly, motion data for the row of blocks 260 on the bottom of the current LCU row 270 has to be stored for the next row of LCUs. As shown in Fig. 2, both current CU/PU 210 and current LCU 220 are adjacent to LCU row boundary 252 and both current CU/PU 210 and current LCU 220 are inside current LCU row 270. For convenience of reference, the side of

15 LCU row boundary that contains blocks stored in the line buffer and used by CUs/PUs as neighboring blocks for neighbor-block-dependent processing is referred to as an *outside boundary* in this disclosure. On the other hand, the side of LCU row boundary that contains CUs/PUs depending on blocks at the outside boundary is referred to as an *inside boundary* in this disclosure. Accordingly, both current CU/PU

20 210 and current LCU 220 are at the inside boundary while the row of blocks 250 are at an outside boundary. Usually, the LCUs in a picture are processed in the raster scan order, where the LCUs of a picture are processed row by row from top to bottom. Within each row, the LCUs are processed from left to right. Therefore, size of the line buffer for motion data is proportional to the picture width.

25 [0017] While the line buffers in the above example are used to store information for all upper blocks across the picture width, the line buffers may be used to store a portion of the upper blocks. For example, the picture may be divided into four vertical stripes (or regions) and each stripe is processed or coded independently. The line buffers used for each stripe correspond to a portion of pixel lines instead of a

30 whole pixel line across the picture width. Accordingly, the line buffers in this disclosure may correspond to storage associated with a portion or a segment of pixel lines. Since LCUs are processed in a raster scan order, buffers required for storing left LCU information are very small and can be easily implemented as on-chip

memory, which will not increase any external memory access bandwidth. However, the line buffer size for wide pictures may be sizeable.

[0018] Table 1 illustrates an exemplary motion data associated with each LCU in HM-4.0. The motion data for the bottom blocks of an LCU in a previous row of LCUs has to be stored for processing of the current row of LCUs, as shown in Fig. 3. The LCU consists of 64x64 pixels and the LCU is adaptively divided into CUs/PUs according to a performance criterion. For motion prediction, the LCU may also be adaptively divided into Prediction Units (PUs). While an LCU may be adaptively divided into CUs/PUs of various sizes, motion data stored in the line buffer for the bottom blocks in an LCU row is always at the smallest block unit, i.e., 4x4 PU as shown in Fig. 3. As shown in Table 1, a total of 1,336 bits are required for each LCU with 64x64 pixels. For super high resolution video with 4kx2k resolution, the line buffers will be around 10.7 Kbytes. If the above line buffers are implemented using on-chip memory, it will increase the chip cost noticeably. If the above line buffers are implemented using off-chip memory, it will increase system memory access bandwidth. Therefore, it is desirable to reduce the line buffers for block information, such as motion data without degradation or with very little degradation of coding performance.

Table 1.

Data	Usage	Required Bits
inter prediction direction	MVP candidates, merge candidates CABAC interDir coding CABAC total MVP/merge candidates	32
reference picture index	MVP candidates, merge candidates CABAC refIdx coding CABAC total MVP/merge candidates	96
MV	MVP candidates, merge candidates CABAC total MVP/merge candidates	896
depth	CABAC split flag coding	16
skip flag	CABAC skip flag coding	8
merge flag	CABAC merge flag coding	16
luma intra mode	CABAC luma intra mode coding	96
chroma intra mode	CABAC chroma intra mode coding	48

$ MVD > 16$?	CABAC MVD coding	32
cbf	CABAC cbf, no residual data flag coding	96
trafoDepth	CABAC cbf coding	64
Total bits in a 64x64 LCU		1336

[0019] The above example is based MH-4.0, specific block structure, and neighboring block dependency associated with MVP candidate derivation to illustrate the issue of line buffer requirement. Nevertheless, the present invention disclosed herein is not limited to the specific parameters of the above example. For generality, the blocks that form neighboring blocks of a current CU/PU and are dependent by the current CU/PU for neighboring-block-dependent processing are referred to as *first-blocks* in this disclosure. In the above example, the LCU is used as a block unit in a picture that forms one or more picture areas for the intended neighboring-block-dependent processing. While the LCU row is used as an example of a picture area, a column of LCUs or multiple columns of LCUs may also be used as a picture area for applying the intended neighboring-block-dependent processing. For generality, the block (i.e. LCU in this example) used to form a picture area for the intended neighboring-block-dependent processing is termed as *second-block* and the corresponding picture area is termed as *second-block stripe* in this disclosure. The CUs/PUs that are formed by partitioning LCU are termed as *third-blocks* in this disclosure. While MVP candidate derivation is used as an example of neighboring-block-dependent processing, the present invention is not limited to the application of MVP candidate derivation. The motion data listed in Table 1 illustrates an example of types of block information used for neighboring-block-dependent processing, other block information may also be used. Accordingly, for generality, *a set of block information* will be used in this disclosure to refer to information associated with the first-block for neighboring-block-dependent processing.

[0020] In order to reduce line buffer size and/or bandwidth of line buffer data access, methods and apparatuses according to the present invention to reduce the line buffers for motion data are disclosed. The motion data being considered for HM-4.0 include the inter prediction direction, reference picture index, MV, MVD and various related information as shown in Table 1. According to an embodiment of the present

invention, every N first-blocks share the set of representative motion data for one first-block so that N:1 data compression is achieved. Various embodiments according to the present invention are disclosed corresponding to various derivations of the set of representative block information (i.e., representative motion data in this case). The set of representative block information derivation may be based on the contents of these motion data and neighboring motion data, or positions of these blocks. For the first-blocks at the outside boundary (i.e. upper side of the boundary in this case) of the LCU row, only the set of representative block information for every N first-blocks will be stored in the line buffer. The set of block information for other blocks can be derived from the set of representative block information stored in the line buffer.

[0021] In order to derive good representative motion data, the manner that the first-blocks at the bottom of an LCU (i.e., second-block) are referenced by neighboring CUs/PUs (i.e., third-blocks) of various sizes may provide useful information. The positions of the blocks may have different impact on line buffer reduction. For example, the 16 blocks at the bottom of an LCU shown in Fig. 3 will be referred by a neighboring CU/PU below differently according to the CU/PU size. For the exemplary dependency on neighboring blocks shown in Fig. 1, the bottom 16 blocks in Fig. 3 will be referenced by the neighboring CU/PU of various sizes as shown in Fig. 4. A check mark “✓” in Fig. 4 indicates that the block is referenced. For example, if the CU/PU size is 4x4, blocks 0 and 1 will be referenced if the CU/PU is located below block 0, and blocks 1 and 2 will be referenced if the CU/PU is located below block 1. Accordingly, all 16 blocks will be referenced if the CU/PU size is 4x4 as shown in Fig. 4. On the other hand, if the CU/PU size is 64x64, only blocks 0 and 15 will be referenced as shown in Fig. 4. Accordingly, some of the bottom blocks are referenced or dependent on more frequently than others. For example, blocks 0 and 15 are referenced by CUs of all sizes while blocks 1, 2, 5, 6, 9, 10, 13 and 14 are only referenced or dependent on by 8x8 and 4x4 CUs/PUs. The frequencies that the blocks are referenced can be ranked into groups: {0, 15}, {7, 8}, {3, 4, 11, 12} and {1, 2, 5, 6, 9, 10, 13, 14}.

[0022] Accordingly, one embodiment of the present invention achieves line buffer reduction by removing motion data associated with the least important blocks. Fig. 5 illustrates an example of 2:1 line buffer reduction by retaining motion data for one

block out of every two blocks. In other words, the motion data for one block out of every two blocks is not stored. One embodiment of 2:1 line buffer reduction according to the present invention drops motion data for the block with less importance between two neighboring blocks. Therefore, the motion data for the block with less importance between two neighboring blocks is not stored in the line buffer. Alternatively, the set of representative block information may be selected according to the block position within the N first-blocks. For example, block information corresponds to the first position, the last position, or the center position of the N first-blocks is selected for stored in the line buffer. Also, the k-th position of every N first-blocks may be selected to determine the set of representative block data, where $0 \leq k \leq N$.

[0023] The motion data for the block that the motion data is not stored can be derived from the block that the motion data is stored. For example, between blocks 0 and 1, motion data is stored for block 0 and is dropped for block 1 as shown in Fig. 5. The dropped motion data for block 1 is derived from block 0 by copying the motion data for block 0. Similarly, between blocks 2 and 3, motion data is stored for block 3 and is dropped for block 2 as shown in Fig. 5. The dropped motion data for block 2 is derived from block 3 by copying the motion data for block 0. In the above exemplary 2:1 line buffer reduction, motion data for one out of two first-blocks is selected as the representative motion data for the two neighboring blocks.

[0024] Fig. 6 illustrates an example of 4:1 line buffer reduction according to one embodiment of the present invention, where the motion data is stored for one block out of every four first-blocks. The motion data for the block that has the highest importance is stored while the motion data for other blocks are skipped. Accordingly, the motion data for block 0 out of four first-blocks is stored while the motion data for blocks 1 through 3 is not stored. Similarly, the motion data for block 7 out of four first-blocks is stored while the motion data for blocks 4 through 6 is not stored. Therefore, 4:1 line buffer reduction is achieved. In this example, motion data for block 0 is selected as the representative motion data for blocks 0 through 3 and motion data for block 7 is selected as the representative motion data for blocks 4 through 7.

[0025] The examples in Fig. 5 and Fig. 6 illustrate an embodiment of the present invention to achieve N:1 line buffer reduction by selecting the motion data from the most important block among a group of N first-blocks. The importance is measured according to the frequency that the block is referenced by neighboring CUs/PUs at various sizes. The importance can be evaluated if the dependency on neighboring blocks is determined. For example, the importance is measured as shown in Fig. 4 for the given dependency on neighboring blocks shown in Fig. 1. For different dependency, the importance for the first-blocks may be different. As is noted in Fig. 4, the importance is related to the position of the block within the LCU. For the given dependency in Fig. 1, the most important blocks are the two blocks at the boundaries of the LCU. The second most important blocks are the two blocks at the boundaries of the 32x32 CU. Similarly, the third most important blocks are the two blocks at the boundaries of the 16x16 CU.

[0026] The exemplary dependency on neighboring blocks shown in Fig. 1 is intended for motion vector prediction. The motion vector associated with each neighboring block is used as a MVP candidate in order to reduce the data associated with motion vector difference between the current motion vector and the motion vector predictor. In the case of Inter mode, if the referenced block is Intra coded, the referenced block does not provide as important information as an Inter coded block. Therefore, if a referenced block is not Inter coded, a neighboring Inter-coded block may be selected to provide representative motion data. For example, in Fig. 6, if block 0 is not Inter-coded and block 1 is Inter-coded, the motion data of block 1 may be stored to represent the motion data of blocks 0, 1, 2 and 3.

[0027] In the examples in Fig. 5 and Fig. 6, the motion data from a block is used as the representative motion data for N first-blocks. However, the representative motion data may also be derived according to other means according to various embodiments of the present invention. For example, the set of representative motion data may be derived by performing a mathematical operation on the sets of block information associated with two or more first-blocks of every N first-blocks. The mathematical operation may correspond to the median of motion data of N first-blocks in one example. The mathematical operation may correspond to the weighted sum of motion data of N first-blocks in another example. The mathematical operation

may also be performed based on motion data for a portion of blocks in the N first-blocks.

[0028] Fig. 3 illustrates an example where the motion data is associated with the minimum prediction unit (4x4 in this example). In other words, the first-block is always 4x4. However, each LCU is adaptively partitioned into CUs/PUs and a leaf CU/PU may not be a minimum CU/PU. If the motion data for the blocks at the bottom of a row of LCUs is referenced according to the PUs instead of minimum PUs, the embodiments according to the present invention is still applicable. For example, blocks 0 and 1 in Fig. 3 may be within a single CU/PU (named block 0' for convenience) and blocks 2 and 3 are individual CUs/PUs. There is only one set of motion data associated with blocks 0 and 1 while individual motion data is associated with blocks 2 and 3. In the case of 4:1 line buffer reduction as shown in Fig. 6, since block 0' contains block 0, the motion data for block 0' is used as the representative motion data for the 4 minimum PU blocks (i.e., three CUs/PUs, blocks 0', 2 and 3). The 4:1 line buffer reduction is achieved in terms of one out of every four minimum blocks (measured in minimum PU size).

[0029] The line buffer reduction method can be selectively turned ON or OFF according to an indication explicitly incorporated in video bitstream or implicitly derived from the video bitstream. For example, a pre-defined value or a flag indicating the minimum PU size or minimum PU width for motion data reduction (e.g., min_motion_compress_PU_size or min_motion_compress_PU_width) can be signaled in sequence, picture, or slice-level of the video bitstream. The pre-defined value or flag can be incorporated in the sequence parameter set (SPS), picture parameter set (PPS), adaptive parameter set (APS), or slice header, where SPS, PPS, APS, and slice header are described in HM-4.0. If the smallest PU size/width of the current slice is larger than the pre-defined value, min_motion_compress_PU_size/min_motion_compress_PU_width, line buffer reduction can be turned OFF. In other words, line buffer reduction is turned ON when the smallest size/width of the first-block is less than or equal to the pre-defined value. In another example, the ON/OFF flag to control motion data reduction can be signaled in sequence, picture, or slice-level of the video bitstream for each LCU-row or each LCU. The ON/OFF flag can be incorporated in the SPS, PPS, APS, or slice

header.

[0030] The line buffer issue also exist in the case that a picture is partitioned into tiles, where each tile consists of $M \times N$ LCUs, M and N are integers greater than zero. Fig. 7 illustrates an example that a picture is partitioned into tiles having various sizes.

5 The tiles in a picture are processed in a raster scan order. Therefore, line buffers to store motion data associated with the blocks at the bottom of a tile row boundary are required for use by CUs/PUs below the tile row boundary. In addition, there may be multiple LCUs in the vertical direction of each tile. Therefore, there is also a need for column buffers to store motion data for multiple blocks (810 in Fig. 8) at the left side
10 of the column boundary of the current tile for use by CUs/PUs to the right of the column boundary. A tile may consist of many blocks in the vertical direction and the column buffer may be sizeable. Consequently, it is desirable to use column buffer reduction to reduce the storage requirement. For convenience, the term *line buffer* may also include column buffer in this disclosure since column buffer is considered as
15 a type of line buffer (vertical lines). Blocks 810 in Fig. 8 are used by CUs/PUs at the right side of the tile column boundary as neighboring blocks for neighboring-block-dependent processing. The exemplary dependency on neighboring blocks in Fig. 1 illustrates that a current CU/PU depends on neighboring blocks UL, L, BL1 and BL0 on the left. The line buffer reduction techniques disclosed previously are also
20 applicable to the line buffers associated with blocks at the vertical boundary of a tile. Exemplary 2:1 line buffer reduction for vertical boundary of a tile is illustrated in Fig. 8, where block 0 is used to provide the representative motion data for blocks 0 and 1, and block 3 is used to provide the representative motion data for blocks 2 and 3. As mentioned before, a block selected to provide representative motion data might be
25 Intra-coded while the current CU/PU is Inter coded. In this case, an Inter-coded neighboring block within the N first-blocks may be used to replace the block selected to provide representative motion data. In addition, other means to derive the representative motion data may also be used, such as the median or weighted sum of N first-blocks.

30 [0031] Embodiment of video systems incorporating line buffer reduction 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

5 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

10 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

15 invention.

[0032] 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. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing

20 description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

CLAIMS

1. A method of line buffer reduction for first-blocks at an outside boundary of a second-block stripe in a video encoder or decoder, the method comprising:

receiving the first-blocks at the outside boundary of the second-block stripe

5 consisting of second-blocks, wherein one or more of the first-blocks are used by a third-block at an inside boundary of the second-block stripe as neighboring blocks for neighboring-block-dependent processing, and wherein each of the first-blocks is associated with a set of block information;

determining a set of representative block information for every N first-blocks,

10 wherein N is a first integer greater than 1; and

storing the set of representative block information for every N first-blocks in memory, wherein the set of representative block information is used to derive the set of block information for every first-block in every N first-blocks.

2. The method of Claim 1, wherein the set of block information comprises one or
15 a combination of inter prediction direction, reference picture index, motion vector, motion vector difference, motion vector predictor (MVP) candidate, and merge candidate, and wherein said neighboring-block-dependent processing is motion vector predictor (MVP) candidate derivation, merge candidate derivation, or reference motion vector derivation.

20 3. The method of Claim 1, wherein the set of representative block information corresponds to the set of block information selected from one of every N first-blocks.

4. The method of Claim 3, wherein said one of every N first-blocks is selected according to positions or importance of every N first-blocks.

25 5. The method of Claim 4, wherein k-th position of every N first-blocks is selected, where k is a second integer from 1 to N.

6. The method of Claim 4, wherein center position of every N first-blocks is selected.

30 7. The method of Claim 4, wherein first position of one N first-blocks is selected and last position of another N first-blocks is selected, wherein said one N first-blocks are adjacent to said another N first-blocks.

8. The method of Claim 4, wherein if said one of every N first-blocks is not Inter-coded, an Inter-coded first-block of the N first-blocks is selected to replace said one of every N first-blocks.

9. The method of Claim 1, wherein the set of representative block information is derived by performing a mathematical operation on the sets of block information associated with two or more first-blocks of every N first-blocks.

10. The method of Claim 9, wherein the mathematical operation corresponds to a
5 median function or a weighted sum function.

11. The method of Claim 1, whether to reduce size of the memory by performing said storing the set of representative block information for every N first-blocks in the memory is according to an indication explicitly incorporated in a video bitstream or implicitly derived from the video bitstream.

10 12. The method of Claim 11, wherein the indication is related to whether a minimum size or width of the first-blocks is larger than a threshold.

13. The method of Claim 12, wherein a syntax element corresponding to the threshold is incorporated in a sequence, picture, or slice level of the video bitstream.

14. The method of Claim 13, wherein the syntax element is incorporated in
15 sequence parameter set (SPS), picture parameter set (PPS), adaptive parameter set (APS) or a slice header.

15. The method of Claim 12, the threshold is a predefined value.

16. The method of Claim 15, the threshold is 8.

17. The method of Claim 11, wherein the indication is a flag incorporated in a
20 sequence, picture, or slice level of the video bitstream.

18. The method of Claim 17, wherein the flag is incorporated in SPS, PPS, APS or a slice header.

19. An apparatus of line buffer reduction for first-blocks at an outside boundary of a second-block stripe in a video encoder or decoder, the apparatus comprising:

25 means for receiving the first-blocks at the outside boundary of the second-block stripe consisting of second-blocks, wherein one or more of the first-blocks are used by a third-block at an inside boundary of the second-block stripe as neighboring blocks for neighboring-block-dependent processing, and wherein each of the first-blocks is associated with a set of block information;

30 means for determining a set of representative block information for every N first-blocks, wherein N is a first integer greater than 1; and

means for storing the set of representative block information for every N first-blocks in memory, wherein the set of representative block information is used to derive the set of block information for every first-block in every N first-blocks.

20. The apparatus of Claim 19, wherein the set of block information comprises one or a combination of inter prediction direction, reference picture index, motion vector, motion vector difference, motion vector predictor (MVP) candidate, and merge candidate, and wherein said neighboring-block-dependent processing is motion vector predictor (MVP) candidate derivation, merge candidate derivation, or reference motion vector derivation.

21. The apparatus of Claim 19, wherein the set of representative block information corresponds to the set of block information selected from one of every N first-blocks.

10 22. The apparatus of Claim 19, wherein the set of representative block information is derived by performing a mathematical operation on the sets of block information associated with two or more first-blocks of every N first-blocks.

23. The apparatus of Claim 19, wherein, in the video encoder, whether to reduce size of the memory by performing said storing the set of representative block information for every N first-blocks in the memory is according to an indication explicitly incorporated in a video bitstream or implicitly derived from the video bitstream.

15

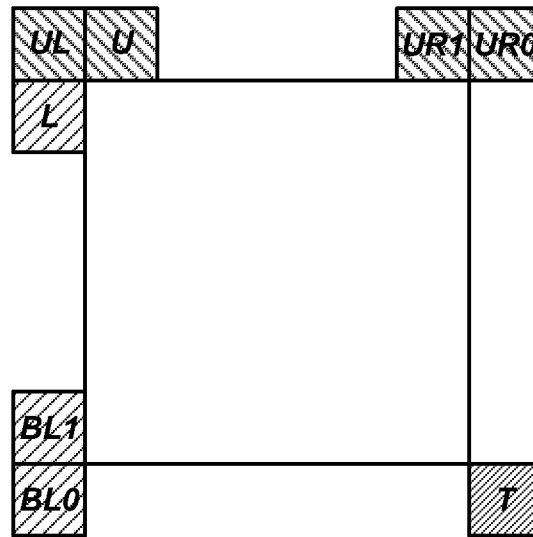


Fig. 1

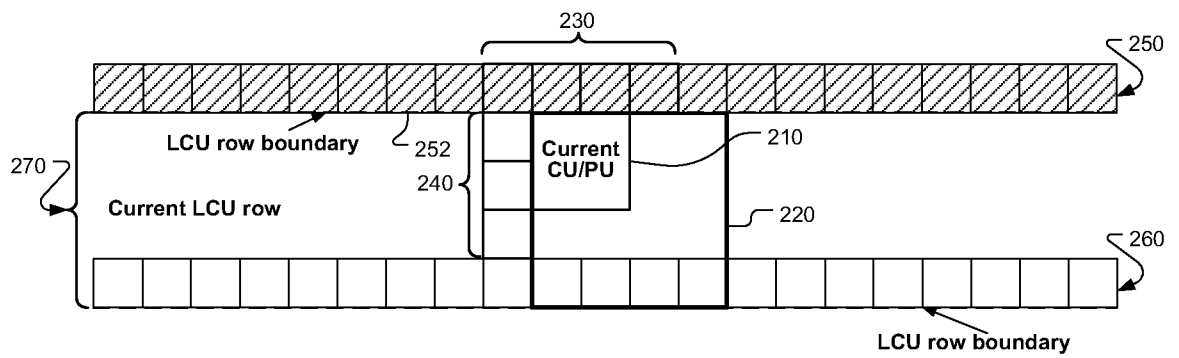


Fig.2

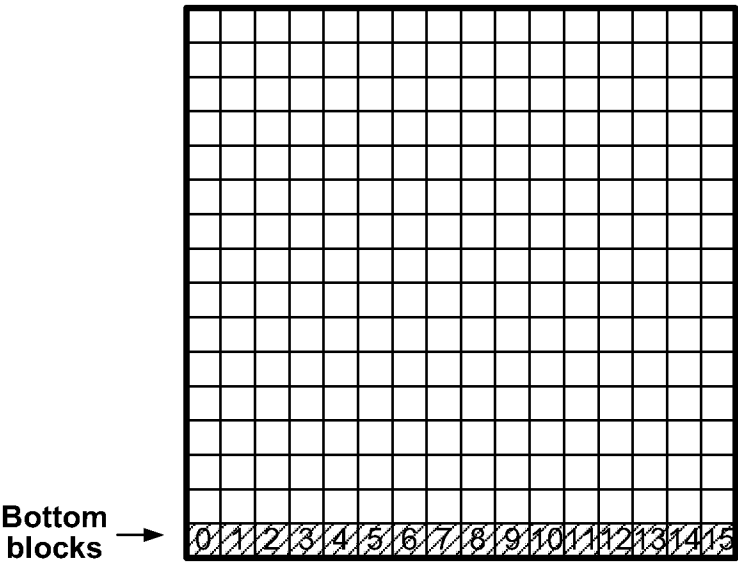


Fig. 3



Fig. 4

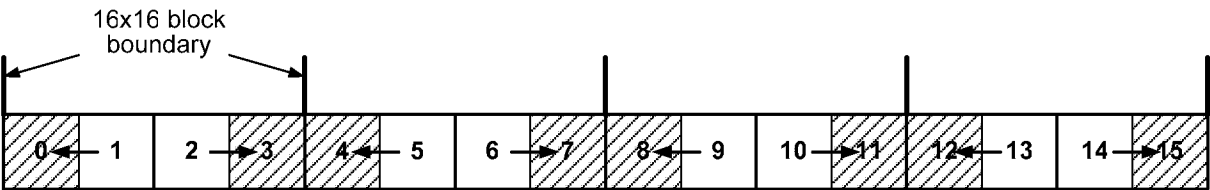


Fig. 5

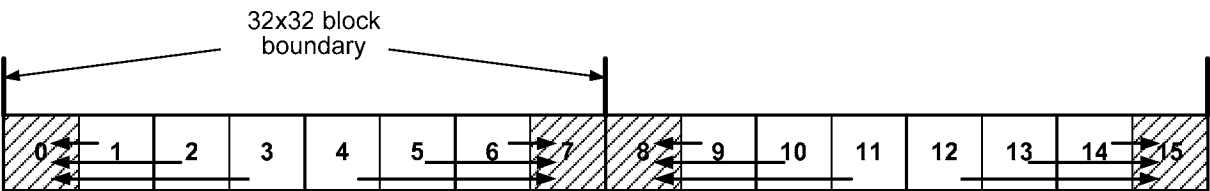
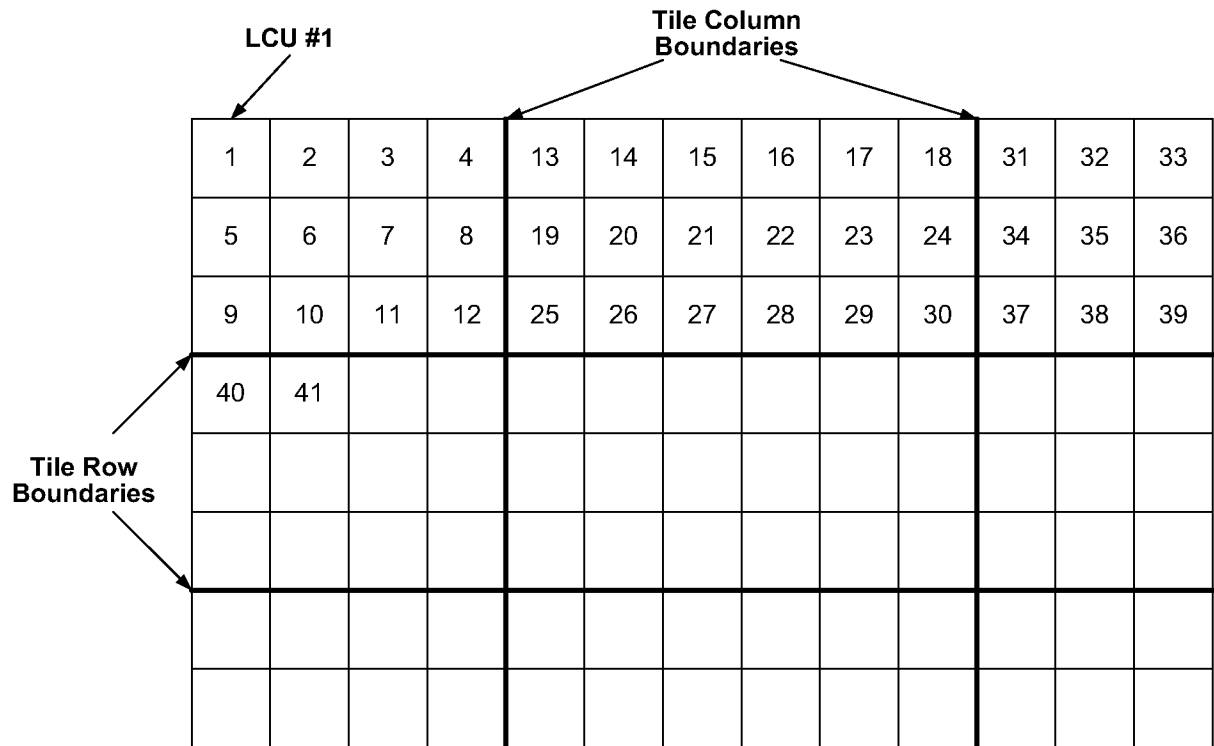


Fig. 6

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**Fig. 7**

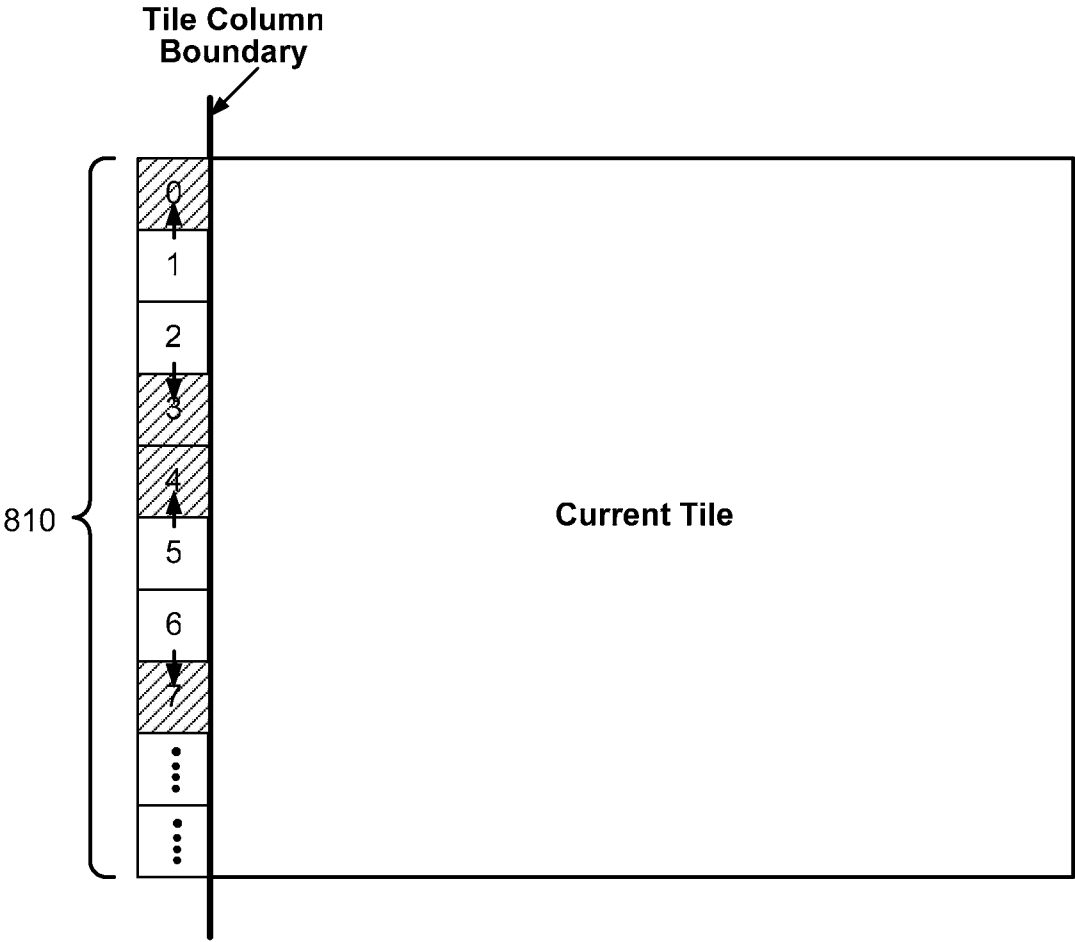


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/076136

A. CLASSIFICATION OF SUBJECT MATTER

H04N 7/26 (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: 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)

CNPAT; WPI; EPODOC: video, line, buffer?, reduce+, block?, boundary, edge, cod+, encod+, decod+, outside, inside, motion, vector, predict+, estimat+, neighbor+,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US2010208820A1 (ACER INCORPORATED) 19 Aug. 2010 (19.08.2010) the whole document	1-23
A	US2008273595A1 (Yu-Wen HUANG et al.) 06 Nov. 2008 (06.11.2008) the whole document	1-23
A	US2008043845A1(FUJITSU LIMITED) 21 Feb. 2008 (21.02.2008) the whole document	1-23

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“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)	“&”document member of the same patent family
“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	

Date of the actual completion of the international search
20 Aug. 2012 (20.08.2012)Date of mailing of the international search report
06 Sep. 2012 (06.09.2012)Name and mailing address of the ISA/CN
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/076136

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