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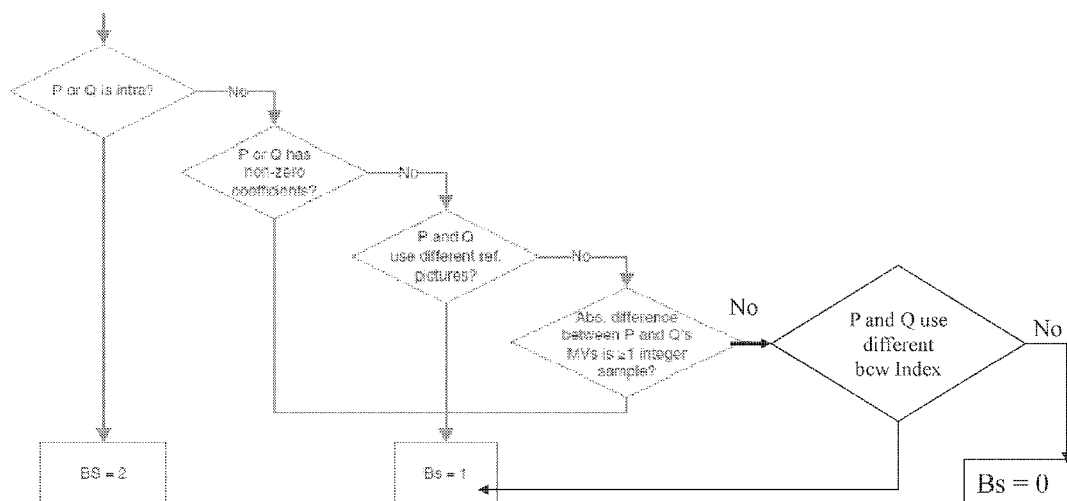


Fig. 16B

(57) **Abstract:** The present invention relates to the field of picture processing. Especially, the invention deals with improving the deblocking filter of an image processing device. In the case two different pairs of weighting factors are applied to the first image block and the second image block, assigning or setting, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; wherein the first block and the second block are predicted by Bi-prediction; and performing deblocking filtering of values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter



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AN IMAGE PROCESSING DEVICE AND METHOD FOR PERFORMING DEBLOCKING

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application claims the priority to U.S. Provisional Patent Application No.
5 62/742,913, filed October 08, 2018. The disclosure of the aforementioned patent
application is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

Embodiments of the present invention relate to the field of picture processing, for
10 example still picture and/or video picture coding. Especially, the invention deals with
improvements of the deblocking filter.

BACKGROUND

Image coding (encoding and decoding) is used in a wide range of digital image
15 applications, for example broadcast digital TV, video transmission over internet and
mobile networks, real-time conversational applications such as video chat, video
conferencing, DVD and Blu-ray discs, video content acquisition and editing systems,
and camcorders of security applications.

20 Since the development of the block-based hybrid video coding approach in the H.261
standard in 1990, new video coding techniques and tools were developed and formed
the basis for new video coding standards. One of the goals of most of the video coding
standards was to achieve a bitrate reduction compared to its predecessor without
sacrificing picture quality. Further video coding standards comprise MPEG-1 video,
25 MPEG-2 video, ITU-T H.262/MPEG-2, ITU-T H.263, ITU-T H.264/MPEG-4, Part 10,
Advanced Video Coding (AVC), ITU-T H.265, High Efficiency Video Coding

(HEVC), ITU-T H.266/Versatile video coding (VVC) and extensions, e.g. scalability and/or three-dimensional (3D) extensions, of these standards.

Block-based image coding schemes have in common that along the block edges, edge artifacts can appear. These artifacts are due to the independent coding of the coding blocks. These edge artifacts are often readily visible to a user. A goal in block-based image coding is to reduce edge artifacts below a visibility threshold. This is done by performing deblocking filtering. Such a deblocking filtering is on the one hand performed on decoding side in order to remove the visible edge artifacts, but also on encoding side, in order to prevent the edge artifacts from being encoded into the image at all.

Inter-picture prediction makes use of the temporal correlation between pictures in order to derive a motion-compensated prediction (MCP) for a block of image samples. For this block-based MCP, a video picture is divided into rectangular blocks. Assuming homogeneous motion inside one block and that moving objects are larger than one block, for each block, a corresponding block in a previously decoded picture can be found that serves as a predictor. The general concept of MCP based on a translational motion model is illustrated in Fig.1. Using a translational motion model, the position of the block in a previously decoded picture is indicated by a motion vector $(\Delta x, \Delta y)$ where Δx specifies the horizontal and Δy specifies the vertical displacement relative to the position of the current block. The motion vectors $(\Delta x, \Delta y)$ could be of fractional sample accuracy to more accurately capture the movement of the underlying object. Interpolation is applied on the reference pictures to derive the prediction signal when the corresponding motion vector has fractional sample accuracy. The previously decoded picture is referred to as the reference picture and indicated by

a reference index Δt to a reference picture list. These translational motion model parameters, i.e. motion vectors and reference indices, are further referred to as motion data. Two kinds of inter-picture prediction are allowed in modern video coding standards, namely uni-prediction and bi-prediction.

5

In case of bi-prediction, two sets of motion data ($\Delta x_0, \Delta y_0, \Delta t_0$ and $\Delta x_1, \Delta y_1, \Delta t_1$) are used to generate two MCPs (possibly from different pictures), which are then combined to get the final MCP. Per default, this is done by averaging but in case of weighted prediction, different weights can be applied to each MCP, e.g. to compensate
10 for scene fade outs. The reference pictures that can be used in bi-prediction are stored in two separate lists, namely list 0 and list 1.

However, the conventional approaches do not take into account that a discontinuity may arise when one of the image blocks / coding units sharing the given edge use Bi-
15 prediction with CU-level weights, i.e. bcw or GBi weights. Thus, deblocking filtering can be challenging or even not yield the results expected.

SUMMARY

In view of the above-discussed problems the present disclosure provides a solution to
20 mitigate or even remove the above-mentioned problem.

Embodiments of the present application provide a deblocking filter apparatus for use in an image encoder and/or an image decoder and a deblocking method for use in an image encoding and/or an image decoding. The respective apparatus and method may
25 mitigate blocking artifacts that would be caused by the application of unequal weights

in bi-prediction by selective application of deblocking filtering, so as to improve coding efficiency. The scope of protection is defined by the claims.

Embodiments of the invention are defined by the features of the independent claims,
5 and further advantageous implementations of the embodiments by the features of the dependent claims.

Particular embodiments are outlined in the attached independent claims, with other embodiments in the dependent claims.

10

According to an aspect of the present disclosure it is provided a deblocking method, for deblocking a block edge between a first image block and a second image block (such as the first image block and the second image block are spatially adjacent image blocks), in an image encoding and/or an image decoding, comprising: in the case two
15 different pairs of weighting factors are applied to the first image block and the second image block, assigning or setting, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; wherein the first block and the second block are predicted by Bi- prediction; and performing deblocking filtering of values of samples near the block edge (such as
20 the samples are in a line perpendicular to and adjacent to the block edge) between the first image block and the second image block based on the first value of the boundary strength parameter.

According to another aspect of the present disclosure it is also provided a deblocking method, for deblocking a block edge between a first image block and a second image
25 block, in an image encoding and/or an image decoding, comprising: assigning or setting, in case one or more conditions are met, a value of a boundary strength

parameter associated with the block edge between the first image block and the second image block, as a first value; and performing deblocking filtering at values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter; wherein the one or more
5 conditions at least comprise: affirmatively determining that two different pairs of weighting factors are applied to the first image block and the second image block; and wherein the first image block and the second image block are predicted by Bi-prediction.

10 The above-mentioned deblocking methods provide an additional check in the deblocking boundary strength derivation process which sets the boundary strength “bS” to 1 if one of the coding units / image blocks sharing the edge uses a different index when compared to the other coding unit / image block. This results in removing a potential discontinuity which may be caused when coding units / image blocks use
15 different indexes. This ensures that the potential discontinuity caused by different coding units / images blocks using different indexes is removed. This allows for an especially accurate and efficient decoding of the image.

It should be understood that different indexes of weighting factors means different
20 pairs of weighting factors are applied to the first image block and the second image block which adjacent or neighboring with respect to each other.

It should be understood that the first image block and the second image block are spatially adjacent image blocks.

In a possible implementation form of the method according to the previous aspect as such, for the samples of the first image block which are in a line perpendicular to and adjacent to the block edge, and for the samples of the second image block which are in a line perpendicular to and adjacent to the block edge, the value of BS is assigned or
5 set as the first value (such as 1).

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such,, wherein the two
10 pairs of weighting factors comprise:
a first pair of weighting factors used for Bi-prediction of the first image block,
wherein first and second weighting factors are included in the first pair of weighting factors, and
a second pair of weighting factors used for Bi-prediction of the second image block,
15 wherein third and fourth weighting factors are included in the second pair of weighting factors.

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the two
20 pairs of weighting factors comprise:
a first pair of weighting factors used for obtaining weighted Bi-predicted value of the first image block, wherein the weighted Bi-predicted value of the first image block is based on a sum of first uni-predicted value multiplied with a first weighting factor and second uni-predicted value multiplied with a second weighting factor, and the first and
25 second weighting factors are included in the first pair of weighting factors; and

a second pair of weighting factors used for obtaining weighted Bi-predicted value of the second image block, wherein the weighted Bi-predicted value of the second image block is based on a sum of a third uni-predicted value multiplied with a third weighting factor and a fourth uni-predicted value multiplied with a fourth weighting factor, and
5 the third and fourth weighting factors are included in the second pair of weighting factors.

It should be understood that motion information of the first image block comprises a first motion vector, a first reference index, a second motion vector and a second reference index, wherein the first reference index indicates the first reference picture,
10 and the second reference index indicates the second reference picture. The first uni-predicted value is obtained based on a first motion vector and a first reference picture, and the second uni-predicted value is obtained based on a second motion vector and a second reference picture.

It should be understood that motion information of the second image block comprises
15 a third motion vector, a first reference index, a fourth motion vector and a second reference index, wherein the first reference index indicates the first reference picture, and the second reference index indicates the second reference picture. The third uni-predicted value is obtained based on a third motion vector and a first reference picture, and the fourth uni-predicted value is obtained based on a fourth motion vector and a
20 second reference picture.

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first weighting factor included in the first pair of weighting factors is different from the
25 third weighting factor included in the second pair of weighting factors, or the second

weighting factor included in the first pair of weighting factors is different from the fourth weighting factor included in the second pair of weighting factors. In general, any one of the first and second weighting factors included in the first pair of weighting factors is different from any one of the third and fourth weighting factors included in the second pair of weighting factors.

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(3/8, 5/8)$;

the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(-1/4, 5/4)$; or

the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(5/8, 3/8)$; or

the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(5/4, -1/4)$; or

the first pair of weighting factors are $(5/8, 3/8)$, and the second pair of weighting factors are $(5/4, -1/4)$; or

the first pair of weighting factors are $(3/8, 5/8)$, and the second pair of weighting factors are $(-1/4, 5/4)$.

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors are $(3, 5)$;

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (-2, 10) ; or

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (5, 3) ; or

5 the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (10, -2) ; or

the first pair of weighting factors are (5, 3), and the second pair of weighting factors are (10, -2) ; or

10 the first pair of weighting factors are (3, 5), and the second pair of weighting factors are (-2, 10).

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the second image block is a current image block, wherein a first image block is a
15 neighboring image block of the current image block.

In a possible implementation form of the method according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the second pair of weighting factors (w_3 , w_4) comprises (3/8, 5/8), (1/2, 1/2), (4/8, 4/8),
20 (5/8, 3/8), (5/4, -1/4) or (-1/4, 5/4), or
the second pair of weighting factors (w_3 , w_4) comprises (3, 5), (4, 4), (5, 3), (10, -2), or (-2, 10).

In a possible implementation form of the method according to any preceding
25 implementation of the previous aspect or the previous aspect as such, wherein the weighting factors are Bi-prediction with coding unit, CU, level weights, BCW.

It should be understood that bcw (which was previously known as Gbi) is a coding tool which enables signalling different prediction weights for coding blocks.

In a possible implementation form of the method according to any preceding
5 implementation of the previous aspect or the previous aspect as such, wherein the weighting factors are generalized Bi-prediction, GBi, weights.

In a possible implementation form of the method according to any preceding
implementation of the previous aspect or the previous aspect as such, wherein a
10 weighting factor of each pair of weighting factors is mapped to a specific index by a predefined mapping.

For example, the first weighting factor (such as w_1) of the first pair of weighting factors is mapped to a specific index by a mapping table, such as the variable w_1 is set
15 equal to $bcwWLut[bcwIdx]$ with $bcwWLut[k] = \{4, 5, 3, 10, -2\}$.
the second weighting factor (such as w_2) of the first pair of weighting factors is derived by a formulation, such as $w_2 = 8 - w_1$.

In a possible implementation form of the method according to any preceding
20 implementation of the previous aspect or the previous aspect as such, wherein a BCW weight of each pair of weighting factors is mapped to a bcw index, denoted bcw_idx , by a predefined mapping.

In a possible implementation form of the method according to any preceding
25 implementation of the previous aspect or the previous aspect as such, wherein a GBi

weight of each pair of weighting factors is mapped to a GBi index, denoted Gbi_idx, by a predefined mapping.

In a possible implementation form of the method according to any preceding
5 implementation of the previous aspect or the previous aspect as such, wherein different indexes bcw_idx or GBi_idx, denote different weighting factors, respectively.

In a possible implementation form of the method according to any preceding
implementation of the previous aspect or the previous aspect as such, wherein the first
10 value is 1.

In a possible implementation form of the method according to any preceding
implementation of the previous aspect or the previous aspect as such, wherein the first
and second image blocks are coding blocks or transform blocks or coding sub-blocks.
15

According to another aspect, an apparatus is provided, which comprises
modules/units/components/circuits to perform at least a part of the steps of the above
method according to any preceding implementation of the any preceding aspect or the
20 any preceding aspect as such.

The apparatus according to the aspect can be extended into implementation forms
corresponding to the implementation forms of a method according to the any preceding
aspect. Hence, an implementation form of the apparatus comprises the feature(s) of the
corresponding implementation form of the method according to the any preceding
25 aspect.

The advantages of the apparatuses according to the any preceding aspect are the same as those for the corresponding implementation forms of the method according to the any preceding aspect.

5 According to a further aspect of the present disclosure it is further provided a non-transitory computer-readable media storing computer instructions that when executed by one or more processors, cause the one or more processors to perform one of the deblocking methods as described above.

10 According to another aspect of the present disclosure it is further provided a deblocking filter apparatus for use in an image encoder and/or an image decoder comprising: an edge locating unit, configured to determine a block edge between a first image block and a second image block, a deblocking determination unit configured to determine whether two different pairs of weighting factors are applied to the first
15 image block and the second image block, and in case the determination is affirmative configured to assign or set, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; wherein the first block and the second block are predicted by Bi- prediction; and a deblocking filtering unit configured to perform deblocking filtering of values of
20 samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter.

According to another aspect of the present disclosure it is also provided a deblocking filter apparatus for use in an image encoder and/or an image decoder comprising: a
25 deblocking determination unit configured to assign or set, in case one or more conditions are met, a value of a boundary strength parameter associated with the block

edge between the first image block and the second image block, as a first value; and a deblocking filtering unit configured to perform deblocking filtering at values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter; wherein the one or more
5 conditions at least comprise: affirmatively determining that two different pairs of weighting factors are applied to the first image block and the second image block; and wherein the first image block and the second image block are predicted by Bi-prediction.

10 In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the two pairs of weighting factors comprise:

a first pair of weighting factors used for Bi-prediction of the first image block, wherein first and second weighting factors are included in the first pair of weighting
15 factors, and
a second pair of weighting factors used for Bi-prediction of the second image block, wherein third and fourth weighting factors are included in the second pair of weighting factors.

20 In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the two pairs of weighting factors comprise:

a first pair of weighting factors used for obtaining weighted Bi-predicted value of the first image block, wherein the weighted Bi-predicted value of the first image block is
25 based on a sum of first uni-predicted value multiplied with a first weighting factor and

second uni-predicted value multiplied with a second weighting factor, and the first and second weighting factors are included in the first pair of weighting factors; and a second pair of weighting factors used for obtaining weighted Bi-predicted value of the second image block, wherein the weighted Bi-predicted value of the second image block is based on a sum of a third uni-predicted value multiplied with a third weighting factor and a fourth uni-predicted value multiplied with a fourth weighting factor, and the third and fourth weighting factors are included in the second pair of weighting factors.

10 In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first weighting factor included in the first pair of weighting factors is different from the third weighting factor included in the second pair of weighting factors, or the second weighting factor included in the first pair of weighting factors is different from the fourth weighting factor included in the second pair of weighting factors.

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(3/8, 5/8)$;
the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(-1/4, 5/4)$; or
the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(5/8, 3/8)$; or
25 the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(5/4, -1/4)$; or

the first pair of weighting factors are $(5/8, 3/8)$, and the second pair of weighting factors are $(5/4, -1/4)$; or

the first pair of weighting factors are $(3/8, 5/8)$, and the second pair of weighting factors are $(-1/4, 5/4)$.

5

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors are $(3, 5)$;

10 the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors are $(-2, 10)$; or

the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors are $(5, 3)$; or

15 the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors are $(10, -2)$; or

the first pair of weighting factors are $(5, 3)$, and the second pair of weighting factors are $(10, -2)$; or

the first pair of weighting factors are $(3, 5)$, and the second pair of weighting factors are $(-2, 10)$.

20

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the second image block is a current image block, wherein a first image block is a neighboring image block of the current image block.

25

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the second pair of weighting factors (w_3 , w_4) comprises $(3/8, 5/8)$, $(1/2, 1/2)$, $(4/8, 4/8)$, $(5/8, 3/8)$, $(5/4, -1/4)$ or $(-1/4, 5/4)$, or

5 the second pair of weighting factors (w_3 , w_4) comprises $(3, 5)$, $(4, 4)$, $(5, 3)$, $(10, -2)$, or $(-2, 10)$.

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the

10 weighting factors are Bi-prediction with coding unit, CU, level weights, BCW.

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the weighting factors are generalized Bi-prediction, GBi, weights.

15

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein a weighting factor of each pair of weighting factors is mapped to a specific index by a predefined mapping.

20

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein a BCW weight of each pair of weighting factors is mapped to a bcw index, denoted `bcw_idx`,

25 by a predefined mapping.

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein a GBi weight of each pair of weighting factors is mapped to a GBi index, denoted Gbi_idx, by a predefined mapping.

5

In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein different indexes bcw_idx or GBi_idx, denote different weighting factors, respectively.

10 In a possible implementation form of the apparatus according to any preceding implementation of the previous aspect or the previous aspect as such, wherein the first value is 1.

In a possible implementation form of the apparatus according to any preceding
15 implementation of the previous aspect or the previous aspect as such, wherein the first and second image blocks are coding blocks or transform blocks or coding sub-blocks.

According to another aspect of the present disclosure it is also provided a device for use in an image encoder and/or an image decoder, for deblocking block edges between
20 image blocks, wherein the block edges comprises a block edge between a first image block and a second image block (such as the first image block and the second image block are spatially adjacent image blocks),

wherein the device comprises a de-blocking filter configured to:

in the case two different pairs of weighting factors are applied to the first image block
25 and the second image block, assign or set, a value of a boundary strength parameter associated with the block edge between the first image block and the second image

block(such as, for the samples of the first image block which are in a line perpendicular to and adjacent to the block edge, and for the samples of the second image block which are in a line perpendicular to and adjacent to the block edge, the value of BS is assigned or set as a first value (such as 1)), as a first value; wherein the first block and the second block are predicted by Bi-prediction; and

perform deblocking filtering of values of samples near the block edge (such as, the samples are in a line perpendicular to and adjacent to the block edge) between the first image block and the second image block based on the first value of the boundary strength parameter.

10

According to another aspect of the present disclosure it is also provided a device for use in an image encoder and/or an image decoder, for deblocking block edges between image blocks, wherein the block edges comprises a block edge between a first image block and a second image block (such as, the first image block and the second image block are spatially adjacent image blocks),

15

wherein the device comprises a de-blocking filter configured to:

assign or set, in case one or more conditions are met, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; and

perform deblocking filtering at values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter;

20

wherein the one or more conditions at least comprise:

two different pairs of weighting factors are applied to the first image block and the second image block;

25

and

wherein the first image block and the second image block are predicted by Bi-prediction.

In the following, it should be understood that the boundary strength parameter may be denoted by BS, Bs, bS, or bs, the meaning of which shall be understood as being the same. The boundary strength, bS, may be a multidimensional array, in particular a two-dimensional array, denoted by $bS[xDi, xDj]$, where xDi, xDj refer to integer numbers representing the indices for the respective array element. For example, xDi, xDj follow a grid structure, i.e. they denote a specific position on a specific grid. Said grid has a specific size of the grid which is also called the grid size and is denoted by the variable gridSize.

According to an aspect of the invention, deblocking filter is applied on the edge between two blocks if they apply two different weighting factors to construct the motion compensated prediction. Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor.

According to another aspect of the invention, at the edge between two spatially adjacent blocks which apply bi-prediction deblocking filter is applied if the two blocks apply two different weighting factors to construct the motion compensated prediction. Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor.

According to another aspect of the invention, at the edge between two spatially adjacent blocks, if both blocks apply inter prediction and specifically bi-prediction

a weak deblocking filter is applied if the two blocks apply two different weighting factors to construct the motion compensated prediction. Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor. A strong deblocking filter is applied otherwise (if any one of
5 the two blocks are predicted by intra prediction)

According to another aspect of the invention, at the edge between two spatially adjacent blocks if both blocks apply inter prediction and specifically bi-prediction, deblocking filter is applied if the two blocks apply two different weighting factors to
10 construct the motion compensated prediction. Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor.

According to another aspect of the invention, at the edge between two spatially adjacent blocks, if both blocks apply inter prediction and specifically bi-prediction,
15 a boundary strength parameter is set equal to one if the two blocks apply two different weighting factors to construct the motion compensated prediction. The boundary strength parameter might be set to zero or one on the edge between two blocks if the two blocks apply the same weighting factor. The boundary strength parameter is used in the determination of application of deblocking filtering at the said block edge.

20

According to another aspect of the invention, a video encoding apparatus is provided. the video encoding apparatus (100) for encoding a picture of a video stream, wherein the video encoding apparatus (100) comprises:

25 a reconstruction unit (114) configured to reconstruct the picture; and

a filter apparatus (120) as previously described for processing the reconstructed picture into a filtered reconstructed picture.

This allows for a very efficient and accurate encoding of the image.

- 5 According to another aspect of the invention, a video decoding apparatus is provided. the video decoding apparatus (200) for decoding a picture of an encoded video stream (303), wherein the video decoding apparatus (200) comprises:

a reconstruction unit (214) configured to reconstruct the picture; and

10

a loop filter apparatus (220) as previously described for processing the reconstructed picture into a filtered reconstructed picture.

This allows for an especially accurate and efficient decoding of the image.

- According to another aspect of the invention, the invention relates to a deblocking
15 method for use in an image encoding and/or an image decoding, is defined according to claims.

This allows for an especially accurate and efficient deblocking.

- According to another aspect of the invention, the invention relates to an encoding
20 method for encoding an image (900, 1300), comprising a previously shown deblocking method.

This allows for a very efficient and accurate encoding of the image.

- According to another aspect of the invention, the invention relates to a decoding
25 method for decoding an image (900, 1300), comprising a previously shown deblocking method.

This allows for a very efficient and accurate decoding of the image.

The method according to the previously aspect of the invention can be performed by the apparatus according to the previously aspect of the invention. Further features and
5 implementation forms of the method according to the previously aspect of the invention result directly from the functionality of the apparatus according to the previously aspect of the invention and its different implementation forms.

According to another aspect the invention relates to an apparatus for decoding a video
10 stream includes a processor and a memory. The memory is storing instructions that cause the processor to perform the previously shown deblocking method.

According to another aspect the invention relates to an apparatus for encoding a video stream includes a processor and a memory. The memory is storing instructions that
15 cause the processor to perform the previously shown deblocking method.

According to another aspect, a computer-readable storage medium having stored thereon instructions that when executed cause one or more processors configured to code video data is proposed. The instructions cause the one or more processors to
20 perform a previously shown method.

According to another aspect, a computer program product with a program code for performing the previously shown method when the computer program runs on a computer, is provided.

Details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description, drawings, and claims.

5 BRIEF DESCRIPTION OF THE DRAWINGS

In the following embodiments of the invention are described in more detail with reference to the attached figures and drawings, in which:

10 Fig. 1 is a block diagram showing an example of a video encoder configured to implement embodiments of the invention;

Fig. 2 is a block diagram showing an example structure of a video decoder configured to implement embodiments of the invention;

15

Fig. 3 is a block diagram showing an example of a video coding system configured to implement embodiments of the invention;

Fig. 4 shows two exemplary coding blocks;

20

Fig. 5A shows two exemplary coding blocks and respective sample values used and modified during filtering;

Fig. 5B illustrates how for deblocking a discontinuity may arise for a first image
25 block and a second image block when different pairs of weighting factors are applied to the first and the second image block.

- Fig. 6 shows a first embodiment of the deblocking filter apparatus according to embodiments of the invention;
- 5 Fig. 7 shows a flow chart illustrating a method for determining whether a longer tap filter shall be used;
- Fig. 8 shows a flow chart illustrating a method for determining whether the HEVC strong filter condition should be satisfied;
- 10 Fig. 9 shows two exemplary coding blocks and sample values used and modified during filtering according to another embodiment of the invention, and
- 15 Fig. 10 shows a flow diagram depicting an exemplary process for increasing the efficiency of deblocking filtering;
- Fig. 11 shows a flow diagram depicting an exemplary process for increasing the efficiency of deblocking filtering;
- 20 Fig. 12A shows a flow diagram for a deblocking filtering method according to the present disclosure;
- Fig. 12B show another flow diagram for a deblocking filtering method according to the present disclosure;
- 25

- Fig. 13 shows a simplified block diagram of an apparatus that may be used as either or both of the source device and the destination device from Fig. 3 according to an exemplary embodiment;
- 5 Fig. 14 shows a schematic diagram of a device for video coding;
- Fig. 15 shows a flow diagram depicting a deblocking determination process according to HEVC;
- 10 Fig. 16A shows a schematic flow diagram depicting a deblocking determination process according to invention;
- Fig. 16B shows another schematic flow diagram depicting a deblocking determination process according to invention;
- 15 Fig. 17 illustrates a block diagram showing an example structure of a content supply system which provides a content delivery service; and
- Fig. 18 illustrates is a block diagram showing a structure of an example of a
20 terminal device.

In the following, identical reference signs refer to identical or at least functionally equivalent features. In part, different reference signs referring to the same entities have been used in different figures.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In the following description, reference is made to the accompanying figures, which form part of the disclosure, and which show, by way of illustration, specific aspects of
5 embodiments of the invention or specific aspects in which embodiments of the present invention may be used. It is understood that embodiments of the invention may be used in other aspects and comprise structural or logical changes not depicted in the figures. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

10

For instance, it is understood that a disclosure in connection with a described method may also hold true for a corresponding device or system configured to perform the method and vice versa. For example, if one or a plurality of specific method steps are described, a corresponding device may include one or a plurality of units, e.g.
15 functional units, to perform the described one or plurality of method steps (e.g. one unit performing the one or plurality of steps, or a plurality of units each performing one or more of the plurality of steps), even if such one or more units are not explicitly described or illustrated in the figures. On the other hand, for example, if a specific apparatus is described based on one or a plurality of units, e.g. functional units, a
20 corresponding method may include one step to perform the functionality of the one or plurality of units (e.g. one step performing the functionality of the one or plurality of units, or a plurality of steps each performing the functionality of one or more of the plurality of units), even if such one or plurality of steps are not explicitly described or illustrated in the figures. Further, it is understood that the features of the various
25 exemplary embodiments and/or aspects described herein may be combined with each other, unless specifically noted otherwise.

Video coding typically refers to the processing of a sequence of pictures, which form the video or video sequence. Instead of the term picture the terms frame or image may be used as synonyms in the field of video coding. Video coding comprises two parts, video encoding and video decoding. Video encoding is performed at the source side, typically comprising processing (e.g. by compression) the original video pictures to reduce the amount of data required for representing the video pictures (for more efficient storage and/or transmission). Video decoding is performed at the destination side and typically comprises the inverse processing compared to the encoder to reconstruct the video pictures. Embodiments referring to “coding” of video pictures (or pictures in general, as will be explained later) shall be understood to relate to both, “encoding” and “decoding” of video pictures. The combination of the encoding part and the decoding part is also referred to as CODEC (COding and DECoding).

In case of lossless video coding, the original video pictures can be reconstructed, i.e. the reconstructed video pictures have the same quality as the original video pictures (assuming no transmission loss or other data loss during storage or transmission). In case of lossy video coding, further compression, e.g. by quantization, is performed, to reduce the amount of data representing the video pictures, which cannot be completely reconstructed at the decoder, i.e. the quality of the reconstructed video pictures is lower or worse compared to the quality of the original video pictures.

Several video coding standards since H.261 belong to the group of “lossy hybrid video codecs” (i.e. combine spatial and temporal prediction in the sample domain and 2D transform coding for applying quantization in the transform domain). Each picture of a video sequence is typically partitioned into a set of non-overlapping blocks and the

coding is typically performed on a block level. In other words, at the encoder the video is typically processed, i.e. encoded, on a block (video block) level, e.g. by using spatial (intra picture) prediction and temporal (inter picture) prediction to generate a prediction block, subtracting the prediction block from the current block (block
5 currently processed/to be processed) to obtain a residual block, transforming the residual block and quantizing the residual block in the transform domain to reduce the amount of data to be transmitted (compression), whereas at the decoder the inverse processing compared to the encoder is applied to the encoded or compressed block to reconstruct the current block for representation. Furthermore, the encoder duplicates
10 the decoder processing loop such that both will generate identical predictions (e.g. intra- and inter predictions) and/or re-constructions for processing, i.e. coding, the subsequent blocks.

As video picture processing (also referred to as moving picture processing) and still
15 picture processing (the term processing comprising coding), share many concepts and technologies or tools, in the following the term “picture” is used to refer to a video picture of a video sequence (as explained above) and/or to a still picture to avoid unnecessary repetitions and distinctions between video pictures and still pictures, where not necessary. In case the description refers to still pictures (or still images) only,
20 the term “still picture” shall be used.

In the following embodiments of an encoder 100, a decoder 200 and a coding system 300 are described based on Figs. 1 to 3 before describing embodiments of the invention in more detail based on Figs. 4-16B.

Fig. 3 is a conceptional or schematic block diagram illustrating an embodiment of a coding system 300, e.g. a picture coding system 300, wherein the coding system 300 comprises a source device 310 configured to provide encoded data 330, e.g. an encoded picture 330, e.g. to a destination device 320 for decoding the encoded data
5 330.

The source device 310 comprises an encoder 100 or encoding unit 100, and may additionally, i.e. optionally, comprise a picture source 312, a pre-processing unit 314, e.g. a picture pre-processing unit 314, and a communication interface or
10 communication unit 318.

The picture source 312 may comprise or be any kind of picture capturing device, for example for capturing a real-world picture, and/or any kind of a picture generating device, for example a computer-graphics processor for generating a computer animated
15 picture, or any kind of device for obtaining and/or providing a real-world picture, a computer animated picture (e.g. a screen content, a virtual reality (VR) picture) and/or any combination thereof (e.g. an augmented reality (AR) picture). In the following, all these kinds of pictures and any other kind of picture will be referred to as “picture” or “image”, unless specifically described otherwise, while the previous explanations with
20 regard to the term “picture” covering “video pictures” and “still pictures” still hold true, unless explicitly specified differently.

A (digital) picture is or can be regarded as a two-dimensional array or matrix of samples with intensity values. A sample in the array may also be referred to as pixel
25 (short form of picture element) or a pel. The number of samples in horizontal and vertical direction (or axis) of the array or picture define the size and/or resolution of

the picture. For representation of color, typically three color components are employed, i.e. the picture may be represented or include three sample arrays. In RGB format or color space a picture comprises a corresponding red, green and blue sample array. However, in video coding each pixel is typically represented in a luminance/chrominance format or color space, e.g. YCbCr, which comprises a luminance component indicated by Y (sometimes also L is used instead) and two chrominance components indicated by Cb and Cr. The luminance (or short luma) component Y represents the brightness or grey level intensity (e.g. like in a grey-scale picture), while the two chrominance (or short chroma) components Cb and Cr represent the chromaticity or color information components. Accordingly, a picture in YCbCr format comprises a luminance sample array of luminance sample values (Y), and two chrominance sample arrays of chrominance values (Cb and Cr). Pictures in RGB format may be converted or transformed into YCbCr format and vice versa, the process is also known as color transformation or conversion. If a picture is monochrome, the picture may comprise only a luminance sample array.

The picture source 312 may be, for example a camera for capturing a picture, a memory, e.g. a picture memory, comprising or storing a previously captured or generated picture, and/or any kind of interface (internal or external) to obtain or receive a picture. The camera may be, for example, a local or integrated camera integrated in the source device, the memory may be a local or integrated memory, e.g. integrated in the source device. The interface may be, for example, an external interface to receive a picture from an external video source, for example an external picture capturing device like a camera, an external memory, or an external picture generating device, for example an external computer-graphics processor, computer or server. The interface can be any kind of interface, e.g. a wired or wireless interface, an

optical interface, according to any proprietary or standardized interface protocol. The interface for obtaining the picture data 312 may be the same interface as or a part of the communication interface 318.

- 5 In distinction to the pre-processing unit 314 and the processing performed by the pre-processing unit 314, the picture or picture data 313 may also be referred to as raw picture or raw picture data 313.

Pre-processing unit 314 is configured to receive the (raw) picture data 313 and to
10 perform pre-processing on the picture data 313 to obtain a pre-processed picture 315 or pre-processed picture data 315. Pre-processing performed by the pre-processing unit 314 may, e.g., comprise trimming, color format conversion (e.g. from RGB to YCbCr), color correction, or de-noising.

- 15 The encoder 100 is configured to receive the pre-processed picture data 315 and provide encoded picture data 171. Further details will be described, e.g., based on Fig. 1.

Communication interface 318 of the source device 310 may be configured to receive
20 the encoded picture data 171 and to directly transmit it to another device, e.g. the destination device 320 or any other device, for storage or direct reconstruction, or to process the encoded picture data 171 for respectively before storing the encoded data 330 and/or transmitting the encoded data 330 to another device, e.g. the destination device 320 or any other device for decoding or storing.

The destination device 320 comprises a decoder 200 or decoding unit 200, and may additionally, i.e. optionally, comprise a communication interface or communication unit 322, a post-processing unit 326 and a display device 328.

- 5 The communication interface 322 of the destination device 320 is configured receive the encoded picture data 171 or the encoded data 330, e.g. directly from the source device 310 or from any other source, e.g. a memory, e.g. an encoded picture data memory.
- 10 The communication interface 318 and the communication interface 322 may be configured to transmit respectively receive the encoded picture data 171 or encoded data 330 via a direct communication link between the source device 310 and the destination device 320, e.g. a direct wired or wireless connection, or via any kind of network, e.g. a wired or wireless network or any combination thereof, or any kind of
- 15 private and public network, or any kind of combination thereof.

The communication interface 318 may be, e.g., configured to package the encoded picture data 171 into an appropriate format, e.g. packets, for transmission over a communication link or communication network, and may further comprise data loss

20 protection and data loss recovery.

The communication interface 322, forming the counterpart of the communication interface 318, may be, e.g., configured to de-package the encoded data 330 to obtain the encoded picture data 171 and may further be configured to perform data loss

25 protection and data loss recovery, e.g. comprising error concealment.

Both, communication interface 318 and communication interface 322 may be configured as unidirectional communication interfaces as indicated by the arrow for the encoded picture data 330 in Fig. 3 pointing from the source device 310 to the destination device 320, or bi-directional communication interfaces, and may be configured, e.g. to send and receive messages, e.g. to set up a connection, to acknowledge and/or re-send lost or delayed data including picture data, and exchange any other information related to the communication link and/or data transmission, e.g. encoded picture data transmission.

10 The decoder 200 is configured to receive the encoded picture data 171 and provide decoded picture data 231 or a decoded picture 231. Further details will be described, e.g., based on Fig. 2.

The post-processor 326 of destination device 320 is configured to post-process the decoded picture data 231, e.g. the decoded picture 231, to obtain post-processed picture data 327, e.g. a post-processed picture 327. The post-processing performed by the post-processing unit 326 may comprise, e.g. color format conversion (e.g. from YCbCr to RGB), color correction, trimming, or re-sampling, or any other processing, e.g. for preparing the decoded picture data 231 for display, e.g. by display device 328.

20

The display device 328 of the destination device 320 is configured to receive the post-processed picture data 327 for displaying the picture, e.g. to a user or viewer. The display device 328 may be or comprise any kind of display for representing the reconstructed picture, e.g. an integrated or external display or monitor. The displays may, e.g. comprise cathode ray tubes (CRT), liquid crystal displays (LCD), plasma

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displays, organic light emitting diodes (OLED) displays or any kind of other display .e.g. beamer, hologram (3D) etc.

Although Fig. 3 depicts the source device 310 and the destination device 320 as
5 separate devices, embodiments of devices may also comprise both or both functionalities, the source device 310 or corresponding functionality and the destination device 320 or corresponding functionality. In such embodiments the source device 310 or corresponding functionality and the destination device 320 or corresponding functionality may be implemented using the same hardware and/or
10 software or by separate hardware and/or software or any combination thereof.

As will be apparent for the skilled person based on the description, the existence and (exact) split of functionalities of the different units or functionalities within the source device 310 and/or destination device 320 as shown in Fig. 3 may vary depending on
15 the actual device and application.

Therefore, the source device 310 and the destination device 320 as shown in Fig. 3 are just example embodiments of the invention and embodiments of the invention are not limited to those shown in Fig. 3.

20

Source device 310 and destination device 320 may comprise any of a wide range of devices, including any kind of handheld or stationary devices, e.g. notebook or laptop computers, mobile phones, smart phones, tablets or tablet computers, cameras, desktop computers, set-top boxes, televisions, display devices, digital media players, video
25 gaming consoles, video streaming devices, broadcast receiver device, or the like. (also

servers and work-stations for large scale professional encoding/decoding, e.g. network entities) and may use no or any kind of operating system.

Fig. 1 shows a schematic/conceptual block diagram of an embodiment of an encoder 100, e.g. a picture encoder 100. The encoder 100 may be a video encoder. The encoder 100 comprises an input 102, a residual calculation unit 104, a transformation unit 106, a quantization unit 108, an inverse quantization unit 110, and inverse transformation unit 112, a reconstruction unit 114, a buffer 118, a loop filter 120, a decoded picture buffer (DPB) 130, a prediction unit 160 [an inter estimation unit 142, an inter prediction unit 144, an intra-estimation unit 152, an intra-prediction unit 154,] a mode selection unit 162, an entropy encoding unit 170, and an output 172. A video encoder 100 as shown in Fig. 1 may also be referred to as hybrid video encoder or a video encoder according to a hybrid video codec.

For example, the residual calculation unit 104, the transformation unit 106, the quantization unit 108, and the entropy encoding unit 170 form a forward signal path of the encoder 100, whereas, for example, the inverse quantization unit 110, the inverse transformation unit 112, the reconstruction unit 114, the buffer 118, the loop filter 120, the decoded picture buffer (DPB) 130, the inter prediction unit 144, and the intra-prediction unit 154 form a backward signal path of the encoder, wherein the backward signal path of the encoder corresponds to the signal path of the decoder (see decoder 200 in Fig. 2).

The encoder is configured to receive, e.g. by input 102, a picture 101 or a picture block 103 of the picture 101, e.g. picture of a sequence of pictures forming a video or video sequence. The picture block 103 may also be referred to as current picture block or

picture block to be coded, and the picture 101 as current picture or picture to be coded (in particular in video coding to distinguish the current picture from other pictures, e.g. previously encoded and/or decoded pictures of the same video sequence, i.e. the video sequence which also comprises the current picture).

5

Embodiments of the encoder 100 may comprise a partitioning unit (not depicted in Fig. 1), e.g. which may also be referred to as picture partitioning unit, configured to partition the picture 103 into a plurality of blocks, e.g. blocks like block 103, typically into a plurality of non-overlapping blocks. The partitioning unit may be configured to
10 use the same block size for all pictures of a video sequence and the corresponding grid defining the block size, or to change the block size between pictures or subsets or groups of pictures, and partition each picture into the corresponding blocks.

Like the picture 101, the block 103 again is or can be regarded as a two-dimensional
15 array or matrix of samples with intensity values (sample values), although of smaller dimension than the picture 101. In other words, the block 103 may comprise, e.g., one sample array (e.g. a luma array in case of a monochrome picture 101) or three sample arrays (e.g. a luma and two chroma arrays in case of a color picture 101) or any other number and/or kind of arrays depending on the color format applied. The number of
20 samples in horizontal and vertical direction (or axis) of the block 103 define the size of block 103.

The encoder 100 as shown in Fig. 1 is configured encode the picture 101 block by block, e.g. the encoding and prediction is performed per block 103.

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The residual calculation unit 104 is configured to calculate a residual block 105 based on the picture block 103 and a prediction block 165 (further details about the prediction block 165 are provided later), e.g. by subtracting sample values of the prediction block 165 from sample values of the picture block 103, sample by sample (pixel by pixel) to obtain the residual block 105 in the sample domain.

The transformation unit 106 is configured to apply a transformation, e.g. a spatial frequency transform or a linear spatial transform, e.g. a discrete cosine transform (DCT) or discrete sine transform (DST), on the sample values of the residual block 105 to obtain transformed coefficients 107 in a transform domain. The transformed coefficients 107 may also be referred to as transformed residual coefficients and represent the residual block 105 in the transform domain.

The transformation unit 106 may be configured to apply integer approximations of DCT/DST, such as the core transforms specified for HEVC/H.265. Compared to an orthonormal DCT transform, such integer approximations are typically scaled by a certain factor. In order to preserve the norm of the residual block which is processed by forward and inverse transforms, additional scaling factors are applied as part of the transform process. The scaling factors are typically chosen based on certain constraints like scaling factors being a power of two for shift operation, bit depth of the transformed coefficients, tradeoff between accuracy and implementation costs, etc. Specific scaling factors are, for example, specified for the inverse transform, e.g. by inverse transformation unit 212, at a decoder 200 (and the corresponding inverse transform, e.g. by inverse transformation unit 112 at an encoder 100) and corresponding scaling factors for the forward transform, e.g. by transformation unit 106, at an encoder 100 may be specified accordingly.

The quantization unit 108 is configured to quantize the transformed coefficients 107 to obtain quantized coefficients 109, e.g. by applying scalar quantization or vector quantization. The quantized coefficients 109 may also be referred to as quantized residual coefficients 109. For example for scalar quantization, different scaling may be applied to achieve finer or coarser quantization. Smaller quantization step sizes correspond to finer quantization, whereas larger quantization step sizes correspond to coarser quantization. The applicable quantization step size may be indicated by a quantization parameter (QP). The quantization parameter may for example be an index to a predefined set of applicable quantization step sizes. For example, small quantization parameters may correspond to fine quantization (small quantization step sizes) and large quantization parameters may correspond to coarse quantization (large quantization step sizes) or vice versa. The quantization may include division by a quantization step size and corresponding or inverse de-quantization, e.g. by inverse quantization 110, may include multiplication by the quantization step size.

Embodiments according to HEVC, may be configured to use a quantization parameter to determine the quantization step size. Generally, the quantization step size may be calculated based on a quantization parameter using a fixed point approximation of an equation including division. Additional scaling factors may be introduced for quantization and de-quantization to restore the norm of the residual block, which might be modified because of the scaling used in the fixed point approximation of the equation for quantization step size and quantization parameter. In one example implementation, the scaling of the inverse transform and de-quantization might be combined. Alternatively, customized quantization tables may be used and signaled

from an encoder to a decoder, e.g. in a bit-stream. The quantization is a lossy operation, wherein the loss increases with increasing quantization step sizes.

Embodiments of the encoder 100 (or respectively of the quantization unit 108) may be
5 configured to output the quantization scheme and quantization step size, e.g. by means
of the corresponding quantization parameter, so that a decoder 200 may receive and
apply the corresponding inverse quantization. Embodiments of the encoder 100 (or
quantization unit 108) may be configured to output the quantization scheme and
quantization step size, e.g. directly or entropy encoded via the entropy encoding unit
10 170 or any other entropy coding unit.

The inverse quantization unit 110 is configured to apply the inverse quantization of the
quantization unit 108 on the quantized coefficients to obtain de-quantized coefficients
111, e.g. by applying the inverse of the quantization scheme applied by the
15 quantization unit 108 based on or using the same quantization step size as the
quantization unit 108. The de-quantized coefficients 111 may also be referred to as de-
quantized residual coefficients 111 and correspond - although typically not identical to
the transformed coefficients due to the loss by quantization - to the transformed
coefficients 108.

20

The inverse transformation unit 112 is configured to apply the inverse transformation
of the transformation applied by the transformation unit 106, e.g. an inverse discrete
cosine transform (DCT) or inverse discrete sine transform (DST), to obtain an inverse
transformed block 113 in the sample domain. The inverse transformed block 113 may
25 also be referred to as inverse transformed de-quantized block 113 or inverse
transformed residual block 113.

The reconstruction unit 114 is configured to combine the inverse transformed block 113 and the prediction block 165 to obtain a reconstructed block 115 in the sample domain, e.g. by sample wise adding the sample values of the decoded residual block 113 and the sample values of the prediction block 165.

The buffer unit 116 (or short “buffer” 116), e.g. a line buffer 116, is configured to buffer or store the reconstructed block and the respective sample values, for example for intra estimation and/or intra prediction. In further embodiments, the encoder may be configured to use unfiltered reconstructed blocks and/or the respective sample values stored in buffer unit 116 for any kind of estimation and/or prediction.

Embodiments of the encoder 100 may be configured such that, e.g. the buffer unit 116 is not only used for storing the reconstructed blocks 115 for intra estimation 152 and/or intra prediction 154 but also for the loop filter unit 120 (not shown in Fig. 1), and/or such that, e.g. the buffer unit 116 and the decoded picture buffer unit 130 form one buffer. Further embodiments may be configured to use filtered blocks 121 and/or blocks or samples from the decoded picture buffer 130 (both not shown in Fig. 1) as input or basis for intra estimation 152 and/or intra prediction 154.

20

The loop filter unit 120 (or short “loop filter” 120), is configured to filter the reconstructed block 115 to obtain a filtered block 121, e.g. by applying a de-blocking sample-adaptive offset (SAO) filter or other filters, e.g. sharpening or smoothing filters or collaborative filters. The filtered block 121 may also be referred to as filtered reconstructed block 121. The loop filter 120 is in the following also referred to as

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deblocking filter. Further details of the loop filter unit 120 will be described below, e.g., based on Fig. 6 or 7 or Fig.10 to Fig.12.

Embodiments of the loop filter unit 120 may comprise (not shown in Fig. 1) a filter
5 analysis unit and the actual filter unit, wherein the filter analysis unit is configured to determine loop filter parameters for the actual filter. The filter analysis unit may be configured to apply fixed pre-determined filter parameters to the actual loop filter, adaptively select filter parameters from a set of predetermined filter parameters or adaptively calculate filter parameters for the actual loop filter.

10

Embodiments of the loop filter unit 120 may comprise (not shown in Fig. 1) one or a plurality of filters (loop filter components/subfilters), e.g. one or more of different kinds or types of filters, e.g. connected in series or in parallel or in any combination thereof, wherein each of the filters may comprise individually or jointly with other
15 filters of the plurality of filters a filter analysis unit to determine the respective loop filter parameters, e.g. as described in the previous paragraph.

Embodiments of the encoder 100 (respectively loop filter unit 120) may be configured to output the loop filter parameters, e.g. directly or entropy encoded via the entropy
20 encoding unit 170 or any other entropy coding unit, so that, e.g., a decoder 200 may receive and apply the same loop filter parameters for decoding.

The decoded picture buffer (DPB) 130 is configured to receive and store the filtered block 121. The decoded picture buffer 130 may be further configured to store other
25 previously filtered blocks, e.g. previously reconstructed and filtered blocks 121, of the same current picture or of different pictures, e.g. previously reconstructed pictures, and

may provide complete previously reconstructed, i.e. decoded, pictures (and corresponding reference blocks and samples) and/or a partially reconstructed current picture (and corresponding reference blocks and samples), for example for inter estimation and/or inter prediction.

5

Further embodiments of the invention may also be configured to use the previously filtered blocks and corresponding filtered sample values of the decoded picture buffer 130 for any kind of estimation or prediction, e.g. intra and inter estimation and prediction.

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The prediction unit 160, also referred to as block prediction unit 160, is configured to receive or obtain the picture block 103 (current picture block 103 of the current picture 101) and decoded or at least reconstructed picture data, e.g. reference samples of the same (current) picture from buffer 116 and/or decoded picture data 231 from one or a plurality of previously decoded pictures from decoded picture buffer 130, and to process such data for prediction, i.e. to provide a prediction block 165, which may be an inter-predicted block 145 or an intra-predicted block 155.

The mode selection unit 162 may be configured to select a prediction mode (e.g. an intra or inter prediction mode) and/or a corresponding prediction block 145 or 155 to be used as prediction block 165 for the calculation of the residual block 105 and for the reconstruction of the reconstructed block 115.

Embodiments of the mode selection unit 162 may be configured to select the prediction mode (e.g. from those supported by prediction unit 160), which provides the best match or in other words the minimum residual (minimum residual means better

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compression for transmission or storage), or a minimum signaling overhead (minimum signaling overhead means better compression for transmission or storage), or which considers or balances both. The mode selection unit 162 may be configured to determine the prediction mode based on rate distortion optimization (RDO), i.e. select
5 the prediction mode which provides a minimum rate distortion optimization or which associated rate distortion at least a fulfills a prediction mode selection criterion.

In the following the prediction processing (e.g. prediction unit 160 and mode selection (e.g. by mode selection unit 162) performed by an example encoder 100 will be
10 explained in more detail.

As described above, encoder 100 is configured to determine or select the best or an optimum prediction mode from a set of (pre-determined) prediction modes. The set of prediction modes may comprise, e.g., intra-prediction modes and/or inter-prediction
15 modes.

The set of intra-prediction modes may comprise 32 different intra-prediction modes, e.g. non-directional modes like DC (or mean) mode and planar mode, or directional modes, e.g. as defined in H.264, or may comprise 65 different intra-prediction modes,
20 e.g. non-directional modes like DC (or mean) mode and planar mode, or directional modes, e.g. as defined in H.265.

The set of (or possible) inter-prediction modes depend on the available reference pictures (i.e. previous at least partially decoded pictures, e.g. stored in DBP 230) and
25 other inter-prediction parameters, e.g. whether the whole reference picture or only a part, e.g. a search window area around the area of the current block, of the reference

picture is used for searching for a best matching reference block, and/or e.g. whether pixel interpolation is applied, e.g. half/semi-pel and/or quarter-pel interpolation, or not.

Additionally to the above prediction modes, skip mode and/or direct mode may be
5 applied.

The prediction unit 160 may be further configured to partition the block 103 into smaller block partitions or sub-blocks, e.g. iteratively using quad-tree-partitioning (QT), binary partitioning (BT) or triple-tree-partitioning (TT) or any combination
10 thereof, and to perform, e.g. the prediction for each of the block partitions or sub-blocks, wherein the mode selection comprises the selection of the tree-structure of the partitioned block 103 and the prediction modes applied to each of the block partitions or sub-blocks.

15 The inter estimation unit 142, also referred to as inter picture estimation unit 142, is configured to receive or obtain the picture block 103 (current picture block 103 of the current picture 101) and a decoded picture 231, or at least one or a plurality of previously reconstructed blocks, e.g. reconstructed blocks of one or a plurality of other/different previously decoded pictures 231, for inter estimation (or “inter picture
20 estimation”). E.g. a video sequence may comprise the current picture and the previously decoded pictures 231, or in other words, the current picture and the previously decoded pictures 231 may be part of or form a sequence of pictures forming a video sequence.

25 The encoder 100 may, e.g., be configured to select a reference block from a plurality of reference blocks of the same or different pictures of the plurality of other pictures and

provide a reference picture (or reference picture index, ...) and/or an offset (spatial offset) between the position (x, y coordinates) of the reference block and the position of the current block as inter estimation parameters 143 to the inter prediction unit 144. This offset is also called motion vector (MV). The inter estimation is also referred to as
5 motion estimation (ME) and the inter prediction also motion prediction (MP).

The inter prediction unit 144 is configured to obtain, e.g. receive, an inter prediction parameter 143 and to perform inter prediction based on or using the inter prediction parameter 143 to obtain an inter prediction block 145.

10

Although Fig. 1 shows two distinct units (or steps) for the inter-coding, namely inter estimation 142 and inter prediction 152, both functionalities may be performed as one (inter estimation) requires/comprises calculating an/the inter prediction block, i.e. the or a “kind of” inter prediction 154) , e.g. by testing all possible or a predetermined
15 subset of possible inter-prediction modes iteratively while storing the currently best inter prediction mode and respective inter prediction block, and using the currently best inter prediction mode and respective inter prediction block as the (final) inter prediction parameter 143 and inter prediction block 145 without performing another time the inter prediction 144.

20

The intra estimation unit 152 is configured to obtain, e.g. receive, the picture block 103 (current picture block) and one or a plurality of previously reconstructed blocks, e.g. reconstructed neighbor blocks, of the same picture for intra estimation. The encoder 100 may, e.g., be configured to select an intra prediction mode from a plurality of
25 (predetermined) intra prediction modes and provide it as intra estimation parameter 153 to the intra prediction unit 154.

Embodiments of the encoder 100 may be configured to select the intra-prediction mode based on an optimization criterion, e.g. minimum residual (e.g. the intra-prediction mode providing the prediction block 155 most similar to the current picture block 103) or minimum rate distortion.

The intra prediction unit 154 is configured to determine based on the intra prediction parameter 153, e.g. the selected intra prediction mode 153, the intra prediction block 155.

10

Although Fig. 1 shows two distinct units (or steps) for the intra-coding, namely intra estimation 152 and intra prediction 154, both functionalities may be performed as one (intra estimation) requires/comprises calculating the intra prediction block, i.e. the or a “kind of” intra prediction 154), e.g. by testing all possible or a predetermined subset of possible intra-prediction modes iteratively while storing the currently best intra prediction mode and respective intra prediction block, and using the currently best intra prediction mode and respective intra prediction block as the (final) intra prediction parameter 153 and intra prediction block 155 without performing another time the intra prediction 154.

20

The entropy encoding unit 170 is configured to apply an entropy encoding algorithm or scheme (e.g. a variable length coding (VLC) scheme, an context adaptive VLC scheme (CALVC), an arithmetic coding scheme, a context adaptive binary arithmetic coding (CABAC)) on the quantized residual coefficients 109, inter prediction parameters 143, intra prediction parameter 153, and/or loop filter parameters,

25

individually or jointly (or not at all) to obtain encoded picture data 171 which can be output by the output 172, e.g. in the form of an encoded bit-stream 171.

Other structural variations of the video encoder 100 can be used to encode the video stream. For example, a non-transform based encoder 100 can quantize the residual signal directly without the transform processing unit for certain blocks or frames. In another implementation, an encoder 100 can have the quantization unit and the inverse quantization unit combined into a single unit.

Fig. 2 shows an exemplary decoder 200, i.e. a video decoder 200 configured to receive encoded picture data, e.g. encoded bit-stream, 171, e.g. encoded by encoder 100, to obtain a decoded picture 231.

The decoder 200 comprises an input 202, an entropy decoding unit 204, an inverse quantization unit 210, an inverse transformation unit 212, a reconstruction unit 214, a buffer 216, a loop filter 220, a decoded picture buffer 230, a prediction unit 260, an inter prediction unit 244, an intra prediction unit 254, a mode selection unit 260 and an output 232.

The entropy decoding unit 204 is configured to perform entropy decoding to the encoded picture data 171 to obtain, e.g., quantized coefficients 209 and/or decoded coding parameters (not shown in Fig. 2), e.g. (decoded) any or all of inter prediction parameters 143, intra prediction parameter 153, and/or loop filter parameters.

In embodiments of the decoder 200, the inverse quantization unit 210, the inverse transformation unit 212, the reconstruction unit 214, the buffer 216, the loop filter 220,

the decoded picture buffer 230, the prediction unit 260 and the mode selection unit 260 are configured to perform the inverse processing of the encoder 100 (and the respective functional units) to decode the encoded picture data 171.

5 In particular, the inverse quantization unit 210 may be identical in function to the inverse quantization unit 110, the inverse transformation unit 212 may be identical in function to the inverse transformation unit 112, the reconstruction unit 214 may be identical in function reconstruction unit 114, the buffer 216 may be identical in function to the buffer 116, the loop filter 220 may be identical in function to the loop
10 filter 220 (with regard to the actual loop filter as the loop filter 220 typically does not comprise a filter analysis unit to determine the filter parameters based on the original image 101 or block 103 but receives (explicitly or implicitly) or obtains the filter parameters used for encoding, e.g. from entropy decoding unit 204), and the decoded picture buffer 230 may be identical in function to the decoded picture buffer 130.

15

The prediction unit 260 may comprise an inter prediction unit 244 and an inter prediction unit 254, wherein the inter prediction unit 144 may be identical in function to the inter prediction unit 144, and the inter prediction unit 154 may be identical in function to the intra prediction unit 154. The prediction unit 260 and the mode
20 selection unit 262 are typically configured to perform the block prediction and/or obtain the predicted block 265 from the encoded data 171 only (without any further information about the original image 101) and to receive or obtain (explicitly or implicitly) the prediction parameters 143 or 153 and/or the information about the selected prediction mode, e.g. from the entropy decoding unit 204.

25

The decoder 200 is configured to output the decoded picture 230, e.g. via output 232, for presentation or viewing to a user.

Although embodiments of the invention have been primarily described based on video coding, it should be noted that embodiments of the encoder 100 and decoder 200 (and correspondingly the system 300) may also be configured for still picture processing or coding, i.e. the processing or coding of an individual picture independent of any preceding or consecutive picture as in video coding. In general only inter-estimation 142, inter-prediction 144, 242 are not available in case the picture processing coding is limited to a single picture 101. Most if not all other functionalities (also referred to as tools or technologies) of the video encoder 100 and video decoder 200 may equally be used for still pictures, e.g. partitioning, transformation (scaling) 106, quantization 108, inverse quantization 110, inverse transformation 112, intra-estimation 142, intra-prediction 154, 254 and/or loop filtering 120, 220, and entropy coding 170 and entropy decoding 204.

The present invention deals with the inner workings of the deblocking filter, also referred to as loop filter in Fig. 1 and Fig. 2. Further details of the loop filter unit 120, 220 will be described below, e.g., based on Fig. 6 or 7 or Fig.10 to Fig.12.

20

Video coding schemes such as H.264/AVC and HEVC are designed along the successful principle of block-based hybrid video coding. Using this principle a picture is first partitioned into blocks and then each block is predicted by using intra-picture or inter-picture prediction. These blocks are coded relatively from the neighboring blocks and approximate the original signal with some degree of similarity. Since coded blocks only approximate the original signal, the difference between the approximations may

25

cause discontinuities at the prediction and transform block boundaries. These discontinuities are attenuated by the deblocking filter. HEVC replaces the macroblock structure of H.264/AVC with the concept of coding tree unit (CTU) of maximum size 64x64 pixels. The CTU can further be partitioned into a quadtree-decomposition
5 scheme into smaller coding units (CU), which can be subdivided down to a minimum size of 8 x 8 pixels. HEVC also introduces the concepts of prediction blocks (PB) and Transform blocks (TB).

In HEVC two filters are defined in deblocking filter: the normal filter and the strong
10 filter. The normal filter modifies at most two samples on both sides of an edge. In strong filter three additional checking between the samples along the edge and some pre-defined threshold are evaluated. If all of those checking are true then the strong filter is applied. The strong filter has a more intensive smoothing effect for samples along the edge and can modify at most three samples on both sides of an edge.

15

ITU-T VCEG (Q6/16) and ISO/IEC MPEG (JTC 1/SC 29/WG 11) are studying the next generation video codec: Versatile Video Coding (VVC). This new video codec standard aims a compression capability that significantly exceeds that of the current HEVC standard (including its current extensions and near-term extensions for screen
20 content coding and high-dynamic-range coding). The groups are working together on this exploration activity in a joint collaboration effort known as the Joint Video Exploration Team (JVET) to evaluate compression technology designs proposed by their experts in this area.

25 The VVC Test Model (VTM) describes the features that are under coordinated test model study by the Joint Video Exploration Team (JVET) of ITU-T VCEG and

ISO/IEC MPEG as potential enhanced video coding technology beyond the capabilities of HEVC.

In bi-prediction, the predictors from reference picture list L0 and reference picture list
 5 L1 are averaged to generate the final predictor using the equal weight 0.5. The predictor generation formula is shown as in Equ. (1)

$$P_{TraditionalBiPred} = (P_{L0} + P_{L1} + RoundingOffset) >> shiftNum, \quad (1)$$

In Equ. (1), $P_{TraditionalBiPred}$ is the final predictor for the conventional bi-prediction, P_{L0} and P_{L1} are predictors from L0 and L1, respectively, and $RoundingOffset$ and $shiftNum$ are used to normalize the final predictor.

10

More generally however the weights that are used to combine the predictors can be different from 0.5. For example the document JVET-K0248 (which is publicly accessible under <http://phenix.it-sudparis.eu/jvet/>) it is presented to allow applying different weights to predictors from L0 and L1. The predictor generation is shown in
 15 Equ. (2).

$$P_{GBi} = ((1-w_1) * P_{L0} + w_1 * P_{L1} + RoundingOffset_{GBi}) >> shiftNum_{GBi}, \quad (2)$$

In Equ. (2), P_{GBi} is the final predictor of generalized bi-prediction, GBi. $(1-w_1)$ and w_1 are the selected GBi weights applied to the predictors of L0 and L1, respectively.

$RoundingOffset_{GBi}$ and $shiftNum_{GBi}$ are used to normalize the final predictor in GBi.

The supported weights of w_1 is $\{-1/4, 3/8, 1/2, 5/8, 5/4\}$. One equal-weight set and four
 20 unequal-weight sets are supported. For the equal-weight case, the process to generate the final predictor is exactly the same as that in the conventional bi-prediction mode. For the true bi-prediction cases in random access (RA) condition, the number of candidate weight sets is reduced to three.

For advanced motion vector prediction (AMVP) mode, the weight selection in GBi is explicitly signaled at CU-level if this CU is coded by bi-prediction. For merge mode, the weight selection is inherited from the merge candidate.

Further according to the document JVET-K0248, an indicator is signaled in the
 5 bitstream to indicate which weighting factors are applied, i.e. the value of w_1 in equation (2). In the document the indication is specified to be GBi index, and the association of the GBi index and the weight value is exemplified as below:

Table 1. Example indication of weighting factors (GBi Index)

GBi Index	Weight value of w_1	Binarization of GBi Index
0	-1/4	0000
1	3/8	001
2	1/2	1
3	5/8	01
4	5/4	0001

10

Table 2. Example indication of weighting factors (GBi Index)

GBi Index	Weight value of w_1	Binarization of GBi Index
0	3/8	00
1	1/2	1
2	5/8	01

According to the JVET-K0248, the default value of the weighting factor is set as 0.5
 15 (combination with equal weighting). It means that of the GBi Index is not explicitly included in the bitstream associated with a bi-predicted block, the weighting values are inferred to be 0.5.

It is noted that the document JVET-K0248 provides an example of how the unequal weighting factors for 2 different predictors are signaled in the bitstream. There might be other alternative ways to signal the weighting factors.

- 5 It is noted that bi-prediction generally refers to the case where non-zero weighting factors are applied on the parts (P_{LO} and P_{LI} in equation (2)) of the combined prediction. The case where w_1 equal to 0 or w_1 equal to 1 are special cases of bi-prediction equation, but they are considered to be uni-prediction. Uni prediction refers to the case where there is only one predictor to construct the final prediction in equation (2).

10

The state of the art video coding standards apply block based intra and inter prediction methods which usually cause blocking artifacts at the boundaries between some of the blocks. Deblocking filtering is usually applied to those edges to mitigate the problem of blocking artifacts. It is important to identify edges between two spatially adjacent
15 blocks that are likely to introduce blocking artifacts, since application of deblocking filtering would cause over-smoothing when applied to edges that do not have deblocking artifact. In other words it is important to identify the edges that would introduce blocking artifacts as precisely as possible in order to achieve the goal of removing the blocking artifacts and in the meantime not over-smoothing the image or
20 video frame.

Figs. 7 and 8 refer to aspects of the HEVC video coding standard or VVC video coding standard. Fig. 7 shows a flow chart illustrating a method for determining whether a longer tap filter shall be used. Fig. 8 depicts the process of deblocking
25 determination according to the HEVC video coding standard, see below.

Fig. 4 discloses two coding units / image blocks P and Q. Block P having sixteen elements $P_{0,0}, \dots, P_{15,3}$ in four columns. Block Q having two times 8 samples. A boundary between blocks P and Q is denoted a CU boundary. A boundary between the two groups of 8 samples of block Q is denoted a Sub-PU boundary.

5

Fig. 5A discloses two codings units / image blocks P and Q, illustrating samples of either coding unit. Fig. 4 further discloses which samples are used in filtering. Fig. 4 further discloses which samples are modified by filtering.

10 Fig. 5B discloses how for deblocking a discontinuity may arise for a first image block and a second image block when different pairs of weighting factors are applied to the first and the second image block. That is, the current deblocking boundary strength derivation process of VTM-6.0 does not take into account that such a potential discontinuity may arise when one of the blocks sharing the given edge use different bi-
15 prediction with CU-level, here denoted bcw, previously denoted GBi weights, meaning the block uses different weighting factors (or in short weights) compared to the other coding block. Different weighting factors means that different pairs of weighting factors are applied to the first image block and the second image block which is adjacent with each other. In Fig. 5B, as an example showing Bi-prediction
20 using reference pictures Ref0 and Ref1, a pair of weighting factors (5/4, 1/4) is applied to the two adjacent image blocks with reference to reference picture Ref0. Another pair of weighting factors, (-1/4, 3/4) is applied with respect to reference picture Ref1. As illustrated in Fig. 5B, the resulting blocks, called P and Q, exhibit an unwanted or undesired discontinuity, which here is illustrated with respect to image block Q being
25 much darker than image block P. This change it discontinuous, e.g. there is no smooth change from P to Q in this respect. The weighting factors typically are provided by

tables, e.g. cf. Table 1 and 2, below. Said Tables may be indexed such that weighting factors are accessible via a respective index. Thus the coding unit / image blocks may produce an unwanted discontinuity when using different indexes. The indexes may be Gbi or bcw_idx indexes, respectively.

5

This problem may also be formulated as follows. Conventional deblocking filtering implementations (e.g. the deblocking filter of HEVC) does not take into account the fact that unequal weighting factors as in equation (1) and (2) can be applied in bi-prediction operation. This causes the following problem:

10

If two spatially adjacent blocks share a common edge, and if the two blocks both apply bi-prediction and if the motion vectors of the two blocks are sufficiently similar, no deblocking filtering is applied on the common edge. For example the determination of filter application is specified in the section 8.7.2.4 (Derivation process of boundary filtering strength) of HEVC video coding standard.

15

However according to document JVET-K0248 different weighting factors can be applied on the parts of the final bi-prediction result (as in equations (1) and (2)). Accordingly it is possible to create discontinuity at the edges between two blocks if the two blocks apply different weighting factors, causing visible blocking artifacts.

20

In view of the above-mentioned challenges, the present invention aims to improve the conventional deblocking filtering. The present invention has the objective to mitigate blocking artifacts that would be caused by the application of unequal weights in bi-prediction by selective application of deblocking filtering.

25

Fig. 8 depicts the process of deblocking determination according to the HEVC video

coding standard. For edges between blocks the decision to apply a strong deblocking filter, a normal (weak) deblocking filter and no deblocking filter is taken by this process. Furthermore the process for deriving the bS value is depicted in Fig. 14. Further details of the filtering determination process for HEVC can be found in the
 5 section 7.2.2.1 (Decisions to Filter a Block Boundary) of the book Vivienne Sze, Madhukar Budagavi, Gary J. Sullivan, “High Efficiency Video Coding (HEVC)”, Springer International, Switzerland, 2014..

A special mode of inter prediction is called bi-prediction, where two motion vectors
 10 are used to predict the sample values of each block.

The invention may be better understood by comparing Fig. 15 with Fig. 16A, 16B, respectively, considering the explanatory illustration of Fig. 5B.

15 Fig. 15 illustrates the determining of a boundary strength parameter bS for two image blocks as illustrated in Fig. 5B. According to Fig. 15, the boundary strength parameter bS may be set to specific values, as is further explained, below.

In conventional bi-prediction, the predictors from reference picture list L0 and
 20 reference picture list L1 are averaged to generate the final predictor using the equal weight 0.5. The predictor generation formula is shown as in Equ. (1)

$$P_{TraditionalBiPred} = (P_{L0} + P_{L1} + RoundingOffset) >> shiftNum, \quad (1)$$

In Equ. (1), $P_{TraditionalBiPred}$ is the final predictor for the conventional bi-prediction, P_{L0} and P_{L1} are predictors from L0 and L1, respectively, and *RoundingOffset* and *shiftNum* are used to normalize the final predictor. The predictors P_{L0} and P_{L1} are pointed by two
 25 different motion vectors.

More generally however the weights that are used to combine the predictors can be different from 0.5. For example the document JVET-K0248 (which is publicly accessible under <http://phenix.it-sudparis.eu/jvet/>) it is presented to allow applying different weights to predictors from L0 and L1. The predictor generation is shown in

5 Equ. (2).

$$P_{GBi} = ((1-w_l) * P_{L0} + w_l * P_{L1} + RoundingOffset_{GBi}) >> shiftNum_{GBi}, \quad (2)$$

In Equ. (2), P_{GBi} is the final predictor of GBi. $(1-w_l)$ and w_l are the selected GBi weights applied to the predictors of L0 and L1, respectively. $RoundingOffset_{GBi}$ and $shiftNum_{GBi}$ are used to normalize the final predictor in GBi.

The supported weights of w_l is $\{-1/4, 3/8, 1/2, 5/8, 5/4\}$. One equal-weight set and four
 10 unequal-weight sets are supported. For the equal-weight case, the process to generate the final predictor is exactly the same as that in the conventional bi-prediction mode. For the true bi-prediction cases in random access (RA) condition, the number of candidate weight sets is reduced to three.

For advanced motion vector prediction (AMVP) mode, the weight selection in GBi is
 15 explicitly signaled at CU-level if this CU is coded by bi-prediction. For merge mode, the weight selection is inherited from the merge candidate.

Further according to the document JVET-K0248, an indicator is signaled in the bitstream to indicate which weighting factors are applied, i.e. the value of w_l in equation (2). In the document the indication is specified to be GBi index, and the
 20 association of the GBi index and the weight value is exemplified as below:

Table 1. Example indication of weighting factors (GBi Index)

GBi Index	Weight value of w_l	Binarization of GBi Index
0	-1/4	0000
1	3/8	001
2	1/2	1
3	5/8	01
4	5/4	0001

Table 2. Example indication of weighting factors (GBi Index)

GBi Index	Weight value of w_l	Binarization of GBi Index
0	3/8	00
1	1/2	1
2	5/8	01

5

According to the JVET-K0248, the default value the weighting factor is set as 0.5 (combination with equal weighting). It means that of the GBi Index is not explicitly included in the bitstream associated with a bi-predicted block, the weighting values are inferred to be 0.5.

10

It is noted that the document JVET-K0248 provides an example of how the unequal weighting factors for 2 different predictors are signaled in the bitstream. There might be other alternative ways to signal the weighting factors.

- 15 It is noted that bi-prediction generally refers to the case where non-zero weighting factors are applied on the parts (P_{L0} and P_{L1} in equation (2)) of the combined prediction. The case where w_1 equal to 0 or w_1 equal to 1 are special cases of bi-prediction equation, but they are considered to be uni-prediction. Uni prediction refers to the case where there is only one predictor to construct the final prediction in equation (2).
- 20 It is noted that the equation (1) and (2) are bi-prediction equations, where in the second one different weighting factors can be applied for the parts of the equation (P_{L0} and P_{L1}).

According to the invention, the following solution is provided: a deblocking filter is applied on the edge between two blocks if they apply two different weighting factors to construct the motion compensated prediction. Deblocking filter might be applied or
5 not applied on the edge between two blocks if the two blocks apply the same weighting factor.

The invention is applied to the Deblocking Determination Unit 604 of Fig. 6, which determines whether a block edge applies deblocking filtering, and if yes the type
10 (normal, strong) of the filtering.

It is noted that the invention is not limited to a specific deblocking filter implementation and that the HEVC deblocking filter is only one of the deblocking filter implementations. The invention modifies the filter application determination
15 process by taking into account the different weighting factors applied by bi-prediction.

The invention targets efficient determination of block edges for deblocking such that the edges that require deblocking are determined more accurately. As a result visible blocking artifacts in the picture are removed and over-smoothing and blurring of the
20 image is avoided.

Alternative implementations of the invention are discussed as follows:

As a first alternative of the invention, at the edge between two spatially adjacent blocks which apply bi-prediction; deblocking filter is applied if the two blocks apply two
25 different weighting factors to construct the motion compensated prediction.

Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor.

Second alternative implementation of the invention: at the edge between two spatially adjacent blocks, if both blocks apply inter prediction and specifically bi-prediction; a weak deblocking filter is applied if the two blocks apply two different weighting factors to construct the motion compensated prediction. Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor. A strong deblocking filter is applied otherwise (if any one of the two blocks are predicted by intra prediction).

Another alternative implementation of the invention: at the edge between two spatially adjacent blocks if both blocks apply inter prediction and specifically bi-prediction, deblocking filter is applied if the two blocks apply two different weighting factors to construct the motion compensated prediction. Deblocking filter might be applied or not applied on the edge between two blocks if the two blocks apply the same weighting factor.

Another alternative implementation of the invention: at the edge between two spatially adjacent blocks, if both blocks apply inter prediction and specifically bi-prediction, a boundary strength parameter is set equal to one if the two blocks apply two different weighting factors to construct the motion compensated prediction. The boundary strength parameter might be set to zero or one on the edge between two blocks if the two blocks apply the same weighting factor. The boundary strength parameter is used in the determination of application of deblocking filtering at the said block edge.

Another alternative implementation of the invention: at the edge between two spatially adjacent blocks which apply bi-prediction deblocking filter is applied if the GBi Idx is different for the two blocks. The deblocking filter might be applied or not applied on the edge between two blocks if the GBi Idx is same for the two blocks. Wherein the
5 GBi Idx is a parameter that indicates the weighting factors used in the equation bi-prediction equation as in (2).

It is noted that the GBi Idx is an indicator that can be signaled in the bitstream or can be inferred. For instance if the GBi Idx is absent for a block, a default value might be
10 assigned to it.

It is noted that this implementation of the invention, which is also depicted in Fig. 16A is not limited to GBi Idx as defined by the prior art in JVET-K0248. The GBi Idx is an indication that determines the weights applied to the bi-prediction equation in (2). In
15 the prior art, the Gbi Idx is mapped to specific weighting factors according to Table 1 or Table 2 as example. The name of GBi Idx can be changed without changing the spirit of the invention.

Fig. 16A illustrates a specific embodiment of the method, using Gbi Idx as indexes.
20 The boundary strength parameter $bS[xDi][yDj]$, which is used in the determination of application of deblocking filtering is derived according to the following processing steps (e.g. the details of the proposed method are described as follows in the format of the specification):

25 **Derivation process of boundary filtering strength**

The variable $bS[xDi][yDj]$ is derived as follows:

- If the sample p0 or q0 is in the luma coding block of a coding unit coded with intra prediction mode, $bS[xDi][yDj]$ is set equal to 2.
- Otherwise, if the block edge is also a transform block edge and the sample p0 or q0 is in a luma transform block which contains one or more non-zero transform coefficient levels, $bS[xDi][yDj]$ is set equal to 1.
- Otherwise, if one or more of the following conditions are true, $bS[xDi][yDj]$ is set equal to 1:
 1. For the prediction of the luma prediction block containing the sample p0 different reference pictures or a different number of motion vectors are used than for the prediction of the luma prediction block containing the sample q0.

NOTE 1 – The determination of whether the reference pictures used for the two luma prediction blocks are the same or different is based only on which pictures are referenced, without regard to whether a prediction is formed using an index into reference picture list 0 or an index into reference picture list 1, and also without regard to whether the index position within a reference picture list is different.

NOTE 2 – The number of motion vectors that are used for the prediction of a luma prediction block with top-left luma sample covering (xPb, yPb) , is equal to $PredFlagL0[xPb][yPb] + PredFlagL1[xPb][yPb]$.

2. One motion vector is used to predict the luma prediction block containing the sample p0 and one motion vector is used to predict the luma prediction block containing the sample q0, and the absolute difference between the horizontal or vertical component of the motion vectors used is greater than or equal to 4 in units of quarter luma samples.

3. Two motion vectors and two different reference pictures are used to predict the luma prediction block containing the sample p0, two motion vectors for the same two reference pictures are used to predict the luma prediction block containing the sample q0 and the absolute difference between the horizontal or vertical component of the two motion vectors used in the prediction of the two luma prediction blocks for the same reference picture is greater than or equal to 4 in units of quarter luma samples.
4. Two motion vectors for the same reference picture are used to predict the luma prediction block containing the sample p0, two motion vectors for the same reference picture are used to predict the luma prediction block containing the sample q0 and both of the following conditions are true:
- ◆ The absolute difference between the horizontal or vertical component of list 0 motion vectors used in the prediction of the two luma prediction blocks is greater than or equal to 4 in quarter luma samples, or the absolute difference between the horizontal or vertical component of the list 1 motion vectors used in the prediction of the two luma prediction blocks is greater than or equal to 4 in units of quarter luma samples.
 - ◆ The absolute difference between the horizontal or vertical component of list 0 motion vector used in the prediction of the luma prediction block containing the sample p0 and the list 1 motion vector used in the prediction of the luma prediction block containing the sample q0 is greater than or equal to 4 in units of quarter luma samples, or the absolute difference between the horizontal or vertical component of the list 1 motion vector used in the prediction of the luma prediction block containing the sample p0 and list 0 motion vector used in the prediction of the luma prediction block containing the sample q0 is greater than or

equal to 4 in units of quarter luma samples.

5. Two motion vectors are used to predict the luma prediction block containing the sample p0, two motion vectors are used to predict the luma prediction block containing the sample q0 and gbi_idx is different for the block containing the sample p0 and the block containing the sample q0.
- Otherwise, the variable $bS[xDi][yDj]$ is set equal to 0.

It is noted that an important aspect of the invention is depicted in said 5th condition. According to the invention the gbi_idx parameter is used in the determination of the boundary strength parameter, which is in turn used in the determination of the deblocking filtering determination process. It is further noted that the step 5 is not present in the prior art, and is added by the current invention.

Another alternative is shown in Fig. 16B which uses different indexes than in Fig. 16A.

In other words, the current boundary strength derivation in VVC test model, VTM, 6.0, does not take into account the discontinuity that might be caused when one of the coding units sharing the edge uses BCW (Bi-prediction with CU-level weights). The current proposal suggest to also include an additional check in the boundary strength derivation rule which is as follows: If the "bcw_idx" of one of the coding units sharing the edge is different from the other coding unit then boundary strength is set to 1 and therefore the edge is further deblocked.

The current deblocking boundary strength derivation process of VTM-6.0 does not take into account that a potential discontinuity may arise when one of the blocks sharing the given edge use different bi-prediction with CU-level, bcw weights. It

should be noted that these were previously named as GBi weights. When one of the blocks sharing the given edge use different bcw weights, this has the meaning the block uses different “bcw_idx” compared to the other coding block. Fig. 5B shows an example where a potential discontinuity which may arise when the coding units use
5 different “bcw_idx”.

The current boundary strength flow chart of VTM-6.0 can be summarized as shown in the Fig. 15.

10 As shown in Fig. 15 if the blocks sharing the edge have cbf=0 and if the motion information (mv difference is less than a threshold (half-pel) and the reference picture are same) is the same then Bs is set to 0 and no further deblocking is performed for the edge.

15 The proposed solution adds an additional check to the previous boundary strength derivation process as shown in Fig. 15. This ensures that the potential discontinuity caused by different coding units using different “bcw_idx” is removed. The details of the proposed method are described as follows in the format of the specification.

20 Inputs to this process are: a picture sample array recPicture, a location (xCb, yCb) specifying the top-left sample of the current coding block relative to the top-left sample of the current picture, a variable nCbW specifying the width of the current coding block, a variable nCbH specifying the height of the current coding block, a variable edgeType specifying whether a vertical (EDGE_VER) or a horizontal
25 (EDGE_HOR) edge is filtered, a variable cIdx specifying the colour component of the current coding block, and a two-dimensional (nCbW)x(nCbH) array edgeFlags.

Output of this process is a two-dimensional (nCbW)x(nCbH) array bS specifying the boundary filtering strength. The variables xD_i, yD_j, xN and yN are derived as follows:

– The variable gridSize is set as follows:

$$\text{gridSize} = \text{cIdx} == 0 ? 4 : 8 \quad (8-1049)$$

5 – If edgeType is equal to EDGE_VER,

$$\text{xDi} = (i * \text{gridSize}) \quad (8-1050)$$

$$\text{yDj} = \text{cIdx} == 0 ? (j \ll 2) : (j \ll 1) \quad (8-1051)$$

$$\text{xN is set equal to } \text{Max}(0, (\text{nCbW} / \text{gridSize}) - 1) \quad (8-1052)$$

$$\text{yN} = \text{cIdx} == 0 ? (\text{nCbH} / 4) - 1 : (\text{nCbH} / 2) - 1 \quad (8-1053)$$

10 – Otherwise (edgeType is equal to EDGE_HOR),

$$\text{xDi} = \text{cIdx} == 0 ? (i \ll 2) : (i \ll 1) \quad (8-1054)$$

$$\text{yDj} = (j * \text{gridSize}) \quad (8-1055)$$

$$\text{xN} = \text{cIdx} == 0 ? (\text{nCbW} / 4) - 1 : (\text{nCbW} / 2) - 1 \quad (8-1056)$$

$$\text{yN} = \text{Max}(0, (\text{nCbH} / \text{gridSize}) - 1) \quad (8-1057)$$

15 For xD_i with i = 0..xN and yD_j with j = 0..yN, the following applies:

– If edgeFlags[xD_i][yD_j] is equal to 0, the variable bS[xD_i][yD_j] is set equal to 0.

– Otherwise, the following applies:

– The sample values p₀ and q₀ are derived as follows:

20 – If edgeType is equal to EDGE_VER, p₀ is set equal to
 recPicture[xCb + xD_i - 1][yCb + yD_j] and q₀ is set equal to
 recPicture[xCb + xD_i][yCb + yD_j].

- Otherwise (edgeType is equal to EDGE_HOR), p_0 is set equal to $\text{recPicture}[x_{Cb} + x_{Di}][y_{Cb} + y_{Dj} - 1]$ and q_0 is set equal to $\text{recPicture}[x_{Cb} + x_{Di}][y_{Cb} + y_{Dj}]$.
- The variable $\text{bS}[x_{Di}][y_{Dj}]$ is derived as follows:
 - 5 – If cIdx is equal to 0 and both samples p_0 and q_0 are in a coding block with intra_bdpcm_flag equal to 1, $\text{bS}[x_{Di}][y_{Dj}]$ is set equal to 0.
 - Otherwise, if the sample p_0 or q_0 is in the coding block of a coding unit coded with intra prediction mode, $\text{bS}[x_{Di}][y_{Dj}]$ is set equal to 2.
 - Otherwise, if the block edge is also a transform block edge and the
 - 10 sample p_0 or q_0 is in a coding block with ciip_flag equal to 1, $\text{bS}[x_{Di}][y_{Dj}]$ is set equal to 2.
 - Otherwise, if the block edge is also a transform block edge and the sample p_0 or q_0 is in a transform block which contains one or more non-zero transform coefficient levels, $\text{bS}[x_{Di}][y_{Dj}]$ is set equal to 1.
 - 15 – Otherwise, if the block edge is also a transform block edge, cIdx is greater than 0, and the sample p_0 or q_0 is in a transform unit with $\text{tu_joint_cbr_residual_flag}$ equal to 1, $\text{bS}[x_{Di}][y_{Dj}]$ is set equal to 1.
 - Otherwise, if the prediction mode of the coding subblock containing the
 - 20 sample p_0 is different from the prediction mode of the coding subblock containing the sample q_0 (i.e. one of the coding subblock is coded in IBC prediction mode and the other is coded in inter prediction mode), $\text{bS}[x_{Di}][y_{Dj}]$ is set equal to 1.

- Otherwise, if $cIdx$ is equal to 0 and one or more of the following conditions are true, $bS[xD_i][yD_j]$ is set equal to 1:
 - The coding subblock containing the sample p_0 and the coding subblock containing the sample q_0 are both coded in IBC prediction mode, and the absolute difference between the horizontal or vertical component of the block vectors used in the prediction of the two coding subblocks is greater than or equal to 8 in units of 1/16 luma samples.
 - For the prediction of the coding subblock containing the sample p_0 different reference pictures or a different number of motion vectors are used than for the prediction of the coding subblock containing the sample q_0 .

NOTE 1 – The determination of whether the reference pictures used for the two coding subblocks are the same or different is based only on which pictures are referenced, without regard to whether a prediction is formed using an index into reference picture list 0 or an index into reference picture list 1, and also without regard to whether the index position within a reference picture list is different.

NOTE 2 – The number of motion vectors that are used for the prediction of a coding subblock with top-left sample covering (xSb, ySb) , is equal to

$$PredFlagL0[xSb][ySb] + PredFlagL1[xSb][ySb].$$

- One motion vector is used to predict the coding subblock containing the sample p_0 and one motion vector is used to predict the coding subblock containing the sample q_0 , and the absolute difference

between the horizontal or vertical component of the motion vectors used is greater than or equal to 8 in units of 1/16 luma samples.

5 – Two motion vectors and two different reference pictures are used to predict the coding subblock containing the sample p_0 , two motion vectors for the same two reference pictures are used to predict the coding subblock containing the sample q_0 and the absolute difference between the horizontal or vertical component of the two motion vectors used in the prediction of the two coding
10 subblocks for the same reference picture is greater than or equal to 8 in units of 1/16 luma samples.

 – Two motion vectors for the same reference picture are used to predict the coding subblock containing the sample p_0 , two motion vectors for the same reference picture are used to predict the
15 coding subblock containing the sample q_0 and both of the following conditions are true:

 – The absolute difference between the horizontal or vertical component of list 0 motion vectors used in the prediction of the two coding subblocks is greater than or equal to 8 in 1/16
20 luma samples, or the absolute difference between the horizontal or vertical component of the list 1 motion vectors used in the prediction of the two coding subblocks is greater than or equal to 8 in units of 1/16 luma samples.

 – The absolute difference between the horizontal or vertical component of list 0 motion vector used in the prediction of
25

the coding subblock containing the sample p_0 and the list 1 motion vector used in the prediction of the coding subblock containing the sample q_0 is greater than or equal to 8 in units of 1/16 luma samples, or the absolute difference between the horizontal or vertical component of the list 1 motion vector used in the prediction of the coding subblock containing the sample p_0 and list 0 motion vector used in the prediction of the coding subblock containing the sample q_0 is greater than or equal to 8 in units of 1/16 luma samples.

- If bcw_idx of coding block containing the sample p_0 is different from the bcw_idx of the coding block containing the sample q_0
- Otherwise, the variable $bs[xD_i][yD_j]$ is set equal to 0.

Summarizing this part, the current invention proposes to add an additional check in the deblocking boundary strength derivation process which basically sets the boundary strength “bs” to 1 if one of the coding units sharing the edge uses a different “ bcw_idx ” when compared to the other coding unit. This results in removing a potential discontinuity which may be caused when coding units use different “ bcw_idx ”. This alternative is particularly shown in Fig. 16B.

20

The invention combines the deblocking filtering operation and a modified bi-prediction generation operation to avoid blocking artifacts.

Fig. 6 is a block diagram illustrating an exemplary deblocking filter apparatus 600 according to the techniques described in this disclosure (further details will be described below, e.g., based on Figs. 7, 8 or Fig. 10 to 12). Deblocking filter apparatus

600 may also be referred to as deblocking filter 600. The deblocking filter apparatus 600 may be configured to perform deblocking techniques in accordance with various examples described in the present application. In general, either or both of loop filter 120 from Fig. 1 and loop filter 220 from Fig. 2 may include components substantially similar to those of deblocking filter 600. Other video coding devices, such as video encoders, video decoders, video encoder/decoders (CODECs), and the like may also include components substantially similar to deblocking filter 600. Deblocking filter 600 may be implemented in hardware, software, or firmware, or any combination thereof. When implemented in software or firmware, corresponding hardware (such as one or more processors or processing units and memory for storing instructions for the software or firmware) may also be provided.

In the example of Fig. 6, deblocking filter 600 includes deblocking determination unit 604, support definitions 602 stored in memory, deblocking filtering unit 606, deblocking filter definitions 608 stored in memory, edge locating unit 603, and edge locations data structure 605. Any or all of the components of deblocking filter 600 may be functionally integrated. The components of deblocking filter 600 are illustrated separately only for purposes of illustration. In general, deblocking filter 600 receives data for decoded blocks, e.g., from a summation component that combines prediction data with residual data for the blocks. The data may further include an indication of how the blocks were predicted. In the example described below, deblocking filter 600 is configured to receive data including a decoded video block associated with a LCU and a CU quadtree for the LCU, where the CU quadtree describes how the LCU is partitioned into CUs and prediction modes for PUs and TUs of leaf-node CUs.

Deblocking filter 600 may maintain edge locations data structure 605 in a memory of deblocking filter 600, or in an external memory provided by a corresponding video coding device. In some examples, edge locating unit 603 may receive a CU quadtree corresponding to an LCU that indicates how the LCU is partitioned into CUs. Edge
5 locating unit 603 may then analyze the CU quadtree to determine edges between decoded video blocks associated with TUs and PUs of CUs in the LCU that are candidates for deblocking.

Edge locations data structure 605 may comprise an array having a horizontal
10 dimension, a vertical dimension, and a dimension representative of horizontal edges and vertical edges. In general, edges between video blocks may occur between two video blocks associated with smallest-sized CUs of the LCU, or TUs and PUs of the CUs. Assuming that the LCU has a size of $N \times N$, and assuming that the smallest-sized CU of the LCU is of size $M \times M$, the array may comprise a size of $[N/M] \times [N/M] \times 2$,
15 where “2” represents the two possible directions of edges between CUs (horizontal and vertical). For example, assuming that an LCU has 64×64 pixels and a 8×8 smallest-sized CU, the array may comprise $[8] \times [8] \times [2]$ entries.

Each entry may generally correspond to a possible edge between two video blocks.
20 Edges might not in fact exist at each of the positions within the LCU corresponding to each of the entries of edge locations data structure 605. Accordingly, values of the data structure may be initialized to false. In general, edge locating unit 603 may analyze the CU quadtree to determine locations of edges between two video blocks associated with TUs and PUs of CUs of the LCU and set corresponding values in edge locations data
25 structure 605 to true.

In general, the entries of the array may describe whether a corresponding edge exists in the LCU as a candidate for deblocking. That is, when edge locating unit 603 determines that an edge between two neighboring video blocks associated with TUs and PUs of CUs of the LCU exists, edge locating unit 603 may set a value of the corresponding entry in edge locations data structure 605 to indicate that the edge exists (e.g., to a value of “true”).

Deblocking determination unit 604 generally determines whether, for two neighboring blocks, an edge between the two blocks should be deblocked. Deblocking determination unit 604 may determine locations of edges using edge locations data structure 605. When a value of edge locations data structure 605 has a Boolean value, deblocking determination unit 604 may determine that a “true” value indicates the presence of an edge, and a “false” value indicates that no edge is present, in some examples.

15

In general, deblocking determination unit 604 is configured with one or more deblocking determination functions. The functions may include a plurality of coefficients applied to lines of pixels that cross the edge between the blocks. For example, the functions may be applied to a line of eight pixels that is perpendicular to the edge, where four of the pixels are in one of the two blocks and the other four pixels are in the other of the two blocks. Support definitions 602 define support for the functions. In general, the “support” corresponds to the pixels to which the functions are applied.

Deblocking determination unit 604 may be configured to apply one or more deblocking determination functions to one or more sets of support, as defined by

support definitions 602, to determine whether a particular edge between two blocks of video data should be deblocked. The dashed line originating from deblocking determination unit 604 represents data for blocks being output without being filtered. In cases where deblocking determination unit 604 determines that an edge between two blocks should not be filtered, deblocking filter 600 may output the data for the blocks without altering the data. That is, the data may bypass deblocking filtering unit 606. On the other hand, when deblocking determination unit 604 determines that an edge should be deblocked, deblocking determination unit 604 may cause deblocking filtering unit 606 to filter values for pixels near the edge in order to deblock the edge.

10

Deblocking filtering unit 606 retrieves definitions of deblocking filters from deblocking filter parameters 608 for edges to be deblocked, as indicated by deblocking determination unit 604. In general, filtering of an edge uses values of pixels from the neighborhood of a current edge to be deblocked. Therefore, both deblocking decision functions and deblocking filters may have a certain support region on both sides of an edge. By applying a deblocking filter to pixels in the neighborhood of an edge, deblocking filtering unit 606 may smooth the values of the pixels such that high frequency transitions near the edge are dampened. In this manner, application of deblocking filters to pixels near an edge may reduce blockiness artifacts near the edge.

20

Fig. 9 shows two exemplary coding blocks and sample values used and modified during filtering according to another embodiment of the invention.

Fig. 10 is a block diagram illustrating an exemplary deblocking method according to the techniques described in this disclosure. Here, further details will be described below, e.g., based on Figs. 7, 8.

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In Fig. 10, an embodiment of the deblocking method is shown.

In step 101, edges between blocks are determined, wherein the edges between blocks
5 comprise a block edge between a first coding block P and a second coding block Q;

In step 102, it is determined whether the block edge between the first coding block P
and the second coding block Q is to be filtered by applying a deblocking filter, by
determining whether different weighting factors are applied for the first coding block P
10 and the second coding block Q respectively.

In step 103, the deblocking filter is applied to values of samples near the block edge
between the first coding block P and the second coding block Q, when it is determined
that different weighting factors are applied for the first coding block P and the second
15 coding block Q respectively.

The step of determining whether the block edge between the first coding block P and
the second coding block Q is to be filtered by applying a deblocking filter, by
determining whether different weighting factors are applied for the first coding block P
20 and the second coding block Q respectively, may further comprise: determining that
the block edge between the first coding block P and the second coding block Q is to be
filtered by applying a deblocking filter if the first coding block P and the second
coding block Q apply two different weighting factors to construct the motion
compensated prediction.

The step of determining whether the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding block P and the second coding block Q respectively, may further comprise: determining the
5 block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if different weighting factors are applied for the first coding block P and the second coding block Q respectively; or determining that the block edge between the first coding block P and the second coding block Q is not to be filtered by applying a deblocking filter if the same weighting factor is applied for
10 the first coding block P and the second coding block Q.

The step of determining whether the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding block P
15 and the second coding block Q respectively, may comprise: determining the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if the same weighting factor is applied for the first coding block P and the second coding block Q; or determining the block edge between the first coding block P and the second coding block Q is not to be filtered by applying
20 a deblocking filter if the same weighting factor is applied for the first coding block P and the second coding block Q.

At the edge between two spatially adjacent blocks which apply bi-prediction, deblocking filter may be applied if the two blocks apply two different weighting
25 factors to construct the motion compensated prediction.

Here, a weak deblocking filter may be applied at the edge between two spatially adjacent blocks, if two blocks are predicted by inter prediction and two different weighting factors are applied to the two blocks to construct the motion compensated prediction.

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Here, a strong deblocking filter may be applied at the edge between two spatially adjacent blocks, if any one of the two blocks is predicted by intra prediction or the same weighting factor is applied to the two blocks to construct the motion compensated prediction.

10

A weak deblocking filter may be applied at the edge between two spatially adjacent blocks, if two blocks are predicted by bi-prediction and two different weighting factors are applied to the two blocks to construct the motion compensated prediction.

15 A weak deblocking filter may be applied at the edge between two spatially adjacent blocks, if two blocks are predicted by inter prediction and two different weighting factors are applied to the two blocks to construct the motion compensated prediction.

At the edge between two spatially adjacent blocks, if both two blocks apply inter
20 prediction, a boundary strength parameter may be set equal to one if the two blocks apply two different weighting factors to construct the motion compensated prediction.

At the edge between two spatially adjacent blocks, if both two blocks apply inter prediction, a boundary strength parameter may be set to zero or one on the edge between two blocks if the two blocks apply the same weighting factor; wherein the
25 inter prediction is bi-prediction.

Here, the boundary strength parameter is used in the determination of application of deblocking filtering at said block edge.

In Fig. 11, an overview block diagram of the inter-picture prediction is shown. The motion data of a block is correlated with the neighboring blocks. To exploit this correlation, motion data is not directly coded in the bitstream but predictively coded based on neighboring motion data.

Fig. 12A is a flowchart of a deblocking method for use in an image encoding and/or an image decoding. The method starts at step 1201. In step 1201 a first image block and a second image block, for an image encoding and/or an image decoding are provided.

In step 1202, in the case two different pairs of weighting factors are applied to the first image block and the second image block, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, is assigned or set as a first value; wherein the first block and the second block are predicted by Bi- prediction.

In step 1203, deblocking filtering is performed, of values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter.

Fig. 12B is a flowchart of another deblocking method for use in an image encoding and/or an image decoding. The method starts at step 1251. a first image block and a second image block, for an image encoding and/or an image decoding are provided. As

for the method indicated for Fig. 12A, the first image block and the second image block are predicted by Bi- prediction.

In step 1252 it is specified that provided a specific condition or more than one
5 conditions are met, the method continues in step 1253. The one or more conditions to be met at least comprise: affirmatively determining that two different pairs of weighting factors are applied to the first image block and the second image block

In step 1253, value of a boundary strength parameter associated with the block edge
10 between the first image block and the second image block, is assigned or set as a first value.

In step 1253, deblocking filtering at values of samples near the block edge between the first image block and the second image block is performed based on the first value of
15 the boundary strength parameter.

Fig. 13 is a simplified block diagram of an apparatus 1300 that may be used as either or both of the source device 310 and the destination device 320 from Fig. 3 according to an exemplary embodiment. Apparatus 1300 can implement techniques of this
20 present application. Apparatus 1300 can be in the form of a computing system including multiple computing devices, or in the form of a single computing device, for example, a mobile phone, a tablet computer, a laptop computer, a notebook computer, a desktop computer, and the like.

25 In Fig. 13, processor 1302 of apparatus 1300 can be a central processing unit. Alternatively, processor 1302 can be any other type of device, or multiple devices,

capable of manipulating or processing information now-existing or hereafter developed. Although the disclosed implementations can be practiced with a single processor as shown, e.g., processor 1302, advantages in speed and efficiency can be achieved using more than one processor.

5

In Fig. 13, memory 1304 in the apparatus 1300 can be a read only memory (ROM) device or a random access memory (RAM) device in an implementation. Any other suitable type of storage device can be used as memory 1304. Memory 1304 may be used to store code and/or data 1306 that is accessed by processor 1302 using bus 1312.

10 Memory 1304 can further be used to store operating system 1308 and application programs 1310. Application programs 1310 may include at least one program that permits processor 1302 to perform the methods described here. For example, application programs 1310 can include applications 1 through N, and further include a video coding application that performs the methods described here. Apparatus 1300
15 can also include additional memory in the form of secondary storage 1314, which can, for example, be a memory card used with a mobile computing device. Because the video communication sessions may contain a significant amount of information, they can be stored in whole or in part in storage 1314 and loaded into memory 1304 as needed for processing.

20

In Fig. 13, apparatus 1300 can also include one or more output devices, such as display 1318. Display 1318 may be, in one example, a touch sensitive display that combines a display with a touch sensitive element operable to sense touch inputs. Display 1318 can be coupled to processor 1302 via bus 1312. Other output devices that permit a user
25 to program or otherwise use apparatus 1300 can be provided in addition to or as an alternative to display 1318. When the output device is or includes a display, the display

can be implemented in various ways, including by a liquid crystal display (LCD), a cathode-ray tube (CRT) display, a plasma display or light emitting diode (LED) display, such as an organic LED (OLED) display.

5 Apparatus 1300 can also include or be in communication with image-sensing device 1320, for example a camera, or any other image-sensing device 1320 now existing or hereafter developed that can sense an image such as the image of a user operating apparatus 1300. Image-sensing device 1320 can be positioned such that it is directed toward the user operating apparatus 1300. In an example, the position and optical axis
10 of image-sensing device 1320 can be configured such that the field of vision includes an area that is directly adjacent to display 1318 and from which display 1318 is visible.

Apparatus 1300 can also include or be in communication with sound-sensing device 1322, for example a microphone, or any other sound-sensing device now existing or
15 hereafter developed that can sense sounds near apparatus 1300. Sound-sensing device 1322 can be positioned such that it is directed toward the user operating apparatus 1300 and can be configured to receive sounds, for example, speech or other utterances, made by the user while the user operates apparatus 1300.

20 Although Fig. 13 depicts processor 1302 and memory 1304 of apparatus 1300 as being integrated into a single device, other configurations can be utilized. The operations of processor 1302 can be distributed across multiple machines (each machine having one or more of processors) that can be coupled directly or across a local area or other network. Memory 1304 can be distributed across multiple machines such as a network-
25 based memory or memory in multiple machines performing the operations of apparatus 1300. Although depicted here as a single bus, bus 1312 of apparatus 1300 may

comprise multiple buses. Further, secondary storage 1314 can be directly coupled to the other components of apparatus 1300 or can be accessed via a network and can comprise a single integrated unit such as a memory card or multiple units such as multiple memory cards. Apparatus 1300 can thus be implemented in a wide variety of configurations.

Fig. 14 is a schematic diagram of an example device 1400 for video coding according to an embodiment of the disclosure. The device 1400 is suitable for implementing the disclosed embodiments as described herein. In an embodiment, the device 1400 may be a decoder such as video decoder 200 of Fig. 2 or an encoder such as video encoder 100 of Fig. 1. In an embodiment, the device 1400 may be one or more components of the video decoder 200 of Fig. 2 or the video encoder 100 of Fig. 1 as described above.

The device 1400 comprises ingress ports 1420 and receiver units (Rx) 1410 for receiving data; a processor, logic unit, or central processing unit (CPU) 1430 to process the data; transmitter units (Tx) 1440 and egress ports 1450 for transmitting the data; a memory 1460 for storing the data. The device 1400 may also comprise optical-to-electrical (OE) components and electrical-to-optical (EO) components coupled to the ingress ports 1420, the receiver units 1410, the transmitter units 1440, and the egress ports 1450 for egress or ingress of optical or electrical signals. The device 1400 may also include wireless transmitters and/or receivers in some examples.

The processor 1430 is implemented by hardware and software. The processor 1430 may be implemented as one or more CPU chips, cores (e.g., as a multi-core processor), field-programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), and digital signal processors (DSPs). The processor 1430 is in

communication with the ingress ports 1420, receiver units 1410, transmitter units 1440, egress ports 1450, and memory 1460. The processor 1430 comprises a coding module 1414. The coding module 1414 implements the disclosed embodiments described above. For instance, the coding module 1414 implements, processes, prepares, or
5 provides the various coding operations. The inclusion of the coding module 1414 therefore provides a substantial improvement to the functionality of the device 1400 and effects a transformation of the device 1400 to a different state. Alternatively, the coding module 1414 is implemented as instructions stored in the memory 1460 and executed by the processor 1430 (e.g., as a computer program product stored on a non-
10 transitory medium).

The memory 1460 comprises one or more disks, tape drives, and solid-state drives and may be used as an over-flow data storage device, to store programs when such programs are selected for execution, and to store instructions and data that are read
15 during program execution. The memory 1460 may be volatile and/or non-volatile and may be read-only memory (ROM), random access memory (RAM), ternary content-addressable memory (TCAM), and/or static random-access memory (SRAM). The device 1400 may also input/output (I/O) device for interacting with an end user. For example, the device 1400 may include a display, such as a monitor, for visual output,
20 speakers for audio output, and a keyboard/mouse/trackball, etc. for user input.

For a deblocking filter apparatus corresponding to the methods of Figs. 16A or 16B, it is referred, again, to Fig. 6. Fig. 6 is a block diagram showing an example structure of a deblocking filter apparatus 600. Said apparatus 600 includes an edge locating unit
25 603, said edge locating unit configured to determine a block edge between a first image block and a second image block, a deblocking determination unit 604

configured to determine whether two different pairs of weighting factors are applied to the first image block and the second image block, and in case the determination is affirmative configured to assign or set, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; wherein the first block and the second block are predicted by Bi-prediction; and a deblocking filtering unit 606 configured to perform deblocking filtering of values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter.

10 The following is an explanation of the applications of the encoding method as well as the decoding method as shown in the above-mentioned embodiments, and a system using them.

FIG. 17 is a block diagram showing a content supply system 3100 for realizing content distribution service. This content supply system 3100 includes capture device 3102, terminal device 3106, and optionally includes display 3126. The capture device 3102 communicates with the terminal device 3106 over communication link 3104. The communication link may include the communication channel 13 described above. The communication link 3104 includes but not limited to WIFI, Ethernet, Cable, wireless (3G/4G/5G), USB, or any kind of combination thereof, or the like.

The capture device 3102 generates data, and may encode the data by the encoding method as shown in the above embodiments. Alternatively, the capture device 3102 may distribute the data to a streaming server (not shown in the Figures), and the server encodes the data and transmits the encoded data to the terminal device 3106. The capture device 3102 includes but not limited to camera, smart phone or Pad, computer

or laptop, video conference system, PDA, vehicle mounted device, or a combination of any of them, or the like. For example, the capture device 3102 may include the source device 12 as described above. When the data includes video, the video encoder 20 included in the capture device 3102 may actually perform video encoding processing.

5 When the data includes audio (i.e., voice), an audio encoder included in the capture device 3102 may actually perform audio encoding processing. For some practical scenarios, the capture device 3102 distributes the encoded video and audio data by multiplexing them together. For other practical scenarios, for example in the video conference system, the encoded audio data and the encoded video data are not

10 multiplexed. Capture device 3102 distributes the encoded audio data and the encoded video data to the terminal device 3106 separately.

In the content supply system 3100, the terminal device 310 receives and reproduces the encoded data. The terminal device 3106 could be a device with data receiving and

15 recovering capability, such as smart phone or Pad 3108, computer or laptop 3110, network video recorder (NVR)/ digital video recorder (DVR) 3112, TV 3114, set top box (STB) 3116, video conference system 3118, video surveillance system 3120, personal digital assistant (PDA) 3122, vehicle mounted device 3124, or a combination of any of them, or the like capable of decoding the above-mentioned encoded data. For

20 example, the terminal device 3106 may include the destination device 14 as described above. When the encoded data includes video, the video decoder 30 included in the terminal device is prioritized to perform video decoding. When the encoded data includes audio, an audio decoder included in the terminal device is prioritized to perform audio decoding processing.

For a terminal device with its display, for example, smart phone or Pad 3108, computer or laptop 3110, network video recorder (NVR)/ digital video recorder (DVR) 3112, TV 3114, personal digital assistant (PDA) 3122, or vehicle mounted device 3124, the terminal device can feed the decoded data to its display. For a terminal device
5 equipped with no display, for example, STB 3116, video conference system 3118, or video surveillance system 3120, an external display 3126 is contacted therein to receive and show the decoded data.

When each device in this system performs encoding or decoding, the picture encoding
10 device / apparatus or the picture decoding device / apparatus, as shown in the above-mentioned embodiments, can be used.

FIG. 18 is a diagram showing a structure of an example of the terminal device 3106. After the terminal device 3106 receives a stream from the capture device 3102, the
15 protocol proceeding unit 3202 analyzes the transmission protocol of the stream. The protocol includes but not limited to Real Time Streaming Protocol (RTSP), Hyper Text Transfer Protocol (HTTP), HTTP Live streaming protocol (HLS), MPEG-DASH, Real-time Transport protocol (RTP), Real Time Messaging Protocol (RTMP), or any kind of combination thereof, or the like.

20

After the protocol proceeding unit 3202 processes the stream, stream file is generated. The file is outputted to a demultiplexing unit 3204. The demultiplexing unit 3204 can separate the multiplexed data into the encoded audio data and the encoded video data. As described above, for some practical scenarios, for example in the video conference
25 system, the encoded audio data and the encoded video data are not multiplexed. In this

situation, the encoded data is transmitted to video decoder 3206 and audio decoder 3208 without through the demultiplexing unit 3204.

Via the demultiplexing processing, video elementary stream (ES), audio ES, and optionally subtitle are generated. The video decoder 3206, which includes the video decoder 30 as explained in the above-mentioned embodiments, decodes the video ES by the decoding method as shown in the above-mentioned embodiments to generate video frame, and feeds this data to the synchronous unit 3212. The audio decoder 3208, decodes the audio ES to generate audio frame, and feeds this data to the synchronous unit 3212. Alternatively, the video frame may store in a buffer (not shown in FIG. 18) before feeding it to the synchronous unit 3212. Similarly, the audio frame may store in a buffer (not shown in FIG. 18) before feeding it to the synchronous unit 3212.

The synchronous unit 3212 synchronizes the video frame and the audio frame, and supplies the video/audio to a video/audio display 3214. For example, the synchronous unit 3212 synchronizes the presentation of the video and audio information.

Information may code in the syntax using time stamps concerning the presentation of coded audio and visual data and time stamps concerning the delivery of the data stream itself.

20

If subtitle is included in the stream, the subtitle decoder 3210 decodes the subtitle, and synchronizes it with the video frame and the audio frame, and supplies the video/audio/subtitle to a video/audio/subtitle display 3216.

The present invention is not limited to the above-mentioned system, and either the picture encoding device or the picture decoding device in the above-mentioned embodiments can be incorporated into other system, for example, a car system.

5 The invention has been described in conjunction with various embodiments herein. However, other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure and the appended claims. In the claims, the word “comprising” does not exclude other elements or steps and the indefinite article “a” or
10 “an” does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in usually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-
15 state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the internet or other wired or wireless communication systems.

Wherever embodiments and the description refer to the term “memory”, the term
20 “memory” shall be understood and/or shall comprise [listing of all possible memories] a magnetic disk, an optical disc, a read-only memory (Read-Only Memory, ROM), or a random access memory (Random Access Memory, RAM),..., unless explicitly stated otherwise.

Wherever embodiments and the description refer to the term “network”, the term “network” shall be understood and/or shall comprise [listing of all possible memories]..., unless explicitly stated otherwise.

- 5 The person skilled in the art will understand that the “blocks” (“units”) of the various figures (method and apparatus) represent or describe functionalities of embodiments of the invention (rather than necessarily individual “units” in hardware or software) and thus describe equally functions or features of apparatus embodiments as well as method embodiments (unit = step).

10

The terminology of “units” is merely used for illustrative purposes of the functionality of embodiments of the encoder/decoder and are not intended to limiting the disclosure.

- 15 In the several embodiments provided in the present application, it should be understood that the disclosed system, apparatus, and method may be implemented in other manners. For example, the described apparatus embodiment is merely exemplary. For example, the unit division is merely logical function division and may be other division in actual implementation. For example, a plurality of units or components may be combined or integrated into another system, or some features may be ignored or not
- 20 performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections may be implemented by using some interfaces. The indirect couplings or communication connections between the apparatuses or units may be implemented in electronic, mechanical, or other forms.

- 25 The units described as separate parts may or may not be physically separate, and parts displayed as units may or may not be physical units, may be located in one position, or

may be distributed on a plurality of network units. Some or all of the units may be selected according to actual needs to achieve the objectives of the solutions of the embodiments.

- 5 In addition, functional units in the embodiments of the present invention may be integrated into one processing unit, or each of the units may exist alone physically, or two or more units are integrated into one unit.

Embodiments of the invention may further comprise an apparatus, e.g. encoder and/or
10 decoder, which comprises a processing circuitry configured to perform any of the methods and/or processes described herein.

Embodiments may be implemented as hardware, firmware, software or any combination thereof. For example, the functionality of the encoder/encoding or
15 decoder/decoding may be performed by a processing circuitry with or without firmware or software, e.g. a processor, a microcontroller, a digital signal processor (DSP), a field programmable gate array (FPGA), an application-specific integrated circuit (ASIC), or the like.

- 20 The functionality of the encoder 100 (and corresponding encoding method 100) and/or decoder 200 (and corresponding decoding method 200) may be implemented by program instructions stored on a computer readable medium. The program instructions, when executed, cause a processing circuitry, computer, processor or the like, to perform the steps of the encoding and/or decoding methods. The computer readable
25 medium can be any medium, including non-transitory storage media, on which the

program is stored such as a Blu-ray disc, DVD, CD, USB (flash) drive, hard disc, server storage available via a network, etc.

An embodiment of the invention comprises or is a computer program comprising
5 program code for performing any of the methods described herein, when executed on a computer.

An embodiment of the invention comprises or is a computer readable medium
comprising a program code that, when executed by a processor, causes a computer
10 system to perform any of the methods described herein.

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

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

Instructions may be executed by one or more processors, such as one or more digital signal processors (DSPs), general purpose microprocessors, application specific integrated circuits (ASICs), field programmable logic arrays (FPGAs), or other equivalent integrated or discrete logic circuitry. Accordingly, the term “processor,” as used herein may refer to any of the foregoing structure or any other structure suitable for implementation of the techniques described herein. In addition, in some aspects, the functionality described herein may be provided within dedicated hardware and/or

software modules configured for encoding and decoding, or incorporated in a combined codec. Also, the techniques could be fully implemented in one or more circuits or logic elements.

- 5 The techniques of this disclosure may be implemented in a wide variety of devices or apparatuses, including a wireless handset, an integrated circuit (IC) or a set of ICs (e.g., a chip set). Various components, modules, or units are described in this disclosure to emphasize functional aspects of devices configured to perform the disclosed techniques, but do not necessarily require realization by different hardware units.
- 10 Rather, as described above, various units may be combined in a codec hardware unit or provided by a collection of interoperative hardware units, including one or more processors as described above, in conjunction with suitable software and/or firmware.

While several embodiments have been provided in the present disclosure, it should be
15 understood that the disclosed systems and methods might be embodied in many other specific forms without departing from the spirit or scope of the present disclosure. The present examples are to be considered as illustrative and not restrictive, and the intention is not to be limited to the details given herein. For example, the various elements or components may be combined or integrated in another system or certain
20 features may be omitted, or not implemented.

In addition, techniques, systems, subsystems, and methods described and illustrated in the various embodiments as discrete or separate may be combined or integrated with other systems, modules, techniques, or methods without departing from the scope of
25 the present disclosure. Other items shown or discussed as coupled or directly coupled or communicating with each other may be indirectly coupled or communicating

through some interface, device, or intermediate component whether electrically, mechanically, or otherwise. Other examples of changes, substitutions, and alterations are ascertainable by one skilled in the art and could be made without departing from the spirit and scope disclosed herein.

5 In addition, the present disclosure provides the following further aspects.

A first aspect of a deblocking filter apparatus for use in an image encoder and/or an image decoder comprising: an edge locating unit, configured to determine edges between blocks, wherein the edges between blocks comprises a block edge between a first coding block P and a second coding block Q; a deblocking determination unit,
10 configured to determine whether the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding block P and the second coding block Q respectively; and a deblocking filtering unit, configured to apply the deblocking filter to values of samples near the block edge
15 between the first coding block P and the second coding block Q, when it is determined that different weighting factors are applied for the first coding block P and the second coding block Q respectively .

A second aspect of a filter apparatus according to the first aspect, wherein the
20 deblocking determination unit is configured to determine the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if the first coding block P and the second coding block Q apply two different weighting factors to construct the motion compensated prediction.

25 A third aspect of a filter apparatus according to the first or second aspect, wherein the deblocking determination unit is configured to determine the block edge between the

first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if different weighting factors are applied for the first coding block P and the second coding block Q respectively; or the deblocking determination unit is configured to determine the block edge between the first coding block P and the
5 second coding block Q is not to be filtered by applying a deblocking filter if the same weighting factor is applied for the first coding block P and the second coding block Q.

A fourth aspect of a filter apparatus according to the first or second aspect, wherein the deblocking determination unit is configured to determine the block edge between the
10 first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if the same weighting factor is applied for the first coding block P and the second coding block Q; or the deblocking determination unit is configured to determine the block edge between the first coding block P and the second coding block Q is not to be filtered by applying a deblocking filter if the same weighting factor is
15 applied for the first coding block P and the second coding block Q.

A fifth aspect of a according to any one of the preceding of aspects, wherein at the edge between two spatially adjacent blocks which apply bi-prediction, deblocking filter is applied if the two blocks apply two different weighting factors to construct the
20 motion compensated prediction.

A sixth aspect of a filter apparatus according to any one of the preceding of aspects, wherein a weak deblocking filter is applied at the edge between two spatially adjacent blocks, if two blocks are predicted by inter prediction and two different weighting
25 factors are applied to the two blocks to construct the motion compensated prediction.

A seventh aspect of a filter apparatus according to any one of the preceding of aspects, wherein a strong deblocking filter is applied at the edge between two spatially adjacent blocks, if any one of the two blocks is predicted by intra prediction or the same weighting factor is applied to the two blocks to construct the motion compensated
5 prediction.

An eighth aspect of a filter apparatus according to any one of the preceding of aspects, wherein a weak deblocking filter is applied at the edge between two spatially adjacent blocks, if two blocks are predicted by bi-prediction and two different weighting factors
10 are applied to the two blocks to construct the motion compensated prediction.

A ninth aspect of a filter apparatus according to any one of the preceding of aspects, wherein a weak deblocking filter is applied at the edge between two spatially adjacent blocks, if two blocks are predicted by inter prediction and two different weighting
15 factors are applied to the two blocks to construct the motion compensated prediction.

A tenth aspect of a filter apparatus according to any one of the preceding of aspects, wherein at the edge between two spatially adjacent blocks, if both two blocks apply inter prediction, a boundary strength parameter is set equal to one if the two blocks
20 apply two different weighting factors to construct the motion compensated prediction.

An eleventh aspect of a filter apparatus according to any one of the preceding of aspects, wherein at the edge between two spatially adjacent blocks, if both two blocks apply inter prediction, a boundary strength parameter is set to zero or one on the edge
25 between two blocks if the two blocks apply the same weighting factor.

A twelfth aspect of a filter apparatus of any one the ninth to eleventh aspect, wherein the inter prediction is bi-prediction.

A thirteenth aspect of a filter apparatus of any one of the preceding of aspects, wherein
5 the boundary strength parameter is used in the determination of application of deblocking filtering at the said block edge.

A fourteenth aspect of a video encoding apparatus for encoding a picture of a video stream, wherein the video encoding apparatus comprises: a reconstruction unit
10 configured to reconstruct the picture; and a filter apparatus according to any one of the first to thirteenth aspects for processing the reconstructed picture into a filtered reconstructed picture.

A fifteenth aspect of a deblocking method for use in an image encoding and/or an
15 image decoding, the method comprising: determining edges between blocks, wherein the edges between blocks comprises a block edge between a first coding block P and a second coding block Q; determining whether the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding
20 block P and the second coding block Q respectively; and applying the deblocking filter to values of samples near the block edge between the first coding block P and the second coding block Q, when it is determined that different weighting factors are applied for the first coding block P and the second coding block Q respectively .

25 A sixteenth aspect of a method according to the fifteenth aspect, wherein the step of determining whether the block edge between the first coding block P and the second

coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding block P and the second coding block Q respectively, comprising: determining the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if the first coding block P and the second coding block Q apply two different weighting factors to construct the motion compensated prediction.

A seventeenth aspect of a method according to the method of the fifteenth or sixteenth aspect, wherein the step of determining whether the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding block P and the second coding block Q respectively, comprising: determining the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if different weighting factors are applied for the first coding block P and the second coding block Q respectively; or determining the block edge between the first coding block P and the second coding block Q is not to be filtered by applying a deblocking filter if the same weighting factor is applied for the first coding block P and the second coding block Q.

An eighteenth aspect of a method of the fifteenth or sixteenth aspect 6, wherein the step of determining whether the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter, by determining whether different weighting factors are applied for the first coding block P and the second coding block Q respectively, comprising: determining the block edge between the first coding block P and the second coding block Q is to be filtered by applying a deblocking filter if the same weighting factor is applied for the first coding block P

and the second coding block Q; or determining the block edge between the first coding block P and the second coding block Q is not to be filtered by applying a deblocking filter if the same weighting factor is applied for the first coding block P and the second coding block Q.

5

A nineteenth aspect of a method of any one of the of the preceding aspects, wherein at the edge between two spatially adjacent blocks which apply bi-prediction, deblocking filter is applied if the two blocks apply two different weighting factors to construct the motion compensated prediction.

10

A twentieth aspect of a method of any one of any one of the of the preceding aspects, wherein a weak deblocking filter is applied at the edge between two spatially adjacent blocks, if two blocks are predicted by inter prediction and two different weighting factors are applied to the two blocks to construct the motion compensated prediction.

15

A twenty-first aspect of a method of any one of the of the preceding aspects, wherein a strong deblocking filter is applied at the edge between two spatially adjacent blocks, if any one of the two blocks is predicted by intra prediction or the same weighting factor is applied to the two blocks to construct the motion compensated prediction.

20

A twenty-second aspect of a method of any one of the of the preceding aspects, wherein a weak deblocking filter is applied at the edge between two spatially adjacent blocks, if two blocks are predicted by bi-prediction and two different weighting factors are applied to the two blocks to construct the motion compensated prediction.

25

A twenty-third aspect of a method of any one of the of the preceding aspects, wherein at the edge between two spatially adjacent blocks, if both two blocks apply inter prediction, a boundary strength parameter is set equal to one if the two blocks apply two different weighting factors to construct the motion compensated prediction.

5

A twenty-fourth aspect of a method of any one of the of the preceding aspects, wherein at the edge between two spatially adjacent blocks, if both two blocks apply inter prediction, a boundary strength parameter is set to zero or one on the edge between two blocks if the two blocks apply the same weighting factor.

10

A twenty-fourth aspect of a method of any one of the twenty-third to twenty-fifth aspects; wherein the inter prediction is bi-prediction.

A twenty-sixth aspect of a method of any one of preceding aspects, wherein the
15 boundary strength parameter is used in the determination of application of deblocking filtering at the said block edge.

CLAIMS

1. A deblocking method, for deblocking a block edge between a first image block
5 and a second image block, in an image encoding and/or an image decoding,
comprising:

in the case two different pairs of weighting factors are applied to the first image
block and the second image block, assigning or setting, a value of a boundary strength
parameter associated with the block edge between the first image block and the second
10 image block, as a first value; wherein the first block and the second block are predicted
by Bi-prediction; and

performing deblocking filtering of values of samples near the block edge
between the first image block and the second image block based on the first value of
the boundary strength parameter.

15

2. A deblocking method, for deblocking a block edge between a first image block
and a second image block, in an image encoding and/or an image decoding,
comprising:

assigning or setting, in case one or more conditions are met, a value of a
20 boundary strength parameter associated with the block edge between the first image
block and the second image block, as a first value; and

performing deblocking filtering at values of samples near the block edge
between the first image block and the second image block based on the first value of
the boundary strength parameter;

25 wherein the one or more conditions at least comprise:

two different pairs of weighting factors are applied to the first image block and the second image block;

and

wherein the first image block and the second image block are predicted by Bi-
5 prediction.

3. The method of claim 1 or 2, wherein the two pairs of weighting factors comprise:
a first pair of weighting factors used for Bi-prediction of the first image block,
wherein first and second weighting factors are included in the first pair of weighting
10 factors, and
a second pair of weighting factors used for Bi-prediction of the second image block,
wherein third and fourth weighting factors are included in the second pair of weighting
factors.

15 4. The method of claim 1 or 2, wherein the two pairs of weighting factors comprise:
a first pair of weighting factors used for obtaining weighted Bi-predicted value of the
first image block, wherein the weighted Bi-predicted value of the first image block is
based on a sum of first uni-predicted value multiplied with a first weighting factor and
second uni-predicted value multiplied with a second weighting factor, and the first and
20 second weighting factors are included in the first pair of weighting factors; and
a second pair of weighting factors used for obtaining weighted Bi-predicted value of
the second image block, wherein the weighted Bi-predicted value of the second image
block is based on a sum of a third uni-predicted value multiplied with a third weighting
factor and a fourth uni-predicted value multiplied with a fourth weighting factor, and
25 the third and fourth weighting factors are included in the second pair of weighting
factors.

5. The method of claim 3 or 4, wherein the first weighting factor included in the first pair of weighting factors is different from the third weighting factor included in the second pair of weighting factors, or the second weighting factor included in the first pair of weighting factors is different from the fourth weighting factor included in the second pair of weighting factors.

6. The method of any one of claims 3 to 5, wherein
the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of
weighting factors are $(3/8, 5/8)$;
the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of
weighting factors are $(-1/4, 5/4)$; or
the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of
weighting factors are $(5/8, 3/8)$; or
the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of
weighting factors are $(5/4, -1/4)$; or
the first pair of weighting factors are $(5/8, 3/8)$, and the second pair of weighting
factors are $(5/4, -1/4)$; or
the first pair of weighting factors are $(3/8, 5/8)$, and the second pair of weighting
factors are $(-1/4, 5/4)$.

7. The method of any one of claims 3 to 5, wherein
the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors
are $(3, 5)$;
the first pair of weighting factors are $(4, 4)$, and the second pair of weighting factors
are $(-2, 10)$; or

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (5, 3) ; or

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (10, -2) ; or

5 the first pair of weighting factors are (5, 3), and the second pair of weighting factors are (10, -2) ; or

the first pair of weighting factors are (3, 5), and the second pair of weighting factors are (-2, 10).

10 8. The method of any one of the preceding claims 1- 7, wherein the second image block is a current image block, wherein a first image block is a neighboring image block of the current image block.

9. The method of claim 8, wherein

15 the second pair of weighting factors (w_3 , w_4) comprises ($3/8$, $5/8$), ($1/2$, $1/2$), ($4/8$, $4/8$), ($5/8$, $3/8$), ($5/4$, $-1/4$) or ($-1/4$, $5/4$), or

the second pair of weighting factors (w_3 , w_4) comprises (3, 5), (4, 4), (5, 3), (10, -2), or (-2, 10).

20 10. The method of any one of the preceding claims 1-9, wherein the weighting factors are Bi-prediction with coding unit, CU, level weights, BCW.

11. The method of any one of the preceding claims 1-10, wherein the weighting factors are generalized Bi-prediction, GBi, weights.

12. The method of any one of the preceding claims 1-11, wherein a weighting factor of each pair of weighting factors is mapped to a specific index by a predefined mapping.

13. The method of any one of the preceding claims 1-12, wherein a BCW weight of
5 each pair of weighting factors is mapped to a bcw index, denoted bcw_idx, by a predefined mapping.

14. The method of any one of the preceding claims 1-12, wherein a GBi weight of each pair of weighting factors is mapped to a GBi index, denoted Gbi_idx, by a predefined
10 mapping.

15. The method of any one of the preceding claims 1-14, wherein different indexes bcw_idx or GBi_idx, denote different weighting factors, respectively.

15 16. The method of any one of the preceding of claims 1-15, wherein the first value is 1.

17. The method of any one of the preceding of claims 1-16, wherein the first and second image blocks are coding blocks or transform blocks or coding sub-blocks.

20 18. An encoding method for encoding an image, comprising a deblocking method of any one of claims 1-17.

19. A decoding method for decoding an image, comprising a deblocking method of any one of claims 1-17.

20. A non-transitory computer-readable media storing computer instructions that when executed by one or more processors, cause the one or more processors to perform the method according to any of the claims 1-17.

5 21. A deblocking filter apparatus for use in an image encoder and/or an image decoder comprising:

an edge locating unit, configured to determine a block edge between a first image block and a second image block,

a deblocking determination unit configured to determine whether two different
10 pairs of weighting factors are applied to the first image block and the second image block, and in case the determination is affirmative configured to assign or set, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; wherein the first block and the second block are predicted by Bi- prediction; and

15 a deblocking filtering unit configured to perform deblocking filtering of values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter.

22. A deblocking filter apparatus for use in an image encoder and/or an image
20 decoder comprising:

a deblocking determination unit configured to assign or set, in case one or more conditions are met, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; and

a deblocking filtering unit configured to perform deblocking filtering at values
25 of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter;

wherein the one or more conditions at least comprise:

two different pairs of weighting factors are applied to the first image block and the second image block;

and

5 wherein the first image block and the second image block are predicted by Bi-prediction.

23. The deblocking filter apparatus of claim 21 or 22, wherein the two pairs of weighting factors comprise:

10 a first pair of weighting factors used for Bi-prediction of the first image block, wherein first and second weighting factors are included in the first pair of weighting factors, and
a second pair of weighting factors used for Bi-prediction of the second image block, wherein third and fourth weighting factors are included in the second pair of weighting
15 factors.

24. The deblocking filter apparatus of claim 21 or 22, wherein the two pairs of weighting factors comprise:

a first pair of weighting factors used for obtaining weighted Bi-predicted value of the
20 first image block, wherein the weighted Bi-predicted value of the first image block is based on a sum of first uni-predicted value multiplied with a first weighting factor and second uni-predicted value multiplied with a second weighting factor, and the first and second weighting factors are included in the first pair of weighting factors; and
a second pair of weighting factors used for obtaining weighted Bi-predicted value of
25 the second image block, wherein the weighted Bi-predicted value of the second image block is based on a sum of a third uni-predicted value multiplied with a third weighting

factor and a fourth uni-predicted value multiplied with a fourth weighting factor, and the third and fourth weighting factors are included in the second pair of weighting factors.

- 5 25. The deblocking filter apparatus of claim 23 or 24, wherein the first weighting factor included in the first pair of weighting factors is different from the third weighting factor included in the second pair of weighting factors, or the second weighting factor included in the first pair of weighting factors is different from the fourth weighting factor included in the second pair of weighting factors.

10

26. The deblocking filter apparatus of any one of claims 23 to 25, wherein the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(3/8, 5/8)$;
- the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of
- 15 weighting factors are $(-1/4, 5/4)$; or
- the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(5/8, 3/8)$; or
- the first pair of weighting factors are $(1/2, 1/2)$ or $(4/8, 4/8)$, and the second pair of weighting factors are $(5/4, -1/4)$; or
- 20 the first pair of weighting factors are $(5/8, 3/8)$, and the second pair of weighting factors are $(5/4, -1/4)$; or
- the first pair of weighting factors are $(3/8, 5/8)$, and the second pair of weighting factors are $(-1/4, 5/4)$.

- 25 27. The deblocking filter apparatus of any one of claims 23 to 25, wherein

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (3, 5);

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (-2, 10) ; or

5 the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (5, 3) ; or

the first pair of weighting factors are (4, 4), and the second pair of weighting factors are (10, -2) ; or

10 the first pair of weighting factors are (5, 3), and the second pair of weighting factors are (10, -2) ; or

the first pair of weighting factors are (3, 5), and the second pair of weighting factors are (-2, 10).

28. The deblocking filter apparatus of any one of the preceding claims 21- 27, wherein
15 the second image block is a current image block, wherein a first image block is a neighboring image block of the current image block.

29. The deblocking filter apparatus of claim 28, wherein the second pair of weighting factors (w3, w4) comprises (3/8, 5/8), (1/2, 1/2), (4/8, 4/8), (5/8, 3/8), (5/4, -1/4) or (-
20 1/4, 5/4), or
the second pair of weighting factors (w3, w4) comprises (3, 5), (4, 4), (5, 3), (10, -2), or (-2, 10).

30. The deblocking filter apparatus of any one of the preceding claims 21-29, wherein
25 the weighting factors are Bi-prediction with coding unit, CU, level weights, BCW.

31. The deblocking filter apparatus of any one of the preceding claims 21-30, wherein the weighting factors are generalized Bi-prediction, GBi, weights.

32. The deblocking filter apparatus of any one of the preceding claims 21-31, wherein
5 a weighting factor of each pair of weighting factors is mapped to a specific index by a predefined mapping.

33. The deblocking filter apparatus of any one of the preceding claims 21-32, wherein a BCW weight of each pair of weighting factors is mapped to a bcw index, denoted
10 bcw_idx, by a predefined mapping.

34. The deblocking filter apparatus of any one of the preceding claims 21-32, wherein a GBi weight of each pair of weighting factors is mapped to a GBi index, denoted Gbi_idx, by a predefined mapping.
15

35. The deblocking filter apparatus of any one of the preceding claims 21-34, wherein different indexes bcw_idx or GBi_idx, denote different weighting factors, respectively.

36. The deblocking filter apparatus of any one of the preceding of claims 21-35,
20 wherein the first value is 1.

37. The deblocking filter apparatus of any one of the preceding of claims 21-36, wherein the first and second image blocks are coding blocks or transform blocks or coding sub-blocks.

38. A device for use in an image encoder and/or an image decoder, for deblocking block edges between image blocks, wherein the block edges comprises a block edge between a first image block and a second image block,

wherein the device comprises a de-blocking filter configured to:

5 in the case two different pairs of weighting factors are applied to the first image block and the second image block, assign or set, a value of a boundary strength parameter associated with the block edge between the first image block and the second image block, as a first value; wherein the first block and the second block are predicted by Bi-prediction; and

10 perform deblocking filtering of values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter.

39. A device for use in an image encoder and/or an image decoder, for deblocking 15 block edges between image blocks, wherein the block edges comprises a block edge between a first image block and a second image block,

wherein the device comprises a de-blocking filter configured to:

assign or set, in case one or more conditions are met, a value of a boundary strength parameter associated with the block edge between the first image block and 20 the second image block, as a first value; and

perform deblocking filtering at values of samples near the block edge between the first image block and the second image block based on the first value of the boundary strength parameter;

wherein the one or more conditions at least comprise:

25 two different pairs of weighting factors are applied to the first image block and the second image block;

and

wherein the first image block and the second image block are predicted by Bi-prediction.

5 40. A video encoding apparatus (100) for encoding a picture of a video stream, wherein the video encoding apparatus (100) comprises:

a reconstruction unit (114) configured to reconstruct the picture; and

a deblocking filter apparatus (120) according to any one of claims 21 to 39 for processing the reconstructed picture into a filtered reconstructed picture.

10

41. A video decoding apparatus (200) for decoding a picture of an encoded video stream (303), wherein the video decoding apparatus (200) comprises:

a reconstruction unit (214) configured to reconstruct the picture; and

a deblocking filter apparatus (120) according to any one of claims 21 to 39 for

15 processing the reconstructed picture into a filtered reconstructed picture.

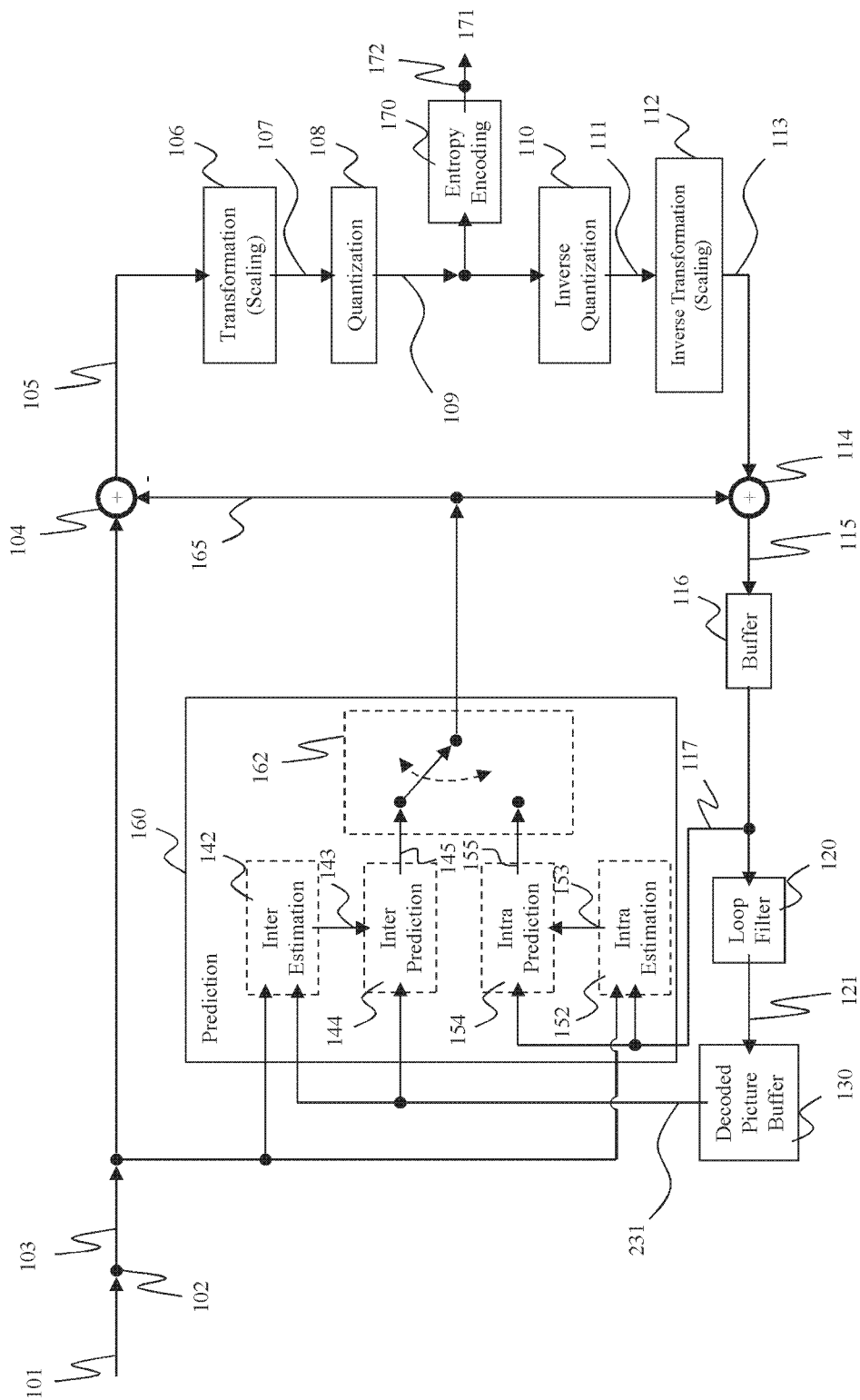


Fig. 1

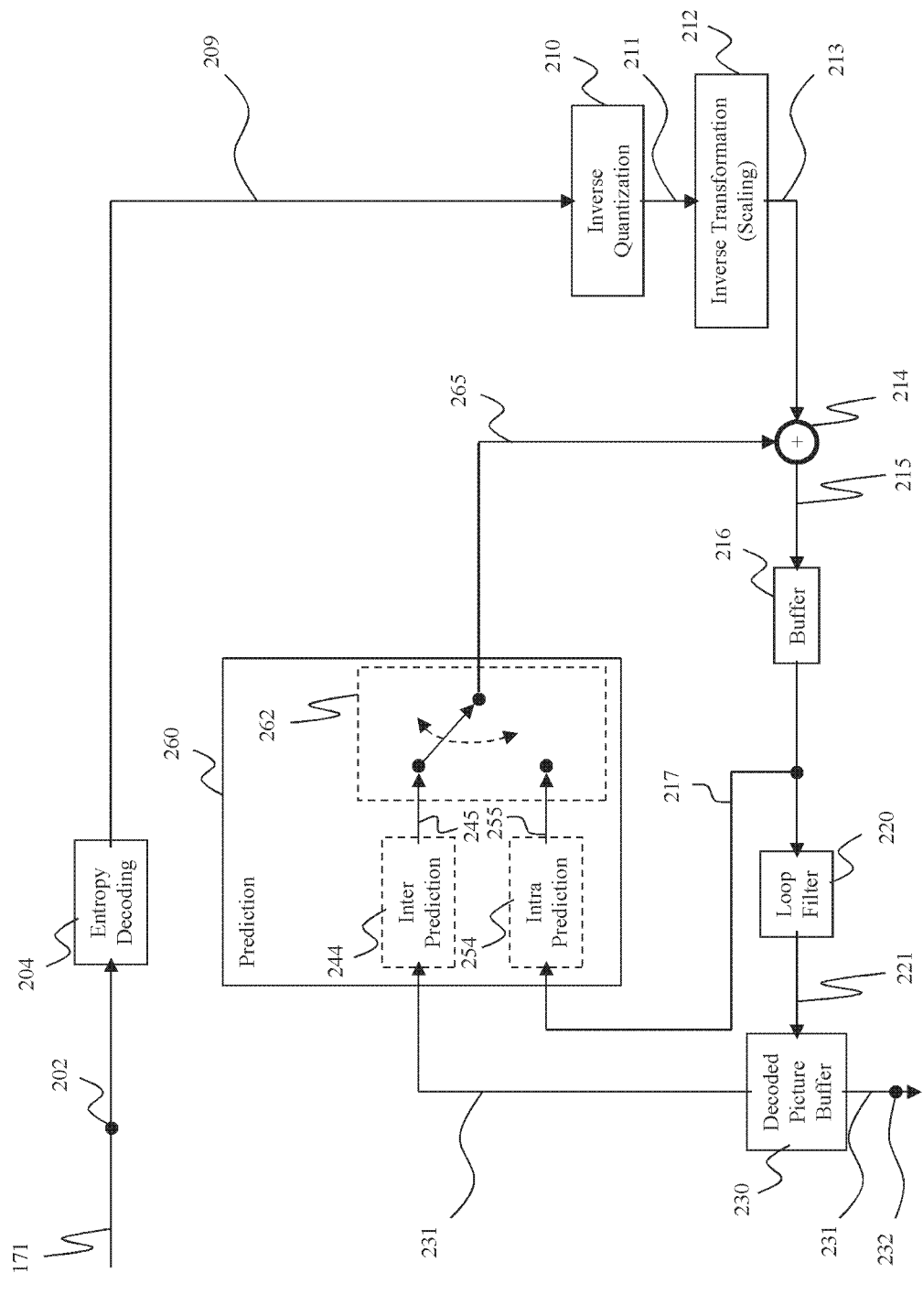


Fig. 2

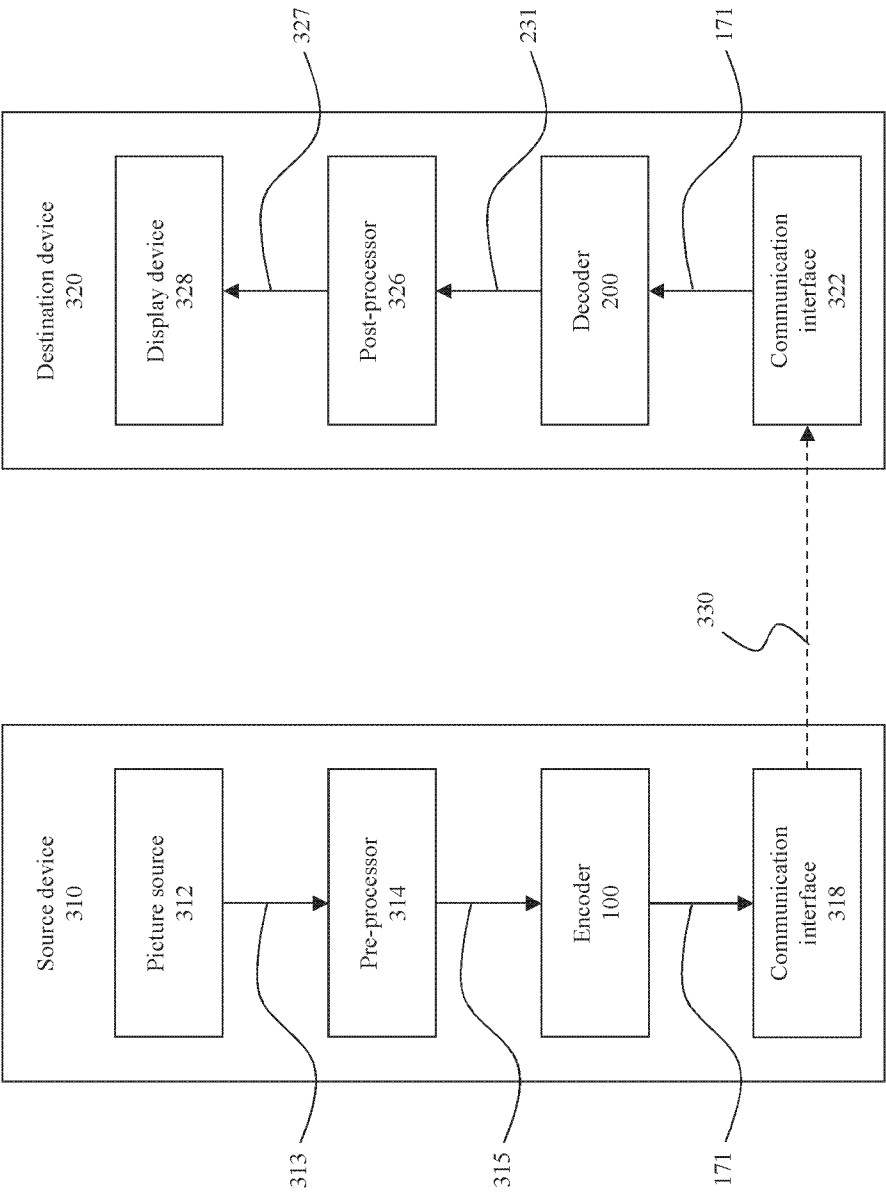


Fig. 3

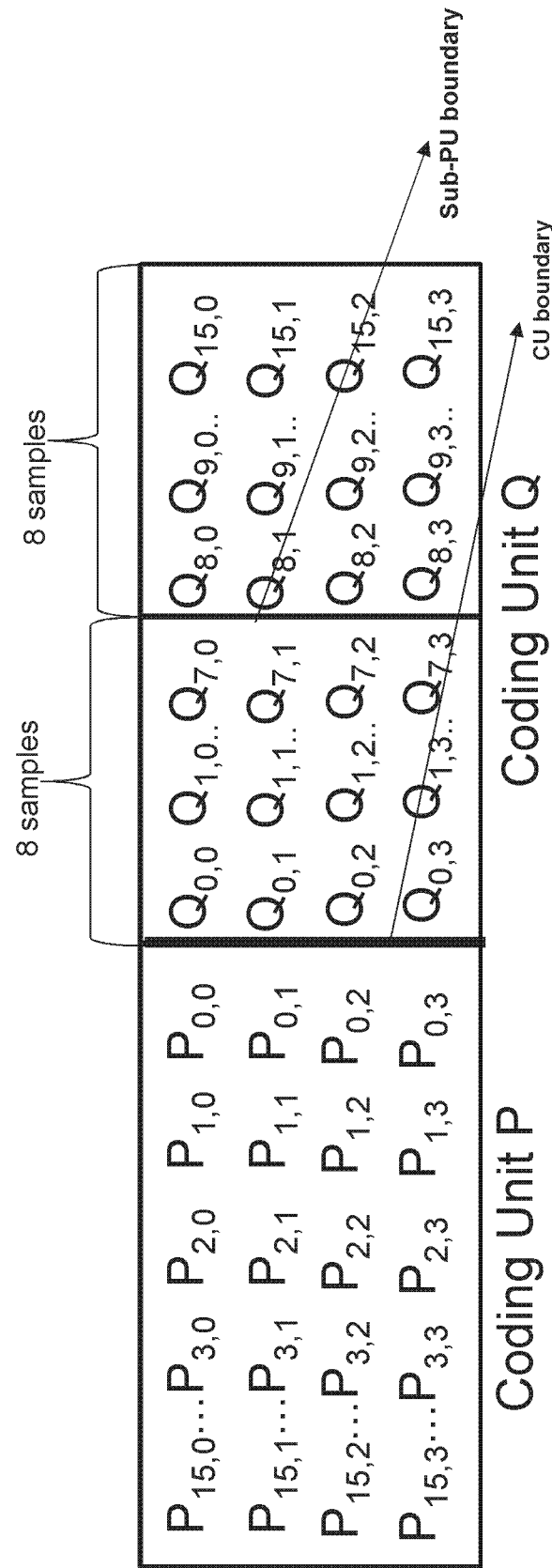


Fig. 4

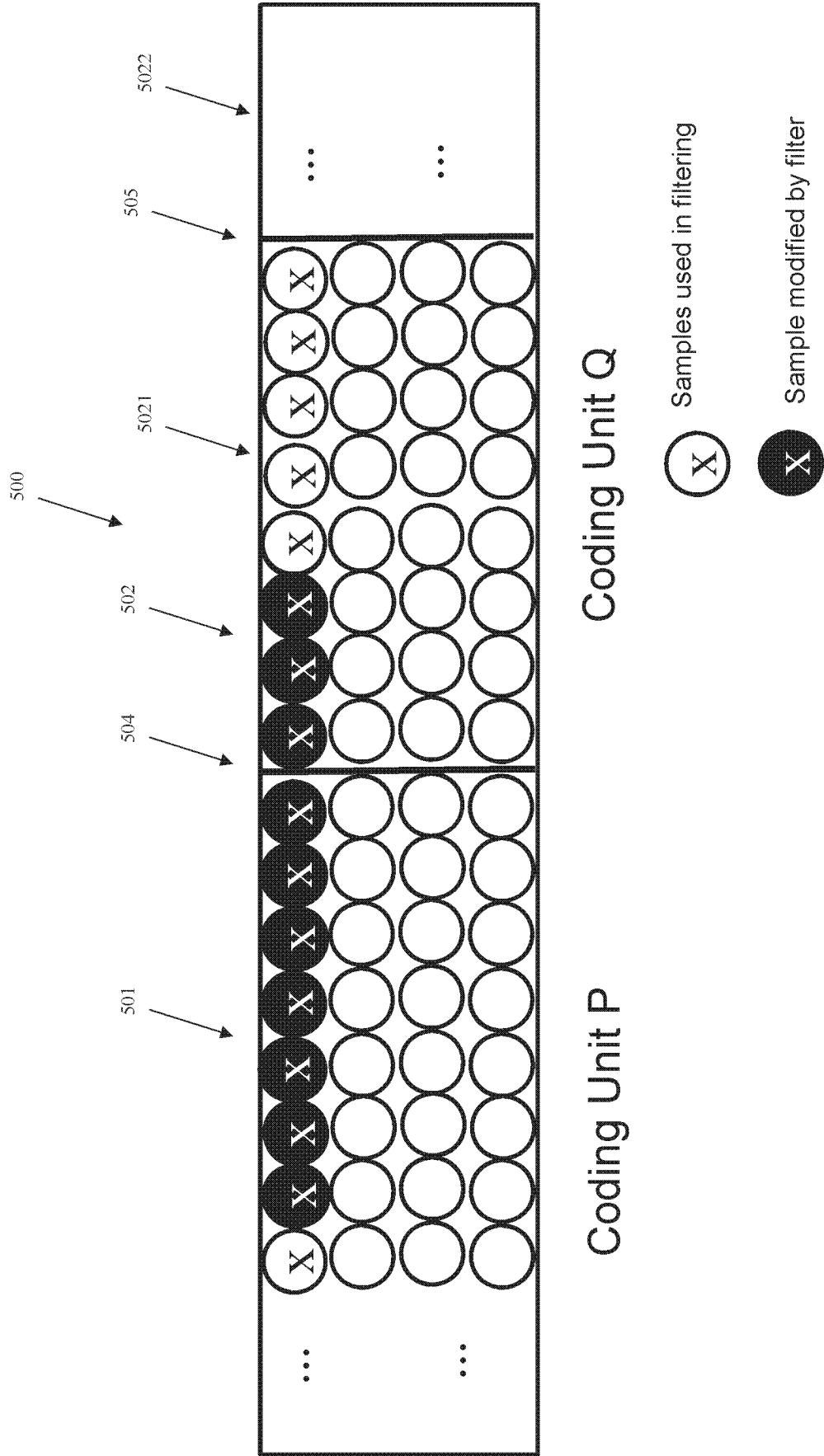


Fig. 5A

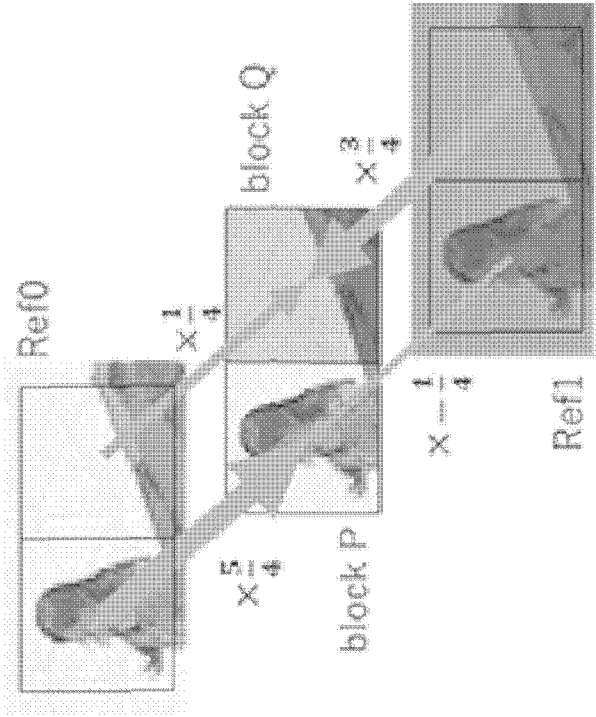


Fig. 5B

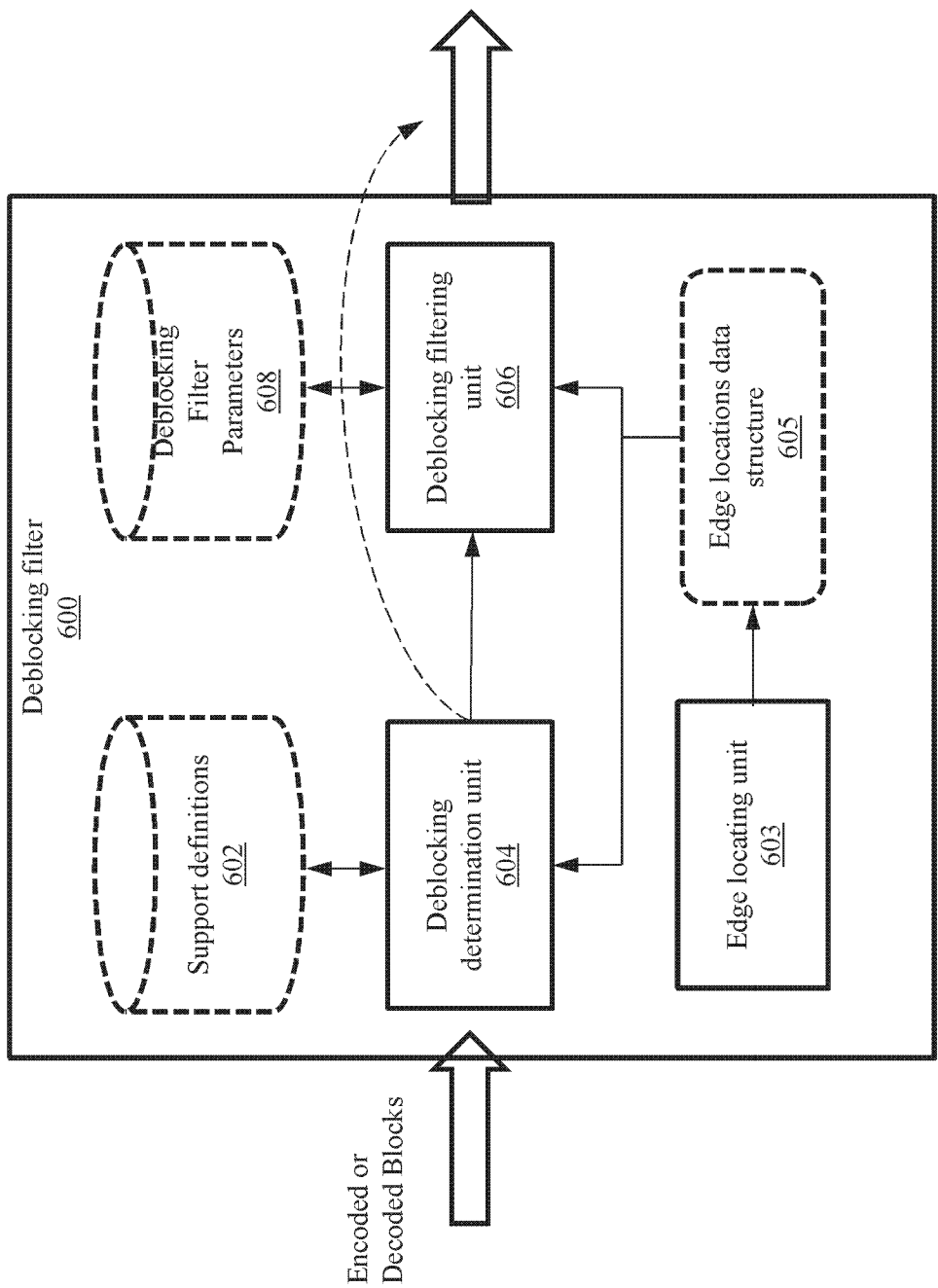


Fig. 6

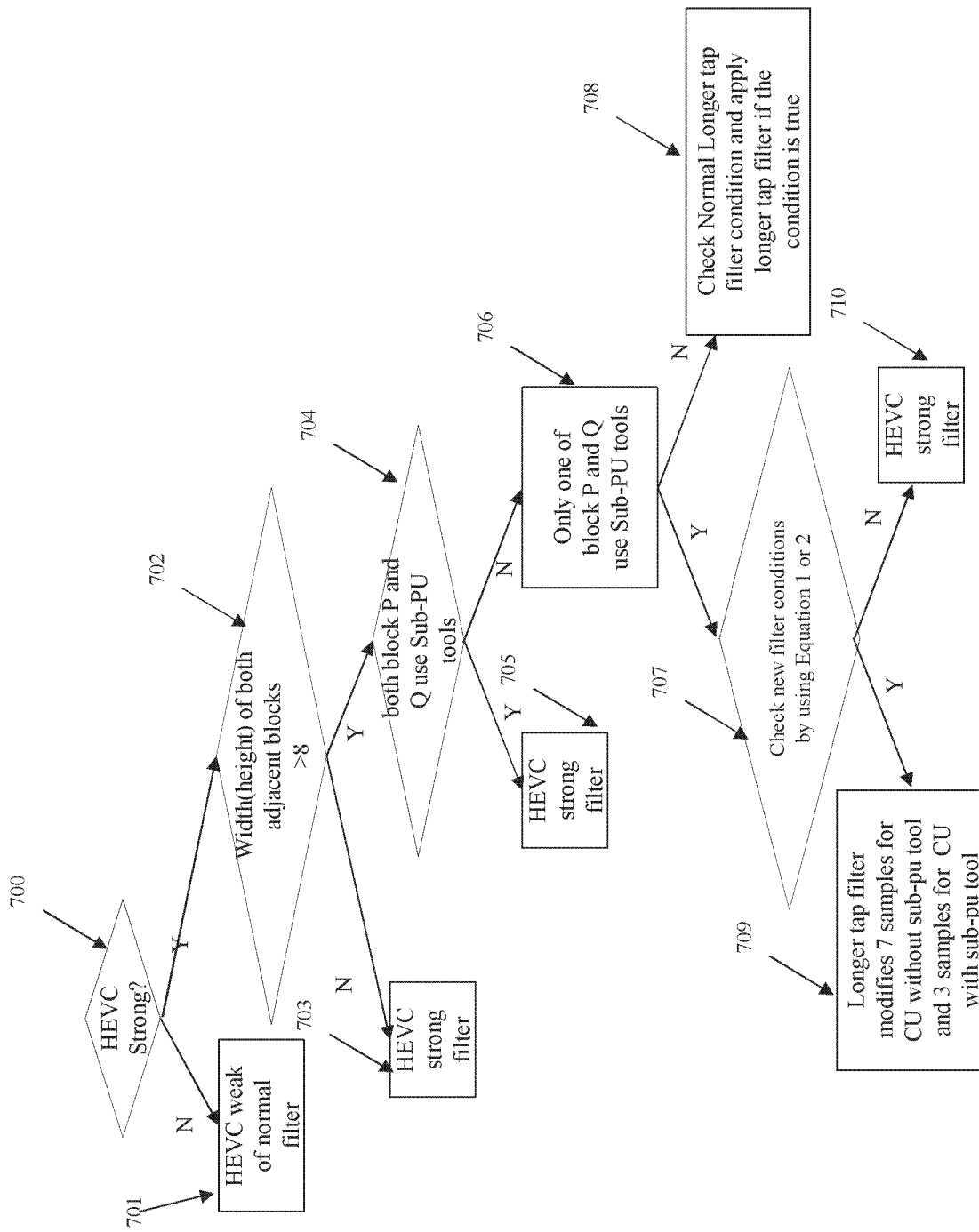


Fig. 7

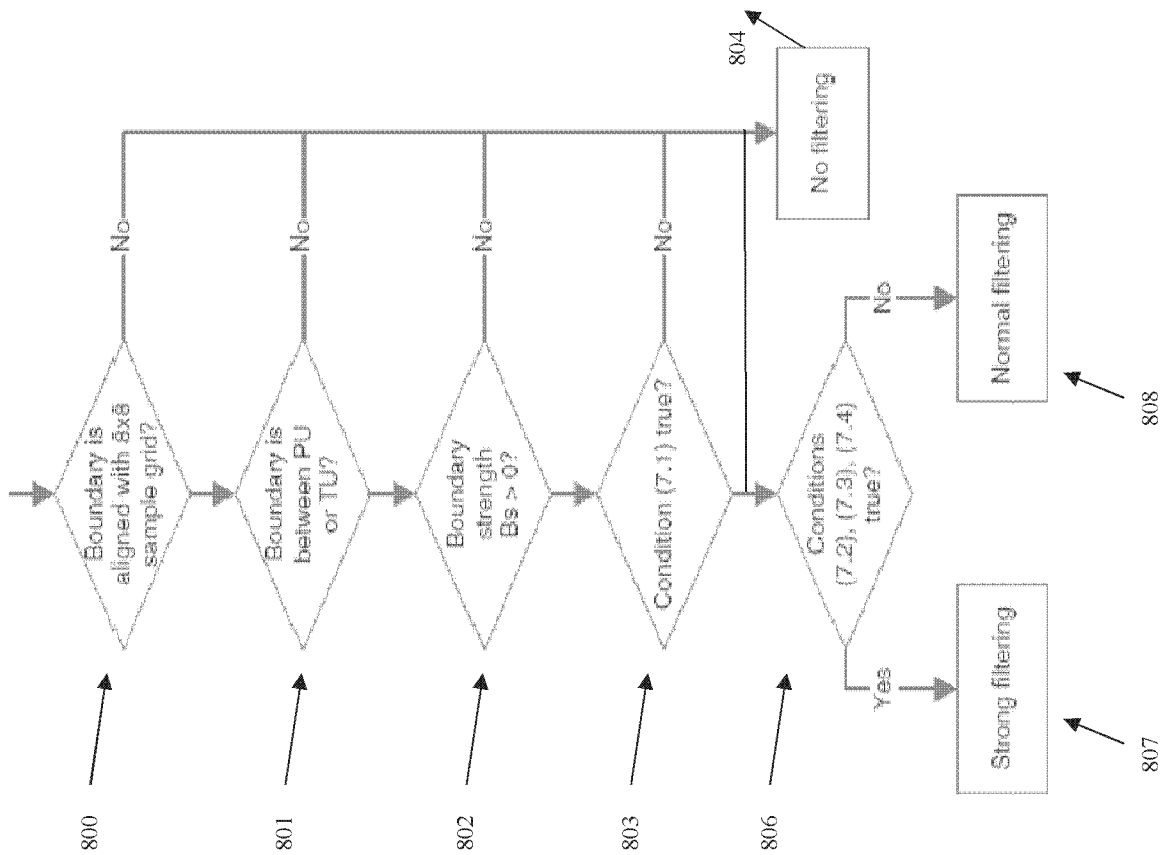


Fig. 8

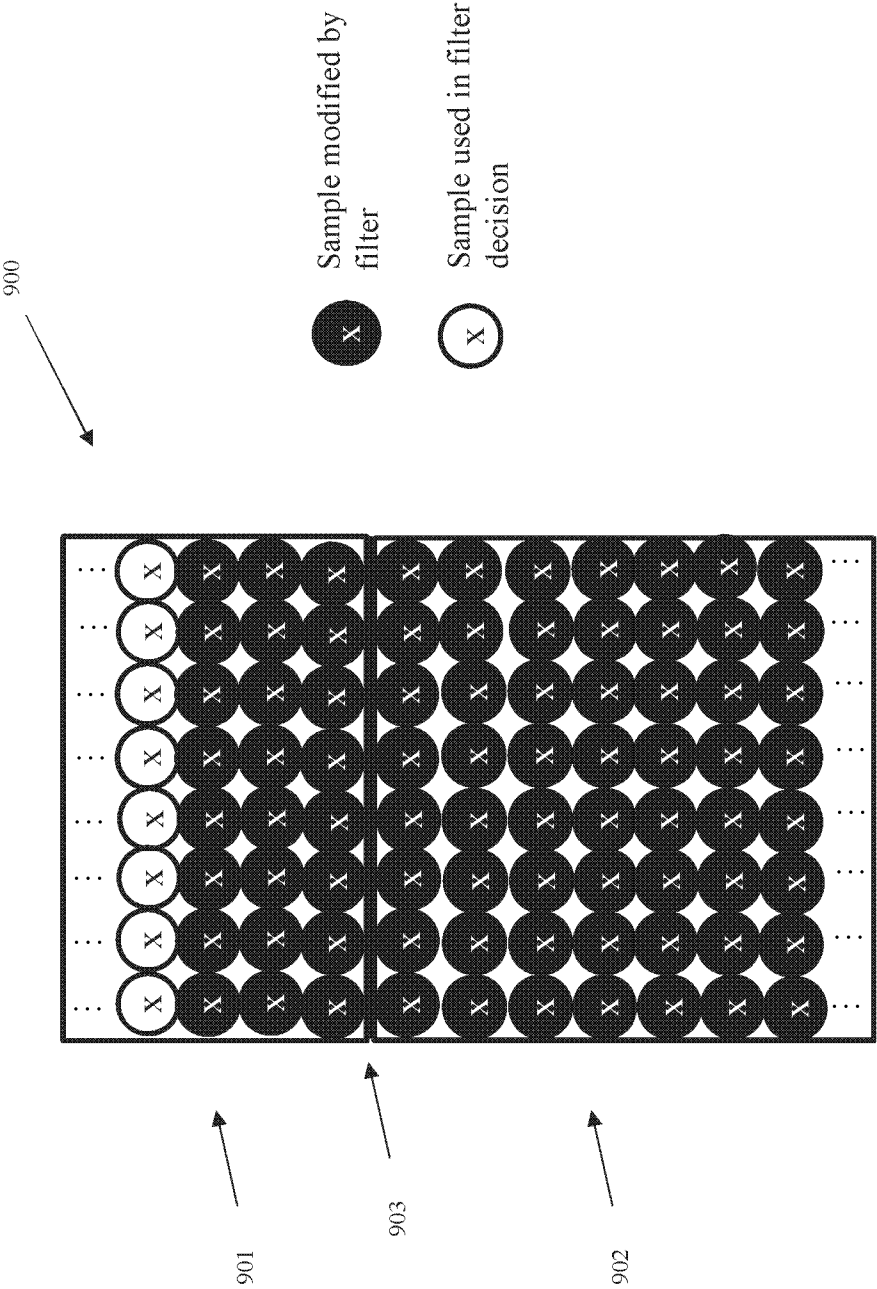


Fig. 9

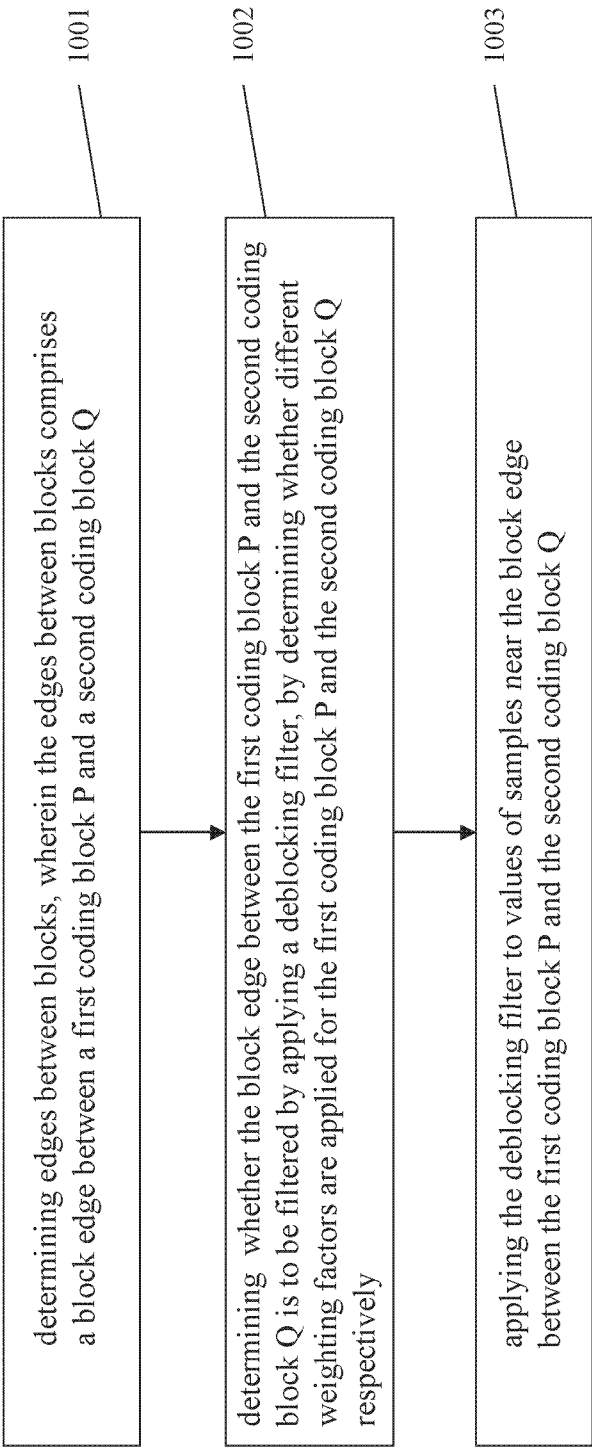


Fig. 10

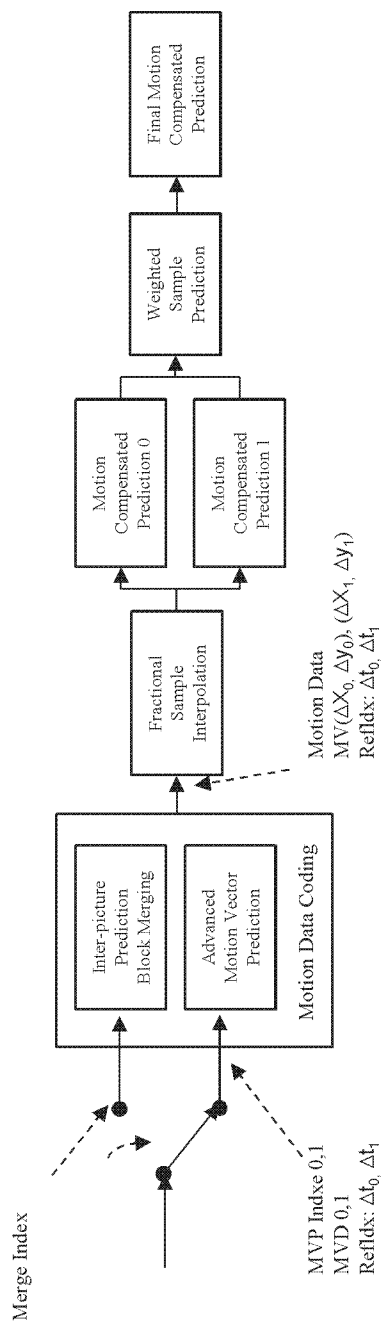


Fig. 11

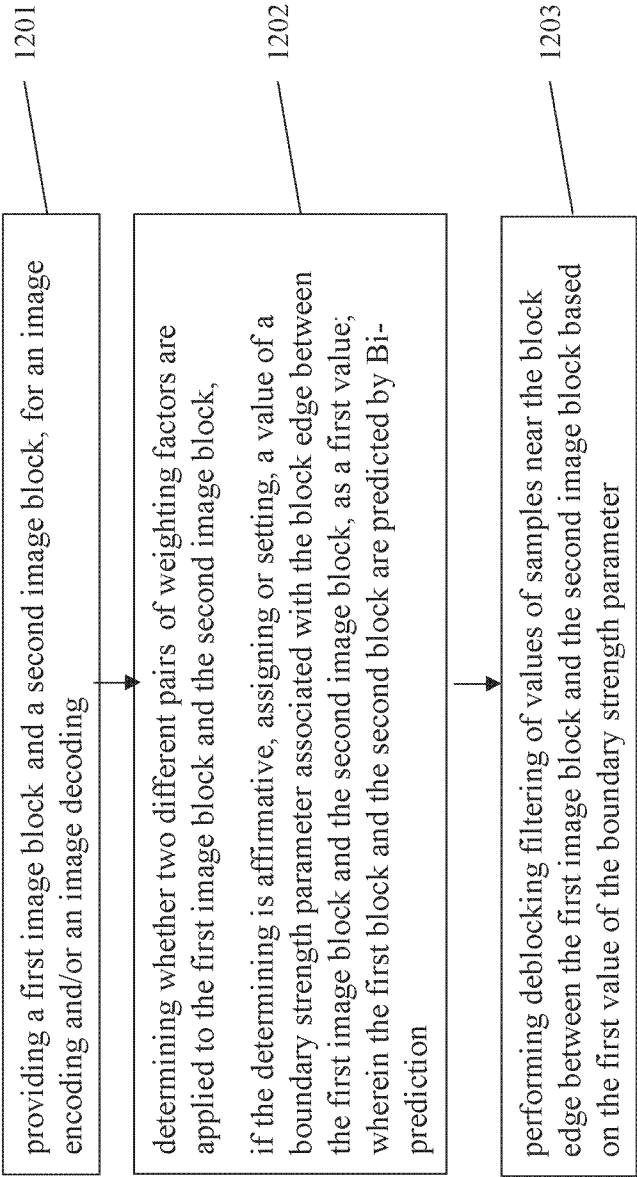


Fig. 12A

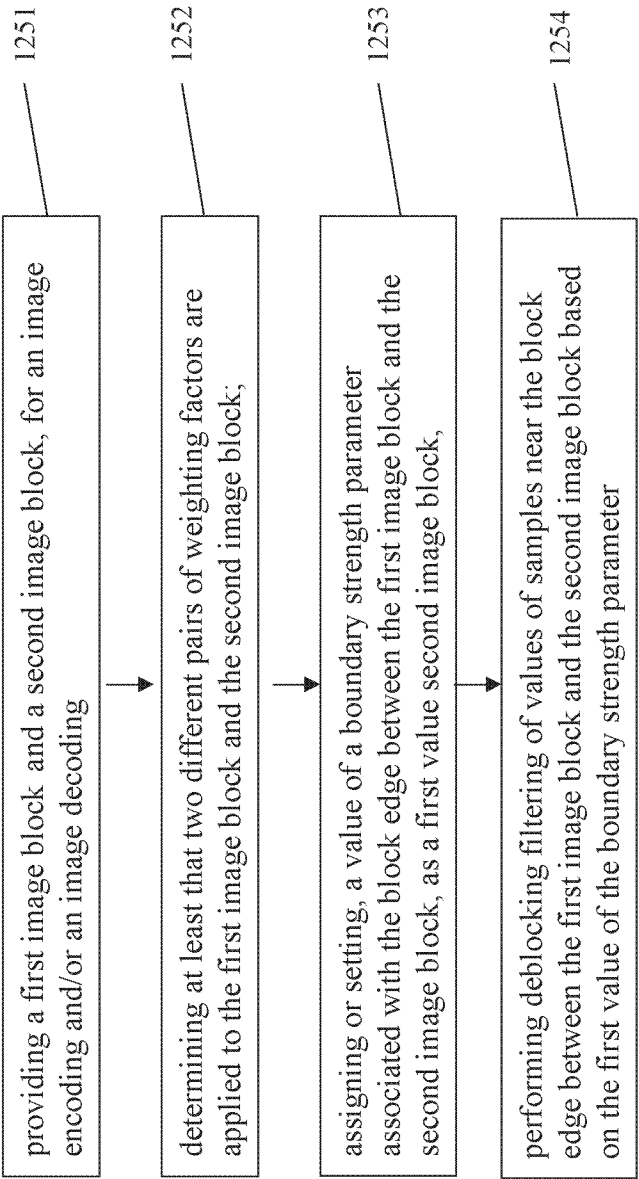


Fig. 12B

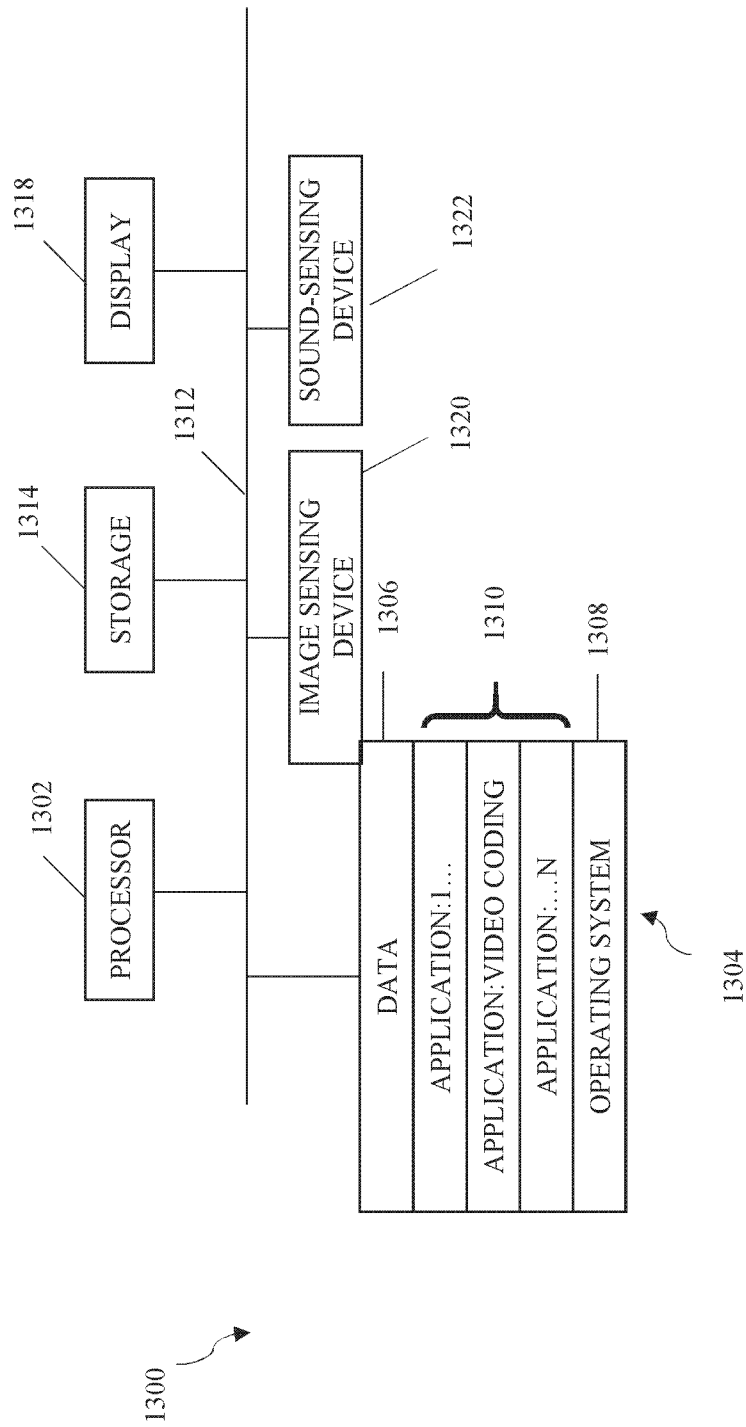


Fig. 13

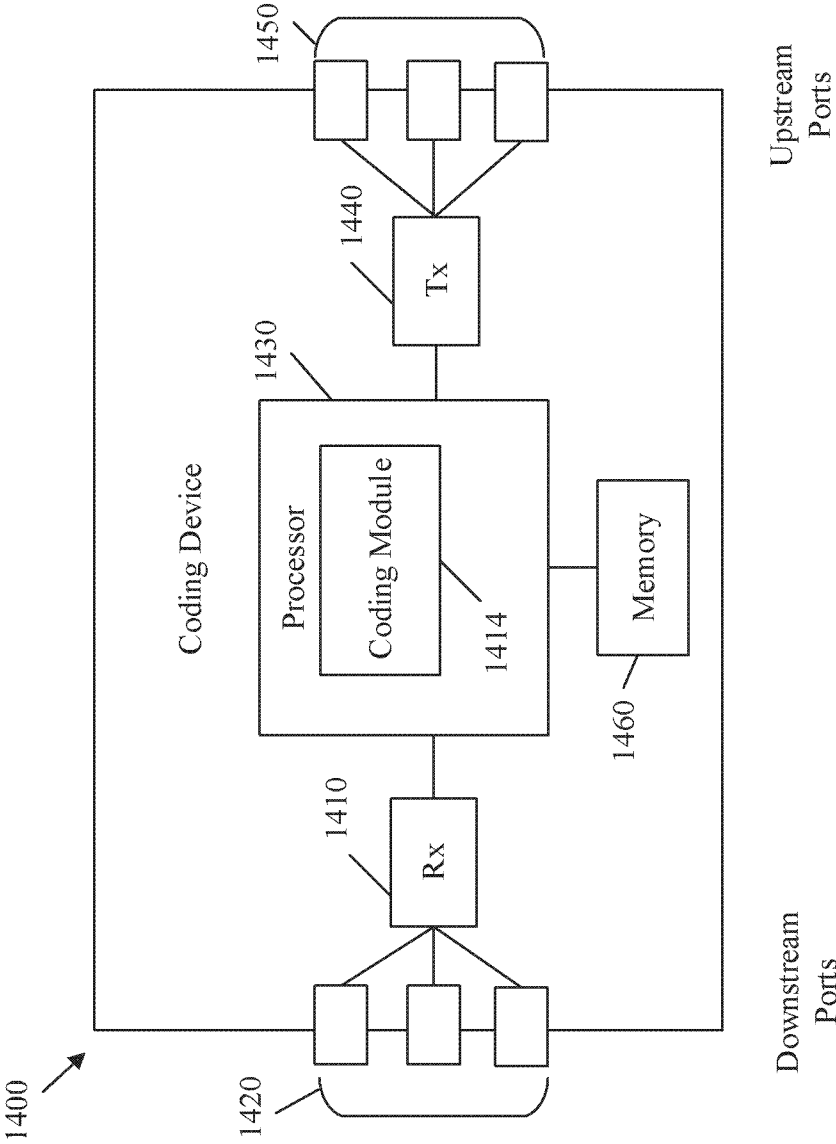


FIG. 14

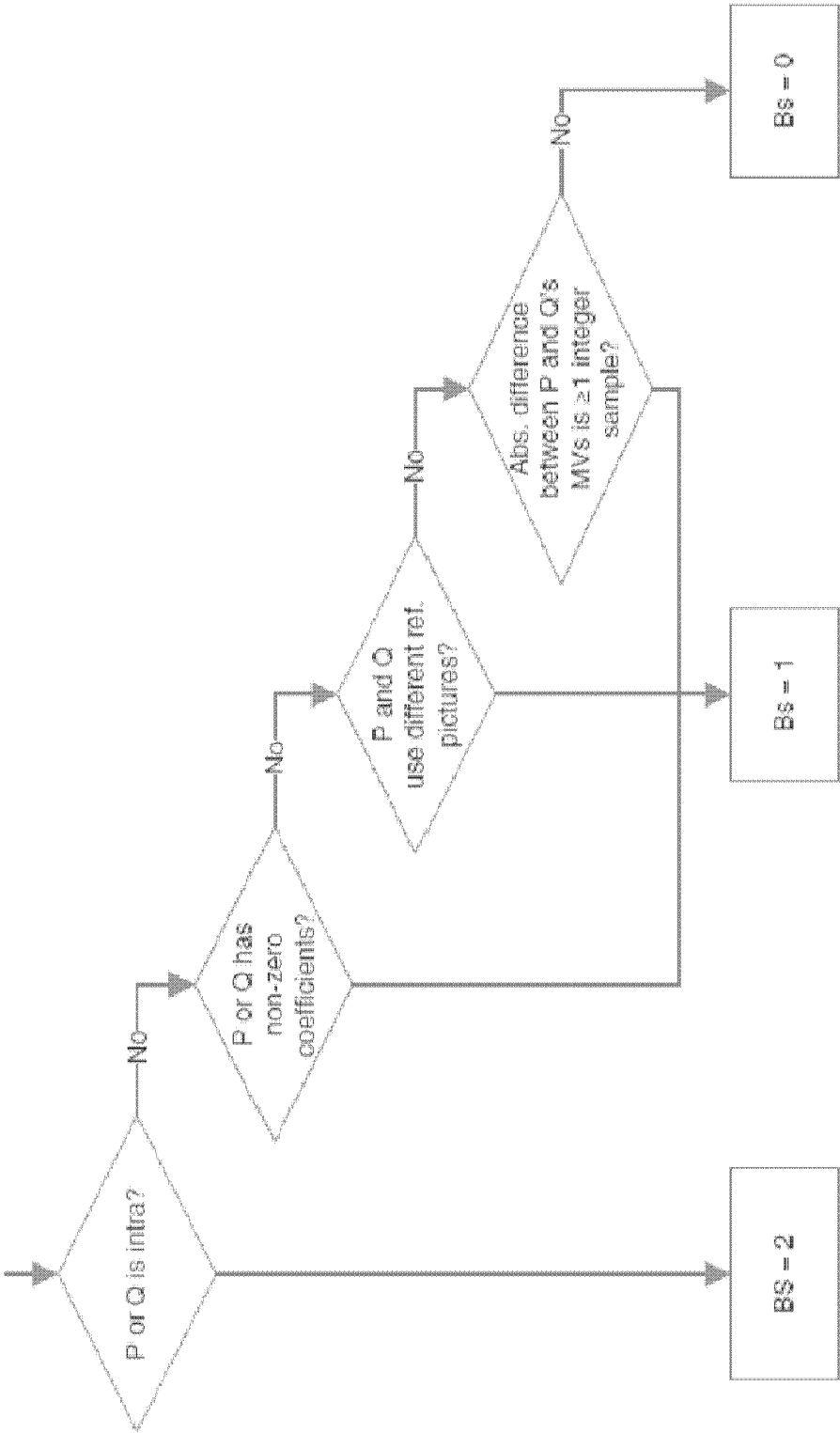


Fig. 15

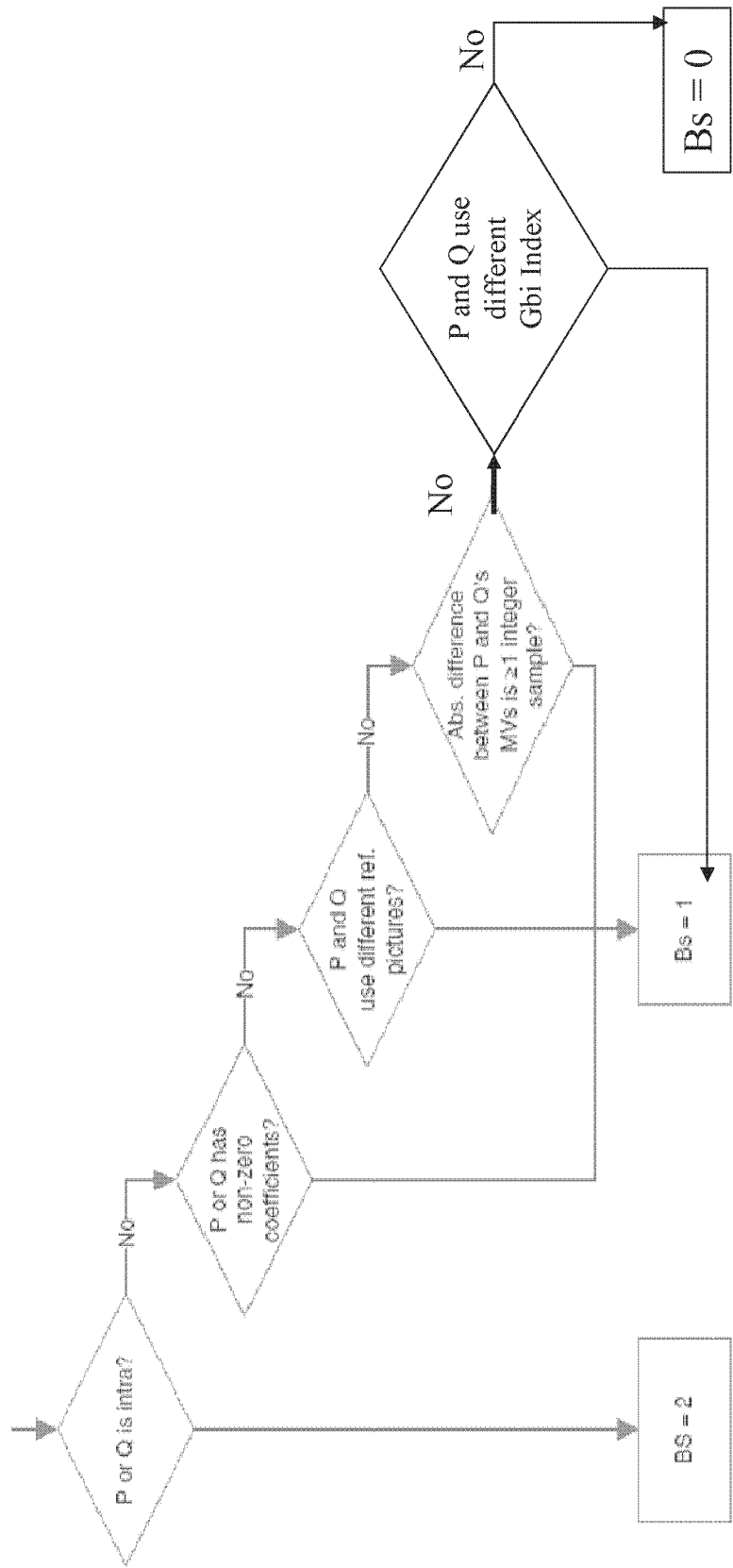


Fig. 16A

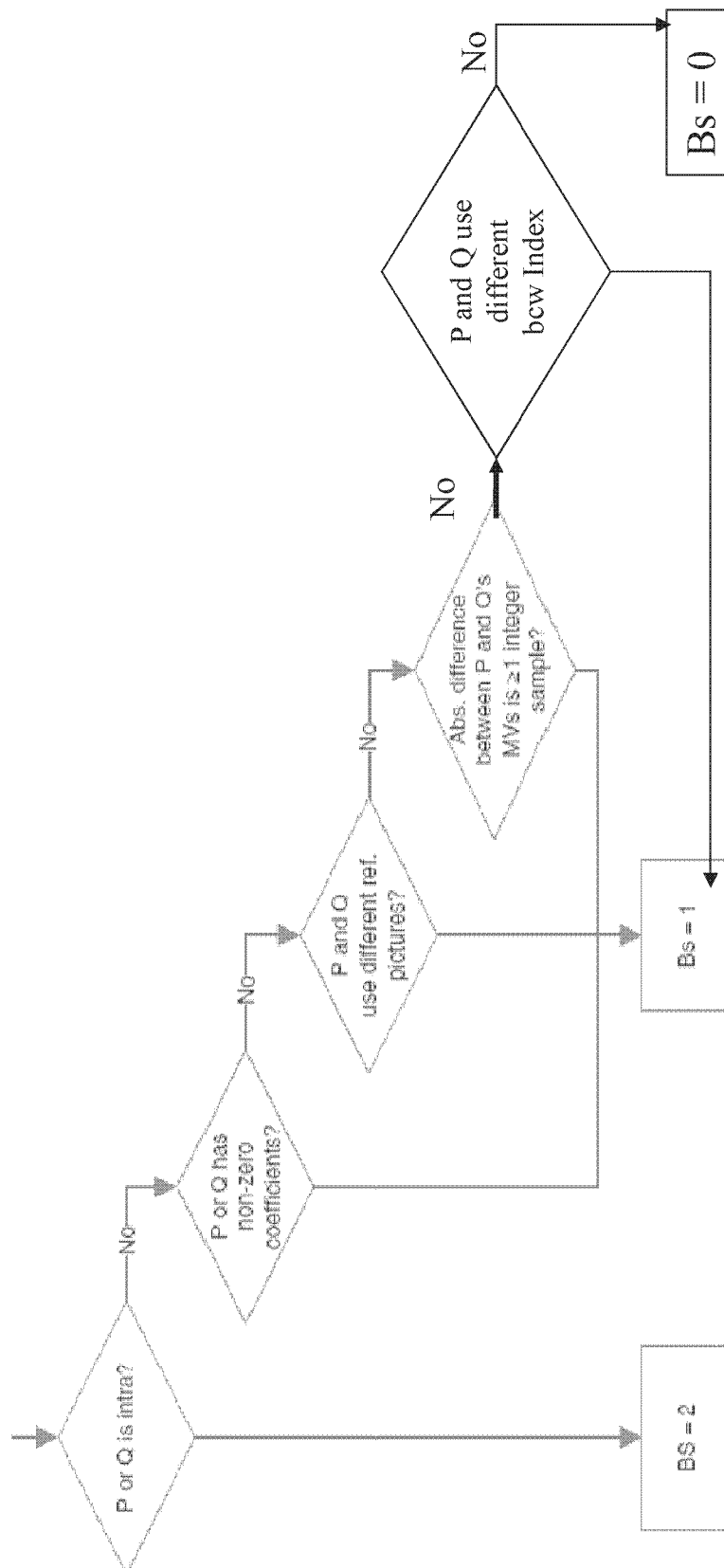


Fig. 16B

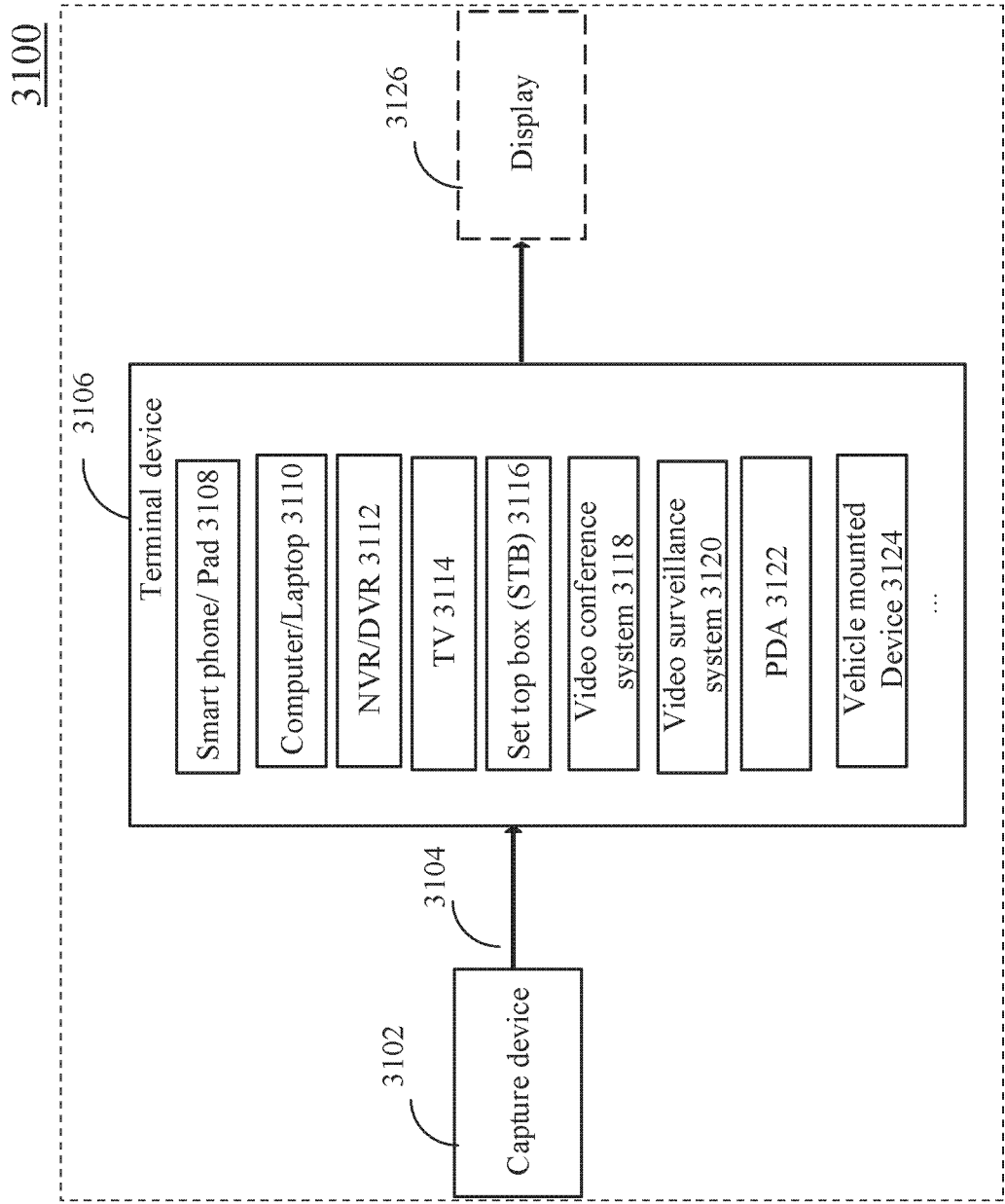


Fig. 17

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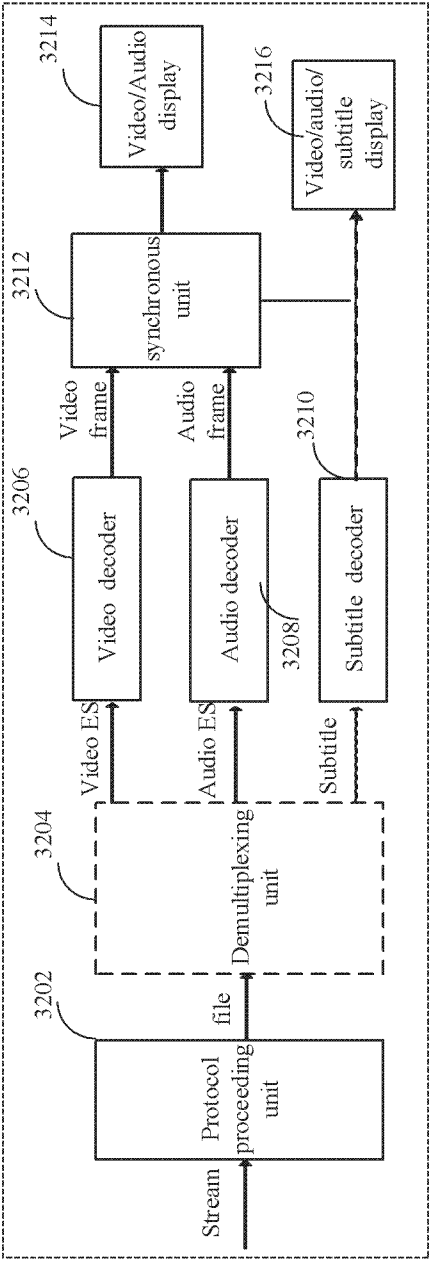


Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/110028

A. CLASSIFICATION OF SUBJECT MATTER

H04N 19/503(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)

G06K; 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)

WPI,EPODOC,CNKI,CNPAT:image,deblock+,block,edge,cod+,encod+,decod+,weight+,boundary,strength,predict+,inter,filter+,different

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011097004 A1 (SAMSUNG ELECTRONICS CO., LTD.) 28 April 2011 (2011-04-28) description, paragraphs [0043]-[0197], figures 1-16	1-41
A	US 2014003522 A1 (LG ELECTRONICS INC.) 02 January 2014 (2014-01-02) the whole document	1-41
A	CN 101389016 A (HUAWEI TECHNOLOGIES CO., LTD.) 18 March 2009 (2009-03-18) the whole document	1-41
A	US 2018103274 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 12 April 2018 (2018-04-12) the whole document	1-41
A	US 2015156516 A1 (LG ELECTRONICS INC.) 04 June 2015 (2015-06-04) the whole document	1-41



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“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

26 December 2019

Date of mailing of the international search report

14 January 2020

Name and mailing address of the ISA/CN

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Facsimile No. (86-10)62019451

Telephone No. 53961711

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/110028

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				WO	2011053022	A3	25 August 2011
				KR	20110045950	A	04 May 2011
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				CN	102763418	A	31 October 2012
				WO	2011074874	A2	23 June 2011
				KR	20110071047	A	28 June 2011
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				CN	106303550	A	04 January 2017
				WO	2016197634	A1	15 December 2016
				IN	201747046357	A	05 January 2018
				VN	57056	A	26 April 2018
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				WO	2013042923	A1	28 March 2013
				EP	2750385	A1	02 July 2014
				CN	108989803	A	11 December 2018
				US	2015156489	A1	04 June 2015
				CN	103947203	A	23 July 2014
				CN	108696753	A	23 October 2018
				CN	108989806	A	11 December 2018
				KR	20140071437	A	11 June 2014
				US	2014204999	A1	24 July 2014
				US	2018242022	A1	23 August 2018