APPARATUS AND METHOD FOR PERFORMING DEBLOCKING

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application claims the priority to U.S. Provisional Patent Application No. 62/717,029, filed August 10, 2018 and U.S. Provisional Patent Application No. 62/723,453, filed August 27, 2018. The aforementioned patent applications are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

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

BACKGROUND

Image coding (encoding and decoding) is used in a wide range of digital image 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.

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, 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. Especially for an image block (such as a transform unit (TU), a prediction unit (PU), a coding unit (CU)) which uses sub-block tools, the deblocking filtering can be challenging.

SUMMARY

In view of the above-mentioned challenges, embodiments of the present invention aim to improve the conventional deblocking filtering. Embodiments of the present invention have the objective to provide a deblocking filter apparatus, an encoder, a decoder and corresponding methods that can perform deblocking filtering with reduced processing time. Further, the deblocking should be efficient and accurate.

Embodiments of the invention are defined by the features of the independent claims, 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.

According to a first aspect of the invention, a deblocking filter apparatus is provided. The deblocking filter apparatus is intended for use in an image encoder and/or an image decoder. The deblocking filter apparatus comprises:

an edge locating unit, configured to determine edges between blocks, wherein the edges between blocks comprises a block edge (e.g. CU edge or CU boundary or TU boundary) between a first coding block P and a second coding block Q and a sub-block edge between sub blocks of the first coding block P or the second coding block Q (i.e. the first coding block P or the second coding block Q has sub-blocks, or the first coding block P or the second coding block Q uses sub-block tools), wherein the first coding block P has a block size being M×N samples or N×M samples, the second coding block Q has a block size being L×T samples or T×L samples (the block size of any of the two coding blocks may also be represented by W*H, wherein W and H indicate the width and height of the respective coding block), for example, N or T

being an even integer 2^n (i.e. of an integer power of two with n being an integer) and larger than a threshold (e.g. a value being 8 or 16 etc.);

a deblocking determination unit, 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 first filter(i.e. a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric long filter); and

a deblocking filtering unit, configured to apply the first filter(i.e. a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric long 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 the block edge between the first coding block P and the second coding block Q is to be filtered by applying the first filter, wherein at most a number MA of sample values of the first coding block perpendicular to and adjacent to the block edge per line are modified and at most a number MB of sample values of the second coding block perpendicular to and adjacent to the block edge per line are modified; or at most a number MA of sample values of the second coding block adjacent to the block edge per line are modified and at most a number MB of sample values of the first coding block adjacent to the block edge per line are modified, MA ≠ MB, particularly MA < MB, such as MA < MB=7. For example, MA=3 and MB=7; or MA=4 and MB=7; or MA=5 and MB=7, etc. It can be understood that the value of MA or MB depends on the value of N or T.

If the second image block Q is a current block which has sub-blocks or uses sub-block tools and the first image block P is a neighboring block of the current block, correspondingly in the second coding block, for each line of input samples which are perpendicular and adjacent to the block edge, at most MA number of samples are modified to generate the output filtered samples; in the first coding block, for each line of input samples which are perpendicular and adjacent to the block edge, at most MB number of samples are modified to generate the output filtered samples. In an example, N or T being an even integer 2^n larger than 8, M or L being an even integer 2^n larger than 2 (e.g. M or L may have the following values 4, 8, 16 or 32,…), M is different from N or M is the same with N; or, L is different from T or L is the same with T; M × N where N > 8 applies for horizontal edges and N × M where N > 8 applies for vertical

edges. In another example, N or T is an even integer 2^n larger than 16, M × N where N > 16 applies for horizontal edges and N × M where N > 16 applies for vertical edges.

The difference between block edge and sub-block edges is described in the further description. A sub-block edge is an edge which is internal to the block which uses sub-block tools which include sub-pu tools like Affine or advanced temporal motion vector prediction (ATMVP), and a block edge (i.e. a coding unit (CU) edge or a coding block edge or CU boundary) is an edge shared between two coding units or two coding blocks or two transform blocks. The sub-block tools also may include tools such as Intra sub-partition (ISP) and Sub-block transform (SBT) tools.

It is noted that the term “block”, “coding block” or “image block” is used in the present disclosure which can be applied for transform units (TUs), prediction units (PUs), coding units (CUs) etc. In VVC in general transform units and coding units are mostly aligned except in few scenarios when TU tiling or sub block transform (SBT) is used. It can be understood that the terms “block/image block/coding block/transform block”, and “block size/transform block size” may be exchanged with each other in the present disclosure. The terms “sample/pixel” may be exchanged with each other in the present disclosure.

The invention works for both vertical and horizontal edges. For vertical edges, the width of the first or second coding block is checked whether the width is larger than 8 samples (e.g. 16 or 32). For horizontal edges, the height of the first or second coding block is checked whether the height is larger than 8 samples (e.g. 16 or 32). For vertical edges the width of the block is considered, only for blocks with a width >= 16 or a width > 16, a longer tap filter (namely a long filter) is applied. For horizontal edges the height of the block is considered, only for blocks with a height >= 16 or a height > 16, a longer tap filter (namely a long filter) is applied.

It is noted that the first filter (i.e. a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric long filter) is a filter which uses DA samples for a filter decision on one side of the block edge and uses DB samples for a filter decision on other side of the block edge, and MB samples are modified on the one side of the block edge (CU edge or TU edge) while MA samples are modified on the other

side of the block edge (CU edge or TU edge), wherein MA ≠ MB, particularly MA < MB, such as MA < MB=7, for example, MA=3 and MB=7, or MA=4 and MB=7, or MA=5 and MB=7. In general, DA= MA + 1 and DB= MB + 1. The first filter may be an asymmetric filter which modifies a different number of samples on either side of the block edge (e.g. CU edge or TU edge).

This allows for differently handling the two sides of a block edge, and therefore the method can avoid filtering overlaps between a block edge and a sub-block edge, and thus can ensure that the deblocking can be performed in parallel. Thus, the processing time for the deblocking filtering is significantly reduced.

It should be noted that the filter apparatus may include a processor configured to carry out the filtering and modifying. Further, this also may ensure that especially edges between blocks in which either of the blocks uses the sub-block tools can be deblocked in parallel.

In a possible implementation form of the apparatus according to the first aspect as such, wherein a sub-block edge between sub blocks exists inside the first coding block and a sub-block edge between sub blocks exists inside the second coding block (i.e. the first coding block and the second coding block have sub-blocks),
the deblocking determination unit is further configured to determine whether the block edge between the first coding block and the second coding block is to be filtered by applying a second filter(e.g. HEVC strong filter); and

the deblocking filtering unit is further configured to apply the second filter(e.g. HEVC strong filter) to values of samples near the block edge, when it is determined that the block edge between the first coding block and the second coding block is to be filtered by applying a second filter(e.g. HEVC strong filter), wherein a number MA' of sample values of the first coding block adjacent to the block edge are modified and a number MB' of sample values of the second coding block adjacent to the block edge are modified, MA'= MB', such as MA'= MB' <7 , for example, MA'= MB'=3. or MA' = MB' = 5.

It is noted that a second filter may be a HEVC strong filter in which MA' (such as 3) samples are modified on one side of the block edge (CU edge) while MB' (such as 3)

samples are modified on other side of the block edge (CU edge). In another example, the second filter is a strong filter that can modify at most three samples on both sides of an edge. In HEVC two filters are defined as deblocking filter: the normal filter and the strong 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 are performed.

In a possible implementation form of the apparatus according to the first aspect as such, wherein when no sub-block edge between sub blocks exists inside the second coding block but a sub-block edge between sub blocks exists inside the first coding block (i.e. when the first coding block has sub-blocks), at most a number MA of sample values of the first coding block adjacent to the block edge per line are modified and at most a number MB of sample values of the second coding block adjacent to the block edge per line are modified, for example, MA=3 and MB=7, or MA=4 and MB=7, or MA=5 and MB=7;

or

when no sub-block edge between sub blocks exists inside the first coding block but a sub-block edge between sub blocks exists inside the second coding block (i.e. when the second coding block has sub-blocks), at most a number MA of sample values of the second coding block adjacent to the block edge per line are modified and at most a number MB of sample values of the first coding block adjacent to the block edge per line are modified, for example, MA=3 and MB=7, or MA=4 and MB=7, or MA=5 and MB=7.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such,, the deblocking determination unit is further configured to determine whether the block edge between the first coding block and the second coding block is to be filtered by applying the first filter(i.e. a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric longer filter) based upon

- at most a number DA of sample values of the first coding block, adjacent to the block edge, as first filter decision values, and
- at most a number DB of sample values of the second coding block, adjacent to the block edge, as second filter decision values.

In general, DA= MA + 1 and DB= MB + 1. If MA=3 and MB=3, DA =DB =4; or if MA=7 and MB=7, DA =DB =8; or if MA=3 and MB=7, DA=4, DB=8; or if MA=4 and MB=7, DA=5, DB=8; or if MA=5 and MB=7, DA=6, DB=8.

This allows for a very accurate and parallel determination of which edges are actually deblocked, and which edges are not deblocked.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, if a sub-block edge between sub blocks exists inside the second coding block Q (i.e. if the second coding block Q has sub blocks), the deblocking determination unit is configured to determine whether a first condition defined by the following first equation is satisfied:

$$\left(|q_3 - q_2 - q_1 + q_0| + |p_0 - p_3 - p_4 + p_7|\right) < \frac{3 * \beta}{32} \;\&\&$$
$$(|q_3 - q_2 - q_1 + q_0| + |p_0 - p_2 - p_3 + p_5|) < \frac{3 * \beta}{32}$$

wherein β denotes a threshold parameter and q_i represent the sample values of the second coding block Q, i=0,1,2,3 and p_j represent the sample values of the first coding block P, j=0, 3, 4, 7 or j=0, 2, 3, 5.

A new filter condition is proposed. This significantly reduces the line memory required for storing the pixel values of the previous coding units necessary for performing the deblocking at the coding unit edge.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, if a sub-block edge between sub blocks exists inside the first coding block P (i.e. if the first coding block P has sub blocks), the deblocking determination unit is configured to determine whether a second condition defined by the following second equation is satisfied:

$$\left(|p_3 - p_2 - p_1 + p_0| + |q_0 - q_3 - q_4 + q_7|\right) < \frac{3 * \beta}{32} \;\&\&$$
$$(|p_3 - p_2 - p_1 + p_0| + |q_0 - q_2 - q_3 + q_5|) < \frac{3 * \beta}{32}$$

wherein β denotes a threshold parameter and p_i represent the sample values of the first coding block P, i=0,1,2,3 and q_j represent the sample values of the second coding block Q, j=0, 3, 4, 7 or j=0, 2, 3, 5.

A new filter condition is proposed. This significantly reduces the line memory required for storing the pixel values of the previous coding units necessary for performing the deblocking at the coding unit edge.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, the threshold parameter β is determined on the basis of a quantization parameter, QP, associated with a quantization step size of the plurality of samples, or

the threshold parameter β is determined on the basis of the quantization parameter, QP, using a look-up table.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (i.e. the first coding block P has no sub-blocks and the second coding block Q has sub-blocks), the deblocking filtering unit is configured to determine the filtered sample value q'_0 of the first sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge (505) between the first image block P and the second image block Q (503a, 503b) on the basis of the following equation:

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 2 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 2 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 2 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

New filter coefficients are proposed. These allows for two kinds of filter coefficients comprising HEVC strong filter coefficients and longer tap asymmetric filter coefficients.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (i.e. the first coding block P has no sub-blocks and the second coding block Q has sub-blocks), the deblocking filtering unit is configured to determine the filtered sample value q_1' of the second sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge (505) between the first image block P and the second image block Q (503a, 503b) on the basis of the following equation:

$$q_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 3 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 4 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

New filter coefficients are proposed. These allows for two kinds of filter coefficients comprising HEVC strong filter coefficients and longer tap asymmetric filter coefficients.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (i.e. the first coding block P has no sub-blocks and the second coding block Q has sub-blocks), the deblocking filtering unit is configured to determine the filtered sample value q_2' of the third sample of the current row or column of samples to the right or bottom of the vertical or

horizontal edge (505) between the first image block P and the second image block Q (503a, 503b) on the basis of the following equation:

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 6 \cdot q_3 + 3 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 6 \cdot q_2 + 2 \cdot q_1 + 2 \cdot q_0 + 2 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

New filter coefficients are proposed. These allow for two kinds of filter coefficients comprising HEVC strong filter coefficients and longer tap asymmetric filter coefficients.

In a possible implementation form of the apparatus according to any preceding implementation of the first aspect or the first aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (i.e. the first coding block P has no sub-blocks and the second coding block Q has sub-blocks), the deblocking filtering unit is configured to determine the filtered sample value p_i' of the corresponding sample of the current row or column of samples to the left or upper of the vertical or horizontal edge (505) between the first image block P and the second image block Q (503a, 503b) on the basis of the following equation:

$$p_0' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 2 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 3 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 3 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 2 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 3 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 2 \cdot p_7)/16,$$

$$p_3' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 1 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 3 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 3 \cdot p_7)/16,$$

$$p_4' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 +$$

In a possible implementation form of the method according to any preceding implementation of the sixth aspect or the sixth aspect as such, wherein the threshold parameter β is determined on the basis of a quantization parameter, QP, associated with a quantization step size of the plurality of samples, or

the threshold parameter β is determined on the basis of the quantization parameter, QP, using a look-up table.

In a possible implementation form of the method according to any preceding implementation of the sixth aspect or the sixth aspect as such, wherein if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (such as the first coding block P has no sub-blocks and the second coding block Q has sub-blocks), the filtered sample value q'_0 of the first sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q is determined on the basis of the following equation:

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 2 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 2 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 2 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to any preceding implementation of the sixth aspect or the sixth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (such as the coding block P has no sub-blocks and the coding block Q has sub-blocks), the filtered sample value q'_1 of the second sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q is determined on the basis of the following equation:

$$q_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 3 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 4 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to any preceding implementation of the sixth aspect or the sixth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q(such as the coding block P has no sub-blocks and the coding block Q has sub-blocks), the filtered sample value q_2' of the third sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q, is determind on the basis of the following equation:

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 6 \cdot q_3 + 3 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 6 \cdot q_2 + 2 \cdot q_1 + 2 \cdot q_0 + 2 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to any preceding implementation of the sixth aspect or the sixth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q (such as the coding block P has no sub-blocks and the coding block Q has sub-blocks), the filtered sample value

p_i' of the corresponding sample of the current row or column of samples to the left or upper of the vertical or horizontal edge between the first coding block P and the second coding block Q, is determined on the basis of the following equation:

$$p_0' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 2 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 3 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 3 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 2 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 3 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 2 \cdot p_7)/16,$$

$$p_3' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 1 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 3 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 3 \cdot p_7)/16,$$

$$p_4' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 3 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 4 \cdot p_7)/16,$$

$$p_5' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 0 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 3 \cdot p_5 + 1 \cdot p_6 + 5 \cdot p_7)/16,$$

$$p_6' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 0 \cdot q_2 + 0 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 3 \cdot p_6 + 6 \cdot p_7)/16,$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to any preceding implementation of the sixth aspect or the sixth aspect as such, if N and T are even integers 2^n larger than 16, MA=3 and MB=7, or MA=4 and MB=7, or MA=5 and MB=7.

According to a seventh aspect the invention relates to a method for deblocking a block edge between a first coding block P and a second coding block Q of an image, for image encoding and/or an image decoding,

wherein the first coding block P has a block size being M*N or N*M, the second coding block Q has a block size being L*T or T*L, for example, N or T being an even integer 2^n larger than 8, particularly, N or T being an even integer 2^n larger than 16,

wherein β denotes a threshold parameter and p_i represent the sample values of the first coding block P, i=0,1,2,3 and q_j represent the sample values of the second coding block Q, j=0, 3, 4, 7 or j=0, 2, 3, 5.

In a possible implementation form of the apparatus according to the twelfth aspect as such, wherein the threshold parameter β is determined on the basis of a quantization parameter, QP, associated with a quantization step size of the plurality of samples, or
the threshold parameter β is determined on the basis of the quantization parameter, QP, using a look-up table.

In a possible implementation form of the apparatus according to the twelfth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the deblocking filtering unit is configured to determine the filtered sample value q'_0 of the first sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 2 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 2 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 2 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the apparatus according to the twelfth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the deblocking filtering unit is configured to determine the filtered sample value q'_1 of the second sample of the current row or column of samples to the right or bottom of the

vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 3 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 4 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the apparatus according to the twelfth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the deblocking filtering unit is configured to determine the filtered sample value q_2' of the third sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 6 \cdot q_3 + 3 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 6 \cdot q_2 + 2 \cdot q_1 + 2 \cdot q_0 + 2 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the apparatus according to the twelfth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the deblocking filtering unit is configured to determine the filtered sample value p_i' of the

corresponding sample of the current row or column of samples to the left or upper of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$p_0' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 2 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 3 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 3 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 2 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 3 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 2 \cdot p_7)/16,$$

$$p_3' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 1 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 3 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 3 \cdot p_7)/16,$$

$$p_4' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 3 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 4 \cdot p_7)/16,$$

$$p_5' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 0 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 3 \cdot p_5 + 1 \cdot p_6 + 5 \cdot p_7)/16,$$

$$p_6' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 0 \cdot q_2 + 0 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 3 \cdot p_6 + 6 \cdot p_7)/16,$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the apparatus according to the twelfth aspect as such, the deblocking determination unit is further 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 first filter; and

the deblocking filtering unit is further configured to apply a third 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 the block edge between the first coding block P and the second coding block Q is not to be filtered by applying the first filter, wherein at most a number MA of sample values of the first coding block adjacent to the block edge per line are modified and at most a number MB of sample values of the second coding block adjacent to the block edge per line are modified, MA=MB=4.

determining the filtered sample value q'_0 of the first sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 2 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 2 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 2 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to the thirteenth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the step of performing deblocking filtering at values of samples near the block edge between the first coding block P and the second coding block Q comprises:

determining the filtered sample value q'_1 of the second sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q'_1 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 3 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_1 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 4 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to the thirteenth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P,

and a sub-block edge between sub blocks exists inside the second coding block Q, the step of performing deblocking filtering at values of samples near the block edge between the first coding block P and the second coding block Q comprises:

determining the filtered sample value q_2' of the third sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 6 \cdot q_3 + 3 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 6 \cdot q_2 + 2 \cdot q_1 + 2 \cdot q_0 + 2 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

In a possible implementation form of the method according to the thirteenth aspect as such, if no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the step of performing deblocking filtering at values of samples near the block edge between the first coding block P and the second coding block Q comprises:

determining the filtered sample value p_i' of the corresponding sample of the current row or column of samples to the left or upper of the vertical or horizontal edge between the first and the second coding block on the basis of the following equation:

$$p_0' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 2 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 3 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 3 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 2 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 3 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 2 \cdot p_7)/16,$$

$$p_3' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 1 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 3 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 3 \cdot p_7)/16,$$

$$p_4' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 +$$

Pre-processing unit 314 is configured to receive the (raw) picture data 313 and to 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.

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 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-processor 326 and a display device 328.

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.

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 private and public network, or any kind of combination thereof.

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).

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 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 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

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 inverse de-quantization, e.g. by inverse quantization unit 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 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 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 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.

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 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 130 form one

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

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 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.

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 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.

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 152) , e.g. by testing all possible or a predetermined 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.

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.

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 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 262 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 262 are configured to perform the inverse processing of the encoder 100 (and the respective functional units) to decode the encoded picture data 171.

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 filter 120 (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.

The prediction unit 260 may comprise an inter prediction unit 244 and an intra prediction unit 254, wherein the inter prediction unit 244 may be identical in function to the inter prediction unit 144, and the inter prediction unit 254 may be identical in function to the intra prediction unit 154. The prediction unit 260 and the mode 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.

The decoder 200 is configured to output the decoded picture 231, 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 or Fig.15 to Fig.16.

of the CU edge are modified in block P, and a maximum of 3 samples on another side of the CU edge are modified in block Q. The filter used is as shown in the table 5. In other words, the present invention may use the filter as shown in the table 5 to de-block the CU boundary between blocks P and Q.

Output pixel	Filter coefficients {p_2, p_1, p_0, q_0, q_1, q_2}	Input pixels
p_2	{**6**, 2, 2, 2, 0, 0}	p_2 ~ q_0
p_1	{4, **4**, 4, 4, 0, 0,}	p_2 ~ q_0
p_0	{2, 4, **4**, 4, 2, 0}	p_2 ~ q_1
q_0	{0, 2, 4, **4**, 4, 2}	p_1 ~ q_2
q_1	{0, 0, 4, 4, **4**, 4}	p_0 ~ q_2
q_2	{0, 0, 2, 2, 2, **6**}	p_0 ~ q_2

Table 5

Fig. 7 is a flow chart illustrating a method for determining whether a longer tap filter (or an asymmetric long filter) shall be used. As illustrated in Fig. 7, the HEVC strong filter condition should be satisfied for the "longer tap filter" conditions to be true. In the step 707, the details have been described above. The longer tap filter used in the step 709 is different from the normal longer tap filter used in the step 708, the details has been described above. The normal longer tap filter condition may be: $|p_7 - p_0| + |q_7 - q_0| < \frac{\beta}{8}$. In some example, on top of the HEVC filter, the normal longer tap filter in the step 708 uses 8 samples for filter decision on each side of the edge, and 7 samples are modified on each side of the edge. However, the longer tap filter in the step 709 uses DB samples for filter decision on one side of the edge and DA samples for filter decision on other side of the edge, and MB samples are modified on said one side of the edge while MA samples are modified on the other side of the edge. MA $\neq$ MB, particularly MA < MB, for example, MA=3 and MB=7, or MA=4 and MB=7, or MA=5 and MB=7. In general, DA=MA+1; DB=MB+1.

The details for determining whether the HEVC strong filter condition should be satisfied is shown in Fig.8. The deblocking filtering decisions for a block boundary including the decisions between the strong and the normal filtering are summarized in a flowchart in Fig. 8.

In a first step 800, it is checked if the currently filtered block edge is aligned with an 8 x 8 encoding sample grid. If this is the case, in a second step 801, it is checked if the block edge to be filtered is a boundary between prediction units or transform units. If this is the case, in a third step 802, it is checked if a boundary strength Bs>0. If also this condition is met, in a fourth step 803 it is checked if a condition 7.1 is true.

Condition 7.1 is used to check if deblocking filtering is applied to a block boundary or not. The condition especially checks how much the signal on each side of the block boundary deviates from a straight line (ramp).

If this condition is not met, or any of the checks of steps 800, 801 and 802 are not fulfilled, it is decided in a fifth step 804 that no filtering is performed.

In a sixth step 805 (not shown in Fig.8), it is now checked, if the block size of any of the two blocks, surrounding the edge to be filtered, is four. If this is not the case, in a seventh step 806, it is checked, if further condition 7.2, 7.3, and 7.4 are met.

Condition 7.2 checks that there are no significant signal variations at the sides of the block boundary. Condition 7.3 verifies that the signal on both sides is flat. Condition 7.4 ensures that the step between the sample values at the sides of the block boundary is small.

If all of these conditions are true, in an eighth step 807, a strong filtering is performed, the step 807 is directly replaced with step 702 of figure 7. If this is not the case, in a ninth step 808 it is decided that a normal filtering is performed.

This solution enforces part of a deblocking flow chart, so that only one sample modification is performed.

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.

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

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

In a first step 1001, edges between blocks are determined, wherein the edges between blocks comprises a block edge between a first coding block and a second coding block and a sub-block edge between sub blocks of the first coding block or the second coding block (e.g. the first coding block or the second coding block has sub-blocks, or the first coding block or the second coding block has sub-block tools), wherein the first coding block has a block size being M×N or N×M, the second coding block has a block size being L×T or T×L and N or T being an even integer 2^n larger than a threshold(e.g. 8 or 16, etc);

In a second step 1002, it is determined whether the block edge between the first coding block and the second coding block is to be filtered by applying a first filter(a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric long filter); in other words, it is determined whether the block edge between the first coding block and the second coding block is enabled for deblocking by applying a first filter(i.e. a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric long filter);

In a third step 1003, the first filter (a longer tap filter or an asymmetric filter or an asymmetric tap filter or an asymmetric longer tap filter) is applied to values of samples(i.e. input pixels) near the block edge between the first coding block and the second coding block, when it is determined that the block edge between the first coding block and the second coding block is to be filtered by applying the first filter, wherein in the case that the first coding block has sub-blocks(or the first coding block has sub-block tools, the first coding block is a current block and the second coding

The previously disclosed details of the exemplary deblocking method may be made reference and not repeated here.

Fig. 11B is a block diagram illustrating another exemplary deblocking method according to the techniques described in this disclosure (further details will be described below, e.g., based on Figs. 7, 8).

In Fig. 11B, another embodiment of the deblocking method is shown.

In a first step 1121, edges between blocks are determined, wherein the edges between blocks comprises the block edge between the first coding block P and the second coding block Q and a sub-block edge between sub blocks of the first coding block P or the second coding block Q, wherein the first coding block P has a block size being M×N or N×M, the second coding block Q has a block size being L×T or T×L and N or T being an even integer 2^n larger than a threshold(e.g. 8 or 16, etc);

In a second step 1122, it is determined that the sub-block edge between sub blocks of the first coding block P or the second coding block Q is not to be filtered; in other words, it is determined that the sub-block edge between sub blocks of the first coding block P or the second coding block Q is disabled for deblocking;

In a third step 1123, a fourth filter (e.g. a normal longer tap filter) is applied to values of samples (i.e. input pixels) near the block edge between the first coding block P and the second coding block Q, wherein a number MA of sample values of the first coding block, adjacent to (i.e. perpendicular to) the block edge are modified and a number MB of sample values of the second coding block, adjacent to (i.e. perpendicular to) the block edge are modified, MA= MB=7.

It can be understood that the first coding block is a current block and the second coding block is a neighboring block of the current block, or the second coding block is a current block and the first coding block is a neighboring block of the current block.

The input pixels correspond to the pixel values or sample values used for filtering, and the output pixels correspond to the modified sample values. It should be noted that the input pixels may be consecutive pixels perpendicular to the block edge beginning at

the block edge. Also, the output pixels may be consecutive pixels perpendicular to the block edge, beginning at the block edge.

Fig. 12 is a block diagram illustrating another exemplary deblocking method according to the techniques described in this disclosure (further details will be described below, e.g., based on Figs. 7, 8, 10, 11A, 11B, 12, and Figs. 15, 16).

In Fig. 12, another embodiment of the deblocking method is shown.

In a first step 1201, edges between blocks, wherein the edges between blocks comprises a block edge between a first coding block P and a second coding block Q and a sub-block edge between sub blocks inside the first coding block P and/or the second coding block Q are determined, wherein the first coding block P has a block size being M×N or N×M, the second coding block Q has a block size being L×T or T×L, for example, N or T being an even integer 2^n larger than a threshold (e.g. 8 or 16, etc);

In a second step 1202, it is determined that the block edge between the first coding block P and the second coding block Q and a first set of sub-block edges between sub blocks inside the first coding block P and/or the second coding block Q are to be filtered, and a second set of sub-block edges between sub blocks inside the first coding block P and/or the second coding block Q are not to be filtered; and

In a third step 1203, deblocking filtering is performed at values of samples near the block edge between the first coding block P and the second coding block Q and deblocking filtering is performed at values of samples near each of the first set of sub-block edges between sub blocks inside the first coding block P and/or the second coding block Q.

It can be understood that the first coding block is a current block and the second coding block is a neighboring block of the current block, or the second coding block is a current block and the first coding block is a neighboring block of the current block.

The input pixels correspond to the pixel values or sample values used for filtering, and the output pixels correspond to the modified sample values. It should be noted that the input pixels may be consecutive pixels perpendicular to the block edge beginning at the block edge. Also, the output pixels may be consecutive pixels perpendicular to the block edge, beginning at

determining the filtered sample value q'_0 of the first sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 2 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_0 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 2 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 2 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

If no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the step of performing deblocking filtering at values of samples near the block edge between the first coding block P and the second coding block Q comprises:

determining the filtered sample value q'_1 of the second sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q'_1 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 5 \cdot q_3 + 1 \cdot q_2 + 3 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q'_1 = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 4 \cdot q_2 + 4 \cdot q_1 + 4 \cdot q_0 + 4 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

If no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the step of

performing deblocking filtering at values of samples near the block edge between the first coding block P and the second coding block Q comprises:

determining the filtered sample value q_2' of the third sample of the current row or column of samples to the right or bottom of the vertical or horizontal edge between the first coding block P and the second coding block Q on the basis of the following equation:

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 6 \cdot q_3 + 3 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

or,

$$q_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 6 \cdot q_2 + 2 \cdot q_1 + 2 \cdot q_0 + 2 \cdot p_0 + 0 \cdot p_1 + 0 \cdot p_2 + 0 \cdot p_3 + 0 \cdot p_4 + 0 \cdot p_5 + 0 \cdot p_6 + 0 \cdot p_7)/16;$$

wherein p_i represent a corresponding sample value of a part of the current row or column of samples of the first coding block P, and q_j represent a corresponding sample value of a part of the current row or column of samples of the second coding block Q, i, j =0, 1..7.

If no sub-block edge between sub blocks exists inside the first coding block P, and a sub-block edge between sub blocks exists inside the second coding block Q, the step of performing deblocking filtering at values of samples near the block edge between the first coding block P and the second coding block Q comprises:

determining the filtered sample value p_i' of the corresponding sample of the current row or column of samples to the left or upper of the vertical or horizontal edge between the first and the second coding block on the basis of the following equation:

$$p_0' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 4 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 2 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_1' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 3 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 3 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 1 \cdot p_7)/16,$$

$$p_2' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 2 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 3 \cdot p_2 + 1 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 2 \cdot p_7)/16,$$

$$p_3' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 1 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 3 \cdot p_3 + 1 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 3 \cdot p_7)/16,$$

$$p_4' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 1 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 + 1 \cdot p_0 + 1 \cdot p_1 + 1 \cdot p_2 + 1 \cdot p_3 + 3 \cdot p_4 + 1 \cdot p_5 + 1 \cdot p_6 + 4 \cdot p_7)/16,$$

$$p_5' = (0 \cdot q_7 + 0 \cdot q_6 + 0 \cdot q_5 + 0 \cdot q_4 + 0 \cdot q_3 + 0 \cdot q_2 + 1 \cdot q_1 + 1 \cdot q_0 +$$

CLAIMS:

1. A deblocking filter apparatus for use in an image encoder or an image decoder, for deblocking a block edge between a first image block and a second image block,

wherein the first image block has a block size of M*N or N*M, and M and N represent the width and height of the first image block respectively, or N and M represent the width and height of the first image block respectively;

wherein the second image block has a block size of L*T or T*L, and L and T represent the width and height of the second image block respectively, or T and L represent the width and height of the second image block respectively, and

wherein the deblocking filter apparatus comprises:

a memory storing instructions; and

a processor in communication with the memory and upon execution of the instructions, is configured to:

determine a value MA as a positive integer equal to or less than 5 based on T being an even integer 2^n larger than 16 in the case that one of the first image block and the second image block includes sub-blocks and the one image block including the sub-blocks is the second image block, wherein n is a positive integer;

determine a value MB as a positive integer equal to 7 based on N being an even integer 2^n larger than 16;

modify values of at most MA samples of the second image block as first output values, wherein the at most MA samples are in a line perpendicular to and adjacent to the block edge; and

modify values of at most MB samples of the first image block as second output values, wherein the at most MB samples are in a line perpendicular to and adjacent to the block edge.

2. The deblocking filter apparatus of claim 1, wherein if N and T are even integers 2^n larger than 16,

MA=3 and MB=7, or

MA=4 and MB=7, or

MA=5 and MB=7.

3. The deblocking filter apparatus of claim 1, wherein if N is an even integer 2^n larger than 16, and T is an even integer 2^n equal to or less than 16,

MA=3 and MB=7.

4. The deblocking filter apparatus of claim 1, wherein upon execution of the instructions, the processor is further configured to:

determine a value MA' as a positive integer less than 7 based on N being an even integer 2^n larger than 16 in the case that the first image block includes sub-blocks;

determine a value MB' as a positive integer less than 7 based on T being an even integer 2^n larger than 16 in the case that the second image block includes sub-blocks;

modify values of at most MA' samples of the first image block as third output values, wherein the at most MA' samples are in a line perpendicular to and adjacent to the block edge, and

modify values of at most MB' samples of the second image block as fourth output values, wherein the at most MB' samples are in a line perpendicular to and adjacent to the block edge, wherein MA'= MB'.

5. The deblocking filter apparatus of claim 4, wherein

MA'= MB' = 3 or MA'= MB' = 5.

6. The deblocking filter apparatus of claim 1,

wherein upon execution of the instructions, the processor is further configured to:

determine one or more of whether the block edge is to be filtered or whether an asymmetric long filtering is to be performed, based upon

- values of at most DA samples of the first image block that are adjacent to the block edge, as first decision values, and

- values of at most DB samples of the second image block that are adjacent to the block edge, as second decision values, wherein DA and DB are integer numbers.

7. The deblocking filter apparatus of claim 6, wherein

DA= MA + 1 and DB= MB + 1.

8. The deblocking filter apparatus of claim 1, wherein

- if the block edge is a horizontal block edge, the direction along the height N of the first image block is perpendicular to the block edge, and the direction along the height T of

the second image block is perpendicular to the block edge, wherein both of the heights of the first and second image blocks are an even integer 2^n larger than 16; or

- if the block edge is a vertical block edge, the direction along the width N of the first image block is perpendicular to the block edge, and the direction along the width T of the second image block is perpendicular to the block edge, wherein both of the widths of the first and second image blocks are an even integer 2^n larger than 16.

9. The deblocking filter apparatus of claim 1, wherein the second image block is a current block and the first image block P is a neighboring block of the current block.

10. The deblocking filter apparatus of claim 9, wherein the first image block is left to the second image block.

11. The deblocking filter apparatus of claim 1, wherein the first image block and the second image block are transform blocks; or the first image block and the second image block are coding blocks.

12. A deblocking method, for deblocking a block edge between a first image block and a second image block in image encoding or image decoding,

wherein the first image block has a block size of M*N or N*M, and M and N represent the width and height of the first image block respectively, or N and M represent the width and height of the first image block respectively;

wherein the second image block has a block size of L*T or T*L, and L and T represent the width and height of the second image block respectively, or T and L represent the width and height of the second image block respectively,

the deblocking method comprising:

determining a value MA as a positive integer equal to or less than 5 based on T being an even integer 2^n larger than 16 in the case that one of the first image block and the second image block includes sub-blocks and the one image block including the sub-blocks is the second image block, wherein n is a positive integer;

determining a value MB as a positive integer equal to 7 based on N being an even integer 2^n larger than 16;

modifying values of at most MA samples of the second image block as first output values, wherein the at most MA samples are in a line perpendicular to and adjacent to the block edge; and

modifying values of at most MB samples of the first image block as second output values, wherein the at most MB values of the samples are in a line perpendicular to and adjacent to the block edge.

13. The deblocking method of claim 12, wherein if N and T are even integers 2^n larger than 16,

MA=3 and MB=7, or

MA=4 and MB=7, or

MA=5 and MB=7.

14. The deblocking method of claim 12, wherein if N is an even integer 2^n larger than 16, and T is an even integer 2^n equal to or less than 16,

MA=3 and MB=7.

15. The deblocking method of claim 12, further comprising:

determining a value MA' as a positive integer less than 7 based on N being an even integer 2^n larger than 16 in the case that the first image block includes sub-blocks;

determining a value MB' as a positive integer less than 7 based on T being an even integer 2^n larger than 16 in the case that the second image block includes sub-blocks;

modifying values of at most MA' samples of the first image block as third output values, wherein the at most MA' samples are in a line perpendicular to and adjacent to the block edge; and

modifying values of at most MB' samples of the second image block as fourth output values, wherein the at most MB' samples are in a line perpendicular to and adjacent to the block edge, wherein MA'= MB'.

16. The deblocking method of claim 15, wherein MA'= MB' = 3 or MA'= MB' = 5.

17. The deblocking method of claim 12, further comprising:

determining one or more of whether the block edge is to be filtered or whether an asymmetric long filtering is to be performed, based upon:

values of at most DA samples of the first image block that are adjacent to the block edge as first decision values, and

values of at most DB samples of the second image block that are adjacent to the block edge as second decision values, wherein DA and DB are integer numbers.

18. The deblocking method of claim 17, wherein DA= MA + 1 and DB= MB + 1.

19. The deblocking method of claim 12, wherein

- if the block edge is a horizontal block edge, the direction along the height N of the first image block is perpendicular to the block edge, and the direction along the height T of the second image block is perpendicular to the block edge, wherein both of the heights of the first and second image blocks are an even integer 2^n larger than 16; or

- if the block edge is a vertical block edge, the direction along the width N of the first image block is perpendicular to the block edge, and the direction along the width T of the second image block is perpendicular to the block edge, wherein both of the widths of the first and second image blocks are an even integer 2^n larger than 16.

20. The deblocking method of claim 12, wherein the second image block is a current block and the first image block is a neighboring block of the current block.

21. The deblocking method of claim 20, wherein the first image block is left to the second image block.

22. The deblocking method of claim 12, wherein the first image block and the second image block are transform blocks; or the first image block and the second image block are coding blocks.

23. A deblocking filter apparatus for use in an image encoder or an image decoder, for deblocking a block edge between a first image block and a second image block,

wherein the first image block has a block size of M*N or N*M, and M and N represent the width and height of the first image block respectively, or N and M represent the width and height of the first image block respectively;

wherein the second image block has a block size of L*T or T*L, and L and T represent the width and height of the second image block respectively, or T and L represent the width and height of the second image block respectively,

wherein the deblocking filter apparatus comprises:

a memory storing instructions; and

a processor in communication with the memory and upon execution of the instructions, is configured to:

determine a maximum filter length MA as a positive integer equal to or less than 5 based on T being an even integer 2^n larger than 16 in the case that the second image block includes sub-blocks, wherein n is a positive integer;

determine a maximum filter length MB as a positive integer equal to 7 based on N being an even integer 2^n larger than 16;

modify, based, at least in part, upon the maximum filter length MA, values of samples of the second image block that are adjacent to the block edge; and

modify, based, at least in part, upon the maximum filter length MB, values of samples of the first image block that are adjacent to the block edge.

24. The deblocking filter apparatus of claim 23, wherein the maximum filter length MA is associated with the second image block and the maximum filter length MB is associated with the first image block.

25. The deblocking filter apparatus of claim 23,

wherein upon execution of the instructions, the processor is further configured to:

modify values of at most MA samples of the second image block and the at most MA samples are in a line perpendicular to and adjacent to the block edge; and

modify values of at most MB samples of the first image block and the at most MB samples are in a line perpendicular to and adjacent to the block edge.

26. A deblocking method, for deblocking a block edge between a first image block and a second image block, in image encoding or image decoding,

wherein the first image block has a block size of M*N or N*M, and M and N represent the width and height of the first image block respectively, or N and M represent the width and height of the first image block respectively;

wherein the second image block has a block size of L*T or T*L, and L and T represent the width and height of the second image block respectively, or T and L represent the width and height of the second image block respectively,

wherein the deblocking method comprises:

determining a maximum filter length MA as a positive integer equal to or less than 5 based on T being an even integer 2^n larger than 16 in the case that the second image block includes sub-blocks, wherein n is a positive integer;

determining a maximum filter length MB as a positive integer equal to 7 based on N being an even integer 2^n larger than 16;

modifying, based, at least in part, upon the maximum filter length MA, values of samples of the second image block that are adjacent to the block edge; and

modifying, based, at least in part, upon the maximum filter length MB, values of samples of the first image block that are adjacent to the block edge.

27. The deblocking method of claim 26, wherein the maximum filter length MA is associated with the second image block and the maximum filter length MB is associated with the first image block.

28. The deblocking method of claim 26, wherein the modifying, based at least in part upon a maximum filter length MA, values of samples of the second image block that are adjacent to the block edge comprises:

modifying values of at most MA samples of the second image block and the at most MA samples are in a line perpendicular to and adjacent to the block edge; and

wherein the modifying, based at least in part upon a maximum filter length MB, values of samples of the first image block that are adjacent to the block edge comprises:

modifying values of at most MB samples of the first image block and the at most MB samples are in a line perpendicular to and adjacent to the block edge.

29. A non-transitory computer-readable medium storing computer instructions that, when executed by one or more processors, cause the one or more processors to perform operations for deblocking a block edge between a first image block and a second image block in image encoding or image decoding,

wherein the first image block has a block size of M*N or N*M, and M and N represent the width and height of the first image block respectively, or N and M represent the width and height of the first image block respectively;

wherein the second image block has a block size of L*T or T*L, and L and T represent the width and height of the second image block respectively, or T and L represent the width and height of the second image block respectively,

wherein the operations comprise:

determining a maximum filter length MA as a positive integer equal to or less than 5 based on T being an even integer 2^n larger than 16 in the case that the second image block includes sub-blocks, wherein n is a positive integer;

determining a maximum filter length MB as a positive integer equal to 7 based on N being an even integer 2^n larger than 16;

modifying, based at least in part upon the maximum filter length MA, values of samples of the second image block that are adjacent to the block edge; and

modifying, based at least in part upon the maximum filter length MB, values of samples of the first image block that are adjacent to the block edge.