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CLAIMS

1. A method, implemented by an encoding device or a decoding device, for bi-directional optical flow prediction based on sample values from sample positions belonging to extended regions of predicted blocks used in the bi-directional optical flow prediction of a current block, the method comprising:
 - obtaining a first motion vector, MV, of the current block relative to a first reference picture, wherein the first MV is a $1/16^{\text{th}}$ of a pixel accurate MV;
 - obtaining a second MV of the current block relative to a second reference picture, wherein the second MV is a $1/16^{\text{th}}$ of a pixel accurate MV;
 - 15 obtaining a sub-pixel sample position in the extended region of the predicted block in the first reference picture based on the first MV, wherein the obtained sub-pixel sample position is pointed to by the first MV and includes a fractional part;
 - obtaining a sub-pixel sample position in the extended region of the predicted block in the second reference picture based on the second MV, wherein the obtained sub-pixel sample position is pointed to by the second MV and includes a fractional part;
 - 20 processing the sub-pixel sample position obtained in the extended region of the predicted block in the first reference picture to obtain an integer pixel sample position in the first reference picture;
 - 25 processing the sub-pixel sample position obtained in the extended region of the predicted block in the second reference picture to obtain an integer pixel sample position in the second reference picture;
 - performing bi-directional optical flow prediction by referring to a reference sample value at the obtained integer pixel sample position in the first reference picture and to a reference sample value at the obtained integer pixel sample position in the second reference picture; and

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5 characterized in that

the processing the sub-pixel sample position obtained in the extended region of the predicted block in the first reference picture includes:

rounding the obtained sub-pixel sample position separately in a horizontal direction and a vertical direction to the respective closest integer pixel sample position in the respective direction, to obtain the integer pixel sample position in the first reference picture based on the closest integer pixel sample positions in the horizontal direction and the vertical direction; and

wherein the processing the sub-pixel sample position obtained in the extended region of the predicted block in the second reference picture includes:

15 rounding the obtained sub-pixel sample position separately in a horizontal direction and a vertical direction to the respective closest integer pixel sample position in the respective direction, to obtain the integer pixel sample position in the second reference picture based on the closest integer pixel sample positions in the horizontal direction and the vertical direction.

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2. The method of claim 1, wherein the reference sample values at the obtained integer pixel sample position in the first and second reference pictures are referred to as the sample values from the sub-pixel sample positions in the bi-directional optical flow prediction.

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3. The method of any one of the preceding claims, wherein the method further comprises:

before performing the bi-directional optical flow prediction, fetching the reference sample values at the obtained integer pixel sample positions in the reference pictures as prediction sample values to be used in the bi-directional optical flow prediction,

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5 wherein the performing bi-directional optical flow prediction referring to the reference sample values comprises:

 performing bi-directional optical flow prediction using the prediction sample values.

10 4. The method of claim 3, wherein rounding the obtained sub-pixel sample position separately in the horizontal direction and the vertical direction includes:

 comparing a fractional part of the obtained sub-pixel sample position in the respective direction with a threshold,

 wherein in a case that the fractional part is equal to or larger than the
15 threshold, a nearest higher integer pixel sample position in the respective direction is obtained as the closest integer pixel sample position in the respective direction, and

 wherein in a case that the fractional part is smaller than the threshold, a nearest lower integer pixel sample position in the respective direction is obtained
20 as the closest integer pixel sample position in the respective direction.

5. The method of claim 1, wherein a nearest higher integer pixel sample position in the respective direction is obtained by adding an offset of 1 to a truncated integer pixel sample position in the respective direction obtained by discarding the

25 fractional part of the obtained sub-pixel sample position; and

 wherein a nearest lower integer pixel sample position in the respective direction is obtained by adding an offset of 0 to the truncated integer pixel sample position in the respective direction obtained by discarding the fractional part of the obtained sub-pixel sample position.

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5 6. The method of claim 4 or 5, wherein the threshold is given by $P/2$ for a $1/P$ pel sub-pixel accuracy.

7. The method of claim 6, wherein the threshold is 8 for $1/16$ pel sub-pixel accuracy.

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8. The method of claim 1, wherein rounding the obtained sub-pixel sample position separately in the horizontal direction and the vertical direction includes:

applying a shifting operation to components of the obtained sub-pixel sample position in the respective directions.

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9. The method of claim 8, wherein the integer pixel sample position (x_pos , y_pos) in the first or second reference picture is obtained according to the following equations:

$$x_pos = (x_spel_pos + (1 \ll (\text{shift_val} - 1))) \gg \text{shift_val}$$

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$$y_pos = (y_spel_pos + (1 \ll (\text{shift_val} - 1))) \gg \text{shift_val}$$

where (x_spel_pos , y_spel_pos) is the obtained sub-pixel sample position and shift_val is chosen according to the sub-pel sample accuracy used.

10. The method of claim 9, wherein for sub-pel sample accuracy of half-pel, quarter-pel, $1/8^{\text{th}}$ of a pel, or $1/16^{\text{th}}$ of a pel, shift_val of 1, 2, 3, or 4 are used respectively.

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11. The method of one of the preceding claims, wherein the first and second MVs of the current block are refined MVs, obtained by motion vector refinement, MVR, on the basis of initial MVs.

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5 12. The method of claim 11, wherein the MVR comprises an integer-distance refinement stage with regard to the initial MVs; and
 wherein, in case the integer-distance refinement stage of the MVR results in a non-zero displacement of the refined MVs with respect to the initial MVs, the integer pixel sample position in the first or second reference picture is obtained by
 10 rounding the obtained sub-pixel sample position.

13. The method of claim 12, wherein, in case the integer-distance refinement stage of the MVR results in a zero displacement of the refined MVs with respect to the initial MVs, the integer pixel sample position in the first or second reference
 15 picture is obtained by discarding a fractional part of the obtained sub-pixel sample position.

14. The method of claim 12, wherein, in case the integer-distance refinement stage of the MVR results in a zero displacement of the refined MVs with respect to the
 20 initial MVs, the integer pixel sample position (x_pos, y_pos) in the first or second reference picture is obtained according to the following equations:

$$x_pos = x_spel_pos \gg shift_val$$

$$y_pos = y_spel_pos \gg shift_val$$

where (x_spel_pos, y_spel_pos) is the obtained sub-pixel sample position and
 25 shift_val is chosen according to the sub-pel sample accuracy used.

15. The method of claim 14, wherein for sub-pel sample accuracy of half-pel, quarter-pel, 1/8th of a pel, or 1/16th of a pel, shift_val of 1, 2, 3, or 4 are used respectively.

5 16. The method of any one of the preceding claims, wherein the current block is a current coding block or a current coding sub-block or a current prediction block.

17. The method of any one of the preceding claims, wherein
the reference sample value at the obtained integer pixel sample position in the first
10 reference picture is used in the computation of a boundary sample gradient
corresponding to a boundary of the predicted block in the first reference picture;
and
the reference sample value at the obtained integer pixel sample position in the
second reference picture is used in the computation of a boundary sample gradient
15 corresponding to a boundary of the predicted block in the second reference picture.

18. An encoder (20) comprising processing circuitry for carrying out the method according to any one of claims 1 to 17.

20 19. A decoder (30) comprising processing circuitry for carrying out the method according to any one of claims 1 to 17.

20. A computer program product comprising instructions which, when the program is executed by a computer, cause the computer to carry out the method according
25 to any one of claims 1 to 17.

21. An encoder (20), comprising:
one or more processors; and
a non-transitory computer-readable storage medium coupled to the one or
30 more processors and storing instructions for execution by the one or more processors, wherein the instructions, when executed by the one or more processors,

- 5 configure the encoder to carry out the method according to any one of claims 1 to
17.

22. A decoder (30), comprising:

- one or more processors; and
10 a non-transitory computer-readable storage medium coupled to the one or
more processors and storing instructions for execution by the one or more
processors, wherein the instructions, when executed by the one or more processors,
configure the decoder to carry out the method according to any one of claims 1 to
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- 15 23. An encoder (20) for bi-directional optical flow prediction based on sample
values from sample positions belonging to extended regions of predicted blocks
used in the bi-directional optical flow prediction of a current block, comprising:

- a prediction unit configured to perform bi-directional optical flow
20 prediction of a current block;

 a first obtaining unit configured to obtain a first motion vector, MV, of the
current block relative to a first reference picture, wherein the first MV is a $1/16^{\text{th}}$ of
a pixel accurate MV, and to obtain a second motion vector of the current block
relative to a second reference picture, wherein the second MV is a $1/16^{\text{th}}$ of a pixel
25 accurate MV;

- a second obtaining unit configured to obtain a sub-pixel sample position in
the extended region of the predicted block in the first reference picture based on
the first MV, wherein the obtained sub-pixel sample position is pointed to by the
first MV and includes a fractional part, and to obtain a sub-pixel sample position in
30 the extended region of the predicted block in the second reference picture based on
the second MV, wherein the obtained sub-pixel sample position is pointed to by
the second MV and includes a fractional part; and

5 a processing unit configured to process the sub-pixel sample position
 obtained in the extended region of the predicted block in the first reference picture
 to obtain an integer pixel sample position in the first reference picture, and to
 process the sub-pixel sample position obtained in the extended region of the
 predicted block in the second reference picture to obtain an integer pixel sample
 10 position in the second reference picture;

 wherein the prediction unit is configured to perform the bi-directional
 optical flow prediction by referring to a reference sample value at the obtained
 integer pixel sample position in the first reference picture and to a reference sample
 value at the obtained integer pixel sample position in the second reference picture;
 15 wherein the processing the sub-pixel sample position obtained in the extended
 region of the predicted block in the first reference picture includes:

 rounding the obtained sub-pixel sample position separately in a horizontal
 direction and a vertical direction to the respective closest integer pixel sample
 position in the respective direction, to obtain the integer pixel sample position in
 20 the first reference picture based on the closest integer pixel sample positions in the
 horizontal direction and the vertical direction; and

 the processing the sub-pixel sample position obtained in the extended
 region of the predicted block in the second reference picture includes:

 rounding the obtained sub-pixel sample position separately in a horizontal
 25 direction and a vertical direction to the respective closest integer pixel sample
 position in the respective direction, to obtain the integer pixel sample position in
 the second reference picture based on the closest integer pixel sample positions in
 the horizontal direction and the vertical direction.

30 24. The encoder (20) of claim 23, wherein rounding the obtained sub-pixel sample
 position separately in the horizontal direction and the vertical direction includes:

5 comparing a fractional part of the obtained sub-pixel sample position in the respective direction with a threshold,

 wherein in a case that the fractional part is equal to or larger than the threshold, a nearest higher integer pixel sample position in the respective direction is obtained as the closest integer pixel sample position in the respective direction,

10 and

 wherein in a case that the fractional part is smaller than the threshold, a nearest lower integer pixel sample position in the respective direction is obtained as the closest integer pixel sample position in the respective direction.

15 25. The encoder (20) of claim 24, wherein the nearest higher integer pixel sample position in the respective direction is obtained by adding an offset of 1 to a truncated integer pixel sample position in the respective direction obtained by discarding the fractional part of the obtained sub-pixel sample position; and wherein the nearest lower integer pixel sample position in the respective direction
20 is obtained by adding an offset of 0 to the truncated integer pixel sample position in the respective direction obtained by discarding the fractional part of the obtained sub-pixel sample position.

26. A decoder (30) for bi-directional optical flow prediction based on sample
25 values from sample positions belonging to extended regions of predicted blocks used in the bi-directional optical flow prediction of a current block, comprising:
 a prediction unit configured to perform bi-directional optical flow prediction of a current block;

 a first obtaining unit configured to obtain, from a bitstream of an encoded
30 video, a first motion vector, MV, of the current block relative to a first reference picture, wherein the first MV is a $1/16^{\text{th}}$ of a pixel accurate MV, and to obtain, from the bitstream of the encoded video, a second motion vector of the current

5 block relative to a second reference picture, wherein the second MV is a $1/16^{\text{th}}$ of a pixel accurate MV;

a second obtaining unit configured to obtain a sub-pixel sample position in the extended region of the predicted block in the first reference picture based on the first MV, wherein the obtained sub-pixel sample position is pointed to by the
 10 first MV and includes a fractional part, and to obtain a sub-pixel sample position in the extended region of the predicted block in the second reference picture based on the second MV, wherein the obtained sub-pixel sample position is pointed to by the second MV and includes a fractional part; and

a processing unit configured to process the sub-pixel sample position
 15 obtained in the extended region of the predicted block in the first reference picture to obtain an integer pixel sample position in the first reference picture, and to process the sub-pixel sample position obtained in the extended region of the predicted block in the second reference picture to obtain an integer pixel sample position in the second reference picture;

20 wherein the prediction unit is configured to perform the bi-directional optical flow prediction by referring to a reference sample value at the obtained integer pixel sample position in the first reference picture and to a reference sample value at the obtained integer pixel sample position in the second reference picture; wherein the processing the sub-pixel sample position obtained in the extended
 25 region of the predicted block in the first reference picture includes:

rounding the obtained sub-pixel sample position separately in a horizontal direction and a vertical direction to the respective closest integer pixel sample position in the respective direction, to obtain the integer pixel sample position in the first reference picture based on the closest integer pixel sample positions in the
 30 horizontal direction and the vertical direction; and

5 rounding the obtained sub-pixel sample position separately in a horizontal direction and a vertical direction to the respective closest integer pixel sample position in the respective direction, to obtain the integer pixel sample position in the second reference picture based on the closest integer pixel sample positions in the horizontal direction and the vertical direction.

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27. The decoder (30) of claim 26, wherein rounding the obtained sub-pixel sample position separately in the horizontal direction and the vertical direction includes:

 comparing a fractional part of the obtained sub-pixel sample position in the respective direction with a threshold,

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 wherein in a case that the fractional part is equal to or larger than the threshold, a nearest higher integer pixel sample position in the respective direction is obtained as the closest integer pixel sample position in the respective direction, and

 wherein in a case that the fractional part is smaller than the threshold, a nearest lower integer pixel sample position in the respective direction is obtained as the closest integer pixel sample position in the respective direction.

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28. The decoder (30) of claim 27, wherein the nearest higher integer pixel sample position in the respective direction is obtained by adding an offset of 1 to a truncated integer pixel sample position in the respective direction obtained by discarding the fractional part of the obtained sub-pixel sample position; and wherein the nearest lower integer pixel sample position in the respective direction is obtained by adding an offset of 0 to the truncated integer pixel sample position in the respective direction obtained by discarding the fractional part of the obtained sub-pixel sample position.

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- 5 29. A storage medium storing a bitstream which is obtained by using a
decoding/encoding method that using the method of any one of claims 1 to 17.
30. A computer-readable storage medium, wherein the computer-readable storage
medium stores a computer program that can be executed by a processor, and when
10 the computer program is executed by the processor, the processor performs the
method according to any one of claims 1 to 17.