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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 a sample value from a sample position belonging to an extended region of a predicted block used in the bi-directional optical flow prediction of a current block, the method comprising:
 - obtaining a motion vector, MV, of the current block;
 - obtaining a sub-pixel sample position in the extended region of the predicted block in the reference picture based on the MV;
 - processing the obtained sub-pixel sample position to obtain an integer pixel sample position in the reference picture; and
 - performing bi-directional optical flow prediction by referring to a reference sample value at the obtained integer pixel sample position in the reference picture.
2. The method of claim 1, wherein the reference sample value at the obtained integer pixel sample position in the reference picture is referred to as the sample value from the sub-pixel sample position in the bi-directional optical flow prediction.
3. The method of claim 1 or 2, wherein processing the obtained sub-pixel sample position includes rounding the obtained sub-pixel sample position to obtain the integer pixel sample position in the reference picture.
4. The method of any one of the preceding claims, wherein processing the obtained sub-pixel sample position includes:
 - rounding the obtained sub-pixel sample position separately in a horizontal direction and a vertical direction to a respective closest integer pixel sample

5 position in the respective direction, and obtaining the integer pixel sample position
in the reference picture based on the closest integer pixel sample positions in the
horizontal direction and the vertical direction.

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

before performing the bi-directional optical flow prediction, fetching the
reference sample value at the obtained integer pixel sample position in the
reference picture as a prediction sample value to be used in the bi-directional
optical flow prediction,

15 wherein the performing bi-directional optical flow prediction referring to a
reference sample value comprises:

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

20 6. The method of claim 4 or 5, 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
25 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
30 as the closest integer pixel sample position in the respective direction.

- 5 7. The method of claim 6, 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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8. The method of claim 6 or 7, wherein the threshold is given by $P/2$ for a $1/P$ pel sub-pixel accuracy.
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9. The method of claim 8, wherein the threshold is 8 for $1/16$ pel sub-pixel accuracy.
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10. The method of claim 4, 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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11. The method of claim 10, wherein the integer pixel sample position (x_pos , y_pos) in the reference picture is obtained according to the following equations:

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

$$y_pos = (y_spel_pos + (1 \ll (\text{shift_val} - 1))) \gg \text{shift_val}$$
where (x_spel_pos , y_spel_pos) is the obtained sub-pixel sample position and
30 shift_val is chosen according to the sub-pel sample accuracy used.

5 12. The method of claim 11, 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.

13. The method of one of the preceding claims, wherein the MV of the current
10 block is a refined MV, obtained by motion vector refinement, MVR, on the basis of an initial MV.

14. The method of claim 13, wherein the MVR comprises an integer-distance refinement stage with regard to the initial MV; and
15 wherein, in case the integer-distance refinement stage of the MVR results in a non-zero displacement of the refined MV with respect to the initial MV, the integer pixel sample position in the reference picture is obtained by rounding the obtained sub-pixel sample position.

20 15. The method of claim 14, wherein, in case the integer-distance refinement stage of the MVR results in a zero displacement of the refined MV with respect to the initial MV, the integer pixel sample position in the reference picture is obtained by discarding a fractional part of the obtained sub-pixel sample position.

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

$$x_pos = x_spel_pos \gg \text{shift_val}$$

30 $y_pos = y_spel_pos \gg \text{shift_val}$

5 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.

17. The method of claim 16, 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
10 respectively.

18. 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.

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

20 20. An encoder (20) comprising processing circuitry for carrying out the method
according to any one of claims 1 to 19.

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

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22. A computer program product comprising instructions which, when the program
is executed by a computer, cause the computer to carry out the method according
to any one of claims 1 to 19.

30 23. An encoder (20), comprising:
one or more processors; and

5 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 encoder to carry out the method according to any one of claims 1 to
 19.

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24. A decoder (30), comprising:

one or more processors; and

a non-transitory computer-readable storage medium coupled to the one or
 more processors and storing instructions for execution by the one or more

15 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
 19.

25. An encoder (20), comprising:

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

a first obtaining unit configured to obtain a motion vector, MV, of the
 current block;

a second obtaining unit configured to obtain a sub-pixel sample position in
 25 an extended region of a predicted block in a reference picture based on the MV;
 and

a processing unit configured to process the obtained sub-pixel sample
 position to obtain an integer pixel sample position in the reference picture;

wherein the prediction unit is configured to perform the bi-directional
 30 optical flow prediction by referring to a reference sample value at the obtained
 integer pixel sample position in the reference picture.

5 26. The encoder (20) of claim 25, wherein processing the obtained sub-pixel sample position includes rounding the obtained sub-pixel sample position to obtain the integer pixel sample position in the reference picture.

27. The encoder (20) of claim 25 or 26, wherein processing the obtained sub-pixel sample position includes:

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

28. The encoder (20) of claim 27, wherein rounding the obtained sub-pixel sample position separately in the horizontal direction and the vertical direction includes:

20 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, and

25 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.

29. The encoder (20) of claim 28, wherein the nearest higher integer pixel sample position in the respective direction is obtained by adding an offset of 1 to a

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5 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
10 sub-pixel sample position.

30. A decoder (30), comprising:

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

15 a first obtaining unit configured to obtain a motion vector, MV, of the
current block from a bitstream of an encoded video;

a second obtaining unit configured to obtain a sub-pixel sample position in
an extended region of a predicted block in a reference picture based on the MV;
and

20 a processing unit configured to process the obtained sub-pixel sample
position to obtain an integer pixel sample position in the 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 reference picture.

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31. The decoder (30) of claim 30, wherein processing the obtained sub-pixel
sample position includes rounding the obtained sub-pixel sample position to obtain
the integer pixel sample position in the reference picture.

30 32. The decoder (30) of claim 30 or 31, wherein processing the obtained sub-pixel
sample position includes:

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

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33. The decoder (30) of claim 32, 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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34. The decoder (30) of claim 33, 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 35. 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 19.
36. 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 19.