WHAT IS CLAIMED IS:

1. A decoder-side motion vector refinement method, the method comprising:

determining a target integer motion vector displacement by comparing integer distance costs corresponding to candidate integer motion vector displacements with respect to an initial motion vector;

determining a sub-pixel motion vector displacement by performing calculation on the integer distance costs; and

determining a refined motion vector based on the target integer motion vector displacement, the sub-pixel motion vector displacement and the initial motion vector.

2. The method of claim 1, wherein the sub-pixel motion vector displacement is determined by the following equations:

$x0 = (E(-1, 0) - E(1, 0)) / (2 \times (E(-1, 0) + E(1, 0) - 2 \times E(0, 0)))$, and

$y0 = (E(0, -1) - E(0, 1)) / (2 \times (E(0, -1) + E(0, 1) - 2 \times E(0, 0)))$;

where x0 and y0 are coordinates associated with the sub-pixel motion vector displacement with respect to a center (0, 0), and E(-1, 0), E(1, 0), E(0, 0), E(0, -1) and E(0, 1) are the integer distance costs corresponding to candidate integer motion vector displacements (-1, 0), (1, 0), (0, 0), (0, -1) and (0, 1) with respect to the initial motion vector, respectively.

3. The method of claim 2, wherein x0 is determined by performing at least one of shift, comparison, and increment operation on E (-1, 0), E(1, 0) and E(0, 0).

4. The method of claim 2, wherein y0 is determined by performing at least one of shift, comparison, and increment operation on E(0, -1), E(0, 1) and E(0, 0).

5. The method of claim 1, wherein the sub-pixel motion vector displacement is bounded between -0.5 and +0.5 pixel.

6. The method of claim 1, further comprising, before determining the sub-pixel motion vector displacement:

determining whether a predetermined motion vector displacement comprises the target integer motion vector displacement;

in the event that the predetermined motion vector displacement comprises the target integer motion vector displacement:

determining the sub-pixel motion vector displacement by performing calculation on the integer distance costs.

7. The method of claim 6, further comprising:

in the event that the predetermined motion vector displacement does not comprises the target integer motion vector displacement:

calculating a refined motion vector based on the target integer motion vector displacement and the initial motion vector.

8. The method of claim 1, wherein determining the target integer motion vector displacement comprising:

calculating an integer distance cost for each candidate integer motion vector displacement; and

selecting a candidate integer motion vector displacement corresponding to a lowest integer distance cost as the target integer motion vector displacement.

9. The method of claim 1, wherein the target integer motion vector displacement comprises a first motion vector displacement corresponding to a reference picture list L0, and a second motion vector displacement corresponding to a reference picture list L1, the method further comprising:

determining the first motion vector displacement by comparing integer costs corresponding to candidate integer motion vector displacements corresponding to the reference picture list L0; and

determining the second motion vector displacement by negating the first motion vector displacement.

10. An apparatus comprising:

an input for receiving encoded video data;

an entropy decoding unit configured to decode the received encoded video data to obtain decoded data; and

one or more processors coupled to the entropy decoding unit and configured to:

determine a target integer motion vector displacement by comparing integer distance costs corresponding to candidate integer motion vector displacements with respect to an initial motion vector according to the decoded data;

determine a sub-pixel motion vector displacement by performing calculation on the integer distance costs; and

~~determine a refined motion vector based on the target integer motion vector displacement, the sub-pixel motion vector displacement and the initial motion vector.~~

~~11. The apparatus of claim 10, wherein the sub-pixel motion vector displacement is determined by the following equations:~~

~~x0 = (E(-1, 0) - E(1, 0)) / (2 ×(E(-1, 0) + E(1, 0) - 2×E(0, 0))), and~~

~~y0 = (E(0, -1) - E(0, 1)) / (2 ×(E(0, -1) + E(0, 1) - 2×E(0, 0)));~~

~~where x0 and y0 are coordinates associated with the sub-pixel motion vector displacement with respect to a center (0, 0), and E(-1, 0), E(1, 0), E(0, 0), E(0, -1) and E(0, 1) are the integer distance costs corresponding to candidate integer motion vector displacements (-1, 0), (1, 0), (0, 0), (0, -1) and (0, 1) with respect to the initial motion vector, respectively.~~

~~12. The apparatus of claim 11, wherein x0 is determined by performing at least one of shift, comparison, and increment operation on E (-1, 0), E(1, 0) and E(0, 0).~~

~~13. The apparatus of claim 11, wherein y0 is determined by performing at least one of shift, comparison, and increment operation on E(0, -1), E(0, 1) and E(0, 0).~~

~~14. The apparatus of claim 10, wherein the sub-pixel motion vector displacement is bounded between -0.5 and +0.5 pixel.~~

15. The apparatus of claim 10, wherein the one or more processors are further configured to, before determining the sub-pixel motion vector displacement:

determine whether a predetermined motion vector displacement comprises the target integer motion vector displacement;

in the event that the predetermined motion vector displacement comprises the target integer motion vector displacement:

determine the sub-pixel motion vector displacement by performing calculation on the integer costs.

16. The apparatus of claim 15, wherein the one or more processors are further configured to:

in the event that the predetermined motion vector displacement does not comprises the target integer motion vector displacement:

calculate a refined motion vector based on the target integer motion vector displacement and the initial motion vector.

17. The apparatus of claim 10, wherein the one or more processors determine the target integer motion vector displacement by:

calculating an integer distance cost for each candidate integer motion vector displacement; and

selecting a candidate integer motion vector displacement corresponding to a lowest integer distance cost as the target integer motion vector displacement.

18. The apparatus of claim 10, wherein n the target integer motion vector displacement comprises a first motion vector displacement corresponding to a reference picture list L0, and a second motion vector displacement corresponding to a reference picture list L1, the one or more processors are configured to:

determine the first motion vector displacement by comparing integer costs corresponding to candidate integer motion vector displacements corresponding to the reference picture list L0; and

determine the second motion vector displacement by negating the first motion vector displacement.

19. A computer-readable medium storing instructions which, when executed on a processor, perform the steps of a method according to any of claim 1-9.

1. A decoder-side motion vector refinement method for refining a motion vector for a block of a frame in a video, the method comprising:

determining a target integer motion vector displacement by comparing integer distance costs associated with respective candidate integer motion vector displacements with respect to an initial motion vector for the block;

determining a sub-pixel motion vector displacement for the motion vector based on the target integer motion vector displacement and the integer distance costs, wherein:

$x0=(E(-1,0)-E(1,0))/(2\times(E(-1,0)+E(1,0)-2\times E(0,0)))$, and

$y0=(E(0,-1)-E(0,1))/(2\times(E(0,-1)+E(0,1)-2\times E(0,0)))$,

wherein: x0 and y0 are coordinates associated with the sub-pixel motion vector displacement relative to a center (0, 0), and E(−1, 0), E(1, 0), E(0, 0), E(0, −1) and E(0, 1) are the integer distance costs with respect to the initial motion vector and corresponding to candidate integer motion vector displacements represented by coordinates (−1, 0), (1, 0), (0, 0), (0, −1) and (0, 1), respectively, relative to the center (0,0); and the center (0,0) represents an integer motion vector displacement among the candidate integer motion vector displacements that has the lowest integer distance cost; determining a refined motion vector based on the target integer motion vector displacement, the sub-pixel motion vector displacement and the initial motion vector.

2. The method of claim 1, wherein the target integer motion vector displacement comprises a first motion vector displacement corresponding to a first reference picture list, and a second motion vector displacement corresponding to a second reference picture list, the method further comprising: determining the first motion vector displacement by comparing the integer distance costs associated with the respective candidate integer motion vector displacements corresponding to the first reference picture list; and determining the second motion vector displacement by negating the first motion vector displacement.

3. The method of claim 1, wherein x0 is determined by performing at least one of a shift operation, a comparison operation, or an increment operation on E (−1, 0), E(1, 0) and E(0, 0).

4. The method of claim 1, wherein y0 is determined by performing at least one of a shift operation, a comparison operation, or an increment operation on E(0, −1), E(0, 1) and E(0, 0).

5. The method of claim 1, wherein the sub-pixel motion vector displacement is bounded between −0.5 and +0.5 pixel.

6. The method of claim 1, further comprising, prior to determining the sub-pixel motion vector displacement: determining whether the integer distance costs are available at a predetermined set of positions relative to the target integer motion vector displacement; and in the event that the integer distance costs are available at the predetermined set of positions relative to the target integer motion vector displacement, determining the sub-pixel motion vector displacement by performing calculation on the integer distance costs.

7. The method of claim 6, further comprising: in the event that the integer distance costs are not available at the predetermined set of positions relative to the target integer motion vector displacement, calculating the refined motion vector based on the target integer motion vector displacement and the initial motion vector.

8. The method of claim 1, wherein determining the target integer motion vector displacement comprising: calculating an integer distance cost for each candidate integer motion vector displacement in a plurality of candidate integer motion vector displacements; and selecting a candidate integer motion vector displacement corresponding to a lowest integer distance cost as the target integer motion vector displacement.

9. An apparatus comprising: an input for receiving encoded video data; an entropy decoding unit configured to decode the received encoded video data to obtain decoded data; and one or more processors coupled to the entropy decoding unit and configured to: determine a target integer motion vector displacement by comparing integer distance costs associated with respective candidate integer motion vector displacements with respect to an initial motion vector for a block of a frame in a video; determine a sub-pixel motion vector displacement based on the target integer motion vector displacement and the integer distance costs, wherein:

$x0=(E(-1,0)-E(1,0))/(2\times(E(-1,0)+E(1,0)-2\times E(0,0)))$, and

$y0=(E(0,-1)-E(0,1))/(2\times(E(0,-1)+E(0,1)-2\times E(0,0)))$, wherein: x0 and y0 are coordinates associated with the sub-pixel motion vector displacement relative to a center (0, 0), and E(−1, 0), E(1, 0), E(0, 0), E(0, −1) and E(0, 1) are the integer distance costs with respect to the initial motion vector and corresponding to candidate integer motion vector displacements represented by coordinates (−1, 0), (1, 0), (0, 0), (0, −1) and (0, 1), respectively, relative to the center (0,0); and the center (0,0) represents an integer motion vector displacement among the candidate integer motion vector displacements that has the lowest integer distance cost; determine a refined motion vector based on the target integer motion vector displacement, the sub-pixel motion vector displacement and the initial motion vector.

10. The apparatus of claim 9, wherein the target integer motion vector displacement comprises a first motion vector displacement corresponding to a first reference picture list, and a second motion vector displacement corresponding to a second reference picture list, and wherein the one or more processors is further configured to: determine the first motion vector displacement by comparing the integer distance costs associated with the respective candidate integer motion vector displacements corresponding to the first reference picture list; and determine the second motion vector displacement by negating the first motion vector displacement.

11. The apparatus of claim 9, wherein x0 is determined by performing at least one of a shift operation, a comparison operation, or an increment operation on E (−1, 0), E(1, 0) and E(0, 0).

12. The apparatus of claim 9, wherein y0 is determined by performing at least one of a shift operation, a comparison operation, or an increment operation on E(0, −1), E(0, 1) and E(0, 0).

13. The apparatus of claim 9, wherein the sub-pixel motion vector displacement is bounded between −0.5 and +0.5 pixel.

14. The apparatus of claim 9, wherein the one or more processors is further configured to: prior to determining the sub-pixel motion vector displacement, determine whether the integer distance costs are available at a predetermined set of positions relative to the target integer motion vector displacement; and in the event that the integer distance costs are available at the predetermined set of positions relative to the target integer motion vector displacement,

determine the sub-pixel motion vector displacement by performing calculation on the integer distance costs.

15. The apparatus of claim 14, wherein the one or more processors is further configured to: in the event that the integer distance costs are not available at the predetermined set of positions relative to the target integer motion vector displacement, calculate the refined motion vector based on the target integer motion vector displacement and the initial motion vector.

16. The apparatus of claim 9, wherein the one or more processors determine the target integer motion vector displacement by: calculating an integer distance cost for each candidate integer motion vector displacement in a plurality of candidate integer motion vector displacements; and selecting a candidate integer motion vector displacement corresponding to a lowest integer distance cost as the target integer motion vector displacement.

17. A non-transitory computer-readable medium storing instructions which, when executed by one or more processors, cause the one or more processors to perform operations comprising: determining a target integer motion vector displacement by comparing integer distance costs associated with respective candidate integer motion vector displacements with respect to an initial motion vector for a block of a frame in a video; determining a sub-pixel motion vector displacement based on the target integer motion vector displacement and the integer distance costs, wherein the sub-pixel motion vector displacement meets:

$x0=(E(-1,0)E(1,0))/(2\times(E(-1,0)+E(1,0)2\times E(0,0)))$, and

$y0=(E(0,-1)-E(0,1))/(2\times(E(0,-1)+E(0,1)-2\times E(0,0)))$, wherein: x0 and y0 are coordinates associated with the sub-pixel motion vector displacement relative to a center (0, 0), and E(−1, 0), E(1, 0), E(0, 0), E(0, −1) and E(0, 1) are the integer distance costs with respect to the initial motion vector and corresponding to candidate integer motion vector displacements represented by coordinates (−1, 0), (1, 0), (0, 0), (0, −1) and (0, 1), respectively, relative to the center (0,0); and the center (0,0) represents an integer motion vector displacement among the candidate integer motion vector displacements that has the lowest integer distance cost; determining a refined motion vector based on the target integer motion vector displacement, the sub-pixel motion vector displacement and the initial motion vector.

18. The non-transitory computer-readable medium of claim 17, wherein the target integer motion vector displacement comprises a first motion vector displacement corresponding to a first reference picture list, and a second motion vector displacement corresponding to a second reference picture list, and wherein the operations further comprise: determining the first motion vector displacement by comparing the integer distance costs associated with the respective candidate integer motion vector displacements corresponding to the first reference picture list; and determining the second motion vector displacement by negating the first motion vector displacement.

19. The non-transitory computer-readable medium of claim 17, wherein x0 is determined by performing at least one of a shift operation, a comparison operation, or an increment operation on E (−1, 0), E(1, 0) and E(0, 0).

20. The non-transitory computer-readable medium of claim 17, wherein y0 is determined by performing at least one of a shift operation, a comparison operation, or an increment operation on E(0, −1), E(0, 1) and E(0, 0).