CLAIMS

What is Claimed:

1. A method of decoding a video, the method comprising:

for a current block of the video, the current block comprising a plurality of sub-blocks:

generating a motion vector of a sub-block of the current block,

generating a sub-block based motion prediction signal using the motion vector of the sub-block,

determining a set of pixel-level motion vector difference values associated with the sub-block of the current block, wherein a pixel-level motion vector difference indicates a difference between a pixel-level motion vector obtained for a sample location in the sub-block and the motion vector of the sub-block,

determining spatial gradients of the sub-block based motion prediction signal,

determining a motion prediction refinement signal for the current block based on the determined set of pixel-level motion vector difference values and the determined spatial gradients, and

combining the sub-block based motion prediction signal and the motion prediction refinement signal to produce a refined motion prediction signal for the current block; and

decoding the video using the refined motion prediction signal, as the prediction for the current block,

wherein the motion vector of the sub-block is generated and the set of pixel-level motion vector difference values is determined using an affine motion model for the current block.

2. A method of encoding a video, the method comprising:

for a current block of the video, the current block comprising a plurality of sub-blocks:

generating a motion vector of a sub-block of the current block,

generating a sub-block based motion prediction signal using the motion vector of the sub-block,

determining a set of pixel-level motion vector difference values associated with a sub-block of the current block, wherein a pixel-level motion vector difference indicates a difference between a pixel-level motion vector obtained for a sample location in the sub-block and the motion vector of the sub-block,

determining spatial gradients of the sub-block based motion prediction signal at each sample location of the sub-block,

determining a motion prediction refinement signal for the current block based on the determined set of pixel-level motion vector difference values and the determined

spatial gradients, and

combining the sub-block based motion prediction signal and the motion prediction refinement signal to produce a refined motion prediction signal for the current block; and

encoding the video using the refined motion prediction signal, as the prediction for the current block, wherein the motion vector of the sub-block is generated and the set of pixel-level motion vector difference values is determined using an affine motion model for the current block.

3. The method of claims 1 or 2, wherein the set of pixel-level motion vector difference values is determined for a sub-block of the current block and is used to determine the motion prediction refinement signal for one or more further sub-blocks of the current block.

4. The method of claims 1 or 2, wherein the determining of the spatial gradients of the sub-block based motion prediction signal includes calculating at least one gradient value for each respective sample location in at least one sub-block of the sub-block based motion prediction signal.

5. The method of claims 1 or 2, wherein the determining of the spatial gradients of the sub-block based motion prediction signal includes:

for one or more respective sub-blocks of the current block:

determining an extended sub-block, using the sub-block based motion prediction signal and adjacent reference samples that border and surround the respective sub-block; and

determining, using the determined extended sub-block, spatial gradients of the respective sub-block to determine the motion prediction refinement signal.

6. The method of claims 1 or 2, wherein:

the determining of spatial gradients of the sub-block based motion prediction signal includes determining a first set of spatial gradients associated with a first reference picture and a second set of spatial gradients associated with a second reference picture; and

the determining of the motion prediction refinement signal for the current block based on the determined spatial gradients includes determining a motion inter-prediction refinement signal for the current block based on the first and second sets of spatial gradients and weight information.

7. The method of claims 1 or 2, wherein the refined motion prediction signal is a refined motion inter-prediction signal generated using one or more Prediction Refinement with Optical Flow (PROF) operations.

8. The method of claims 1 or 2, further comprising determining affine motion

model parameters for the current block of the video such that the sub-block based motion prediction signal is generated using the determined affine motion model parameters.

9. The method of claims 1 or 2, wherein the calculating of the at least one gradient value for each respective sample location in at least one sub-block of the sub-block-based motion prediction signal includes, for each respective sample location, applying a gradient filter to the respective sample location in the at least one sub-block of the sub-block based motion prediction signal.

10. A decoder configured to decode a video, comprising:

a processor configured to:

for a current block of the video, the current block comprising a plurality of sub-blocks:

generate a sub-block based motion prediction signal using the motion vector of the sub-block,

determine a set of pixel-level motion vector difference values associated with a sub-block of the current block, wherein a pixel-level motion vector difference indicates a difference between a pixel-level motion vector obtained for a sample location in the sub-block and the motion vector of the sub-block,

determine spatial gradients of the sub-block based motion prediction signal at each sample location of the sub-block,

determine a motion prediction refinement signal for the current block based on the set of pixel-level motion vector difference values and the determined spatial gradients, and

combine the sub-block based motion prediction signal and the motion prediction refinement signal to produce a refined motion prediction signal for the current block; and

decode the video using the refined motion prediction signal, as the prediction for the current block,

wherein the processor is configured to use an affine motion model for the current block to generate the motion vector of the sub-block and to determine the set of pixel-level motion vector difference values.

11. An encoder configured to encode a video, comprising:

a processor configured to:

for a current block of the video, the current block comprising a plurality of sub-blocks:

generate a motion vector of a sub-block of the current block,

generate a sub-block based motion prediction signal using the motion

vector of the sub-block,

determine a set of pixel-level motion vector difference values associated with a sub-block of the current block, wherein a pixel-level motion vector difference indicates a difference between a pixel-level motion vector obtained for a sample location in the sub-block and the motion vector of the sub-block,

determine spatial gradients of the sub-block based motion prediction signal at each sample location of the sub-block,

determine a motion prediction refinement signal for the current block based on the set of pixel-level motion vector difference values and the determined spatial gradients, and

combine the sub-block based motion prediction signal and the motion prediction refinement signal to produce a refined motion prediction signal for the current block; and

encode the video using the refined motion prediction signal, as the prediction for the current block,

wherein the processor is configured to use an affine motion model for the current block to generate the motion vector of the sub-block based motion prediction signal and to determine the set of pixel-level motion vector difference values.

12. The decoder or encoder of claims 10 or 11, wherein the processor is configured to:

for one or more respective sub-blocks of the current block:

determine an extended sub-block, using the sub-block based motion prediction signal and adjacent reference samples that border and surround the respective sub-block; and

determine, using the determined extended sub-block, spatial gradients of the respective sub-block to determine the motion prediction refinement signal.

13. The decoder or encoder of claims 10 or 11, wherein the processor is configured to:

determine a first set of spatial gradients associated with a first reference picture and a second set of spatial gradients associated with a second reference picture; and

determine a motion inter-prediction refinement signal for the current block based on the first and second sets of spatial gradients and weight information.

14. The decoder or encoder of claims 10 or 11, wherein the processor is configured to generate a refined motion inter-prediction signal using one or more Prediction Refinement with Optical Flow (PROF) operations.

15. The decoder or encoder of claims 10 or 11, wherein the processor is configured to determine affine motion model parameters for the current block of the video such that the sub-block based motion prediction signal is generated using the determined affine motion model parameters.

16. The decoder or encoder of claims 10 or 11, wherein the processor is configured to, for each respective sample location, apply a gradient filter to the respective sample location in the at least one sub-block of the sub-block based motion prediction signal.