[1] In some video compression techniques, an MV applicable to a certain area of sample data can be predicted from other MVs, for example from those related to another area of sample data spatially adjacent to the area under reconstruction, and preceding that MV in decoding order. Doing so can substantially reduce the amount of data required for coding the MV, thereby removing redundancy and increasing compression. MV prediction can work effectively, for example, because when coding an input video signal derived from a camera (known as natural video) there is a statistical likelihood that areas larger than the area to which a single MV is applicable move in a similar direction and, therefore, can in some cases be predicted using a similar motion vector derived from MVs of neighboring area. That results in the MV found for a given area to be similar or the same as the MV predicted from the surrounding MVs, and that in turn can be represented, after entropy coding, in a smaller number of bits than what would be used if coding the MV directly. In some cases, MV prediction can be an example of lossless compression of a signal (namely: the MVs) derived from the original signal (namely: the sample stream). In other cases, MV prediction itself can be lossy, for example because of rounding errors when calculating a predictor from several surrounding MVs.

[2] Various MV prediction mechanisms are described in H.265/HEVC (ITU-T Rec. H.265, "High Efficiency Video Coding", December 2016). Out of the many MV prediction mechanisms that H.265 offers, described here is a technique henceforth referred to as "spatial merge".

[3] Referring to FIG. 2, a current block (201) comprises samples that have been found by the encoder during the motion search process to be predictable from a previous block of the same size that has been spatially shifted. Instead of coding that MV directly, the MV can be derived from metadata associated with one or more reference pictures, for example from the most recent (in decoding order) reference picture, using the MV associated with either one of five surrounding samples, denoted A0, A1, and B0, B1, B2 (202 through 206, respectively). In H.265, the MV prediction can use predictors from the same reference picture that the neighboring block is using.

SUMMARY

[4] Aspects of the disclosure provide methods and apparatuses for filtering in video encoding/decoding. In some examples, an apparatus for filtering in video coding includes processing circuitry. The processing circuitry buffers first boundary pixel values of first reconstructed samples at a first node along a loop filter chain. The first node is associated with a

non linear mapping based filter that is applied in the loop filter chain before a loop restoration filter. The first boundary pixel values are values of pixels at a frame boundary in an example. The processing circuitry applies the loop restoration filter on to-be filtered reconstructed samples based on the buffered first boundary pixel values.

[5] In some examples, the non linear mapping based filter is a cross-component sample offset (CCSO) filter. In some examples, the non linear mapping based filter is a local sample offset (LSO) filter.

[6] In some examples, the first reconstructed samples at the first node are input of the non linear mapping based filter. In some examples, the processing circuitry buffers second boundary pixel values of second reconstructed samples at a second node along the loop filter chain. The second reconstructed samples at the second node are generated after an applying of sample offsets generated by the non linear mapping based filter. The second boundary pixel values are values of the pixels at the frame boundary. Then, the processing circuitry can apply the loop restoration filter on the to-be filtered reconstructed samples based on the buffered first boundary pixel values, and the buffered second boundary pixel values.

[7] In an example, the processing circuitry combines the sample offsets generated by the non linear mapping based filter with output of a constrained directional enhanced filter to generate the second reconstructed samples. In another example, the processing circuitry combines the sample offsets generated by the non linear mapping based filter with the first reconstructed samples to generate intermediate reconstructed samples, and applies a constrained directional enhanced filter to the intermediate reconstructed samples to generate the second reconstructed samples.

[8] In some examples, the processing circuitry buffers second boundary pixel values of second reconstructed samples at a second node along the loop filter, and combines the second reconstructed samples at the second node with sample offsets generated by the non linear mapping based filter to generate the to-be filtered reconstructed samples. The second boundary pixel values are values of the pixels at the frame boundary. Then, the processing circuitry applies the loop restoration filter on the to-be filtered reconstructed samples based on the buffered first boundary pixel values, and the buffered second boundary pixel values.

[9] In some examples, the processing circuitry buffers second boundary pixel values from second reconstructed samples generated by a deblocking filter, and applies a constrained directional enhanced filter on the second reconstructed samples to generate intermediate

[10] WHAT IS CLAIMED IS:

1. A method for filtering in video coding, comprising:

buffering, by a processor, first boundary pixel values of first reconstructed samples at a first node along a loop filter chain, the first node being associated with a non linear mapping based filter that is applied in the loop filter chain before a loop restoration filter, the first boundary pixel values being values of pixels at a frame boundary; and

applying, by the processor, the loop restoration filter on to-be filtered reconstructed samples based on the buffered first boundary pixel values.

2. The method of claim 1, wherein the non linear mapping based filter is at least one of a cross-component sample offset (CCSO) filter and a local sample offset (LSO) filter.

3. The method of claim 1, wherein the first reconstructed samples at the first node are input of the non linear mapping based filter.

4. The method of claim 3, further comprising:

buffering, by the processor, second boundary pixel values of second reconstructed samples at a second node along the loop filter chain, the second reconstructed samples at the second node being generated after an applying of sample offsets generated by the non linear mapping based filter, the second boundary pixel values being values of the pixels at the frame boundary; and

applying, by the processor, the loop restoration filter on the to-be filtered reconstructed samples based on the buffered first boundary pixel values, and the buffered second boundary pixel values.

5. The method of claim 4, further comprising:

combining, by the processor, the sample offsets generated by the non linear mapping based filter with output of a constrained directional enhanced filter to generate the second reconstructed samples.

6. The method of claim 4, further comprising:

combining, by the processor, the sample offsets generated by the non linear mapping based filter with the first reconstructed samples to generate intermediate reconstructed samples; and

applying, by the processor, a constrained directional enhanced filter to the intermediate reconstructed samples to generate the second reconstructed samples.

7. The method of claim 3, further comprising:

buffering, by the processor, second boundary pixel values of second reconstructed samples at a second node along the loop filter, the second boundary pixel values being values of the pixels at the frame boundary;

combining, by the processor, the second reconstructed samples at the second node with sample offsets generated by the non linear mapping based filter to generate the to-be filtered reconstructed samples; and

applying, by the processor, the loop restoration filter on the to-be filtered reconstructed samples based on the buffered first boundary pixel values, and the buffered second boundary pixel values.

8. The method of claim 1, further comprising:

buffering second boundary pixel values of second reconstructed samples generated by a deblocking filter, the second boundary pixel values being values of the pixels at the frame boundary;

applying a constrained directional enhanced filter on the second reconstructed samples to generate intermediate reconstructed samples; and

combining the intermediate reconstructed samples with sample offsets generated by the non linear mapping based filter to generate the first reconstructed samples.

9. The method of claim 1, further comprising:

clipping the to-be filtered reconstructed samples before the applying of the loop restoration filter.

10. The method of claim 9, further comprising:

clipping intermediate reconstructed samples before a combination with sample offsets generated by the non linear mapping based filter.

11. An apparatus for filtering in video coding, comprising processing circuitry configured to:

buffer first boundary pixel values of first reconstructed samples at a first node along a loop filter chain, the first node being associated with a non linear mapping based filter that is applied in the loop filter chain before a loop restoration filter, the first boundary pixel values being values of pixels at a frame boundary; and

apply the loop restoration filter on to-be filtered reconstructed samples based on the buffered first boundary pixel values.

12. The apparatus of claim 11, wherein the non linear mapping based filter is at least one of a cross-component sample offset (CCSO) filter and a local sample offset (LSO) filter.

13. The apparatus of claim 11, wherein the first reconstructed samples at the first node are input of the non linear mapping based filter.

14. The apparatus of claim 13, wherein the processing circuitry is configured to:

buffer second boundary pixel values of second reconstructed samples at a second node along the loop filter chain, the second reconstructed samples at the second node being generated after an applying of sample offsets generated by the non linear mapping based filter, the second boundary pixel values being values of the pixels at the frame boundary; and

apply the loop restoration filter on the to-be filtered reconstructed samples based on the buffered first boundary pixel values, and the buffered second boundary pixel values.

15. The apparatus of claim 14, wherein the processing circuitry is configured to:

combine the sample offsets generated by the non linear mapping based filter with output of a constrained directional enhanced filter to generate the second reconstructed samples;

and/or,

combine the sample offsets generated by the non linear mapping based filter with the first reconstructed samples to generate intermediate reconstructed samples; and apply a constrained directional enhanced filter to the intermediate reconstructed samples to generate the second reconstructed samples.

16. The apparatus of claim 13, wherein the processing circuitry is configured to:

buffer second boundary pixel values of second reconstructed samples at a second node along the loop filter, the second boundary pixel values being values of the pixels at the frame boundary;

combine the second reconstructed samples at the second node with sample offsets generated by the non linear mapping based filter to generate the to-be filtered reconstructed samples; and

apply the loop restoration filter on the to-be filtered reconstructed samples based on the buffered first boundary pixel values, and the buffered second boundary pixel values.

17. The apparatus of claim 11, wherein the processing circuitry is configured to:

buffer second boundary pixel values of second reconstructed samples generated by a deblocking filter, the second boundary pixel values being values of the pixels at the frame boundary;

apply a constrained directional enhanced filter on the second reconstructed samples to generate intermediate reconstructed samples; and

combine the intermediate reconstructed samples with sample offsets generated by the non linear mapping based filter to generate the first reconstructed samples.

18. The apparatus of claim 11, wherein the processing circuitry is configured to:

clip the to-be filtered reconstructed samples before the applying of the loop restoration filter.

19. The apparatus of claim 18, wherein the processing circuitry is configured to:

clip intermediate reconstructed samples before a combination with sample offsets generated by the non linear mapping based filter.

20. A non-transitory computer-readable medium storing instructions which when executed by a computer cause the computer to perform the method of any one of claims 1 to 10.