CLAIMS

What is claimed is:

1. A method to reconstruct coded video data with one or more processors, the method comprising:

receiving a coded bitstream (122) comprising one or more coded reshaped images in an input codeword representation;

receiving reshaping metadata (207) for the one or more coded reshaped images in the coded bitstream;

generating a forward reshaping function (282) based on the reshaping metadata, wherein the forward reshaping function maps pixels of an image from a first codeword representation to the input codeword representation;

generating an inverse reshaping function (265-3) based on the reshaping metadata or the forward reshaping function, wherein the inverse reshaping function maps pixels of a reshaped image from the input codeword representation to the first codeword representation;

extracting from the coded bitstream a coded reshaped image comprising one or more coded units, wherein:

for an intra-coded coding unit (intra-CU) in the coded reshaped image:

generating reshaped reconstructed samples of the intra-CU (285) based on reshaped residuals in the intra-CU and intra-predicted reshaped prediction samples;

applying the inverse reshaping function (265-3) to the reshaped reconstructed samples of the intra-CU to generate decoded samples of the intra-CU in the first codeword representation;

applying a loop filter (270) to the decoded samples of the intra-CU to generate output samples of the intra-CU; and

storing the output samples of the intra-CU in a reference buffer;

for an inter-coded CU (inter-CU) in the coded reshaped image:

applying the forward reshaping function (282) to inter-prediction samples stored in the reference buffer in the first codeword representation to generate reshaped prediction samples for the inter-CU in the input codeword representation;

generating reshaped reconstructed samples of the inter-CU based on reshaped residuals in the inter-CU and the reshaped prediction samples for the inter-CU;

applying the inverse reshaping function (265-3) to the reshaped reconstructed samples of the inter-CU to generate decoded samples of the inter-CU in the first codeword representation;

applying the loop filter (270) to the decoded samples of the inter-CU to generate output samples of the inter-CU; and

storing the output samples of the inter-CU in the reference buffer; and

generating a decoded image in the first codeword representation based on output samples in the reference buffer.

2. The method of claim 1, wherein generating a reshaped reconstructed sample (*RecSample*) of the intra-CU comprises computing:

$$RecSample = (Res + IpredSample),$$

wherein *Res* denotes a reshaped residual sample in the intra-CU in the input codeword representation, and *IpredSample* denotes an intra-predicted reshaped prediction sample in the input codeword representation.

3. The method of claim 1, wherein generating a reshaped reconstructed sample (*RecSample*) of the inter-CU comprises computing:

$$RecSample = (Res + Fwd(PredSample)),$$

wherein *Res* denotes a reshaped residual in the inter-CU in the input codeword representation, *Fwd*() denotes the forward reshaping function, and *PredSample* denotes an inter-prediction sample in the first codeword representation.

4. The method of claim 2 or claim 3, wherein generating an output sample to be stored in the reference buffer (*RecSampleInDPB*) comprises computing:

$$RecSampleInDPB = LPF(Inv(RecSample)),$$

wherein, *Inv*() denotes the inverse reshaping function and LPF() denotes the loop filter.

5. The method of claim 1, wherein for chroma residual samples in the inter-coded CU (inter-CU) in the input codeword representation, further comprising:

determining a chroma scaling factor based on luma pixel values in the input codeword representation and the reshaping metadata;

multiplying the chroma residual samples in the inter-CU with the chroma scaling factor to generate scaled chroma residual samples in the inter-CU in the first codeword representation;

generating reconstructed chroma samples of the inter-CU based on the scaled chroma residuals in the inter-CU and chroma inter-prediction samples stored in the reference buffer to generate decoded chroma samples of the inter-CU;

applying the loop filter (270) to the decoded chroma samples of the inter-CU to generate output chroma samples of the inter-CU; and

storing the output chroma samples of the inter-CU in the reference buffer.

6. The method of claim 5, wherein in intra-mode the chroma scaling factor is based on an average of intra-predicted luma values.

7. The method of claim 5, wherein in inter mode the chroma scaling factor is based on an average of inter-predicted luma values in the input codeword representation.

8. The method of claim 1 wherein the reshaping metadata comprise:

a first parameter indicating a number of bins used for representing the first codeword representation;

a second parameter indicating the minimum bin index being used in reshaping;

a first set of parameters indicating absolute delta codeword values for each bin in the input codeword representation; and

a second set of parameters indicating signs of the delta codeword values for each bin in the input codeword representation.

9. The method of claim 1, wherein the forward reshaping function is reconstructed as a piece-wise linear function with linear segments derived by the reshaping metadata.

10. A method for adaptive reshaping of a video sequence with a processor, the method comprising:

accessing with a processor an input image in a first codeword representation; and

generating a forward reshaping function mapping pixels of the input image to a second codeword representation, wherein the second codeword representation allows for a more efficient compression than the first codeword representation, wherein generating the forward reshaping function comprises:

dividing the input image into multiple pixel regions;

assigning each of the pixel regions to one of multiple codeword bins according to a first luminance characteristic of each pixel region;

computing a bin metric for each of the multiple codeword bins according to a second luminance characteristic of each of the pixel regions assigned to each of the multiple codeword bins;

allocating a number of codewords in the second codeword representation to each of the multiple codeword bins according to the bin metric of each of the multiple codeword bins and a rate distortion optimization criterion;

and generating the forward reshaping function in response to the allocation of codewords in the second codeword representation to each of the multiple codeword bins.

11. The method of claim 10, wherein the first luminance characteristic of a pixel region comprises the average luminance pixel value in the pixel region.

12. The method of claim 10, wherein the second luminance characteristic of a pixel region comprises the variance of luminance pixel values in the pixel region.

13. The method of claim 12, wherein computing a bin metric for a codeword bin comprises computing the average of the variances of luminance pixel values for all pixels regions assigned to the codeword bin.

14. The method of claim 10, wherein allocating a number of codewords in the second codeword representation to a codeword bin according to its bin metric comprises:

assigning no codewords to the codeword bin, if no pixel regions are assigned to the codeword bin;

assigning a first number of codewords if the bin metric of the codeword bin is lower than an upper threshold value; and

assigning a second number of codewords to the codeword bin otherwise.

15. An apparatus comprising a processor and configured to perform a method as recited in any one of the claims 1-14.

16. A non-transitory computer-readable storage medium having stored thereon computer-executable instruction for executing a method with one or more processors in accordance with any one of the claims 1-14.

CLAIMS

1. A method to reconstruct coded video data with one or more processors, the method comprising:

receiving a coded bitstream comprising one or more coded reshaped images in an input codeword representation;

receiving reshaping metadata for the one or more coded reshaped images in the coded bitstream, wherein the reshaping metadata comprise parameters to generate a forward reshaping function based on the reshaping metadata, wherein the forward reshaping function maps pixels of an image from a first codeword representation to the input codeword representation, wherein the reshaping metadata comprise:

a first parameter indicating a minimum bin index being used in reshaping;

a second parameter to determine an active maximum bin index being used in the reshaping, wherein the active maximum bin index is smaller or equal to a predefined maximum bin index, and determining the active maximum bin index comprises computing a difference between the predefined maximum bin index and the second parameter;

absolute delta codeword values for each active bin in the input codeword representation; and

signs of the absolute delta codeword values for each active bin in the input codeword representation;

generating a forward reshaping function based on the reshaping metadata;

generating an inverse reshaping function based on the reshaping metadata or the forward reshaping function, wherein the inverse reshaping function maps pixels of a reshaped image from the input codeword representation to the first codeword

representation; and

decoding the coded bitstream based on the forward reshaping function and the inverse reshaping function.

2. The method of claim 1, wherein the forward reshaping function is reconstructed as a piece-wise linear function with linear segments derived by the reshaping metadata.

3. A method for adaptive reshaping of a video sequence with a processor, the method comprising:

accessing with a processor an input image in a first codeword representation; and

generating a forward reshaping function mapping pixels of the input image to a second codeword representation, wherein generating the forward reshaping function comprises:

dividing the input image into multiple pixel regions;

assigning each of the pixel regions to one of multiple codeword bins according to a first luminance characteristic of each pixel region;

computing a bin metric for each of the multiple codeword bins according to a second luminance characteristic of each of the pixel regions assigned to each of the multiple codeword bins;

allocating a number of codewords in the second codeword representation to each of the multiple codeword bins according to the bin metric of each of the multiple codeword bins and a rate distortion optimization criterion;

generating the forward reshaping function in response to the allocation of codewords in the second codeword representation to each of the multiple codeword bins; and

generating reshaping parameters to represent the forward reshaping function, wherein the reshaping parameters comprise:

a first parameter to determine an active maximum codeword bin index used for reshaping, wherein the active maximum codeword bin index is smaller or equal to a predefined maximum codeword bin index;

a second parameter indicating a minimum codeword bin index being used in the reshaping;

absolute delta codeword values for each active codeword bin in the first codeword representation; and

signs of the absolute delta codeword values for each active bin in the first codeword representation.

4. The method of claim 3, wherein the first luminance characteristic of a pixel region comprises the average luminance pixel value in the pixel region.

5. The method of claim 3, wherein the second luminance characteristic of a pixel region comprises the variance of luminance pixel values in the pixel region.

6. The method of claim 5, wherein computing a bin metric for a codeword bin comprises computing the average of the variances of luminance pixel values for all pixel regions assigned to the codeword bin.

7. The method of claim 3, wherein allocating a number of codewords in the second codeword representation to a codeword bin according to its bin metric comprises:

assigning no codewords to the codeword bin, if no pixel regions are assigned to the codeword bin;

assigning a first number of codewords if the bin metric of the codeword bin is lower than an upper threshold value; and

assigning a second number of codewords to the codeword bin otherwise.

8. An apparatus comprising a processor and configured to perform a method as recited in claim 1.

9. A non-transitory computer-readable storage medium having stored thereon computer-executable instruction for executing a method with one or more processors in accordance with claim 1.

10. A method to reconstruct coded video data, the method comprising:

receiving a coded bitstream comprising one or more coded reshaped pictures in an input codeword representation;

receiving reshaping metadata for the one or more coded reshaped pictures in the coded bitstream;

wherein the reshaping metadata comprise:

a first parameter to determine a minimum bin index being used in reshaping;

a second parameter to determine a maximum bin index being used in reshaping;

a second parameter to determine an active maximum bin index being used in the reshaping, wherein the active maximum bin index is smaller or equal to a predefined maximum bin index, and determining the active maximum bin index comprises computing a difference between the predefined maximum

bin index and the second parameter;

a first set of parameters indicating absolute delta codeword values for each active bin in the input codeword representation; and

a second set of parameters indicating signs of the delta codeword values for each active bin in the input codeword representation;

generating a forward reshaping function based on the reshaping metadata, wherein the forward reshaping function maps pixels of a picture from a first codeword representation to the input codeword representation;

generating an inverse reshaping function based on the reshaping metadata or the forward reshaping function, wherein the inverse reshaping function maps pixels of a reshaped picture from the input codeword representation to the first codeword representation;

extracting from the coded bitstream a coded reshaped picture comprising one or more coded units, wherein:

for an inter-coded CU (inter-CU) in the coded reshaped picture:

applying the forward reshaping function to inter-prediction samples stored in a reference buffer in the first codeword representation to generate reshaped prediction samples for the inter-CU in the input codeword representation;

generating reshaped reconstructed samples of the inter-CU based on reshaped residuals in the inter-CU and the reshaped prediction samples for the inter-CU;

applying the inverse reshaping function to the reshaped reconstructed samples of the inter-CU to generate decoded samples of the inter-CU in the first codeword representation;

applying a loop filter to the decoded samples of the inter-CU to generate output

samples of the inter-CU; and

storing the output samples of the inter-CU in the reference buffer; and

generating a decoded picture in the first codeword representation based on output samples in the reference buffer.

11. The method of claim 10, wherein generating a reshaped reconstructed sample (*RecSample*) of the inter-CU comprises computing:

$$RecSample = (Res + Fwd(PredSample)),$$

wherein *Res* denotes a reshaped residual in the inter-CU in the input codeword representation, *Fwd*() denotes the forward reshaping function, and *PredSample* denotes an inter-prediction sample in the first codeword representation.

12. The method of claim 11, wherein generating an output sample to be stored in the reference buffer (*RecSampleInDPB*) comprises computing:

$$RecSampleInDPB = LPF(Inv(RecSample)),$$

wherein, *Inv*() denotes the inverse reshaping function and LPF() denotes a loop filter.

13. The method of claim 10, wherein for chroma residual samples in the inter-coded CU (inter-CU) in the input codeword representation, further comprising:

determining a chroma scaling factor based on luma pixel values in the input codeword representation and the reshaping metadata;

multiplying the chroma residual samples in the inter-CU with the chroma scaling factor to generate scaled chroma residual samples in the inter-CU in the first codeword representation;

generating reconstructed chroma samples of the inter-CU based on the scaled chroma

residuals in the inter-CU and chroma inter-prediction samples stored in the reference buffer to generate decoded chroma samples of the inter-CU;

applying the loop filter (270) to the decoded chroma samples of the inter-CU to generate output chroma samples of the inter-CU; and

storing the output chroma samples of the inter-CU in the reference buffer.

14. The method of claim 13, wherein in inter mode the chroma scaling factor is based on an average of inter-predicted luma values in the input codeword representation.

15. The method of claim 10, wherein the forward reshaping function is reconstructed as a piece-wise linear function with linear segments derived by the reshaping metadata.