The set of intra-prediction modes may comprise 35 different intra-prediction modes, e.g. non-directional modes like DC (or mean) mode and planar mode, or directional modes, e.g. as defined in HEVC, or may comprise 67 different intra-prediction modes, e.g. non-directional modes like DC (or mean) mode and planar mode, or directional modes, e.g. as defined for VVC.

The intra-prediction unit 254 is configured to use reconstructed samples of neighboring blocks of the same current picture to generate an intra-prediction block 265 according to an intra-prediction mode of the set of intra-prediction modes.

The intra prediction unit 254 (or in general the mode selection unit 260) is further configured to output intra-prediction parameters (or in general information indicative of the selected intra prediction mode for the block) to the entropy encoding unit 270 in form of syntax elements 266 for inclusion into the encoded picture data 21, so that, e.g., the video decoder 30 may receive and use the prediction parameters for decoding.

Inter-Prediction

The set of (or possible) inter-prediction modes depends on the available reference pictures (i.e. previous at least partially decoded pictures, e.g. stored in ~~DBP~~ DPB 230) and other inter-prediction parameters, e.g. whether the whole reference picture or only a part, e.g. a search window area around the area of the current block, of the reference picture is used for searching for a best matching reference block, and/or e.g. whether pixel interpolation is applied, e.g. half/semi-pel and/or quarter-pel interpolation, or not.

Additional to the above prediction modes, skip mode and/or direct mode may be applied.

Decoder and Decoding Method

Fig. 3 shows an ~~exemple~~ example of a video decoder 30 that is configured to implement the techniques of this present application**.** The video decoder 30 is configured to receive encoded picture data 21 (e.g. encoded bitstream 21), e.g. encoded by encoder 20, to obtain a decoded picture 331. The encoded picture data or bitstream comprises information for decoding the encoded picture data, e.g. data that represents picture blocks of an encoded video slice (and/or tile groups or tiles) and associated syntax elements.

In the example of Fig. 3, the decoder 30 comprises an entropy decoding unit 304, an inverse quantization unit 310, an inverse transform processing unit 312, a reconstruction unit 314 (e.g. a summer 314), a loop filter 320, a decoded picture buffer (~~DBP~~DPB) 330, a mode application unit 360, an inter prediction unit 344 and an intra prediction unit 354. Inter prediction unit 344 may be or include a motion compensation unit. Video decoder 30 may, in some examples, perform a decoding pass generally reciprocal to the encoding pass described with respect to video encoder 100 from FIG. 2.

As explained with regard to the encoder 20, the inverse quantization unit 210, the inverse transform processing unit 212, the reconstruction unit 214 the loop filter 220, the decoded picture buffer (DPB) 230, the inter prediction unit 344 and the intra prediction unit 354 are also referred to as forming the “built-in decoder” of video encoder 20. Accordingly, the inverse quantization unit 310 may be identical in function to the inverse quantization unit 110, the inverse transform processing unit 312 may be identical in function to the inverse transform processing unit 212, the reconstruction unit 314 may be identical in function to reconstruction unit 214, the loop filter 320 may be identical in function to the loop filter 220, and the decoded picture buffer 330 may be identical in function to the decoded picture buffer

prediction block .

Embodiment 4. The method of any one of embodiments 1-3, wherein the intra predicted sample predSamples[x][y]is generated by:

predSamples[x][y] = (predV[x][y] + predH[x][y] + nW) >> (Log2 (nW) +1).

Embodiment 5. The method of any one of embodiments 1-4, wherein the bottom reference sample row is padded by p[-1][nTbH].

Embodiment 6. According to another aspect the invention relates to a method for decoding or encoding. The method is performed by a decoding or an encoding apparatus. The method includes: obtained the height and width of a current prediction block without applying clipping operation; calculating a value of a vertical component of an intra predicted sample based on the height and width of the prediction block; calculating a value of a horizon component of the intra predicted sample based on the height and width of the prediction blocks ; and generating the intra predicted sample based on the value of the vertical component and the value of the horizon component.

Embodiment 7. The method of embodiment 6, wherein the value of the vertical component predV[x][y]is calculated by:

predV[x][y] = ((nTbH − 1 − y) * p[x][−1] + (y + 1) * p[−1][nTbH]) << Log2 (nTbW) ,

wherein x = 0..nTbW – 1, y = 0..nTbH – 1, nTbH represents the height of the prediction block or a transform block, nTbW represents the width of the prediction block or the transform block.

Embodiment 8. The method of embodiment 6 or 7, wherein the value of the horizon component predH[x][y] is calculated by:

predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1]) << Log2 (nTbH) ;

wherein x = 0..nTbW – 1, y = 0..nTbH – 1, nTbH represents the height of the prediction

block or a transform block, nTbW represents the width of the prediction block or the transform block.

Embodiment 9. The method of any one of embodiments 6-8, wherein the intra predicted sample predSamples[x][y]is generated by:

predSamples[x][y] = (predV[x][y] + predH[x][y] + nTbW * nTbH) >> (Log2 (nTbW) + Log2 (nTbH) + 1).

Embodiment 10. The method of any one of embodiments 5-9, wherein the bottom reference sample row of the prediction block is padded by p[-1][nTbH].

Embodiment 11. The method of any one of embodiments 5-10, wherein the width of the prediction block is obtained without applying clipping operation nW = Max(nTbW, 2).

Embodiment 12. The method of any one of embodiments 5-11, wherein the height of the prediction block is obtained without applying clipping operation nH = Max(nTbH, 2).

Following is an explanation of the applications of the encoding method as well as the decoding method as shown in the above-mentioned embodiments, and a system using them.

FIG. 10 is a block diagram showing a content supply system 3100 for realizing content distribution service. This content supply system 3100 includes capture device 3102, terminal device 3106, and optionally includes display 3126. The capture device 3102 communicates with the terminal device 3106 over communication link 3104. The communication link may include the communication channel 13 described above. The communication link 3104 includes but not limited to WIFI, Ethernet, Cable, wireless (3G/4G/5G), USB, or any kind of combination thereof, or the like.

The capture device 3102 generates data, and may encode the data by the encoding method as shown in the above embodiments. Alternatively, the capture device 3102 may distribute the data to a streaming server (not shown in the Figures), and the server encodes the data and transmits the encoded data to the terminal device 3106. The capture device 3102 includes but

can feed the decoded data to its display. For a terminal device equipped with no display, for example, STB 3116, video conference system 3118, or video surveillance system 3120, an external display 3126 is contacted therein to receive and show the decoded data.

When each device in this system performs encoding or decoding, the picture encoding device or the picture decoding device, as shown in the above-mentioned embodiments, can be used.

FIG. 11 is a diagram showing a structure of an example of the terminal device 3106. After the terminal device 3106 receives stream from the capture device 3102, the protocol proceeding unit 3202 analyzes the transmission protocol of the stream. The protocol includes but not limited to Real Time Streaming Protocol (RTSP), Hyper Text Transfer Protocol (HTTP), HTTP Live streaming protocol (HLS), MPEG-DASH, Real-time Transport protocol (RTP), Real Time Messaging Protocol (RTMP), or any kind of combination thereof, or the like.

After the protocol proceeding unit 3202 processes the stream, stream file is generated. The file is outputted to a demultiplexing unit 3204. The demultiplexing unit 3204 can separate the multiplexed data into the encoded audio data and the encoded video data. As described above, for some practical scenarios, for example in the video conference system, the encoded audio data and the encoded video data are not multiplexed. In this situation, the encoded data is transmitted to video decoder 3206 and audio decoder 3208 without through the demultiplexing unit 3204.

Via the demultiplexing processing, video elementary stream (ES), audio ES, and optionally subtitle are generated. The video decoder 3206, which includes the video decoder 30 as explained in the above mentioned embodiments, decodes the video ES by the decoding method as shown in the above-mentioned embodiments to generate video frame, and feeds this data to the synchronous unit 3212. The audio decoder 3208, decodes the audio ES to generate audio frame, and feeds this data to the synchronous unit 3212. Alternatively, the video frame may store in a buffer (not shown in FIG. ~~Y~~11) before feeding it to the

synchronous unit 3212. Similarly, the audio frame may store in a buffer (not shown in FIG. ~~¥~~11) before feeding it to the synchronous unit 3212.

The synchronous unit 3212 synchronizes the video frame and the audio frame, and supplies the video/audio to a video/audio display 3214. For example, the synchronous unit 3212 synchronizes the presentation of the video and audio information. Information may code in the syntax using time stamps concerning the presentation of coded audio and visual data and time stamps concerning the delivery of the data stream itself.

If subtitle is included in the stream, the subtitle decoder 3210 decodes the subtitle, and synchronizes it with the video frame and the audio frame, and supplies the video/audio/subtitle to a video/audio/subtitle display 3216.

The present invention is not limited to the above-mentioned system, and either the picture encoding device or the picture decoding device in the above-mentioned embodiments can be incorporated into other system, for example, a car system.

Mathematical Operators

The mathematical operators used in this application are similar to those used in the C programming language. However, the results of integer division and arithmetic shift operations are defined more precisely, and additional operations are defined, such as exponentiation and real-valued division. Numbering and counting conventions generally begin from 0, e.g., "the first" is equivalent to the 0-th, "the second" is equivalent to the 1-th, etc.

Arithmetic operators

The following arithmetic operators are defined as follows:

+ Addition

CLAIMS

1. A method of intra Planar prediction in a picture, comprising:

calculating a value of a vertical component predV[x][y] of an intra prediction sample included in a block of the picture, wherein the value of the vertical component predV[x][y] is:

predV[x][y] = ((nTbH − 1 − y) * p[x][−1] + (y + 1) * p[−1][nTbH]) << Log2 (nTbW) ;

calculating a value of a horizontal component predH[x][y] of the intra prediction sample, wherein the value of the horizontal component predH[x][y] is:

predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1]) << Log2 (nTbH); and

generating the intra prediction sample ~~predSamples[x][y]~~ based on the value of the vertical component predV[x][y] and the value of the horizon component predH[x][y],

wherein nTbH represents the height of the block, nTbW represents the width of the block, p[x][y] represents neighbouring samples with x = −1, y = −1..nTbH and x = 0..nTbW, y = −1.

2. The method of claim 1, wherein the intra prediction sample predSamples[x][y] is:

predSamples[x][y] = (predV[x][y] + predH[x][y] + nTbW * nTbH) >> (Log2 (nTbW) + Log2 (nTbH) + 1).

3. The method of claim 1 or 2, wherein the bottom reference sample row of the block is padded by p[-1][nTbH].

4. The method of claim 1 or 2, wherein the right reference sample column of the block is padded by p[nTbW][−1].

5. The method of any one of claims 1 to 3, wherein when the height of the block is equal to 1,

predV[x][y] = ((y + 1) * p[−1][nTbH]) << Log2 (nTbW)

predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1])

predSamples[x][y] = (predV[x][y] + predH[x][y] + nTbW) >> (Log2 (nTbW) +1).

6. The method of any one of claims 1 to 3, wherein the block is a transform block, or a prediction block.

~~6~~7. A method of intra Planar prediction with a height of a block equal to 1, comprising:

calculating a value of a vertical component predV[x][y] of an intra prediction sample included in the block, wherein the value of the vertical component predV[x][y] is predV[x][y] = ((y + 1) * p[−1][nTbH]) << Log2 (nTbW) ;

calculating a value of a horizon component predH[x][y] of the intra prediction sample, wherein the value of the horizontal component predH[x][y] is predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1]) ; and

generating the intra prediction sample based on the value of the vertical component and the value of the horizon component,

wherein nTbH represents the height of the block, nTbW represents the width of the block, p[x][y] represents neighbouring samples with x = −1, y = −1..nTbH and x = 0..nTbW, y = −1.

~~7~~8. The method of claim ~~6~~7, wherein the intra prediction sample is calculated by:

predSamples[x][y] = (predV[x][y] + predH[x][y] + nTbW) >> (Log2 (nTbW) +1).

~~8~~9. The method of claim ~~6–~~7 or ~~7~~8, wherein the bottom reference sample row of the prediction block is padded by p[-1][nTbH].

10. The method of any one of claims 7 to 9, wherein the block is a transform block, or a prediction block.

~~9~~11. A method of coding implemented by a decoding device, comprising:

obtaining the height and width of a current block without applying clipping operation;

calculating a value of a vertical component of an intra prediction sample based on the height and width of the prediction block;

calculating a value of a horizontal component of the intra prediction sample based on the height and width of the prediction blocks; and

generating the intra prediction sample based on the value of the vertical component and the value of the horizontal component.

~~10~~12. The method of claim ~~9~~11, wherein the value of the vertical component predV[x][y] is calculated by:

predV[x][y] = ((nTbH − 1 − y) * p[x][−1] + (y + 1) * p[−1][nTbH]) << Log2 (nTbW) ,

wherein predV[x][y] represents the value of the vertical component withx = 0..nTbW – 1, y = 0..nTbH – 1, nTbH represents the height of the current block, nTbW represents the width of the current block.

~~11~~13. The method of claim ~~9–~~11 or ~~10~~12, wherein the value of the horizon component predH[x][y] is calculated by:

predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1]) << Log2

(nTbH) ;

wherein x = 0..nTbW – 1, y = 0..nTbH – 1, nTbH represents the height of the current block, nTbW represents the width of the current block.

~~12~~14. The method of any one of claims ~~9~~11- to ~~11~~13, wherein the intra prediction sample predSamples[x][y]is generated by:

predSamples[x][y] = (predV[x][y] + predH[x][y] + nTbW * nTbH) >> (Log2 (n TbW) + Log2 (nTbH) + 1).

~~13~~15. The method of any one of claims ~~9~~11- to ~~12~~14, wherein the bottom reference sample row of the prediction block is padded by p[-1][nTbH].

~~14~~16. The method of any one of claims ~~9~~11- to ~~13~~15, wherein the width of the prediction block is obtained without applying clipping operation nW = Max(nTbW, 2).

~~15~~17. The method of any one of claims ~~9~~11- to ~~14~~16, wherein the height of the prediction block is obtained without applying clipping operation nH = Max(nTbH, 2).

18. The method of any one of claims 11 to 17, wherein the block is a transform block, or a prediction block.

~~16~~19. An encoder (20) comprising processing circuitry for carrying out the method according to any one of claims 1 to ~~15~~18.

~~17~~20. A decoder (30) comprising processing circuitry for carrying out the method according to any one of claims 1 to ~~15~~18.

~~18~~21. A computer program product comprising a program code for performing the method according to any one of claims 1 to ~~15~~18.

~~19~~22. A decoder, comprising:

one or more processors; and

a non-transitory computer-readable storage medium coupled to the processors and storing programming for execution by the processors, wherein the programming, when executed by the processors, configures the decoder to carry out the method according to any one of claims 1 to ~~15~~18.

~~20~~23. An encoder, comprising:

one or more processors; and

a non-transitory computer-readable storage medium coupled to the processors and storing programming for execution by the processors, wherein the programming, when executed by the processors, configures the encoder to carry out the method according to any one of claims 1 to ~~15~~18.

~~21~~24. A device of intra Planar prediction in a picture, comprising:

a calculating unit (902), configured to calculate a value of a vertical component predV[x][y] of an intra prediction sample included in a block of the picture, and calculate a value of a horizon component predH[x][y] of the intra prediction sample, wherein the value of the vertical component predV[x][y] is: predV[x][y] = ((nTbH − 1 − y) * p[x][−1] + (y + 1) * p[−1][nTbH]) << Log2 (nTbW), and the value of the horizontal component predH[x][y] is: predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1]) << Log2 (nTbH) , nTbH representing the height of the block, nTbW representing the width of the block,

p[x][y] represents neighbouring samples with x = −1, y = −1..nTbH and x = 0..nTbW, y = −1;

a predicting unit (903), configured to generate the intra prediction sample based on the value of the vertical component and the value of the horizon component.

~~22~~25. The device of claim ~~21~~24, wherein the predicting unit (903), configured to generate the intra prediction sample predSamples[x][y] by:

predSamples[x][y] = (predV[x][y] + predH[x][y] + nTbW * nTbH) >> (Log2 (nTbW) + Log2 (nTbH) + 1).

~~23~~26. The device of claim ~~21~~ 24 or ~~22~~25, wherein the device further comprises a padding unit (904), the padding unit (904) configured to pad the left reference sample column of the block by p[nTbW][−1]; or pad the bottom reference sample row of the block by p[-1][nTbH].

~~24~~27. The device of any one of claims ~~21~~24~~-~~ to ~~23~~26, when the height of the prediction block is equal to 1, the calculating unit (902), configured to calculate the value of the vertical component and the value of the horizon component by:

predV[x][y] = ((y + 1) * p[−1][nTbH]) << Log2 (nTbW)

predH[x][y] = ((nTbW − 1 − x) * p[−1][y] + (x + 1) * p[nTbW][−1]).

~~25~~28. The device of any one of claims ~~21~~24~~-~~~~23~~26, when the width of the prediction block is equal to 1, the calculating unit (902), configured to calculate the value of the vertical component and the value of the horizon component by:

predV[x][y] = ((nTbH − 1 − y) * p[x][−1] + (y + 1) * p[−1][nTbH])

predH[x][y] = ((x + 1) * p[nTbW][−1]) << Log2 (nTbH).

~~26~~29. The device of any one of claims ~~21~~24~~-~~ to ~~25~~28, wherein the device is a decoder or an encoder.

30. The device of any one of claims 24 to 29, wherein the block is a transform block, or a prediction block.