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Line-based Intra Coding for High Quality Video Using H.264/AVC

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1. Introduction

H.264/AVC is currently one of the most commonly used video coding standards. The compression efficiency of H.264/AVC is higher than any other previous video coding standards, as it includes more sophisticated coding techniques, such as intra prediction, variable block size motion estimation, rate-distortion optimized mode decision, and entropy coding (Luthra *et al.*, 2003; Sullivan & Wiegand, 2005; Wiegand *et al.*, 2003).

Intra prediction is an important technique in image and video coding to reduce the spatial redundancy between spatially adjacent blocks. Unlike previous coding standards such as H.263+ and MPEG-4 Part-2, in which intra predictions were performed in the transform domain, the intra prediction of H.264/AVC is completely defined in the pixel domain by referring to neighboring samples of coded blocks (Sullivan *et al.*, 2004; Sullivan *et al.*, 2004).

Recently, many intra prediction approaches have been proposed. To capture the local information of neighboring reconstructed samples more accurately, 34 prediction modes are employed in angular intra prediction for the Intra_8×8 mode (Ugur *et al.*, 2010), and arbitrary directional intra (ADI) for the Intra_16×16 mode (McCann *et al.*, 2010). In order to combine two types of the H.264/AVC intra prediction modes, bidirectional intra prediction (BIP) is proposed (Matsuo *et al.*, 2007).

In some cases, the image blocks have repeated patterns instead of distinctive direction information. In this case, utilizing the global information in place of the spatial neighboring samples will bring better coding efficiency. Related works include intra displacement compensation (IDC) (Yu & Chrysafis, 2002) and template matching (TM). IDC uses an intra-displacement vector per block partition to get the reference samples. In TM, they choose to match the templates which have already been reconstructed. Further enhancements using the TM scheme are matching using a single template (Tan *et al.*, 2006), backward-adaptive texture synthesis (Wei & Levoy, 2000), multiple candidates (Tan *et al.*, 2007), priority-guided template matching (Guo *et al.*, 2008), and locally adaptive illumination compensation (Zheng *et al.*, 2008).

Although these approaches improve the coding performance, they still suffer from the limitation of the block-based structure. In the block-based structure, it is difficult to predict the samples far from the reconstructed block boundaries. Thus, a new intra prediction method, line-based intra prediction (Sohn & Han, 2007; Peng *et al.*, 2010) is suggested. Until now, line-based coding seems to overcome the shortcomings of block-based prediction, because each line within the current block shares an equal processing and is predicted and transformed as a basic unit. Since the basic prediction unit is smaller than the case of block-based prediction, the amount of the residual data is reduced so that entire coding efficiency is improved. However, these works require modifying syntax elements of H.264/AVC and overhead bits for prediction modes should be delivered to the decoder side. Also, it is not easy to implement in the current H.264/AVC standard.

In this chapter, we have tried to design the implicit line-based prediction for high bit-rate compression. In our observation, high-definition (HD) contents are likely to have complex patterns - a lot of homogeneous texture patterns with variations such as gradation. However, Intra_16×16 has only four simple prediction directions. In H.264/AVC Intra_16×16 prediction, 256 pixels within the current block are predicted from maximum 33 neighboring pixels. Thus, its prediction accuracy is not enough to be selected as the best mode. As a result, Intra_4×4 or Intra_8×8 is determined as the best mode for most macroblocks.

To improve the prediction accuracy of the Intra_16×16 mode and take full advantage of the line-based structure, we implicitly implement line-based coding to directional prediction modes of the Intra_16×16 mode such as vertical and horizontal mode. In terms of syntax elements that are transmitted to the decoder, the Intra_4×4 mode requires more bits to represent the mode information than the Intra_16×16 mode. As such, with the proposed method, the entire number of coding bits will be efficiently reduced. Note that the proposed method does not require any modification of syntax element in H.264/AVC, so it can be easily applied to the current standard.

2. Overview of intra prediction methods in H.264/AVC

Intra prediction requires data from only within the current picture. Unlike the previous video coding standards such as H.263+ and MPEG-4 Visual, intra prediction in H.264/AVC is always conducted in the spatial domain, by referring to neighboring pixels of the current block. Moreover, to better capture the local properties of video signal, H.264/AVC employs flexible macroblock partition modes: Intra_4×4, Intra_8×8, and Intra_16×16. For predicting the luminance component, nine prediction modes are employed in both Intra_4×4 and Intra_8×8 modes, and four prediction modes are utilized for Intra_16×16. The details of the prediction process are shown in following subsections.

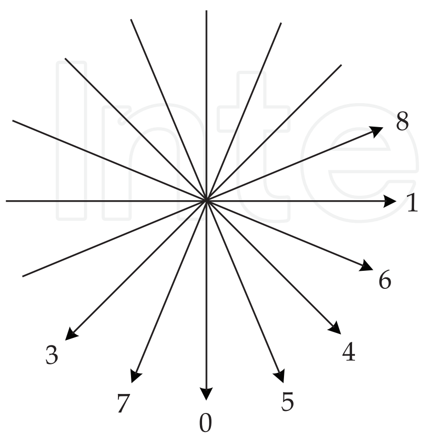
The efficiency of each partition mode is first evaluated by the encoder using the Lagrangian cost function, defined as

$$J = D + \lambda_{MODE} \times R \qquad where\, MODE \in \{\text{Intra\_4} \times 4, \text{Intra\_16} \times 16\} \tag{1}$$

where the distortion term is the absolute difference between the original and reconstructed signals, the rate term represents the amount of actual bits produced by H.264/AVC entropy coding, and λ_{MODE} is the Lagrangian constant, which depends on the quantization level. After this, the best mode which optimizes the cost function will then be selected for the actual coding. After intra prediction, the difference between estimated and real sample values, called residual data is coded and transmitted.

2.1 Overview of Intra_4x4 prediction

In Intra_4×4 mode, each 4×4 luma block is predicted from spatially neighboring pixels. The 16 pixels within the 4×4 block are predicted using position-specific linear combinations of previously-decoded pixels from adjacent blocks. The encoder can either select DC prediction or one of eight directional prediction types, as illustrated on Fig. 1. The directional modes are designed to model object edges at various angles.



Mode number	Name of prediction mode
0	Vertical
1	Horizontal
2	DC
3	Diagonal Down-Left
4	Diagonal Down-Right
5	Vertical-Right
6	Horizontal-Down
7	Vertical-Left
8	Horizontal-Up

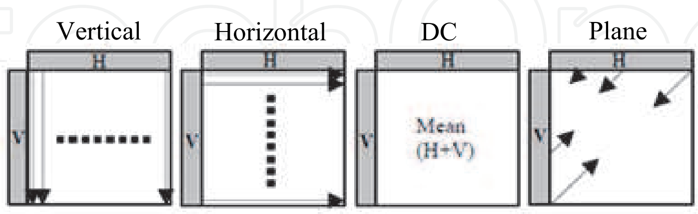
Fig. 1. Nine prediction directions of Intra_4×4 mode.

2.2 Overview of Intra_8x8 prediction

For high quality video, Intra_8×8 prediction is introduced in H.264/AVC high profile by extending the concepts of Intra_4×4 mode. Prediction directions of Intra_8×8 mode are same with those of Intra_4×4 mode, except the size of block. Each Intra_8×8 prediction generates 64 predicted pixel values within the 8×8 block using some or all of the upper and left-hand neighboring pixels.

2.3 Overview of Intra_16x16 prediction

The Intra_16×16 prediction mode is selected in relatively homogeneous area. Four prediction modes are supported, as shown in Fig. 2. The 256 pixel values within the macroblock are generated from some or all of the upper and left-hand neighboring pixels. These modes are specified similar to modes in Intra_4×4 predictions except the plane prediction.



Mode number	Name of prediction mode
0	Vertical
1	Horizontal
2	DC
3	Plane

Fig. 2. Four prediction mode directions for Intra_16×16.

Although the intra prediction in H.264/AVC shows lower complexity and good coding efficiency, there is still room for further improvement. The correlation between two samples is inversely relative to the distance between them. Therefore, samples at each position within one block should be predicted closer reference pixels.

3. Analysis of characteristics of high quality video coding for HD contents

In high resolution video service, the quality of reconstructed video is important. Figure 3 shows the decoded video of the high definition (HD) contents, *BQTerrace* using various quantization parameters (QP) from 24 to 32. Over 28, we can observe that the complex texture region within the white circle is abruptly corrupted.

Fig. 3. Decoded quality comparison (left: QP=24, middle: QP=28, right: QP=32).

Since an intra-coded frame can be used as a reference frame of inter frames, the quality is more important than any others. Thus, we determine that the suitable QP for high quality video coding is below 28. In this research, we set QP from 16 to 28 (high bitrate compression). Using this range of QP, we can encode the high resolution video without noticeable quality degradation.

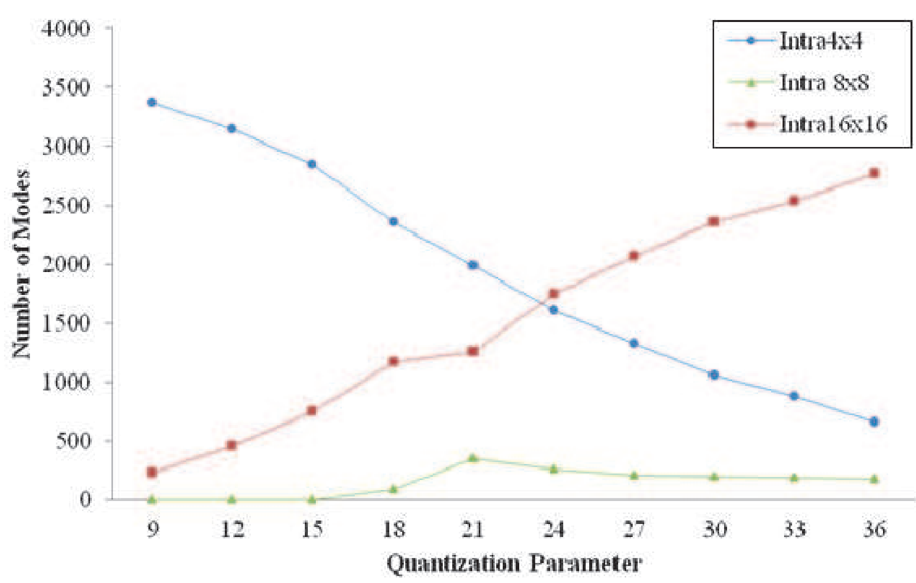


Fig. 4. Selected best mode distribution for various quantization parameters.

We checked the selected best mode distribution for various QPs, as shown in Fig. 4. In low bitrate, the number of Intra_16×16 modes is larger than the number of Intra_4×4 modes. In high bitrate, the number of Intra_16×16 modes is smaller. This result indicates that the prediction accuracy of Intra_16×16 mode is not sufficient for selection as the best mode in high bitrate compression. From this observation, we can know that the performance of H.264/AVC Intra_16×16 prediction in high bitrate compression should be improved.

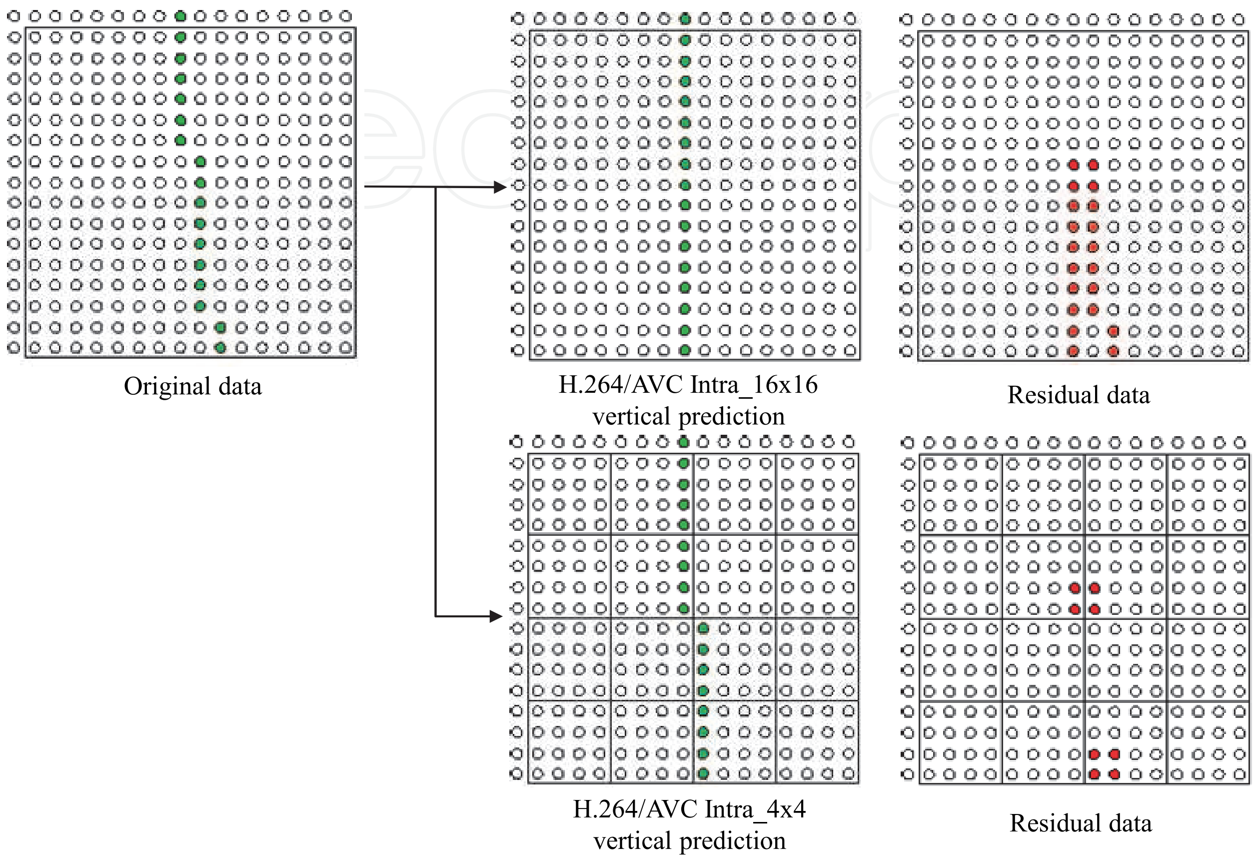


Fig. 5. Prediction result comparison between the Intra_16×16 and Intra_4×4 modes.

High resolution video generally has many complex patterns due to its substantially higher resolution. Figure 5 shows the prediction results of Intra_16×16 and Intra_4×4 modes, when we try to predict the left-hand block. Red circle in Fig. 5 stands for remaining pixels that are not removed by prediction, i.e. residual data. We can know that the amount of residual data after Intra_4×4 prediction is smaller than that after Intra_16×16 prediction. Simple directional prediction of Intra_16×16 cannot cover this kind of block. In this reason, Intra_4×4 mode is frequently selected as the best mode. Especially, in high bitrate, the correlation between reference pixels and current pixels is kept, because the noise of quantization and the smoothing effect of deblocking filter in high bitrate are smaller than that in low bitrate.

4. Implicit line-based intra prediction

In this section, we introduce an implicit line-based intra coding method (Choi *et al.*, 2010). In the conventional intra prediction of H.264/AVC, the Intra_16×16 mode is selected as the best mode in the homogeneous region. However, since the prediction unit is 16×16 block, pixels located further provide poor prediction performance in the vertical and horizontal modes. Thus, when the input sequence has a homogeneous texture pattern with variations such as gradation, the Intra_16×16 mode in H.264/AVC cannot yield sufficient prediction accuracy. It results in the increase of the residual data.

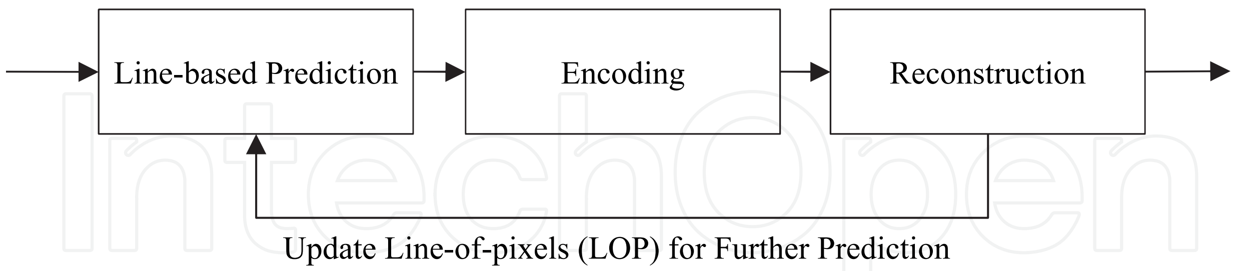


Fig. 6. Line-based prediction process.

In order to improve prediction accuracy of the Intra_16×16 mode, we propose a more efficient line-based intra prediction method in H.264/AVC by modifying the relevant coding procedure of the Intra_16×16 mode. The entire coding procedure of the proposed line-based intra prediction is shown in Fig. 6. The proposed method can be summarized in the following steps:
Step 1. Prediction of the first line of pixels (LOP).
Step 2. Transformation and quantization of the residual LOP (Encoding).
Step 3. Inverse quantization and inverse transformation (Reconstruction).
Step 4. Encoding next LOP using the reconstructed LOP.
Further details of the proposed coding method are described in the following subsections.

4.1 Prediction of the first LOP

To take full advantage of the correlation between pixels, we perform a line-based prediction instead of the traditional block-based prediction. Note also that in the proposed method we do not predict the entire macroblock in one operation. Figures 7(a) and 7(b) show the proposed line-based prediction procedures for the vertical and horizontal modes, respectively.

For the vertical mode, we define 1×16 pixels as the LOP. Then, we make prediction values for this LOP by copying neighboring pixels in the upper macroblock, as shown in Fig. 7 (a). The prediction equation of the vertical mode is given by

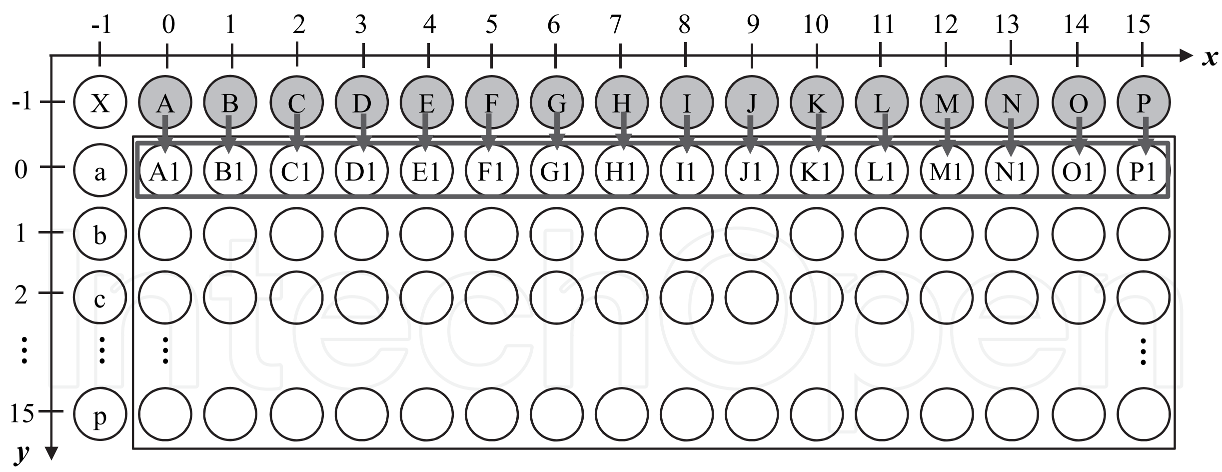
$$pred(x,0) = p(x,-1), \quad x \in \{0,1,2,\cdots 15\} \tag{2}$$

where $pred(\cdot)$ and p(x, -1) represent predicted values and neighboring pixel values of previously coded upper macroblock. After this prediction, the predicted LOP is subtracted from the corresponding LOP of the original block to produce residual data; only the residual LOP is encoded.

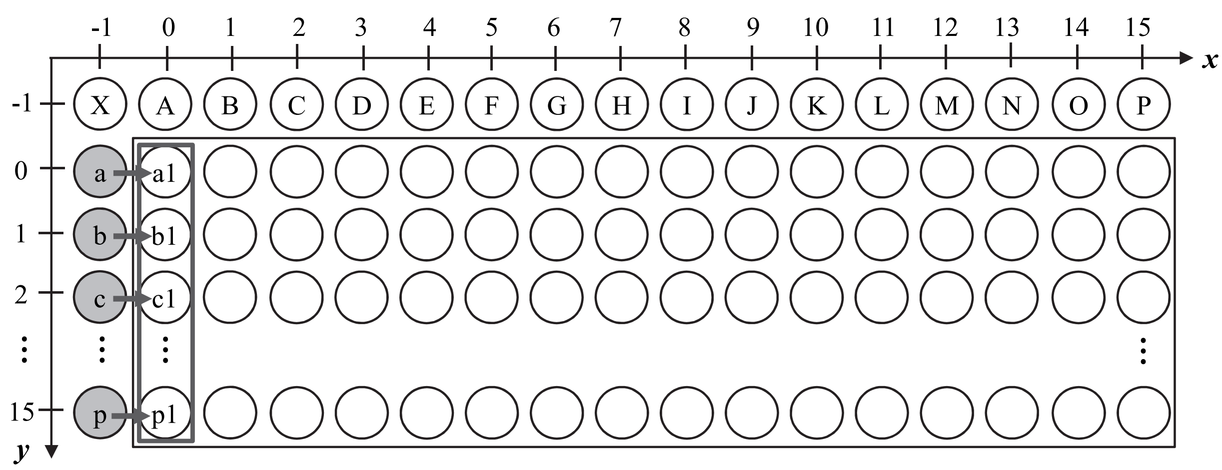
On the other hand, we define 16×1 pixels as the LOP for the horizontal mode, then make prediction values for this LOP using

$$pred(0,y) = p(-1,y), \quad y \in \{0,1,2,\cdots 15\}. \tag{3}$$

The predicted LOP is subsequently subtracted from the corresponding LOP of the original block to produce residual LOP.



(a) Vertical mode of the Intra_16 × 16 mode



(b) Horizontal mode of the Intra_16 × 16 mode

Fig. 7. Prediction method for the first LOP.

4.2 Transformation and quantization of residual LOP

After prediction of the first LOP, the residual LOP is transformed and quantized to give a set of quantized transform coefficients. In recent research works, line-based prediction with one dimensional (1D) transform has been introduced (Chen & Han, 2009; Sohn & Han, 2007). Their Intra_4×4 prediction method is cooperated with 1D transform. However, in the case of Intra_16×16 block, coding performance is not guaranteed because the residual signal after line-based prediction is quite random and there is not so much dependency in 1D signal. Thus, the 4×4 integer discrete cosine transform (DCT) and the quantization of the conventional H.264/AVC are used. There could be a potential work for finding the best rearrangement pattern for residual 1D data.

Prior to the transformation, the residual LOP should be rearranged to construct the 4×4 block, X. Note that an accurate prediction reduces the quantity of residual data to be coded. As the residual data decreases, its correlation is subject to a substantial decrease; thus, since line-based prediction gives more accurate prediction results than the conventional prediction, the correlation of its residual data becomes lower. To construct the 4×4 block to be used for the transformation and quantization, we rearrange the residual LOP in raster order, as shown in Fig. 8. For this low-correlated signal, there is no rearrangement method that can provide an even better coding efficiency than the raster scan, which we have confirmed by performing extensive experiments using various rearrangement methods, including zigzag order.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Fig. 8. Rearrangement of residual LOP for transformation.

The transformation operates on the 4×4 rearranged block of the residual data, with the procedure of the 4×4 forward transform being as follows:

$$Y = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 1 & -1 & -2 \\ 1 & -1 & -1 & 1 \\ 1 & -2 & 2 & -1 \end{bmatrix} \begin{bmatrix} X \end{bmatrix} \begin{bmatrix} 1 & 2 & 1 & 1 \\ 1 & 1 & -1 & -2 \\ 1 & -1 & -1 & 2 \\ 1 & -2 & 1 & -1 \end{bmatrix} \tag{4}$$

where X is the reordered residual LOP and Y represents the transformed coefficients. After performing the forward transform, the quantization of transformed coefficients is given by

$$Z_{(i,j)} = sign(W_{(i,j)}) \cdot (\left|W_{(i,j)}\right| \cdot MF_{(i,j)} + f) >> (15 + Q_D) \tag{5}$$

where *MF(i,j)* represents the multiplication factor and *f* controls the dead zone. In the reference model software, *f* is $2^{(15+Q_D)}/3$. In addition, the symbol >> indicates a binary shift right, $sign(\cdot)$ represents the sign function, and Q_D represents the greatest integer smaller than or equal to QP/6.

4.3 Inverse quantization and inverse transformation

The encoder immediately reconstructs the inverse transformed and inverse quantized block of the residual LOP to provide reference data for further predictions of the next LOPs. First, the inverse quantization is performed as follows:

$$Y'_{(i,j)} = (Z_{(i,j)} \cdot SF_{(i,j)}) << Q_D \tag{6}$$

where $SF_{(i,j)}$ is the scaling factor. The following equation represents the inverse transform.

$$X' = \begin{bmatrix} 1 & 1 & 1 & 1/2 \\ 1 & 1/2 & -1 & -1 \\ 1 & -1/2 & -1 & 1 \\ 1 & -1 & 1 & -1/2 \end{bmatrix} \begin{bmatrix} Y' \end{bmatrix} \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1/2 & -1/2 & -1 \\ 1 & -1 & -1 & 1 \\ 1/2 & -1 & 1 & -1/2 \end{bmatrix} \quad (7)$$

The differential block X′ is produced; note that X′ is not same as X because of the quantization error. Then, X′ is rearranged from a 4×4 block to a line, as shown in Fig. 9. We add the predicted LOP to X′ to create the reconstructed LOP, which is then used as reference data for predicting the next LOP.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Fig. 9. Rearrangement of the reconstructed block for further prediction.

4.4 Further prediction using reconstructed LOP

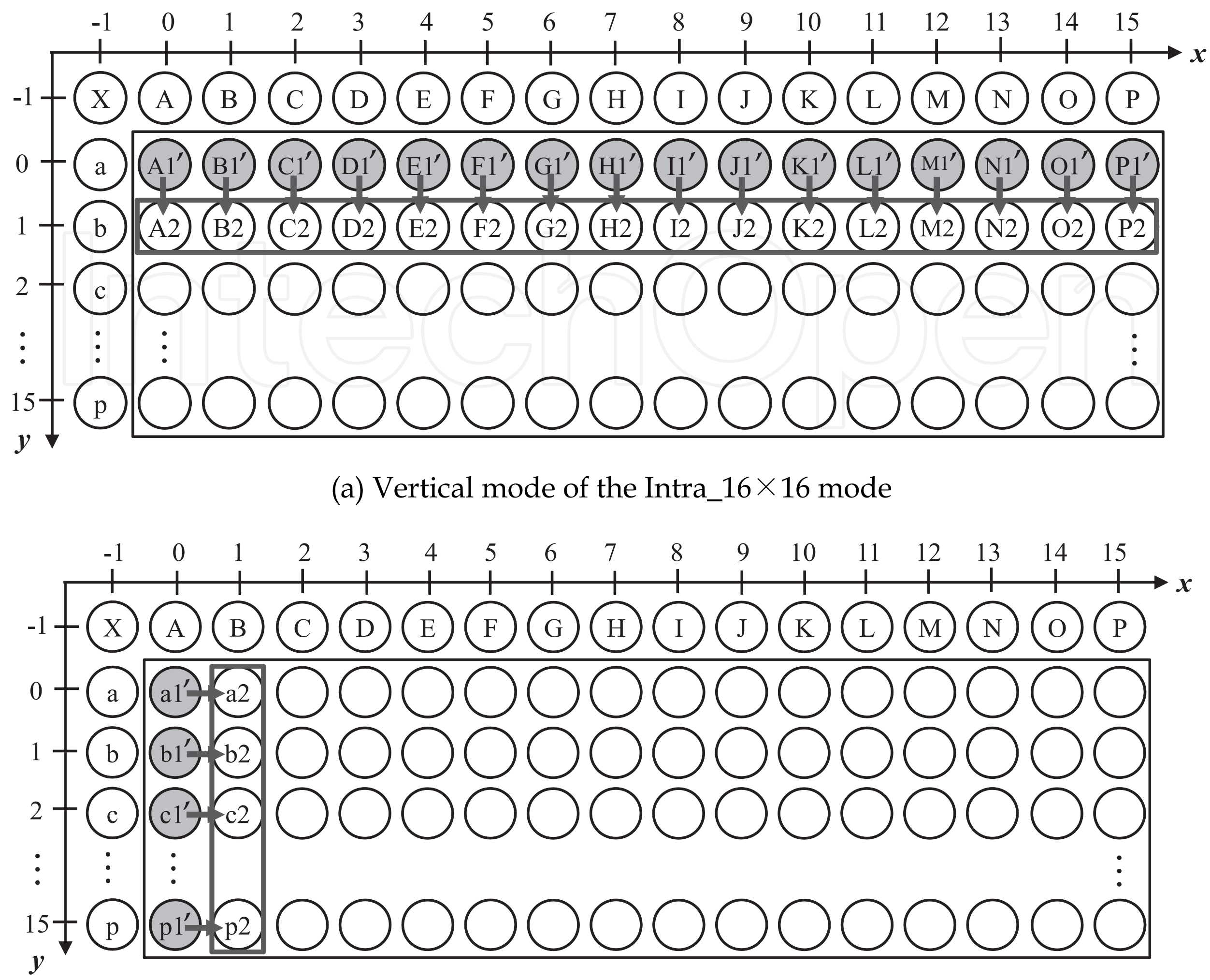
Using the reconstructed LOP, the next LOP is predicted, as shown in Fig. 10. Figures 10(a) and 10(b) show the prediction process of the vertical and horizontal modes, respectively; this process is repeated until the last LOP within the current macroblock.
The equation for further predictions of the vertical mode is

$$pred(x,y) = r(x,y-1), \quad x \in \{0,1,2,\cdots 15\},\ y \in \{1,2,\cdots 15\} \quad (8)$$

where r(x, y-1) indicates the reconstructed pixels and y is the line index that represents the position of the current line within the macroblock, which varies from 1 to 15.
Predictions of the horizontal mode are performed using a similar method. Equation (9) shows the prediction equation for the horizontal mode, with the only change being the prediction direction. Unlike the vertical mode, x is the line index that represents the position of the current line, and it varies from 1 to 15.

$$pred(x,y) = r(x-1,y), \quad x \in \{1,2,\cdots 15\},\ y \in \{0,1,2,\cdots 15\}. \quad (9)$$

The coded block pattern (cbp) signals as to whether there are coefficients in the transform block or not. In the conventional H.264/AVC, one cbp is calculated for each macroblock in the intra 16×16 mode. Thus, we should change the calculation procedure for cbp in the proposed algorithm. Since the prediction unit of the proposed intra 16×16 coding is in terms of LOP, we can compute the cbp for each LOP. The cbp for the macroblock is then calculated from the cumulative value of cbp for each LOP.



(a) Vertical mode of the Intra_16×16 mode

(b) Horizontal mode of the Intra_16×16 mode

Fig. 10. Further prediction using the reconstructed LOP.

Figure 11 shows the improvement of the prediction accuracy by the proposed method. The left-hand original data is same with that in Fig. 5. Using the proposed method, we can predict the original data well and the amount of the residual data is significantly reduced. Moreover, by comparing Fig. 5 and Fig. 11, we can confirm that the prediction performance of the proposed method is better than that of the Intra_4×4 mode.

5. Experimental results and analysis

In order to verify the efficiency of this method, we performed experiments on *Bigships* (1280x720), *Jets* (1280x720), *ShuttleStart* (1280x720), *BasketballDrive* (1920x1080), *Cactus* (1920x1080), *BQTerrace* (1920x1080) with YUV 4:2:0 in 8 bits per pixel format. The proposed method is implemented in the H.264/AVC reference software version JM 12.2(Fraunhofer Institute for Telecommunications Heinrich Hertz Institute, 2011).

Implementation of the proposed method was achieved by replacing the conventional Intra_16×16 vertical and horizontal modes. All the tested sequences are intra only coded and have various frame rates. The detailed encoding parameters for the experiment are summarized in Table 1.

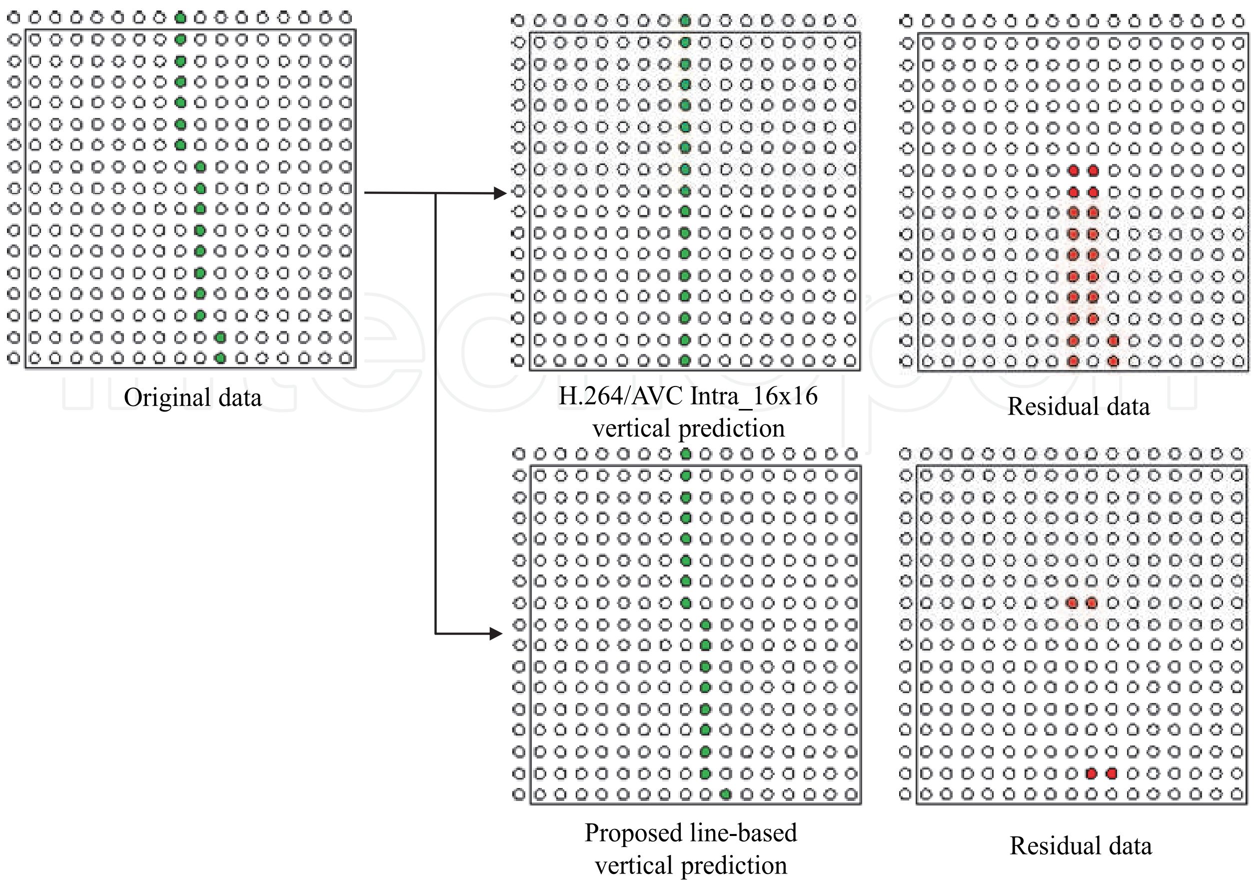


Fig. 11. Prediction result comparison between the conventional Intra_16×16 and proposed line-based Intra_16×16 predictions.

Parameter	Value
ProfileIDC	100 (High)
IntraPeriod	1 (only intra coding)
QPISlice	16, 20, 24, 28
Transform8x8Mode	1
SymbolMode	1

Table 1. Encoding parameters

In order to verify the efficiency of our proposed method, we compare coding result of the proposed method with that of H.264/AVC. The results for several test sequences are shown in Table 2. Here, the Bjøntegaard delta peak signal-to-noise ratio (dB) and the Bjøntegaard delta bitrate (%) are used to evaluate performance of the proposed algorithm(Bjontegaard, 2008). In the experiment, we used all intra prediction modes (Intra_16×16, Intra_8×8, and Intra_4×4 modes) by turning on the *Transform8x8Mode* option. We confirmed that the proposed method provides average bit savings of 6.42% for 720p and 1080p HD resolution sequences, compared to the conventional H.264/AVC FRExt high profile.

Sequence	QP	H.264/AVC		Proposed Algorithm		Bjøntegaard Delta	
		PSNR (dB)	Bitrate (Kbps)	PSNR (dB)	Bitrate (Kbps)	BDPSNR (dB)	BDRATE (%)
Bigships (HD, 1280×720) First frame	16	47.08	61143.12	46.00	51110.40	0.31	-4.74
	20	43.47	40422.96	42.62	33569.76		
	24	40.54	25798.08	40.01	23119.68		
	28	37.76	16042.80	37.46	15061.68		
Jets (HD, 1280×720) First frame	16	46.45	32622.48	45.99	23141.04	0.20	-7.57
	20	43.67	16313.04	43.37	13814.40		
	24	42.00	8712.00	41.82	8208.72		
	28	40.45	5236.56	40.25	4983.12		
ShuttleStart (HD, 1280×720) First frame	16	48.58	19584.24	48.04	16558.56	0.09	-2.55
	20	46.13	11039.04	45.77	9649.68		
	24	44.14	6380.64	43.89	5915.28		
	28	42.13	3559.20	41.97	3405.12		
BasketballDrive (HD, 1920×1080) First frame	16	48.13	112107.12	46.42	76696.56	0.51	-14.90
	20	42.83	59862.48	42.34	45584.40		
	24	40.33	27544.08	40.16	25075.44		
	28	38.84	14913.84	38.70	14117.28		
Cactus (HD, 1920×1080) First frame	16	46.48	172070.88	45.79	150515.00	0.29	-5.78
	20	42.25	106455.36	41.83	92064.72		
	24	39.38	60227.52	39.07	54915.84		
	28	37.36	34913.28	37.13	32742.72		
BQTerrace (HD, 1920×1080) First frame	16	48.06	169545.12	47.26	158143.90	0.30	-2.98
	20	44.52	124250.16	43.64	112598.60		
	24	40.23	83761.44	39.51	73423.44		
	28	36.90	53018.64	36.38	47027.52		
Average						**0.28**	**-6.42**

Table 2. Performance comparison between H.264/AVC and the proposed method

Figure 12 shows the rate-distortion curve of test sequences. We can find that the proposed technique achieves consistent gains for all test sequences and especially efficient in the high bitrate range. As expected, the proposed method performed much better in test sequences such as *BasketballDrive* that contain a lot of gradation patterns, as shown in Fig. 13. Table 3 shows the mode distribution change for all test sequences when we use the proposed method. In the tables, we can observe that the number of intra 16×16 modes, i.e., the best modes of some blocks changed to Intra_16×16 mode. This change implies that the proposed prediction method improves prediction accuracy of intra 16×16 coding quite well. Providing same image quality, Intra_4×4 requires more bits to represent the mode information than the Intra_16×16 mode, we can reduce the bit rate using the proposed method.

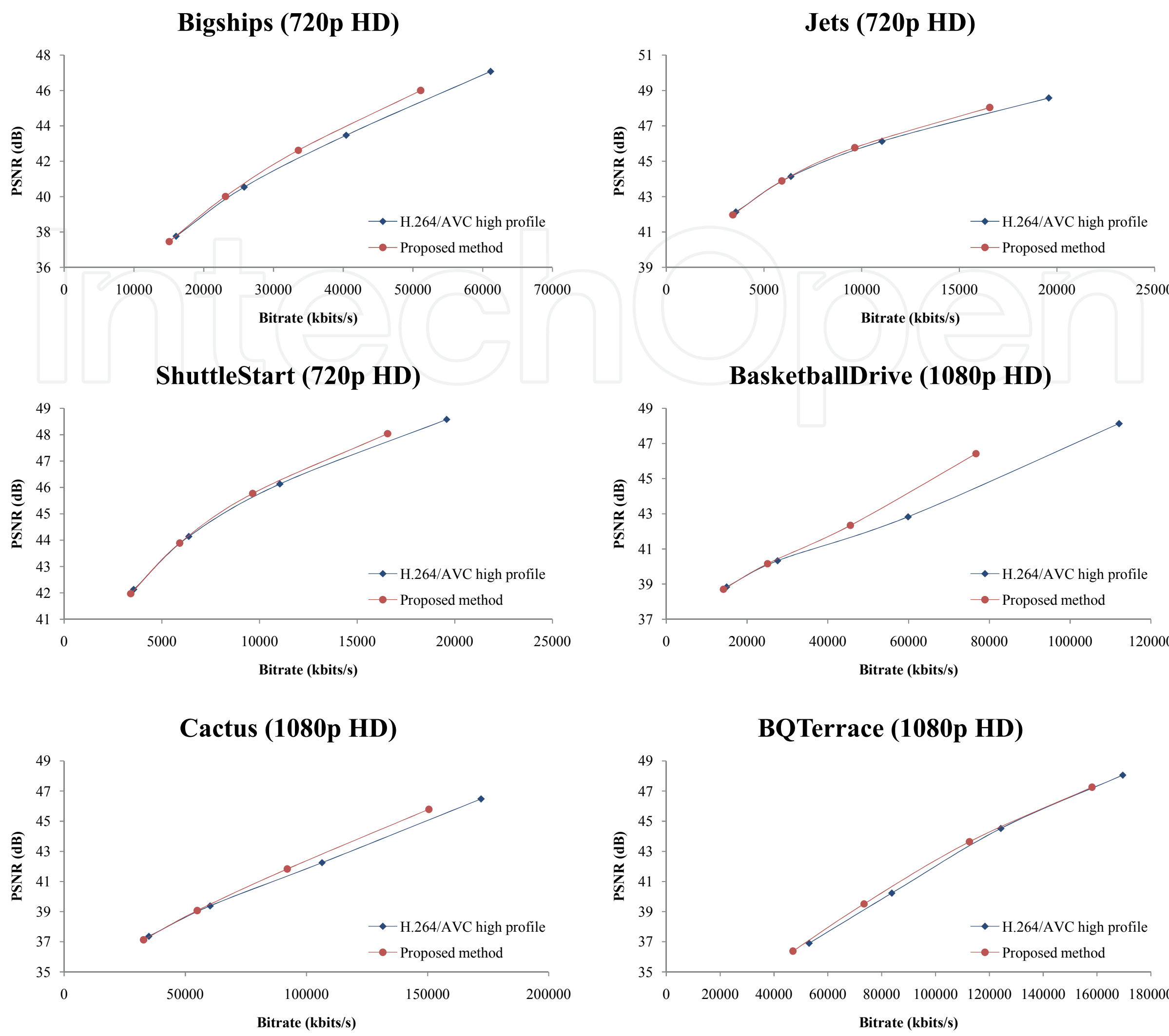


Fig. 12. Rate-distortion curve of proposed technique.

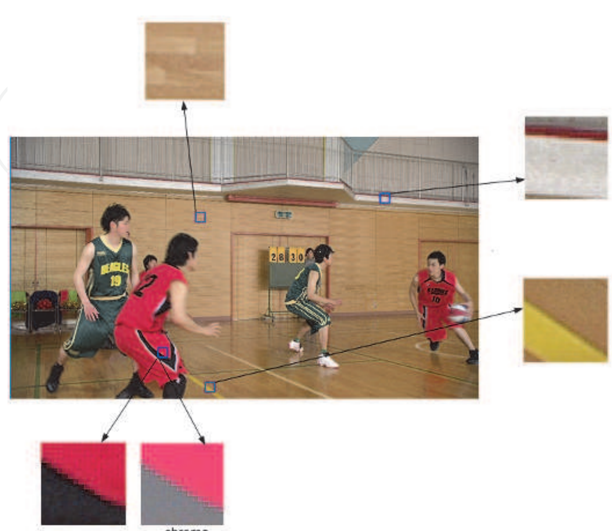


Fig. 13. *BasketballDrive* that contains a lot of complex patterns.

Sequence	QP	H.264/AVC			Proposed Method			I16MB Increase (%)
		I16MB (%)	I8MB (%)	I4MB (%)	I16MB (%)	I8MB (%)	I4MB (%)	
Bigships (HD, 1280×720) First frame	16	0.1	96.3	3.5	33.5	64.1	2.5	33.3
	20	3.7	81.6	14.7	25.7	67.5	6.8	21.9
	24	15.7	64.7	19.6	12.7	69.5	17.8	-3.0
	28	28.4	59.4	12.2	26.7	61.5	11.8	-1.7
Jets (HD, 1280×720) First frame	16	5.6	47.3	47.1	18.4	42.0	39.6	12.8
	20	4.1	60.9	34.9	18.9	51.0	30.1	14.7
	24	9.4	59.4	31.2	14.6	57.9	27.5	5.2
	28	14.9	63.7	21.4	18.2	61.9	19.9	3.3
ShuttleStart (HD, 1280×720) First frame	16	1.4	76.2	22.4	7.3	70.0	22.8	5.8
	20	6.3	69.1	24.6	10.8	63.2	26.0	4.5
	24	15.4	37.7	46.9	26.2	34.3	39.5	10.8
	28	12.7	37.4	49.9	23.5	35.7	40.7	10.8
BasketballDrive (HD, 1920×1080) First frame	16	1.6	45.8	52.6	19.3	36.9	43.8	17.7
	20	2.4	51.3	46.3	17.6	46.7	35.7	15.1
	24	5.8	53.5	40.7	10.9	53.4	35.8	5.1
	28	9.3	60.7	30.0	10.3	60.2	29.5	1.0
Cactus (HD, 1920×1080) First frame	16	25.2	39.4	35.4	51.5	24.4	24.1	26.4
	20	13.9	61.7	24.4	21.8	58.3	19.9	7.8
	24	22.4	50.3	27.3	26.0	53.8	20.2	3.6
	28	32.4	52.4	15.2	45.2	40.1	14.7	12.8
BQTerrace (HD, 1920×1080) First frame	16	35.0	58.4	6.6	34.0	33.8	32.2	-1.0
	20	45.3	46.9	7.9	45.6	46.0	8.4	0.3
	24	58.6	31.4	10.0	59.8	31.3	8.9	1.2
	28	65.5	29.5	5.0	63.8	30.6	5.6	-1.7

Table 3. Mode distribution change

6. Conclusion

In this chapter, we proposed an efficient line-based intra 16×16 prediction method for high bitrate compression. Considering the different characteristics of high definition (HD) contents, we modified the intra coding mechanism without any change of syntax elements of the H.264/AVC standard. Note that we break from the traditional block-based prediction method and designed a new prediction method based on line-of-pixels (LOP). As a result, we could achieve a more accurate intra 16×16 mode by reducing the distance between the reference and current pixels. Experimental results show that the proposed method provides approximately 6.42% bit savings, compared to the H.264/AVC FRExt high profile.

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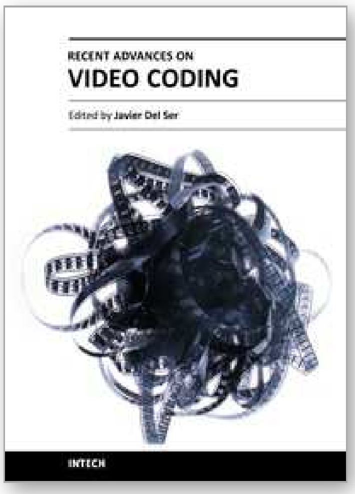

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This book is intended to attract the attention of practitioners and researchers from industry and academia interested in challenging paradigms of multimedia video coding, with an emphasis on recent technical developments, cross-disciplinary tools and implementations. Given its instructional purpose, the book also overviews recently published video coding standards such as H.264/AVC and SVC from a simulational standpoint. Novel rate control schemes and cross-disciplinary tools for the optimization of diverse aspects related to video coding are also addressed in detail, along with implementation architectures specially tailored for video processing and encoding. The book concludes by exposing new advances in semantic video coding. In summary: this book serves as a technically sounding start point for early-stage researchers and developers willing to join leading-edge research on video coding, processing and multimedia transmission.

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