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The Algorithm of Fast Intra Angular Mode Selection for HEVC

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Abstract. In this paper, we propose an algorithm of angular mode selection for high-performance HEVC intra prediction. HEVC intra prediction is used to remove the spatial redundancy. Intra prediction has a total of 35 modes and block size of 64x64 to 4x4. Intra prediction has a high amount of calculation and operational time due to performing all 35 modes for each block size for the best cost. The angular mode algorithm proposed has a simple difference between pixels of the original image and the selected angular mode. A decision is made to select one angular mode plus planar mode and DC mode to perform the intra prediction and determine the mode with the best cost. In effect, only three modes are executed compared to the traditional 35 modes. Performance evaluation index used are BDPSNR and BDBitrate. For the proposed algorithm, BDPSNR results averagely increased by 0.035 and BDBitrate decreased by 0.623 relative to the HM-16.9 intra prediction. In addition, the encoding time is decreased by about 6.905%.

Keywords: HEVC, Intra Prediction, Fast Mode Selection, Angular Mode

1 Introduction

As the latest video and communication technology development has rapidly become popular with UHD-TV and multimedia devices, there is increased interest and demand from users for high-definition video services. Next-generation video devices are being developed for 4K, 8K UHD-level resolution imaging services. HEVC is the new video compression standard for UHD-level video service. HEVC was standardized by the JCT-VC (Joint Collaborative Team on Video Coding) in April 2013. JCT-VC is a collaboration of VCEG (Video Coding Experts Group) of ITU-T and MPEG (Moving Picture Experts Group) of ISO/IEC. HEVC supports a variety of video compression resolution up to ultra-high-resolution video from low-resolution video. It includes a variety of image compression technologies to improve the coding efficiency. HEVC has an encoding efficiency improving at least about 50% as compared to the H.264/AVC video compression standard previously employed. Prediction of the new techniques is to generate intra prediction similar to the current frame, performing a prediction for a variety of sizes from 4x4 PU (Prediction Unit) to

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64x64 PU. HEVC PU has 35 modes. The amount of calculation and computational time is high because of the size applied to each PU i.e. all 35 modes [1].

In this paper, we propose an algorithm for selecting one of 33 angular modes for high-performance HEVC intra prediction. The proposed algorithm has a simple difference between the pixels and the location by selecting one angular mode and performs intra prediction with Planar, DC and the selected angular mode

This paper is organized as follows. Section 2 describes the prediction of HEVC intra prediction standard technology and Section 3 describes the proposed Angular mode selection algorithm. Performance comparison of the proposed algorithm is described in section 4, and the conclusion of this study, Section 5.

2 HEVC Intra Prediction

HEVC intra prediction is used to remove spatial redundancy. The previous standard H.264 / AVC supports a total of nine prediction modes. On the other hand, HEVC supports a total of 35 prediction mode. In addition, HEVC provides Coding tree block (CTB) which supports block size from 4x4 to 64x64. HEVC intra prediction flow proceeds in this order: generation of reference sample pixel, filtering of referenced sample pixel and intra sample prediction [2].

Intra_Planar mode generates a predicted pixel value using the location of the reference pixel. Intra_DC mode generates a predicted pixel using the average value of the reference pixel. Intra_Angular mode as shown in Figure 1 has 33-directions. Predictive reference pixels in each direction calculate the difference between the original pixel. Considering the amount of bits generated in the calculated pixel size with the PU in each mode determines the best mode and PU size [3].

HEVC intra prediction rediction screen has high prediction performance than the H.264 / AVC because it supports PU 35 modes and split mode. However, the number of PU proceeding from the intra prediction totals 341 from 64x64 to 4x4 PU block size. There is high amount of calculation and operational time because performing the intra prediction takes 11,935(341*35) times.

3 Proposed Fast Angular Mode Selection Algorithm

Angular mode selection algorithm is proposed to estimate the direction with the difference between the position of information of original pixel to one selected Angular mode.

Figure 1 shows the operational methods of a horizontal line in the 5x5 pixel size, as the calculation method of horizontal lines and vertical lines. I) separates the 5x5 pixels in the horizontal line. II) Calculates the position with the higher value by calculating the pixel differences in each horizontal line. III) The red circle on each line is the number corresponding to the difference of +1. Red circle is the pixel position (Best Pointer) having the maximum difference.

The threshold value used to select the mode is the same as in paper (1). It uses the sum of the intervals -2, -1 and +2, +1, with BPDV difference of +1. In addition, the total number of different values for each PU BPDV size (2) shows how to obtain the value of each PU BPDV size.

$$\text{Threshold value} = \{26, 21, 17, 13, 9, 5, 2\} \quad (1)$$

$$\begin{aligned} 64x64 &= (BPDV[\pm1] + BPDV[\pm2]) >> 1 \\ 32x32 &= (BPDV[\pm1] + BPDV[\pm2]) \\ 16x16 &= (BPDV[\pm1] + BPDV[\pm2]) << 1 \\ 8x8 &= (BPDV[\pm1] + BPDV[\pm2]) << 2 \\ 4x4 &= (BPDV[\pm1] + BPDV[\pm2]) << 3 \end{aligned} \quad (2)$$

4 Performance Comparison

The proposed Angular mode selection algorithm's performance was compared to the standard software HM- 16.9. After applying the proposed Angular mode selection algorithm, only the affected parts were transformed in order to measure the exact test. Encoding time(ΔTS) was calculated as in equation (3).

$$\Delta TS(\%) = \left(\frac{TS_{HM} - TS_{propse}}{TS_{HM}}\right) \times 100 \quad (3)$$

Table 2. The proposed algorithm compared to HM-16.9 standard software

Class	Proposed algorithm			[4]	
	BDPSNR	BDBitrate	ΔTS (%)	BDBitrate	ΔTS (%)
4k	0.016	-0.613	7.181	-	-
Average	0.035	-0.623	6.905	0.710	49.830

Comparison with the HM-16.9 standard software algorithm shows BDPSNR averagely increased by 0.035, BDBitrate reduced by 0.623 and encoding time showed good results with up to 11.389% decrease.

A recent paper[4] compares the results of BDBitrate and encoding time with the proposed algorithm(refer to Table 2).The proposed method showed a better BDBitrate of -0.623 while the paper[4] had +0.71. On the other hand, the paper[4] has superior encoding time.

5 Conclusion

This paper describes an algorithm of angular mode selection for high-performance HEVC intra prediction. HEVC intra prediction is used to remove the spatial redundancy. Intra prediction has a high amount of calculation and operational time due to performing all 35 modes for each block size for the best cost. The proposed algorithm calculates the difference between pixel positions obtained through a simple operation on the original image compared with each directional location predicted. Quick mode can be selected as a predictive Angular orientation. When the Angular mode selection algorithm was compared to the results and performance of HM-16.9 standard software, BDPSNR averagely increased by 0.035, BDBitrate reduced by 0.623 and encoding time showed good results with up to 11.389% decrease.

Also, designing the algorithm for the hardware module has the advantage of minimizing hardware size and computational time. In directional mode, there is continuous research of Angular mode selection algorithm considering the relationship between the TU and the block division in order to reduce the encoding time without high estimation in intra prediction.

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