Fast Mode Decision for H.264/AVC Encoder Based on Interblock Correlation

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Abstract

The up-to-date video coding standardH.264/AVC could achieve higher encoding performance compared with previous versions since it employs many tools to increase the coding accuracy, particularly the rate-distortion optimization technique for mode decision. However, an extremely high computational complexity isproduced because all possible combinations of modes are calculated in order to find the optimal rate-distortion cost. To reduce the encoding complexity, a fast intra/intercoding mode selection algorithm for the H.264/AVC video coding standard is proposed in this paper. According to the observation of intra/inter prediction mode of any MB and those of its four neighboring blocks from different real video sequences, we find that there exists a high mode correlation in intra/inter mode map of H.264/AVC. We exploit the interblock correlation in the intra/intermode domain to early terminate the rate-distortion optimization (RDO) calculations. Experimental results show that the proposed fast mode selection algorithm can yield more encoding-time saving effects with similar image quality as compared with existing fast methods.

Keywords: video coding, H.264/AVC, rate-distortion optimization

1. Introduction

H.264/AVC is the ITU-T's latest video coding standard, which is also known as MPEG-4 Advanced Video Coding (AVC) [1]. In recent years, H.264/AVC standard has become one of the most widely used video compression standards in many digital broadcasting services, such as broadcast satellite television (TV) systems, high-definition TV (HDTV), digital video (DV) and so on [2].The H.264/AVC standard can achieve much higher coding efficiency than the previous standards such as MPEG-1/2/4 and H.261/H.263 [3]. This is mainly due to the fact that the H.264/AVC encoder employs more complicated approaches in the coding procedure. Two of the novel features of H.264/AVC video coding are the intra and inter mode predictions. H.264/AVC offers a rich set of prediction patterns for intra prediction, i.e., nine prediction modes for 4×4 luma blocks, four modes for 16×16 luma MBs, and four modes for 8×8 chroma blocks, respectively. In addition, H.264/AVC also uses a variable block size for an inter mode prediction, which has 7 different MB coding modes so that the temporal and spatial details in an MB are best presented. To select the best coding mode, which the rate distortion optimization (RDO) is employed for each MB, all the MB coding modes are tried, and the one that leads to the least rate distortion cost (RDcost) is selected. However, this "try all and select the best" method will result in high computational complexity and limit the use of H.264/AVC encoders in real-time applications. Thus, fast intra/inter mode decision is a necessary part of the encoder in H.264/AVC, especially for real time applications. To reduce the number of RDO computations, many fast mode selection methods have been proposed [4-10]. These fast mode selection algorithms mainly include fast SKIP mode decision [4], fast INTER mode decision [5-6], fast INTRA mode decision [7-8], the combination of the above [9], and multiphase classification scheme [6].All these existing me thods are based on the temporal correlation between current MB and its reference MB in the previous frame, and the spatial correlation between current MB and its neighboring MB sinthe currentframe. Pan et al. proposed a fast intra mode decision method based on analysis of edge direction histogram within the block so as to reduce the number of probable modes [7]. Kim and Jeong proposed a modified version based on Pan's method using simple directional masks and adjacent mode information to further speed up RDO procedure [8]. Although Pan's and Kim's algorithms have reduced much complexity of intra prediction, they need extra pre-processing time to detect edge and analyze edge direction histogram. Therefore, the effects of both fast mode decision algorithms are reduced.

In this paper, we present a new algorithm that exploits the interblock correlation in intra and inter mode domains rather than in a pixel domain. We first search four candidate intra/inter modes mapped by the previous neighboring coded MBs. If one of the four candidates is good enough, we select the mode to match the current MB. Otherwise, other modes are performed to find the optimal mode. The key contribution of this work is to propose a more straightforward and effective method for intra/inter mode decision in H.264/AVC video coding.

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The rest of this paper is organized as follows. The intra/inter mode selection in H.264/AVC is discussed in Section 2. Proposed fast mode decision algorithm using interblock correlation is presented in Section 3. Simulation results and conclusions are given in Section 4 and 5, respectively.

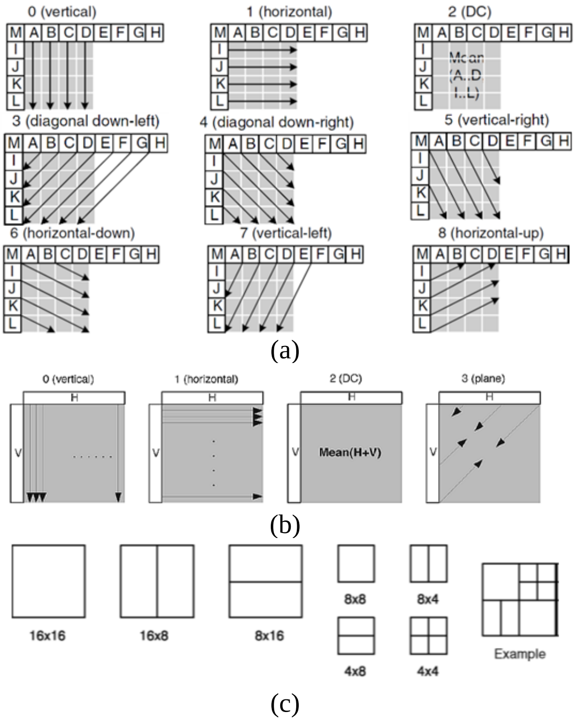


Figure 1:Intra/Inter prediction modes for macroblock : (a) 4×4 intra modes (b) 16×16 intra modes (c) inter modes

2. Mode Selection in H.264/AVC

The intra/inter mode decision scheme employed in the H.264/AVC reference code is classified into four categories of predictive coding mode: the skip mode, the direct mode (B-slice), the intra and inter modes. Specifically, H.264/AVC offers four intra modes for 16×16 luma blocks and nine prediction modes for 4×4 luma blocks, as shown in Figs. 1 (a) and (b). For theinter mode prediction, seven modes of different sizes and shapes are supported by H.264/AVCas shown in Fig.1 (c) [1].

2.1 Best Mode Selection Using RDO

As studied in the H.264 test model codec [12], H.264/AVC encoder testsall possible modes to select the best mode with the smallest RD cost by evaluating the cost associated with each of intra/inter modes.The RDO procedure can bedescribed as follows:

Initialization: Select the MB quantization parameter (QP) and the Lagrangian multiplier.

Step1 Calculate the residuals of various intra/inter prediction modes.

Step2 Select the best prediction mode among all possible intra/inter predictive modes by minimizing the following *RDcost*function:

$$J(s,c,mode \mid QP,\lambda_{mode}) = SSD(s,c,mode \mid QP) + \lambda_{mode} \cdot R(s,c,mode \mid QP) \quad (1)$$

where QP is the MB quantization parameter, λ_{mode} is the Lagrange multiplier for mode decision, SSD means the sum of the squared differences between the original block s and its reconstruction c and $mode$ represents one of the potential prediction modes.

As studied in the H.264/AVC test model codec [12], the intra prediction procedures of luma and chroma components ($\mathrm{YC_rC_b}$) using RDO can be described as follows:

Step1 Generate an 8×8 predicted chroma block according to a mode.

Step2 Determine the best intramode for a 16×16 MB among 4 modes. Code the chroma components with the given mode and compute the rate distortion cost (*RDCost*) of the MB for $\mathrm{YC_rC_b}$ components $RDCost_{16\times16}$.

Step3 Select the 16 best intramodes for sixteen 4×4luma blocks among 9 modes. Code the chroma components with the given modes and compute the rate distortion of the MB for $\mathrm{YC_rC_b}$ components $RDCost_{4\times4}$.

Step4 If $RDCost_{16\times16} > RDCost_{4\times4}$, the block type 4×4 is selected; otherwise the 16×16 block type is selected in the given chroma mode. And the minimum cost is saved as $RDCost$.

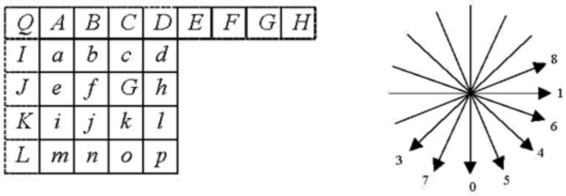
Step5 Repeat step 1 to 4 for all chroma intra prediction modes, and choose the one with minimum $RDCost$.

The inter prediction procedures of luma and chroma components ($\mathrm{YC_rC_b}$) using RDO have the similar encoding process to test 7 modes of different sizes and shapes, and the detailed study is completely described in [4].

The computational cost of the above RDO procedure for intra/inter mode decision is very high. Even without RDO, the complexity is still high since the encoder checks all inter and intra modes. Especially, the RDO procedure for inter modes is more complex than that for intra modes since the former involves a full motion search over a window of reference positions. When the best mode is one of the intra modes, a large amount of computation for a motion search is wasted.

2.2 RDO Intra/Inter Mode Map

H.264/AVC is a block-based coding scheme, and the frame is encoded block by block in a raster scan order. For a luma MB in an I-slice, RDO exhaustively searches the combinations of the predefined 13 intra modes to produce the best mode for this MB. Figure 2 shows prediction samples and nine prediction modes for each 4×4 lumablock. It can be seen that 4×4 block prediction is conducted for samples a-p of a block using samples A-Q. There are eight prediction directions in total (denoted the numbers 1 to 8) and one DC prediction (denoted the number 0) for 4×4 block prediction [4]



(a) (b)

Figure 2: (a) 4×4 block and the neighboring samples (b) Eight prediction modes for 4×4 block

Figure 3(a) shows part of the RDO intra-mode map of an I-frame (Hall-monitor video sequence) conducted by the JM 18.1 [12] with RDO procedure in a main profile (HP) and QP=32. Each point (location) in the intra-mode map corresponds to a 4×4 block. In the same procedure, for a luma MB (16×16) in a P-slice, RDO exhaustively searches the combinations of the predefined intra/inter modes to produce the best mode for this MB. For the convenience of inter mode description, we set mode numbers of 0, 1, 2, 3, 4, 5 and 6to represent mode SKIP,INTER 16×16, INTER 16×8,INTER 8×16, INTER 8×8, INTRA 16×16 and INTRA 4×4, respectively. Figure 3(b) shows the RDO inter mode map of P-frame type. From Fig. 1, we have observed that the coding modes of neighboring MBs are correlated. Since blocks of real life video sequences are highly correlated, many blocks in I-frame or P-frame are corresponding to the same modes.

2.3 Probability Distribution of MB Coding Mode

We have observed that in encoding a real life video sequence, MBs in a slow-motion and low complexity frames are usually coded using larger partitions such as SKIP or 16×16, but MBs in a fast-motion or high-complexity frames are likely to be coded using smaller partitions such as 8×8, 8×4, 4×8 or 4×4. Due to the high correlation between consecutive frames, the probability of encoding an MB using INTER mode is much higher than using INTRA mode in P-frame type.

Tables1 and 2 analyze the probability distributions of the same mode between the current MB (or 4×4 block), as denoted mode X, for I-frame and P-frame and its four neighboring modes including left (mode A), left-top (mode B), top (mode C) and top-right (mode D), as shown in Fig. 4(a) for MB and Fig. 4(b) for 4×4 block in I-frame. The probability distribution is defined as follows.

$$p = \frac{N_{same}}{N_{same} + N_{diff}} \times 100\% \tag{2}$$

where N_{same} represents the same prediction mode with the four neighboring modes and N_{diff} is the different modes. From Tables1and 2, we can see that the mode correlations between the current MB or block (MB/block) and its four neighboring blocks are very high for any I-frame or P-frame. Therefore, the decided modes of the neighboring MBs/blocks may be the good candidate modes for the current block. In this work, the four causal neighboring modes of the current MBs/blocks shown in Fig. 4 are first chosen to perform RDO computations. The modes A, B, C, and D represent the four candidate modes, which have been encoded by previous MB/blocks. A regular clockwise scheme is employed to search for the causal neighboring modes.

2	1	1	1	1	1	1	1	2	1	2	1	8	1	1	1	1	1	1	1	1	1	1	1
0	0	4	5	6	6	1	0	0	8	0	7	4	4	4	0	0	1	1	1	1	1	1	0
0	4	4	4	4	4	6	0	0	0	0	0	4	4	4	5	0	1	1	1	5	0	1	2
0	0	2	4	6	6	8	0	0	7	0	0	6	5	4	4	0	0	0	0	1	1	1	1
2	2	2	2	2	2	2	0	0	0	0	0	0	5	7	4	0	0	1	1	1	1	1	1
2	2	2	2	2	2	0	0	0	0	0	0	0	0	5	3	0	6	1	1	1	1	1	1
2	2	2	2	2	2	1	0	0	0	0	3	1	0	0	0	0	0	0	0	0	1	1	1
2	2	2	2	2	2	1	0	0	0	0	0	0	3	0	0	0	5	1	4	0	0	0	0
0	2	2	2	2	2	2	2	0	0	0	0	4	0	1	0	0	0	7	4	0	1	1	1
0	0	1	1	2	2	2	2	0	0	0	0	6	6	6	0	0	0	0	5	5	1	1	1
0	1	1	1	2	2	2	2	0	0	0	0	1	1	6	1	0	0	0	1	3	4	1	0
0	0	0	0	2	2	2	2	0	0	0	0	1	1	1	0	0	3	4	0	5	1	1	1
2	2	2	2	2	2	2	2	0	0	0	7	1	1	0	0	0	0	6	2	1	1	6	3
2	2	2	2	2	2	2	2	0	0	0	0	6	1	1	0	0	0	0	0	0	0	8	4
2	2	2	2	2	2	2	2	0	0	0	2	1	1	1	8	0	0	3	8	0	7	0	0
2	2	2	2	2	2	2	2	0	0	0	0	0	0	8	0	0	3	0	4	0	0	0	0
0	0	0	0	1	1	1	0	0	0	0	0	0	8	8	8	0	5	1	4	0	1	1	0
0	1	0	1	2	1	1	0	0	0	0	8	8	8	8	8	0	0	8	7	8	1	1	8
0	0	0	0	1	1	8	8	0	0	0	3	3	3	7	0	0	0	0	0	1	1	1	1
2	1	8	8	3	8	8	8	0	5	0	0	0	0	0	0	0	3	8	7	1	1	1	1

(a)

0	0	0	0	0	0	4	4	1	4	4
3	3	1	1	0	0	0	1	1	1	0
0	1	0	4	1	2	2	2	4	1	1
0	1	0	4	1	1	1	3	1	0	0
3	1	0	4	2	1	0	4	1	0	0
1	0	0	3	0	0	2	3	0	0	0
1	0	0	1	3	2	2	3	0	0	0
0	0	1	1	1	4	2	2	0	0	0
0	0	0	1	4	4	1	2	0	0	0

(b)

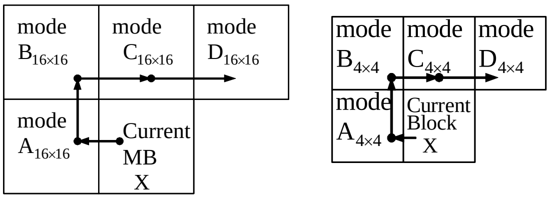
Figure 3: Part of the RDO intra/inter-mode map for sequence "Hall-monitor" (a) intra-mode map for I-frame. (b) inter-mode map for P-frame

Table 1: The probability distributions for I-frame with main profile (HP) and QP=32

Sequence(QCIF)		mode A (%)	mode B (%)	mode C (%)	mode D (%)
Container	Luma_4×4	72.20	64.06	72.57	62.31
	Luma_16×16	27.98	25.87	40.83	25.55
	Chroma_8×8	53.92	52.33	60.92	52.65
Hall-monitor	Luma_4×4	68.32	57.92	65.11	55.14
	Luma_16×16	31.87	34.27	35.99	25.58
	Chroma_8×8	32.51	30.48	38.35	26.78
News	Luma_4×4	61.41	52.62	61.63	51.19
	Luma_16×16	33.16	36.65	34.99	29.55
	Chroma_8×8	34.34	29.57	40.10	31.24

Table 2: The probability distributions for P-frame

mode / Sequence	A (%)	B (%)	C (%)	D (%)
Container	73.5	75.5	74.8	78.7
Hall-monitor	80.2	84.1	79.6	80.6
News	36.7	42.7	37.7	40.1
Foreman	31.3	37.1	31.1	36.9



(a) (b)

Figure 4: Four causal neighboring modes of the current block (a) 16×16 MB (b) 4×4 block.

3. Proposed Fast Intra/Inter Mode Selection Scheme

If the best coding mode can be determined at an early stage of RD cost computation, the significant timesaving can be achieved. The early termination strategy can be fulfilled based on the analysis of the video content, and by using preset thresholds to terminate the computational process a target threshold is achieved.

To determine whether a candidate mode is good enough for the current MB/block, we compute the *RDCost* of YC_rC_b components by Eq. (1). After the candidate mode (one of the modes A, B, C and D) is found, we check it is good enough by comparing its *RDcost* with a threshold. If it is less than the threshold, the candidate is good enough for the current MB/block. Otherwise, it implies that the MB/block correlation is low, and the other modes are needed to find the optimal prediction mode for the current MB/block. There may exist some repetition modes in the neighboring of the search path, as shown in Fig. 3. Due to this repetition, the proposed RDO procedure will yield redundant computation and thereby decrease the coding efficiency. Therefore, before RDO computation, we should determine whether the candidate mode is a repetition. If it is a repetition mode, the RDO computation for this candidate is skipped. The new algorithm for intra/inter mode decision in H.264/AVC can be summarized as follows:

For I-frame,

Intra-mode decision for 16×16 luma MBs:

Step1 Check whether the mode $A_{16\times16}$ is 'good'. If it is true, the mode is selected. Otherwise go to step 2.

Step2 Repeat step 1 for the next priority neighboring MB until a 'good' candidate mode is found or all neighboring modes are examined. If no good candidate is found, go to step 3.

Step3 Perform the other modes to find the optimal mode.

Intra-mode decision for 4×4luma blocks:

Step1 Check whether the mode $A_{4\times4}$ is 'good'. If it is true, the mode is selected and proceeded to the next block in the same manner. Otherwise go to step 2.

Step2 Repeat step 1 for the next priority neighboring block until a 'good' candidate mode is found or all neighboring modes are examined. If no good candidate is found, go to step 3.

Step3 Perform the other modes to find the optimal mode.

For P-frame,

Intra/Inter-mode decision for 16×16 luma MBs:

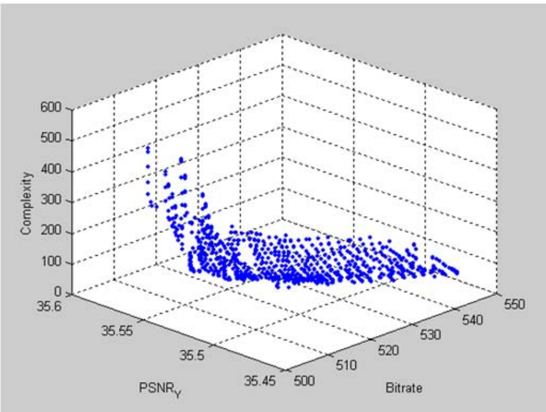
Step1 Check whether the mode $A_{16\times16}$ is 'good'. If it is true, the mode is selected. Otherwise go to step 2.

Step2 Repeat step 1 for the next priority neighboring MB until a 'good' candidate mode is found or all neighboring modes are examined. If no good candidate is found, go to step 3.

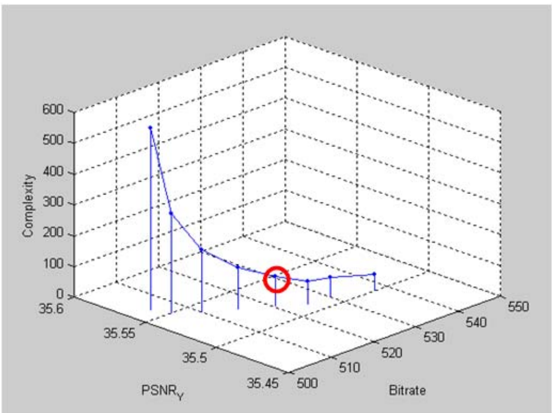
Step3 Perform the other modes to find the optimal mode.

4. Experimental Results

In order to test the efficiency of the proposed algorithm, different sequences were coded with different quantization parameter values, and different intra and inter coding modes were enabled. The proposed fast mode decision strategy was implemented into the JM 18.1 software. The video sequences of QCIF-format (News, Container, Hall_monitor, Foreman) and sequences of CIF-format (Mobile, Stefan, Mother_daughter, Bike) were used for testing the performance. For each sequence, 300 frames are encoded with all I-framesand IPPP… frames. The frame rate is 30 frames per second (fps)and $QP = \{28, 32, 36, 40\}$. The searching range of motion estimation is ±32, and the search strategy is a full search. All the concerning methods are implemented using Visual C++, and the Pentium 4 CPU with3.06G Hz and 512 RAM.



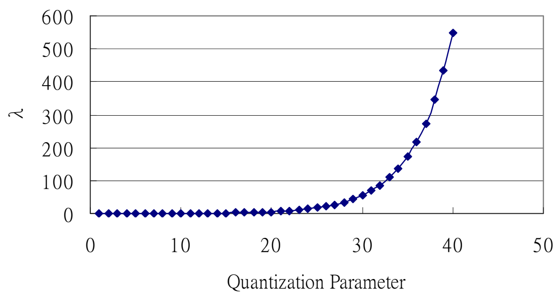
(a)



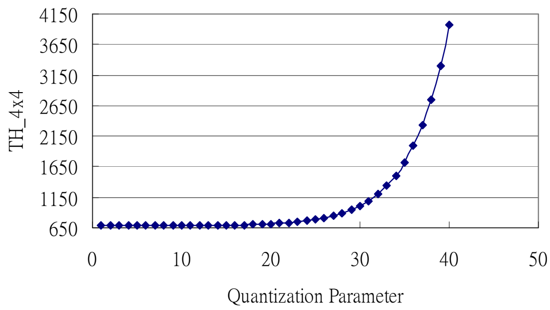
(b)

Figure 5: The relationship between RD and Complexity (a) scatter diagram of simulation results (b)multiple regression curve of RD-complexity

How to determine the thresholds is the key issue to the proposed method in H.264/AVC. It is clear that the larger the thresholds are, the more search modes can be skipped, and the encoding complexity can be further reduced. However, more modes are incorrectly selected at the same time, which results in more significant loss in image quality and more bits used in encoding prediction error signals. We have conducted several experiments with different candidate sets of thresholds based on different degradation of video quality for some video sequences, and then select



(a)



(b)

Figure 6: (a) the relationship between λ and QP (b) the relationship between and QP.

an appropriate set which provides a good tradeoff between R-D performance and computational complexity in practice. Figure 5(a) shows the scatter diagram of the simulation results including peak signal-to-noise ratio of luma ($PSNR_Y$), bitrate (kbps) and complexity with different thresholds $(TH_{8\times8}, TH_{16\times16}, TH_{4\times4}, TH_{inter})$ for $QP = 32$. The complexity is defined as the number of performing RDO calculations. To analyze the relationship among variables $PSNR_Y$, bitrate and complexity, a multiple regression model is adopted in the proposed method. A polynomial fitting to approximate an estimation function is shown in Fig. 5(b). From Fig. 5(b), we can find that the performance is approximately the same for all thresholds larger than the threshold set $(35000, 15000, 1200,\ 1200, 10000)$.

The set of the threshold $(TH_{8\times8}, TH_{16\times16}, TH_{4\times4}, TH_{inter})$ is an important parameter which affects the R-D curve and complexity of our method. Furthermore, experiments show that different QP values result in different thresholds. This is due to the fact that the $RD\cos t$ value is related to QP. InEq. (1), J is directly related to λ, while λ is obtained from a lookup table indexed by QP. Figure 6 shows the relationship among λ, $TH_{4\times4}$ and QP. Therefore, we need to adjust the thresholds according to the value of QP from the Figure6. In our method, we select the threshold set $(35000, 15000, 1200, 10000)$ for $QP = 32$ to be the principal threshold, so the threshold sets for other QP values can be set as

Table 3: Performance comparison of theproposed algorithm for IIII sequences

QP	Methods	Foreman (QCIF)			Mobile (CIF)		
		∆PSNRY	∆Bitrate	∆Time	∆PSNRY	∆Bitrate	∆Time
28	RDO	0	0	0	0	0	0
	Pan’s	-0.04	2.2	58.1	-0.06	2.5	60.1
	Kim’s	-0.07	3.1	65.1	-0.08	3.4	67.2
	Proposed	-0.07	4.1	77.4	-0.08	4.8	80.4
32	RDO	0	0	0	0	0	0
	Pan’s	-0.03	3.2	58.3	-0.04	3.8	60.4
	Kim’s	-0.08	4.0	70.2	-0.08	4.9	71.2
	Proposed	-0.06	2.9	74.7	-0.07	3.6	79.6
36	RDO	0	0	0	0	0	0
	Pan’s	0	4.1	57.2	0	4.8	59.2
	Kim’s	-0.07	1.9	68.2	-0.06	2.9	70.2
	Proposed	-0.05	2.2	73.5	-0.07	3.3	77.5
40	RDO	0	0	0	0	0	0
	Pan’s	+0.01	5.1	56.5	+0.01	5.9	58.5
	Kim’s	-0.08	5.9	70.2	-0.06	6.2	72.2
	Proposed	-0.04	2.9	75.6	-0.03	3.9	80.1

Table 4: Performance comparison of the proposed algorithm for IPPP sequences

QP	Methods	Foreman (QCIF)			Mobile (CIF)		
		∆PSNRY	∆Bitrate	∆Time	∆PSNRY	∆Bitrate	∆Time
28	RDO	0	0	0	0	0	0
	Pan’s	-0.01	-1.1	20.0	-0.03	-2.2	19.1
	Kim’s	-0.11	2.1	21.4	-0.07	3.1	20.1
	Proposed	+0.07	1.4	26.8	+0.05	4.1	24.4
32	RDO	0	0	0	0	0	0
	Pan’s	0	1.5	17.1	-0.03	2.1	17.6
	Kim’s	-0.11	2.8	26.3	-0.18	3.1	25.2
	Proposed	+0.05	1.8	32.8	+0.06	2.9	30.7
36	RDO	0	0	0	0	0	0
	Pan’s	+0.01	1.2	16.1	0	1.9	17.2
	Kim’s	-0.09	3.1	18.4	-0.07	3.6	23.2
	Proposed	+0.08	6.5	26.4	+0.05	5.6	28.5
40	RDO	0	0	0	0	0	0
	Pan’s	-0.01	-1.1	15.4	-0.02	-0.9	15.3
	Kim’s	-0.18	3.4	17.8	-0.12	4.9	20.2
	Proposed	+0.02	6.6	22.8	+0.04	7.9	25.6

follows:

$$TH_{8\times 8} = 35000 + (\lambda_{QP} - \lambda_{32}) \times 100 \quad (3)$$

$$TH_{16\times 16} = 15000 + (\lambda_{QP} - \lambda_{32}) \times 3 \quad (4)$$

$$TH_{4\times 4} = 1200 + (\lambda_{QP} - \lambda_{32}) \times 6 \quad (5)$$

$$TH_{Inter} = 10000 + (\lambda_{QP} - \lambda_{32}) \times 20 \quad (6)$$

The performance of the proposed method is compared with other fast methods [7-8] and JM 18.1 with RDO procedure [12]. We define several measures for evaluating the encoding performance, including $\Delta PSNRY$, $\Delta Bitrate$ and $\Delta Time$ as follows:

$$\Delta PSNRY = PSNRY_{RDO} - PSNRY_{method} \quad (7)$$

$$\Delta Bitrate = \frac{Bitrate_{method} - Bitrate_{RDO}}{Bitrate_{RDO}} \times 100\% \quad (8)$$

$$\Delta Time = \frac{Time_{RDO} - Time_{method}}{Time_{RDO}} \times 100\% \quad (9)$$

The test results are shown in Tables 3 and 4 for Foreman sequence of QCIF-format and Mobile sequence of CIF-format. Table 3 shows the all IIII… frame sequences, and Table 4shows the IPPP… sequences type. From Table 3, we can find that the encoding time of the proposed algorithm is obviously less than JM18.1, Pan's and Kim's methods in all kinds of QP with little degradation in the R-D

Table 5: Comparison of the number of RDO

Block type \ modes	Total number by JM	Total number by Pan's	Average number by ours
4×4 luma	9	4	3.68
16×16 luma	4	2	1.82
8×8 chroma	4	3 or 2	1.54

performance. In other words, the proposed algorithm can further achieve time improving ratio $(\Delta Time)$ as compared with the other two fast mode decision methods. Additionally, as compared with Pan's and Kim's method, our approach yields more bitrate and encoding-time saving effects with similar image quality. This is because there is not any on-line pre-processing time that is needed by our method. In addition, we can verify that our method can decrease the encoding time by maximum of 77.4% and 80.4% for IIII frame with QCIF and CIF sequences, respectively, and, 32.8% and 30.7% for IPPP frame with QCIF and CIFsequences, respectively, as compared with the original JM 18.1.

On the other hand, the computational complexity comparisons of all I-frame sequences, and the number of candidate modes selected for RDO computation, are summarized in Table 5. From Table5, we can find that our method has less intra modes and is close to R-D performance than Pan's method. Taking the "Hall-monitor" under $QP = 32$ as an example, the encoder with the proposed method carries out only $1.54 \times (3.68 \times 16 + 1.82) = 93.5$ RDO computations on the average, which are much less than that of Pan's fast algorithm used in H.264/AVC video coding, i.e., 132 or 198 RDO computations.

5. Conclusion

In this paper, we propose a fast intra/inter mode decision algorithm that exploits the interblock correlation to further reduce prediction modes. Four modes of neighboring coded macro blocks/blocks are considered as the good candidate intra/inter modes of the current block and terminated by threshold sets. We verified the proposed algorithm by implementing on JM reference software and comparing with RDO. Simulation results show that our method can achieve encoding time improving ratio to 73~80%in intra prediction and to 22~67% in inter prediction compared to RDO, respectively, with negligible loss of PSNR and bitrate increase. Experimental results show our method is superior to existing fast methods in computational complexity due to no on-line computational overhead.

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