Low Complexity Intra Prediction Algorithm for MPEG-2 to H.264/AVC Transcoder

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Abstract —*Transcoding MPEG-2 video into H.264/AVC format is highly necessary for the broad distribution of digital video contents to mobile terminals. Since H.264/AVC achieves great coding efficiency by employing computationally demanding algorithms, the computational complexity of the transcoder is one of technically challenging issues. The empirical results show that DCT energy trend in the decoded MB of MPEG-2 bitstream has strong correlation with the Intra prediction modes of H.264/AVC. Based on the relationship, the mode skipping rule of intra prediction mode decision in the H.264/AVC encoder part of the transcoder is proposed in this paper. The simulation results show that the proposed algorithm can achieve on average 72.36% reduction in computational complexity, compared with that of the conventional transcoder.*

Index Terms — MPEG-2, H.264/AVC, Transcoder, Intra Prediction, MB Energy Trend, Rate-to-Distortion Cost (RDCost)

I. Introduction

Since digital TV signals are broadcasted in MPEG-2 format [1], MPEG-2 is the main format for the production and distribution of digital contents. MPEG-2, however, was developed for high quality and high resolution digital video contents; it cannot be accommodated in mobile terminals, such as PMP (Portable Multimedia Player), DMB (Digital Multimedia Broadcasting) terminals, etc. The latest video standard, H.264/AVC [2], is rapidly deployed in mobile multimedia terminals for its impressive coding efficiency. Due to these divided markets, transcoding between MPEG-2 (contents) and H.264/AVC (mobility) is highly necessary for mobile multimedia applications.

The inevitable problem of transcoders is their computational complexity, since they must perform both the decoding and encoding of video contents [3]. For the MPEG-2 to H.264/AVC transcoder, the problem is much more serious since H.264/AVC codec achieves high compression ratio by adopting computationally demanding encoding tools, such as intra prediction with numerous prediction directions, multiple reference frames for motion compensation, in-DPCM loop de-blocking filtering, motion compensation with the deep sub-pixel resolution, etc [4].

There are several efforts to reduce the computational complexity of transcoders, especially on the intra prediction of the H.264/AVC encoder side in transcoders. Hari et al. proposed the intra mode decision method in the transform domain. However, the method requires additional transformations of 8×8 DCT into 16×16 and 4×4 transform coefficients to estimate INTRA16×16 and INTRA4×4 modes [5]. Li et al. proposed the intra mode decision algorithm by using 8×8 DCT coefficients of MPEG-2 decoder. This algorithm achieved an average of 55.44% reduction in CPU time, but the bitrates of the given PSNR were increased by 20-25%, compared with the cascaded transcoder. This low coding efficiency is caused by the poor mode decision of INTRA 4×4 modes [6].

In this paper, we propose a low complexity INTRA16×16 mode decision algorithm by utilizing the directional correlation from the 8×8 DCT coefficients of the MPEG-2 decoder. The proposed algorithm additionally uses the correlation between INTRA16×16 and INTRA4×4 modes, resulting in fast INTRA4×4 mode decisions. By considering MB homogeneity, the full search INTRA4×4 mode decision is applied to non-homogeneous MB to maintain the coding efficiency. Unlike the previous methods, the fast INTRA 8×8 mode decision method for the chroma components is proposed in this paper based on the spatial similarity between the luma and chroma components. The empirical results show that the proposed algorithm achieves an average of 72.36% reduction in computational complexity at a slight loss in coding efficiency.

This paper is organized as follows. The most popular cascaded MPEG-2 to H.264/AVC transcoder and its complexity analysis are summarized in Section II. The proposed intra mode decision algorithm is presented in Section III. Section IV shows the simulation results that confirm high performance of the proposed algorithm. This paper is drawn to a conclusion in Section V.

II. The Conventional Cascaded Transcoder

A. Overview of Cascaded Transcoders

Cascaded transcoders have been widely used in the market because they are conceptually straightforward and they can be easily implemented [3]. The structure of the cascaded transcoder is shown in Fig. 1.

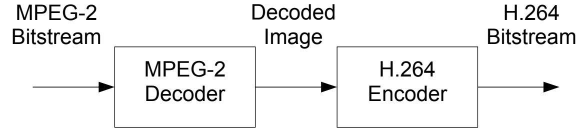

Fig. 1 The structure of cascaded MPEG-2 to H.264 transcoder

As shown in Fig. 1, the MPEG-2 bitstream is decoded by the MPEG-2 decoder to produce the reconstructed image.

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The image is used for the source of H.264 encoder that generates the H.264 bitstream. In terms of hardware and software implementation, this structure is a really implementation-friendly structure and it can reduce lab-to-market time and engineering cost. However, the computational complexity of the H.264 encoder side is impractically huge, requiring multiple DSP cores and sophisticated parallel processing algorithms. This implementation issue is very serious for real-time communication; for instance, real-time broadcasting of big sport events to handheld devices using H.264.

For mobile devices, the communication link is unstable due to the problems of mobility and line-of-sight of satellite communications, e.g., the H.264-based satellite DMB services in South Korea [7]. For this reason, the H.264 video encoders of mobile devices periodically use the intra-frame to quickly recover from channel error propagation [8] at one intra frame per five frames. Therefore, we mainly focus on transcoding intra frames in this paper.

B. *Complexity Analysis of H.264/AVC Intra Coding*

Unlike previous video coding standards, H.264/AVC uses the intra prediction and Rate Distortion Optimization (RDO) for achieving better coding efficiency [9, 10]. Three types of intra prediction methods, such as INTRA16×16, INTRA4×4 and INTRA8×8 are used for the whole 16×16 luma block, partitioned sixteen 4×4 luma subblocks and two 8×8 chroma blocks, respectively. All the methods are based on the directional prediction methods in the spatial domain, as shown in Fig. 2. Note that the prediction directions of INTRA8×8 are the same as those in Fig. 2-(b). As shown in Fig. 2, the INTRA16×16, INTRA4×4 and INTRA8×8 prediction methods require 4, 16 and 4 spatial predictions, respectively, to calculate the best prediction mode.

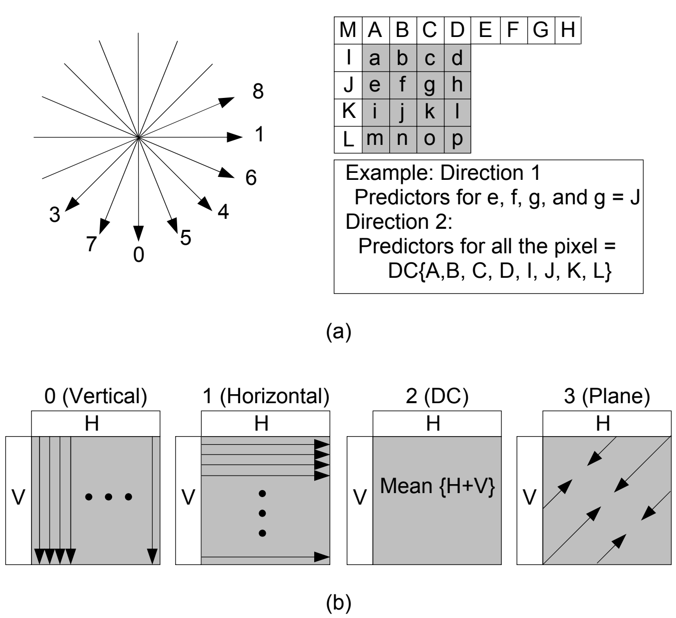


Fig.2. H.264/AVC Intra prediction directions for luma; (a) INTRA4×4; (b) INTRA16×16; the shaded area represents the pixels to be predicted.

For making the decision of each prediction direction, the cost is computed based on the RD theory [10] as follows:

$$RD_{COST} = D + \lambda_{MODE} \times R \quad (1a)$$

$$\lambda_{MODE} = 0.85 \times 2^{(Q-12)/3} \quad (1b)$$

where R and D represent the distortion and bitrate for a given prediction direction, respectively. Q and λ_{Mode} are the quantization parameter (QP) and Lagrangian multiplier, respectively. Note that for computing R and D, the actual coding is performed for each 4×4 subblock that is the basic processing unit for transformation and Variable Length Coding (VLC) in H.264/AVC encoders. Therefore, the computational complexity can be measured by the number of 4×4 subblocks used in computing RD costs. Fig. 3 shows the number of RD costs for each Macroblock (MB) [11]. To determine the best mode for each MB, 640 RD costs should be calculated. This huge computational complexity is a serious bottleneck for transcoding into H.264/AVC bitstream.

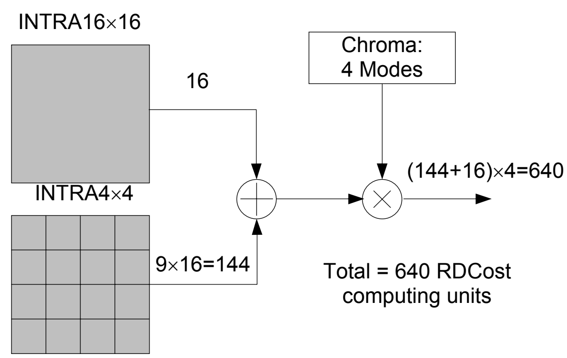


Fig.3. *RDCost* Computing the Intra prediction for one MB

III. The Proposed Intra Transcoding Algorithm

The key ideas of the proposed algorithm are based on several properties of image signals and DCT coefficients. First, the spatial variation of the pixel values can be derived from the DCT coefficients [12], which are available on the MPEG-2 decoder side. Second, MBs with low spatial activities are frequently encoded in INTRA16×16 mode rather than in INTRA4×4 [5, 9]. Third, there is strong correlation on the spatial characteristics between 16×16 block and its sixteen 4×4 subblocks; in other words, if the 16×16 block has strong spatial correlation in a certain direction, its subblock has a high possibility of having strong correlation in the same direction. Finally, the spatial characteristics of chroma blocks are very similar to those of luma blocks, since both signals contain the same objects.

Based on the above properties, we propose a low complexity INTRA16×16 mode decision algorithm by utilizing the directional correlation from the 8×8 DCT coefficients of an MPEG-2 decoder. The proposed algorithm additionally uses the correlation between the INTRA16×16 and INTRA4×4 modes, resulting in a fast INTRA4×4 mode decision. By considering the MB homogeneity, the full search INTRA4×4 mode decision is applied to a non-homogeneous MB to maintain coding efficiency. Unlike previous methods, the fast INTRA 8×8 mode decision method of the chroma components are proposed in this paper based on the spatial similarity between luma and chroma components.

A. Smoothness Decision for the Branching INTRA16×16 and INTRA4×4 modes

Most smooth MBs are encoded in INTRA16×16 mode in the H.264/AVC encoders. By confining MB mode to the INTRA16×16 mode for a smooth MB, the computational complexity of the INTRA4×4 mode decision can be reduced. This branching algorithm can greatly reduce the computational complexity in H.264/AVC Intra coding, and a similar concept is used in several studies [5].

Unlike the branching method in [5], which used the variance of DCT coefficients, the proposed algorithm uses the SAD (Sum of Absolute Difference) of DCT coefficients for achieving fast computation as follows:

$$C_{DC} = 0.5\left(\sum_{n=0}^{3}\left|E_n - \overline{E}\right|\right) < \gamma_0 \tag{2}$$

where $\overline{E}$ is the average of E_n, n = 0, 1, 2, 3 and the energy measure, E_n is defined as follows:

$$E_n = \sum_{i,j=0}^{7}\left| D_n(i,j)\right|, n = 0, 1, 2, \text{and } 3 \tag{3}$$

where $D_n(i,j)$ is a DCT coefficient at (i,j) in the n-th 8×8 subblock for a given MB that is obtained from the MPEG-2 decoder.

If the cost function of (2) is less than the threshold, then the MB is determined to be a smooth MB, and only the INTRA16×16 mode decision is performed as described in Subsection III-B.

B. INTRA16×16 Mode Decision for Luma Component of MB

To investigate the possibility of using the inter-block energy trend of the INTRA16×16 mode decision, four sample patterns are generated as shown in Fig. 4, which can be perfectly predicted by the INTRA16×16 modes.

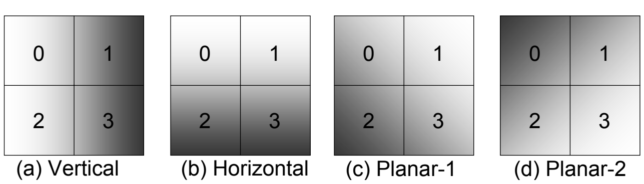


Fig. 4. An example of luma block pattern perfectly predictable via the INTRA16×16 modes; the luma block size is 16×16 and four partitioned 8×8 blocks are marked with numbers.

The patterns are generated by the following equations:

$$I(x,y) = -15x + 250 \tag{4a}$$

$$I(x,y) = -15y + 250 \tag{4b}$$

$$I(x,y) = 255((15-x)+y)/30 \tag{4c}$$

$$I(x,y) = 255(x+y)/30 \tag{4d}$$

where $(x,y) \in [0,15]$ and $I(x,y)$ are MB coordinates of the pixel intensity at (x,y), respectively.

In Fig. 4-(a), intensities vary in the horizontal direction and intensity does not change in the vertical direction. Therefore, intensity can be perfectly predicted according to the vertical mode (Mode 0 of INTRA16×16). The energies of four 8×8 luminance subblocks in Fig. 4-(a) are measured by using pixel intensities. Table I shows that the energy difference between blocks '0 and 2' or between blocks '1 and 3' is zero. On the other hand, the inter-block energy difference in the horizontal direction is very high. This sample study implicates that the inter-block energy difference can be used in the simplified INTRA16×16 mode decision.

TABLE I
A BLOCK ENERGY COMPARISON OF HORIZONTALLY VARYING IMAGE BLOCKS

Measure	Block 0	Block 1	Block 2	Block 3
Pixel energy	2,572,000	460,000	2,572,000	460,000
DCT energy	2,571,781	459,781	2,571,781	459,781
DCT SA†	1,891	931	1,891	931

†SA represents the 'Sum of Absolute (SA)' values of the DCT coefficients for a given 8×8 block.

To reduce the computation of the inter-block energy difference, the energies in the transform domain are also measured in Table I based on the Parseval's energy theorem [12]. Note that the slight different values between two measures are due to the truncation errors in DCT. Table I further shows that the Sum of Absolute (SA) values of the DCT coefficients can also be a good energy measure. Notice that unlike pixel or DCT energy, SA does not require multiplication, and thus, further reducing the computational complexity in the inter-block energy measure.

Based on the measure derived above, the cost functions are defined as follows:

$$C_V = \left|E_0 - E_2\right| + \left|E_1 - E_3\right| \tag{5a}$$

$$C_H = \left|E_0 - E_1\right| + \left|E_2 - E_3\right| \tag{5b}$$

$$C_P = 2\min\left\{\left|E_1 - E_2\right|, \left|E_0 - E_3\right|\right\} \tag{5c}$$

$$C_{DC} = 0.5\left(\sum_{n=0}^{3}\left|E_n - \overline{E}\right|\right) \tag{5d}$$

where C_V, C_H, C_P, and C_{DC} represent the cost functions of the vertical, horizontal, planar and DC modes, respectively, and the energy measure, E_n, n=0, 1, 2, 3 is defined in (3). Note that the weighting factors, 2 and 0.5 in (5c) and (5d) are introduced to balance the magnitudes of all costs.

The results obtained by the proposed cost function of (5) for all the patterns of Fig. 4 are summarized in Table II. The cost functions perfectly detect the prediction directions of all directions, showing the effectiveness of the proposed cost functions. One interesting trend is that the measures of DC mode are the smallest values, except the best measure for all patterns. This trend implies that the DC mode can be frequently selected in INTRA16×16 mode when the MB is smoothly varying and has no dominant directional correlation. To confirm the trend, the probabilities of INTRA16×16 modes are measured by using MPEG-2-to-H.264/AVC cascaded transcoder, which is theoretically optimum in terms of coding efficiency. Table III shows that DC mode is most frequently used for all sequences. On average, 59.79% of MBs are selected as DC mode.

TABLE II
MEASUREMENTS BY THE PROPOSED INTRA16×16 COST FUNCTIONS FOR THE PATTERNS OF FIG. 4

Cost functions	C_V	C_H	C_P	C_{DC}
Vertical pattern	0	1920	1920	240
Horizontal pattern	1920	0	1920	240
Planar pattern - 1	1088	1088	0	136
Planar pattern -2	1088	1088	0	136

TABLE III
THE PROBABILITY OF INTRA16×16 MODES FOR VARIOUS SEQUENCES

Sequences	Vertical	Horizontal	Planar	DC
Flower	15.15%	11.11%	15.66%	58.08%
Mobile	10.86%	13.64%	16.92%	58.59%
Table Tennis	5.30%	7.58%	17.68%	69.44%
Waterfall	12.63%	10.86%	23.48%	53.03%
Average	10.98%	10.80%	18.43%	59.79%

Moreover, the importance of predicting DC in Intraframe coding can be easily observed in previous video coding standards. In Intraframe coding of an MPEG-4 baseline codec, DC prediction in the DCT domain is used as the default method [13]. The Annex I, advanced Intraframe coding of the recommendation H.263 uses DC prediction in the DCT domain [14]. For these reasons, DC mode should be the default candidate mode for achieving robustness of the proposed method.

Based on the above analyses shown in Tables II and III, the following fast INTRA16×16 mode decision method is proposed:

Step 1: If C_{DC} is the smallest value for a given MB, then the DC mode is used for INTRA16×16 mode and other prediction modes are skipped.

Step 2: Otherwise, the DC mode and the mode with the minimum cost are used as candidates for INTRA16×16 mode. Other prediction modes are not considered.

By using the above proposed method, the candidates of INTRA16×16 mode can be reduced from 4 to 1.40 for the probability of Table III, resulting in 64.95% reduction in the candidate numbers of INTRA16×16 mode decisions.

C. INTRA8×8 Mode Decision for Chroma Components of MB

Fig. 5 shows the luma and chroma components of 'Foreman' sequence. Both components evidently have the same trends of textures and edge orientations. Also the prediction directions used for the INTRA16×16 and INTRA8×8 modes are exactly the same. These factors implicate that the probability of both modes having the same prediction direction is very high.

To confirm the high correlation between INTRA16×16 and INTRA8×8 modes, the similarities of both modes are measured by using MPEG-2-to-H.264/AVC cascaded transcoder, which is theoretically optimum in the sense of coding efficiency. Table IV shows that the probability of both modes being the same is about 55.87%. When the INTRA8×8 mode is not the same as the INTRA16×16 mode, the probability of the INTRA8×8 mode to be a DC mode is about 60.98%. This means that the prediction directions of INTRA8×8 mode can be reliably reduced by using the INTRA16×16 mode and DC mode.

(a) Luma (b) Chroma

Fig. 5. The luma and chroma components of 'Foreman' sequence

Based on this observation and reasoning, the following fast INTRA8×8 mode decision method is proposed:

Step 1: If the INTRA16×16 mode is a DC mode, then the INTRA8×8 mode is DC mode. Other prediction modes are skipped in the mode decision process.

Step 2: Otherwise, the prediction direction of INTRA16×16 mode and DC mode are used by the candidate directions of the INTRA8×8 mode. Other prediction modes are not considered.

By using the above proposed method, the INTRA8×8 mode candidates can be reduced from 4 to 0.80 for the probability of Table III, resulting in 80.00% reduction in the candidate numbers of INTRA8×8 mode decisions. Notice that there is no arithmetic operation for the INTRA8×8 mode decision, since the results from INTRA16×16 are used in mode decision.

TABLE IV
THE SIMILARITIES BETWEEN INTRA16×16 AND INTRA8×8 MODES

Sequences	Same mode	DC mode for different mode
Flower	53.03%	63.44%
Mobile	53.79%	64.48%
Table Tennis	62.12%	62.27%
Waterfall	54.55%	53.33%
Average	55.87%	60.98%

D. INTRA4×4 Mode Decision for the Luma Component of MB

Comparing the prediction directions of INTRA16×16 and INTRA 4×4 modes, there are directional similarities between these two modes. For instance, if the INTRA16×16 mode is 'Horizontal', then there are small variations of pixel values in the horizontal direction. For the INTRA4×4 mode, the prediction directions, 1, 6, and 8 also assume small pixel variations as shown in Fig. 2-(a). The candidate groups of INTRA4×4 are summarized in Table V based on the similarity in prediction directions in both modes. Note that DC mode '2' is commonly included because of the importance of DC mode as explained in Subsection III-B.

TABLE V
CANDIDATES 4X4 DIRECTIONS FOR 16×16 BLOCK SMOOTHNESS

Candidate group	INTRA16×16 mode	INTRA4×4 Candidates	Conditional Probability
V	0 (Vertical)	0, 2, 5, 7	64.4%
H	1 (Horizontal)	1, 2, 6, 8	65.7%
DC	2 (DC)	0, 1, 2, 3, 4	77.4%
P	3 (Planar)	0, 1, 2, 3, 4	68.7%

To discover the relationship between the INTRA16×16 mode and 4×4 prediction directions of the sub-blocks, the conditional probabilities of INTRA4×4 mode for a given INTRA16×16 mode are measured by using the cascaded transcoder for the various sequences of 'Foreman', 'Highway', 'Mother', 'Flower' and 'Waterfall' sequences. Table V shows that 68.7% of MBs are selected among the candidate groups for a given INTRA16×16 mode. This implies that the candidate group is very useful in reducing the computational complexity of the INTRA4×4 mode decision, but 31.3% of MBs should be handled differently for achieving coding efficiency. The inconsistency between the INTRA16×16 mode and INTRA4×4 candidates occurs in the MB with edges or with small objects. In other words, the directional correlation is non-homogeneous in the MB.

Since the non-homogenous MB does not have a strong directional correlation in the MB resolution, the following existence of a dominant energy trend can be used to detect the non-homogeneous MB:

$$\gamma = \frac{C_{\max} - C_{\min}}{C_{\max}} < \gamma_1 \quad (6)$$

where γ and γ_1 are the homogeneity factor and constant, respectively. $C_{\max}$ and $C_{\min}$ are defined as follows:

$$C_{\max} = \max\{C_x, x = \mathrm{V, H, P, and\ DC}\} \quad (7a)$$

$$C_{\min} = \min\{C_x, x = \mathrm{V, H, P, and\ DC}\} \quad (7b)$$

If γ is equal to zero, i.e., $C_{\max} = C_{\min}$, then there is no dominant directional correlation in MB. In case of γ=1, i.e., $C_{\min}$ =0, there is a dominant directional correlation in MB.

Since the non-homogeneous MB does not have dominant directional correlation all over MB, the full search algorithm should be applied to each 4×4 sub-blocks in the MB for maintaining coding efficiency. Based on this observation and reasoning, the following fast INTRA4×4 mode decision method is proposed:

Step 1: If the MB is a homogenous MB, i.e., $\gamma \geq \gamma_1$, then only the INTRA4×4 candidate directions of a given INTRA16×16 mode are considered in the INTRA4×4 mode decision.

Step 2: Otherwise, all the possible INTRA4×4 directions are used for the mode decision, i.e., the Full Search Algorithm (FSA) is used in the INTRA4×4 mode decision.

E. The Proposed Fast Intra Transcoding Algorithm Procedure

Based on the proposed algorithms for each intra prediction mode, the procedure of the proposed intra transcoding algorithm is as follows:

Step 1: The MB smoothness decision of Section III-A
If the given MB is smooth, then go to Step 2
Else, go to Step 3.

Step 2: The INTRA16×16 mode decision of Section III-B
After finishing the INTRA16×16 mode decision, go to Step 4

Step 3: The INTRA4×4 mode decision of Section III-D
After finishing the INTRA4×4 mode decision, go to Step 4

Step 4: The INTRA8×8 mode decision of Section III-C

To evaluate the computational complexity of the proposed algorithm, the numbers of candidate modes for the cascaded and proposed transcoders are compared. The number of candidates for the H.264/AVC intra coding can be expressed as follows:

$$N_C = (N_{C16\times16} + 16N_{C4\times4}) \times N_{C8\times8} \quad (8)$$

where N_C, $N_{C16\times16}$, $N_{C4\times4}$, and $N_{C8\times8}$ are the numbers of overall candidates, INTRA16×16, INTRA4×4 and INTRA8×8 mode candidates, respectively. Note that for INTRA4×4 modes, each of the sixteen 4×4 blocks may have different prediction directions. Note that the multiplication between the luminance and chrominance modes in (8) is due to the RDO process. The numbers of candidates are summarized in Table VI. It shows that the number of candidates in the proposed method is significantly reduced. According to the comparison between the minimum and maximum number of candidates, the proposed method can reduce the number of candidates, ranging from 50.67% to 99.83%.

TABLE VI
COMPARISON BETWEEN THE NUMBERS OF CANDIDATES IN MODE DECISION

Method		Luma 16×16	Luma 4×4	Chroma 8×8	Overall Candidates (min/max)
Cascaded (FSA)		4	9	4	592/592
Proposed	Homogeneous MB	1 or 2	0	1 or 2	1/4
	Heterogeneous MB	1 or 2	4 or 5 or 9	1 or 2	65/292

IV. THE SIMULATION RESULTS

To evaluate the proposed intra prediction method, various transcoding algorithms are compared. Details of the simulation environments are summarized in Table VII.

TABLE VII
SIMULATION ENVIRONMENTS

Item	Environment
Hardware	PC with core 2(CPU 3.0GHz), 2GB RAM
Software Codec	MPEG-2 Decoder TM5 [16] and H.264/AVC Encoder JM10.1[17]
Sequences	‘Flower’, ‘Mobile’, ‘Table Tennis’, and ‘Waterfall’
Sequence Format	CIF, 4:2:0, 30Hz
GOP	I I I ···
QP	28, 32, 36, 40
Comparing Algorithms	Cascaded transcoder [3], [5], [6], and proposed method

Traditionally the performance of coding efficiency is measured based on the RD (Rate-Distortion) theory. In other words, the distortions of various methods are compared for a given quality, or vice versa. Unlike the traditional approach, the performance measure here is three-dimensional, i.e., quality, distortion and computational complexity. In this paper, the CPU time is used for measuring the computational complexity, which has been commonly used in the literature [18, 19].

To evaluate the coding efficiency of the four transcoding algorithms, RD performances are compared for specified sequences. Notice that the cascaded transcoder [3] shows the best performance because it encodes the decoded images without skipping any possible modes on the H.264/AVC encoder side. Fig. 6 shows that the three algorithms, [3, 5] and the proposed method have similar performances for all sequences. However, [6] shows slightly low performance in coding efficiency. These low performances are mainly caused by the assumption made in [6] that there is always a correlation between the INTRA16×16 and INTRA4×4 modes without considering the homogeneity of MB. Therefore, [6] shows low performance, especially for sequences with small objects.

To evaluate computational complexity, the average CPU times for the 100 sequences are measured. The CPU time reduction ratios relative to the cascaded transcoder [3] are depicted in Fig. 7. The computational complexity is compared for a given quality, in other words, fixed QP (Quantization Parameter). The results show that the proposed algorithm significantly reduces computational complexity by 72.38%, relative to the cascaded transcoder [3]. Also it provides an average of 44.85% and 24.41% reductions in average CPU time, compared with [6] and [5], respectively. One important shortcoming of [5] and [6] is that there is no complexity reduction in the chroma components, which can significantly impact computational complexity, especially when the RDO is used for mode decision.

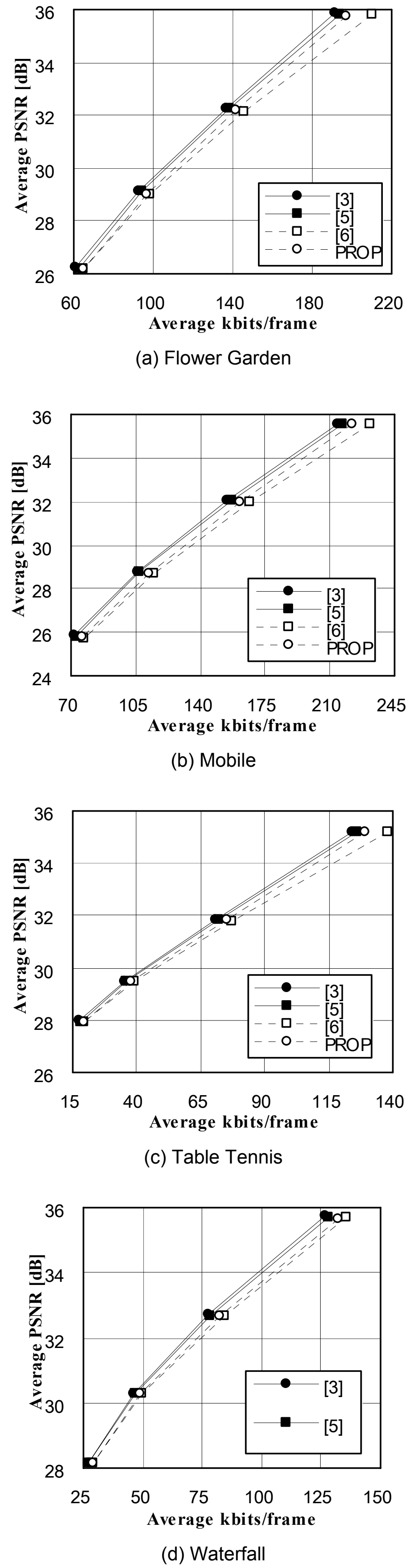
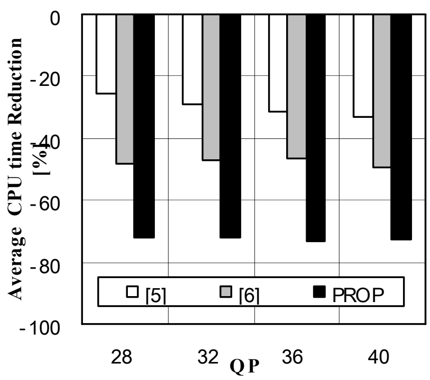
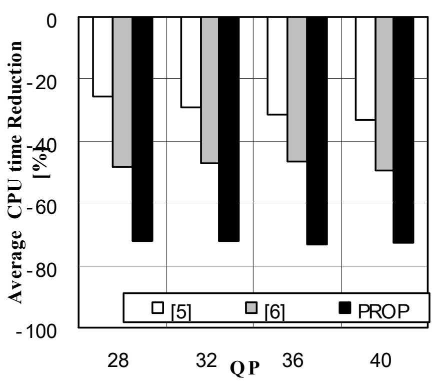


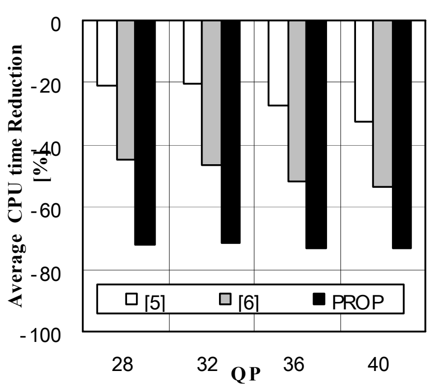
Fig. 6. The average RD performance comparison for various sequences



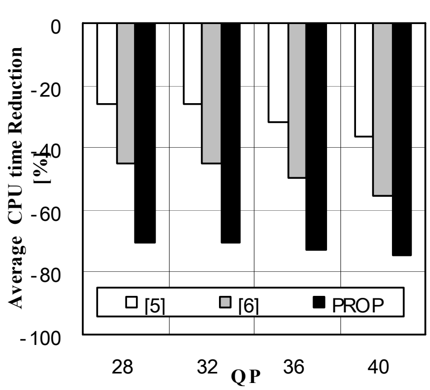
(a) Flower Garden



(b) Mobile



(c) Table Tennis



(d) Waterfall

Fig. 7. Performance comparison based on the average CPU time reduction

V. CONCLUSION

In this paper, we proposed a low complexity Intra prediction algorithm for MPEG-2 to H.264/AVC transcoder. The proposed methods are derived from several important properties and empirical observations: the relationship between the MPEG-2 DCT coefficients and INTRA16×16 prediction direction, the directional correlation between INTRA16×16 and INTRA4×4 prediction directions and between INTRA16×16 and INTRA8×8 prediction directions. For the non-homogenous MB in terms of the directional correlations, the full search INTRA4×4 mode decision is introduced to maintain coding efficiency. In the proposed method, only inter-block energy trends are derived by using the SA (Sum of Absolute) operation and the INTRA8×8 mode decision is made with logical operations.

The simulation results confirm that the proposed algorithm can significantly reduce the computational complexity. The proposed algorithm would be a very useful tool for enabling mobile or Internet multimedia products to serve video contents, originally produced in MPEG-2 format.

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