ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

A Survey on Intra Prediction in H.264 Encoder.

Bernatin T*, Sherin John*, and Sandhya P.

Department of ETCE, Sathyabama University , Chennai, Tamil Nadu, India.
bernatin@gmail.com

ABSTRACT

Video compression involves encoding the information using fewer bits than the original representation and reducing the data size than original size. There are various ways for coding a video file in which intra and inter prediction plays a very vital role. Intra prediction offers following modes: 9 modes for 4X4 luma blocks, 9 modes for 8X8 luma blocks, 4 modes for 16X16 luma blocks and 4 modes for 4X4 chroma blocks. There are so many proposed algorithms for Intra prediction is available. Among those some intra predictions are discussed here. In Fast intra mode decision algorithm by using the dominant edge strength the modes are predicted. In the bidirectional intra prediction, two modes are clubbed among the 9 modes and hence a new mode is predicted. In three step intra prediction algorithm the modes are predicted only in three steps. In the gradient intensity adapted algorithm with adaptive selection strategy is a simple yet effective gradient evaluation approach is presented so that the texture orientation can be evaluated efficiently in the coding block. In this review, gradient evaluation has the best choice for intra prediction in H.264 video codec.

Keywords: Intra Prediction , H.264 , Gradient Evaluation, DES, Bidirectional.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

H.264 AVC is the video standard industry name. This was invented by JVT (Joint Video Team, a collection of five groups) and it is used in compression and decompression of video. The intra prediction is a coding technique in which the coding of blocks is done within the frame. Intra prediction can be simply said as the coding of blocks is done within the frame and not from outside the frame. This is done by comparing the coded block (i.e. the previous block) with the block that is to be predicted and hence the current block is found. This is called spatial domain. Intra prediction in H.264 collectively uses this spatial domain technique [1]. The different modes in intra prediction are: 4X4 luma prediction modes, 16X16 luma prediction modes, 8X8 luma prediction for high profile, 8X8 chroma prediction modes. Note that, Luma represents the brightness in black and white region. Chroma (chrominance) represents the brightness in color region. Here, H.264 performs intra prediction by full search fashion which is very expensive. Hence, we go for fast intra prediction algorithms. Mang et al [2] proposed this fast intra prediction based on three main aspects. For highly probable modes partial computation of the cost function, early termination and selective computation are available. Cheng and Chang[3] proposed a fast three step algorithm for H.264 4X4 intra prediction. Since, it is a fast search he used only six modes instead of all those nine modes which is the full search algorithm. Pan et al [4] performed pixel-by-pixel process in which he used an edge detection method using the sobel operator. This method was applicable for 4X4 luma, 16X16 luma and 8X8 chroma blocks. Even though this system has less computational time, the PSNR degradation is higher than 0.2db and the computing load is high. Hence, the above disadvantages are overcome by the following proposed system by Jia-Ching Wang [5] and his team. Here DES (Dominant Edge Strength) mode prediction is achieved. This is especially used to reduce the modes (i.e. 9 to 4) for 4X4 luma blocks and 4 to 2 for 16X16 luma and 8X8 chroma blocks. Lih-Jen Kau and Jia-Wei Leng[6] proposed gradient evaluation, in which the intra-prediction modes will be sorted according to the gradient intensities accumulated, and a subset with a variable number of the most probable intra-prediction modes will be selected for the RD evaluation based on the proposed adaptive selection strategy. Dae-Yeon Kim Ki-Hun Han Yung Lyul and Lee [7] presented an adaptive single-multiple prediction method for H.264/AVC Intra coding that increases coding efficiency and decreases encoding complexity. The encoder complexity can be reduced by adaptively skipping the prediction mode bits. Ben Atitallah, H. Loukil and N. Masmoudi [8] presented an FPGA

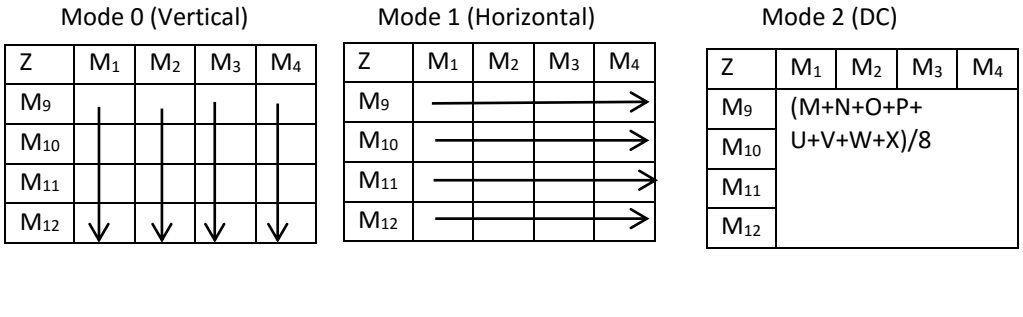
H.264/AVC encoder architecture performing at real-time. To reduce the critical path length and to increase throughput, the encoder uses a parallel and pipeline architecture and all modules have been optimized with respect the area cost. Xingang liu, Kwanghoon sohn [9] One of the important issues of green mobile networking is the low energy consumption for either mobile devices or transmissions. To adapt this, a low-cost Inter frame mode decision (MD) algorithm is proposed for H.264/AVC encoder to reduce the computational complexity of the original encoding procedure. The information extracted from macro block (MB), such as energy, temporal domain mode similarity and so on, which can be used to pre-estimate the optimal mode of the MB is investigated and utilized to eliminate the redundant mode candidates. Hassen Loukil, Imen Werda, Nouri Masmoudi[10] proposed novel hardware architecture for intra 16 × 16 module for the macro block engine of a new video coding standard H.264. To reduce the cycle of intra prediction 16 × 16, transform/quantization, and inverse quantization/inverse transform of H.264, an advanced method for different operation is proposed. Video codec is nothing but compressing and decompressing the data at transmission and reception side. This technique produces the copy of an original image or video which depends on the input we give. If the decoded sequence is similar to that of the original sequence, then the process is called lossless coding. If the decoded sequence is different to that of the original sequence, then the process is called lossy coding. The process can be either done by intra or inter prediction. In this area, we deal only with intra prediction.

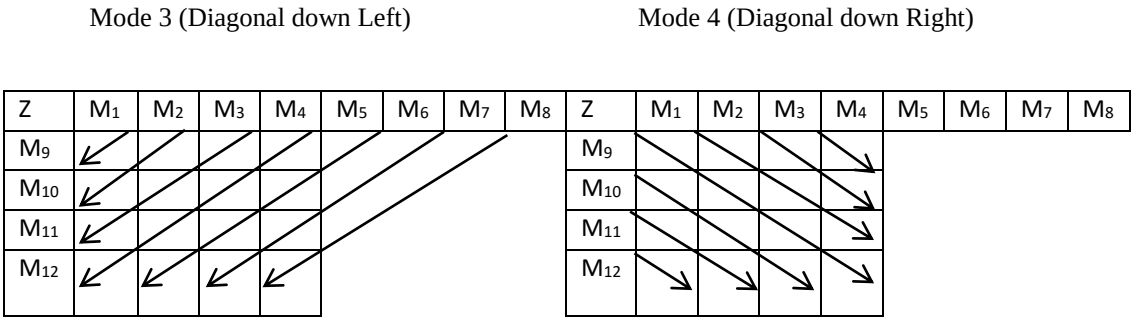
INTRA PREDICTION

In H.264 the first and standard unit is intra prediction. Here, the current block is predicted spatially from reconstructed pixels of causal neighbors. In intra prediction, there are nine standard modes. In practice, many intra prediction modes are available but only nine modes are considered as standard modes. It is because if all the combinations of intra prediction modes are applied then there will be high complexity in computation and also in real time applications it will be difficult to use. Among these nine standard modes one mode is selected, depending upon the prediction so that it would give good PSNR value, high compression ratio and low bit rate. Intra prediction has good coding performance than inter prediction. All these modes

ISSN: 0975-8585

here will have own rate distortion. The intra prediction network consists of an encoder circuit. The work of the encoder is to choose the apt mode which will have low rate distortion among others. This process will be computationally intensive. Even though this intra prediction technique has complexity and pipeline complications, the coding efficiency is much high.





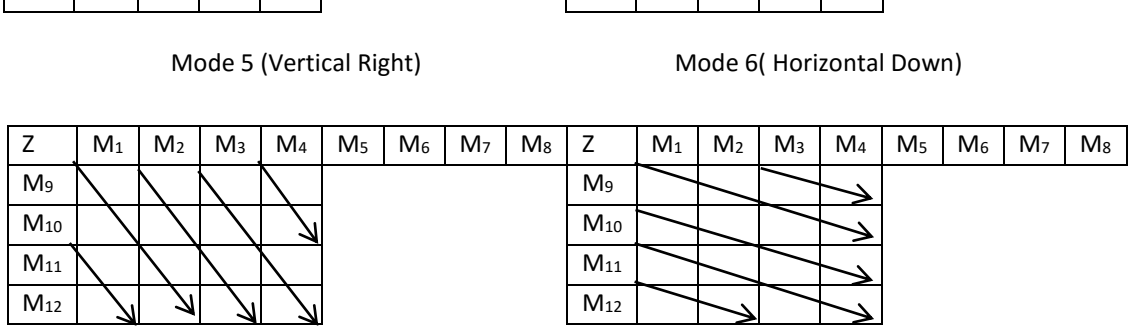


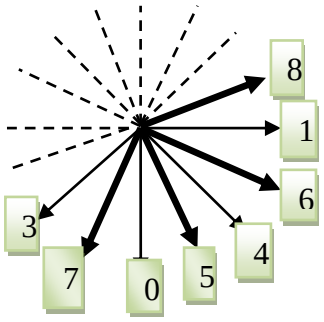
Figure1. Nine Modes In 4x4 Luma Predictions

FAST INTRA MODE DECISION

This is based on dominant edge strength. We can take the edges in different directions which are horizontal, vertical, 45deg, 135deg and one with non directional edge. For the edge detection process take an original image and divide it into sub blocks of four. Calculate the mode decision of each mode we need to take the average of image pixels. Using the filter coefficient of each edge and with the average pixels we can able to find the edge strength. The maximum edge strength will be selected as the dominant edge strength. This detected dominant edge is related to the predicted mode. Depend on this predicted mode the algorithm of

ISSN: 0975-8585

fast mode decision has created .For the detection of dominant edge strength 4x4 luma in different direction of edges.



DES is S_v - only do modes 7, 0, 5 and DC
DES is S_h - only do modes 8, 1, 6 and DC
DES is S_{45^o} – only do modes 3,7,8 and DC
DES is S_{135^o} – only do modes 5,4,6 and DC
DES is S_{nd} _ do for all 9 modes
Mode 2 _ DC modes

Figure2. Fast Intra Prediction

In this for finding the DES vertical edge we must do with the modes 7, 0, 5 & DC, for horizontal modes 8, 1, 6 & DC. For 45 deg& 135deg do with 3, 7, 8, DC & 5, 4, 6, DC respectively. And for the DES of the non directional edge we can use all the modes. In 16x16 luma the DES can be detected by taking 0 & DC modes for vertical, horizontal with modes 1& DC and 45 deg do with modes 3 &DC. In 8x8 luma the DES in vertical direction must do with 2 & DC modes and modes 1& DC for horizontal and for 45 deg the DES can do with modes 3 & DC. In 16x16 & 8x8 luma we are eliminating the 130 deg and non directional edge that's why we are using only detected & DC modes for computing the DES.

BI-DIRECTIONAL INTRAPREDICTION

There are 9 predictions in H.624 including DC mode & other 8 directional modes for 4x4 and 8x8 luma. In the mode 0 to predict the current block we are using the top neighbors because that is vertical mode and for horizontal mode (mode 1) we are using left neighbors to predict the current block. For better prediction in bi-directional two prediction modes are clubbed. There are 45 total combinations of 2 predictions are used that is with this 35 bidirectional intra prediction and with the 9 modes already exist. But this much intra modes have some drawbacks.

- Increased encoder complexity
- Increased bit overhead
- The modes used will be less frequentuality

So in order to overcome this simplified BIP are used by the combination of frequently used modes or by the combination of modes from vertical category to the modes of horizontal category.

Mode 9: Vertical + horizontal (1+0)
Mode 10: DC + vertical (2+0)
Mode 11: DC + horizontal (2+1)
Mode 12: Diagonal down left + horizontal (3+1)
Mode 13: Diagonal downright + vertical (4+0)
Mode 14: Vertical right + horizontal (5+1)
Mode 15: Horizontal down + vertical (6+0)
Mode 16: Vertical left + horizontal (7+1)
Mode 17: Horizontal up + vertical (8+0)

Mode 0 prediction

ISSN: 0975-8585

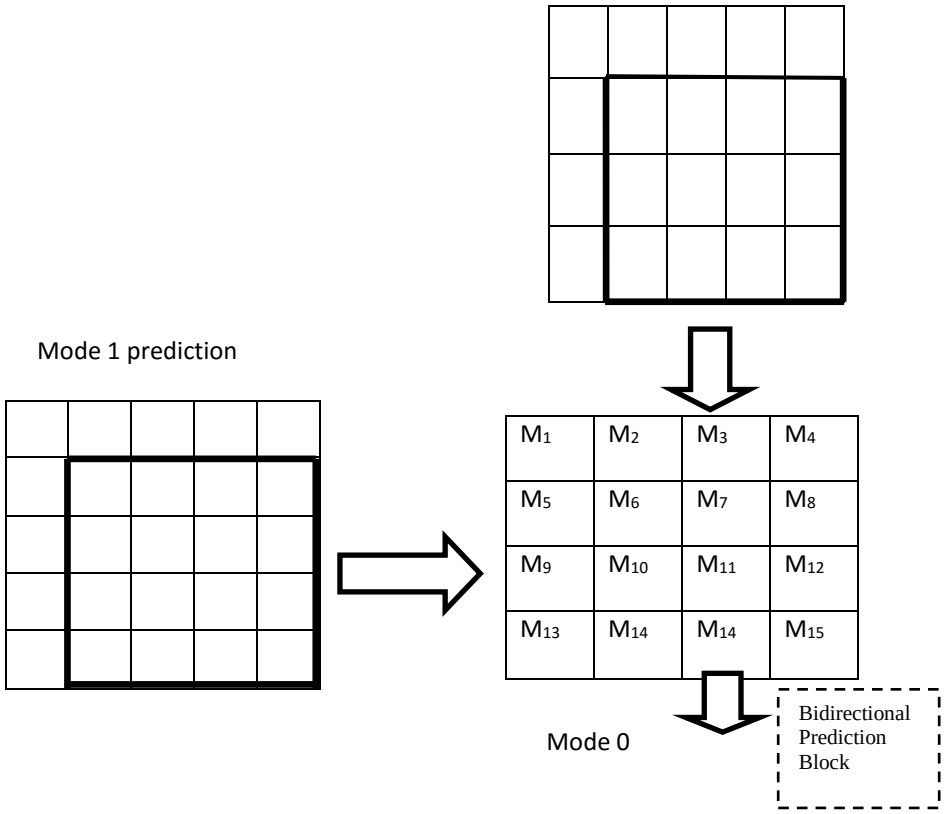


Figure3. Bidirectional IntraPrediction

THREE STEP INTRA ALGORITHM

In order to save the computation power we can also skip some modes after the initial step. In this we are choosing mode 0, 1 & DC mode for the initial step because of its high probability. We are calculating the cost of modes and select the mode of minimum cost. On the second step we are choosing the modes that are smaller of horizontal or vertical modes. So for this we are selecting mode 5, 7 whether mode 0 is less than mode 1and if mode 0 is greater than mode 1 select 6, 8 are horizontal for second step. And for the third step we are choosing the rest two modes 3, 4. In this we are comparing the best mode from the first and second step to get the final mode output decision.

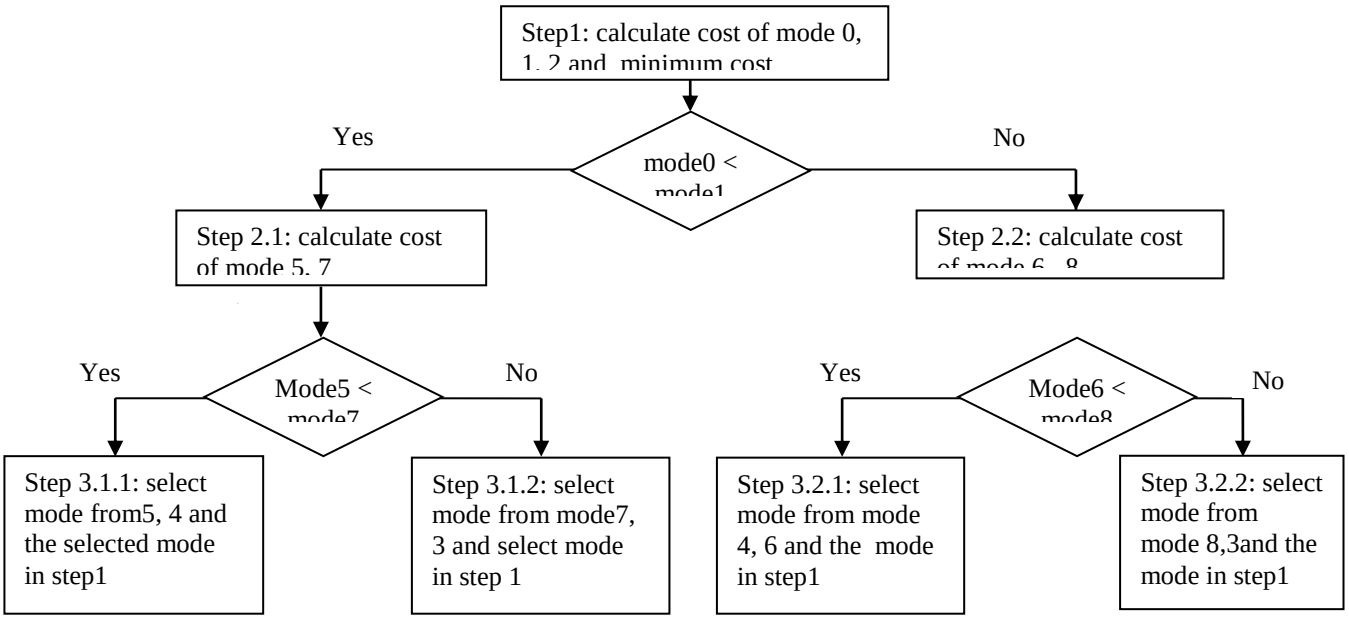


Figure4. Three step Intra Algorithm

GRADIENT INTENSITY-ADAPTED ALGORITHM WITH ADAPTIVE SELECTION STRATEGY

ISSN: 0975-8585

This algorithm has proposed, to increase the run time performance of the encoding in intra prediction. In which the texture orientation inside the block can be evaluated efficiently with a minor degradation of visual quality and bit rate expense. Here a subset of the most probable intra-prediction modes will be chosen and sent for rate distortion optimization process based on the proposed adaptive selection strategy.

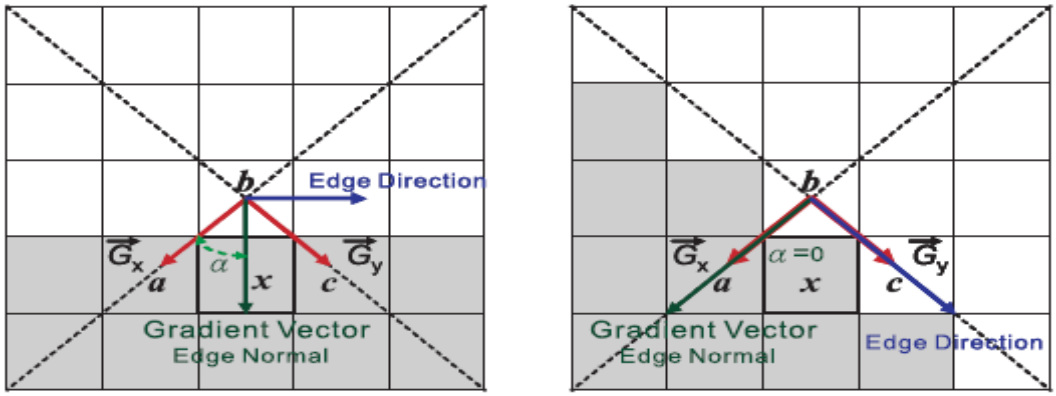


Figure5. Gradient Intensity Algorithm

Sequence	Fast intra mode decision			Three step intra algorithm			Gradient evaluation		
	PSNR (db)	BIT RATE (%)	TIME (%)	PSNR (db)	BIT RATE (%)	TIME (%)	PSNR (db)	BIT RATE (%)	TIME (%)
Foreman	-0.020	2.124	-60.35	-0.019	2.257	-59.58	-0.048	0.65	75.44
News	-0.023	3.493	-58.78	-0.02	1.09	-15.92	-0.038	0.72	74.62
Container	-0.011	3.129	-59.12	-0.01	0.79	-16.03	-0.032	1.63	70.55
Silent	-0.013	2.998	-59.45	-0.07	0.93	-16.62	-0.041	0.69	74.59
Coastguard	-0.036	2.830	-61.49	-0.01	0.79	-16.22	-0.052	0.75	75.01
Average	-0.021	2.915	-59.84	-0.017	2.659	-58.50	-0.052	0.75	75.01

Table1. Comparative analysis for different intra prediction

CONCLUSION

In fast intra mode decision the proposed method has reduced 60% computation time by using DES based algorithm which is computed with the help of spatial filters. But this method has very less PSNR degradation. The bidirectional intra prediction has achieved an improved coding scheme for intra prediction which has developed three functional blocks in H.264 intra coding. Since two modes are clubbed the resultant mode will have complexity. In the three step intra algorithm, it has used only six intra prediction modes out of nine intra prediction modes which results in the reduction of computational time. Since three step algorithms used, the simulation result of this will give the PSNR value similar to the full step search algorithms. Though the result is increase in bit rate. In this review, gradient evaluation technique has the best approach because the adaptive selection strategy selects the most probable intra prediction modes to get a better rate distortion optimization during the process. And also this gradient evaluation had achieved noticeable speedup in the run time performance.

REFERENCES

[1] T. Bernatin, G. Sundari. "Video compression based on Hybrid transform and quantization with Huffman coding for video codec" IEEE International conference on control, instrumentation, communication and computational technologies (ICCICCT) 2014; 452-456.

[2] Lih-Jen Kau, *Member, IEEE, and Jia-Wei Leng* "*Gradient* Intensity-Adapted Algorithm With Adaptive Selection Strategy for the Fast Decision of H.264/AVC Intra-Prediction Modes" IEEE Transactions On Circuits And Systems For Video Technology 2015; 25(6):944-957.

[3] Jia-Ching Wang, *Member, IEEE, Jhing-Fa Wang, Fellow, IEEE, Jar- Ferr Yang, Fellow, IEEE, and Jang-Ting Chen,*. "Fast Mode Decision Algorithm and Its VLSI Design for H.264/AVC Intra-Prediction" .IEEE transactions on circuits and systems for video technology 2007; 17(10):1414-1422.

[4] *Yan Ye and Marta Karc.zewicz* Qualcomm Inc., San Diego, "Improved H.264 Intra Coding Based On Bi-Directional Intra Prediction, Directional Transform, And Adaptive Coefficient Scanning" IEEE International conference on image processing 2008; 2116- 2119.

[5] Chao-Chung Cheng, Tian-Sheuan Chang Dept. Electronics Engineering, National Chiao-Tung University Hsinchu, Taiwan, R.O.C. "Fast Three Step Intra Prediction Algorithm for 4x4 blocks in H.264" IEEE international symposium on circuits and system 2005;503-509.

[6] Mohammed Golam Sarwer and Q. M. Jonathan Wu, *University of Windsor, Canada, Improved* "Intra Prediction of H.264/AVC" IEEE transaction on signal processing 2009; 1508- 1512.

[7] Dae-Yeon Kim Ki-Hun Han Yung-Lyul Lee " Adaptive Single-Multiple prediction for H.264/AVC Intra Coding" , IEEE Transactions on Circuits and Systems for Video Technology, 2010; 20(4):610-615.

[8] A. Ben Atitallah, H. Loukil , N. Masmoudi " Fpga design for H.264/AVC encoder", International Journal of Computer Science, Engineering and Applications (IJCSEA) 2011;1(5):119-132.

[9] Kuen-Cheng Chiang, Ming Feng Wu, et.al " Modification and implementation of an edge based intra prediction mode decision algorithm for H.264/AVC high resolution real-time systems", Journal of visual communication and Image representation , 2012 ; 23(2): 245-253.

[10] Hassen Loukil, Imen Werda, Nouri Masmoudi, Ahmed Ben Atitallah " FPGA Design of an Intra 16 × 16 Module for H.264/AVC Video Encoder *Circuits and Systems*, 2010; 1(1): 18-29.