PERFORMANCE, ANALYSIS OF H.264/AVC LOSELESS VIDEO CODING USING HADAMARD TRANSFORM

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ABSTRACT

An efficient lossless video codec based on H.264/AVC uses the Hadamard transform and adaptive truncation (HTAT).Transforms in their coding procedures are mostly video lossless coding algorithms. The HTAT method has adopted the Hadamard transform to the compaction of data; The Hadamard provides the quotient parts to be encoded. Simulation results show that the proposed HTAT method has better coding performance than that of the original H.264/AVC lossless coding, with 6.2% and 3.7% reductions in bitrate.

Key words: AVC (Advanced Video Coding), Compression artifacts, Hadamard transform,, PSNR (Peak Signal-Noise Ratio). Deblocking filter, DCT (Discrete Cosine, Transform), Video coding,

INTRODUCTION

Information is conveyed through pictures .It conveys about positions, sizes and relationships between objects. Information can be received well from images by human. Analysis for remotely sensed images can be focused. When represented as numbers, brightness can be added, subtracted, multiplied, divided can be added, subtracted. Although the digital analysis of remotely sensed data dates from early days of remote sensing, previously, digital remote sensing data could be analyzed at specialized remote sensing laboratories. Specialized equipment and trained personnel necessary to conductroutine machine analysis of data were not widely available, in part because of limited availability of digital remote sensing data and a lack of appreciation of their qualities.

EXISTING SYSTEM

Advanced standards, such as H.264 MP/HP, SVC, and MVC, adopt Macro Block Adaptive Frame Field (MBAFF) to enhance coding efficiency which results in the performance bottleneck of deblocking filter due to complex data access requirement. [1]. The a high throughput VLSI architecture develops a 4times4/8times8 filter and a buffer management scheme to perform the various coding tools in H.264 de-blocking filter for supporting the coding tools of picture adaptive frame/field (PAFF) coding, macro block adaptive frame/field (MBAFF) coding, and 8times 8 transform coding. [2]. The VLSI architecture for multi-standard in-loop deblocking filter (ILF) supporting H.264 BP/MP/HP, AVS, and VC-1 video decoding. It comprises 38.4 K gates and 672 bytes of local memory using TSMC 0.13 mum CMOS technology when operating at 225 MHz which meets the real-time processing requirement for high-resolution video decoding. [3].

An efficient VLSI architecture for the deblocking filter in H.264/JVT/AVC uses an array of 8×4 8-bit shift registers with reconfigurable data path to support both horizontal filtering and vertical filtering on the same circuit (a parallel-in parallel-out reconfigurable FIR filter). Two SRAM modules are carefully organized not only for the storage of current macroblock data and adjacent block data but also for the efficient access of pixels in different blocks.[4]. Making good use of data dependence between neighboring 4x4 blocks, Design reduces the requirement of on-chip SRAM bandwidth and increases the throughput of the filter processing[5].Amemory-efficient architecture design for a de-blocking filter in H.264/AVC uses the novel column-of-pixel data arrangement to facilitate the memory access and reuse the pixel value.With the novel data arrangement and hybrid filter scheduling, an efficient architecture design is implemented.[6].

A novel method and the efficient integrated architecture design, which involves an 12 times 12 overlapped block that combines overlap smoothing with loop filtering for performance and cost by sharing circuits and resources. [7].One of the details concerns the elimination of the loss in inter block correlation due to block-based prediction, transformation, and quantization. In order to overcome the loss in blocking artifacts, a deblocking filtering method is necessary to maximize coding performance and consequently improve image quality. This letter describes a programmable VC-1 deblocking filter architecture with capabilities to support different standards. [8].AVS is Chinese new audio and video coding standard, in which a loop filter has been applied to remove blocking artifacts. A platform-based architecture for the loop filter of AVS standard is proposed [9].Optimized filtering order and effective filtering process are applied to improve the system efficiency. Parallel processing of filtering operations, data reading, caching, transposing and writing is realized, which facilitates filtering operation while reducing temporary data storage. [10]. performance improvement is very mild if a post-loop filter with an in-loop filter is developed. To alleviate this problem, Derive an integration-oriented algorithm that can be reconfigured as the in-loop or post-loop filter. Moreover, A hybrid filtering schedule to reach a lower bound of processing cycles is developed [11].In order to reduce the memory reference and make the intermediate data reused as soon as possible, an advanced filtering order is taken, and read/write operation on external memory is executed in parallel with filtering computation. [12]. A memory and performance optimized architecture to accelerate the operation speed of adaptive deblocking filter for H.264/JVT/AVC video coding. [13].The process of the deblocking filter causes the intensive requirement of data and computations and increases the execution time of both encoding and decoding. [14]. The two efficient and low power H.264 deblocking filter (DBF) hardware implementations that can be used as part of an H.264 video encoder or decoder for portable applications. The first implementation (DBF_4times4) starts filtering the available edges as soon as a new 4times4 block is ready by using a novel edge filtering order to overlap the execution of DBF module with other modules in the H.264 encoder/decoder. [15].

PROPOSED SYSTEM

LOSSLESS VIDEO CODING

The residual coefficients were not directed coded by entropy coding. They are coded by Hadamard transform. This transform is applied to compact the energy of residual coefficients in a block in to lower frequencies. These coefficients are separated in to quotient and remainder. For truncate process adaptive truncation Algorithm is used. Quotient parts are encoded by entropy coding, remainder by fixed-length coding after redundancies are removed. In order to avoid extra bits, the propose mechanism includes two stages, truncation prediction and truncation update is applied to both encoder and decoder.

H.264/AVC/MPEG-4 has a number of new features which allow to compress video and to provide flexibility.

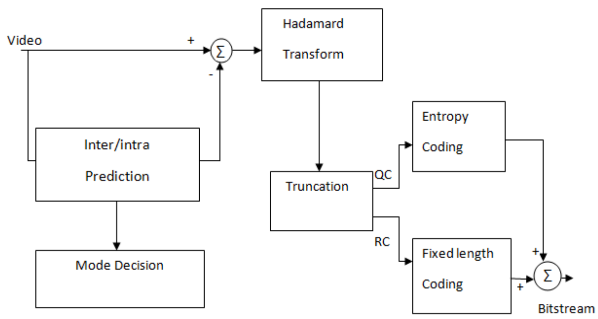

Fig:1.H.264/AVC Modified encoding procedure with the Hadamard transform for lossless video coding.

The simplified encoding procedure of lossless H.264/AVC shown in Fig.1 where the transform and quantization units adopted in lossy H.264/AVC are skipped to avoid any loss of information. The residual data, after the subtraction of inter/intra prediction, are directly encoded by entropy coding. The feedback is not necessary no longer in the encoder since the reconstructed data are identical to the original input data.

A transform can compact the energies to lower frequencies to increase efficiency for entropy coding in lossy H.264/AVC Loss occurs due to rounding errors. The issues of the transform and the mode decision criterion are briefly discussed below. Lossless compression has an incontrovertible value to the archival community. Wavelet compression is the most effective methods of image compression. Algorithm is based on multiresolutional analysis. Like the traditional compression, wavelet compression algorithm presents an image as sets of real coefficients. Most of the wavelet coefficients of a typical image are nearly zero, thus is well-approximated with a small number of large wavelet coefficients. The characteristic of wavelet compression allows the process to get best compression ratio, while maintaining the quality.

INTRA PREDICTION

H.264/AVC defines a block-based hybrid video codec. H.264/AVC does not define the encoder. The codec combines intra-picture prediction with inter-picture prediction.

Intra-prediction is based on the observation that adjacent macro blocks tend to have similar properties.so, for first step, one may predict the macro block of interest from the surrounding macroblocks. The difference between the actual macro block and its prediction is encoded. Prediction may be formed for each 4x4 luma blocks, 16x16 luma MB.

INTER PREDICTION IN H.264/AVC ENCODER

In inter prediction; there are 7 different block-sizes such as 16x16, 16x8, 8x16, 8x8, 8x4, 4x8, and 4x4. These different block sizes actually form a one or two level hierarchy. In case of two levels, the macroblock is specified as P8x8 type.

HADAMARD TRANSFORM

Walsh–Hadamard transform is an example of generalized class of Fourier transforms. The Hadamard transform can be regarded as being built out of size-2 discrete Fourier transforms (DFTs).It decomposes an arbitrary input vector into a superposition of Walsh functions.

The proposed generalized Hadamard transform is symmetric, whereas the generalized Walsh transform is asymmetric. The existing Walsh and the Hadamard transform can be obtained from special case. There generalized transform is used in fields of signal. Transforms play important roles in engineering and applied science fields. Working on the transformed data is much easier and more useful information is obtained. Fourier Transform, cosine transform, sine transform, etc. are the common transforms which based on sinusoids. This is because of the cyclic nature of the sinusoids. Walsh transform and Walsh Hadamard transform are much simple. Transform when compared to sinusoid-based transforms, where the kernel is made of 1 and –1. As a result these transforms can be implemented without any cost of multiplication operation. Hence Walsh and Hadamard transforms are much faster than FFT.

For designing optimal weighting experiments as well as experimental design (analysis of variance) models such as factorial designs, you den designs and Latin Squares Hadamard matrices are used. Kernels of the Walsh-Hadamard transforms are orthogonal and the elements of the kernels are 1 and –1.Walsh transform and Hadamard transform are special cases of these generalized transforms. The generalized Walsh transform and generalized Hadamard transform are interrelated. As the Walsh and Hadamard transforms are ordered differently, so in the generalized Walsh transform and Walsh Hadamard transform are different so far as the kernel composition is concerned.

Generalized Walsh kernel is asymmetric, whereas the generalized Hadamard kernel is symmetric. Pseudo Walsh kernel is symmetric but it cannot be generated as the original kernel is generated. Sequency which is an analogue term of frequency is used in Walsh transform and the Hadamard transform. The average number of zero crossing per unit time is generally mean by sequency. With referred to a transform kernel of a specific size, it refers to the number of change in sign in a particular sequence or the row of the kernel. The size o is generally a power of 2. The signal to be transformed must be a length of power 2. In the original transform kernel all the elements are of 1 or –1. The minimum kernel in both Walsh and Hadamard transform is a 2×2 symmetric matrix.The Hadamard transform H_m is a $2^m \times 2^m$ matrix, the Hadamard matrix (scaled by a normalization factor), that transforms 2^m real numbers x_n into 2^m real numbers X_k. In two ways the Hadamard transform can be defined: recursively, or by using the binary (base-2) representation of the indices n and k. Recursively, the 1 × 1 Hadamard transform H_0 is defined by the identityH_0 = 1, and then define $H_m$for $m > 0$ by:

$$H_m = \frac{1}{\sqrt{2}} \begin{bmatrix} H_{m-1} & H_{m-1} \\ H_{m-1} & -H_{m-1} \end{bmatrix} \quad (1)$$

where the 1/√2 is a normalization that is sometimes omitted. The Hadamard matrices are made up entirely of 1 and −1.

Hadamard matrix by its (k, n)-th entry by writing

$$\mathbf{k} = \sum_0^{i<m} \mathbf{k}_i 2^i = \mathbf{k}_{m-1} 2^{m-1} + \mathbf{k}_{m-2} 2^{m-2} + \cdots + \mathbf{k}_1 2 + \mathbf{k}_0 \quad (2)$$

and

$$\mathbf{n} = \sum_0^{i<m} \mathbf{n}_i 2^i = \mathbf{n}_{m-1} 2^{m-1} + \mathbf{n}_{m-2} 2^{m-2} + \cdots + \mathbf{n}_1 2 + \mathbf{n}_0 \quad (3)$$

where the k_j and n_j are the binary digits (0 or 1) of k and n, respectively. The element in the top left corner,

Define: $k = j = 0$.

In this case;

$$(H_m)_{k,n} = \frac{1}{2^{m/n}}(-1) \sum_j k_j n \quad (4)$$

This is exactly the multidimensional 2 X 2 X 2 X 2 X2 DFT, normalized to be unitary, if the inputs and outputs are regarded as multidimensional arrays indexed by the n_j and k_j, respectively.

MODE DECISION MECHANISM FOLLOWED

In H.264/AVC, By minimizing the cost function, the best inter/intra mode for encoding is selected. H.264/AVC adopts different cost functions in different scenarios. The complexity increases when rate distortion optimization (RDO) is enabling. In prediction process the real encoding procedures, including FT and IT, quantization, and entropy coding, are required. The cost function when RDO is enabled is defined as

$$RDcost = D_{SSD} + \lambda R \quad (5)$$

Where $\lambda = 0.85\ X\ 2^{(QP-12)/3}$ (6)

*D*SSD is the sum of the square differences between the original and the reconstructed coefficients in a block, and *R* is the true coded bit rate. Estimation techniques are adopted in H.264/AVC to avoid the real encoding procedures in the RDO process,. The cost function when RDO is disabled is defined as

$$RDcost = D_{SSE/SAD/SATD} + \lambda' R' \quad (7)$$

Where *D*SSE*/*SAD*/*SATD is the sum of square errors, sum of absolute differences, or sum of absolute transformed differences between the original and the predicted blocks, and *R*_ is the predicted bit rate.

For *D*SSE, $\lambda' = \lambda$ is used; however, for *D*SAD and *D*SATD, the following is used:

$$\lambda' = round(2^{(QP-12)/6}) \quad (8)$$

In lossless coding, since the differences between the original and the reconstructed coefficients in a block are zeros, the cost function in the RDO process can be simplified to

RDcost = R

By minimizing the true coded rate in H.264/AVC lossless coding the best inter/intra prediction mode in the RDO process should be determined. When RDO is disabled, the bit rate is only predicted for encoding the macro block header. The bit rate of encoding the residual data is not considered. Here only the case of RDO being enabled is considered.

Prediction:

A process by which a set of prediction values is created (often based in part on an indication sent by an encoder to form the prediction based on analysis of the input samples and the types of prediction that can be selected in the system design) that is used to predict the values of the input samples so that the values that need to be represented become only the differences from the predicted values, such differences being called the residual values.

ENCODING PROCEDURE

The overall encoding procedure of lossy H.264/AVC is shown in the figure: 2.Temporal/spatial redundancies of the input video or image removed by inter/intra prediction. The best inter/intra prediction mode is determined by the mode decision module in terms of the minimum rate distortion cost. After the prediction, by using entropy coding, the residual data are transformed, quantized, and then encoded to generate the output bitstream. The inverse transforms and inverse quantization reconstructs the reference pixel data for future inter/intra prediction performed by the feedback path used in the subsequent blocks and frames. A deblocking filter is also required in the feedback path to eliminate the blocking artifacts of the reference frames.

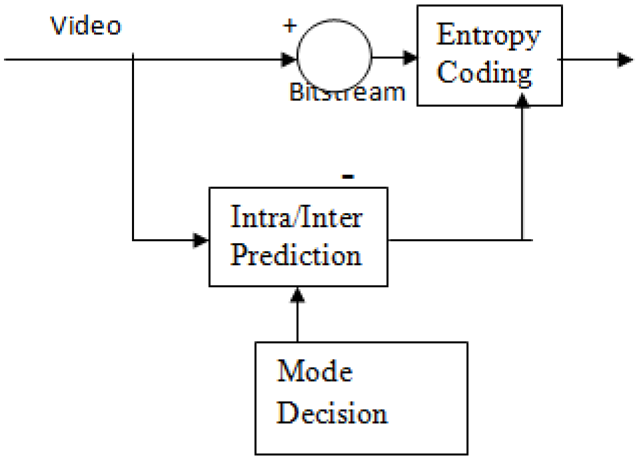

Fig: 2. Block diagram of Entropy encoding

Loss of information avoided by using transform and quantization units adopted in lossy H.264/AVC are skipped .The Residual data, after the subtraction of inter/intra prediction, are directly encoded by entropy coding. The feedback path is no longer needed in the encoder, since the reconstructed data are identical to the original input data, the stored input data directly used by the inter/intra prediction

In lossy H.264/AVC to increase efficiency for entropy coding by transform can compact the energies to low frequencies , it is skipped in lossless H.264/AVC to avoid inflation of the data magnitude and loss due to rounding errors. In lossless coding the mode decision criterion of H.264/AVC can be simplified.

ENTROPY ENCODING

An entropy encoding is a lossless data compression .It is independent of the specific characteristics of the medium. Each unique symbol that occurs in the input that can be creates and assigns a unique prefix-free code by Entropy Encoding. Entropy encoders compress data by replacing each fixed-length, variable-length prefix-free output code word corresponds to the input symbol. Negative logarithm of the probability is approximately proportional to the length of each code word. Most common symbols use the shortest codes.

Based on Shannon's source coding theorem, $-\log_b P$ is the optimal code length for a symbol, where b is the number of symbols used to make output codes and P is the probability of the input symbol. Huffman coding and arithmetic coding are the common entropy encoding techniques. Entropy characteristics of a data stream are known in advance (mainly for signal compression), a simpler static code is useful. Universal codes (such as Elias gamma coding or Fibonacci coding) and Golomb codes (such as unary coding or Rice coding) are included in the static codes.

ENTROPY AS A MEASURE OF SIMILARITY

Digital data compress by using Entropy Encoding. The amount of similarity between streams of data can also be measured by Entropy Encoder. This is done by generating an entropy coder/compressor for each class of data; unknown data is then classified by feeding uncompressed data to each compressor and to know which compressor yields highest compression. The coder with the best compression is the coder trained on the data is most similar to the unknown data.

EXPERIMENTALRESULTS

Encode Sequence:

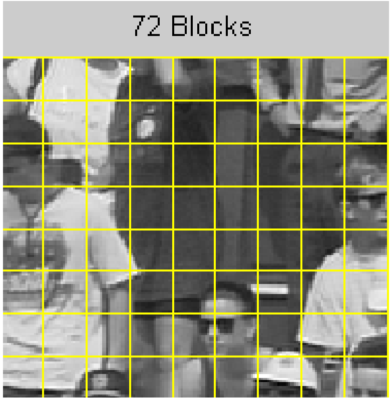

Fig: 3. Encode Sequence
(72 block sequence)

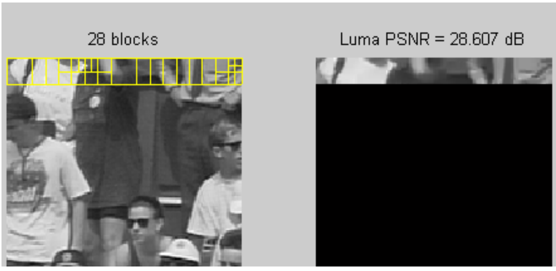

Fig: 4 .Encode Sequence
(28 block sequence)

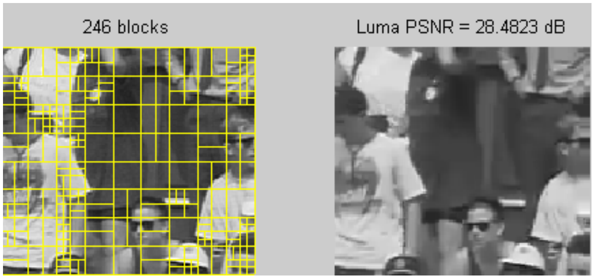

Fig: 5. Encode Sequence
(246 block sequence)

Decode Sequences:

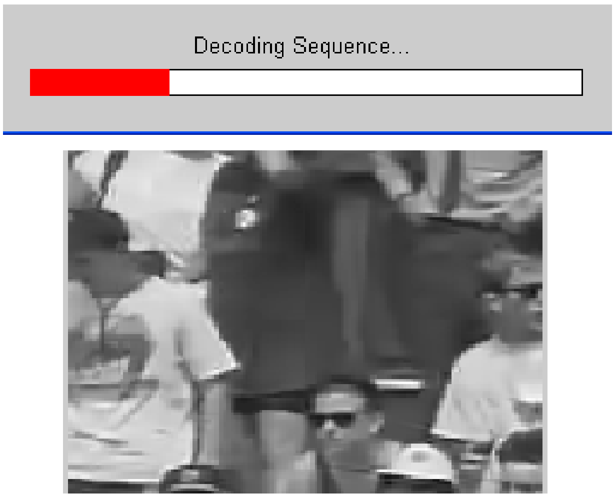

Fig: 6.Decoded sequence

First step to get the input sequence. Here taken a input as crowd sequence in YUV format. Sequence can be divided into blocks. Blocks are randomly chosen. For example Let consider the blocks 28,43,66,72,246 blocks shown in (fig 3,4&5).Once these blocks are formed the sequence is passed for inter and intra prediction. The image sequence is passed into the Hadamard transform matrix after inter and intra prediction. To get the respective output corresponding function is executed. After the coding process these bits are added using an adder and then the bits can be combined in such a way that they can be decoded once again to get the decoded sequence that is, the original image. The sequence is only divided into blocks but the blocks are not divided separately and extracted shown in fig .6. The PSNR value increases during the encoding process and then it attains a constant value at the end of the process shown in fig 7.

COMPARISON FOR COMPRESSION PERFORMANCE OF EXISTING AND PROPOSED METHOD

ALL FRAMES I SEQUENCES

IPPP SEQUENCES	H.264-LS RATE(MB)	Mochizuki		Proposed	
		Rate(MB)	Savings(%)	Rate(MB)	Savings(%)
Coastguard	7.18	8.29	43.90	6.93	-0.17
Foreman	7.13	7.99	15.49	7.03	-3.41
Mobile	10.25	10.54	12.06	9.65	-1.46
News	4.16	5.47	2.85	4.14	-5.89

FOR IPPP SEQUENCES

ALL FRAMES 1 SEQUENCES	H.264-LS RATE(MB)	Mochizuki		Proposed	
		Rate(MB)	Savings(%)	Rate(MB)	Savings(%)
Coastguard	8.14	8.88	9.11	7.68	-5.74
Foreman	7.81	8.29	6.16	7.17	-8.23
Mobile	11.95	11.99	0.39	10.97	-8.16
News	7.74	8.33	7.68	7.16	-7.50

Table: 1. PERFORMANCE ANALYSIS TABLE

Comparison table (1) shows bit rate reduction in the proposed method compared to the existing method for all FRAMES I sequences and for IPPP sequences. Simulation results show that the proposed HTAT method has better coding performance than that of the original H.264/AVC lossless coding, with 6.2% and 3.7% reductions in bit rate for all I frame sequences and IPPP sequences, respectively.

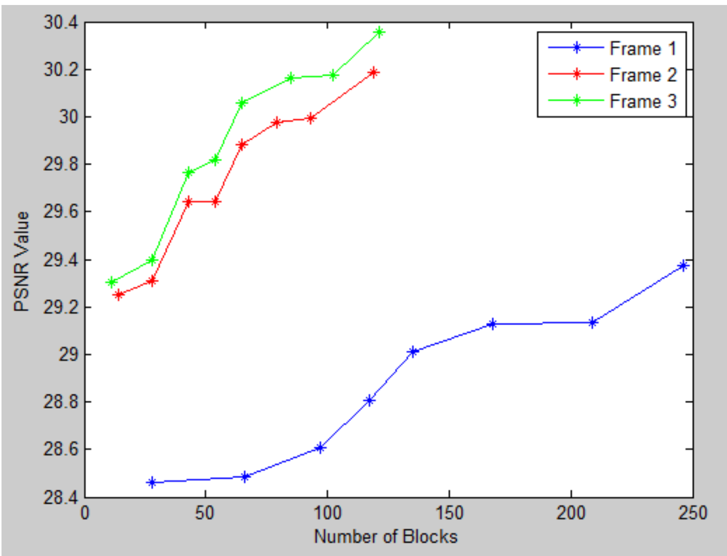

Fig: 7. PSNR IMPROVEMENT

CONCLUSION

An efficient video coding uses the Hadamard transform with adaptive truncation. The coefficients which are generated and processed. After the transform, the coefficients are separated by the proposed algorithm. Due to the Hadamard transform, the remainder parts contain redundancies. Removal of redundancies, remainder parts is encoded. The adaptive truncation algorithm contains two stages: truncation prediction and truncation update. No need of the extra bits to notify the decoder. Finally, simulation results reveal the proposed algorithm the original H.264/AVC lossless coding.

REFERENCES

[1] C. A. Chien, H. C. Chang, and J. I. Guo, “A High Throughput In-Loop Deblocking Filter Supporting H.264 /BP / MP / HP Video Coding,” Proc.*IEEE* APC-CAS,pp.312-315, Dec .2008.
[2] C. A. Chien, H. C. Chang, and J. I. Guo, “A High Throughput DeblockingFilter Design Supporting Multiple Video Coding Standards,” Proc. IEEE ISCAS, pp.2377 - 2380, May 2009.
[3] Y. W. Huang, T. W. Chen, B.Y. Hsieh, T. C. Wang, T. H. Chang, and L. G.Chen, “Architecture design for deblocking filter in H.264/JVT/AVC,” Proc.IEEE ICME, vol.1, pp. I - 693-6, July 2003.
[4] B. Sheng, W. Gao, and D. Wu, “An Implemented architecture of deblocking filter for H.264/AVC,” Proc. IEEE ICIP, vol.1, pp. 665-668, Oct. 2004.
[5] T. M. Liu, W. P. Lee, T. A. Lin, and C. Y. Lee, “A memory-efficient deblocking filter for H.264/AVC video coding,” Proc. IEEE ISCAS, pp.2140-2143, May 2005.
[6] Y. L. Lee, and T. Nguyen, “Analysis and Integrated Architecture Design for Overlap Smooth and In-Loop Deblocking Filter in VC-1,” Proc. IEEE ICIP, vol.5, pp. 169-172, 2007.
[7] R. Citro, M. Guerrero, J. B. Lee, and M. Pantoja, “Programmable Deblocking Filter Architecture for a VC-1 Video Decoder,” IEEE Trans. Circuits Syst. Video Technol., vol. 19, No.8, pp.1227-1233, Aug. 2009.
[8] B. Sheng, W. Gao, and D. Wu, "A Platform-based Architecture of Loop Filter for AVS,“IEEE ICSP, vol. 1, September 2004.
[9] Q. Chen, Q. M. Yi, and M. Shi, “High-Performance Deblocking Filter Design and Implementation for AVS HDTV Applications,” Proc. IEEE WiCOM, pp. 1-4, 2011.
[10] T. M. Liu, W. P. Lee, and C. Y. Lee, “An in/post-loop deblocking filter with hybrid filtering schedule,” IEEE Trans. Circuits Syst. Video Technol., vol. 17,No.7, pp.937-943, Jul. 2007
[11] Y. X. Zhao, and A. P. Jiang, “A novel parallel processing architecture for deblocking filter in H.264 using vertical MB filtering order,” Proc. ICSSIC T, pp.2028-2030, Shanghai, 2006.
[12] K.Y. Min and J. W. Chong, “A memory and performance optimized architecture of deblocking filter in H.264/AVC,” Proc. ICMUE, pp.220-225, Seoul Korea, April 2007.
[13] T. H. Tsai, and Y. N. Pan, “High Efficient H.264/AVC Deblocking Filter Architecture for Real-time QFHD,” IEEE Trans. Consumer Electron., vol. 55, no. 4, pp. 2248-2256, Nov. 2009
[14] H. C. Chung, Z.Y. Chen, and P. C. Chang, “Low Power Architecture Design and Hardware Implementations of Deblocking Filter in H.264/AVC,” IEEE Trans.Consumer Electron., vol. 57, no. 2, pp. 713-719, May 2011
[15] Proposed SMPTE Standard for Television: VC-1 Compressed Video Bitstream Format and Decoding Process, “SMPTE 421M,” 2005.