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Exploration of De blocking Filter and Sample Adaptive offset for HEVC Standard

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Abstract

High Efficiency Video Coding (HEVC) is presently the advancing standard with enhanced compression arrangement when related with the former video (AVC) standards. This paper provides a survey on this standard and is being done on efficient implementation of de blocking filters. The De blocking filters used in this standard reduces the blocking artifacts which increases the video quality. The SAO (Sample Adaptive Offset) which is done subsequent to de blocking is the introduction of advanced loop filtering. High level parallelism tools are employed in this standard. This compression capability can be implemented in broadcasting applications. An estimation of quality, file size and compression ratio has been made in this paper by using Codec Visa simulation software which proves that H.265 has better efficiency than H.264.

Keywords: *HEVC, De blocking filter, Sample adaptive offset (SAO), H.264, parallelism*

1. Introduction

High Efficiency Video Coding (HEVC) and H.265 are the latest standards created by JCT-VC working together with MPEG which is the next in succession for video standard. The primary work done by HEVC is, to reduce the speed of the transfer of bits to half while measuring up with the previous video standard (AVC) under same visual quality with efficient coding tools. The most sorted is de blocking filter algorithm. HEVC, in a similar fashion as earlier video compression standards, splits video frames into blocks then deals with transforms together with quantization separately for individual block. De blocking filter is used to tackle the element identification, boundaries of Coded blocks and then downgrades their effects by employing a respective design of the filter [2]. HEVC exhibits a new loop filtering stage in addition to the de blocking filter called as Sample Adaptive Offset (SAO) which is performed after de blocking filter to process the undesired elements. The HEVC encoding and decoding is typically divided into 3 different courses of actions. The first strategy is the picture reconstruction. The second scheme is the DBF and finally SAO filtering. In distinction to the DBF of AVC, DBF of HEVC requires least number of computational resources and provides more parallelization possibilities with an advantage of notable shrinkage of visual artifacts[1][2].The remaining contents of the paper is outlined as follows. Section II describes the HEVC standard and its internal block architecture. Section III includes the comparison of HEVC with the current standard (AVC) and its applications.

2. Overview of HVEC Standard

To maintain the block based hybrid video coding is the fundamental design of any significant video coding standards spanning over H.261. Every block of the image is intra coded regardless of other image of the video arrangement or it is inter coded where the expectation signal is shaped by the dislodged block of a previously coded picture [3].The internal blocks of HEVC and its functions are explained in the following.

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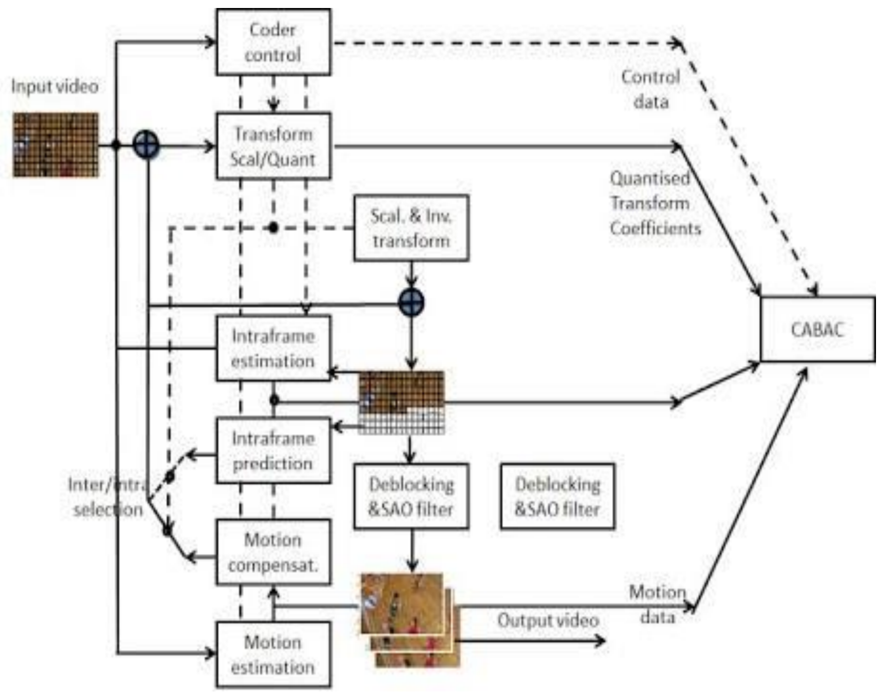

Figure 1. HVEC Encoder[6]

2.1. Coding Tools of HVEC

Several new coding structures are included in this standard: CU (coding unit), PU (prediction unit), TU (transform unit).The essential working unit in HEVC is the Coding Tree Unit (CTU) that is included as the Macro block in H.264 (AVC).The CTU is additionally divided into different CU to comply with the diversified local characteristics [4].The size of code tree unit may be 64×64, 32×32, 16×16. The CU is the fundamental blocks of partition utilized for intra/inter coding. PU holds the knowledge connected to the prediction procedure. TU is utilized to perform the transform and the quantization process, and it leans on PU partitioning modes.CU is further divided into LUMA CB (luminance) and Cb CB and Cr CB (Chrominance). CB is the deciding blocks to carry out either inter picture or intra picture. But CB is too large to detect the motion of the picture. So each CB is further divided into PB's

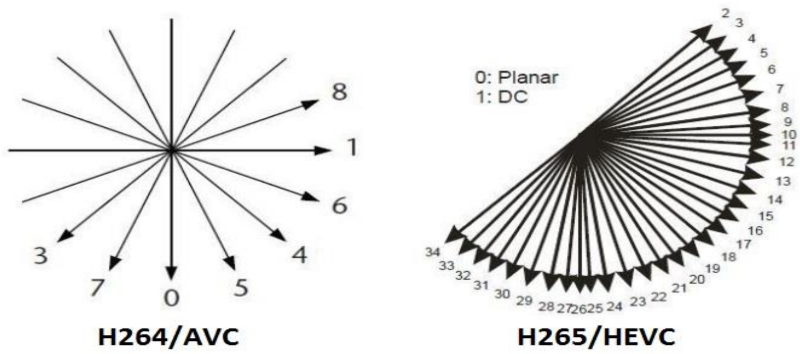

Figure 2. Prediction Modes

The 33 angular modes including DC mode was depicted in HEVC when compared with the previous video standard (AVC) which has exclusively 9 number of prediction modes. Block transform is used to determine the prediction residual. The luma CB residual is same as that of the luma transform block (TB).

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2.2. Motion Vector Signaling

Advanced motion vector prediction (AMVP) is utilized which includes the extraction of predominant convenient candidates which relies on the data from nearby PB's and the resource picture. Furthermore, in contrast to h.264/AVC, enhanced, diverted and direct motion interference is also listed. [8]

2.3. Motion Estimation and Compensation

Estimation of Movement is the generally utilized effective method to diminish temporal correlation between's the frames and yields a major compression gain with steady picture quality [5].Multiple reference pictures are used as similar to h.264/AVC,. For all possible block one or two PB's are sent which yields in all possible uni-predictive or bi-predictive coding accordingly [8]. The discrimination among the chosen predictor and actual motion vector is transmitted.

2.4. Entropy Coding

Context adaptive binary arithmetic coding (CABAC) is utilized in the process of entropy coding. This uses the same fashion as the CABAC in h.264/AVC but encounters a variety of transformations in producing higher output data speed and its accomplishment of compression in addition to minimizing the context storage provisions [8].

3. Filtering DBF and SAO

For implementing the high quality resolution for HEVC encoders, blocking artifacts between the MB's of the video has to be reduced. To remove the blocks and to smoothen these blocks we need filters which removes the high frequency components. Thus the filters used in the encoding process are De blocking filters and SAO filters. The brief description and its architecture of these filters are as follows.

3.1. De blocking Filter algorithm in HEVC

De blocking filters assumes a significant job so as to recognize and break down the real and artificial edges on coded block [7]. De blocking filters are video filters applied to the compressed video to improve video quality by smoothing the sharp edges. HEVC DBF algorithm is applied to luma and Chroma of LCU. The primary trouble when planning a de blocking channel is to conclude just in case to filter a distinct block boundary, and to conclude on the filtering strength that is to be practically correct [2]. Extreme separation prompts the pointless smoothing of the image and the absence of filtering results in blocking artifacts which lessens the video attribute.

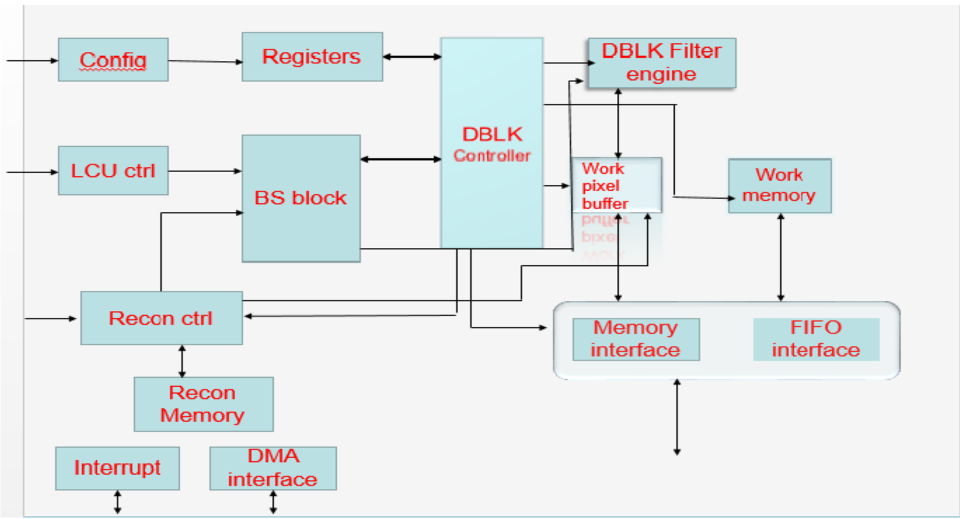

Figure 3: Block diagram of De blocking filter [8]

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The top – level structure includes a filter engine to use filters on Luma as well as Chroma items. To back up the nearby picture elements and in different fashion for Left and Top LCU, a Work Memory is employed. A First In First Out member is employed to transfer with additional hardware modules of HEVC [8].

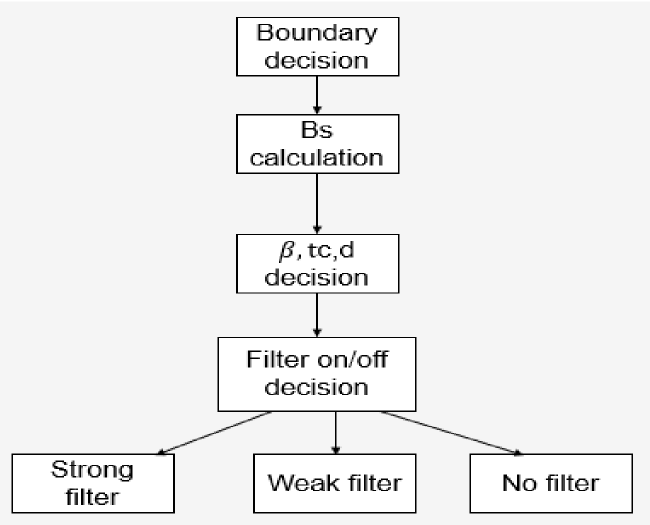

Figure 4: Overall processing flow of DBF [2]

The de blocking filter starts with the filtering of the edges. Initially vertical edges are smoothened by horizontal filtering and at the next moment, horizontal edges are smoothened by vertical filtering. The diversified circumstances that chooses if the segment is smoothened or not. Powerful or less smoothening is brought to the edge controlled by these situations. The procedure for DBF is represented in figure 4. Initial block, the boundary decision provider, will make the decision depending on the current block whether it is CU, PU or TU. When the condition is not satisfied, at that point, the filtering procedure should be avoided to the present limits. The next module will determine the strength of the boundary to be filtered. Its values ranges from 0 to 2.Finally the β, tc decision, decision of ON/OFF of a filter, strength and weakness of filter selection and the procedure of filtering are revised which are located on the QP block[2].
The decision boundary describes that the picture is divided into CTU in which each contains Chroma CTB and Luma CTB. Then according to the values we determine whether the block is CU, TU, and PU. The Z-scan format is represented in figure 5.The Z-scan is performed to achieve recursive partitioning of the pictures. [2]

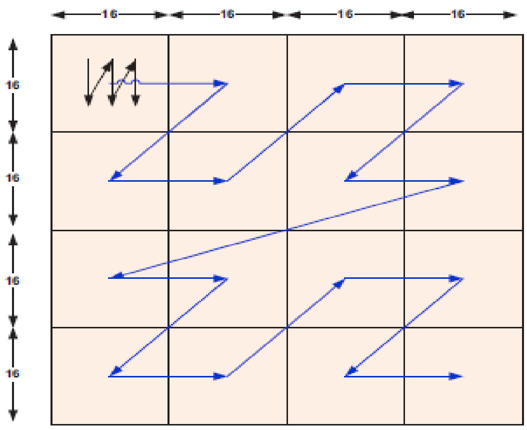

Figure 5: Z-scan order [8]

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3.2. SAO in HEVC

Sample Adaptive Offset (SAO) is done after De blocking. Sample Adaptive Offset is the procedure of including the balance values to the Deblocked pixels tendering to the SAO type. They are BO ,the Band Offset and EO, the Edge Offset. Due to this filtering process bitrates are saved up to 6%.

3.2.1 Band Offset (BO)

Band Offset categorizes the picture elements of a range into multiple range of band. Every band contains picture elements with same intensity. The intensity level is classified into thirty two intervals from zero to highest intensity value. These 32 bands are divided into 2 groups with each group containing 16 bands. [8]

3.2.2 Edge Offset (EO)

Edge Offset uses 4 1 D pixel patterns as shown in figure 5.Each region of the picture selects one pattern into multiple categories by comparing each pixels with its neighboring pixels. The edge directions are 0°, 90°, 135°, and 45°.

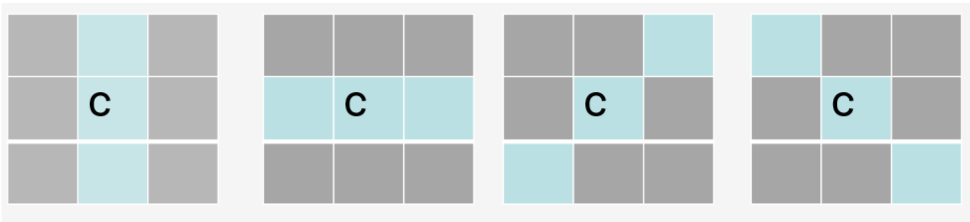

Figure 6: EO pixel classification patterns

The top level blocks of SAO filter are shown in figure 7. The Hardware has SAO filter engine that acts on filtering procedure on respective pixel elements. "Work Memory" is used to backup the nearby pixel and mode for left and top LCU. Work Pixel Buffer is utilized to accumulate the run time input and output data and also the specifications of Left and Top LCU. A Formatter unit is adopted in this procedure of faster conversion and Cb, Cr interleaving. A VDMA trigger is put to use in the writings in top and left pixel data.

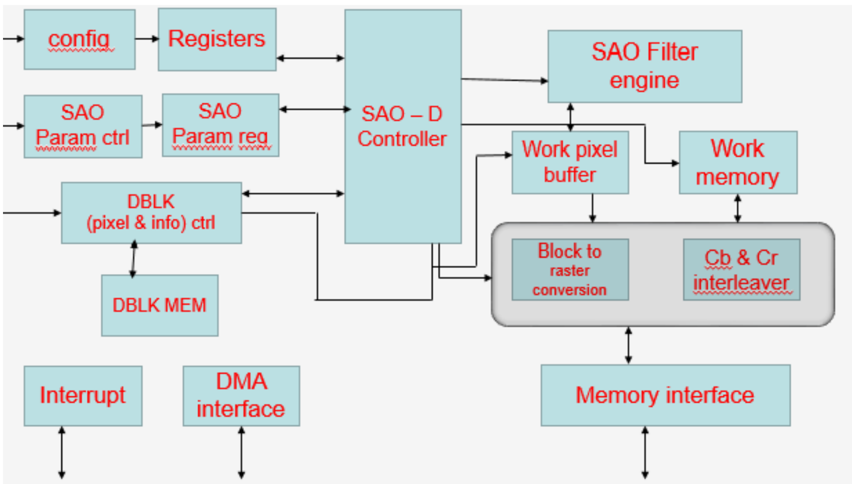

Figure 7: Block diagram of SAO filter [8]

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3.2.3 Core Engine

The Core pixel level processing is formulated on SAO type i.e. BO, EO.

3.2.4 Pipeline

Pipelining is a process to maximize the throughput of the filter. In figure 7 a three level vast pipeline operating at 4×4 2D level is represented in figure 8.

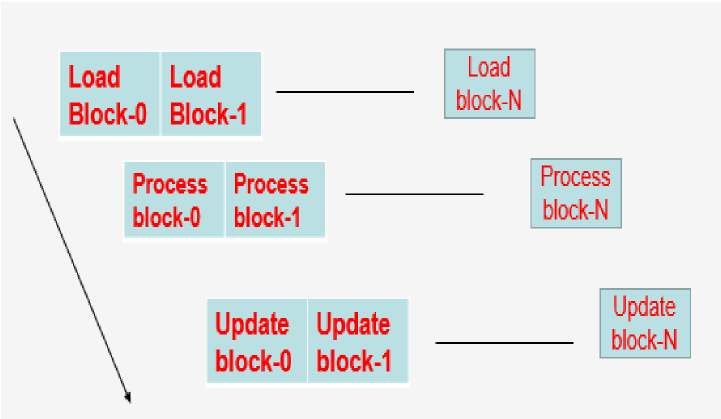

Figure 8: SAO Decoder pipeline [8]

4. Parallelization Approach

To enhance the speed of video processing and to prevent the frequency scaling, parallelization is employed. The parallelization of the de blocking filters is performed in the following ways.

4.1. Slices

Slices are the partitioning of the pictures which is used in the current video standard (AVC). One or more slices are found in partitioning a single video picture. [9] The slices are partitioned in raster scan. Slices are designed for generating network packets and in addition for parallel processing. However the boundaries which divides the frames cause's rate distortions and also a range of specifications should be transferred at the initial stage of every slice which increases memory requirement.

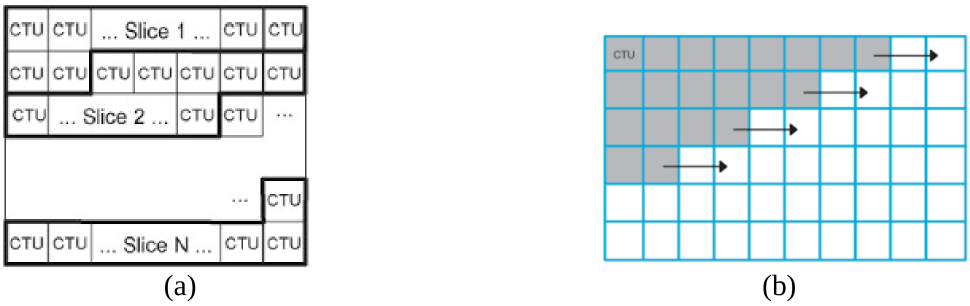

Figure 9: a) Division of picture into different slices

b) Parallel approach using tiles

4.2. Tiles

A new pattern to overcome the limitations of slices is the introduction of tiles in HEVC. Tiles are designed which targets the use of parallel processing techniques. Tiles are rectangular structures composed by number of CU's.

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5. Comparison of Current Standard with HEVC

Compared with the current standard, HEVC keeps some of its original technologies and make things relevant. HEVC shows better improvement in bitrate, good quality, and reduction in bandwidth, file size reduction and to achieve better optimization as far as possible. In the following part a list of comparison was made depending on the bandwidth consumption, file size and quality.

5.1 H.265 vs H.264 Compression Ratio and Bandwidth Utilization

H.265 offers higher quality compression when compared with H.264 and lower bandwidth utilization.

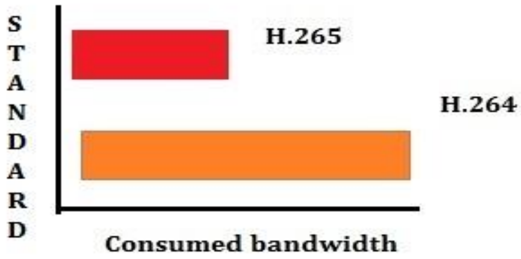
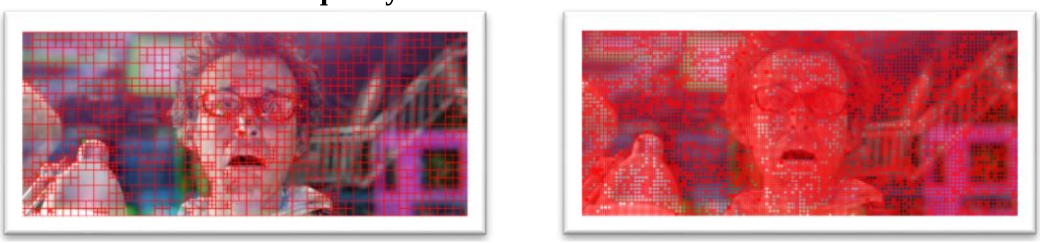


Figure 10: Bandwidth consumption of AVC over HEVC.

[Source – Codec Visa]

For video related solutions, the eventual purpose for the motion picture file is to decrease the size of the file, so that it takes up less memory space and also to lessen the usage of network in transfer of data [11]. In Contrast to H.264, the best quality of H.265 is that it has improved compression ratio and the essential utilization is to decrease the speed of the design flow so as to bring down the expense for transmission. H.265 exhibits higher number of tools to decrease the bit rate. For instance, in H.265, the CTU fluctuates from 8×8 to 64×64 where as in H.264 every individual macro block is predetermined at a size of 16×16.

5.2. H.265 vs H.264 video quality



(a) (b)

Figure 11: Video quality of (a) HEVC (b) AVC [Source – Codec Visa]

H.265 can deliver a improved quality motion picture data at a 50 percent of the bandwidth which can be used for broadcasting applications with low internet speed. The difference in video quality is seen in figure 11.In H.264 (figure b) modernization, the segments are totally autonomous to one another. So the errors in coding are expected to occur. On controversy, we have our HEVC encoding in right (figure a) in which we can see that the picture quality enhancement is superior than H.264[11].

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5.3. File size H.265 vs H.264

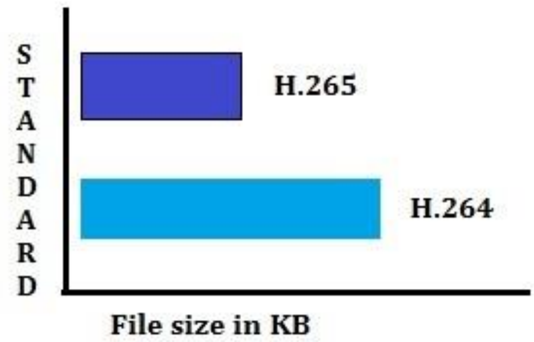

Figure 12: File size comparison of AVC with HEVC[Source-Codec Visa]

On comparing with AVC standard, the HEVC has reduced file size along with high quality video compression. Thus the file size comparison of the current standard and H.265 is provided in figure 1. Now it is known that H.265 is better than H.264. Without any question H.265 will turn into a future insurgency in coding innovations with unique quality being remained.

6. Conclusion

In order to reduce the bit rate, several tools and techniques have been introduced with higher computational complexity. This paper provides a survey of HEVC implementation on real time applications such as broadcasting videos. These videos can be achieved with higher resolution with a lesser bit rate than H.264 by implementing DBF and SAO tools. The investigations done in this paper is to be extended to realize an optimum parallel & pipelined architecture for de blocking filters in video coding.

References

[1] Anand Meher Kotra, Mickael Raulet, Olivier Deforges,"Comparison of Different Parallel Implementations For De blocking Filter Of HEVC" IEEE IETR-INSA, UEB, UMR , 6164,Rennes, 35708, France.2013

[2] Kang Runlong, Zhou Wei, Huang Xiaodong ,Dong BingChao, "An Efficient De blocking Filter Algorithm for HEVC" IEEE ,School of Electronics and Information, Northwestern Polytechnical University, Xi'an, China,2014

[3] Jens-Rainer Ohm, Gary J. Sullivan,Heiko Schwarz, ThiowKeng Tan, and Thomas Wiegand, "Comparison of the Coding Efficiency of Video Coding Standards—Including High Efficiency Video Coding (HEVC)"IEEE,Vol 22 ,No 12,December 2012

[4] HONG Liang He Weifeng, Zhu Hui Mao "A Cost Effective 2-D Adaptive Block Size IDCT Architecture for HEVC Standard" IEEE , School of Microelectronics, Shanghai Jiao Tong University, Shanghai 200240, China.2014

[5] Deepak Singh &SukadevMeher,"Direction-Adaptive Motion Estimation(DAME) for Efficient Video Compression" IETE Technical Review, Volume 33,2016

[6] Gary J. Sullivan, Woo-Jin Han, and ThomasWiegand"Overview of the High Efficiency Video Coding (HEVC) Standard"IEEE,Member,Vol22,No 12,December 2012

[7] Anand Paul, " High Performance Adaptive De blocking Filter for H.264/AVC",IETE Technical Review , Volume 30 2013

ISSN: 2233-7857 IJFGCN

[8] MihirMody, NirajNandan and Tamama Hideo*“High Throughput VLSI Architecture supporting HEVC Loop Filter for Ultra HDTVMultimedia Architecture Group, OMAP,Texas Instruments Inc Bangalore India, Dallas, USA.2013

[9] Philippe Bordes, Gordon Clare, Félix Henry, MickaëlRaulet, JérômeViéron Technicolor, &Orange Labs, “An overview of the emerging HEVC standard” France. 2010 IEEE

[10] http://www.videoconverterfactory.com/tips/h265vsh264.html

[11] www.codecian.com [Codec Visa]

ISSN: 2233-7857 IJFGCN