

Rate Distortion Performance of Motion Estimation for High Efficiency Video Coding

Perla Anitha, P. Sudhakara Reddy, M N Giri Prasad

Abstract: The contemporary coding standard for video is High Efficiency Video Coding Standard (HEVC). It's introduced by ITU-T (International Telegraph Union) and Joint Collaborative Team on Video Coding (JCT-VC). HEVC attains the requirement of videostorage and transmission with high resolution. Although it requires the high amount of computational complexity. Motion Vectors are determined with motion estimation analysis; it is implemented with different types of algorithm. In this paper, Motion Estimation Process is implementing with the content split block search algorithm. It improves Peak Signal Noise Ratio (PSNR) than to the existing algorithms. The Objective evaluation has been performed with PSNR. The Subjective analysis also verified through Matlab Software in the process of encoding and decoding.

Index Terms: high resolution, motion vectors, video storage and transmission, motion estimation.

I. INTRODUCTION

A Meteoric Evolution of mobile technology with new exercise requires a large data of towering quality. Projecting of such data leads unrushed transmission and extortionate retention. Hence cognitive content of data needs a contraction in a number of bits using for image compression techniques [1]. People demand high quality of video entertainment services, even though a lot of bandwidth (BW) and resources are required to store the videos and transmit the video over the channel [2,3]. In the earlier years does not offer enough Compression ratio and also not suitable enough for the videos. The countable performance can be attained by H.264/AVC; it provides more compression that comparing with existing standards such as H.26X [1] [2]. The aim of the HEVC is improving the efficiency by reduction the bit-rate at least 50% that means its performance of the efficiency is improved [7]. The high efficiency video coding (HEVC) standard [3]. HEVC was developed by Joint Collaborative Team on video coding established by the IUT-T video coding Experts Group [2,3]. Screen Content videos are used idely for lots of application such as remote pcs, video conferencing and emote education [4]. Orthogonal transform is nothing but Rotated Orthogonal Transform is transactsthe

Better on Motion Compensation –residual than the Discrete Cosine Transform (DCT) for coding [5]. Motion Estimation (ME) is a major coding grappling hook that consists of upto 4X64 prediction units [6]. An Adaptive Coding Unit selection algorithm reported to each depth level's texture accommodative coding unit (CU) selection algorithm. According to each depth level. Texture complexity is presented to filter out unessential coding block [7], CU depth decision process in HEVC has three levels of hierarchical decision problem. Another process is three dimensional video systems, imperfect depth images frequently bring on pestering temporal noise such as flickering, to the synthesized video [9] the residual signal is minimized, the signal is minimized, therefore coding efficiency is accumulates [10][21]. The one parameter is Structural Similarity Index is enchanting become greater amount of deliberation in recent times in the community of video coding as noncognitive criterion for appraise and ameliorate video codecs [12,13]. And also to be used in the Rate Distortion Optimization of the HEVC.

Estimating the motion for the video is a major complexity it is approximately 70% above. Because motion or movement is presented in the video [10]. Video can be divided into the number of frames/slices [6]. Many conventional algorithms are existed such as Full search three stage logarithmic [9], UM Hexagon full search algorithms are good to estimation the motion vectors, although the optimization is necessary with different types of motion estimation algorithm [12]. Nowadays, mobile devices and personal computers are accommodated with multiple core processors. [11] To maximize the efficiency of the processor has to be made structural modifications in the application [2]. The subjective and objective quality assessment is essential in fully validating the video codec performance, its highly desirable how the objective image are existing in the video quality assessment [18]. More over a new application have to be developed with parallelization methods for improving the maximum efficiency of multi-core processors. [8] The H.264 standard is doing motion estimation with block matching algorithm with macro blocks [14]. Video can be divided into contiguous frames [15] and it also having temporal redundancy, temporal redundancy is increasing the effectiveness of the inter-frame video compression with content of the macroblock by referenceto the known content block [13]. Astobe considering the subjective quality the deblocking filter, Sample Adaptive Offset filter the filtering process in the encoding and decoding loops in the video coding standard (HEVC) to improve the subjective quality as well as objective quality with help of in-looping and post-looping filters in algorithmic [17]]

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and architectural levels to save the cost. And improve visual quality [15] The remaining sections has followed to be section II Literature Survey, section III. Proposed work contribution with content block search algorithm, Section IV follows Simulation Results with test sequences results, Section V Conclusion.

I. LITERATURE SURVEY

Motion Estimation and compensation makes a significant role in video coding and decoding. Motion estimation is the method to finding the motion vectors (MV). It describing the transformation between sequential frames in the video sequence [13]. Motion Compensation it's one of the algorithmic technique to predict the frame in video from previous and future frame [14]. There are two essential process in HEVC that is motion estimation and motion compensation, Motion estimation tools find that the matching is the best in the previous coded frames for each and every in contemporary frame. Subsequently the motion compensation process exploit the generation of motion vectors with compensated frames [17]. ME Algorithms in video compression make performance with both motion estimation and motion compensation simultaneously [19]. From the below figure 01 motion vectors are represented in the frames with the reference and current frame.

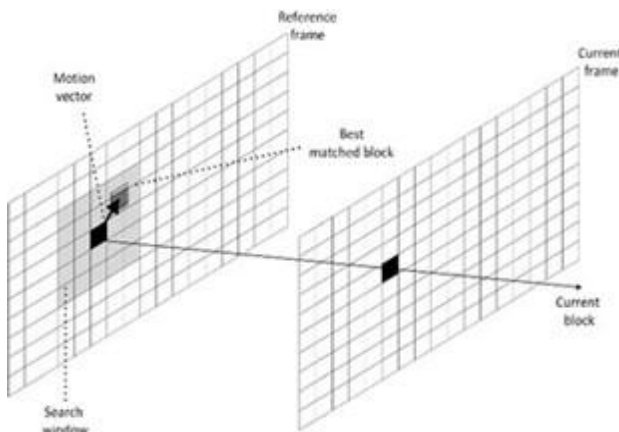


Figure 1: Representation Of Motion Vectors (MV) In The Frame

Motion estimation can be worked in the form of two ways one is inter prediction and intra prediction, the discussion is going on with the intra prediction, when the anticipation heavy in the situation the predicted samples have the correlation with reference samples are low [18]. The temporal redundancy exists between consecutive video frames. The temporal redundancy can be removed by temporal prediction using Motion Estimation and Motion Compensation [9,10]. In the case of proposed filter band design session, consider $L_0(f)$, $L_1(f)$ and $H_0(f)$ and $H_1(f)$ are the filter coefficients of Low Pass and High Pass respectively. The transformed filter bank representation are,

$sTf(z) = -F_m(z) \{ H_0(z) L_0(z) + H_1(z) L_1(z) \} + F_m(-z) \{ H_0(-z) L_0(z) + H_1(-z) L_1(z) \} (1) [20]$. Size of the block Intra 4×4 to Intra 16×16 Prediction. Chroma Intra Prediction is same in both cases. The main aim of the HEVC with tool is to improve the coding efficiency using with transformation of the pixel. And also motion estimation based on the Sub-Pixel

reference software interpolation and motion vectors fractionally with quarter accuracy is implemented in the same as with H.264 standard. The whole picture can be split into the quad-tree structure and also have flexibility with variable block size. Any more, for the high resolution video content, using longer blocks is beneficial for encoding. Nomenclature of various blocks in HEVC pictures are rime into Coding Tree Unit. The CTU sizes are 64×64 , 32×32 , 16×16 , 8×8 , 4×4 [3,4]. HEVC streams consists of three types of blocks namely, Luma (Y) and also two Chroma components such as Cb and Cr. The size of the Luma block is $N \times N$, and each Chroma block is $L/2 \times L/2$ samples.

II. PROSED WORK CONTRIBUTION WITH CONTENT – SPLIT BLOCK SEARCH ALGORITHM

Proposed CBLS (Content Block Layer Search) method is able to implement standard encodings from MPEG-2 to H.265/HEVC. CBLS is mostly performed using single layer per frame through bit depth rate per frame using BL (block layer) and CL (content layer), bit depth module is to allow CBLS video coding at constant quantization and bit rate. A CBLS video coding is a process flow applied at each video frame level. This process flow is illustrated in Figure 2. Where steps based on pre-processing operations, Group Of Picture (GOP) construction with motion estimation, inter and intra prediction for encoding the coded frames and transform information including decoding frame for inter prediction.

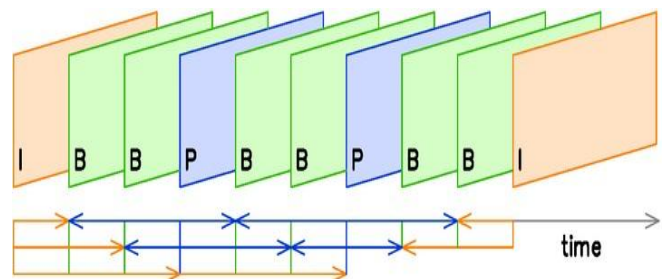


Figure 2: Group Of Pictures IBBPBBPBBI ... Sequence

The process flow initiates at frame extraction to acquire the frame information to be encoded. Pre-processing involves the Group Of Picture (GOP) construction or motion estimation. Preceding inter and intra prediction is followed to encode the next coded frames which introduces latency between frame coding, can be reduced by coding decisions made by structuring the quad-tree transform and prediction coding information through Decoded Frame Buffer located at C Land BL. At the Coding Decisions, coding information carries reconstructed frame for Inter Prediction and reconstructs the frame as in the coding manner. Proposed CBLS (Content Block Layer Search) method is able to implement standard encodings from MPEG-2 to H.265/HEVC. CBLS is mostly performed using single layer per frame through bit depth rate per frame using BL (block layer) and CL (content layer), bit depth module is to allow CBLS video coding at constant quantization and bit rate. A CBLS video coding is a process flow applied at each video frame level. This process flow is illustrated in Figure 2. Where

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In this paper, the content block based motion estimation is work out on the pixels in the coding tree units. In order to restore the video, make a good approximation of the point spread function and hence the motion vector is required to improve the motion estimation using with content block search algorithm, many motion estimation algorithms are exist. In the proposed algorithm, the content in the each motion vector of P frame and B frames with greater magnitude, it denotes faster moving of the coding tree units. The method of the modifying video coding is derived from the Standard High - Efficiency Video Coding.

- A) Considering P and B frame, get the motion vector values such as content values from the frame compression, whereas content motion vector (CMV) is the motion vector with the variation in the frame and is the number of coding tree units in the analyzed content varied frame. Calculate the magnitude of the motion vector of the content regarding the horizontal and vertical component in the CTU.
- B) Find Content threshold value for the MV.
- C) Considering outright the P frames and B frames in the GOP, we do the same calculation and achieve the number of eligible factors. The content in I frame to facilitate data extraction.
- D) Content data in the CTU and calculate the phase value.
- E) From the GOP, calculate start and end position of the segment with the content capacity

The data extinction was ingenious on Group of Pictures on the basis. For GOP content information in the I frame is totally available. In the case of the multiple encodings at different Signal to Noise Ratio qualities with more or less quantization levels and based on these, the block structure is reused for the greater quality representation to speed up the encoding with the lower quality. By using the content analysis approach, the video frames are based on intra prediction

mode of the HEVC. In this approach some of the blocks are skipped with content structure analysis. The proposed algorithm extracts one bit at each in a block 4X4, it should be qualified by modifying intra prediction mode. In the one bit of the content information the significant bit of the bit stream is considered. It supports I and P slices and the other type of video coding is intra coding that is called Intra prediction Motion estimation (IPME). The encoder is selected typically in the Prediction mode for each and every block that minimizes the difference between predicted block and also that block to be encoded. The Inter-frame mode is based on the block sizes such as 4x4 separately and it is also suited for coding parts of the detailed significance. In addition to that 16X16 block is more suited code for untroubled picture. As coming to the IPME block mode, those sample values has to be sent directly without Prediction, transformation and quantization. Video coding standard High Efficiency Video Coding (HEVC) has an improved RD optimization performance compare to the previous video codec's, at the cost of single layer coding and increased encoding process. Since dynamic streaming requires a coding standard which represent the multiple bitrates by improving the RD performance, which generally perform in single layer coding. This paper limit the complexity of encoding by increasing the multiple bitrates to imply the degree of redundancy in the codec. The context of multiple fixed bitrates [3] to perform motion estimation is analyzed for single bitrate value for a reference video stream. The motion compensation [4] with the [3] performed as severe degradation of RD optimization. This paper introduces the Motion Estimation and Compensation by block structuring the video stream from a high content quality frame to low content quality frame by reusing the quantized bits for multiple fixed bitrates.

BLOCK SEARCH ALGORITHM:

It considers the bits necessary to indicate which mode has been the use of the IPME mode actually results in a minor degree of data expansion. The first step of proposed work contribution is performed in the following steps:

1. Using MATLAB, get a block unit from the H.265 stream as shown in figure 1 and 2.
2. Analyze content of each block's header to determine if this is an IPME content block in IBBPBB sequence.
3. In case of an IPME block:
 - a. Extract the block payload in order to get the pixel values. Feature the content into new data into the low bits of the pixels.
 - b. Compare the content block with sequence of blocks,
 - c. Store the block back to the frame unit.

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4. Go to step1.

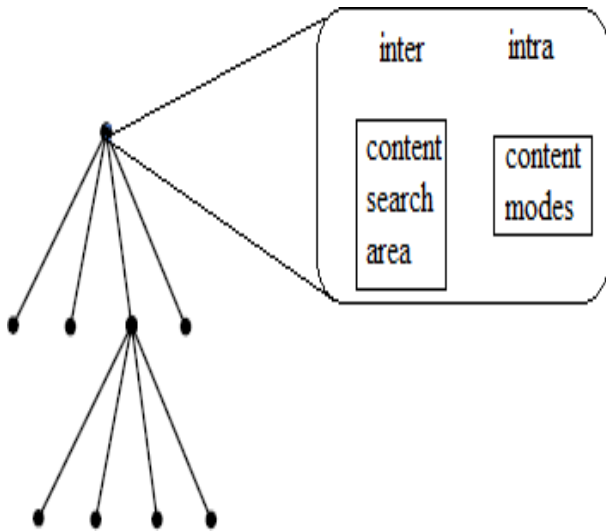


Figure 2: Blockmode: Schema of the CU content search area to analyze each CU and content modes

The real time content analysis is achieved by the fact that the method needs only to bit-level analysis and block-level analyze the IPME blocks, thus avoiding the time consuming normal encoding process.

The second step of proposed work contribution is performed in block structure based on HEVC video coding standards is analyzed as follows:

1. With HM 16.7 tool the entire video can be divided into slices. i.e. First division is CTU which is comprising a Content – Tree structure whose leafs are name as Coding Units.
2. Determination of the Prediction mode (Inter/Intra) is made at Coding Unit (CU) level. The size of the CTU is decided it is depth 0, is the biggest block size and a greater depth corresponding to a smaller block size.
3. Now determination of the suitable block structure is accountable with Rate Distortion Optimization (MDO), which is the most consuming part of the HEVC.

The Time difference of the encoding (T) is deliberated as the difference between the total encoding time with different size of the video representation with different Quantization parameters with various quality of the video (fixed 22,27,32,37). All encoding and encoding and decoding time has to be performed with Ubuntu 64 bit at frequency is 2.60GHz and 8GB RAM. The different types of video resolutions from (416X240) to (2560X1600) Pixels and frame rates between 24 frames per second (fps) and 30 24 frames per second are encoded. All the below sequences are encoded. All the sequences are tested Intra, Low-Delay and Random Access, but Intra has to give more Peak signal Noise Ratio in dB and Bit rate in Kbps. In the experiment, a video sequences selected for analysis are given in table 1 and 2.

Table 1: Proposed work Sequences

Class	Size (WXH)	Sequence	Bit Depth	Frame Rate
Class A	2560x1600	People On Street	8	30

Class B	1920x1080	Party Scene	8	24
Class C	832x480	BQ Mall	8	60
Class D	416x240	Blowing Bubbles	8	50

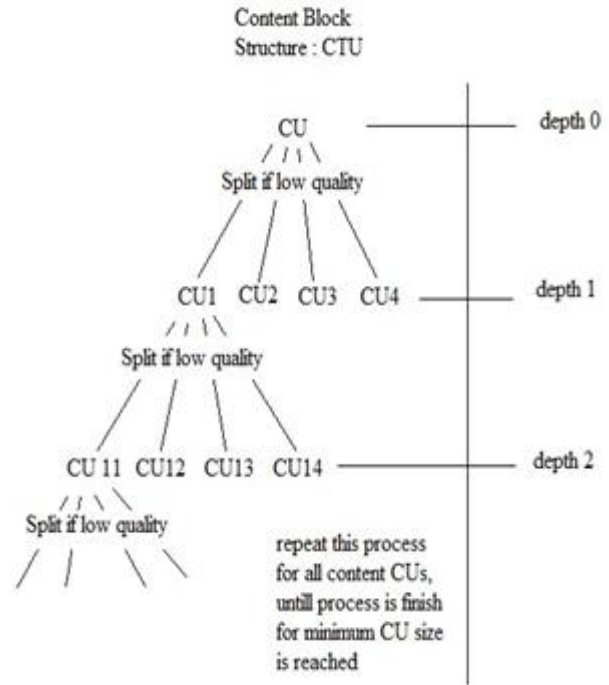


Table 2 is showing the different classification of the videos such as Class A, Class B, Class C and Class D with different breadth and width, and also to be considering the no of frames are used to the experiment with its bit depth and frame rate (frames per sec).

Table 2: classification details of video sequence

	Proposed
Reference Software	HM 16.4
QP	22, 27, 32, 37
Sequences	People Street Cactus BQ Terrace Basketball Pass
Resolution	(2460 x 1600), (1920 x 1080), (832 x 480), (416 x 240)
CPU	Intel core i7 X990 3.47GHz
OS	Windows 8 (64-bit)
Version	2.0
Compiler	MSVC 2012

We contraction our proposed algorithm on HM 16.7 [6] with RD performance, time saving and reduction of complexity with our method. Our Proposed work in this paper is implemented with HM 16.7 reference software different test sequences has to be taken with different frame rates such sequences are mentioned table in Table. 02. Our proposed algorithm CSBS algorithm implemented in HEVC reference Software 16.7. The number of frames

taken for each video sequence is different frame rate and different number. The simulations were carried out on Linux flavor with Intel core I5 @3.4GHz, 12GB RAM. The Quantization Parameters (QP) varies from 22 to 37 (22, 27, 32 and 37) and the different video sequences are from Classes A, B, C, D, and E. The Test Configurations are random access main (RA-main), Low Delay main (LD-main) and Intra main based on the Common JCT-VC test conditions. The Simulation results are summarized in QP 22 (BQ Terrace), QP 27 (BQ Terrace), QP 32 (BQ Terrace), QP 37 (BQ Terrace), with frame 2,4,6,10,20 and observing the PSNR values Y,U,V and YUV PSNR with different bit rate and encoding times. YUV PSNR values has to be measured in dB, bit rate in Kbps and finally time is measured in seconds.

Table 3. RD performance of QP 22 with BQ terrace sequence

Frame	Y	U	V	YUV	Bitrate	Time
2	42.39	40.93	40.88	41.86	6419	1.39
4	42.14	40.92	40.83	41.68	6174	1.39
6	41.07	40.51	40.50	40.83	6339	1.98
8	40.98	40.50	40.50	40.78	6365	2.77
10	40.93	40.48	40.50	40.75	6377	3.30
20	40.81	40.47	40.45	40.68	6403	6.82

Table 4: RD performance of QP 27 with BQterrace sequence.

Frame	Y	U	V	YUV	Bit rate	Time
2	37.50	35.78	35.78	36.84	5164	1.48
4	37.23	35.77	35.78	36.68	5369	1.51
6	37.15	35.80	35.79	36.48	5423	2.28
8	37.12	35.80	35.77	36.62	5448	5.65
10	37.08	35.81	35.78	36.60	5462	7.08
20	37.03	35.81	35.80	36.58	5491	8.33

Table 5. RD performance of QP 32 with BQterrace sequence.

Frame	Y	U	V	YUV	Bit rate	Time
2	32.53	31.93	31.94	32.30	4288	0.76
4	32.29	31.96	31.99	32.17	4459	1.56
6	32.20	31.91	32.00	32.11	4502	2.41
8	32.15	31.93	31.98	32.07	4521	3.51
10	32.10	31.92	31.95	32.04	4526	4.17
20	32.04	31.92	31.94	32.00	4531	7.76

Table 6. RD performance of QP 37 with BQterrace sequence.

Frame	Y	U	V	YUV	Bit rate	Time
2	27.5	28.89	28.95	27.87	3484	0.70
4	27.3	28.98	29.03	27.70	3635	1.47
6	27.2	28.97	28.97	27.68	3666	2.22

8	27.1	28.98	28.97	27.66	3681	3.10
10	27.1	28.97	28.96	27.64	3686	3.72
20	27	28.97	28.97	27.59	7463	14.16

Rate Distortion Optimization Performance with BQ Terrace and People on Street. PSNR value has to be valid 25dB. Here QP=42 is increased and bitrate is also improved 15338 but psnr is 23dB only. In this case when QP is 42 psnr value is not to be satisfied more than 25dB. YUV PSNR values has to be varying with different QP values such as 22, 27, 32, 37. QP value is less than 30 YUV PSNR. As same as decoding time is also increasing with number of frames. All the simulation results has been proven with HM 16.7 simulation with BQ Terrace and People on Street is shown in the below Table 7. In this table RD performance with two video sequences with QP values are 16, 22, 27, 32, 37 and 42. In general PSNR is considerable 27 to 48 dB, while the simulation part has been analyzed between 16 to 27 QP those values are considerable PSNR 47 to 36 dB, and Bitrate also improved in Kbps, encoding time is in Sec. like that we simulated video sequences are BQ Terrace and People on Street. These are to be considered as objective parameter analysis, whereas subjective analysis comes under visual appearance.

Table 7. RD performance of BQ Terrace and People On Street.

BQ Terrace			People on Street		
Qp	PSNR	BIT RATE	Qp	PSNR	BIT RATE
16	47.14	15314	16	47.16	15338
22	41.71	12655	22	41.72	12674
27	36.69	10584	27	36.75	10602
32	32.16	8772	32	32.21	8803
37	27.84	7184	37	27.80	7168
42	23.03	5449	42	23.08	5477

V. CONCLUSION

In this work, content - split block search motion algorithm is proposed, in this process multi - directional motion estimation was proposed to exact motion vectors with less Complexity regarding computations. Multi- rate distortion optimization process needs to traverse each content tree such as coding tree unit in order to find the block structure such as the coding unit, which is directing the best Rate Distortion Performance. The proposed algorithm shows high PSNR with different video sequences with different dimensions with various QP (16, 22, 27, 32, 37) values and also Bitrate and encoding time also analyzed with HM 16.7, this is comes under an objective evaluation comparing with existing algorithms as we discussed in the introduction.

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