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Survey on Image and High Efficiency Video Coding standard

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ABSTRACT

HEVC- High Efficiency Video Coding standard is the new rising video coding standard which give upgraded piece rate diminishment when evaluated to other existing benchmarks. Despite the fact that a superior pressure execution and coding proficiency is accomplished, HEVC holds a higher computational intricacy. In HEVC standard, Motion Estimation (ME) possesses more than half of coding time to encode. The normal piece rate in respect to HEVC for equivalent PSNR for stimulation and intelligent applications is diminished. This paper studies the ideas included in ME calculations, in the parts of seeking and examining techniques.

KEY WORDS: Motion estimation, HEVC, Search pattern, scanning.

1. INTRODUCTION

HEVC- It was as one made by ISO/ICE Moving Picture Experts Group (MPEG) and ITU- I TVideo Coding Experts Group (VCEG) as ISO/ICE 23008-2 MPEG-H Part-2 and ITU-T H.265. The headway of ISO/IEC affiliations and ITU-T are key clarification behind the improvement in video coding rules. H.263 and H.261 are made by the ITU-T, MPEG-4 and MPEG-1 Visual is conveyed by ISO/ICE, and the two affiliations conveyed H.262/MPEG-2 Video and H.264/MPEG-4 Advanced Video Coding (AVC) benchmarks, which are extensively utilized as a part of assortment of item in our everyday life (Ugur, 2010; Kim, 2012; Lainema, 2012; Zhou, 2012). HEVC consequently produced by the joint exertion of both ITU-T and ISO/ICE.

These days, the movement brought on by video applications in system is more on account of the expanding prominence of High Definition (HD) Video and past HD recordings. Tablets, Personal PCs and even cell phones need to acquire and show HD recordings, and this turn into a test on today's system. Activity in Network can be made least by expanding video pressure. HEVC is actualized to manage every single existing application and issues of H.264/MPEG-4 AVC. It gets centered around two issues (1) video determination is expanded (2) expanded utilization of parallel handling architectures (Ohm, 2013; Karthik, 2013; Philomina, 2014; Jasmin, 2015). HEVC and H.264 have a distinction in fact and by and large identified with applications. Table I demonstrates the key contrasts in the middle of H.264 and HEVC.

Table.1. Key differences between H.264 and HEVC standards

Category	H.264	HEVC
Year of approval	2004	January 2013
Bit rate	bit rate reduction is 40-50% when compared to MPEG 2	bit rate reduction is 40-50% with same visual quality compared to H.264
Specification	Support up to 4k (4096x2304) Supports up to 59.94 fps	Support up to 8k (8192x4320) Supports up to 300 fps
Compression model	Hybrid Spatial-temporal prediction model	Enhanced Hybrid -temporal prediction model
Block structure	Macro block structure with maximum block size of 16x16	CTU supporting large block structure of 64x64
Intra prediction directional modes	9 directional modes	35 directional modes
Improvements	Led increase of HD content delivery for broadcast and online	possible to realize UHD, 2k, 4k for broadcast and online
Other Names	MPEG 4 PART 10 AVC	MPEG H, H.265

HEVC encoders are more complex when evaluated to H.264/AVC. The motion associated complexity aspects were considered in standardization in HEVC (Karthik, 2014, Saravanan, 2014; Gopalakrishnan, 2014). The most imperative part in video coding (VC) benchmarks like MPEG-2, H.264/AVC and HEVC is motion estimation. But, Motion Estimation occupies greater than 50% of complexity in coding or time to encode. Block based motion estimation is broadly used in many video coding standards includes HEVC which is efficient for equivalent translation between frames. Rotating tilting, zooming and wrapping, various algorithms are other motion models such as been discussed in (Karthik, 2014, Saravanan, 2014). To decrease the computational complexity, the time needed for Motion Estimation should be reduced. This paper provides an overview of HEVC standard and emerging study on implementation of Motion Estimation Algorithm in hardware.

The remaining portion of this paper is arranged as follows. Section II represents the overall overview of HEVC standard. Section III, the scanning and searching methodologies involved in Motion Estimation is been discussed. Section IV presents the performance measures in terms of bitrate, PSNR when compared to other standards. Finally, Conclusion is made in Section

Overview of HEVC: A few encoding devices are made to raise the productivity of video pressure in HEVC Standard. Figure 1 speaks to the piece chart of HEVC video encoder (Karthik, 2013, Kanniga, 2011, 2014; Saravanan, 2014). The HEVC uses hybrid approach for video coding and the HEVC encoder contains the following steps: partitioning, prediction, transformation, scaling, quantization and entropy coding.

Partitioning: This standard uses Quadtree based partitioning as shown in Figure 2(a). In the video sequence each frame is split into Coding Tree Unit which has a luma Coding Tree Block (CTB) and two chroma CTB's. The size of Coding Tree Unit (CTU) is selected by encoder as represented in Figure 2(b). The CTB can be of 16x16 or 32x32 or 64x64, provides an efficient compression if the size is largest.

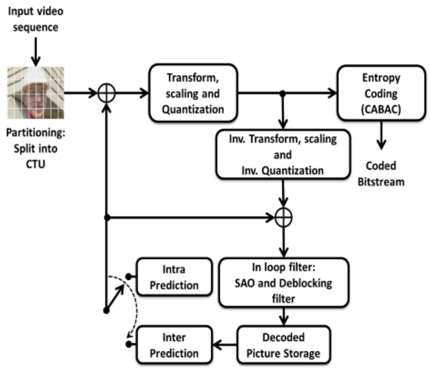

Figure.1. Block diagram of HEVC encoder

A CTB may be split to form contain a single Coding Unit or multiple Coding Units (CU). Luma CB is as small as 8x8 and Chroma Coding Block's can be small as 4x4. (CU) further splits into Prediction Units (PU) depends on the prediction type decision. Transform Units (TU) have their root at Coding Unit where prediction residuals are coded using block transforms (Karthi, 2013). This approach has a problem of transmitting redundant motion parameters in set which can be efficiently removed by Block merging algorithm (Jasmin, 2015).

Intra picture Prediction: The first picture in video frames are used to code the Intra-Picture prediction. Angular Prediction and Planar are two techniques which are used to improve visual quality of decoded video in H.264/AVC, which are further used in HEVC TMuC (Test model under consideration).

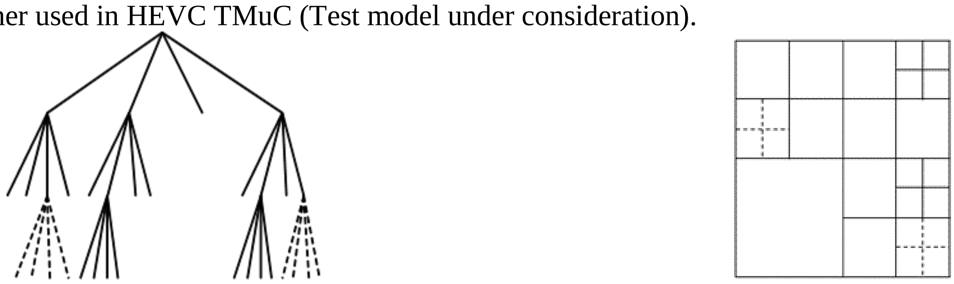

Figure.2. (a) Quad tree (b)Coding Tree Unit(CTU)

Spatial specimen excess in intra coded CUs is created by Block-based precise intra expectation in HEVC. The adjacent neighbor in Sample-Based Angular Intra Prediction (SAIP) (Saravanan, 2014) design in intra prediction samples produces lossless coding mode in spatial redundancy. Intra-Picture prediction supports 33 directional modes in HEVC which is shown in Figure 3. One of 33 spatial intra prediction modes signals the luma CB and each block of four square sub-blocks signals one intra prediction mode. Spatial example repetition in intra coded CUs is produced by Block-based precise intra forecast in HEVC. It utilizes single intra forecast mode is utilized as a part of luma or utilizing a horizontal angular, vertical anguar, left downward diagonal, DC mode or planar, For each transform block the intra prediction mode is also applied separately (Karthi, 2014).

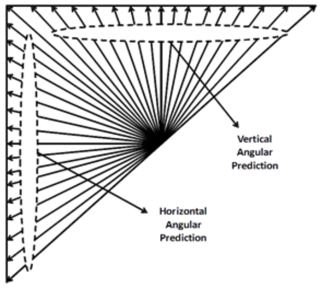

Figure.3. Predictions

Interpicture Prediction: The picked motion vector and reference picture which is connected for recognizing the examples in every piece which is known Inter-Picture expectation process. Encoder and Decoder both produces Identical between picture expectation signals by movement remuneration. The Inter-Prediction complexity (IPC)is very high and is upto 80% in the entire encoding process (Lainema, 2012). This complexity is mostly due to Motion Estimation (ME). So, the heavy complexity of ME is reduced.

Transform, Scaling and Quantization: The distinction in unique piece and expectation are created in leftover sign by intra-picture prediction or between picture prediction.

This remaining sign is changed by Linear Spatial Transformed. The changed sign are further scaled and quantized. Uniform Reconstruction Quantization (URQ) is utilized as a part of HEVC.

Entropy Coding: For lossless pressure at the last stage utilizes Entropy coding, in the wake of decreasing the video to its sentence structure components. Context-adaptive binary arithmetic coding (CABAC) is one of the coding utilized as a part of HEVC. In CABAC, predictive error is transmitted as opposed to sending the pixels. It is then changed over from spatial space to frequency domain and it can compare to in wording little number of coefficients after quantization. The procedure of frequency position and flagging the estimation of these coefficients experiences different examining instruments, for example, diagonal scan, zig-zag scan. CABAC gives high coding proficiency yet influences throughput. CABAC Entropy coding has high throughput in HEVC utilizes procedures, for example, grouping bypass bins together, reducing context coded bins, grouping bins that uses the same context together, reducing context selection dependencies and reducing total number of signaled bins (Karthik, 2014).

Deblocking Filter: Deblocking filter is implemented inside the inter-picture prediction loop. Artifacts are detected at the coded block boundaries which is performed by deblocking filter and also gets attenuated by selected filter (Karthik, 2014). In HEVC the design is made friendlier for parallel processing.

Sample adaptive offset: Sample Adaptive Offset (SAO) is the loop filtering newly added in HEVC. The sample distortion is first reduced by decoding Sample Adaptive Offset and reconstructed into many categories, each category whose offsets are obtained, and then the offset is added to all samples (Karthik, 2014).

Motion estimation in HEVC: Block based motion estimation removes the temporal redundancy effectively and so it is used generally in various video coding standard. For each PU motion vector is obtained, at the encoder block matching algorithm (BMA) is carried out. To obtain half-pel and quarter-pel accuracy samples, interpolation filtering is carried out for reference picture frames in the video. Integer-pel accuracy motion vector is obtained at first, instead of searching all the vectors for quarter-pel accuracy motion. Sum of Absolute Difference (SAD) is used for Sum of Absolute Transformed difference (SATD) and integer-pel motion search is used for half-pel and quarter-pel motion vector search in HEVC.

Integer pel accuracy Motion search: A three step motion search strategy is used to reduce the search point for integer-pel motion search. The position to start of the searched first. Motion vector predictor (PMV) attained by motion vector predictor derivation model is used as default start position of integer-pel search and neighbor positions of motion vectors and zero motion can be checked.

After selecting the start position, the second step is to do the first search. Figure 4 illustrates the three search patterns used for the first search. First search uses square search pattern or diamond search pattern. Currently, diamond search pattern is used as default. Raster search is obtained when there is much dissimilarity between obtained motion vector and start position. Currently, search range is set as 64 in integer-pel accuracy. Current position and squares represent candidate search positions for each pattern is represented as Centre circle. The square of same color stand for positions having same distance from the start position. Finally refinement search is carried out by changing the start position to the best position from the second step.

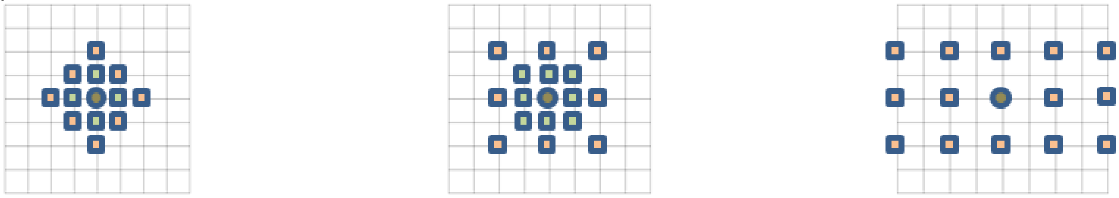

Figure.4. (a)Diamond (b) Square and (c)Raster

Search Patterns

Bipredictive Search: Inter-frame coding performance improves Bi-prediction and optimal reference block is searched by encoder from forward and backward pictures. Mainly for video sequence having scene or illumination changes, zoom in /out, camera panning, and abrupt object. The bi-prediction time is reduced, Sum of absolute Difference (SAD) is based on selective bi-prediction method is discussed in (Lainema, 2012). This method determines whether or not to carry out bi-prediction method for a current CU block. Bi-prediction of current block is performed as in (1), just if the SAD of uni-expectation is more contrasted with the normal SAD of beforehand coded CU obstructs by uni-prediction.

$$\text{Bi-prediction= on, if}\begin{cases} J_{\text{motion}}^{L0} > \text{avg } J_{\text{motion}}^{L0} \\ \qquad\text{(or)} \\ J_{\text{motion}}^{L1} > \text{avg } J_{\text{motion}}^{L1} \end{cases} \qquad (1)$$

Here, J_{motion}^{L0} and J_{motion}^{L1} are the SAD's computed by forward and backward prediction mode for current CU, where $avg\ J_{motion}^{L0}$ and $avg\ J_{motion}^{L1}$ are average SAD for previously coded CU by uni-prediction respectively.

Fast Search: The ME algorithm which perform search on all blocks in search window of reference frame are known to be full search algorithms and the algorithms which perform search on blocks which produces sub optimal Motion vectors are called fast motion estimation algorithm(FMEA). Test Zone Search (TZS) is the fast ME algorithm that is mostly preferred in HEVC.

To hunt best coordinated square vectors in quick Motion Estimation calculations there are four stages. Prediction in initial stage, coded CUs are used by algorithm in motion vectors which predicts the initial search block. Global minimum point are used to find the search patterns. Early end stage are utilized as a limit to end the hunt process (Vijayaragavan, 2014). At last stage, the Motion Estimation calculation treat the movement vector in the last stage, if the early termination criteria is not satisfied by motion vector.

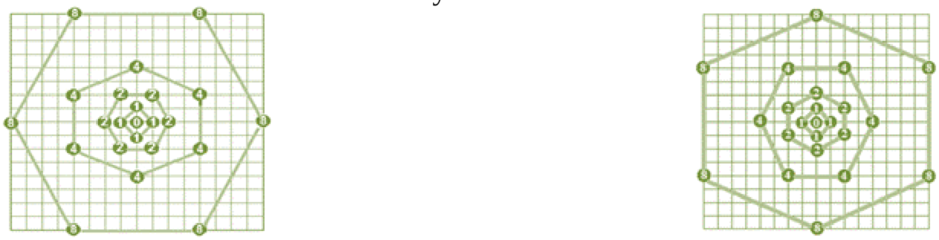

Figure.5. (a) Rotating Hexagon type-1 **(b)Rotating Hexagon type-2**

The global minimum points are calculated by search patterns such as diamond, square or hexagon grid patterns. Hexagon pattern save around 23% of search window when compared to diamond pattern. There are two basic hexagon search pattern. Horizontal hexagons is good for horizontal motion and have poor performance for vertically moving objects, whereas Vertical hexagons is good for vertical motion and horizontally moving objects have poor performance. In these patterns without loss of performance we consider hexagon patterns. Rotating hexagonal patterns as shown in Figure 5 is used, as it incorporates both motion. Type-1 Rotating hexagon pattern is somewhat better than Type-2 Rotating hexagon pattern (Vijayaragavan, 2014).

Performance measures: Performance measure is analyzed based on bit rate savings and PSNR. Sequences are coded in different bit rates using all available standards. Bjøntegaard method used for calculation of main differences between rate distortions curves which are considered as evaluation parameter. Luma and chroma (Rate distortion curves) are combined and used in this method (Ohm, 2013). PSNR for individual component ($PSNR_Y$, $PSNR_U$ and $PSNR_V$) per picture is first calculated and combined $PSNR_{YUV}$ is calculated as their weighted sum as indicated in equation 2

$$PSNR_{YUV} = (6.PSNR_Y+PSNR_U+PSNR_V)/8 \qquad (2)$$

Individual PSNR is calculated as shown in equation 3

$$PSNR = 10 \log_{10} ((2^B-1)^2 /MSE) \qquad (3)$$

Where, B is the number of bits per sample of video signal, MSE (Mean Squared Error) is the SSD divided by number of samples in the signal.

Average bit rate relative to HEVC for equal PSNR is evaluated for entertainment and interactive applications. Here the PSNR is kept constant and performance parameters are evaluated for bit rate savings. Keeping HEVC as a reference standard, the average bit rate savings is compared to other standards such as H.264/MPEG-4 AVC, MPEG-4 ASP, H.263 HLP and MPEG-2/H.262 and are shown graphically in Figure 6.and Figure 7. It is clear that a greater amount of bit rate is saved by HEVC. Several works have been proposed so as to obtain higher bit rate saving. Kamp proposed a motion vector derivation algorithm at the decoder end, which provides 6% to 8% of bit rate saving when contrasted to H.264/AVC.

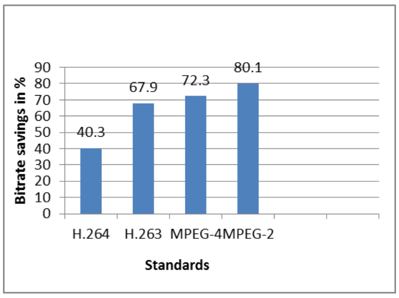

Figure.6. Average bitrate saving relative to HEVC for equal PSNR for entertainment applications

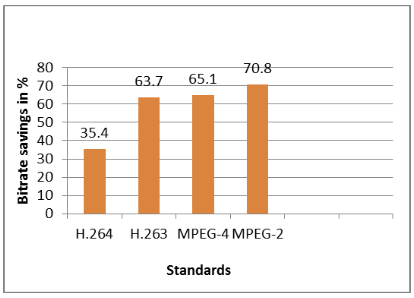

Figure.7. Average bitrate saving relative to HEVC for equal PSNR for interactive applications

2. CONCLUSION

The rising HEVC standard speaks to a primary stride in the development of video coding procedures. This work brings in an investigation of the HEVC standard and elements, which enhances its adaptability over a wide assortment of use areas. The most computationally costly process in video handling additionally gives the techniques included in movement estimation. The normal piece rate with respect to HEVC for equivalent PSNR for excitement and intelligent applications is lessened, when contrasted with other existing measures. The future work is to extend the ideas in ME to have a superior change as far as secluded refinement, making it more suitable for Multimedia applications.

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