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COMPARATIVE STUDY OF H. 265 WITH ITS PREDECESSORS USING MATLAB

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ABSTRACT

The compression efficiency of "H.265/High Efficiency Video Coding (HEVC)" is high and standard video coding approach. The predecessors of HEVC fall behind due to shortfalls in encoding but HEVC has a well matured encoding efficiency. One of the factors for higher efficiency is intra prediction that has a huge number of prediction modes (35 modes) when compared to its predecessor standards. This high efficiency is made possible with a trade-off between high complexities vs performance. This paper provides an impression for technical characters of HEVC framework providing a good PSNR and Entropy value.

KEYWORD: HEVC, Compression Efficiency, PSNR and Entropy.

I. INTRODUCTION

Video codec is used to compress and decompress a video signal to conserve the necessary bandwidth and memory negotiating the feature of the video. HEVC/H.265 a recent video coding technique, standardized by "Joint Collaborative Team on Video Coding", ITU-Telecommunication and "Video Coding Experts Group" in January 2013.[1] Video streaming is a process that helps any user to download a video while the same person is watching the video and it saves time as well. Video streaming plays important role in various fields like-downloading and uploading of video over internet, video conference, live streaming channels, and earth-bounded broadcast systems, video, camcorders, mobile networks and security system. H.262/MPEG2 a predecessor of H.264/AVC, a good capable of handling a HD videos in local but the same is not suitable for online and device streaming due to poor quality in encoding. This disadvantage of MPEG-2 is taken over by H.264/AVC that allows a higher compression rate. This is really a true advantage for online and device streaming. H.264/AVC is earlier version of HEVC/H.265.

The scope of HEVC is to intensify the compression performance slowly but surely in distinct to the previous standards and to ease the bit rate by 50% for equal perceptual video quality. There are many add on features in HEVC than its previous standards. H.265 also follow the approach of H.264 such as hybrid coding, in-loop filtering and Sample Adaptive Offset and transformation coding.[1] HEVC has 35 modes with the planar mode as mode 0, the DC mode as mode 1 and 33 angular modes as mode2-34 when compared with AVC which has only 9 modes.[2] This high increase in the modes, rate distortion optimization (RDO)[3] becomes the major concern. This problem is overcome by using quad-tree prediction which identifies the best mode with less rate distortion, which in turn increase the video efficiency by minimizing the bit-rate and preserving the video quality.[4]

II. Literature survey

This section describes the review of literature based on research carried out by other researches concerned with the proposed work.

Xingang liu et.Al.[5]: Illustrated a machine learning framework to develop a flexible coding unit size decision method for Intra estimate formulated from "CU complexity classification (CC)". This technique proves and accomplishes results having consumed 60% less time for encoding on several video series on average with increment of "Bjontegaard Delta Bit Rate (BDBR)" by 1.26% in contrast with trial model "HM15.0 of HEVC".

Damian Ruiz-Coll et.al.[6]: has proved that compared to the image compression techniques such as JPEG, new JPEG XR or the JPEG2000, the technique with Intraframe gives higher compression in the "All Intra" mode. All these advancement are due to high computational complexity in implementing in real time. Hence, a RDO algorithm can be used to pick finest coding unit size for Intra-Prediction, with data mining classifier. This framework results up to 30% Time Saving against a large range of high resolution videos with negligible loss of coding efficiency.

Antonio Jesus Diaz-Honrubia et.al.[7]: Has given an "Adaptive Fast Quad Tree Level Decision (AFQLD) algorithm" where decoder make quick decisions for CU splitting by using

Naive-Bayes (NB) probabilistic classifier in HEVC from the H.264/AVC information. Good trade-off between coding complexity and efficiency is achieved by this algorithm compared to anchor transcoders.

Mateus grellert et.al.[8]: HEVC encoders use a faster coding unit. These units are based on Support Vector Machines (SVM). The SVM is trained offline rather than online. These trained SVM are redefined coding units and named as faster Coding Unit (CU) partition decision algorithms. The framework based on this algorithm achieves a reduction in complexity by 48% with 0.48% Bjontegaard Delta bitrate (BD-BR) loss. A random Access Coding is configured in the same work.

Guilherme correa et.al.[9]: HEVC gives a higher compression proportion. It is achieved through a flexible dividing structure named as coding trees, prediction units, and the residual quad-trees. The top configuration among these is determined by rate-distortion optimization (RDO) progression.

Eduardo peixoto et.al.[10]: HEVC is most popular than H.26/AVC with a faster transcoder. This faster transcoder is accomplished by 2 stage transcoder. Out of these two stages, 1st phase is training stage- where information of H.264 and HEVC is collected. This information is utilized to develop a coding unit and the same is recycled in the 2nd phase called as transcoder stage. This scheme is 3.4 times marginally swifter than preceding transcoder.

Edward tamunoiyowuna jaja et.al.[11]: has recommended an algorithm that has all the advanced techniques of coding the video. Due to the advanced techniques, it has delay in encoding the video. The proposed algorithm is known as “Mode decision”, it computes minute residuals. This will help to make precise decisions against 4 irregular motion partitions in each and every depth as mentioned. This algorithm generates results with 72 % faster in contrast to mode decision method instigated in HM14 reference software.

Linwei zhu et.al.[12]: Encoding complexity of HEVC is reduced without compromising the compression. This is accomplished by predicting CU and PU directly by classifiers. This better prediction is achieved by incorporating a new method of cascading offline and online machine learning method. This cascading helps with multiple reviewers system that helps in better predicting CU and PU. To accelerate the scheme an extra optimal parameters are included for simplifying the complexity.

Detlev Marpe, Heiko schwarz et.al.[13]: Has proposed a block-based hybrid video coding for H.264/AVC. A block based partitioning swifts the process of prediction and transform coding. Author claims- the swiftness in achieved by nested and reconfigurable quad-tree structures used for a video signal in predicting residuals.

Vivienne Sze, Madhukar budagavi et.al.[14]: "Context-adaptive binary arithmetic coding (CABAC)"- an entropy coding available in H.264/AVC offering a high coding efficiency and the same is used in HEVC. The only drawback is throughput when parallelized. To overcome this limitation and to retain more coding efficiency, a method is implemented in which context coded bins are reduced, grouping similar bunch of bypass bins, similar context bins are grouped together. Also mentioned less memory requirements improves throughput. Results show context-coded bins are shrunk by 8 times, and the context memory and line buffer are shrunk by 3 times and 20times, respectively.

III. METHODOLOGY

Fig1 represents the block diagram of the anticipated work. The objective is to design a higher coding efficiency for a provided video signals. The video coding standard has two standard of computing the coding proficiency of a video. First one is use of an "objective metric-*Peak Signal to Noise Ratio* (PSNR)" or the second one is "*subjective evaluation"* of video quality.

The second method is more significant and hence it is considered as important in measuring the video quality based on human insight.

Coding tree Units and Coding tree block structure: HEVC incorporates coding tree unit (CTU) and the size of CTU is determined by the encoder. The size of CTU consists of a 16*16 block of luma samples and two corresponding 8*8 blocks of Chroma samples in the typical case of 4:2:0 color sampling. For better compression, CTB with the larger sizes are used which are then divided into smaller blocks using a quad tree structure.

Prediction Units (PU) and Prediction Blocks (PB): A Coding tree Unit level consists of a subdividing assembly which is named as prediction unit (PU). Luma and Chroma Coding Blocks may be split into small pieces and these pieces are forecasted by prediction blocks. This forecasting is based on elementary prediction form decision. HEVC allows you to choose between 64*64 and 4*4 samples for your PB.

Transform Units (TU) and Transform Blocks (TB): Utilizing the transform blocks, the prediction blocks are coded. The Integer basis functions are derived from transform blocks having a square shape with 4*4, 8*8, 16*16 dimensions, this function is similar to discrete cosine function.

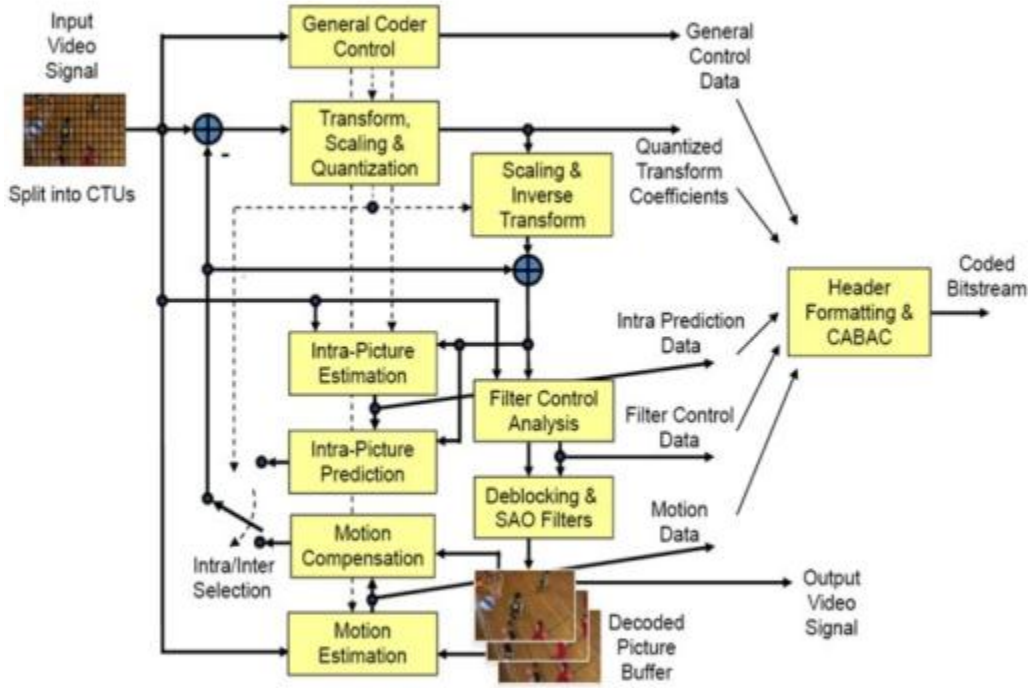

Fig. 1: Block diagram of High Efficiency Video Coding/H.265.

Motion vectors: “Advanced motion vector prediction (AMVP)” is used for motion vector signaling, with similar feature candidates derived from neighboring PBs and a reference image. It's also possible to use a "merge" mode for MV coding, which allows MVs from neighboring PBs to be inherited. Furthermore, enhanced “skipped” & “direct” motion inferences are defined parallel to H.264/MPEG-4AVC.

Motion compensation: Motion vectors are obtained from Quarter-sample precision and 7-tap or 8-tap filters are recycled for finding the fractional-sample positions. Each PB, receives 1 or 2 motion vectors, in turn producing either in “uni-predictive or bi-predictive coding”, correspondingly.

Intra-picture prediction: Intra prediction includes 33 directional prediction modes, along with surface fitting and flat prediction modes. Encoding of required prediction blocks are coded by selecting same kind of already decoded block.

Quantization control: H.264/MPEG-4 includes "Uniform Reconstruction Quantization (URQ)"; the same quantization is practiced at HEVC that scales up quantization matrices.

Entropy coding: For entropy coding, "context adaptive binary arithmetic coding (CABAC)" is employed which is also employed in H.264/MPEG-4 AVC, but it has been enriched significantly to upsurge throughput swift and compression proficiency.

In-loop de-blocking filtering (DF): "De-blocking filter (DF)" is employed in H.264/MPEG-4 AVC for inter-picture prediction, however the decision-making and filtering processes design, on the other hand has been simplified and it is parallel-processing friendly.

Sample adaptive offset (SAO): After the de-blocking filter, a "non-linear amplitude mapping" is presented in the inter-picture estimate by employing a look-up table that is labeled by some supplementary factors, computed by histogram of an encoder to better reconstruct the original signal amplitudes.

IV. RESULTS

The investigational results of the anticipated model has illustrated below. The different parameters are used to calculate the efficiency of the proposed technique, those are illustrated below.

- **Mean Square Error (MSE):** An estimator's "mean squared error (MSE)/mean squared deviation (MSD)" finds an average squared difference between estimated and predicted values. The MSE is a non-negative value, lower values signify higher quality of an estimator's efficiency. i.e. Given in the Eq. (1).

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - k(i,j)]^2 \qquad (1)$$

- **Peak Signal-to-Noise Ratio:** "Peak signal-to-noise ratio (PSNR)" is the ratio of a signal's optimum conceivable strength to the power of noise. The values of PSNR is measured and represented in terms of the logarithmic decibel. Higher the PSNR better the picture quality.

The PSNR (in dB) - defined in the Eq. (2).

$$PSNR = 20.\log_{10}(MAX1) - 10.\log_{10}(MSE) \quad (2)$$

Here $(MAX1)$ is utmost pixel value of an image.

- **Entropy:** The histogram of an image may be used to estimate the image's entropy, or average detail. The histogram depicts the image's different grey level probabilities. The entropy is useful for automatic image focusing. The Entropy is defined in the Eq. (3):

$$Entropy = Sum(p.* \log_2 p) \qquad (3)$$

Here p is the histogram counts.

- **Correlation:** It computes the correlation between vector A and B given in Eq. (4), Eq. (5) and Eq. (6).

$$a = a - mean2(a) \qquad (4)$$

$$b = b - mean2(b) \qquad (5)$$

$$c = sum(sum(a.* b))/sqrt(sum(sum(a.* a)) * sum(sum(b.* b))) \qquad (6)$$

- **Structural Similarity Index (SSIM):** SSIM is used to compare the resemblance between two photographs. The distance between two windows x and y of the same size N*N is, illustrated in Eq. (7).

$$SSIM(x,y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)} \qquad (7)$$

With μ_x is the mean of x, μ_y is the mean of y, σ_x^2 is the variance of x, σ_y^2 is the variance of y, and σ_{xy} is the covariance of x and y.

$$C_1 = (k_1 L)^2 \qquad (8)$$

$$C_2 = (k_2 L)^2 \qquad (9)$$

In Eq. (8) and Eq. (9) 2 variables make the division process with denominator having least value, L is the dynamic range of the pixel values. k_1=0.01 and k_2=0.03 by default.
SSIM satisfies the condition of symmetry. As illustrated in the Eq. (10).

$$SSIM(x,y) = SSIM(y,x) \qquad (10)$$

The input video frame sample is shown in the Fig. 2, the resultant encoding and decoding process is described in Fig. 3 and Fig. 4, the resultant parameters are shown in the Fig. 5.
Table 1: Displays the parameters such as *"mean square error (MSE), peak signal-to-noise ratio (PSNR), entropy, correlation, and structural similarity index (SSIM)"* in comparison to other standards such as H.261, H.263 and H2.64.

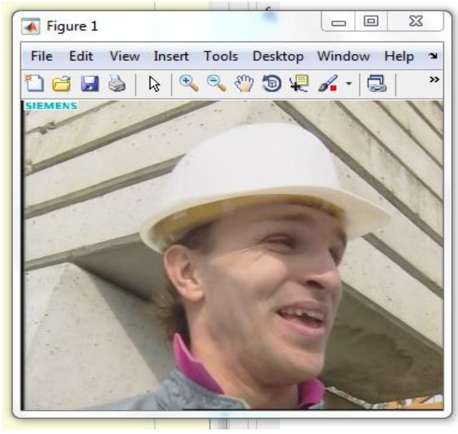

Fig. 2: Input frame.

```
Encoding I-Frame: 1
Encoding P Frame: 2
Encoding P Frame: 3
Encoding P Frame: 4
Encoding P Frame: 5
Encoding P Frame: 6
Encoding P Frame: 7
Encoding P Frame: 8
Encoding P Frame: 9
Encoding P Frame: 10
```

Fig. 3: Encoding process.

```
Decoding I Frame: 1
Decoding P Frame: 2
Decoding P Frame: 3
Decoding P Frame: 4
Decoding P Frame: 5
Decoding P Frame: 6
Decoding P Frame: 7
Decoding P Frame: 8
Decoding P Frame: 9
Decoding P Frame: 10
```

Fig. 4: Decoding process.

```
MSE:
     0.4250

PSNR:
   51.8470

Entropy:
     0.1024

Correlation:
   -0.0140

Structure Similarity Index:
     0.4121

Compression Ratio:
   18.5625
```

Fig. 5: Snapshot of resultant parameters.

Table 1: Result parameters.

Method	MSE	PSNR	SSIM	Entropy	Correlation
H.261	2.33	14.45	0.22	0.163	0.71
H.262	1.08	17.78	0.78	0.0044	0.79
H.263	2.83	13.61	0.30	0.09	0.30
H.264	3.20	13.07	0.37	0	0.25
H.265	0.4250	51.84	0.4121	0.1024	-0.014

V. CONCLUSION

The latest development in video coding technologies is H.265/High Efficient video coding (HEVC). HEVC has a much better encoding quality than previous encoding techniques. Video coding's main objective is compression and decompression, which are employed to reduce bandwidth and memory requirements without sacrificing video attributes. The experimental findings reveal that the recommended model is extremely proficient that the emerging HEVC offers a remarkable improvement in coding performance. The PSNR (objective) greater than 30 will have good quality and lesser entropy gives higher information, less SSIM more similar to the original image (Subjective).

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