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Performance Parameters of Hevc Video Codec

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Abstract— In Video Codecs, The Main Focus Of Researchers Is On Improving Compression Performance To Achieve Higher Compression Rates And To Obtain High Quality Of Video Signals After Encoding At Low Bitrates. There Is Lot Of Satisfactory Research Has Been Done In The Field Video Encoders. Newly Invented HEVC Or H.265 Is A High Efficiency Video Coding Standard Which Improves Video Quality Double For Similar Bit-Rate Than That Of Others Preceders Video Codecs. Here, In This Research Work, We Mainly Focused On Performance And Quality Of Motion JPEG, H.264 And H.265 Using Different Video Encoding Libraries. There Is Lot Of Requirement Of High Efficiency In Video Compression To Handle Complex Computational Video Codecs. Though HEVC Has More Efficiency In Video Compression, Its Cost Is Significant High As Compared To H.264. As Per The Experimentation Conducted, HEVC Shows Best Quality In Video Compression Than That Of H.264. Motion JPEG Required Very Less Time With The Help Of H.264 But, It Generates Worst Encoded Video Quality Using Library Open JPEG. The Encoding Speed Of H.264 Was Slowest Than That Of Other Video Encoders. It Usually Generates Better Video Quality As Compare To Motion JPEG (Kakadu) Encoded Videos. In This Research Paper, We Focused On Video Codec And Its Futuristic Development.

Index—H.264, Hevc/H.265, Kakadu, Open Jpeg 2000, Ssim, Psnr.

I. INTRODUCTION

As per Moore's law, the computation power required gets doubles after every year and gets efficient and device gets cheaper. Day by day, customer's expectation rapidly changing and every times they want improved performance from hardware. As we know that, old super computer becomes today's smart phones and that becomes tomorrow's wearable devices. During this fast revolution, power consumption is the main issue or we can say its limitation. We know that day by day, electronic devices or parts gets compact which results in reduction of battery capacity. With the proper management of system resources, we can manage equal balance in between power consumption and devices functionality [1]. There are lot of multimedia devices has been entered into market in which most of the devices becomes consumer products. Hence because of this reason there will be necessity is generated for visual basis multimedia products which should consume low power and should have low bit rate. Due to which, there is always research going on day by day in video codecs to meet the best video quality and good performances. There are so many video codecs launched in the market while some of them have been succeeded to get attention of consumers.

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Also, in video codec compression technology, there is huge revolution has been done right from 1194 year to 2013 year. In the current video codec HEVC, Data bitrates, data decoding time and memory storage has been reduced for improving the quality of video streaming.[2], [3]. The data compression rate of HEVC video codec is double than that of H.264 for same quality video . HEVC video codec has achieved good quality of video and high compression rate, is just because of variable entropy length coding, Intra-Prediction, Motion estimation deblocking filter and decorrelation transforms [2], [4]. By 2004, to improve the video quality with best performances and high compression rates, there is development has been started in the field of video codec. Video Coding Expert Group (VCEG) of International Telecom Union has started study and analysis of different potential parametric techniques to get new version of H.264 or AVC. Joint Model created under VCEG Video Team and MPEG Video Team that was established for Call for proposal for AVC/H.264 video standard, with KTA based software code. In the year 2010, it was accepted worldwide and standardized to HEVC Module in association with MPEG project module. The 1st version module of HEVC was end up and was published in the year 2013 [5]. The computational video codec performance is also plays vital role along with need of attaining high compression data rates generally in video codecs and the target devices maintain and sustain lifelong devices which usually possess low reserve battery power. The main objective of my research work is disinterment of video codec on the basis of low power consumption, higher performance and high compression ratio.

II. VARIOUS LIBRARIES USED IN VIDEO CODEC

Here, we mainly focused on various software based libraries used in video data encoding and the selected video codecs.

A. (High-Efficiency-Video-Codec) HEVC

The next updated video codec after H.264 or MPEG4 Advanced-Video-Coding is High Efficiency Video Codec. The main motive of HEVC Video Codec is to make transport system integration easy, implement parallel architecture with data resilience loss and coding efficiency better. High Efficiency Video Coding has Intra- and Inter-Prediction De-blocking filters, CABAC Entropy Based Video encoder that are Advanced versions of tools used in H.264 video codec. Apart from discussed tools, High Efficiency Video Coding Incorporates with other additional encoding properties like tile mode, wave-front mode of encoding, CTU and Adaptive offset mode. HEVC video codec mainly focuses on improvement of resolution of video and increment of parallel processing based architectures. In 1st version of HEVC, main still, main 10 and simple main picture profiles are used.

While 2nd version profile represents 1 Multiview, 21 range extension and 2 scalable extension profiles [6], [7]. To achieve better video data compression performance, hardware complexity cost cannot able to predict exactly. Some of the design aspects of HEVC video codec required more processing time than that of H.264 while, others are cut-down [8]. HM 14 version was utilized in the evaluation of H.265 inter and intra encoder. In that, the Intra-Period was used is1, slice mode of 0, Max-CU of 64x64, 1500 slice argument. HM source code was obtained from their web-link and for its compilation; we have used Microsoft's Visual Studio 2005.

B. Advance Video Codec or H.264

H.264 or AVC (Advanced Video Coding) is a widely adopted standard and for H.264 first time the ISO, ITU and IEC have work together on a same international standard. H.264 involves considerable improvements in robustness, latency, coding competence and complexity. It offers a potential for creating better video coders which gives higher quality video streams at same bit-rate, or on the other hand, lower the bitrates at the same quality video. In addition to encoding options in H.264 include multiple reference frames, variable block sizes, advanced entropy coding, Loop/Deblocking Filter, and much more. Some encoding profiles supported by H.264 are Baseline, Main, High, and High10 and Extended profiles. H.264 can decrease the size of digital video file by 50% more than with the MPEG-4 part-2 standard at same video quality [9], [10]. Version 18.6 was used for the evaluation of H.264/AVC inter coding with different profiles (main, high and baseline). We compiled the source code downloaded from JM website using Microsoft's Visual Studio 2005 with default settings.

C. Motion-JPEG-2000

Motion JPEG 2000 is one of the codec used for coding of video sequences which is an extension of JPEG 2000.In 1996, for current and future applications the JPEG committee starts to examine chances for a new still image compression standard that was named

JPEG2000. JPEG2000 encodes a sequence of independently coded JPEG images of a video. As there's no motion compensation, the temporal redundancy problem in video is not solved so lower compression ratio is achieved. Without decompression and recompression, Motion JPEG 2000 video streams can be edited because each frame of video is encoded individually. It speed up the editing process and making functions much faster such as frame-by-frame reverse play [11], [12].

1) *Kakadu:* Kakadu is a closed source library used for JPEG 2000 images & Motion JPEG video encoding. It is written by David Taubman. It is used in Apple's Quick time player. It implements the ISO/IEC 15444-1 standard. We used it for encoding videos at different rates.

2) *OpenJPEG:* OpenJPEG is an open source library used for coding of JPEG 2000 images & Motion JPEG 2000 videos that is actively maintained. It was forked from libj2k which is another open source JPEG 2000 library written by David Janssens. OJ2 provides open-source C-language implementations of MJ2 and JP2 for Linux and Windows [13].

III. OBJECTIVE VIDEO QUALITY ASSESSMENT METHODS

The main characteristic of codec comparisons is video quality. Video quality assessment can be objective or subjective. Subjective assessment shows how video is apparent by viewer but such tests are quite expensive regarding time and human resources. Due to this fact, mostly used method is the objective quality assessment method which produces values that score the video quality. This method consists of the use of computational methods called metrics. The mostly used objective metrics are peak signal-to-noise ratio (PSNR) and structural similarity index (SSIM) [14].

A. Peak-Signal-to-Noise-Ratio

The PSNR is the most widely used video quality metric. It is defined as in (1):

$$PSNR = 10\log\frac{m^2}{MSE}\,[dB] \text{----------------} (1)$$

Where m is the maximum pixel value e.g. for 8-bit image its value is 255 and MSE is the Mean Squared Error defined in (2) as the mean of the squared

differences between the pixels gray level values in two pictures or sequences I and I' .

$$MSE = \frac{1}{TXY}\sum_t\sum_x\sum_y[I(t,x,y) - I'(t,x,y)]^2 \text{--------} (2)$$

Where X and Y are size of pictures and T are frames. Technically PSNR measures image fidelity whereas MSE measures image difference. PSNR metric is can be computed easily and fast which is its main advantage [14].

B.Structural-Similarity-Index

B.Structural-Similarity-Index)

This method differs from the PSNR method, which is error based. Instead of the error SSIM use the structural distortion measurement it is due to the human vision system which is more devoted in structural information extraction and it is not specific for errors extraction. Due to which SSIM metric attains good association with subjective impression [14]. The general formula of the SSIM metric is given by (3) which is the measure between two windows x and y of common size N×N.

$$SSIM(x,y) = \frac{(2u_x u_y + C_1)(2\sigma_{xy} + C_2)}{(u_x^2 + u_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)} \quad \text{-------- (3)}$$

Where µx is the average value of x, µy is the average value of y, 45 ' is the variance of x, 46 ' is the variance of y while 456 is the covariance of x and y. For stabilizing the division with weak denominator two variables C1= (k1L) 2 and C2= (k2L) 2 are used where K1=0.03, K2=0.05 and L is the dynamic range of the pixel. The resultant values of SSIM are in interval [0, 1], where 1 is for the best quality and 0 is for the worst. The SSIM is based on the idea that image signals have strong relations amongst themselves, which get information regarding the structures of the objects in the scene. The difference with respect to PSNR or MSE is that SSIM consider image degradation as apparent change in structural information while PSNR or MSE try to estimate apparent errors [15].

IV. SIMULATION ENVIRONMENT

In order to make conclusion concrete and useful, it is very important to define certain test conditions that are meaningful and relevant from practical approach.

For doing experimentation, Microsoft 32-Bit Win-7 Ultimate PC OS is used. Processor Used: Intel core i3-3110M CPU, frequency 2.40 GHz

PC Configuration: 32-Bit OS RAM memory Available: 1.86 GB usable out of 2 GB.

We have done whole research work under same circumstances.

V. PERFORMANCE OF DATA COMPRESSION

In this section, we have provided comparative analysis of HEVC Inter and Intra encoding with the help of main profile of random access, H.264 standard inter with baseline profile, high profile and main profile. For video standard MJ2K, Generally two standard libraries has been referred; first one is Kakadu. It is one of best closest source of library used in famous software's like OpenJPEG and Apple's QuickTime which are open source libraries used in encoder and decoder of JPEG 2000. In the experimentation, we have taken three 1080 pixel full HD videos of 4:2:0 YUV color format for encoding and for every color pixel, we have considered 8 bits for various compression data rates. Table I shows information about different video sequences. During video encoding, 50 frames from each video sequence were taken for comprehensibility purpose. In our research work, our main emphasis was on HD high resolution video contents and every video sequence was compressed with the help of H.264, Motion JPEG and HEVC video codec standards at different data rates. We have considered 16/24/32/40 quantization parameter values for each video sequence. For encoding MJ2K type videos at various compression rate, default option of OpenJPEG and Kakadu were used. We have tested H.264 inter video encoding technique for various profiles to obtain gain against video performance and its quality than that of HEVC inter and intra video encoding techniques with the help of random access profile.

Table I: Tabular Analysis of Difference video Data Sequences.

Sequence Name	Resolution	Frame Rate
Station	1920x1080	30
Pedestrian	1920x1080	30
Kimono	1920x1080	30

The graphical statistic represented in figure 1 , figure 2, and figure 3 shows PSNR and SSIM vs BitRates for station , pedestrian, and kimono video sequence. MATLAB software was used for generating the graphs for HEVC, H.264 and Motion JPEG video codec standard using OpenJPEG and Kakadu. On the other hand, for H.264,H.265/HEVC, other profiles were taken for comparative analysis. We have generated PSNR Vs Bitrates Saving graphs using MATLAB software for kimono, station an pedestrian video sequences. The graphs are shown in Figure. 4, Figure. 5 and Figure. 6.

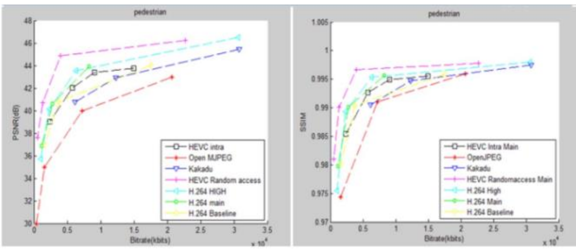

Figure 1: Comparison of Pedestrian Data Sequence at 30 Hz for the RD Performance

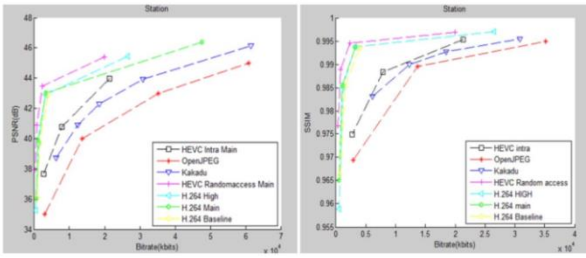

Figure 2: Comparison of Station Data Sequence at 30 Hz for the RD Performance

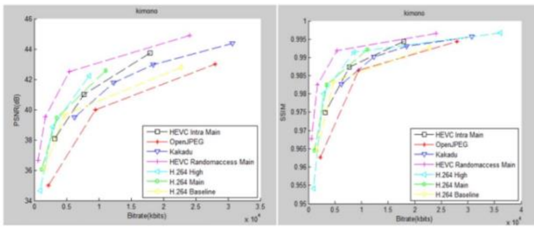

Figure 3: Comparison of Kimono Data Sequence at 30 Hz for the RD Performance

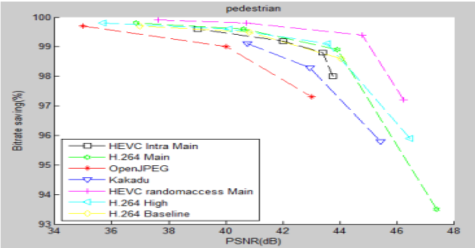

Figure 4: Pedestrian Data Sequence PSNR vs. Bit-Rate

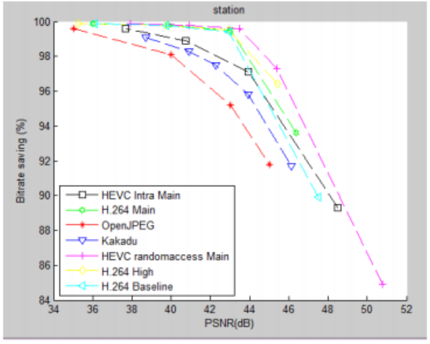

Figure 5: Station Data Sequence PSNR vs. Bit-Rate

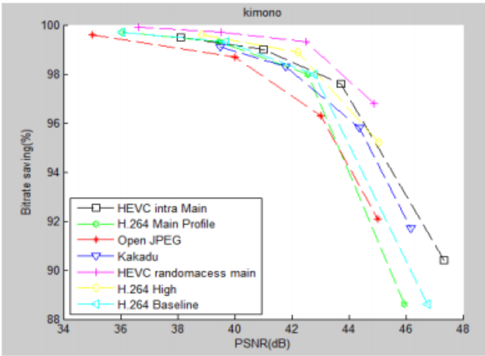

Figure 6: PSNR vs. Bit-Rate saving for kimono sequence.

It is clearly observed from the graphs represented in figure 1 to figure 6 that High Efficiency Video Coding main profile of random access encoding usually takeover in all mentioned configurations to H.264 and Motion JPEG 2000 encoding using OpenJPEG and kakadu. HEVC intra video codec performs better than that of other video codecs when there is less Bitrates and high PSNR. The video produced with kakadu Motion JPEG 2000 encoding scheme were almost analogous and sometimes they beat H.264 baseline profile in video quality. Though high profile of h.264video standard performance better but still It unable to attain good compression rates than that of main random access profile of HEVC video codec.

Open JPEG video codec usually generates bad quality of video data output that fairly had large amount of noise and too artifacts and also its computational data power consumption is more than kakadu method and better than HEVC-intra, HEVC-inter & H.264-inter encoding methods. Kakadu method can easily able to produce such good quality of video within too less consumption timing and too less utilization of hardware than both h.264 configurations.

VI. COMPUTATIONAL VIDEO CODEC PERFORMANCE

As per the time required for encoding data sequence, computation parameters of video codec have been calculated. With reference to our experimental results, Kakadu Algorithm has shown best performance than that of others by achieving fastest data encoding timing with the help of OpenJPEG. High Efficiency Video Coding stand up at 3rd fastest encoding time position due to HEVC Random and Intra access less encoding timings than that of H.264 video codec standard. Because of baseline and main encoding methods takes more time for encoding than HEVC, H.264 has taken 4rth position in video encoding timing among other video standards.

VII. CONCLUSION

On the basis of our analysis and research work conducted by us, the performance and video quality of HEVC (High Efficiency Video Coding) is better than H.264 and Motion JPEG 200. HEVC produces best quality compression videos with best compression rates as compare to other video encoders. Though H.264 video codec standards is having high profile, it has gained good compression rate and its time required for execution is less as compared to other configurations of H.264 still, HEVC main profile in random access is having good performance than that of H.264. Among the other video codecs, H.264 main and baseline profiles outperforms in execution times. HEVC intra video standard performs better than that of other video encoders but at low compression rate. The kakadu method required least amount of time for video encoding and compression than that of H.264. At different compression rates, worst video quality is usually produced if we use an OPENJPEG i.e. MJ2K.

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