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Bandwidth Optimization for Real Time Video Streaming

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Abstract: There is an emerged demand of video communication which represents more than half of the network traffic. Due to rise in video streaming in smartphone and tablets along with the difference in their computational capability has given rise for a scalable extension. HEVC is recently introduced Video Coding standard; it is an advanced version of H.264/Advance Video Coding which is currently used in various applications to reduce the bandwidth by half with same video quality. Therefore, this technique is aiming at more efficient way of compression. This paper describes the existing features, techniques, related work done on the various modes of prediction and few approaches are discussed.
Keywords: Inter-mode, Intra-mode, Prediction, Scalability, Video, HEVC.

1. INTRODUCTION

The Internet has been conventionally used for various different purposes such as data application like chatting, web surfing and other multimedia technology. This technology of multimedia has been developed from decades but came into demand after some time and now a days it has become the most important part of the web. There are various other applications ranging from video conferencing to video lectures and various gaming videos. In today's world, the main source of multimedia content generation is internet and multimedia technology is gaining the attention from developers, researchers and other variety of users[1].

Due to the increases in the demand for various mobile devices like smartphones, tablets, computers, palmtops, notebooks with different screen sizes and computational capability there arises a need of scalable extension. Total cost saving, ease of complexity, scalability, improved productivity are the key drivers for this technology.

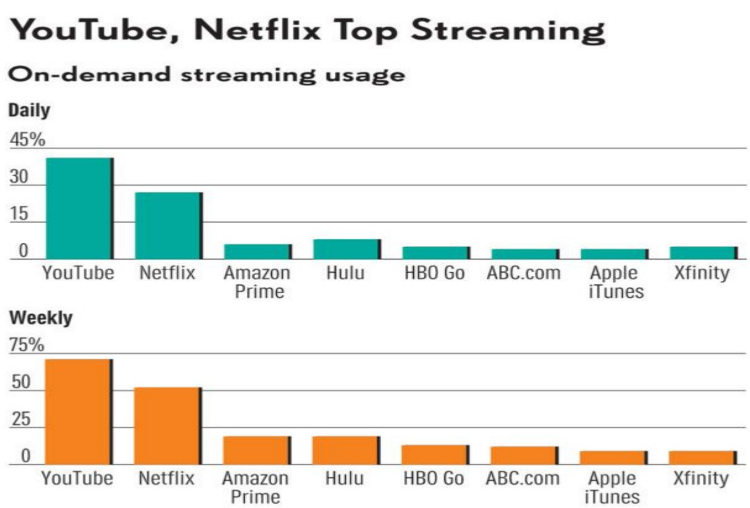

Fig. 1. Demand for video

Transmission of various videos in various formats with different display screens has been a necessity for every internet users. This transmission of video requires higher bandwidth. Compression is necessary as it has to transmit over various wireless or wired networks. Due to the high demand of devices and their capability of capturing quality has increased, there are various traditional protocols used for such high volume multimedia. There are many on-going research that work on various protocols based on the real network. HEVC has more noteworthy features and ability for video with high element range. Besides modern ways for transmission using the internet, there are wide range connection qualities which are the result of resource sharing mechanism. Wide ranging applications of video can vary significantly in application requirements. Broadcast TV: Cable TV over Wi-Fi, HDTV, satellite, DSL, terrestrial, cable modem, live event video streaming: Corporate webcasts, university events on TV, Surveillance video, Interactive video conferencing, On-demand video, First person view quadcopter, Multimedia messaging services (MMS) over ISDN. The main objective is to optimize bandwidth utilization, optimization of parameters for live video streaming, Coding efficiency, Data loss resilience, Bitrates reduction: same subjective visual quality.

High-Efficiency Video Coding (HEVC) has the potential to deliver better performance than the earlier version H.264/AVC. They generate bitstream which are stored or transmitted. This video decoder decompresses this bitstream to decode a sequence of the frame[2]. H.264 has the same basic structure like we have for HEVC which provides many incremental improvements such as flexibility of partitioning from various ranges of sizes large to small or vice versa. Moreover, it provides more flexibility in prediction mode, transforms block sizes, good interpolation, deblocking filters, motion vectors and parallel processing.

2. HEVC CODING AND DESIGN FEATURES

Multiple goals are achieved like the ease of transport system integration, parallel processing, data loss and architecture using HEVC standard. Descriptions of the key elements are briefly explained in this subsection[8].

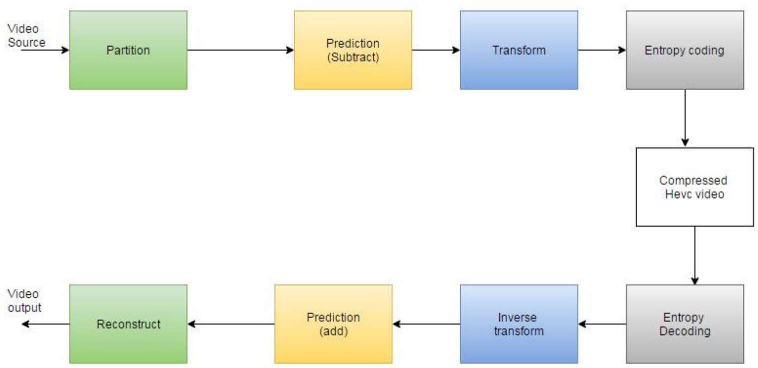

Fig. 2. Block diagram of the HEVC

2.1 Partitioning

In this type of encoder, it provides flexible partitioning of video sequences into frames. Each video frame is further partition into Coding tree units (CTUs). CTU are the basic unit of coding, different from what we have in H.264 which has 64x64 pixels. These CTUs are further subdivided into small regions of the square which is known as Coding Units[1].

2.2 Prediction

Coding Unit is partitioned into some more units of prediction by using inter or intra prediction. Intra prediction: Every Prediction Unit (PU) is formed from the neighboring image data by planar prediction Discrete Cosine (DC). Inter prediction: Every PU is a prediction from data of images from the reference picture by compensation of motion. This component is called as the luma component [2].

2.3 Transform and quantization

Prediction Units are formed from the coding units, they are intra prediction and inter prediction. Coding Unit is partitioned into some more units of prediction by using inter or intra prediction. Intra prediction: Every PU is formed from the neighboring image data by planar prediction DC. Inter prediction: Every PU uses the prediction of two pictures and uses motion compensation. Motions are half sampled resolution[4]. After prediction motion vectors based on the various transformation of discrete cosine transformation. These blocks are transformed into different sizes of 32x32, 16x16, 8x8 and 4x4.4.

2.4 Entropy coding

HEVC bitstream is been quantized transform coefficients, that are prediction information such modes are predicted and motion vectors. All the elements are using Context Adaptive Binary Arithmetic Coding[1].

2.5 In-loop deblocking filtering

In inter-picture, prediction uses a similar deblocking filter that we used in H.264/AVC. Decision-making designs and filtering techniques are been simplified compared to the previous version. Parallel processing is additionally supported in deblocking filtering[6].

2.6 Adaptive Sample offset

After deblocking filtering a new concept is introduced in inter prediction that is nonlinear amplitude mapping. Using the lookup table it reconstructs the original signal amplitudes and few other parameters at encoder's side that can be determined by histogram analysis [7].

3. SAMPLED REPRESENTATIONS OF PICTURES

Extension of sampling format is straight forward Representation of video signals are tristimulus YCbCr color space having a sampling of 4:2:0.There are three types of color representation which are Y,Cb and Cr. Luma is known as Y components. Cb and Cr are two chroma components which represent the color deviation from gray toward red. Luma is sensitive to the human visual system, 4:2:0 sampling structure is used[3]. Each component of every sample is represented by 8 or 10 b of precision. The representation of the encoded input and decoded output video signal.

4. SPECIAL CODING MODES

There are mainly different types of coding modes which are invoked at CU levels. I-PCM mode bypasses prediction, transformation, and entropy coding and predefined bits represents the samples. Excess consumption of bits is avoided in this process and this signal characteristic extremely unusual like noise signal. The decoded picture are bypassed and affected by the transformation, quantization and pre-processing in lossless mode. The entropy encoder is fed with a residual signal from the inter and intra-picture prediction. Additional coding tools are not required as it allows mathematically lossless reconstruction. It improves the compression for various types of video content like computer-generated images and transform is bypassed in transform skipping mode[8].

5. APPROACHES

HEVC covers a wide range of application, which needs for increasing the requirements for several ways that have been analyzed, using various work and range extension and different color and luma format. Bit depth enhancement, 3D video, Multi-view video, Screen Context coding (Graphics, text, animations), embedded bitstream scalability. Compression is achieved by removing redundant information from the video sequence[6]. Spatial redundancy, Perceptual redundancy, and Temporal redundancy. The use of embedded bitstream is a subset as they reduce the bandwidth for the representation of video content Scalability which defines the bit stream representation of the source content with a reduction of picture size and frame rate that has spatial and temporal Scalability.

6. BLOCK-BASED MOTION ESTIMATION

6.1 Motion Estimation Algorithm

Each current frame is divided into equal-size blocks. The reference frame of these source blocks is associated with search region. A candidate block in the search region best matched to the source is the objective of the block-matching. Motion vectors are the relative distance between a source block and its candidate. Various types of algorithms are Hexagonal Search Algorithm, Diamond search, full Search Algorithm.

6.2 Full Search Algorithm

The current block is compared with the reference frame of candidate block as to get the best match block in the reference frame. The sum of absolute difference values at each possible location in the search window is calculated by full search motion estimation. All the candidate blocks for large search windows are calculated by full search. Computational complexity is of order n^2.

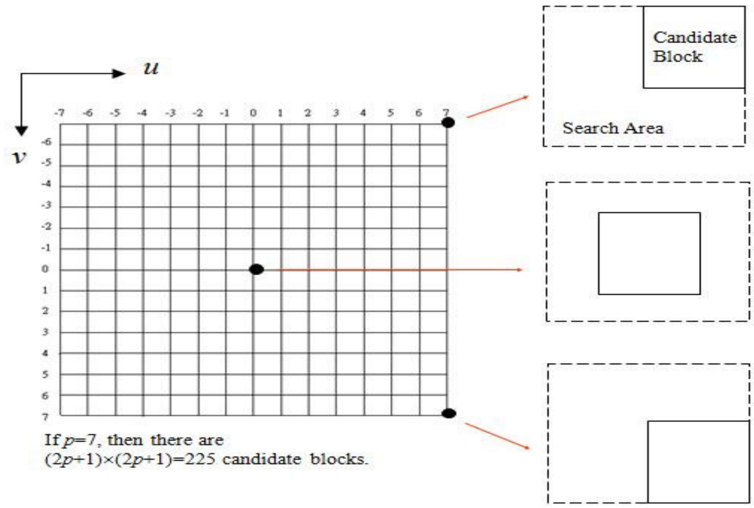

Fig. 3. Full Search Algorithm

6.3 Diamond Search Algorithm

There are two search patterns in Diamond search algorithms. Small diamond search pattern: A small diamond shape comprising of 5 check points. Large Diamond Search Pattern: Comprises 9 check points from which eight points surround the center one to compose a diamond shape.

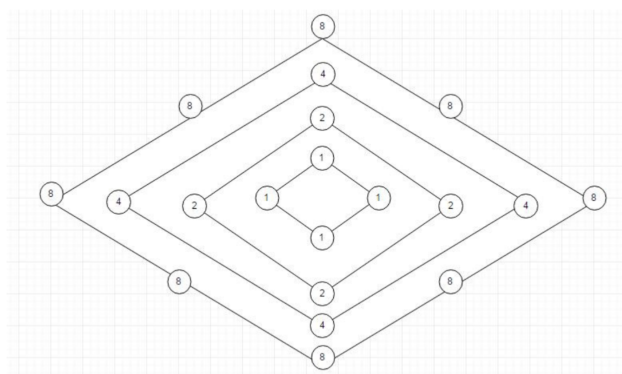

Fig. 4. Diamond Search Algorithm

6.4 Hexagonal Search Algorithm

HEXBS has the minimum cost compared to the DS algorithm with same motion vectors and fewer search points. The more search points can be saved when there are larger motion vectors. The last block distortion occurs at the center point if LDSP is repeatedly used.

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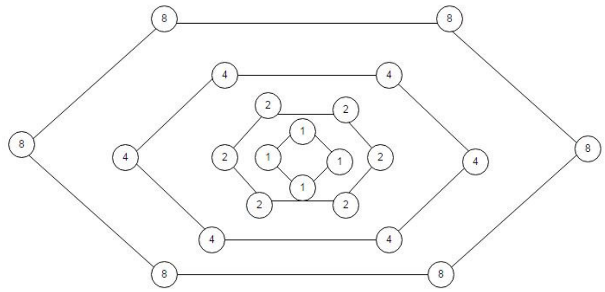

Fig. 5. Hexagonal Search Algorithm

7. SIMULATION

Various Benchmark Videos are been taken with a different resolution for the simulations purpose.

Benchmark Videos	Random Access profiles(Full search)				Random Access profiles(diamond search)		
RaceHorses_416x240_30.yuv	QP	PSNR in dB	Bitrates in kbps	Encoding time in seconds	PSNR in dB	Bitrates in kbps	Encoding time in seconds
	22	38.5854	1503.942	121.766	98.5959	1499.045	1400.011
	27	34.8914	770.750	102.088	36.789	765.0442	1506.972
BQMall_832x480_30.yuv	22	38.5854	1503.942	121.766	98.5959	1499.045	1400.011
	27	34.8914	770.750	102.088	36.789	765.0442	1506.972

Table-1. Comparison of Full search and Diamond search algorithms

Comparing various algorithms and contain information about video frames like PSNR value, bitrates in DB, time stamp etc from the video which is traced. The figure shows the results for RaceHorses.yuv sequence and BQMall in Random Access Configuration with different algorithms are been compared. Table shows the comparison of the hexagon search algorithm with the full search algorithm using access profiles. According to simulation, the full search takes more time and bitrate compared to the hexagon search and diamond search algorithm.

Benchmark Videos	Random Access profiles(Full search)				Random Access profiles(HEX search)		
KristenAndSara_1280x720_60.yuv	QP	PSNR in dB	Bitrate in kbps	Encoding time in seconds	PSNR in dB	Bitrate in kbps	Encoding time in seconds
	22	44.1366	2675.546	545.038	40.1771	2207.027	1808.623
	27	42.5424	1236.854	570.421	38.7540	3657.3675	1358.78
ParkScene_1920x1080_60.yuv	22	48.458	2980.564	577.124	45.127	2855.045	1900.10
	27	47.123	1342.457	598.445	46.124	2154.54	1706.124

Table-1. Comparison of Full search and Hexagonal search algorithms

8. CONCLUSION

HEVC is a newly developed technology which has many open issues. There are various techniques and tools used for the block-based technique for motion estimation/compensation. A lot of work has been done on the motion compensation and estimation and various algorithms have been designed. This paper represents comparisons of different block-based motion detection algorithms. Raw video can be encoded by the required codec using tools provided by HM 16.8 software. The frame type, time stamp, video frames, bitrates, PSNR value etc are generated by using HM software encoder. Simulation results are presented in the table. According to the analysis, we found out that full search algorithm takes much more time and bandwidth compared to hexagon search and diamond search.

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