A NOVEL APPROACH TO IMPROVE QUALITY OF 4G WIRELESS NETWORK FOR H.265/HEVC STANDARD WITH LOW DATA RATE

Kavita Monpara[1], Dr. Dipesh Kamdar[2], Dr. Nirali A. Kotak[3], Dr. Bhavin Sedani[4]

[1]Research Scholar, Electronics and Communication Engineering Department, CU Shah University, Wadhvan (India)

[2]Asso. Prof., [4]Head and Prof., Electronics and Communication Engineering Department, VVP Engineering College, Rajkot (India)

[3]Asst. Prof., Electronics and Communication Engineering Department, GIT, Gandhinagar (India)

ABSTRACT

H.265/HEVC (High Efficiency Video Coding) is recently prepared new video coding standard by ITU-T Video Coding Expert Group along with ISO/IEP Moving Picture Expert Group. The HEVC standard is design to achieve higher compression compared to existing standard and approx. 50% low bit rate for same quality video. Wi-Max is design to serve over MAN, targeting approx 50KM range with the approx speed more than 1 Gbps with large no of users. It must support the HD quality video and all other data traffic at the same time to all users. Hence, the video must be compressed in such a way that HD quality video should be passed at lower data rate. This paper is focused on transmitting high quality video over the 4G Network with low data rate.

Keywords*: *H.265/HEVC, HEVC Encoder, HEVC Decoder, 4G Wireless Network

I. INTRODUCTION

As per today's scenario, the networking giant cisco estimates that video consumed about 70% of all online traffic in 2014, and it will be rise up to 80 to 90 % by 2018. And all these traffic is raised due to a perfect storm of rapidly increasing demand and quality. There is no any reversing trend. As time of 21st sanctuary video is going to become more popular and it will consume more bandwidth. Therefore there is a huge need to compress the video with the high quality and less bandwidth requirements. As per increasing the diversity of services, the growing need of HD (High Definition) video and the beyond HD formats like 4k x 2k are, there is a huge need of high coding efficiency and less bandwidth requirements. The H. 264 standard - the foundation of most online video is overtaken by H.265/HEVC (High Efficiency Video Coding) standard because of its huge gains in coding efficiency. The traffic generated by video applications in wireless communication are imposing several challenges due to an increased desire of higher quality and resolutions.

II. H.265/HEVC – ADVANCE VIDEO CODING STANDARD

H.265/HEVC is a new video coding standard that defines how decodes the video. HEVC generally focuses on two key issue: increased video resolution and increased key of parallel processing architectures. These standard is designed to fulfill many requirements including coding efficiency, data loss resilience, lower memory requirements.

In video coding layer of HEVC, there is a same hybrid approach (inter/ intrapicture prediction and 2-D transform coding) is used as in all video compression standard since H.261. In HEVC coding algorithm, each picture is divided into blocked shape regions, with the exact block partitioning being conveyed to the decoder. The first picture of a video sequence is coded using only intrapicture prediction that means some prediction of data from region to region within same picture, but has no dependence on other pictures. For all remaining pictures of a sequence, interpicture temporally predictive coding modes are typically used for most blocks. In H.264 9 directional modes are used for intra-prediction while in H.265 35 directional modes are used. In order to increase coding efficiency, reduce computational complexity and maintain lower memory requirements a new block structure is used in HEVC standard. In that structure the coding tree units (CTU), replaces the macroblock structure found in H.264.[2]

2.1 Hevc Video Encoder

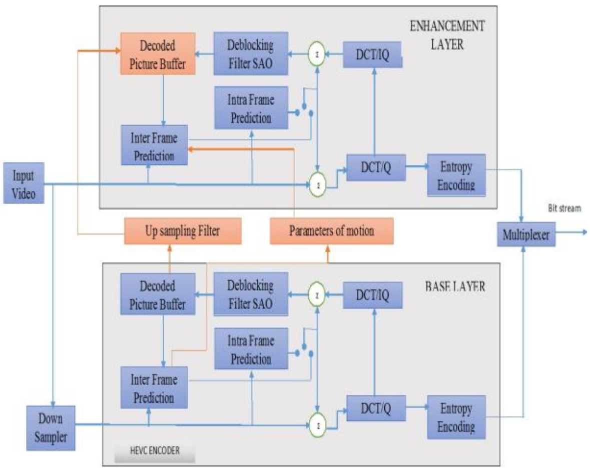


Fig. 1. HEVC Video Coder

As in H.264/AVC, HEVC consist of Inter frame prediction, Intra frame prediction, 2D transformation, entropy coding and in loop filters. One main difference between H.264/AVC and HEVC is that HEVC uses a quad tree coding structure. In HEVC, a frame is partitioned into multiple coding tree units (CTUs) which is similar to the concept of macroblock in previous standard. A CTU supporting a larger sub block of a picture with a variable size up to 64 x 64 luma samples, while in macroblock structure allows maximum size of 16 x 16 luma samples. A coding tree units (CTU) is subdivided into coding tree blocks (CTBs) and CTBs can be further split into smaller coding blocks (CBs). One luma CB and two Chroma CBs compose a coding unit (CU). A CU also defines the prediction units (PU), for intra or inter picture prediction decision, and transform units (TUs), describing the block transform coding of the prediction residual. The CBs can then have identical or smaller in size prediction blocks (PBs) and luma transform blocks (TBs). The luma CB residual may be identical to the luma transform block (TB) or may be further split into smaller luma TBs. The same applies to the Chroma TBs.Integer basis functions similar to those of a discrete cosine transform (DCT) are defined for the square TB sizes 4×4, 8×8, 16×16, and 32×32. For the 4×4 transform of luma intrapicture prediction residuals, an integer transform derived from a form of discrete sine transform (DST) is alternatively specified. A detailed overview and performance evaluation of the emerging HEVC standard can be found in [1]

In HEVC standard, advanced motion vector prediction (AMVP) is used which includes a merge mode for MV to derive information of motion from temprarory or spatially adjacenting blocks. Moreover, compared to H.264/MPEG-4 AVC, improvedSkipped and direct motion inference are also specified [2].

In this standard, Quarter-sample precision is used for the moving video, and 7-tap or 8-tap filters are used for interpolation of fractional-sample positions. In HEVC multiple reference pictures are used which is same as H.264/AVC.For each picture block, there is either one or two motion vectors can be transmitted and it resulting either in unipredictive or bipredictive coding respectively. In HEVC, a scaling and offset operation may be applied to the prediction signals which is same as H.264/AVC

For the intra prediction, HEVC supports 33 directional, planner and DC prediction modes. The decoded boundary samples of adjacent blocks are used as reference data for spatial prediction in regions where interpicture prediction is not performed..

A Context adaptive binary arithmetic coding (CABAC) is used for entropy coding in HEVC. This is similar to the CABAC scheme in H.264/MPEG-4 AVC, but has undergone several improvements to improve its throughput speed (especially for parallel-processing architectures) and its compression performance, and to reduce its context memory requirements [2].

The in-loop filtering process includes a SAO(Sample adaptive offset) as well as deblocking filter. A deblocking filter similar to the filter which is used in H.264/MPEG-4 AVC. However, the design is simplified in regard to its decision-making and filtering processes, and is made more friendly to parallel processing. A nonlinear amplitude mapping is introduced within the interpicture prediction loop after the deblocking filter.

2.2 Hevc Video Décoder

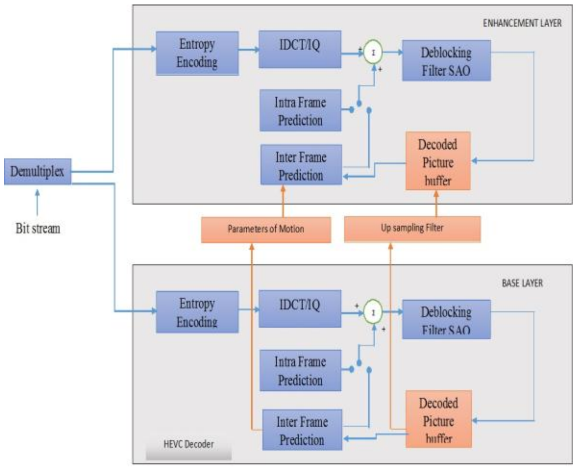


Fig. 2. HEVC Video Decoder

The video codec can be design based on either single loop architecture or multi loop decoding architecture. There are inter-layer prediction schemes such as residual prediction requires to achieve comparable coding efficiency to that of the multi-loop decoding architecture. In the multi-loop decoding architecture, the motion compensation is done in every Reference layer, which is needed to reconstruct the target layer. Both inter-coded blocks and intra-coded blocks are reconstructed in all reference layers, and the reconstructed samples of the reference layers can be used as additional predicted samples for the enhancement layer .Although the multi-loop decoding architecture increases the decoded picture buffer size and memory bandwidth for motion compensation on the decoder side depending on the number of layers, it is known that the coding efficiency is better than that of the single-loop decoding architecture. It also has the advantage that the multi-view scalability can easily be supported at the same time since the scalable codec based on multi-loop decoding architecture can display any view of the multi-view configuration as view scalability. Therefore in HEVC based on multi-loop decoding architecture is used which employs inter-layer sample prediction and motion parameter prediction.[1]

2.3 Comparision Between H.264/Avc And H.265/Hevc

Category	H.264	H.265/HEVC
Known as	MPEG 4 AVC	MPEG-H,HEVC
Progression	Successor to MPEG -2	Successor to H.264
Compression Model	Hybrid Spatial Temporal Model	Enhanced Hybrid Spatial Temporal Model
Intra Prediction	9 Directional modes	33 directional modes + Planar (Surface fitting) + DC (flat) Prediction modes
Structure	Macroblock Structure with maximum size of 16 x 16	CTU supporting block structure size of 64 x 64
Partitioning	Sub block down to 4 x4	PU Quad tree down to 4 x4 square (For intra) , symmetric and asymmetric
Entropy Coding	CABAC and CAVLC	Only CABAC

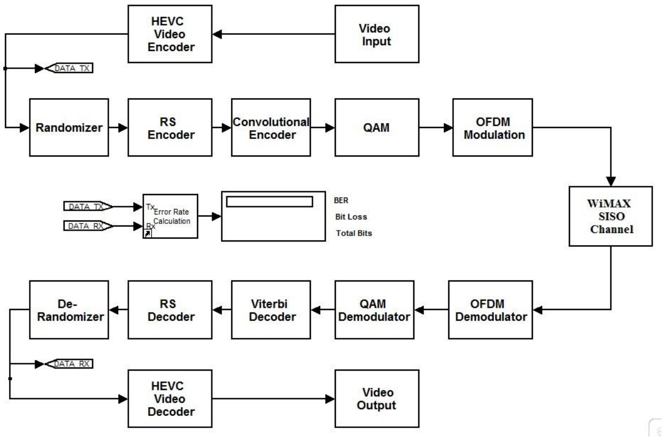
Transform	Integer DCT 8x8, 4x4	Transform Unit square IDCT from 32x32 to 4x4 +DST Luma intra 4x4
Specification	Support up to 4k(4094 x 2304) Support up to 59.92 fps	Support up to 8kUHDTV(8192 x4320) Support up to 300fps
Bit reduction	40-50 % bit rate reduction Compared to MPEG 2 at same visual quality	40-50 % bit rate reduction Compared to H.264 at same visual quality
Filters	Deblocking filter	Deblocking Filter Sample Adaptive Offset

TABLE I: H.264 VS H.265/HEVC STANDARD

IV. 4G WIRELESS NETWORK

WiMAX, the Worldwide Interoperability for Microwave Access is the highly anticipated technology that aims to provide business and consumer wireless broadband services in form of Metropolitan Area Network (MAN). The technology has a target range of up to 31 miles and a target transmission rate exceeding 100 Mbps and is expected to challenge DSL and T1 lines (both expensive technologies to deploy and maintain) especially in emerging markets. The IEEE 802.16 standard was firstly designed to address communications with direct visibility in the frequency band from 10 to 66 GHz. Due to the fact that non-line-of-sight transmissions are difficult when communicating at high frequencies, the amendment 802.16a was specified for working in a lower frequency band, between 2 and 11 GHz.WiMAX is a technology standardized by IEEE for wireless MANs conforming to parameters which enable interoperability. WiMAX developments have been moving forward at a rapid pace since the initial standardization efforts in IEEE 802.16.WiMAX is one of the closest technologies to meet the standards of true 4G and as it develop should surpass the 100MB/second which is the 4G standard [5],[6],[7].

V. SIMULATION AND PERFORMANCE ANALYSIS OF H.265/HEVC



The uncompressed video is compressed to H.265/HEVC standard. The compressed video frames is then passed to the Wi-max system. The SISO Wi-max channel is used to pass in the model and the received bit stream is passed to H.265/HEVC decoder to recover the video.

*A. **Quality Factor (QF)***

A modest metric to assess a video file's compression density is the Quality factor (QF). The QF indicate the three parameters of video compression: bitrate, the number of pixels in the frame, and the overall frame-rate of the video. QF is essentially a measure of, "the amount of data allocated to each pixel in the video". This metric doesn't take into account the type of compression profile used, the number of passes originally utilized in the encoding process, or any tweaks implemented by the encoding engineer to optimize the video quality. So QF or compression density, is just a baseline guide for an administrator that is responsible for transcoding or managing large video libraries.

$$QF = \frac{bit\ rate}{pixels\ per\ frame * frame\ rate}$$

$$= \frac{bits/_{second}}{pixels/_{frame} * frames/_{second}}$$

$$= \frac{bits}{pixels}$$

V. RESULTAND ANALYSIS

The H.265/HEVC can compress the video compared to H.264/AVC, hence it can be transmitted with lower data rates and higher QF. While considering same PSNR and Video Quality, the H.265 can transmit it with lower bit rate. While considering same bit rate, H.265/HEVC can deliver the higher quality video. The H.265/HEVC Video can be transmitted through the 4G Wireless Network at very low data rate. The bit rate to the QF comparison for same PSNR is shown in Table 2. For the same quality picture, the bit rate v/s PSNR is shown in Table 3.

Video Coded	Bitrate (MBPS)	QF
MPEG2	16.7	.34
H.264	10.0	.20
H.265	6.0	.12

TABLE II:: Comparative Analysis of bit rate and QF for various video encoding techniques

Bit rates (kb/s)	**PSNR(dB)**		
	H.265	**H.264**	**MPEG 2**
1000	48	43	23
2000	49	47.5	34
4750	51	49	44
9000	52	51	49

TABLEIII: Comparative Analysis of bit rate v/s PSNR for various video encoding techniques

REFERENCES

[1] Hahyun Lee, Jung Won Kang, Jinho Lee, Jin Soo Choi, Jinwoong Kim, and Donggyu Sim, "Scalable Extension of HEVC for FlexibleHigh-Quality Digital Video Content Services" ETRI Journal 2013

[2] Gary J. Sullivan, Jens-Rainer Ohm, Woo-Jin HanandThomas Wiegand, "Overview of the High Efficiency Video Coding(HEVC) Standard" IEEE transaction on circuits and systems for video technology, VOL. 22, NO. 12, December 2012

[3] B. Bross, W.-J. Han, G. J. Sullivan, J.-R. Ohm, and T. Wiegand, HighEfficiency Video Coding (HEVC) Text Specification Draft 9, documentJCTVC-K1003, ITU-T/ISO/IEC Joint Collaborative Team on VideoCoding (JCT-VC), Oct. 2012.

[4] Dan Grois,Detlev Marpe, Amit Mulayoff, Benaya Itzhaky,and Ofer Hadar, "Performance Comparison of H.265/MPEG-HEVC, VP9, andH.264/MPEG-AVC Encoders" PICTURE CODING SYMPOSIUM 2013

[5] Rashid A. Saeed, Ahmed A. M. Hassan Mabrouk, Amitava Mukherjee, FranciscoFalcone and K. DanielWong, "WiMAX, LTE, and WiFi Interworking", Journal ofComputer Systems, Networks, and communications, Volume-2010, Article ID 754187,pp.1-2, April 2010.

[6] Bhavin Sedani, Dipesh Kamdar, Komal Borisagar and Dr. Gopal R. Kulkarni (2011), "Simulation and Performance Analysis of WiMAX system usingTransmit Diversity and Alamouti coding scheme with real time image input", CICN, Kanyakumari.

[7] Bhavin Sedani, Nirali Kotak, Dr. G.R. Kulkarni (2010), "Performance Analysis of WiMAX structure-current status and future trends", CIIT, International Journal of Wireless Communication, ISSN:0974-9640.