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Basics of High-Efficiency Video Coding (HEVC) and its Comparison from H.264/AVC Video Codec

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Abstract:

This paper deals with the overview of latest video coding standard High-Efficiency Video Coding (HEVC). Also this work presents a performance comparison of the two latest video coding standards H.264/MPEG-AVC and H.265/MPEG-HEVC. According to the experimental results, which were obtained for a whole test set of video sequences by using similar encoding configurations, H.265/MPEG-HEVC provides significant average bit-rate savings of around 40%.

Keywords: - CABAC, **CAVLC, H.264/AVC, HEVC PSNR and SBAC.**

I. INTRODUCTION

The H.264/AVC video coding standard explicitly defines all the syntax elements, such as motion vectors, block coefficients, picture numbers, and the order they appear in the video bitstream.
There are several Advanced Features of H.264/AVC video Codec which distinguish it from the previous video compression standards such as H.261,MPEG-1,2 and H.263 etc.[1, 2].

The H.265/MPEG-HEVC standard was designed to be applicable for almost all existing H.264/MPEG-AVC applications, while putting emphasis on high-resolution video coding. Since the development process of H.265/MPEGHEVC was also driven by the most recent scientific and technological achievements in the field of video coding, dramatic bit-rate savings were achieved for substantially the same visual quality, when compared to its predecessor like H.264/MPEG-AVC [3-5].

In parallel with the open video coding standardization processes of ITU-T and ISO/IEC, a few companies individually developed their own video codecs, which often were based partly on their own secretly kept technologies and partly on variants of the state-of-the-art technologies used in their standardized counterparts, available at that time. One of these kind of proprietary video codecs is the VP8 codec [6-8], which was developed privately by On2 Technologies® Inc.

that in turn, was later acquired by Google® Inc. Based on VP8, Google® Inc. started the development of its successor
VP9 [6,7] in 2011, which was recently announced to be finalized [8].

II. TECHNICAL OVERVIEW OF H.264

The H.264 design supports the coding of video (in 4:2:0 chroma format) that contains either progressive or interlaced frames. Generally a frame of video contains two interleaved field.

A. Network Abstraction Layer (NAL)

The VCL, which is described in the following section, is specified to represent, efficiently, the content of the video data. The NAL is specified to format that data and be responsible for header.

B. Video coding layers

The video coding layer of H.264 is similar in script to other standards such as MPEG-2 video. It consists of a hybrid temporal and spatial predictions, in conjunction with transform coding. Figure-2 shows the H.264 encoder. In common with earlier coding standards, H.264 does not explicitly define a Codec but rather defines the syntax of an encoded video bit stream together with the method of decoding this bitstream [9].

C. Basic of video coding

A digitized video signal consists of a periodical sequence of images called frames. Each frame consist of a two dimensional array of pixels. Each pixel consist of three color components R, G and B. Usually, pixel data is converted from RGB to another color space called YUV in which U and V components can be sub-sampled. A block-based coding approach divides a frame into macroblocks (MBs) each consisting of say 16x16=256 Y components. Each of three components of a MB, a hybrid of three techniques is used: prediction, transformation & quantization and entropy coding. This procedure works on a frame of video [10-12].

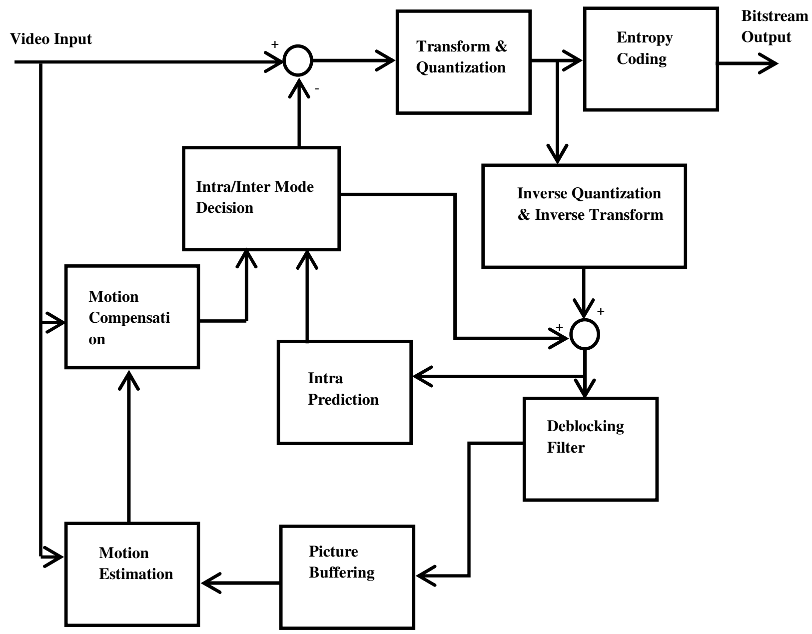

Fig. 2. Block diagram of H.264/AVC encoder

III. OVERVIEW OF HEVC

Main Features of HEVC are as follows;

1. Achieves 2x higher compression compared to H.264/AVC.
2. High throughput (Ultra---HD 8K @ 120fps) and low power.
3. Implementation friendly features (e.g. built-in parallelism).
4. Reduce the burden on global networks.
5. Easier streaming of HD video to mobile devices.

6. Account for advancing screen resolutions (e.g. Ultra---HD).

HEVC is based on the same structure as prior hybrid video
codecs like H.264/AVC but with enhancements in each coding stage [13]. HEVC includes a prediction stage composed of motion compensation and spatial intra-prediction, an integer transform applied to prediction residuals, and an entropy coding stage that uses either arithmetic coding or variable length coding. Also, as in H.264/AVC, an in-loop deblocking filter is applied to the reconstructed frame. Fig. 2 depicts a general diagram of the HEVC decoder and its coding stages.

An important difference of HEVC compared to H.264/AVC
is the frame coding structure. In HEVC each frame is divided
into Largest Coding Units (LCUs) that can be recursively split into smaller Coding Units (CUs) using a generic quad tree segmentation structure. CUs can be further split into Prediction Units (PUs) used for intra- and inter-prediction and Transform Units (TUs) defined for transform and quantization.

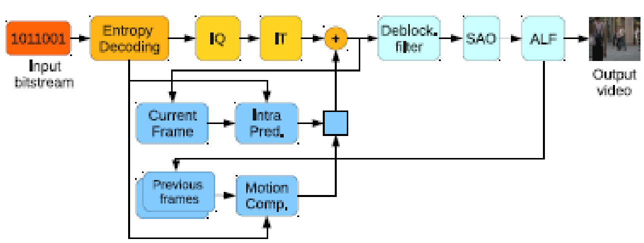

Fig.2 General diagram of HEVC Decoder [13]

IV. SIMULATION, IMPLEMENTATION AND RESULTS

For evaluating H.264/MPEG-AVC, an open H.264/MPEGAVC encoder implementation - the x264 encoder was selected [14-17]. The first version of the x264 encoder was released in 2006, and since then, it has proven to be very fast, efficient, and reliable. Particularly, due to its flexible trade-off between coding efficiency and computational complexity, it was widely adopted in many network-based applications. Currently, the x264 video encoder is considered to be one of the most popular encoders for H.264/MPEG-AVC-based video coding [14].

Table 1depicts the HEVC Bit Rate savings for equal Peak Signal to Noise Ratio (PSNR) obtained for various video sequences .Video sequences are Traffic,People on Street and Park Scene respectively.

TABLE I. HEVC BIT RATE SAVINGS FOR EQUAL PSNR

Video→ ↓ Sequences/QP	**Traffic**	**People on street**	**Park Scene**
22	25.4	27.8	34.6
27	32.4	23.6	29.1
32	36.9	28.7	33.5
37	41.1	31.7	37.3

V. CONCLUSION

Basics of High Efficiency Video Codec are discussed along with the Technical overview of H.264/AVC.

Also performance comparison of H.265/MPEG-HEVC, and H.264/MPEG-AVC encoders was presented. According to the experimental results, the coding efficiency of H.264/MPEG-AVC is inferior than H.265/MPEG-HEVC with an average bit-rate overhead at the same objective quality of 40%.

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