OVERVIEW OF H.265 STANDARDS

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ABSTRACT

High Efficiency Video Coding (HEVC) is newest video coding standard, It also known as H.265 and MPEG-H Part 2, is a video compression standard, It is able to supports resolutions up to 8192×4320. The main aim of the HEVC is bit rate reduction, the average bit rate reduction for HEVC was 52% for 480p, 56% for 720p, 62% for 1080p, and 64% for 4K UHD. This paper presents an overview of the reduction features and characteristics of the HEVC standard.

Keyword: H.264, High Efficiency Video Coding (HEVC), Joint Collaborative Team on Video Coding (JCT-VC), MPEG-4, video compression.


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1. INTRODUCTION

High Efficiency Video Coding (HEVC) is the current joint video coding standardization project of the ITU-T Video Coding Experts Group (ITU-T Q.6/SG 16) [1] and ISO/IEC Moving Picture Experts Group (ISO/IEC JTC 1/SC 29/WG 11). The Joint Collaborative Team on Video Coding (JCT-VC) was established to work on this project. The scope of this group was extended to continue working on Format Range Extensions (RExt), Scalable HEVC (SHVC) and Screen Content Coding (SCC) as extensions of HEVC. The Joint Collaborative Team on 3D Video Coding Extension Development (JCT-3V) was established to work on multiview and 3D video coding extensions of HEVC and other video coding standards.

The first version of the HEVC standard was finalized in April 2013. The second version of HEVC including the RExt, SHVC and MV-HEVC extensions was finalized in October 2014. The third version of HEVC including the 3D-HEVC extension was finalized in February 2015.
The most important video coding standard is H.264/MPEG-4 AVC, which was developed in the period between 1999 and 2003, and then was extended from 2003–2009. H.264 was developed by the ITU-T Video Coding Experts Group (VCEG) together with the ISO/IEC JTC1 Moving Picture Experts Group (MPEG). H.264 is the classical application of videoconferencing and broadcasting of TV contented (satellite, cable, and terrestrial), the improved compression capability of H.264/MPEG-4 AVC enables new services.

H.264 is the result of a joint project between the ITU-T’s Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group (MPEG)[2][3]. ITU-T is the sector that coordinates telecommunications standards on behalf of the International Telecommunication Union. ISO stands for International Organization for Standardization and IEC stands for International Electro technical Commission, which oversees standards for all electrical, electronic and related technologies. H.264 is the name used by ITU-T, while ISO/IEC has named it MPEG-4 Part 10/AVC since it is presented as a new part in its MPEG-4 suite. The MPEG-4 suite includes, for example, MPEG-4 Part 2, which is a standard that has been used by IP-based video encoders and network cameras.

Designed to address several weaknesses in previous video compression standards, H.264 delivers on its goals of supporting:

1. Implementations that deliver an average bit rate reduction of 50%, given a fixed video quality compared with any other video standard
2. Error robustness so that transmission errors over various networks are tolerated
3. Low latency capabilities and better quality for higher latency
4. Straightforward syntax specification that simplifies implementations
5. Exact matches decoding, which defines exactly how numerical calculations are to be made by an encoder and a decoder to avoid errors from accumulating. A Typical HEVC video encoder is shown in figure 1.

Figure 1 Typical HEVC video encoder
H.264 also has the flexibility to support a wide variety of applications with very different bit rate requirements. For example, in entertainment video applications—which include broadcast, satellite, cable and DVD—H.264 will be able to deliver a performance of between 1 to 10 Mbit/s with high latency, while for telecom services, H.264 can deliver bit rates of below 1 Mbit/s with low latency.

2. HEVC CODING

The main aim of the HEVC is bit rate reduction. The average bit rate reduction for HEVC was 52% for 480p, 56% for 720p, 62% for 1080p, and 64% for 4K UHD. Video coding Layer:

HEVC used in all modern video coding standards, initially from H.261, in that it used as inter and intra-picture prediction and 2D make over coding. A HEVC encoder proceeds by split a picture into block formed regions for the first picture. Fig. 1 depicts the Typical HEVC video encoder, which could make a bit stream to the HEVC standard.

In the following, the various features involved in HEVC are as follows.

a) Coding tree unit:

The HEVC containing 16×16 pixel macro-blocks, with coding tree units (CTUs) which can use larger block structures of 16×16, 32×32, or 64x64 samples and it can with a larger pixel size usually increasing the coding efficiency.

b) Coding units (CUs) and coding blocks (CBs):

The quad tree syntax of the Coding tree units specifies the pixel size and positions of its luma and chroma CBs. The root of the quad tree is linked with the CTU. Hence, the size of the luma CTB is the largest supported size for a luma CB. The splitting of a CTU into luma and chroma CBs is signaled jointly. One luma CB and ordinarily two chroma CBs, together with associated syntax, form a coding unit (CU). A CTB may contain only one CU or may be split to form multiple CUs, and each CU has an associated partitioning into prediction units (PUs) and a tree of transform units (TUs).

c) Prediction units and prediction blocks (PBs):

A PU partitioning structure has its root at the CU level. Depending on the basic prediction-type decision. HEVC supports variable PB sizes from 64×64 down to 4×4 samples.

d) TUs and transform blocks:

A TU tree structure has its root at the CU level. 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 intra-picture prediction residuals, an integer transform derived from a form of discrete sine transform (DST) is alternatively specified.

e) Motion vector signaling:

A merge mode for MV coding can also be used, allowing the inheritance of MVs from temporally or spatially neighboring PBs. Moreover, compared to H.264/MPEG-4 AVC, improved.

f) Motion compensation:

Quarter-sample precision is used for the MVs, and 7-tap or 8-tap filters are used for interpolation of fractional-sample positions. As in H.264/MPEG-4 AVC, a scaling and offset operation may be applied to the prediction signal(s) in a manner known as weighted prediction.

g) Intrapicture prediction:

The selected intrapicture prediction modes are encoded by deriving most probable modes (e.g., prediction directions) based on those of previously decoded neighboring PBs.
h) Quantization control:
As in H.264/MPEG-4 AVC, uniform reconstruction quantization (URQ) is used in HEVC, with quantization scaling matrices supported for the various transform block sizes.

i) Entropy coding:
Context adaptive binary arithmetic coding (CABAC) is used for entropy coding. This is similar to the CABAC scheme in H.264/MPEG-4 AVC, but has undergone several improvements to improve its throughput speed.

j) In-loop deblocking filtering:
A deblocking filter similar to the one used in H.264/MPEG-4 AVC is operated within the interpicture prediction loop.

k) Sample adaptive offset (SAO):
A nonlinear amplitude mapping is introduced within the interpicture prediction loop after the deblocking filter. Its goal is to better reconstruct the original signal amplitudes by using a look-up table that is described by a few additional parameters that can be determined by histogram analysis at the encoder side.

3. HIGH-LEVEL SYNTAX ARCHITECTURE
The HEVC standard improves flexibility for operation over a variety of applications and network environments and improves robustness to data losses. However, the high-level syntax architecture used in the H.264/MPEG-4 AVC standard has generally been retained, including the following features.

a) Parameter set structure:
Parameter sets contain information that can be shared for the decoding of several regions of the decoded video. The concepts of sequence and picture parameter sets from H.264/MPEG-4 AVC are augmented by a new video parameter set (VPS) structure.

b) NAL unit syntax structure:
Each syntax structure is placed into a logical data packet called a network abstraction layer (NAL) unit.

c) Slices:
A slice is a data structure that can be decoded independently from other slices of the same picture, in terms of entropy coding, signal prediction, and residual signal reconstruction. One of the main purposes of slices is resynchronization in the event of data losses.

d) Supplemental enhancement information (SEI) and video usability information (VUI) metadata:
The syntax includes support for various types of metadata known as SEI and VUI. Such data provide information about the timing of the video pictures, the proper interpretation of the color space used in the video signal, 3-D stereoscopic frame packing information, other display hint information, and so on.

3.1. Parallel Decoding Syntax and Modified Slice Structuring:
Finally, four new features are introduced in the HEVC standard to enhance the parallel processing capability or modify the structuring of slice data for packetization purposes.

a) Tiles:
The option to partition a picture into rectangular regions called tiles has been specified. The main purpose of tiles is to increase the capability for parallel processing rather than provide error resilience. Tiles can additionally be used for the purpose of spatial random access to
local regions of video pictures. A typical tile configuration of a picture consists of segmenting the picture into rectangular regions with approximately equal numbers of CTUs in each tile.

b) Wave Front Parallel Processing:
When wave front parallel processing (WPP) is enabled, a slice is divided into rows of CTUs. The first row is processed in an ordinary way, the second row can begin to be processed after only two CTUs have been processed in the first row, and the third row can begin to be processed after only two CTUs have been processed in the second row, and so on.

c) Dependent Slice Segments:
A structure called a dependent slice segment allows data associated with a particular wave front entry point or tile to be carried in a separate NAL unit, and thus potentially makes that data available to a system for fragmented packetization with lower latency than if it were all coded together in one slice.

3.2. Profiles, Tiers, and Levels:
Profile, Level, and Tier Concepts Profiles, tiers, and levels specify conformance points for implementing the standard in an interoperable way across various applications that have similar functional requirements. Level restrictions are established in terms of maximum sample rate, maximum picture size, maximum bit rate, minimum compression ratio and capacities of the DPB, and the coded picture buffer (CPB) that holds compressed data prior to its decoding for data flow management purposes. In the design of HEVC, it was determined that some applications existed that had requirements that differed only in terms of maximum bit rate and CPB capacities. To resolve this issue, two tiers were specified for some levels—a Main Tier for most applications and a High Tier for use in the most demanding applications.

A decoder conforming to a certain tier and level is required to be capable of decoding all bitstreams that conform to the same tier or the lower tier of that level or any level below it. Decoders conforming to a specific profile must support all features in that profile. Encoders are not required to make use of any particular set of features supported in a profile, but are required to produce conforming bitstreams, i.e., bitstreams that obey the specified constraints that enable them to be decoded by conforming decoders.

4. THE HEVC PROFILE AND LEVEL DEFINITIONS:
The three drafted profiles consist of the coding tools and high layer syntax described in the earlier sections of this paper, while imposing the following restrictions.

1) Only 4:2:0 chroma sampling is supported.

2) When an encoder encodes a picture using multiple tiles, it cannot also use wavefront parallel processing, and each tile must be at least 256 luma samples wide and 64 luma samples tall.

3) In the Main and Main Still Picture profiles, only a video precision of 8 b per sample is supported, while the Main10 profile supports up to 10 b per sample.

4) In the Main Still Picture profile, the entire bitstream must contain only one coded picture.

5. CONCLUSION
The emerging HEVC standard has been developed and standardized collaboratively by both the ITU-T VCEG and ISO/IEC MPEG organizations. HEVC represents a number of advances in video coding technology. Its video coding layer design is based on conventional block-
based motion compensated hybrid video coding concepts, but with some important differences relative to prior standards.

REFERENCES


Overview of H.265 Standards


