A Survey of Emerging ITU-T H.264 Video Encoding Standard

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Abstract— H.264/AVC is a recently completed video compression standard jointly developed by ITU-T and ISO MPEG standards committees. The standard is becoming more popular as it promises much higher compression than that possible with earlier standards. The intent of the H.264/AVC project was to create a standard capable of providing good video quality at substantially lower bit rates than previous standards (i.e., half or less the bit rate of MPEG-2, H.263, or MPEG-4 Part 2), without increasing the complexity of design so much that it would be impractical or excessively expensive to implement. This paper provides an overview of the technical features of H.264 and summarizes the emerging studies related to new coding features of the standard.

Keywords— H.264, AVC, video compression, Video Comparison. Video Quality Matrices.

I. INTRODUCTION

The digital video compression technology has been gaining popularity for many years. Today, when people enjoy HDTV (high definition television), movie broadcasting through Internet or the digital music such as MP3, the convenience that the digital video industry brings to us cannot be forgotten.

All of these should attribute to the advances in compression technology, enhancement on mass storage media or streaming video/audio services.

The core of the MPEG-4 standard was developed early twenty first century [1], however MPEG-4 is a existing standard with new parts added continuously as and when technology exists to address evolving applications [2].

The significant advances in core video standard were achieved on the capability of coding video objects, while at

the same time, improving coding efficiency at the expense of a modest increase in complexity.

II. OVERVIEW OF THE H.264 STANDARD

H.264/MPEG-4 AVC is a block-oriented motion compensation based codec standard developed by the ITU-T Video Coding Experts Group (VCEG) together with the ISO/IEC JTC1 Moving Picture Experts Group (MPEG)[3]. The project partnership effort is known as the Video Team (JVT). The ITU-T H.264 standard and the ISO/IEC MPEG-4 AVC standard are jointly maintained so that they have identical technical content.

The standard provides flexibilities in coding and organization of data which enable efficient error resilience. The increased coding efficiency offers new Application areas and business opportunities. As might be expected, the increases in compression efficiency and flexibility come at the expense of increase in complexity, which is a fact that must be overcome.

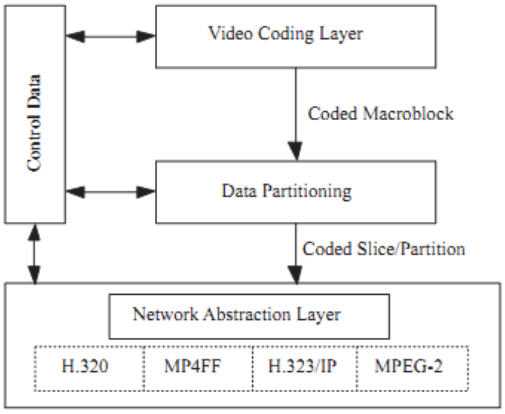

Fig I. STRUCTURE OF H.264/AVC VIDEO ENCODER [3]

To deal with the need for flexibility and customizability, the H.264 standard covers a Video Coding Layer (VCL), which is designed for well-organized representation of the video content and is a block based hybrid video coding approach [7], and a Network Abstraction Layer (NAL), which formats the VCL representation of the video and provides header information in a way that is appropriate for transportation by different transport layers or storage media.

A picture maybe split into one or several slices. In H.264 slices consist of macro blocks processed in raster scan order. A picture then can be split into many macroblock scanning patterns such as interleaved slices, dispersed macroblock allocation [2].

H.264 standard is more flexible in the selection of motion compensation (MC) block sizes and shapes than any previous standard, with a minimum luma MC block size as small as 4x4 [2],[10],[11].

III. H.264 FEATURES

H.264/AVC/MPEG-4 Part 10 contains a number of new features that allow it to compress video much more effectively than older standards and to provide more flexibility for application to a wide variety of network environments. In particular, some such key features include:

- Multi-picture inter-picture prediction.
- Variable block-size motion compensation
- The ability to use multiple motion vectors per macroblock.
- Quarter-pixel precision for motion compensation.
- Spatial prediction from the edges of neighboring blocks for "intra" coding.
- Flexible interlaced-scan video coding features.
- New transformation design features.
- An entropy coding design including Context-adaptive binary arithmetic coding and Context-adaptive variable-length coding.

IV. H.264 APPLICATION

The H.264 was designed to be flexible video format and has a very broad application range including [5],[9]:

- Low bit-rate Internet streaming applications.
- HDTV broadcast and Digital Cinema applications.
- Web software Embedding.
- Mobile TV standardization.
- Video conferencing products.
- SDTV and HDTV standardization and deployment.
- HD Video Storage applications.

V. LITERATURE SURVEY

Paper [3] provides an overview of the technical features of H.264/AVC, describes profiles and applications for the standard, and outlines the history of the standardization process.

H.264/AVC is latest video coding standard of the ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group. The main goals of the H.264/AVC Standardization effort have been enhanced compression Performance and prerequisite of a "network-friendly" Video representation addressing "conversational" (video Telephony) and "no conversational" (storage, broadcast, or Streaming) applications. H.264/AVC has achieved a Significant improvement in rate-distortion efficiency Comparative to existing standards.

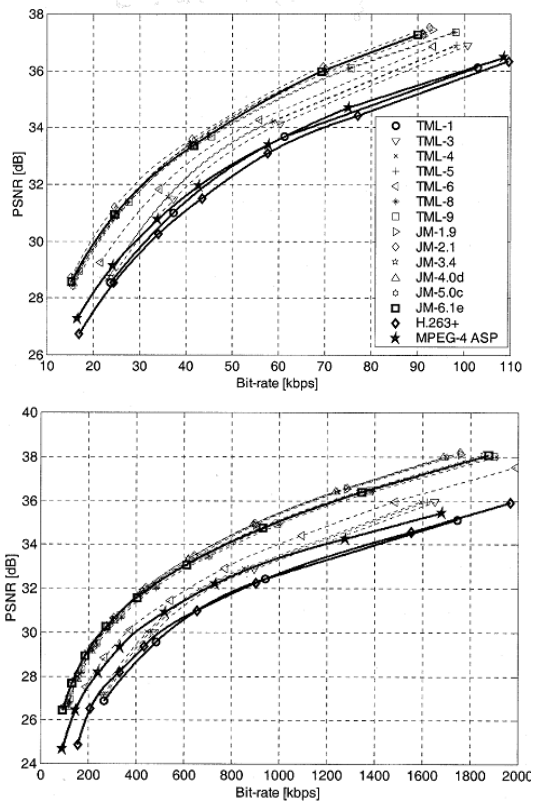

Fig. 1. EVOLUTION OF H.264/AVC SINCE AUGUST 1999 UNTIL MARCH 2003. TOP: QCIF SEQUENCE BOTTOM: CIF SEQUENCE TEMPTED. THE LEGEND IN THE TOP FIGURE INDICATES THE VARIOUS VERSIONS THAT HAVE USING TYPICAL H.264 SETTINGS[3]

The paper concludes by evaluating the performance of H.264 implementations using PSNR under QCIF and CIF profiles.

Paper [5] gives information that H.264/AVC represents a foremost step advance in the development of video coding standards. It usually outperforms all existing standards by a factor of two and particularly in comparison to MPEG-2, which is the basis for digital TV systems worldwide; an improvement factor of 2.25 - 2.5 has been reached. This improvement enables new applications and business opportunities to be developed. Example uses for DVB-T, DVB-S2, DVD, xDSL and 3G have been presented.

He decides that even though H.264/AVC is 2 -3 times more composite than MPEG-2 at the decoder and 4 - 5 times more composite at the encoder, it is relatively less composite than MPEG-2 was at its outset, due to the huge progress in technology which has been made at that time.

An additional important fact is that H.264/AVC is a public and open standard. Each manufacturer can build encoders and decoders in a spirited market. This will bring prices down quickly, making this technology reasonable to everybody. There is no dependence on proprietary formats, as on the Internet today, which is of utmost importance for the broadcast community.

Coder	MPEG-4 ASP	H.263 HLP	MPEG-2
H.264/AVC	38.62%	48.80%	64.46%
MPEG-4 ASP	-	16.65%	42.95%
H.263 HLP	-	-	30.61%

TABLE I. AVERAGE BIT-RATE SAVINGS COMPARED WITH VARIOUS PRIOR DECODING SCHEMES [5].

The paper compares the average bit-rate savings provided by each encoder, relative to all other tested encoders over. The entire set of sequences and bit-rates are depicted in Table 1. It can be seen that H.264/AVC significantly outperforms all other standards [8].

The main goal of paper [6] was the presentation of a comparative evaluation of the quality of new H.264 codecs using objective measures of assessment. The comparison was done using settings provided by the developers of each codec. The main task of the comparison is to analyse different H.264 encoders for the task of transcoding video—e.g., compressing video for personal use.

Speed requirements are given for a sufficiently fast PC; fast presets are analogous to real-time encoding for a typical home-use PC.

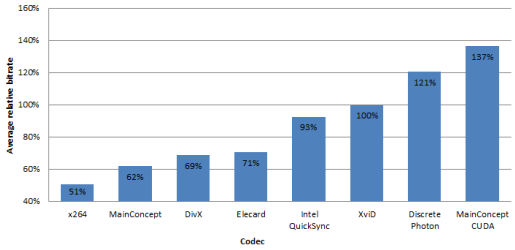

Fig. 2: OVERALL BITRATES FOR SAME QUALITY, EIGHTH MSU MPEG-4/AVC H.264 VIDEO CODEC COMPARISION[6].

The overall leader in this comparison for software encoders is x264, followed by Main Concept, DivX H.264 and Elecard.

The overall ranking of the software codecs tested in their comparison was as follows:

- x264
- Main Concept
- DivX H.264
- Elecard
- Intel Ivy Bridge QuickSync
- XviD
- Discrete Photon
- Main Concept CUDA

This rank was based only on the encoders' quality results. Encoding speed was not considered here.

The Quality matrices report [6] also provides some additional objective metrics for PSNR, 3-SSIM, MS-SSIM. Also on all metrics results for all color planes (Y,U,V and overall) and results for all the sequences, codecs and presets used in comparison

VI. CONCLUSION

H.264/AVC represents a major step in the development of video coding standards, in terms of both coding efficiency enhancement and flexibility for effective use over a broad variety of network types and application domains.

It is based on conventional block-based motion-compensated hybrid video coding concepts, but with some important differences. Among them is enhanced motion prediction capability, use of small block-size

exact-match transform, adaptive in-loop de-blocking filter, and enhanced entropy coding methods.

The highly flexible motion model and the very efficient context-based arithmetic-coding scheme are the two primary factors that enable the superior rate-distortion performance of H.264/AVC as described in the paper.

VII. FUTURE WORK

Every year many companies contribute in development and comparative evaluation of the quality of new H.264 and other Codecs. However, Successful estimation of all profiles under which is a developing codec is over ever changing modern hardware is impossible to estimate.

ARM RISC Architecture is used widely in almost all Handheld Devices. The Decoder and decoding process of ITU/T AVC H.264 codec has been standardize much like MP3 decoding has been standardize. Most of the work carried out is related to the CISC architecture.

In our future work we will work on providing ITU/T AVC H.264 profile comparision especially designed for ARM architecture and evaluate resulting media using video quality assessment methods such as, PSNR and SSIM.

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