Advanced Video Coding Techniques for Smart Phones

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Abstract—**In recent years, the mobile industry is growing rapidly. Since various smart phones have employed big screen sizes and fast processors that can display high resolution and high quality video contents, the number of users and their quality demands increase. However, lack of sufficient data rates as well as the prices to be paid for transmission will remain problems for the long term. In other words, required video bit-rates will go up much faster than those that the network infrastructure can carry economically. Therefore, video compression becomes more and more important. Recently, MPEG and VCEG initiated to develop a next generation video coding standard, called high efficiency video coding (HEVC). It aims to achieve sufficiently higher compression capability than the existing H.264/AVC standard. In this paper, we introduce the new HEVC standard, including its history, requirements, coding structures, recent issues, and its applications.**

Keywords- H.264/AVC, HEVC, Video coding, smart phones

I. INTRODUCTION

A smart phone is a small and all-in-one device that is used for communication and computing functions. Ordinary cell phones limit applications that come up with the phone. So, users have no choice but to use provided applications. In contrast to the ordinary cellular phones, smart phones allow users to choose applications that they want to install and use. This means that users can personalize the range of applications in their smart phones to suit their life style and their job.

We no longer have to be tied down to a desktop computer to connect to the Internet and interact with the world around us. With this usefulness, the smart phone technology is growing faster than any technology before it. The latest products raise their display resolutions and increase the CPU speed. Thus, the smart phone can display high resolution and high quality video contents. More and more, people want to watch videos on their smart phones quickly without any obstacles.

However, lack of sufficient data rates as well as the prices to be paid for transmission will remain problems for the long term. Moreover, mobile video will generate a significant part of the mobile traffic growth. As shown in Fig. 1, mobile video content has much higher bit rates than other mobile content types. Therefore, a new video compression technology that has sufficiently higher compression capability than the existing H.264/advanced video coding (AVC) [1] standard is needed.

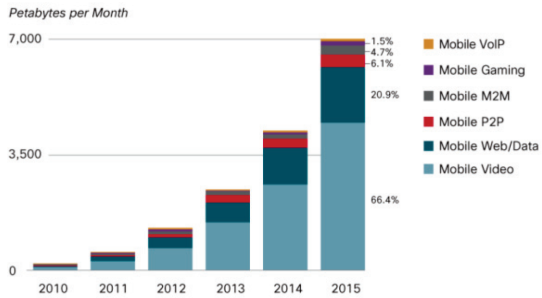

Figure 1. Mobile Internet traffic [2].

In order to meet rising consumer demands, two premier video coding standardization organizations ISO/IEC MPEG and ITU-T VCEG have established a joint collaborative team on video coding (JCT-VC). They started to develop a next-generation video coding standard, high efficiency video coding (HEVC) [3]. In this paper, we introduce the new HEVC standard. After reviewing the history, vision, requirements, coding structures of the HEVC standard, we are going to cover recent issues and applications.

II. HIGH EFFICIENCY VIDEO CODING

A. History

As the costs for both processing power and memory have reduced, network support for coded video data has diversified, and advances in video coding technology have progressed, the need has arisen for an industry standard for compressed video representation with substantially increased coding efficiency and enhanced robustness to network environments.

Toward these ends the ITU-T VCEG and the ISO/IEC MPEG formed JCT-VC in 2010 for development of a new international standard. Since the first JCT-VC meeting in April 2010, the HEVC standard is still under investigation and the current timeline calls for completing the drafting of a final standard for HEVC by approximately January 2013.

B. Requirements

In Table 1, requirements of HEVC are summarized. More detailed explanations can be found in the HEVC vision, applications, and requirements document issued by MPEG in January 2011 [4].

TABLE I. REQUIREMENTS

Compression Performance	- A substantially greater bitrate reduction over MPEG-4 AVC High Profile - Subjective visually lossless compression - Lossless compression
Picture Format	- Rectangular picture formats that will include all commonly used picture formats, ranging at least from QVGA to 8K×4K
Color Spaces and Color Sampling	- YCbCr 4:2:0, YCbCr 4:2:2, and YCbCr/RGB 4:4:4 - Higher bit depth up to 14 bits per component - Wide gamut color and a transparency channel
Frame Rates	- Fixed and variable rational frame rates starting from 0Hz
Complexity	- Trading-off complexity and compression efficiency - Parallel processing
Coding Structures	- Intra-only coding - Low latency operation for real-time streaming - Random access to certain positions of a stored video - Fast channel switching in the case of multi-channel
Scanning Methods	- Progressive scanning for all profiles and levels

C. Coding Structures

As shown in Fig. 2, there are three types of coding structures in HEVC: intra-only, low delay, and random access. In Fig. 2, the number indicates the encoding order. In the intra only structure, each picture is encoded as intra picture. No temporal reference pictures are used. In low delay structure, only the first picture is encoded as intra picture and other successive pictures are encoded as generalized P and B picture (GPB) [3]. It is designed to enable interactive real-time communication. Random access structure is similar to hierarchical structure and intra picture is inserted cyclically per about one second. It is designed to enable relatively-frequent random access points in the coded video data.

D. Recent Issues

The 5th JCT-VC meeting was the starting point to discuss extension of the HEVC standard [5]. The requirement of scalable extension was asserted and several contributions for scalable video coding based on HEVC were presented. Soon, the stereo 3D and multi-view supports will be also suggested. HEVC is still under development. Depending on the final tools and structure of HEVC, the scalable extension will be further evolved and finalized.

In addition, there had been some input documents on screen content coding (SCC). Currently, SCC test materials were made available. There are still plenty of issues that need to be addressed. For example, further investigations about multi-view, lossless, near-lossless, color space increase, bit depth increase and depth map coding [6] using the HEVC platform are required.

E. Applications

The HEVC standard is designed to cover a broad range of applications: home cinema, digital cinema, surveillance, broadcast, real-time communications, video chat, video conferencing, mobile streaming, broadcast, storage, camcorders, video on demand (VOD), telepresence, and medical imaging, etc. Further applications for stereo 3D, multi-view, and scalable video capabilities based on the HEVC design can be easily foreseen.

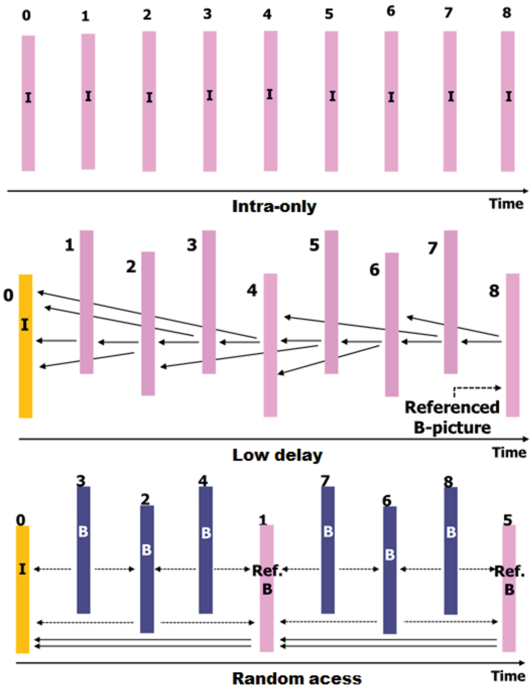

Figure 2. Coding structures of HEVC.

III. CONCLUSION

High efficiency video coding (HEVC) is the current joint video coding standardization project of ITU-T VCEG and ISO/IEC MPEG. The joint collaborative team on video coding (JCT-VC) has been established to work on this project. Since the first JCT-VC meeting in April 2010, the HEVC standard is still under development and the current timeline calls for completing the drafting of a final standard for HEVC by approximately January 2013. Further improvements are expected within the on-going development process and it is expected that HEVC will have a wide range of applications.

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