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MOBILE3DTV: Content Delivery Optimization over DVB-H System

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Abstract. *Mobile TV has recently received a lot of attention worldwide with the advances in technologies such as Digital Multimedia Broadcasting (DMB), Digital Video Broadcasting - Handheld (DVB-H) and MediaFLO. On the other hand 3DTV is a new approach to watching TV, introducing the third dimension for a more realistic and interactive experience. With the merge of these two technologies it will be possible to have 3DTV products and services based on portable platforms with switchable 2D/3D autostereoscopic displays. The paper presents the European Mobile3DTV project approach toward achieving such a merge. The project specifically addresses the mobile 3DTV delivery over DVB-H system. It develops a technology demonstration system comprising suitable stereo-video content-creation techniques; efficient, scalable and flexible stereo-video encoders with error resilience and error-concealment capabilities, tailored for robust transmission over DVB-H; and also the corresponding stereo-video decoders and players working on a portable terminal device equipped with an autostereoscopic display.*

Keywords. Mobile3DTV, error resilient transmission, DVB-H.

Introduction

The concept of providing television-like services to handheld devices is well known. The results from pilots on broadcast mobile TV services amongst consumers in Finland, the UK, Spain and France have revealed clear consumer demand for such services as well as important indications over future business models for commercial mobile TV services. Recognizing this high market potential, the European Commission has called for a single European standard for mobile TV and identified DVB-H as the “strongest contender for future terrestrial Mobile TV deployment in Europe”. At the same time, chipmakers and developers have offered new mobile platforms enriched with multimedia capabilities. Display producers have been continuously improving the quality of visual representation of scenes on portable devices. Greater realism appealing to the mobile user has been pursued by increasing the spatial resolution, utilizing an ever more realistic gamut of light and colour and by adding a third dimension. Autostereoscopic displays have been introduced for laptops and handheld devices. The combination of opportune European Commission support, technology conditions and the availability of appropriate standards call for the development of a next generation of mobile 3D TV services (3DTV). However, mobility comes at high costs due to the specific features of the handheld devices and the radio propagation medium, e.g. multi-antenna diversity unavailable, battery operated devices (reduced power consumption), etc. Therefore, new video encoding technologies need to be developed in order to overcome the impairments imposed by these characteristics. This is especially true for the coding and transmission of 3D visual scenes, where the third dimension add to the amount of information to be efficiently compressed and properly maintained through the error-prone channel.

In this project, we address core elements of the future mobile 3DTV technology. In our concept, we focus on the channel as a whole: from capture, through coding, transmission and display. Specifically, we consider the following scenario: 3D video content is captured, properly encoded, encapsulated and then broadcast over mobile TV (DVB-H system) to be received, decoded and played by a DVB-H enabled portable device. The concept is illustrated in Figure 1.

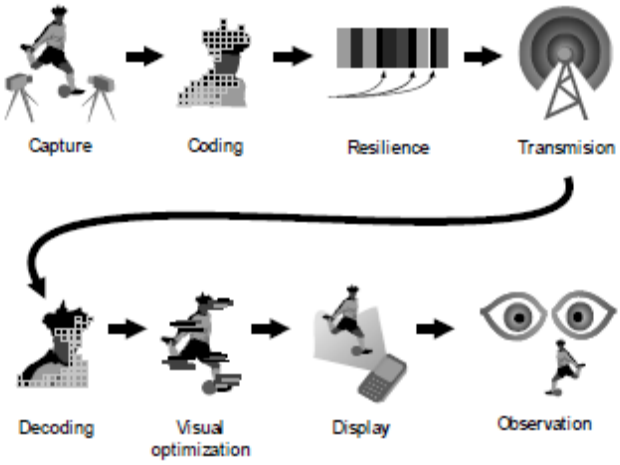

Figure 1. The concept of Mobile3DTV

There are important unsolved questions and problems that are being addressed and answered through this project such as the optimal data format for mobile 3DTV content taking specific

conditions into account, error-resilience transmission of 3D video content, the degradations caused by channel errors or compression artifacts side in terms of user acceptance of quality, subjective quality metric for 3D video and the associated hardware platform.In this paper we particularly address the coding and transmission aspects of the project.

3D Video Coding

Compression of conventional stereo video has been studied for a long time and the corresponding standards are available. A conventional stereo video pair consists of two video sequences showing the same scene from two slightly different viewpoints corresponding to the distance of the human eyes. The combination of inter-view and temporal prediction is the basic principle for efficient compression. A corresponding standard specification has been defined in ITU-T Rec. H.262 / ISO/IEC 13818-2 MPEG-2 Video, the Multi-view Profile. However, the gain in compression efficiency compared to independent encoding of both video streams is rather limited due to the fact that temporally neighbouring pictures are typically more similar than spatially neighbouring pictures. Research into compression of conventional stereo video has continued in several directions, however, without so far gaining market relevance, mainly because 3DTV itself has not yet developed into a mass market.

Recently, 3DTV has received a lot of attention and extensive research has been done on multi-view video coding (MVC), including standardization activities. ISO/MPEG and ITU/VCEG decided on developing a dedicated MVC specification. MVC is currently the most efficient codec for stereo and multi-view video.

In contrast to stereoscopic video coding, a new approach known as the video-plus-depth representation has been proposed by the EU-funded FP5 project ATTEST for 3DTV. The ATTEST representation uses a regular video stream, where each frame is enriched with a depth map providing a Z-value for each pixel. The final left and right views are reconstructed by using depth-image-based rendering (DIBR). This concept provides backward compatibility with existing DVB services for delivering conventional (monoscopic) video, efficient compression, and easy adaptation to different 3D display systems, viewing conditions and user preferences. The encoding of the depth map imposes a small overhead, typically less than 15%, on the video bitrate. MPEG has released a corresponding standard known as MPEG-C Part 3. Thus, research on coding of stereo video, multi-view video and associated depth or disparity data has reached a high level of maturity. Related international standards are available enabling a variety of 3DTV systems and applications. However, compared to coding of other types of media data, the scientific field is relatively young and therefore there is still much scope for the optimization and improvement of algorithms. Available codecs H.264/AVC, MVC and MPEG-C Part 3 provide extreme flexibility. Optimum settings for mobile 3DTV still need to be found in terms of spatial and temporal resolution, bitrate, computational and memory complexity. As a result, the initial focus of the MOBILE3DTV project will be on the study and optimization of available coding algorithms and standards for mobile 3DTV, such as H.264/AVC, MVC and MPEG-C Part 3.

A new approach for stereo video is based on decreasing the spatial resolution of one of the views at a time. One of the views can be kept intact while the other can be properly spatially decimated down to a level where the stereo is still well perceived. Human factors investigations have shown that, if done properly, perceived stereo quality will not degrade. By alternating decimated left and right views the effect of reduced stereo can be made negligible and bitrate will be reduced significantly. Therefore, this approach of mixed spatial resolution stereo is developed and investigated within the MOBILE3DTV project. A comparative study of the

advantages and drawbacks of alternatives for 3D video representation and coding given the target application of mobile 3DTV is also investigated within the project.

Error resilient transmission

As described in the previous section, research on coding of stereo video, multi-view video and associated depth or disparity data has reached a certain level of maturity. However, little research has been done on error-resilient transmission of such content over a wired or a wireless channel and the effects of transmission artifacts. Wireless networks are often error prone due to factors such as multipath fading and interferences. In addition, the channel conditions of these networks are often non-stationary, such that the available bandwidth and channel error rates are changing over time with large variations. In order to maintain satisfactory QoS, a number of technologies have been proposed targeting different layers of the networks. Among them, error resilient video coding is a technique at application layer to tackle the errors introduced during transmission.

Concentrating more on DVB-H, it is a point-to-multipoint channel and by itself does not provide a reverse channel. Furthermore, DVB-H is expected to be used by many thousands of receivers under varying error conditions. If all receivers having bad reception were to send an Automatic Repeat Request (ARQ), a request implosion at the sender would be highly probable. For these reasons, the use of ARQs is not an efficient solution for DVB-H. Forward Error Correction (FEC), on the other hand, does not require a return channel and is a good solution to correct errors for receivers experiencing different error conditions. DVB-H uses FEC for error protection and comes with an optional FEC tool at the link-layer. This FEC uses Reed-Solomon (RS) FEC codes encapsulated into Multi-protocol encapsulated sections (MPE-FEC). The MPE-FEC was also introduced to provide additional robustness required for hand-held mobile terminals. MPE-FEC improves the carrier-to noise (C/N) and Doppler performance in the DVB-H channel while also providing improved tolerance of impulse interference. However, MPE-FEC might fail in the presence of very erroneous conditions. Using a-priori knowledge of the transmitted media and tuning the way MPE-FEC is applied across the media datagrams can provide better robustness. Unequal error protection (UEP) is such a scheme that uses a-priori knowledge of the media to differentially protect data using FEC. In UEP, the coded data is divided into layers of different importance. High priority (HP) layers are well protected and low priority (LP) layers are less protected. Many UEP schemes exist for video streaming, but only a few deal with a time-sliced DVB-H channel. Even though UEP is used for error resilience in monoscopic streaming, there are only a few studies for stereoscopic streaming [19] and none for DVB-H channels. Thus, in this project we will develop novel tools for error-resilience of 3D content tailored to the specifics of the DVB-H channel. The different layered structure of 3DTV together with the dependencies between layers, are intelligently addressed for a new UEP scheme.

Conclusion

This paper gives an overview of the European Mobile3DTV project specifically addressing the mobile 3DTV delivery over DVB-H system.

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