1 Introduction

Your goals for this "Introduction" chapter are to learn about:

- Recent developments of 3D video.
- Identify the components of 3D video end-to-end chain.
- Major challenges for 3D video application deployment.
- A brief description about contents covered in this book.

Recent developments in audio/video/multimedia capture, real-time media processing capabilities, communication technologies (e.g., Long Term Evaluation (LTE)), and display technologies (e.g., 3D displays) are now facilitating rich multimedia applications beyond conventional 2D video services. 3D video reproduces real-world sceneries as viewed by the human eyes. It provides a state of 'being there' or 'being immersed' feeling to its end users. Moreover, the consumers will be more pleased with immersive video than the computer generated 3D graphics. 3D video is described in technical terms as "geometrically calibrated and temporally synchronized (group of) video data or image-based rendering using video input data" in [1]. According to [1] another possible definition is image-based rendering using video input data or video based rendering. The necessary technologies to realize 3D video services over communication networks are illustrated in Figure 1.1. The technological advancements in 3D video capture, representation, processing, transmission and display will enable the availability of more and more immersive video applications to the consumer market at an affordable cost. This will further improve the comfortness in 3D viewing and quality of experience in general. Therefore, in the future, 3D media applications will not be limited to flight simulators, cyberspace applications and IMAX theatres. 3D video applications will enhance the quality of life in general by capturing home and office media applications (e.g. video conferencing, video broadcasting, broadband video, etc.).

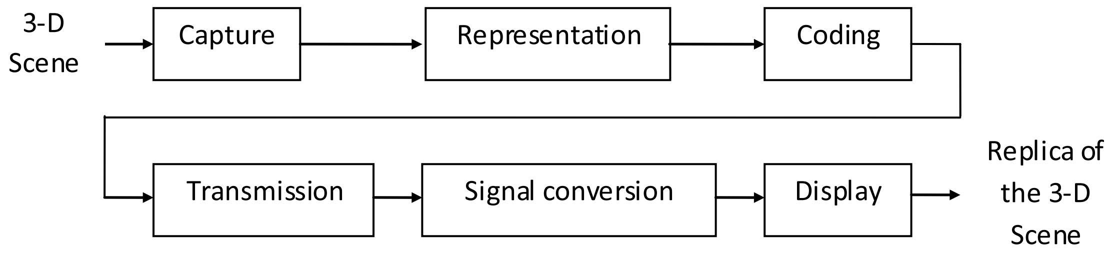

Figure 1.1: 3D video chain

Stereoscopic video is one of the simplest forms of 3D video. It provides the sensation of depth to end users through rendering of two adjacent views of the same scene. Moreover, this 3D video representation has the potential to be the next step forward in the video communication market due to its simple scene representation and adaptability to existing audio-visual technologies. In order to support 3D video services, the existing 2D video application scenarios need to be scaled into a fourth dimension, called "the depth". The availability of multimedia content in 3D will enhance the overall quality of reconstructed visual information. Therefore, this technology will bring us one step closer to the true representation of real-world sceneries. Moreover, 3D video technologies will improve our Quality of Experience (QoE) in general at home and in the work place. The main challenge of these emerging technologies is to adapt them into the existing video communication infrastructure in order to widely disseminate the content during the introduction/migration phase of these new multimedia technologies.

Even though the initial developments of 3D video technologies are in place, there are a several open areas to be investigated through research. For instance, the storage and transport methods (i.e. signaling protocols, network architectures, error recovery) for 3D video are not well exploited. Moreover, the addressing of these problems is complex due to the diversity of different 3D video representations (e.g. stereoscopic video, multi-view video). In addition, the ways and means of fulfilling the extensive demand for system resources (e.g. storage and transmission bandwidth) need to be addressed. Furthermore, the backward compatibility and scalability issues of these applications need to be addressed in order to facilitate the convergence/integration of these services with the existing 2D video applications. The evaluation of 3D video quality is important to quantify the effects of different system parameter settings (e.g. bitrate) on the perceived quality. However, the measurement of 3D video quality is not straight forward as in 2D video due to multi-dimensional perceptual attributes (e.g. presence, depth perception, naturalness, etc.) associated with 3D viewing. Therefore, much more investigation needs to be carried out to simplify the quality evaluation of 3D video or 3D QoE. This book has presented the proposed solutions for some of the issues mentioned above with a major focus on 3D video compression and transmission, which are described below.

The captured 3D video content is significantly larger than 2D video content. For example, stereoscopic video could be twice the size of a conventional 2D video stream, as it has two closely related camera views. As a result, 3D video requires a large storage capacity and high transmission bitrates. In order to reduce the storage and bandwidth requirements, the immersive video content needs to be efficiently compressed. Existing video compression algorithms may or may not be suitable for encoding 3D video content. Moreover, the unique characteristics of 3D video can be exploited during compression in order to further reduce the storage and bitrate required for these applications. The transmission of these contents should be easily synchronized among different views during playback. In addition, backward compatibility with conventional 2D video applications would be an added advantage for emerging 3D video applications.

Transmission of 3D content is also a major challenge due to the larger size of the 3D video content. Therefore, effective mechanisms need to be in place to compress 3D video content into a more manageable size to be transmitted over band-limited communication channels. On the other hand, the transmission of immersive video content could be optimized based on the perceptual importance of the content. For instance, the different elements of the 3D video content can be prioritized over communication channels based on their error sensitivities. These prioritized data transmission schemes can be effectively used in optimizing the resource allocation and protection for immersive media content over error prone communication channels without any degradation to the perceived quality of the reconstructed 3D replica. The quality of transmitted video suffers from data losses when transmitted over an error prone channel such as wireless links. This problem is also common for emerging 3D video communication applications. The effect of transmission errors on perceived 3D quality is diverse in nature due to the multi-dimensional perceptual attributes associated with 3D viewing. Therefore, efficient error resilient and error concealment algorithms need to be deployed to overcome the detrimental effects that occur during transmission. Existing error recovery techniques for 2D video could also be used in recovering corrupted frames. Moreover, error resilient/concealment techniques which are tailor-made to particular types of 3D video could be implemented at the application level.

This book investigates and presents efficient 3D compression and transmission technologies which offer improved compression efficiency, backward compatibility, efficient error recovery and perceptually prioritized data transmission. Even though 3D video comes in different scene representations (e.g. Omni-directional video and Multi-view video), this book focuses on facilitating stereoscopic video communications, since stereoscopic video has the potential to be easily adopted into the existing video communication infrastructure compared to other complex representations of 3D video. The first chapter provides the rationale and a brief description of the book while the final chapter, Chapter 7, summarizes the 3D video concepts covered in this book and discusses the potential areas for future research in efficient and robust 3D video communications. The work presented in the other chapters is summarized below.

Chapter 2 describes stereo vision, the state of the art 3D video technologies for scene capture and different scene representations of 3D video. Then, existing multimedia compression technologies are described with more specific details about 3D video coding techniques in Chapter 3. In Chapter 4, the transmission aspects of 3D video and potential application scenarios are presented. Furthermore, an introduction to error resilience and error concealment techniques used in multimedia communication is presented. The display technologies and viewing aids associated with potential 3D video applications are also discussed in Chapter 5. Finally, an explanation of measuring 3D video quality subjectively and objectively is presented in Chapter 6.