Chapter 19
Multi-View Autostereoscopic Visualization using Bandwidth-Limited Channels

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ABSTRACT

The increasing popularity of stereoscopic cinema and television paves the way for more advanced stereoscopic technologies, such as high-resolution multi-view autostereoscopic displays. The amount of information conveyed by such displays surpasses, however, the bandwidth capacity of the current broadcasting infrastructure. In this chapter, we will focus on technical solutions to overcome the bandwidth bottleneck that only minimally affect the viewer experience. The presented solutions consist of (1) employing depth-based free-viewpoint interpolation with the aim to reduce the number of views that need to be transmitted, (2) the optimal compression of the depth and texture images while minimizing the resulting image artifacts, and (3) the optimal resolution considerations for a given autostereoscopic display.

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INTRODUCTION

Multi-view autostereoscopic displays add depth impression to the visualized image without requiring the viewer to wear goggles. The presentation of more than two views (which would be sufficient for the stereoscopic effect) allows viewers to move freely within a certain range and still perceive a proper stereoscopic image. A further advantage for the viewer is the ability to slightly look behind objects by a small motion of the viewer.

The transmission of multi-view video to the display is seriously challenged by the bandwidth limitations of the transmission channel. Multiple views of each video frame have to be transmitted (modern multi-view autostereoscopic displays present 8 to 25 views), which increases the required bandwidth considerably. Especially for medical applications, the views are demanded to be of high-resolution and artifacts requirements are very stringent.

In this chapter, several techniques are studied that enable to fit the multi-view video stream in a bandwidth-limited channel. The focus of this chapter is to not only present results for individual steps but to show dependencies and contributions in the complete processing chain.

The chapter begins with a description of the background, which is followed by the three main sections. These sections present solutions for key problems in the overall multi-view video communication. The first main section concerns display and rendering aspects of multi-view presentation. The second section is on multi-view compression, particularly depth compression, as this influences the 3D rendering and the obtained quality. The third main section presents the study on resolution optimization and sampling for professional applications.

BACKGROUND

Multi-view autostereoscopic displays and the problem of video signal transmission for such displays are discussed in this section. We introduce the concept of stereoscopic viewing and discuss the broadcasting options for it.

Multi-View Autostereoscopic Displays

A stereoscopic display presents the viewer with different images for the left and the right eye. Provided that these images contain proper stereoscopic information, the viewer will have the sensation of seeing depth. Principally there are two kinds of stereoscopic displays: the first type requires the viewer to wear goggles or glasses, and the second type, called autostereoscopic display, allows stereoscopic viewing without any external aid. The autostereoscopic effect can be achieved by using lenticular lenses (see Figure 1), or parallax barriers in order to emit different images when viewing under a (slightly) different angle. Modern so-called multi-view autostereoscopic displays provide between 8 and 25 views in order to achieve a smooth transition when the viewer moves his head (van Berkel, 1999; Dodgson, 1997; Maupu et al., 2005; Ruijters, 2009).

Multi-view autostereoscopic displays can be regarded as three-dimensional light field displays (Levoy & Hanrahan, 1996; Isaksen et al., 2000) (or four- dimensional, when also considering time). The dimensions are described by the parameters (x, y, φ), whereby x and y indicate a position on the screen and φ indicates the angle in the horizontal plane in which the light is emitted. The light is further characterized by its intensity and its color.

The multi-view lenticular display device consists of a sheet of cylindrical lenses (lenticulars) placed on top of an LCD in such a way that the