Chapter 1
Introduction

There is no doubt that in the future the Internet will be more densely integrated at the infrastructure level, and thus, be an integral extension of our physical lives and environment. Such an extension will affect all aspects of individual and social lifestyles. Many expert studies have been conducted to predict those effects and the subsequent changes. The scope of this book is not quite so broad; instead, it will focus on a particular technology—3D media—and its interaction with the Internet.

Among the various novel modalities of content delivery via the Internet, 3D video is expected to be the choice for visual communications. The future Internet will bring a new user experience by delivering rich media in 3D, and in turn, 3D technologies will be influenced by developments in such an infrastructure.

The general public is well aware of the ultimate goal of 3D video: ghostlike, moving 3D images have already been depicted in many science fiction films. The ultimate goal in visual recording and communications is to create an exact (except perhaps in size) optical replica of a 3D environment with 3D objects in it at another time or another place. Optical receivers, including our eyes and cameras, sense the light they receive. In other words, we "see" only the light that enters through our pupils. Consider two optical environments: one of them is the original illuminated 3D environment. The light, which is generated by artificial light sources, falls onto the objects and reflects off of them. This reflected light carries the information

about the geometry and optical properties of the environment and fills the 3D space. The observer moves in this light-filled space and sees the environment via the light that enters his visual receptors (eyes) at his position. The other environment does not have the same physical objects but has exactly the same light distribution as the original environment in a 3D space. Since the two light distributions are the same, any observer immersed in either environment will see exactly the same scene; those who are observing the recreated optical environment will see the true 3D optical replica of the original. This physical duplication of light is the key to ghostlike visual reproduction. Such moving video images would be floating in space or standing on a tabletoplike display, and viewers would be able to peek or walk around the images to see them from different angles or perhaps even from behind (Fig.1.1).

Figure 1.1 Artist's impression of a futuristic 3D television display unit (Artist: Erdem Yücel) (H.M. Ozaktas and L. Onural, Eds., *Three-Dimensional Television: Capture, Transmission, Display*. Springer, 2008).

As in all other recording systems, such a visual duplication system needs two key elements: a means of recording the original space-filling light, and then, physical devices that can recreate that recorded light. Of course, the success depends on the fidelity of the recreated light distribution to the original; ideally, all detectable physical properties must be recorded and exactly recreated. All 3D video techniques attempt to achieve such a goal. However, some of these, such as stereoscopy, are quite distant from the ideal case, whereas other techniques, such as integral imaging and holography, are closer to it. Another basic component of any visual reproduction system is the delivery medium. As usual, content is delivered either in stored form via different transportable hard devices or by electronic or optic means. Thus, capture or creation of content, its transportation, and eventually its display, are the three key functional elements of an end-to-end 3D video system (Fig.1.2).

The 3D Media Cluster, which consists of the EC-funded projects in 3D-related topics, collectively covers almost all related technical issues in this field. This includes content capture and creation, its transportation, and its display. During the past decade the Internet has become a fast-growing delivery

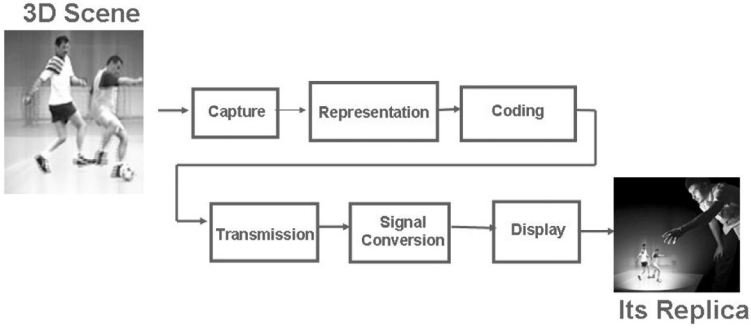

Figure 1.2 Functional units of a possible end-to-end 3DTV chain. (From L. Onural, H. M. Ozaktas, E. Stoykova, A. Gotchev, and J. Watson, "An Overview of the holographic related tasks within the European 3DTV project," *Proc. SPIE* **6187**, 61870T, 2006.)

medium for video, and the Internet will likely be the choice for any kind of data delivery—including video in 3D—surpassing all other delivery alternatives such as the conventional broadcast modes for TV. This book is a spinoff of the 3D Media Cluster activities and covers a broad range of issues in 3D media and the future Internet. The scope of the book is 3D content generation and its delivery and display, together with interaction with such content. Therefore, capture of visual information associated with dynamic 3D scenes, processing of such content, creation of synthetic 3D content via computer graphics procedures, techniques associated with abstract representation of such data, storage and transmission of such content, and different forms of display are all within this book's scope. Compression and coding of such data for digital delivery are included as well. The technological details of each of these functional components are also of fundamental importance and within the scope. End-to-end systems and their associated integration issues are also discussed.

Since our focus is primarily visual 3D content, other forms of 3D imaging, such as MRI, tomography, etc., which are used primarily for medical purposes, are not within the scope of this book. However, this exclusion is only for the technical details of the associated imaging (image capture) devices; once the captured data is converted to an abstract 3D representation, the delivery, display, and interaction are still within this book's scope. Although audio usually accompanies visual content, our interest in audio within the 3D Media Cluster is quite limited and therefore, audio is not included in the book.

The book starts with a brief overview of 3D imaging and visualization. Then, an overview of major successes in the field that collectively make up the current state-of-the-art is presented. Ongoing research activities in Europe are outlined; research goals and recent results are briefly presented. The book then gives an overview of short-, medium-, and long-term research trends. The book concludes with predictions for the position and role of 3D-media technologies within the future Internet, together with some strategic goals.