1 Introduction

Three-dimensional (3-D) imaging systems are the appropriate technology to meet modern advanced demands, and they have been a popular topic since the 2000s. 3-D imaging techniques have been studied since Sir C. Wheatstone invented "stereoscopy" in 1838,[1] but there has been renewed emphasis since the 2009 release of the 3-D movie *Avatar*. Generally, 3-D imaging systems acquire 3-D information of real or virtual objects, and show the 3-D images or video, including the width, height, and depth characteristics of the objects, to observers naturally (whereas conventional two-dimensional (2-D) images are unnatural). Nowadays, 3-D systems are widely used and developed in movies and various fields, and the investment in this field continues to increase.[2]

Integral photography is a light-field 3-D imaging technique that is very practical and useful. It was invented by Franco-Luxembourgish physicist G. Lippmann, under the title "La photographie integrale," and it earned him the Nobel Prize for Physics in 1908.[3] Basically, an elemental image array (EIA), which is an array of multiple, closely packed, small perspectives (elemental images), is captured from the real object through an array of small lenses, and the 3-D visualization of the object is reconstructed through the same lens array from the captured EIA where the EIA includes the parallax, color, and depth information of the object. Note that the number of lenses is the same as the number of elemental images, each of which is captured differently than others due to the different viewpoints of the lenses.[4–7] The term "integral" means that the technique generates a complete 3-D image by integrating the elemental images. Earlier EIAs were captured on simple photographic plates or films, but nowadays, the EIA capturing process involves a digital camera and computer graphics. The theory of "integral photography" can be extended to "integral imaging" when computer generation or a digital camera is utilized in the pickup process; therefore, these two terms can be used interchangeably.

Since 1931, research institutes have studied how to enhance the viewing characteristics of integral photography. Nowadays, integral photography creates a more realistic viewing experience and has practical use in such fields as biomedicine and entertainment. Furthermore, integral photography has been defined as one of the key factors of future 3-D imaging technologies.

In this chapter, we discuss 3-D integral photography, its fundamentals and features, and its practical applications. First, the basic concepts for the EIA acquisition and the 3-D image reconstruction process are described. Also, the main advantages and disadvantages of integral photography are explained. Then computer-generation and digital reconstruction methods for integral photography are explained. Finally, several examples of practical applications of integral