Sequential Multi-Directional Elemental Image Projection Scheme for the Viewing Angle Enhancement of Integral Imaging 3D Display

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1. Introduction

Integral imaging (II) is a powerful autostereoscopic 3D display technique that provides a number of attractive features such as full color, full-parallax 3D image with continuous viewpoints in normal room environment that distinguishes the II from other techniques. II was first introduced by Lipmann in 1908, which called as integral photography [1]. Despite a number of attractive advantages, the II has some serious drawbacks, such as low resolution, narrow viewing angle, and small depth range. Among all the drawbacks of II, the narrow viewing angle is the most serious barrier to its commercial applications. Many researches have been investigated to overcome this problem [2-10], but II is still suffering for this limit. In order to develop a wide-viewing angled II display, a new approach to the viewing zone control of II display using a directional projection with a directional elemental image generation and resizing (DEIGR) algorithm, was successfully demonstrated and reported in a most recent study [11]. Using this method, the point light source (PLS) of each elemental image (EI) shifts in terms of the projection angle, resulting in a shift in the viewing zone. This method can control only the viewing zone of II display but it cannot widen the viewing angle itself. If multi-directional projections of a multiple sets of EIs are used with suitable projection angles in a sequential time-multiplex manner, a wide-viewing-angled II display can be achieved. To implement a viewing angle enhanced II display system, a multi-directional projection scheme is proposed.

2. Proposed method

Figure 1 illustrates the basic principle of the proposed method by using two-directional projections. In this method, each elemental lens of the lens array collects multi-directional illuminations of multiple EI sets and produces multiple point light sources (PLSs) at different positions in the focal plane; and the positions of the PLSs can be controlled by the projection angles. In this case, the viewing zone constitutes with multiple diverging ray bundles emerging from the multi-directional projections of multiple EI sets, which is wider than that of the conventional method; whereas the conventional system produces the viewing zone using only a single set of EI projection. Hence the viewing angle of the reconstructed image is enhanced.

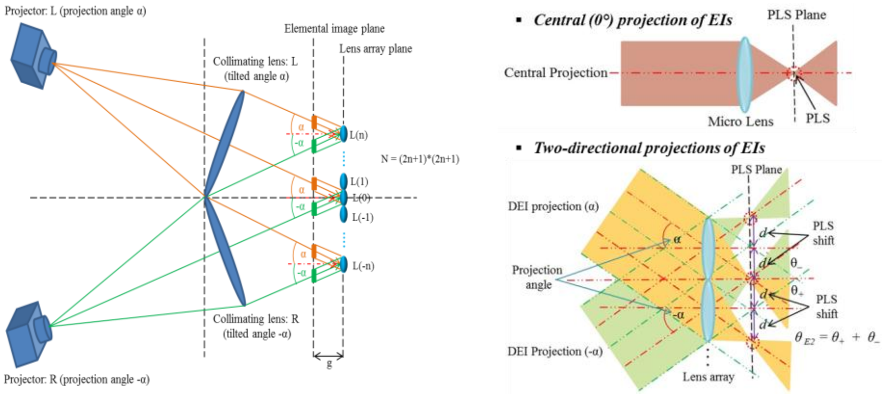
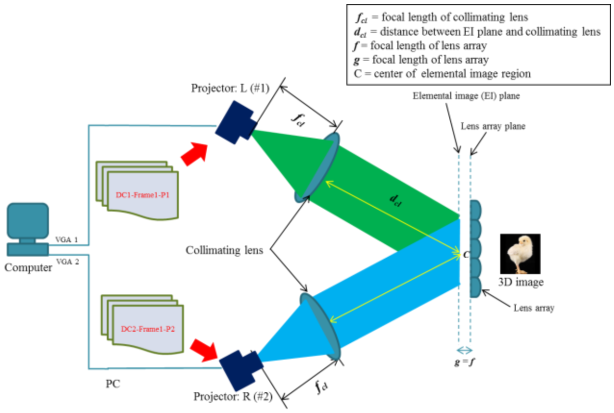


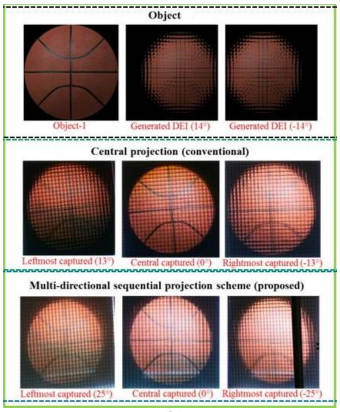
Figure 1. Principle of the proposed method (using a two-directional projection scheme).

3. Experimental results

Figure 2(a) shows the system configuration of the proposed method and the preliminary experimental results using a single (0° projection) and multi-directional (14° and -14° projections) projections are presented in Fig. 2(b). Figure 2(b) [the bottom row] presented the reconstructed 3D images for two-directional (14° and -14°) projections scheme and the total viewing angle observed as 50° (25°+25°); whereas for a single projection scheme (central projection) provide only 26° [the middle row of Fig. 2(b)]. As a result, in the two-directional sequential projection scheme, the viewing angle is enhanced by almost two times than that of the conventional scheme.



(a)



(b)

Figure 2. (a) System configuration of the proposed method (using two-directional sequential projections scheme) and (b) experimental results.

4. Conclusion

It can be concluded that the viewing angle of an integral imaging display system can be enhanced by using the proposed method. The experimental result conforms that the two-directional sequential projections scheme enhances the viewing angle by almost two times than a conventional method.

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