Simple Projection-Type Integral Photography System Using Single Projector and Fly's Eye Lens

Kazuhisa Yanaka
Kanagawa Institute of Technology

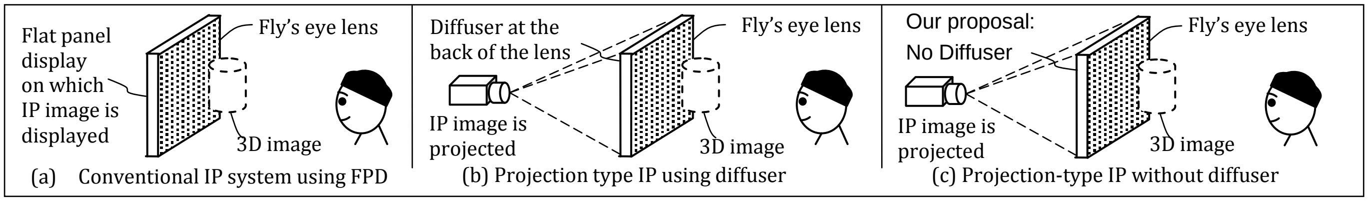

Figure 1. *Comparison of IP systems*

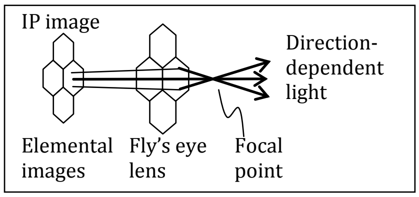

Figure 2. *Path of light*

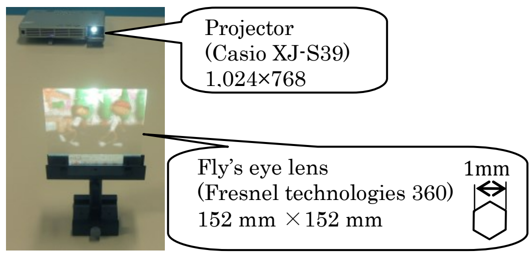

Figure 3. *Configuration of the experimental*

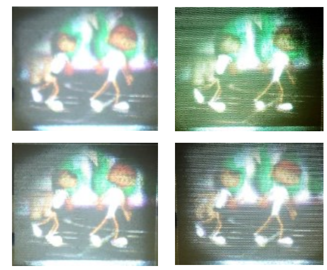

Figure 4. *Displayed images*

1. Motivation

Integral photography (IP) is one of the best stereoscopic display systems because horizontal as well as vertical parallax can be obtained without the need to wear 3D glasses. A simple IP system consists of a flat panel display (FPD), such as a liquid crystal display (LCD), with a fly's eye lens on it. The FPD is usually placed on or near the focal plane of the fly's eye lens. In this case, the size of a display is similar to the size of the FPD. However, in some cases, a large screen is preferred to obtain a better sense of reality. In these cases, a projection-type 3D display [Okoshi 1976] is highly necessary. Most display systems are very sophisticated and thus very expensive even in instances where only horizontal parallax is obtained. This condition is mainly attributed to the fact that a large number of projectors, each of which corresponds to a view, have to be used. Our motivation for this study is to provide a simple and inexpensive projection-type integral photography system in which only one projector is used.

2. Method

Figure 1(a) shows a conventional IP system [Yanaka 2008, Yanaka and Kimura 2013] that consists of an FPD and a fly's eye lens. An image displayed on the FPD is an IP image synthesized based on the size of the fly's eye lens. An IP image consists of an array of tiny hexagonal images called "elemental images," each of which corresponds to a tiny hexagonal convex lens of the fly's eye lens sheet. Although the light emitted from each pixel of the LCD is spread widely, only the light emitted from a specific pixel can be seen by the action of the fly's eye lens when viewed from a specific viewing position.

When the FPD is replaced with a transmissive diffuser in which an IP image is projected by a projector, the system shown in Figure 1(b) is obtained. Although this system is also a projection-type IP system with a projector, it has a disadvantage: the displayed stereoscopic images are not always bright and sharp enough because the transmittance of the diffuser is not 100% and light is scattered in the diffuser.

yanaka@ic.kanagawa-it.ac.jp

Therefore, we propose a system in which no diffuser is utilized (Figure 1(c)). The light emitted from each pixel of an elemental image is refracted by a minute convex lens of a fly's eye lens. After meeting at a focal point, the light spreads as shown in Figure 2. The principle of operation in this case is completely different from that in the case where diffusers are utilized. Nevertheless, this system can produce direction-dependent light, and as a result, IP can be achieved. This situation demonstrates why diffusers are unnecessary.

3. Experiments

The synthesis method of the IP image is similar to that utilized in a previous study [2]. Specifically, a 3D CG scene is rendered from 32 × 32 camera positions by using CG software and our script. An IP image is then synthesized from 1,024 still images by using our software. The IP image is flipped horizontally in advance given that rear projection is employed. The configuration of our experimental system is shown in Figure 3. The relative position of the foreground and background changes with the change in a user's viewpoint as shown in Figure 4.

4. Conclusion

A novel rear projection-type IP system was developed. The effectiveness of the system was confirmed by experiments where a bright and clear autostereoscopic image with horizontal and vertical parallax can be displayed. This system is inexpensive because only one projector is utilized and no special component other than a fly's eye lens is necessary. Nevertheless, the image is bright and clear probably because no diffuser is employed. The screen is small. However, a better sense of reality would be achieved when the screen size is enlarged in the near future.

References

OKOSHI, T. 1976. Three-Dimensional Imaging Techniques, Academic Press, New York.

YANAKA, K. 2008. Integral photography using hexagonal fly's eye lens and fractional view, Proc. SPIE 6803, Stereoscopic Displays and Applications XIX, 68031K, pp. 1–8.

YANAKA, K., KIMURA, S. 2013. GPU Accelerated Interactive Integral Photography System Using Extended Fractional View Method, SIGGRAPH 2013 Posters.

SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

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