Arc DFD (Depth-fused 3D) display by fusing arc 3D and DFD display

Kazuki Yoshioka, Shingo Nishiyama and Shiro Suyama
Dept. of Optical Science and Technology, Faculty Engineering, The Univesity of Tokushima, 2-1 minamijyosanjima, Tokushima 770-8506 Japan
Tel.: +81 88 656 9428, E-mail: goldexperience.giogio0808@gmail.com

In recent years, 3D display technology has attracted attention for the development of high-realistic communication by using optical fiber and wireless communication technology. In order to extend the applicability of the 3D images, the 3D display technologies have been developed for large perceived depth, compact and simple structure.

In various 3D display technologies, we have studied DFD (Depth fused 3D) display which has merits of a simple structure and a little fatigue[1], and arc 3D display with merits of a simple and thin structure. However, two 3D display technologies have some demerits. For example, DFD display needs the same gap as desired 3D image depth and arc 3D display cannot provide the full color filled image but wireframe image. These disadvantages can be compensated by combining two technologies.

In this paper, we propose a new arc DFD display by the fusion of DFD display and arc 3D display for thinner and simpler structure, which can provide full color filled image.

DFD display[1] is composed of two conventional 2D displays. In DFD display, two overlapped images with different depth can be perceived as a single depth image. The perceived depth of the fused image continuously changes as the luminance ratio of the two images is changed. Only edge parts of the image have an important role for perceived depth change. In edge-based DFD display,[2] the perceived depth can be successfully changed only by edge image luminance change.

The arc 3D display[3] is composed of many arc-shaped scratches. By lightning these scratches, two highlight spots can be observed in one arc-shaped scratch with both eyes, resulting in perception of one floating highlight spot in front of or behind the display.

Figure 1 shows principle of arc DFD display. Arc DFD display was composed of light and two displays (arc 3D display and rear display) without a gap. Arc DFD display has the same mechanism of perceiving depth as edge-based DFD display. However, front edge image is made of arc 3D display for thinner and simpler structure.

Figure 2 shows experimental set up for estimating perceived depth in the Arc DFD display. Arc 3D plane was stuck directly onto rear display. Front plane was set in the front of rear plane by illuminating Arc 3D plane from the bottom. The light intensity from the light source was adjusted in order to change the edge image luminance. Front edge image luminance ratio compared to rear image luminance was changed of 0%, 10%, 20%, 40%, 60%, 80%, 100%. Two subjects evaluated the perceived depths of stimuli by moving the reference display.

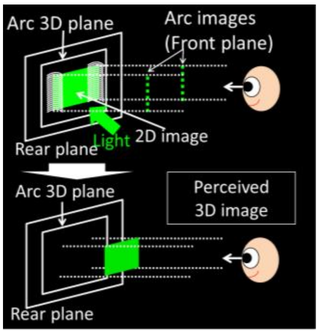


Fig.1. Principle of arc DFD display

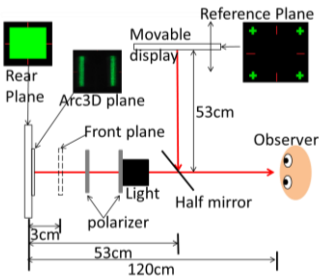
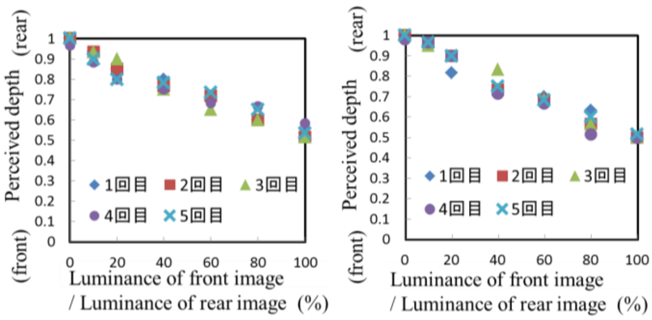


Fig.2. Experimental set up for estimating perceived depth



(a) Subject A (b) Subject B

Fig.3. Perceived depth dependence on front image luminance ratio

Perceived depth dependence on edge image luminance is shown in Fig. 3. Perceived depth was measured from the distance from front plane. In subject A (Fig. 3(a)), perceived depth is smoothly increased as from rear plane to edge image luminance is increased. In subject B (Fig. 3(b)) perceived depth is also smoothly increased as edge image luminance is increased. Difference between two subjects is small enough.

We propose a new Arc DFD display which has merits of a little fatigue, a simple and thinner structure. By changing luminance ratio of front edge image by arc 3D display, continuous change of perceived depth can be successfully obtained. Thus, the Arc DFD display is promising because of compact, simple, thinner structure, and large depth.

References

1. S. Suyama et al, NTT Technical Review, 3(12), pp. 82-89(2005).
2. T. Soumiya et al, IDW'14, pp. 902-905(2014).
3. C.Maeda et all, IDW'11, pp. 279-282(2011).