17a-D5-6

Color volumetric display based on image plane scanning by use of multi-projector

Yuki Maeda[1], Daisuke Miyazaki[1], Takaaki Mukai[1], Satoshi Maekawa[2]

[1] Graduate School of Eng., Osaka City Univ., [2] Univ. of Hyogo
E-mail: maeda@picasso.elec.eng.osaka-cu.ac.jp

1. Introduction

A volumetric display system based on image plane scanning creates a three-dimensional (3D) floating image that is observable with the naked eye [1]. The 3D floating image is created from a stack of cross-sectional images displayed on a two-dimensional (2D) display, as illustrated in Fig. 1. In this system, the number of displayable volumetric pixels (voxels) and colors are proportional to the frame rate of the 2D display. Therefore, a high frame rate 2D display, such as Texas Instruments DLP projector, is required to display a high-resolution and color 3D volume image. However, there is a limit to increase the refresh rate using a single projector.

In this study, we propose to use a multi-projector as a 2D display to display a color 3D volume image.

2. Optical Devices and Experimental Setup

We used three projectors (DLP® LightCrafter™). For each projector, a color of a light source was set to red, green and blue, respectively. The frame rate was set to 4000 [Hz] and the resolution was 854 × 480 pixels.

A rotating two-sided mirror with prism sheets for increasing light quantity was used as the optical scanner [2]. The optical scanner was attached to a servo mortar and rotated at a speed of 10 [rps] synchronized with switching of the projector. Since the mirror was two-sided, the scanning speed was twice of the rotation speed, i.e., 20 [Hz].

A dihedral corner reflector array (DCRA) [3] was used as the imaging element, which is a reflection-type and distortion-free imaging element.

The experimental setup of the proposed display system including these optical devices is shown in Fig. 2.

3. Result and Discussion

The color 3D floating-volume image was displayed by the experimental setup, as shown in Fig 3. Three volume images displayed by projectors were overlapped and seen as a unified image having 3 [cm] on a side and a total frame rate of 20 [Hz]. The total displayable space having a volume of 1000 [cm^3] was created by 576 cross-sectional images, i.e., the space had 854 × 480 × 576 voxels.

However, image blurring and color unevenness were observed because a display location and brightness varied slightly with each projector. To avoid these problem, precise alignment and brightness adjustment are required. We are now planning to develop a measurement system using a camera for the floating image plane of the 2D display formed by the DCRA.

4. Conclusion

We developed the color volumetric 3D display consisting of the three DLP projectors, the rotating mirror with the prism sheets and the DCRA.

Acknowledgements

This research was partly supported by the ICOM Electronics Communication Engineering Promotion Foundation, Japan.

References

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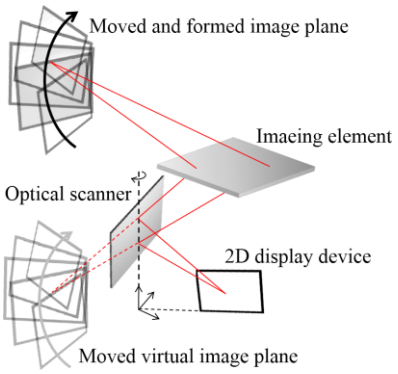

Figure 1. Volumetric display based on image plane scanning.

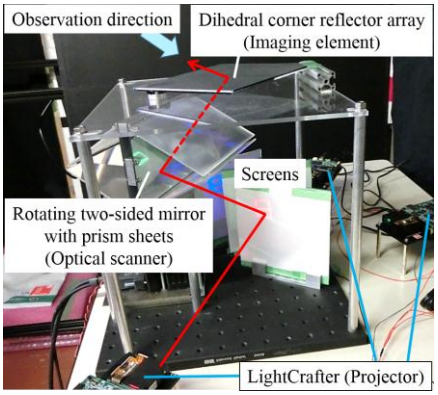

Figure 2. Experimental volumetric display. The red arrow shows a ray path from the front side projector.

Figure 3. Color 3D volume image of a cubic wire frame.