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Multi-layered aerial LED display with occlusions between layers

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1. Introduction

Aerial display provides a new field for signage because the aerial display forms a real image without no hardware at the image position [1, 2]. Our goal is to realize aerial LED signage that is shown at desired 3D locations, for example, in front of cars and people's faces. In the previous work, we have realized aerial LED display. However, the previous setup has an occlusion problem, that is, inconsistency between occlusions and depths. In this paper, we propose a new optical setup to solve the occlusion problem in multi-layered LED display.

2. Aerial imaging by cascaded crossed-mirror arrays

An optical element for aerial LED display was designed and fabricated for aerial imaging of LED signs [3]. We propose a new setup for aerial LED display to solve the occlusion problem.

Crossed-mirror array(CMA) designed for LED display

In order fill the gaps between LED lamps, we have designed a crossed-mirror array (CMA), as shown in Fig. 1. The CMA is composed of stainless mirrors that surround square apertures. The size of apertures in the CMA enables blurred imaging to fill the LED gaps. The imaging is based on dihedral corner reflectors [1], that is, rays emitted from a light source converge the imaging position after double reflections.

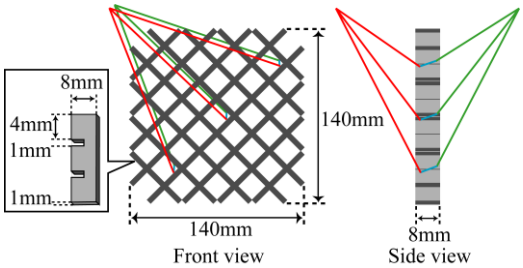

Fig. 1. Crossed-mirror array for aerial LED display.

Cascaded-CMAs setup to solve the occlusion problem

Proposed optical setup is shown in Fig. 2. The aerial imaging by use of single CMA reverses the depths between the multi-layered LED signs. The 2nd CMA returns the depths that was flipped by the 1st CMA.

3. Experimental results

Three-layered LED signs are used for experiments. The locations are shown in Fig. 2. In the conventional setup, which employs only the 1st CMA, the occlusion problem was observed as shown in Fig. 3. In the proposed setup, occlusions and image depths were consistent.

4. Conclusion

Multi-layered aerial LED display without the occlusion problem has been realized by use of cascaded CMAs.

Acknowledgements

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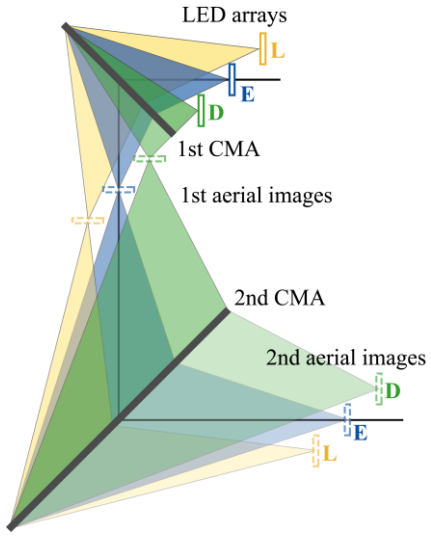
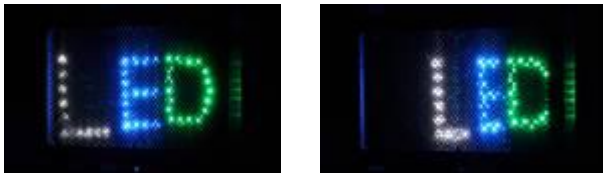


Fig. 2. Proposed setup to form multi-layered aerial LED display to solve the occlusion problem.



(a) (b)

Fig. 3. Viewed images of multi-layered LED display in the conventional setup, which forms aerial image by use of the 1st CMA in Fig. 2. While the viewing position was changed from the left side (a) to the right side (b), there occurs the occlusion problem, such that the farthest sign D covers the near sign E.

(a) (b)

Fig. 4. Viewed images of multi-layered LED display in the proposed setup, which forms aerial image by use of cascaded double CMAs. While the viewing position was changed from the left side (a) to the right side (b), there is no occlusion problem; the nearest sign D covers the further sign E.

References

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