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Comparison of retroreflective elements in directivity of aerial imaging by retroreflection (AIRR)

Yuka Tomiyama[1], Shiro Suyama[1] and Hirotsugu Yamamoto[1, 2]

[1] Dept. of Optical Science and Technology, The University of Tokushima
[2] Center for Optical Research and Education (CORE), Utsunomiya University,
E-mail: c501438017@tokushima-u.ac.jp

1. Introduction

Aerial sign is prospective for a new digital signage, because it enables sign messages to float in the required position without interruption of walking through of people. We have proposed Aerial Imaging by Retro-Reflection (AIRR) [1]. By utilizing retroreflection, AIRR can form an aerial real image of a light source as shown in Fig. 1. We have realized AIRR by using two types of retroreflective elements, that is, micro-beads type and prism type, of which retroreflective characteristics are different.

In this paper, in order to investigate the viewing angle difference between the retroreflective elements, we compare the luminance distributions of an aerial LED image along the rotation angle of retroreflective sheeting of micro-beads type and prism type.

2. Principle of aerial imaging by retroreflection (AIRR)

Optical system for AIRR is composed of a light source, a half mirror, and a retroreflective sheeting [1], as shown in Fig. 1. An LED lamp and a piece of retroreflective sheeting are located in one side of a beam splitter. The retroreflective sheeting reflects light in reversely toward the incident direction. Half of the LED lights are reflected by the beam splitter and impinge on the retroreflective sheeting. The retroreflective sheeting reflects the lights back to their source. On the way to the source, half of the lights transmit through the beam splitter and form the aerial real image. The position of the aerial image is the plane-symmetrical position of the light source regarding to the beam splitter.

3. Directivity of AIRR

Experimental setups are shown in Fig. 1. Luminance changes of the aerial LED image by rotating the retroreflective sheeting were measured with a luminance meter. Luminance distributions are compared between retroreflective sheeting of micro-beads type and prism type.

The dependences of luminance of the aerial LED image upon the rotation angle are shown in Fig. 2. The horizontal origin, 0 degree, is defined by the direction of the retroreflective sheeting that is perpendicular to the aerial image position. The aerial image by using prism type has the maximum brightness around 0 degree and its full-width half-maximum (FWMH) is 55 degrees.

The aerial image by micro-beads type has no significant change in luminance between -30 degrees and 50 degrees, resulting in wide FWHM that is more than 90 degrees.

Thus, although the prism type forms a brighter aerial image than the micro-beads type between 15 and 50 degrees, the micro-beads type forms the aerial image in significantly wider ranges than the prism type.

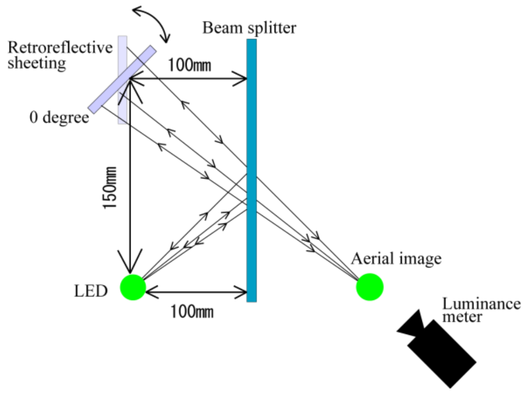

Fig.1. Aerial imaging by retroreflection (AIRR) system and experimental setup to investigate directivity.

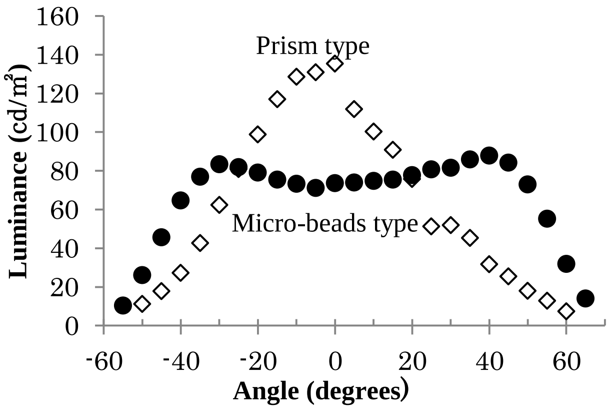

Fig. 2. Comparisons of retroreflective elements in dependences of luminance intensity of an aerial LED image upon rotation angle of retroreflective sheeting.

4. Conclusion

We have compared angular distribution of luminance intensity in rotation angle of retroreflective sheeting.

Micro-beads type is suitable for aerial LED signage, because the aerial LED image formed by the micro-beads type was visible in a wide range of viewing angle.

References

[1] H. Yamamoto and S. Suyama: Proc. SPIE 8648 (2013) 86480Q.