Experimental Characteristics of LED-array Based Increased Power Optical Wireless Power Transmission System for Compact IoT

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1. Introduction

The LED-based optical wireless power transmission (OWPT) system is a novel approach of remote power transmission technology, and it has virous merits such as long transmission distance, no noise comparing with the conventional wireless power transmission technologies. However, the output power of OWPT system with single LED is difficult to raise due to current manufacturing technology. Therefore, arraying multiple LEDs as LED array is the effective way to enhance the total output of the LED-based OWPT system. Part of the simulation results is shown in the previous report of Ref. 1). In this paper, the experiment data of the LED-array OWPT system will be discussed.

2. Configuration of LED-array OWPT system

In this research, two kinds of configurations of the LED-array OWPT system are designed. In the first configuration “A”, one set of collimation lenses is used to collimate the light beam emitted from LED array, and then an image lens is closely installed after collimation lens to focus the target transmission distance. In order to get collimation, the LED array needs to be placed at the back-focus point of collimation lenses, which makes such distance slightly long thus part of intensity lost in this region due to large radiation angle of LED. For improving the efficiency, the second configuration “B” is proposed. Two sets of collimation lenses are applied and the collimation is achieved in two steps in such configuration, which results the efficiency improved. On the other hand, the exist pupil of the configuration B becomes smaller, and the size of the irradiation spot will slightly increase according to the principle of etendue.

3. Characteristics of LED-array OWPT system

Figure 1 shows the experiment setup of two configurations of LED-array OWPT system with 3 LEDs. In the experiment, multiple high-intensity NIR LEDs (Osram SFH-4703AS, 810 nm, 1040 mW, ± 40°) were used to form the LED array, the aspheric condenser lenses with 50 mm aperture and 50 mm focal length (SIGMAKOKI, AGL-50-50P) were used as collimation lenses, and a Fresnel lens (NTKJ Co., Ltd., CF1000) with 1 m focal length and 120 mm aperture was used as the image lens. All lenses are not AR coated. Two pieces of single-junction GaAs solar cells (Advanced Technology Institute, LLC) with size of 17 mm × 50 mm were series connected to form an optical energy receiver with 34 mm × 50 mm size. The practical dimension of LED-array OWPT system with the two configurations is a cylinder with a diameter of 120 mm as the base and a length of 43 mm. The IR images of the irradiation spot of the two configurations is shown in Fig. 2. The size of irradiation spot at 1 m transmission distance is 34×44 mm^2 of configuration A and 35×54 mm^2 of configuration B, and corresponding output power is 316mW and 380 mW, respectively. The output power will decline to 196 mW and 268 mW of two configurations if only 2 LEDs are applied. The efficiency of the lens system of configuration A is around 27%, and such value enhanced to 35% in configuration B. Due to the higher efficiency of the lens system, the configuration B can realize larger output power than configuration A, even its irradiation spot size is larger.

4. Conclusion

The characteristics of LED-array OWPT system with two configurations for high output power was reported. Besides, suppressing the alignment deviation is a key factor to ensure the performance of LED-array OWPT system, and the detailed discussion will be processed in the presentation.

References

1) Y. Zhou and T. Miyamoto, JSAP2020autumn, 9a-Z13-9.

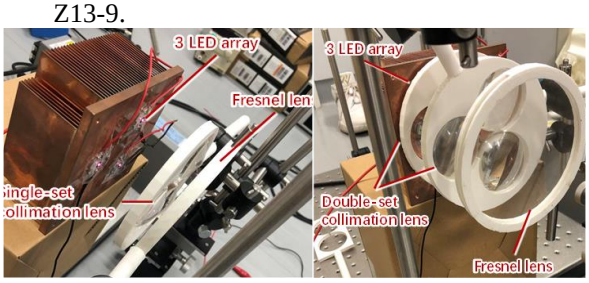

Fig. 1. Experiment setup of (left) “A” and (right) “B”

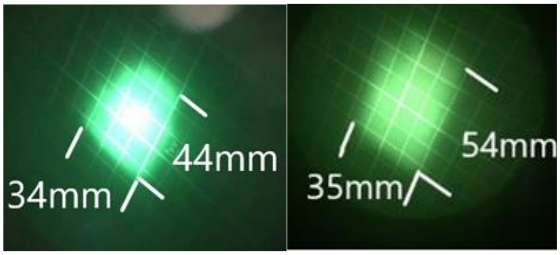

Fig. 2. Irradiation spots of (left) “A” and (right) “B”