Research on LED-array Optical Wireless Power Transmission System Designing

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1. Introduction

Due to the relatively loose regulation compared with laser, LED-based optical wireless power transmission (OWPT) system is a potential candidate for remotely power charging application. However, the output power of OWPT system with single LED is difficult to raise due to current manufacturing technology. Thus, investigating on LED-array OWPT system is far more necessary. In this paper, the designing of LED-array OWPT system and simulation results are shown in detail.

2. Designing of LED-array OWPT system

Although LED chip can be seen as a Lambertian object, after first-order lens packaging, radiation will be restrained in a certain angle and distribution. If LEDs are arrayed, corresponded light rays from different LEDs have same divergence angle. In case of applying a single image lens, such same angle rays will be emitted at different curvature radius points on lens. Thus, beams will not be overlapped, and radiant intensity will be not improved.

The common method is applying same lens set for each LED and then tilting optical axis. However, the aperture size will largely limit arraying compact level. Due to the spatially incoherent of LED, collimation on whole transmission distance is impossible, but approximate collimation in a very short distance is not so difficult. After collimation, just one image lens can rearrange intensity distribution. Figure 1 shows the configuration of 4-LED array system and irradiance map, double aspheric condenser lenses (50 mm diameter, 38 mm focal length) are applied to each LED for collimation, and a single Fresnel lens with 120 mm aperture and 1 m focal length is selected as image lens for focusing. The irradiation size is 5 cm × 5.3 cm and overlapped. Although collimation by single plano convex lens is possible, light source need be placed at the rear focus, which makes transversal magnification unlimited. In another word, the irradiation will be irregular, and efficiency is largely deteriorated.

3. Simulation results

Figure 2 shows the simulation results of 1 m power transmission for 1-5 LEDs. The “origin” data is the LED-based configuration shown in previous report[1)] for comparison. The irradiation intensity depends on the solar cell (irradiation) size, and it is almost proportional to the number of LEDs. If 40% PV conversion efficiency is assumed, several cm solar cell can provide over 1 W output power when LED number beyond 3. What’s more, system length is unchanged no matter how many LEDs are applied.

4. Conclusion

The design of LED-array OWPT system for high output power was reported. The detailed data and results of other transmission conditions will be discussed at presentation.

References

1) Y. Zhou and T. Miyamoto, JSAP2019autum, 19p-E204-7.

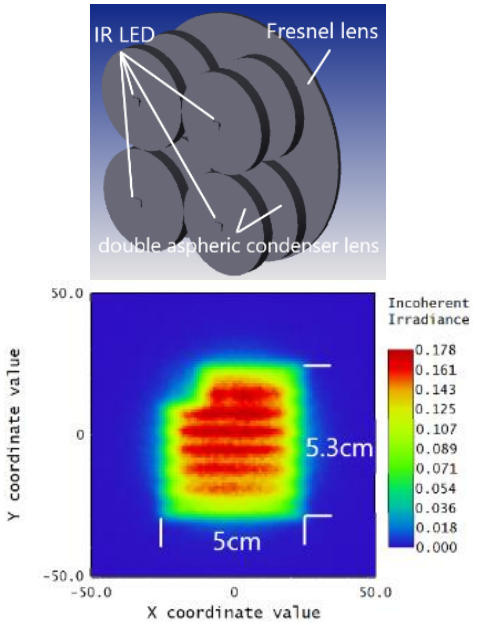

Fig. 1. Model of LED-array system and irradiance map

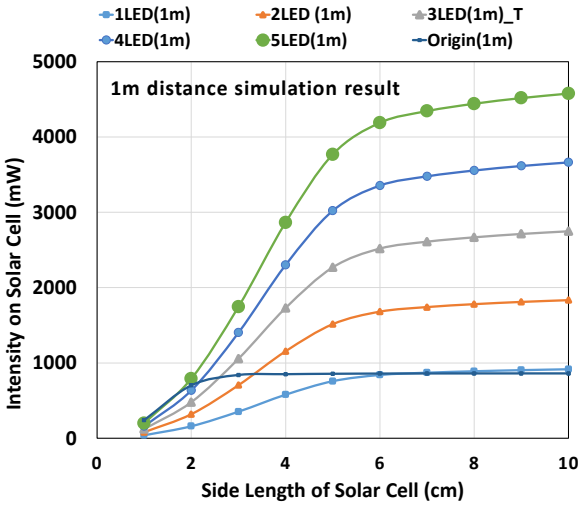

Fig. 2. Simulation results of 1 m power transmission