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Design of Fresnel lens for uniform LED lighting

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A uniform light diffuser for a light-emitting diode (LED) light source is an essential device widely used in lighting engineering. We present a linear Fresnel lens design for LED uniform illumination applications. The LED source is an array of LED. An array of collimating lens is applied to collimate output from the LED array. Two linear Fresnel lenses are used to redistribute the collimated beam along two dimensions in the illumination area. Collimating lens and linear Fresnel lens surfaces are calculated by geometrical optics and non-imaging optics. A collimating lens has the simple structure of a plano-convex lens. The linear Fresnel lens is constructed by many grooves. The collimated beam output from the collimating lens array is divided into many fragments corresponding to the number of Fresnel lens grooves. Each fragment is refracted by a groove and distributed over the illumination area, so that total beam can be distributed to the illumination target uniformly. The designed system was modeled and simulated with LightTools software to explore the optical performance. The simulation results indicate that 82% optical efficiency was achieved at a uniformity of 76.9% for the proposed system. The simulation of the performance of our design for practical purposes, such as indoor and street lighting, and the comparison with a conventional light source were conducted. The simulation results show that this design has a compact structure, a high optical efficiency, and a good uniform distribution. Some consideration on the energy saving and optical performance are discussed by comparison with other typical light sources. The results show that our proposed LED lighting system is a strong candidate for low cost, energy saving for indoor and outdoor lighting applications.

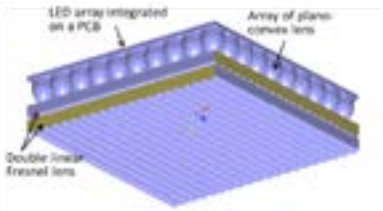

Figure 1: Physical layout of the uniform illumination system for a light-emitting diode (LED) array

Recent Publications

1. Vu N H, Pham T T and Shin S (2016) Modified optical fiber daylighting system with sunlight transportation in free space. Optics Express 24(26):1528-1545.
2. Vu N H and Shin S (2016) Cost- effective optical fiber daylighting system using modified compound parabolic concentrators. Solar Energy 136:145-152.
3. Vu N H and Shin S (2017) Flat optical fiber daylighting system with lateral displacement sun-tracking mechanism for indoor lighting. Energies 10:1679.
4. Vu N H and Shin S (2017) Flat concentrator photovoltaic system with lateral displacement tracking for residential rooftops. Energies 11(1):114.
5. Pham T T, Vu N H and Shin S (2005) Daylighting system based on novel design of linear Fresnel lens. Buildings 7(4):92.

Biography

Seoyong Shin has been in the Department of Information and Communication Engineering at Myongji University since 1994. He has published more than 40 SCI and SCI-E papers so far. He started research in the field of optical communication, especially optical active functional modules including wavelength converter, optical buffers for WDM network, and dynamically gain-controlled EDFA for WDM networks. His research has moved on to solar energy related topics since 2007 where he can apply his prepared knowledge of optics and optical fibers. His main interested topics are optical fiber based daylighting system and concentrator photovoltaic systems.

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