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发光学应用及交叉前沿

LED显示屏高光效高画面填充比光学设计与研究

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摘要： 针对传统LED显示屏光能利用率和图像画面填充比低的缺点，基于非成像光学理论，提出了一种提高光能利用率和画面填充比的全彩LED显示模块结构系统和设计方法。利用复合抛物面集光器CPC对LED管芯发出光线的发散角进行变换压缩，从而避免了外表面全反射损耗，大幅度提高了系统的光能利用率。利用积分方腔匀光原理和散射元件对光能的二次分配，提高了显示屏的画面填充比、单位像素均匀度及基色复用面积。作为实例，根据上述方法设计了一个P10 mm全彩LED显示模块，利用光学设计软件LIGHTTOOLS对该显示模块系统进行了仿真建模和光线追迹，并对设计结果进行了分析。结果表明，系统光能利用率大于70%，画面填充比接近100%，单位像素区域内均匀度好于85%。显示模块具有能量利用率高、高画面填充比、显示效果均匀柔和、易于生产和装调的优点。

关键词： LED显示屏 画面填充比 光能利用率 非成像光学

Optical Design and Research of High Optical Efficiency and High Filling Ratio of LED Display Screen

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Abstract: In traditional LED display screen, optical energy utilization rate and imaging filling ratio are very low. Based on the theory of non-imaging optics, a structure system and a design method are developed to improve optical energy utilization rate and imaging filling ratio of full-color LED display. Using compound parabolic concentrator (CPC), light diverging angle emitted from LED chips is transformed and compressed. Therefore, total reflection loss on external surface of display module can be avoided. Accordingly, optical energy utilization rate of display system is greatly improved. Based on uniform lighting principle of integrator-rod and light distribution principle of scattering, imaging filling ratio, pixel uniformity and primary color multiplexing area of LED display screen are improved. According to the above method, a P10 mm full-color LED display module is designed. Using LIGHTTOOLS software, the display module system is simulated and analyzed. The simulation results show that, optical energy utilization rate of system is higher than 70%, imaging filling ratio closes to 100%, uniformity of unit pixel area is better than 85%. The display module has the advantages of high energy utilization rate, high imaging filling ratio, uniform and soft showing, easy manufacturability.

Keywords: LED display screen imaging filling ratio optical energy utilization rate non-imaging optics

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