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多主色LED照明光源的相关色温调控

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Control of correlated color temperature for multi-primary color LED illumination

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摘要

通过建立光电热(PET)模型, 研究了发光二极管(LED)光源相关色温(CCT)的模型预测控制方法, 实现了多主色LED光源的相关色温控制。首先, 提出了热平衡状态稳定假设和修正的非对称高斯函数作为基函数的假设;根据软模型建模思路, 用最小二乘估计求解各个模型参量的回归子模型, 分析光谱敏感系数曲线随CCT变化的关系。然后, 通过重力线法调试出在3 000, 4 500和6 500 K 下3个常用色温点处所需的电流控制量。最后, 在调设好的电流控制量上加以一定的无规则扰动产生一组验证数据, 用于评价模型精度。实验结果表明:建立的多主色LED光源的PET数学模型能够很好地通过电流控制量和环境温度来预测LED的热沉温度和多主色合成光谱功率分布函数, 进而能够预测控制色温, 具有很好的模型精度。得到的色度坐标预测精度优于±0.005, CCT预测精度优于±150 K。提出的基于模型的控制方法不仅适用于常用LED光源的CCT调控, 还可推广到更多通道的LED光源的色度及CCT控制中。

关键词 : 照明光源, 多主色发光二极管, 相关色温, 光电热模型

Abstract :

Based on the established photo-electro-thermal (PET) model, a model predictive control method of Correlated Color Temperature(CCT) for a Light Emission Diode(LED) was investigated to realize the CCT control of multi-primary color LEDs. The Guassian distribution hypothesis and the thermal equilibrium variable relationship stability hypothesis were presented. The regression sub-models of different model parameters were calculated by least square estimation method successively according to the strategy of soft model. The change trend of spectral sensitive coefficient curves with different CCT curves was analyzed. Then, current control parameter values of 3 typical CCTs at 3 000, 4 500 and 6 500 K were fixed by the gravity line adjusted method. Finally, a set of spectral power distribution curves were obtained by bringing a certainty random variation to the fixed current control parameter values to validate and evaluate the accuracy of the PET model. Experimental results indicate that the PET model predicts accurately the heat sink temperature and the Spectral Power Density(SPD) of the LED by control of the currents and environment temperatures, the accuracy of predictive chromatic coordinate value is better than ±0.005, and the accuracy of predictive CCT is better than ±150 K. The model-based control method has good accuracy for CCT control and can be generalized to the multi-primary color LED illumination with more primary color channels.

Key words : illumination source multi-primary color Light Emission Diode(LED) correlated color temperature photo-electro-thermal model

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