光学 精密工程
OPTICS AND PRECISION ENGINEERING
核心期刊
主管：中国科学院
主办：中国科学院长春光学精密机械与物理研究所
中国仪器仪表学会
主编：曹健林

光学精密工程 2013, 21(11) 2980-2988 ISSN: 1004-924X CN: 22-1198/TH DOI:10.3788/OPE.20132111.2980

信息科学

用于高动态范围图像生成的CCD辐照度标定

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摘要： 为了使低动态范围（LDR）图像采集设备能够生成高动态范围（HDR）图像，研究了对同一场景进行多次曝光生成HDR图像的技术，提出了不苛求输入图像为低噪声的CCD辐照度标定方法。为避免参数个数过多导致参数求解偏离全局最优值，构建了大幅削减参数个数的能量函数，该能量函数由CCD辐照度响应曲线参数模型、残差惩罚函数、权重函数3部分组成；分别使用低拟合误差的EMoR参数模型、抑制图像高斯噪声的平方和残差惩罚函数、平衡图像噪声与截止域干扰的权重函数最优实现能量函数的各个部分，继而通过快速迭代和精确迭代相切换的Levenberg Marquardt(LM)算法最小化能量函数求解参数。实验结果表明，依据图像噪声大小和参数模型参数个数的不同，拟合响应曲线的均方根误差RMSE∈\[0.0022, 0.0163\]，精度提高了39%~90%，处理时间缩短了38%~56%，得到的HDR-LDR映射图更忠实地反映了LDR图像序列的色彩特征，且明暗细节清晰可见。

关键词： 高动态范围图像 CCD 辐照度标定 能量函数

CCD irradiance calibration algorithm for HDR image acquisition

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Abstract: To acquire a High Dynamic Range(HDR) image from the Low Dynamic Range(LDR) image acquisition equipment, the HDR image production technology was researched based on different exposure images in the same scene. Then, a CCD irradiance calibration method which doesn't require low noise images as the input was proposed. To avoid the deviation from the global optimum solution by excessive number of parameters, an energy function with fewer parameters consisting of the parameter model of CCD irradiance response curve, a residual penalty function, and a weighting function was proposed. The energy function was optimized by a low fitting error EMoR parameter model, squared residual penalty function suppressing image Gaussian noise, and the weighting function balancing image noise with deadline domain interference. Then the parameters were solved by minimizing energy function with Levenberg Marquardt(LM) algorithm which switched from rapid iteration to accurate iteration. Experimental results indicate that, with different number of model parameters and intensities of image noise, the response curve fitting Root Mean Squared Error(RMSE)∈\[0.0022, 0.0163\], the accuracy is increased by 39%-90%, the processing time is reduced by 38%-56%, and the obtained HDR-LDR mapping image is more similar with LDR image sequences and all the details of bright and dark regions are visible clearly.

Keywords: High Dynamic Range(HDR) image CCD Irradiance calibration energy function

收稿日期 2013-06-20 修回日期 2013-09-17 网络版发布日期 2013-11-22

基金项目:

低频振动体系中环境能量捕获的关键问题研究;江苏省科技支撑计划;江苏省自然科学基金

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