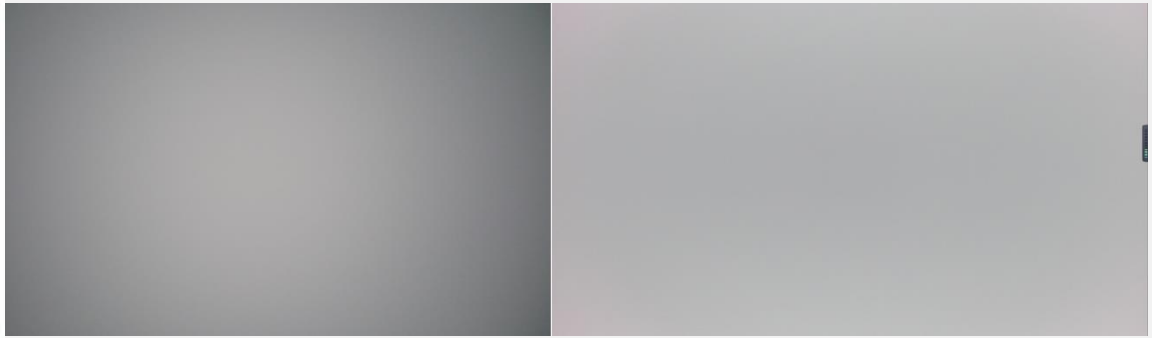
LSC-Lens Shading Correction

食鱼者

202107

LSC-Lens Shading Correction

color shading



Luma shading

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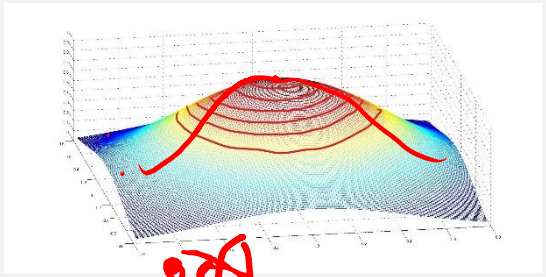
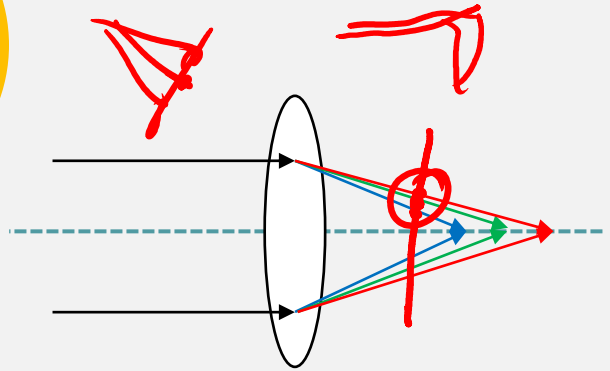
01 产生原因

LS产生原因

Luma shading

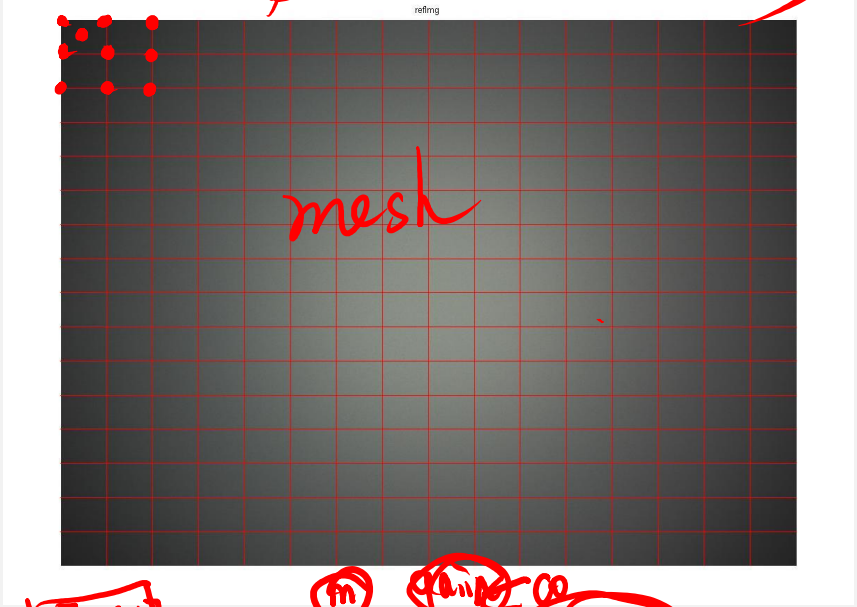


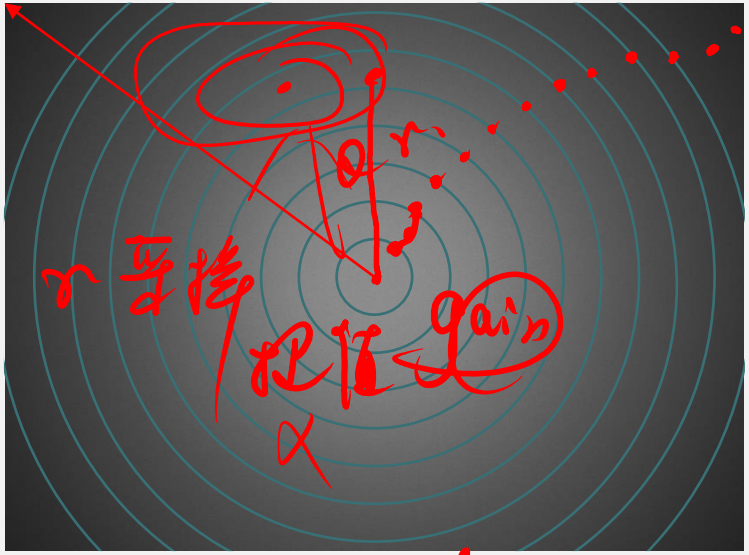
Color shading



02 LS校正方法

LS校正-LUT校正法





LS校正-多项式拟合

基于 FPGA 的镜头光照度补偿算法研究与实现

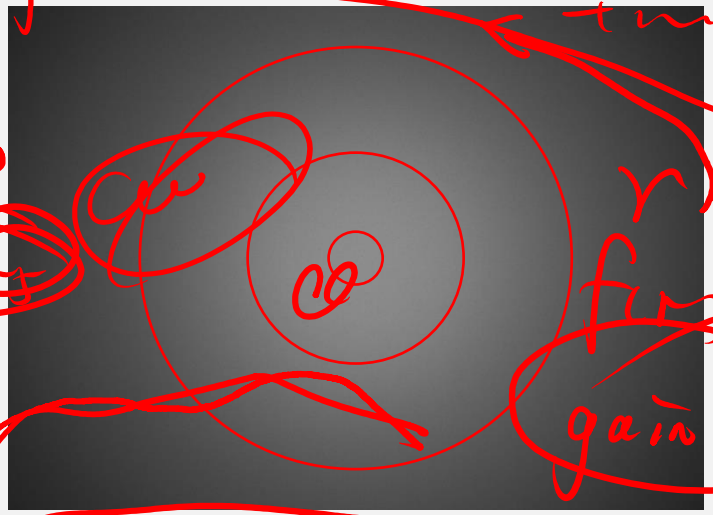
摘　要

当今，CMOS 成像技术已经获得主流成像市场的认可，诸如笔记本电脑、PAD、数码相机、智能手机相机等手持电子设备均采用了 CMOS 图像传感器技术。然而，单纯经过 CMOS 图像传感器得到的图像并不可以直接使用，它存在图像亮度不均匀、边缘亮度不足方面的质量缺陷，还需经过图像处理器进一步进行处理，方可得到较为满意的图像。

文章首先对镜头光照度衰减成因进行了深入研究。镜头光照度补偿作为图像处理器的一部分，其作用在于提升图像亮度均匀性，重点提高图像边缘的亮度，消除因镜头光照度衰减导致的图像中心与边缘亮度差异较大的缺陷，保证图像信息的完整性。采用分段线性补偿、高次曲线拟合等技术手段，以提高拟合曲线的平滑度，使处理后的图像亮度分布较分段线性处理更加均匀，运用 MATLAB 软件编写光照度补偿算法对图像进行处理，根据处理结果调整算法和参数，具有计算方便、参数调整简易的特点。运用 Verilog 语言设计论文算法，给出了数据流程图及实际编译后的顶层模块图，引入便于硬件实现的近似计算，减少芯片面积、降低功耗，设计结果符合算法要求。采用操作数隔离与时钟门控技术对设计进行了功率优化。

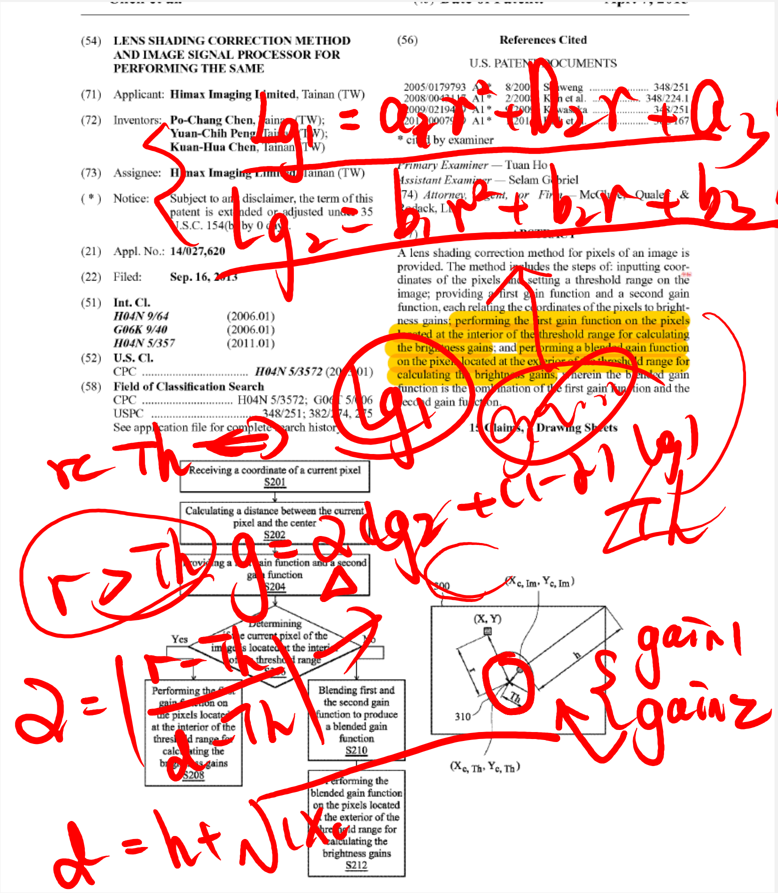
经 Imatest 软件对处理后图像进行测试，测试表明论文的算法达到了镜头光照度补偿的目的，与处理前图像相比，图像亮度平滑度明显提升，满足了图像边缘与中心亮度差不高于 20%的预期性能指标要求。

关键词：　CMOS 图像传感器；图像处理；光照度补偿；暗角修正



$$
\begin{aligned}
gain = {} & 32 + (r - x(2)) \cdot (r - x(3)) \cdot (r - x(4)) \cdot (r - x(5)) \\
& / (x(1) - x(2)) \cdot (x(1) - x(3)) \cdot (x(1) - x(4)) \cdot (x(1) - x(5)) \cdot rGain(1) \\
& + (r - x(1)) \cdot (r - x(3)) \cdot (r - x(4)) \cdot (r - x(5)) \\
& / (x(2) - x(1)) \cdot (x(2) - x(3)) \cdot (x(2) - x(4)) \cdot (x(2) - x(5)) \cdot rGain(2) \\
& + (r - x(1)) \cdot (r - x(2)) \cdot (r - x(4)) \cdot (r - x(5)) \\
& / (x(3) - x(1)) \cdot (x(3) - x(2)) \cdot (x(3) - x(4)) \cdot (x(3) - x(5)) \cdot rGain(3) \\
& + (r - x(1)) \cdot (r - x(2)) \cdot (r - x(3)) \cdot (r - x(5)) \\
& / (x(4) - x(1)) \cdot (x(4) - x(2)) \cdot (x(4) - x(3)) \cdot (x(4) - x(5)) \cdot rGain(4) \\
& + (r - x(1)) \cdot (r - x(2)) \cdot (r - x(3)) \cdot (r - x(4)) \\
& / (x(5) - x(1)) \cdot (x(5) - x(2)) \cdot (x(5) - x(3)) \cdot (x(5) - x(4)) \cdot rGain(5)
\end{aligned}
$$

LS校正-多项式拟合



(54) LENS SHADING CORRECTION METHOD AND IMAGE SIGNAL PROCESSOR FOR PERFORMING THE SAME

(71) Applicant: Himax Imaging Limited, Tainan (TW)

(72) Inventors: Po-Chang Chen, Tainan (TW); Yuan-Chih Peng, Tainan (TW); Kuan-Hua Chen, Tainan (TW)

(73) Assignee: Himax Imaging Limited, Tainan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 14/027,620

(22) Filed: Sep. 16, 2013

(51) Int. Cl.
H04N 9/64 (2006.01)
G06K 9/40 (2006.01)
H04N 5/357 (2011.01)

(52) U.S. Cl.
CPC *H04N 5/3572* (2013.01)

(58) Field of Classification Search
CPC H04N 5/3572; G06T 5/006
USPC 348/251; 382/274, 275
See application file for complete search history.

(56) References Cited

U.S. PATENT DOCUMENTS

* cited by examiner

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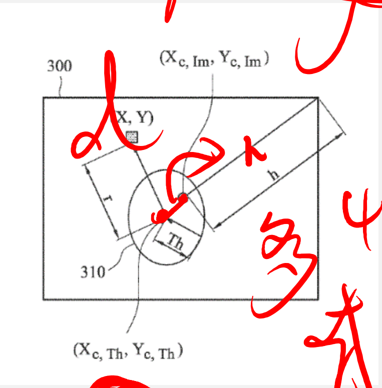
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

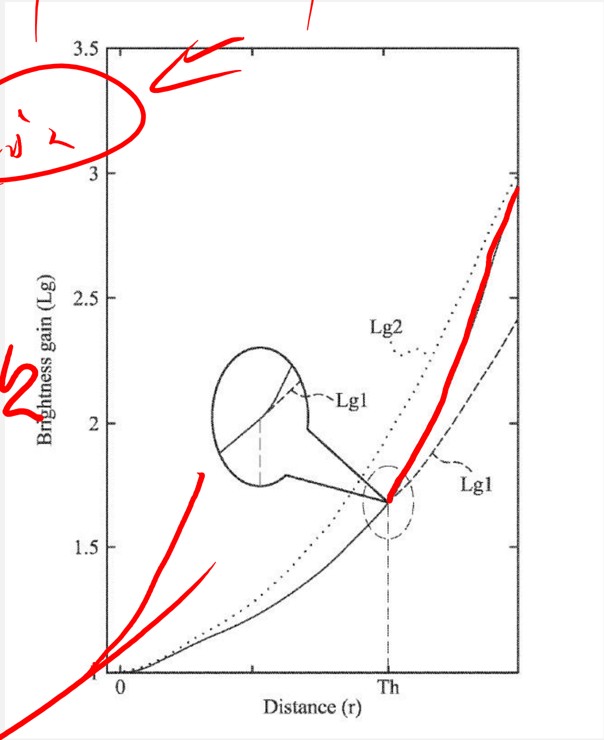
(57) ABSTRACT

A lens shading correction method for pixels of an image is provided. The method includes the steps of: inputting coordinates of the pixels and setting a threshold range on the image; providing a first gain function and a second gain function, each relating the coordinates of the pixels to brightness gains; performing the first gain function on the pixels located at the interior of the threshold range for calculating the brightness gains; and performing a blended gain function on the pixels located at the exterior of the threshold range for calculating the brightness gains, wherein the blended gain function is the combination of the first gain function and the second gain function.

15 Claims, 5 Drawing Sheets

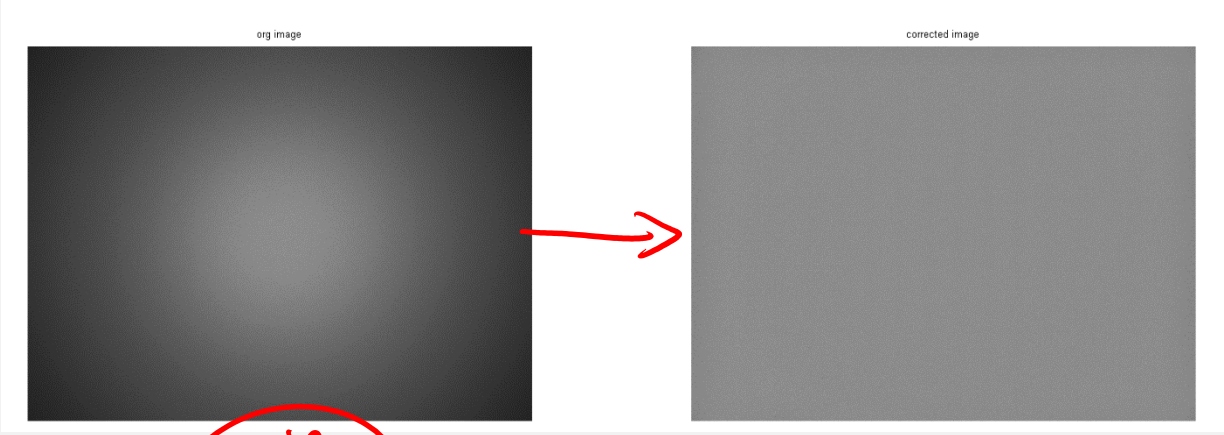
Receiving a coordinate of a current pixel S201
Calculating a distance between the current pixel and the center S202
Providing a first gain function and a second gain function S204
Determining whether the current pixel of the image is located at the interior of the threshold range
Yes / No
Performing the first gain function on the pixels located at the interior of the threshold range for calculating the brightness gains S208
Blending first and the second gain function to produce a blended gain function S210
Performing the blended gain function on the pixels located at the exterior of the threshold range for calculating the brightness gains S212

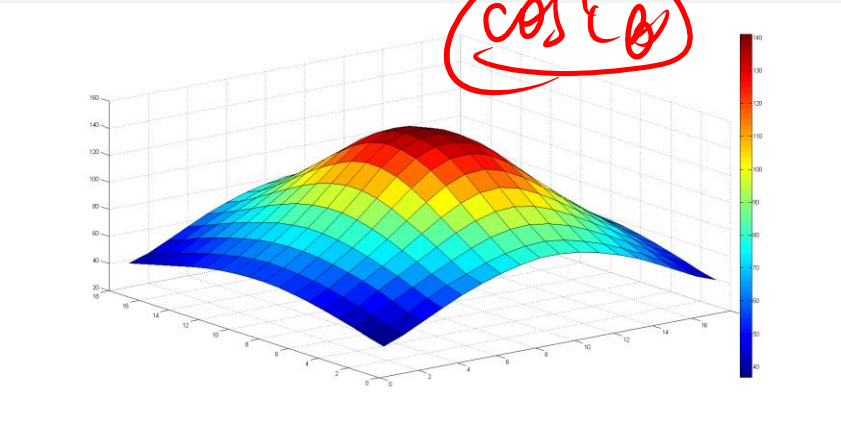


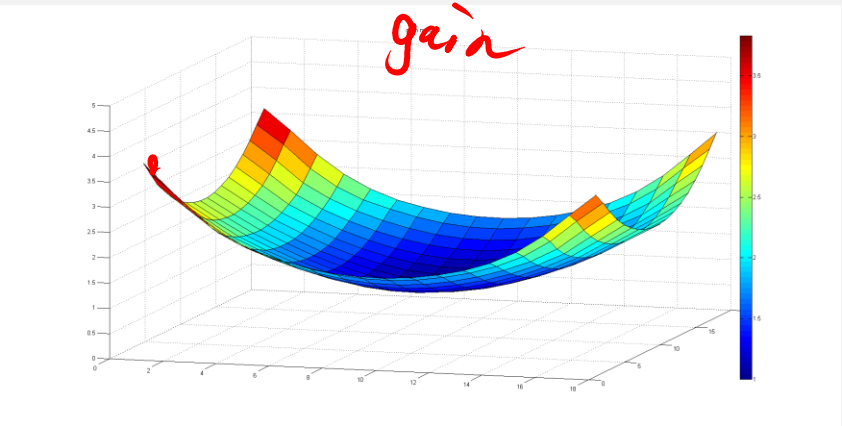


02 LSC的实现

LSC实现







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See You!