

大话成像之 数字成像系统 32讲

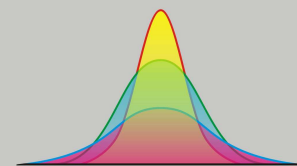
- CMOS sensor 基础

Maver Jiang

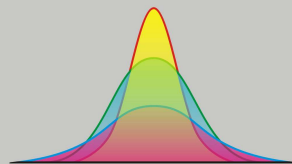
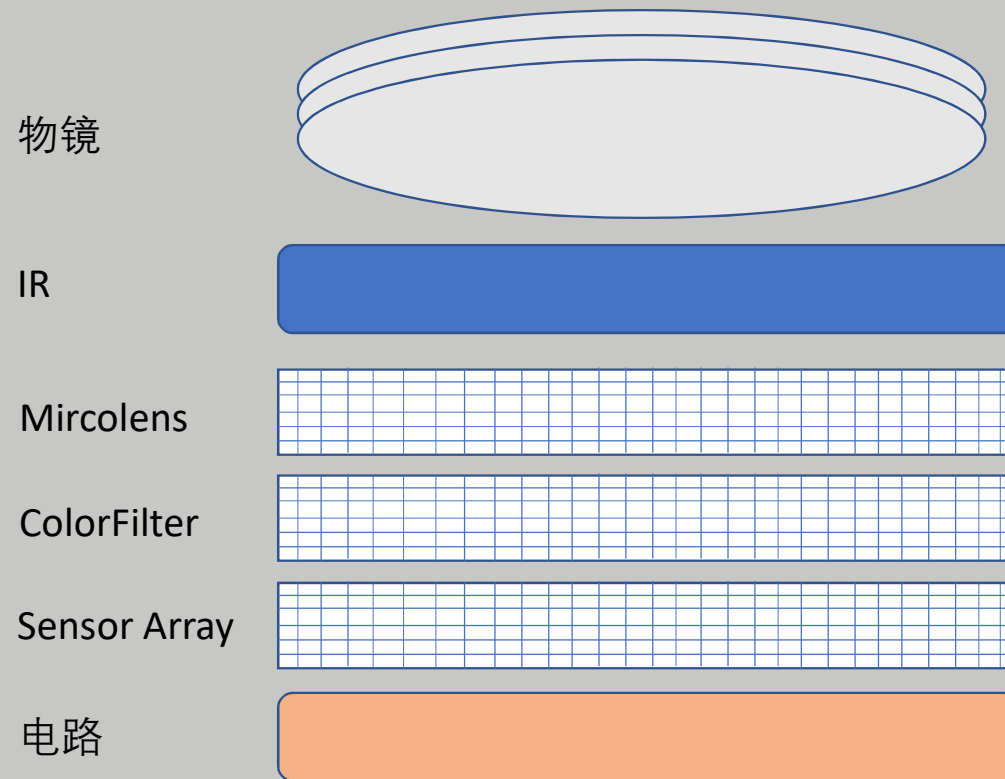
imaging algorithm specialist

staff image quality engineer

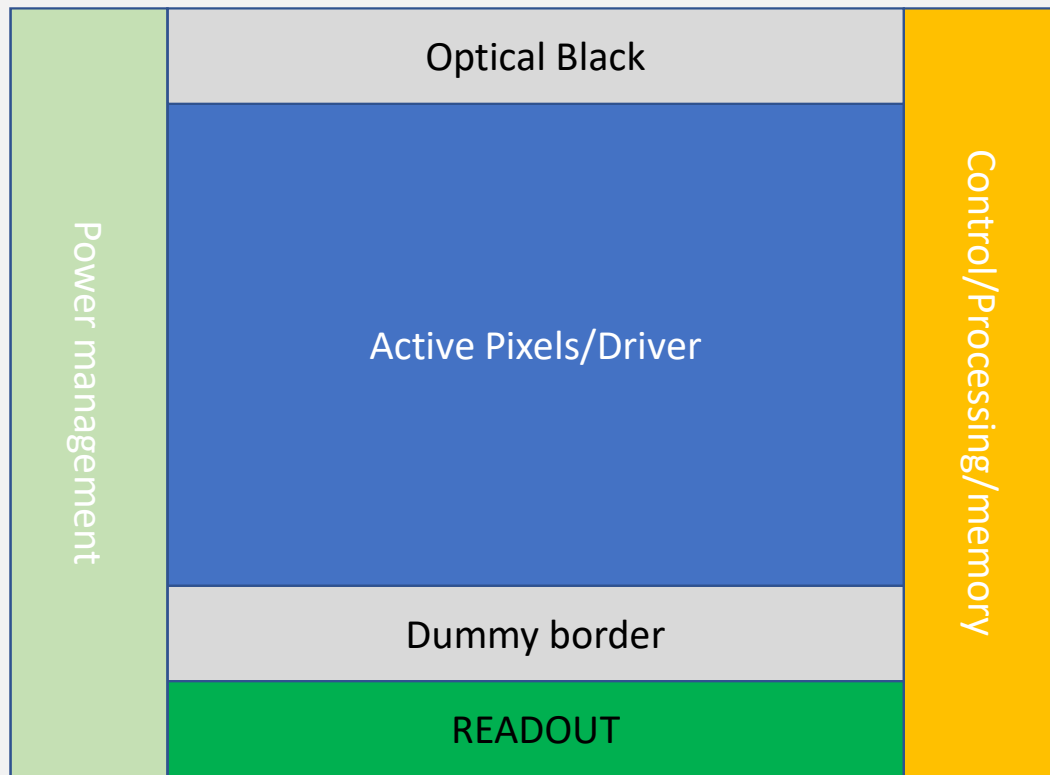
maver.jiang@gmail.com



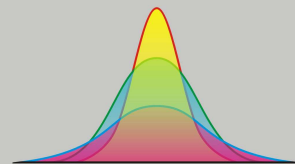
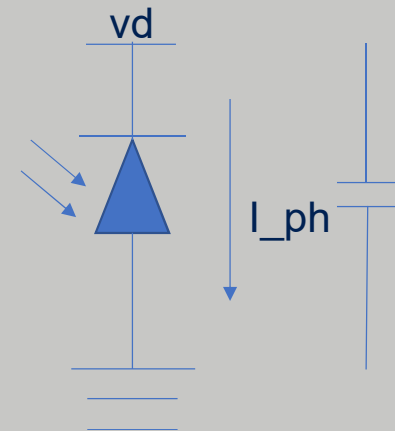
Cmos sensor stack



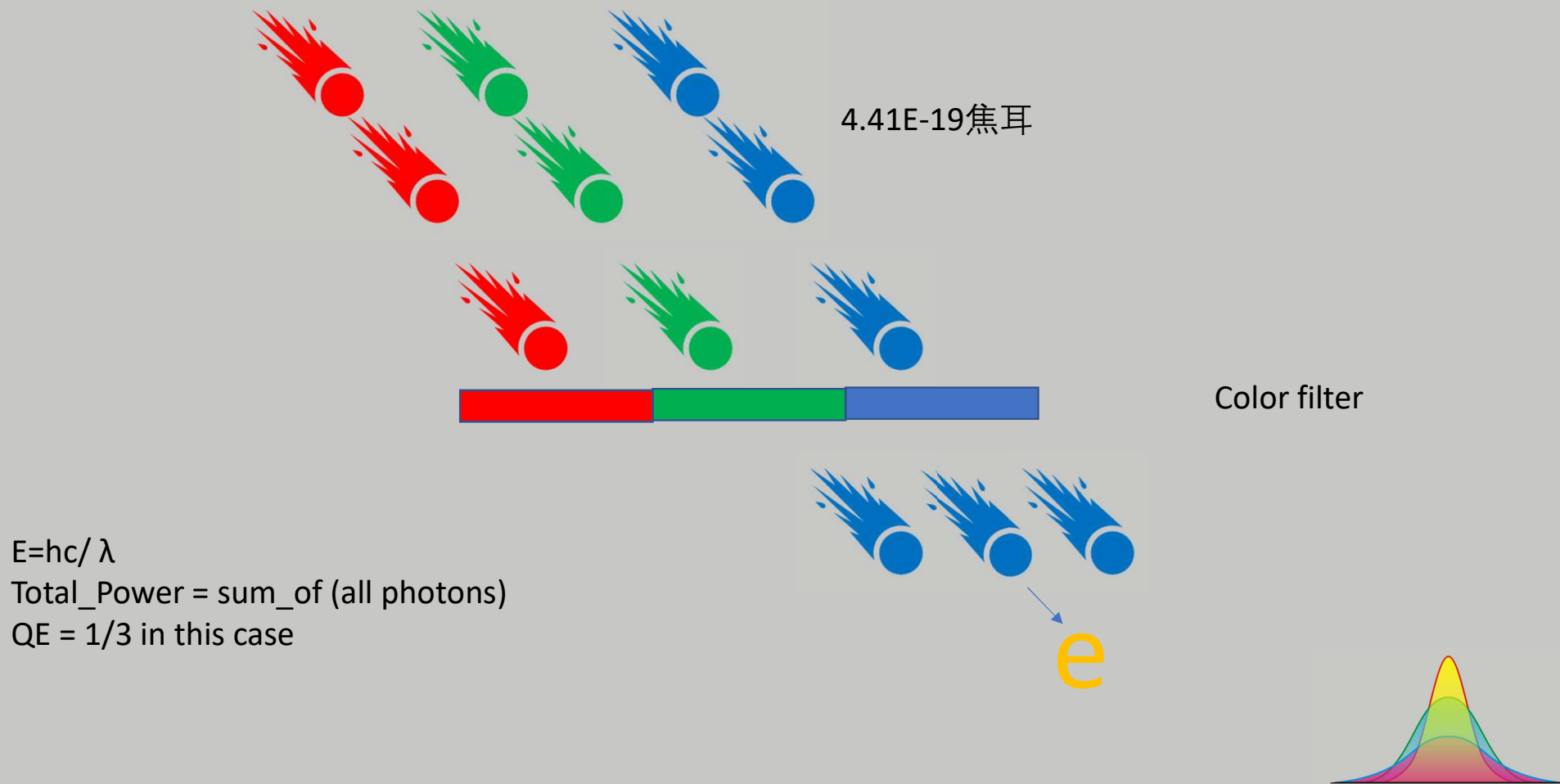
sensor floorplan



PCB

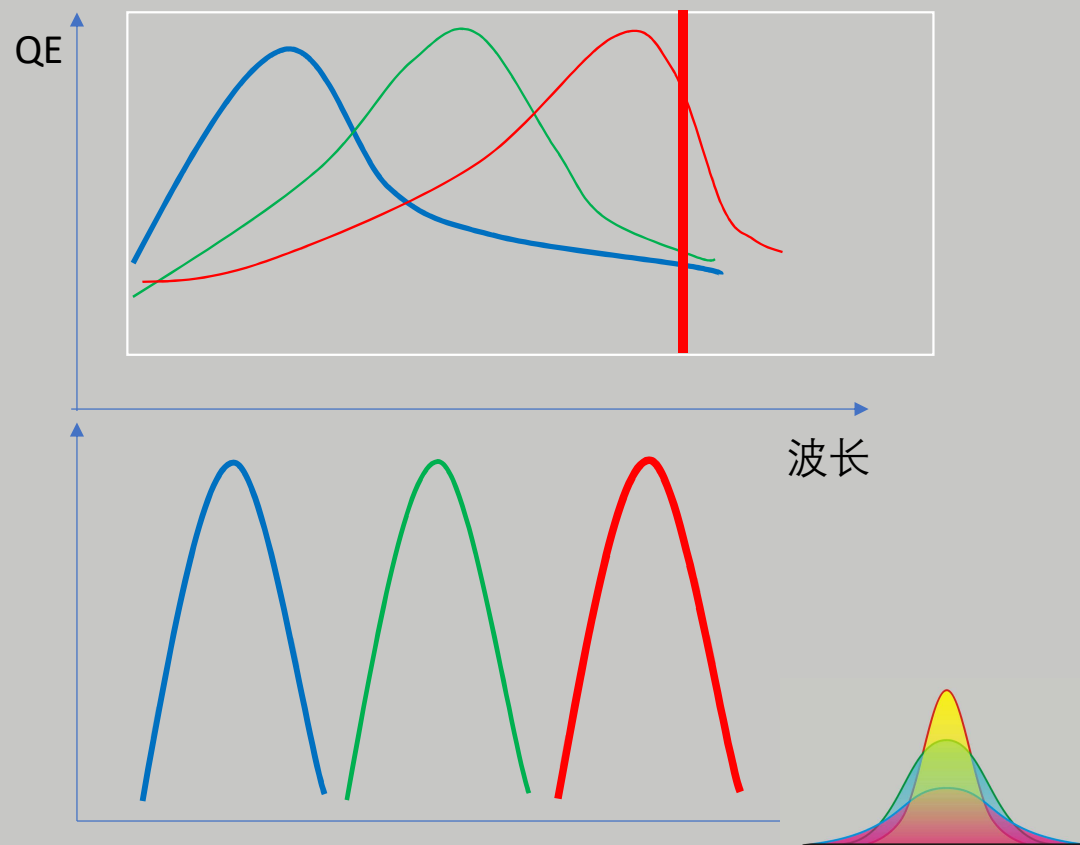
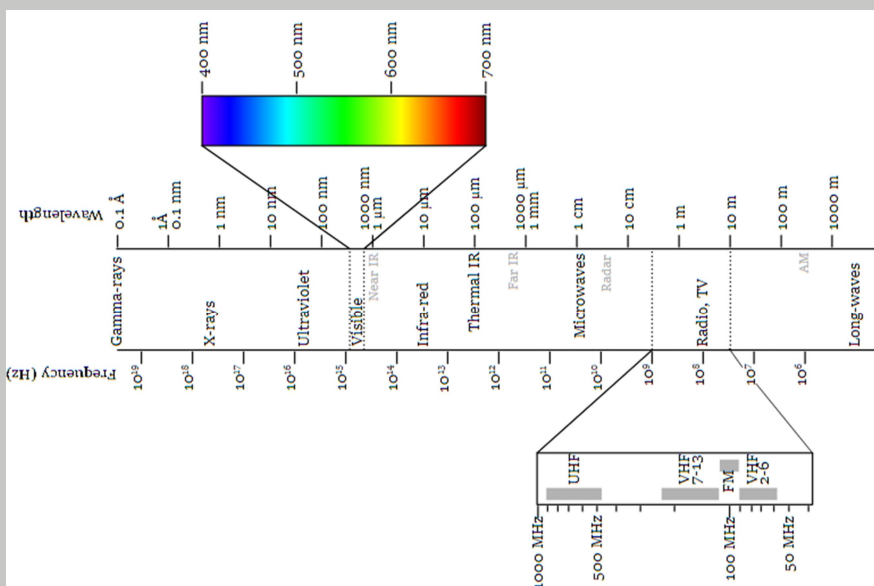


光子 (Photon) 与量子效率 quantum efficiency



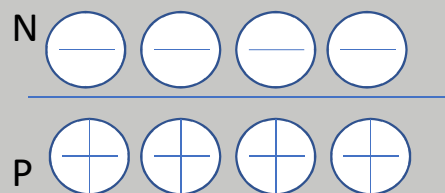
与量子效率QE有关的几个重要概念

- QE是衡量某个颜色通道某个频率/波长的光子转换成电子的效率
- IR cutter----cut near IR
- Crosstalk
- Sensitivity 感光度=QE X Pixel_Size

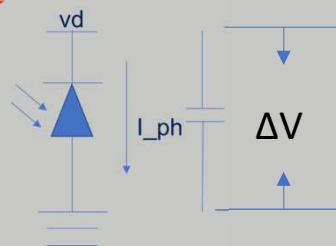
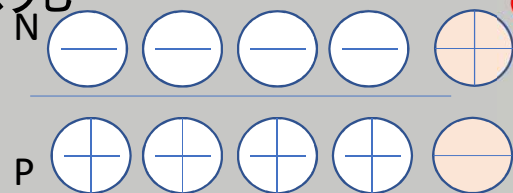


感光过程

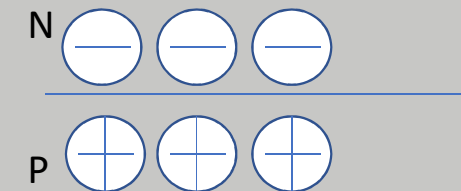
- 充电----reset



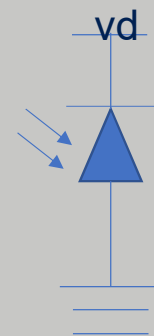
- 感光



- 放电



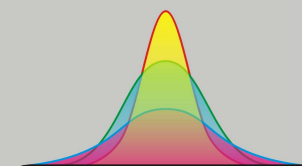
$$\begin{aligned}\Delta Q &= Ne \times e \times QE \\ Q &= V \times C \\ \Delta V &= \Delta Q / C\end{aligned}$$



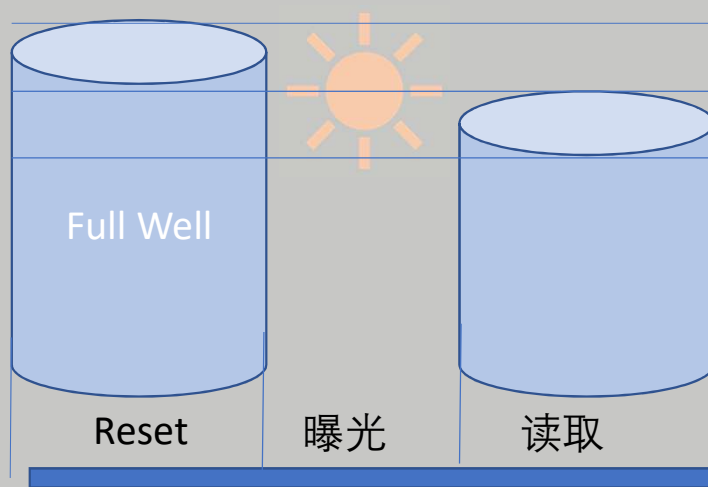
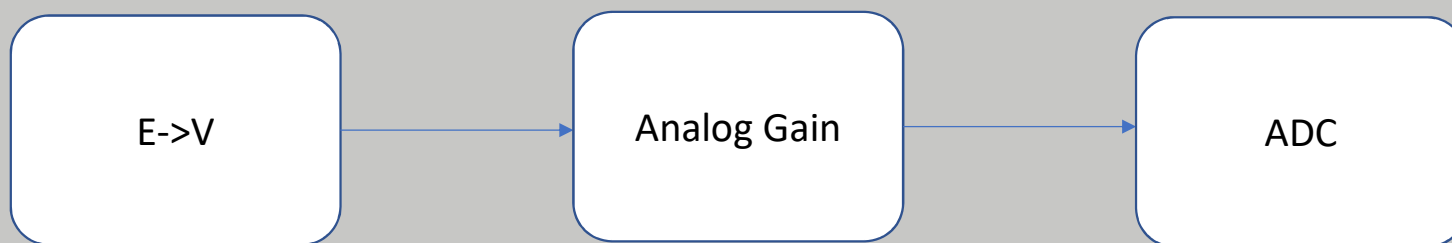
e



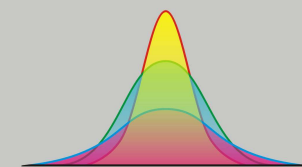
V



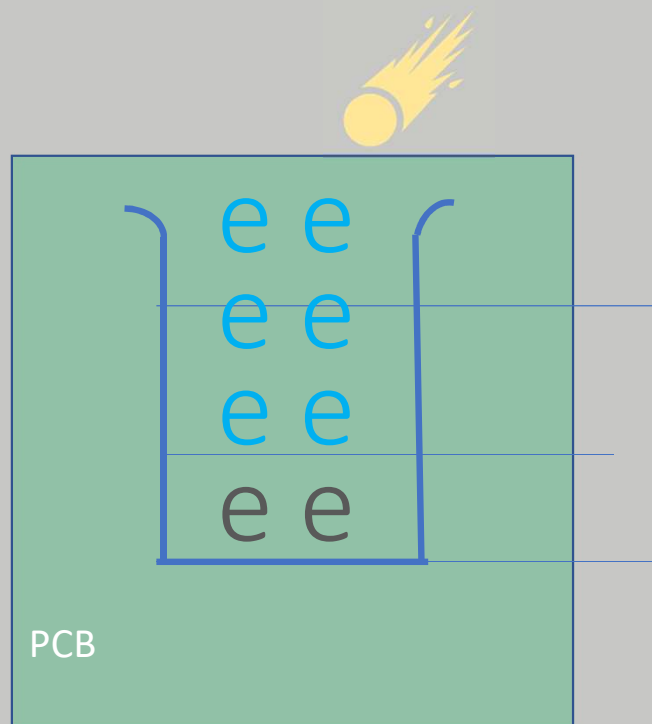
读取过程



$$\text{Total_time} = \text{reset_time} + \text{exposure_time} + \text{readout_time}$$

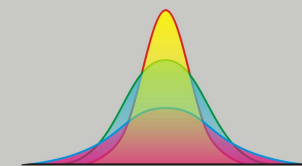


Sensor动态范围



- 1 : Full well Capacity
- 2 : Dark Current
- 3 : Fill Factor

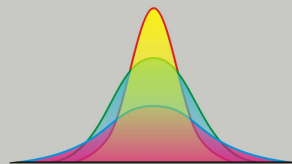
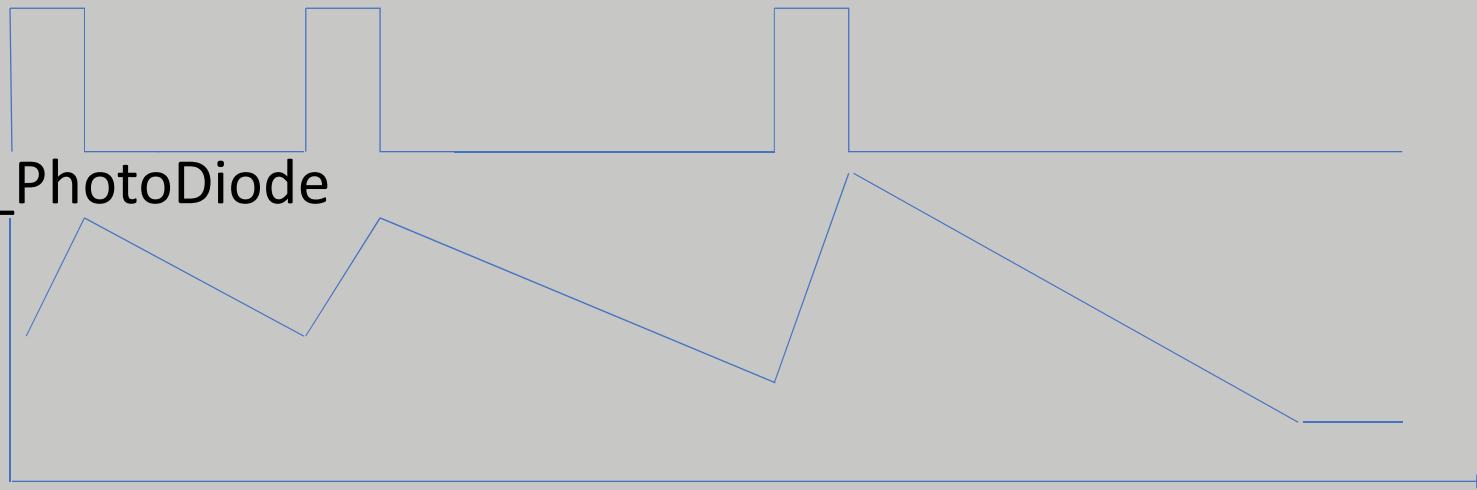
Dynamic Range = Saturation / Noise floor \longrightarrow 简化算法 Dynamic Range = Saturation/ black level



Sensor 时序

- Reset

- V_PhotoDiode



Noise in Sensor

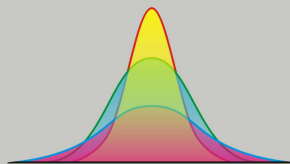
- 时域噪声与空域噪声

时域噪声----

KTC Noise(readout), PhotonShotNoise, DarkCurrentNoise, PowerNoise

- 空域噪声

空域噪声----DefectPixel, Row/ColumnNoise, PRNU, DSNU



Crosstalk 对 noise的影响

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$R' = a_{11} \times R + a_{12} \times G + a_{13} \times B$$

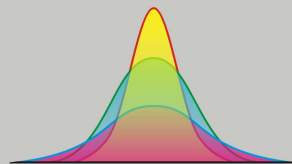
加模型的噪声计算：

$$\text{ADD } (N1, N2) = (N1^2 + N2^2)^{0.5}$$

$$N' = (a_{11} \times R)^2 + (a_{12} \times G)^2 + (a_{13} \times B)^2$$

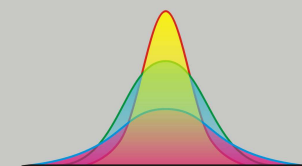
负的系数越大SNR越低

<http://www.ericfossum.com/Publications/Papers/2015%20JOSA%20Color%20Filters.pdf>



THANKS

本课程由 Maver Jiang提供



大话成像之 数字成像系统 32 讲

内容目录

1. 数字成像系统介绍
2. CMOS image sensor基础
3. 光学基础
4. 颜色科学基础
5. ISP 信号处理基础
6. 3A概述
7. 黑电平与线性化
8. Green Imbalance
9. 坏点消除
10. Vignetting与Color shading
11. SNR 与Raw Denoise
12. Dynamic Range与Tone Mapping
13. MTF与Demosaic
14. 色彩空间与色彩重建
15. Color Correction Matrix与3D LUT
16. Gamma与对比度增强
17. Sharpening
18. Color Space Conversion
19. 空域去噪
20. 时域去噪
21. Color Aberrance Correction and Depurple
22. ISP 的统计信息
23. 自动曝光
24. 自动白平衡
25. 自动对焦
26. 闪光灯
27. HDR
28. Exif 和DNG
29. Encoder
30. 图像防抖
31. 图像质量评价工具与方法
32. 画质调优

