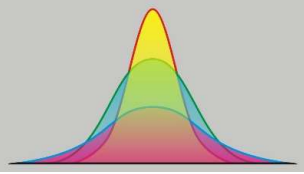
大话成像之

数字成像系统 32讲

MTF与Demosaic

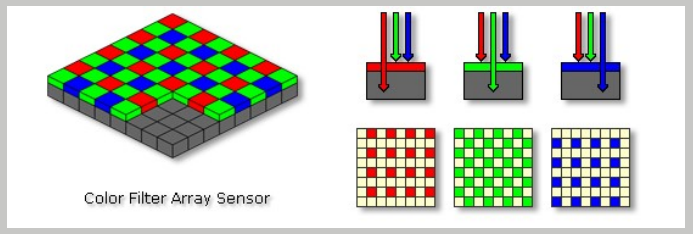
Ming Yan

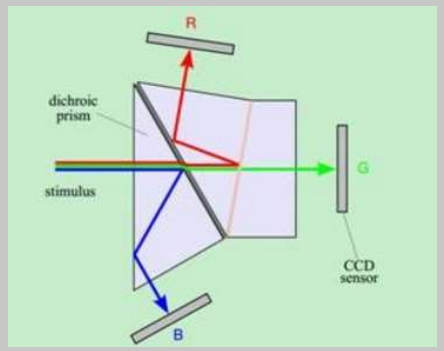
imaging algorithm engineer

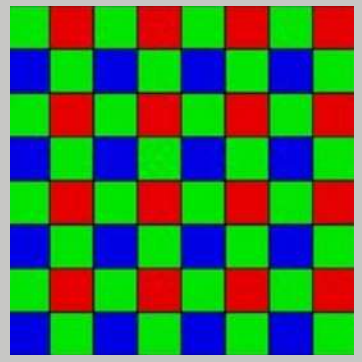


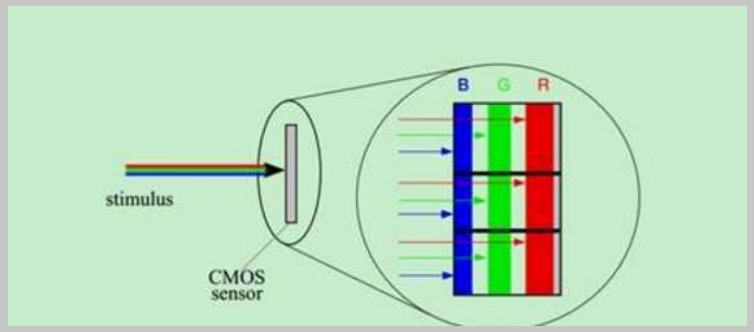
demosaic 的基础知识

Color filter array：色彩滤镜阵列



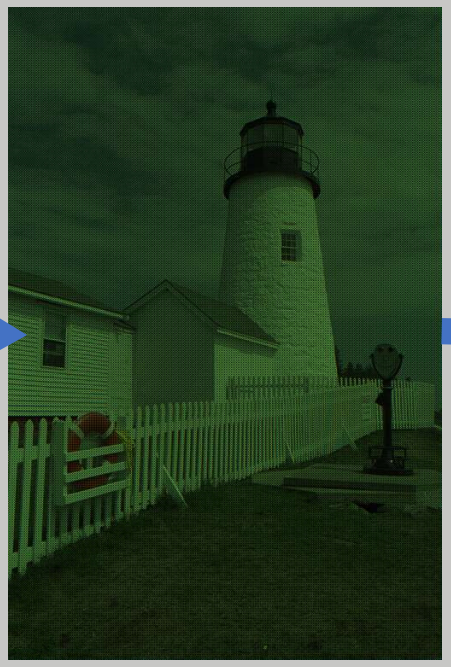


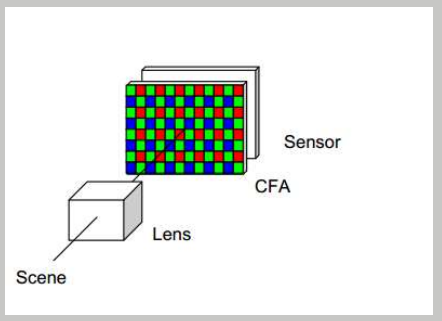




Bayer filter:The filter pattern is 50% green, 25% red and 25% blue, hence is also called BGGR, RGBG, GRGB, or RGGB.

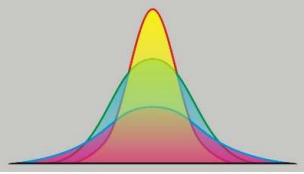
demosaic 的定义



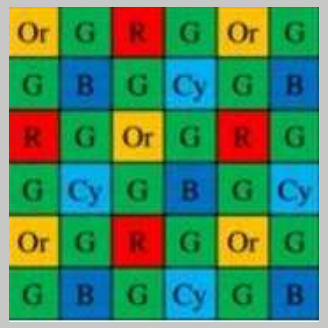


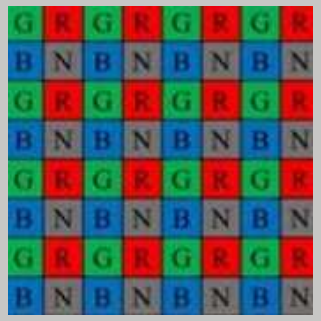
真实场景　　Bayer　　demosaic

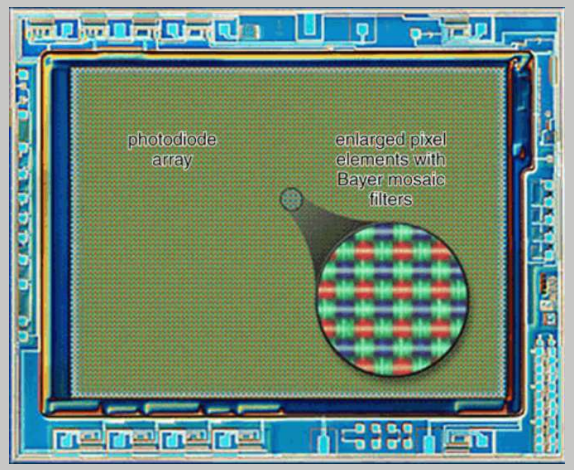
color filter array 其实就是一个对现实场景的信号采样，Demosaic 就是恢复出原始信号的办法



CFA 的种类





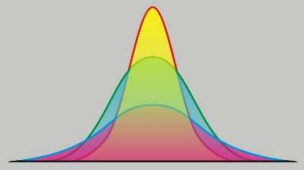


传统的除了bayer sensor以外，还有RGBNIR、RGBW 以及一些多光谱sensor。

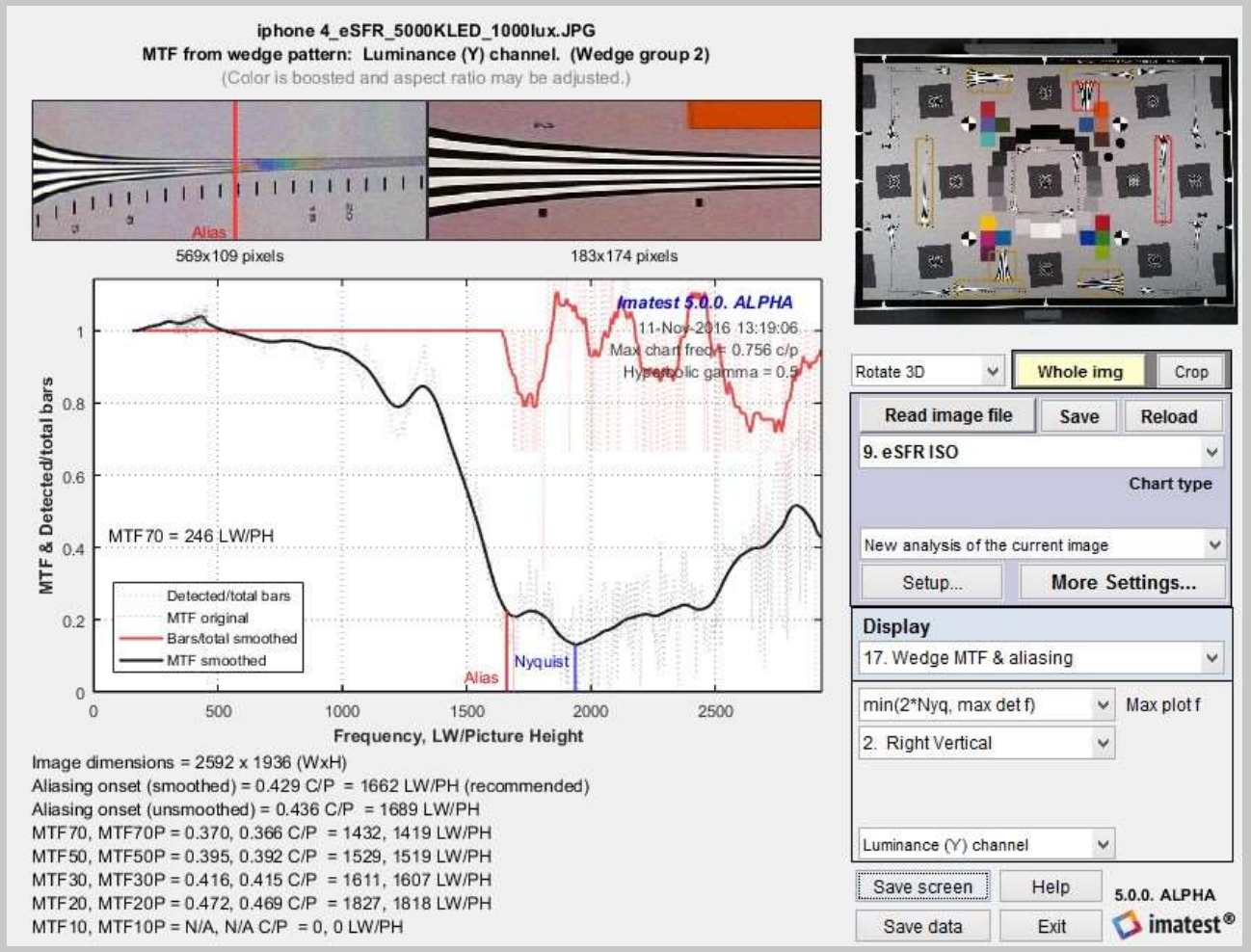
R1C1	R1C2	R1C3	R1C4
R2C1	R2C2	R2C3	R2C4
R3C1	R3C3	R3C3	R3C4
R4C1	R4C2	R4C3	R4C4

近些年刚兴起的RCCC sensor

http://www.analog.com/media/en/technical-documentation/application-notes/EE358.pdf

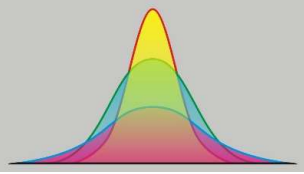


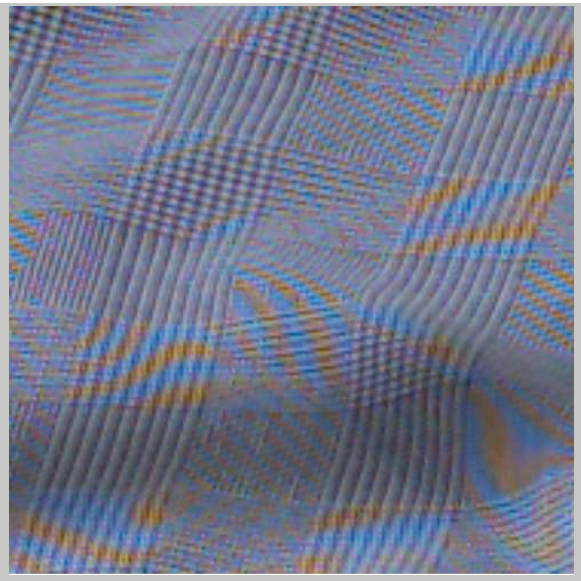
MTF 和demosaic 的关系

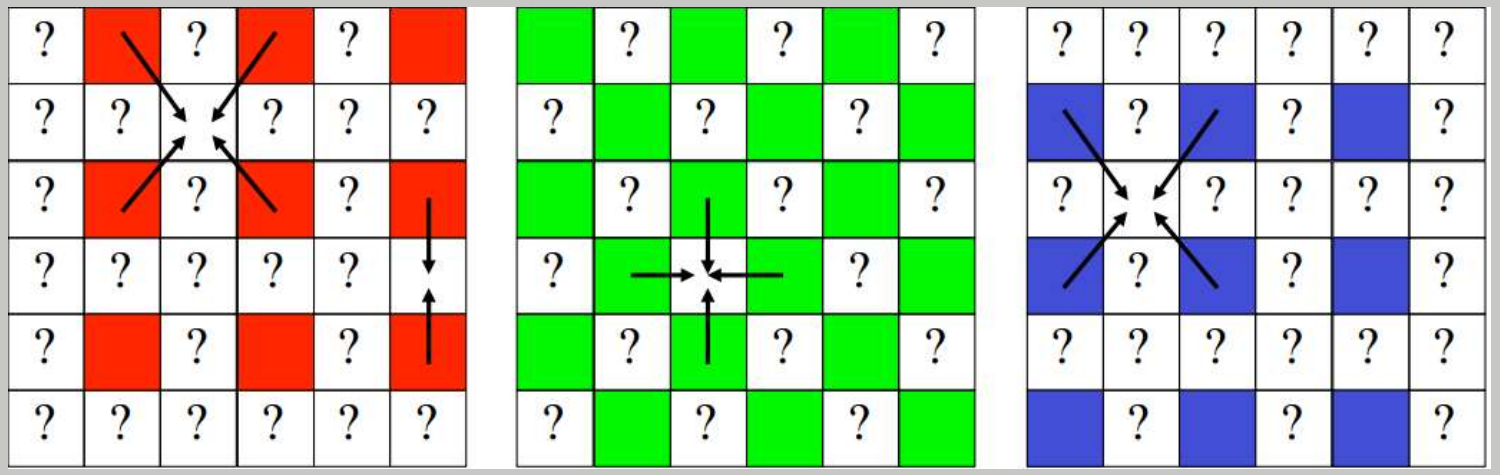


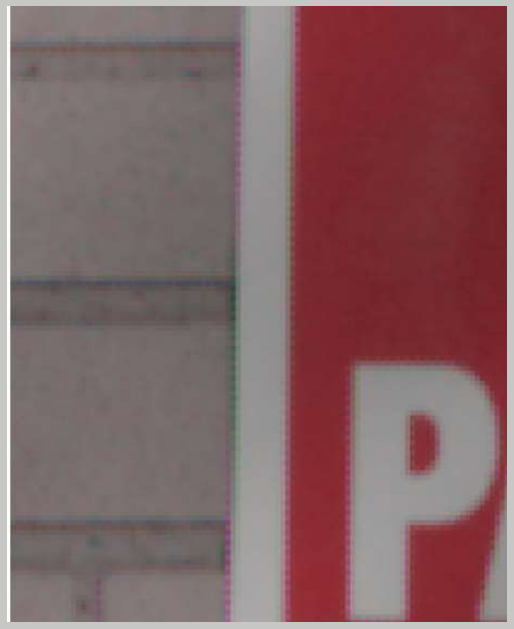
采样定理：在进行模拟/数字信号的转换过程中，当采样频率fs.max大于信号中最高频率fmax的2倍时(fs.max>=2fmax)，采样之后的数字信号完整地保留了原始信号中的信息，一般实际应用中保证采样频率为信号最高频率的5~10倍;采样定理又称奈奎斯特定理。

Aliasing:如果不能满足采样定理，采样后信号的频率就会重叠，即高于采样频率一半的频率成分将被重建成低于采样频率一半的信号。





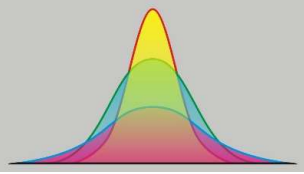


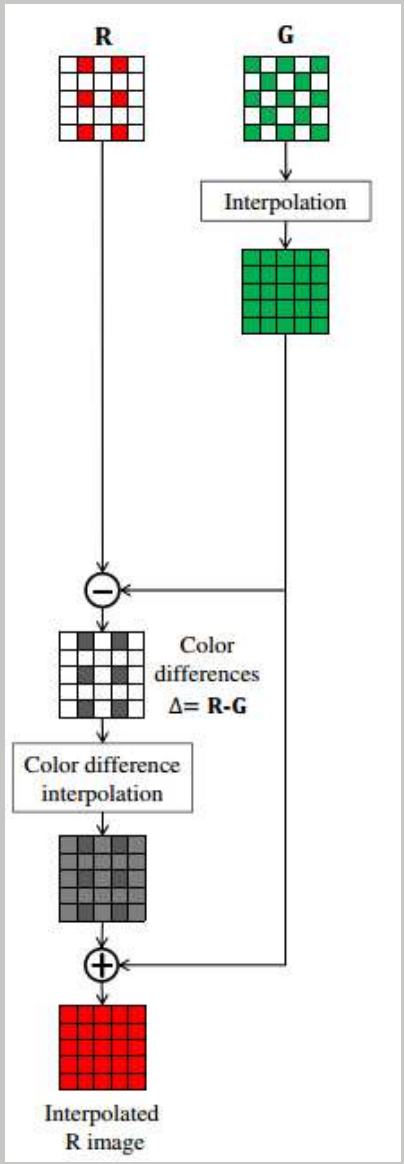


Demosaic的步骤 ：

三个步骤：

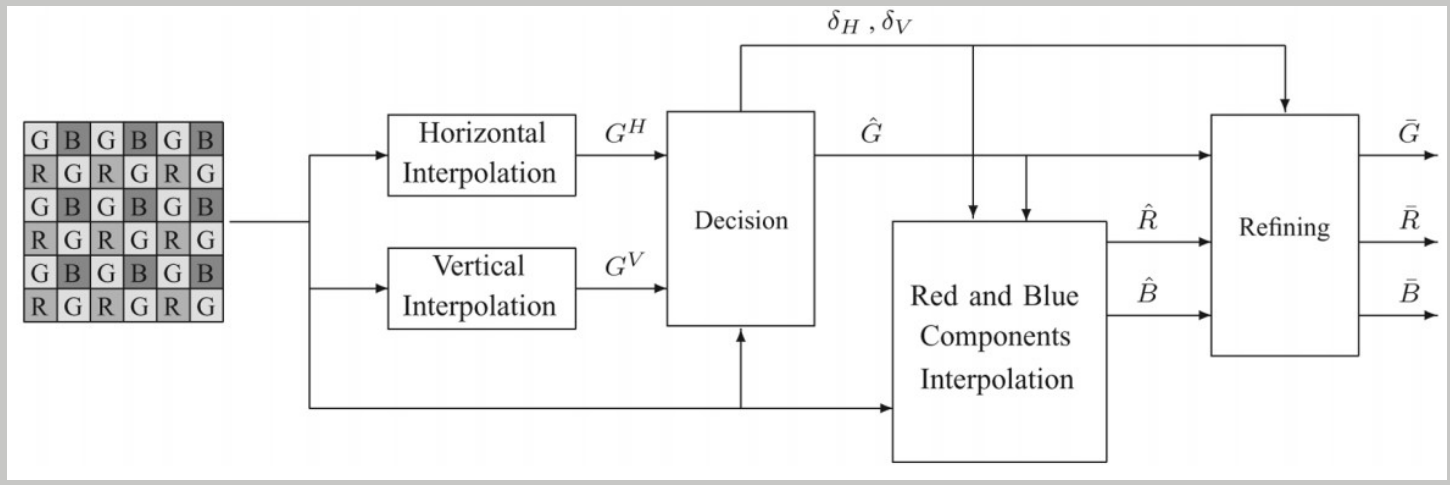
（1）判断插值的方向；
（2）在判定的方向上进行插值；
（3）后处理



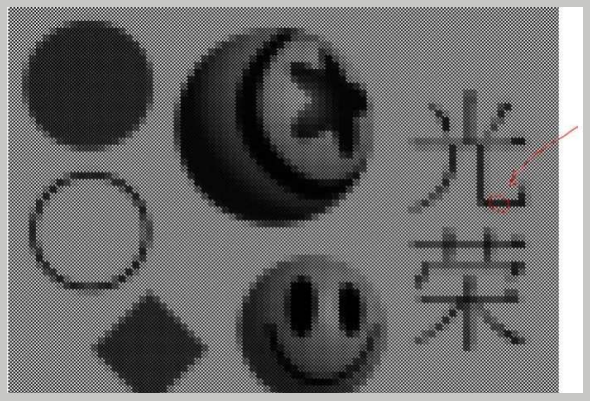


基础点：

1 . Green-based demosaicking
2. Edge-based demosaicking
3. 相关性原理



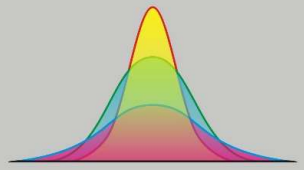
判断插值的方向 ：



R-2,-2 (248)	G-1,-2 (248)	R0,-2 248	G1,-2 248	R2,-2 248
G-2,-1 (248)	B-1,-1 (248)	G0,-1 (248)	B1,-1 (248)	G2,-1 (248)
R-2,0 (64)	G-1,0 (64)	R00 (64)	G1,0 (64)	R2,0 (64)
G-2,1 (64)	B-1,1 (64)	G0,1 (64)	B1,1 (64)	G2,1 (64)
R-2,2 (64)	G-1,2 (64)	R0,2 (64)	G1,2 (64)	R2,2 (64)

水平方向上的梯度为：GX=abs(G-1,0 - G1,0) = 64-64=0;
垂直方向上的梯度为：GY=abs(G0,-1 - G0,1) = 248-64=184;

结论：插值的方向为梯度最小的方向



插值的方法：（Hamilton and Adams 原理）

色差恒定法

Gr1	R1	Gr2	R2	Gr3	R3
B1	Gb1	B2	Gb2	B3	Gb3
Gr4	R4	Gr5	R5	Gr6	R6
B4	Gb4	B5	Gb5	B6	Gb6
Gr7	R7	Gr8	R8	Gr9	R9
B7	Gb7	B8	Gb8	B9	Gb9

$$R_{Gr5} = Gr5 + (R_{Gr5} - Gr5)$$

大话成像

$$\tilde{G}^H_{i,j} = (G_{i,j-1} + G_{i,j+1})/2 + (2 * R_{i,j} - R_{i,j-2} - R_{i,j+2})/4$$

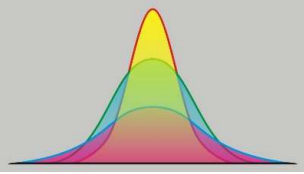
$$\tilde{G}^V_{i,j} = (G_{i-1,j} + G_{i+1,j})/2 + (2 * R_{i,j} - R_{i-2,j} - R_{i+2,j})/4.$$

$$\begin{aligned} R_{Gr5} &= Gr5 + (R_{Gr5} - Gr5) \\ &= Gr5 + \frac{1}{2}[(R4 - \frac{Gr4 + Gr5}{2}) + (R5 - \frac{Gr5 + Gr6}{2})] \\ &= \frac{R5 + R4}{2} + \frac{Gr5}{2} - \frac{Gr4}{4} - \frac{Gr6}{4} \end{aligned}$$

$$\tilde{R}^V_{i,j} = (R_{i-1,j} + R_{i+1,j})/2 + (2 * G_{i,j} - G_{i-2,j} - G_{i+2,j})/4.$$

$$\tilde{R}^H_{i,j} = (R_{i,j-1} + R_{i,j+1})/2 + (2 * G_{i,j} - G_{i,j-2} - G_{i,j+2})/4.$$

小话Demosaic（一）



demosaic 的难点：

1 摩尔纹

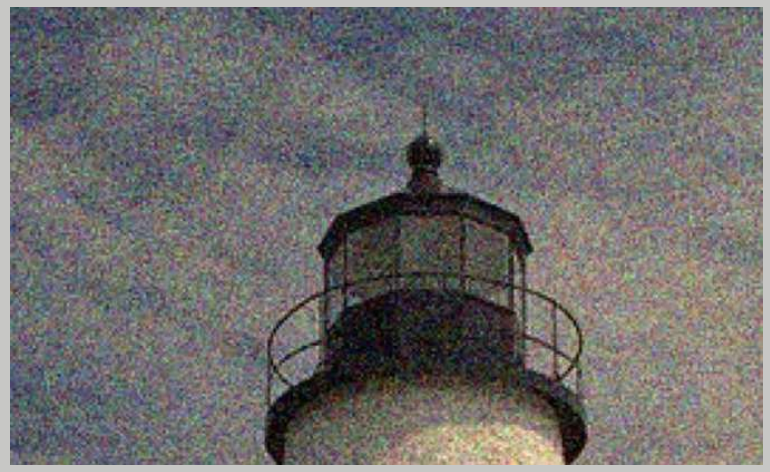
2 noise

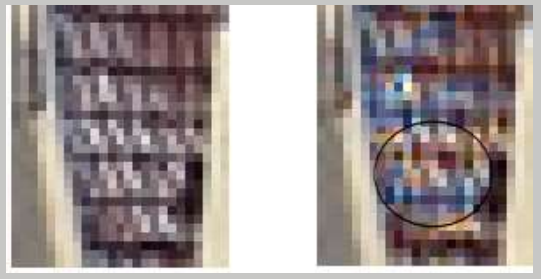
a 放大噪声

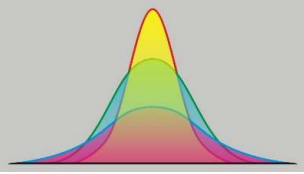
b 会影响判断

3 模糊

4 false color

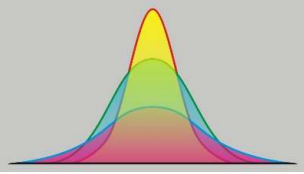






THANKS

本课程由 Ming Yan提供



大话成像之
数字成像系统 32 讲

内容目录