

大话成像之 数字成像系统 32讲

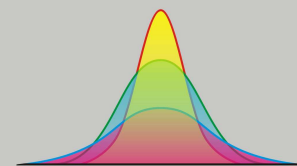
ISP信号处理基础

Maver Jiang

imaging algorithm specialist

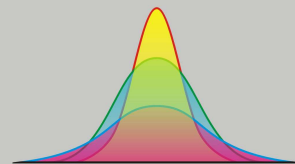
staff image quality engineer

maver.jiang@gmail.com

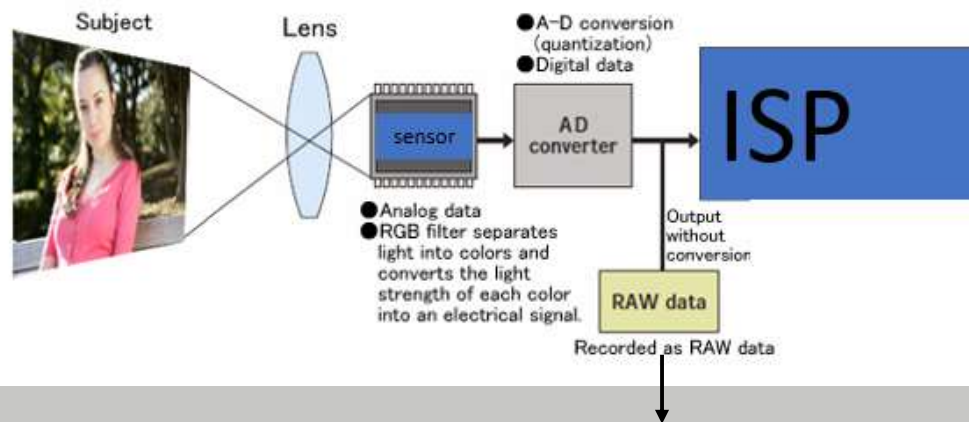


数字图像处理的基本概念与操作

1. 图像的数字化与定点数，浮点数
2. 直方图 (histogram) / 积分直方图 (cumulative histogram) / 图像的直方图均衡
3. 查找表 (lookup table)
4. 图像滤波 (高通, 低通滤波)



图像的数字化+数字信号处理 (ISP)



色彩重建

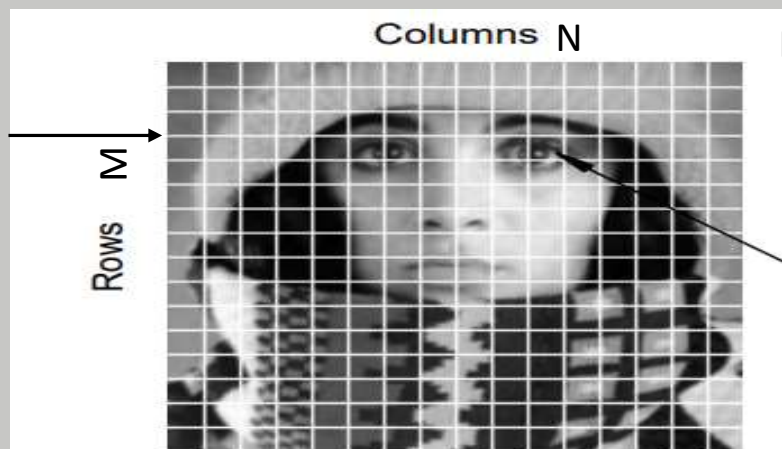
图像重建

https://en.wikipedia.org/wiki/Floating-point_arithmetic

https://en.wikipedia.org/wiki/Fixed-point_arithmetic

M行 N 列 2D离散数字信号

原始2D连续信号
 $a(x,y)$



$$P(i,j) = L;$$

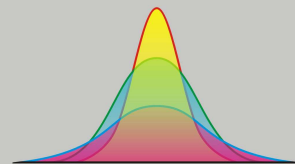
$L = 0 \sim 1$; float

$L = 0 \sim 255$; 8 bit fix point

$L = 0 \sim 1023$; 10 bit fix point

$L = 0 \sim 4095$; 12 bit fix point

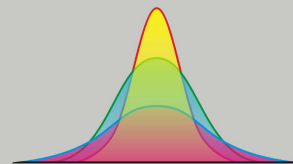
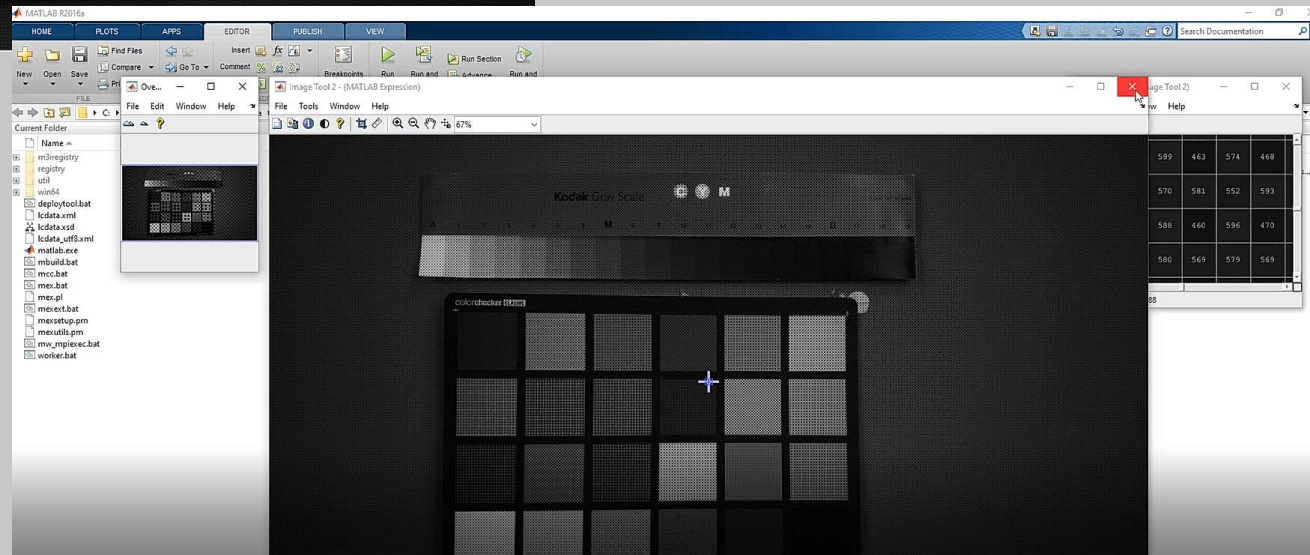
$$P(i,j) = F(L,D,T,C,...);$$



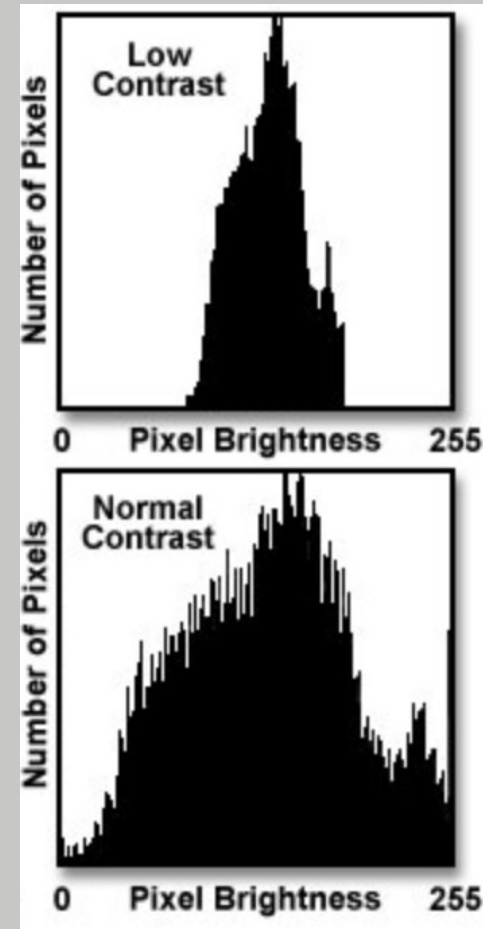
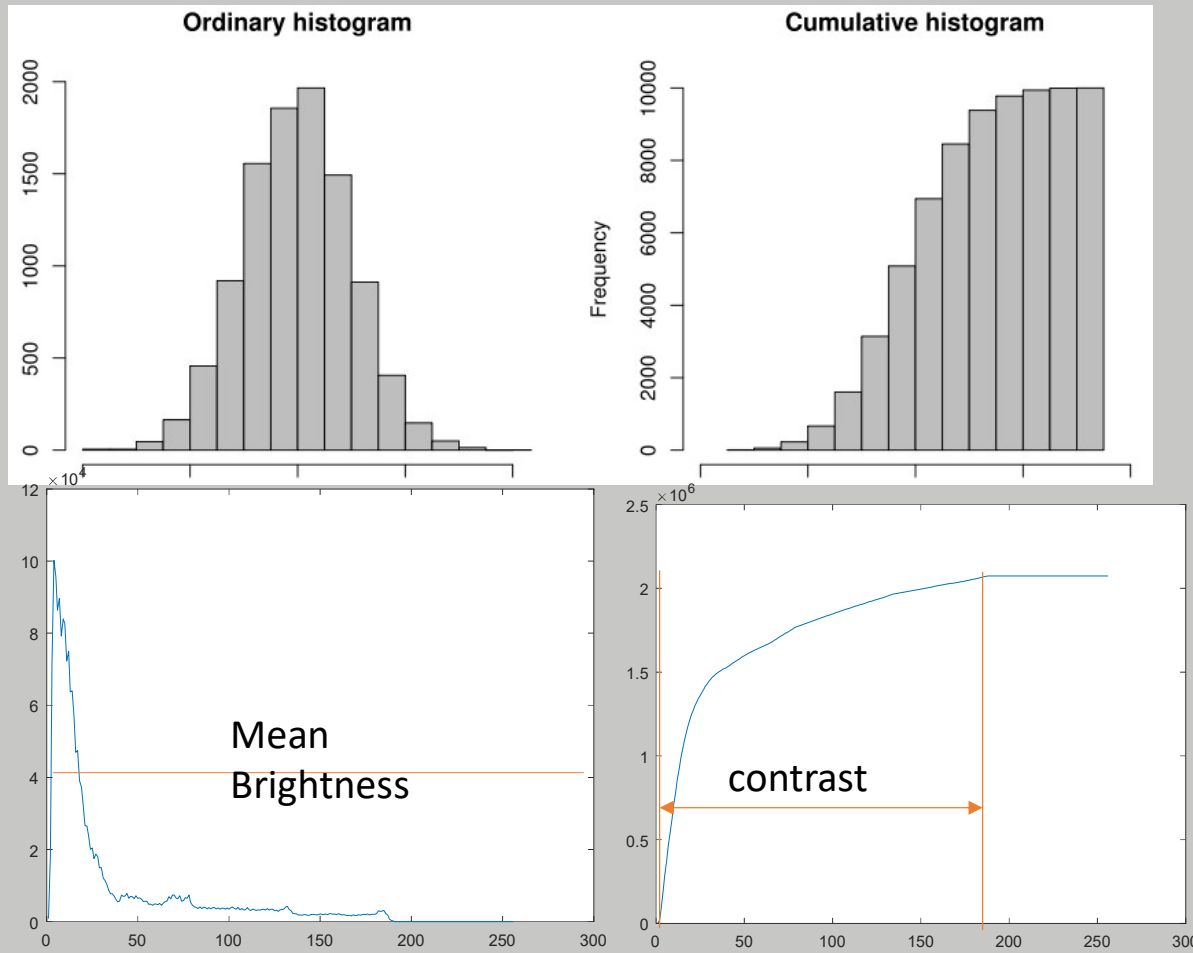
数字图像处理的基本操作:图像读取



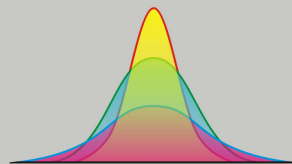
```
filename = 'C:\raw_plain16_test.raw';  
f=fopen(filename);  
frame = fread(f,[1920 1080],'uint16=>uint16');  
imtool(frame,[]);
```



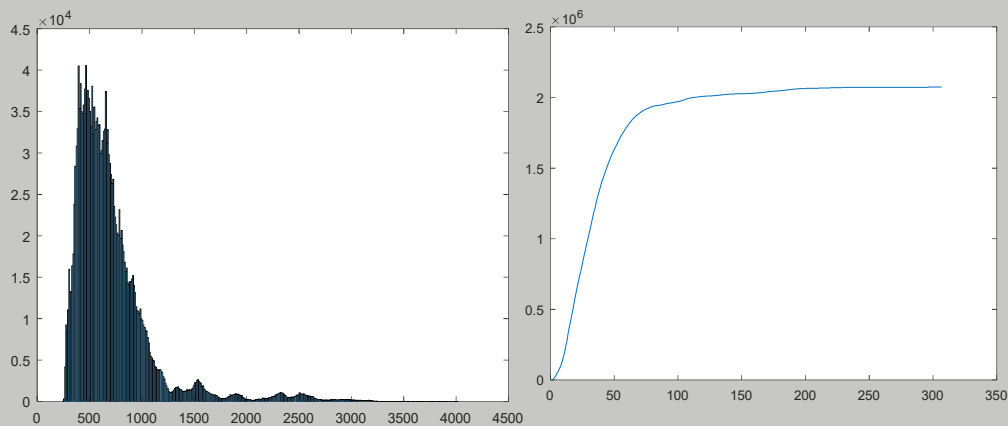
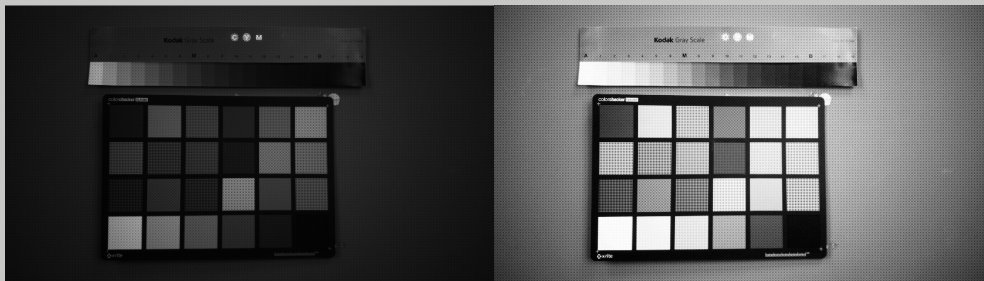
直方图 histogram 与 积分直方图 Cumulative histogram



https://en.wikipedia.org/wiki/Image_histogram



数字图像处理的基本操作:直方图



显示直方图

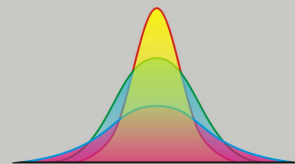
```
filename = 'C:\raw_plain16_test.raw';  
f=fopen(filename);  
frame = fread(f,[1920 1080],'ubit16=>uint16');  
imtool(frame',[]);  
figure(11),histogram(frame);
```

显示积分直方图

```
image = double(image);  
image = image./4096;  
h = histogram(frame);  
cum = cumsum(h.Values);  
figure(22),plot(cum);
```

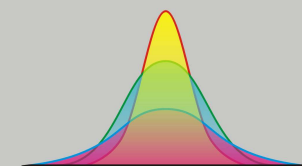
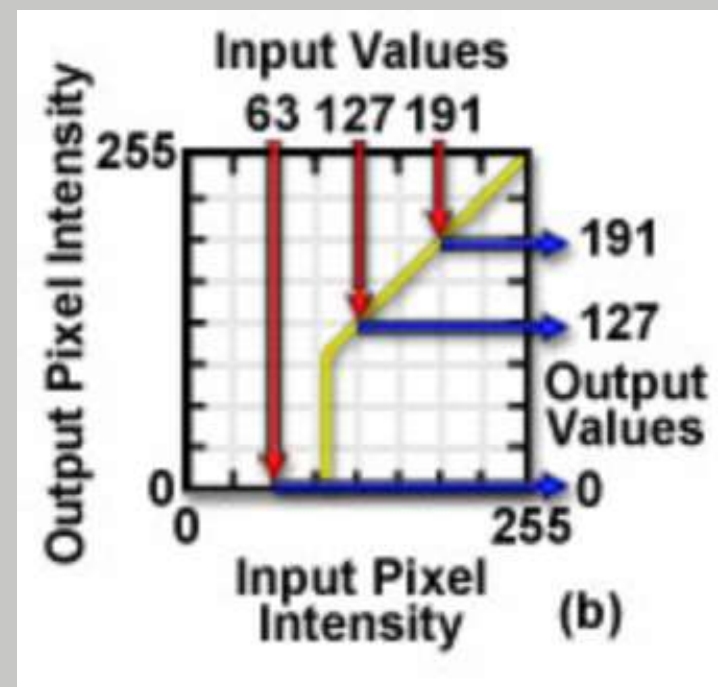
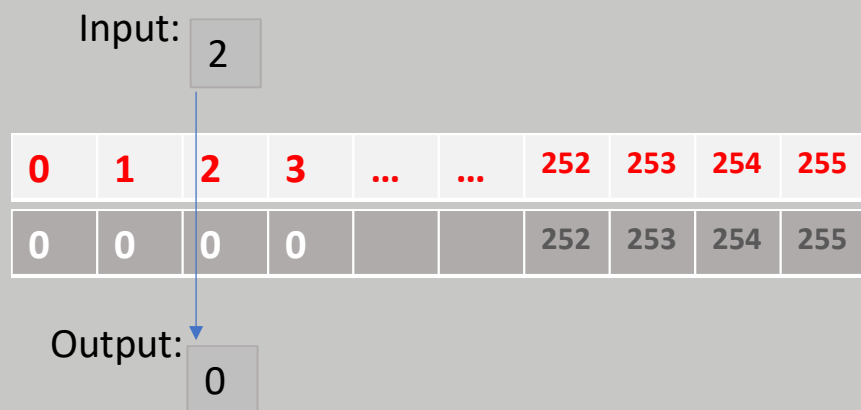
直方图均衡

```
jj = histeq(image);  
imtool(jj',[]);
```



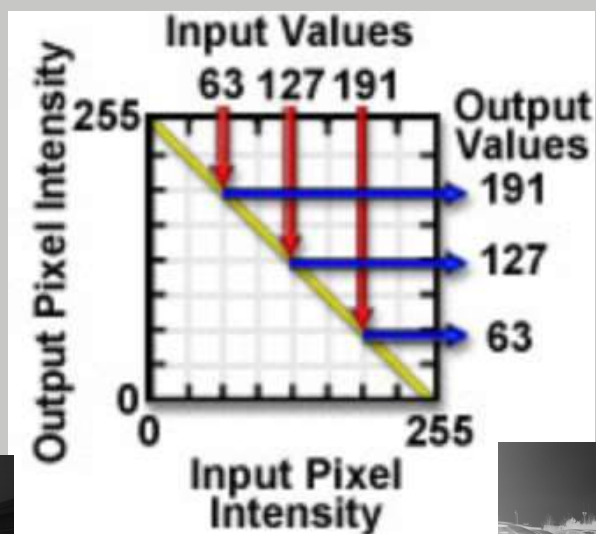
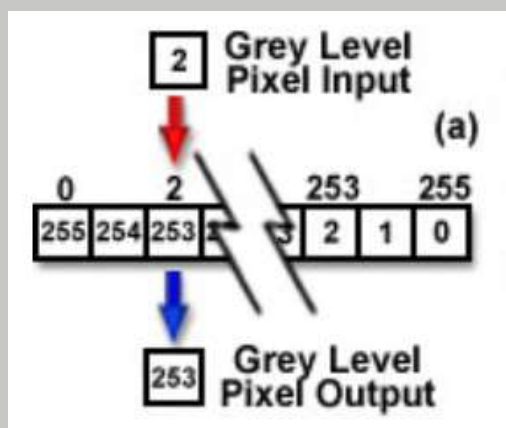
查找表 lookup table

应用1：thresholding



查找表 lookup table

查找表练习：取反



```
clear all
```

```
clc
```

```
I=rgb2gray(imread('sample.jpg'));  
I=imresize(I,0.1);
```

```
i=255:-1:0;
```

```
lut=i;
```

```
out=zeros(size(I));
```

```
for i=1:size(I,1)  
    for j=1:size(I,2)
```

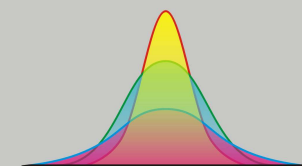
```
        out(i,j)=lut(I(i,j)+1);
```

```
    end
```

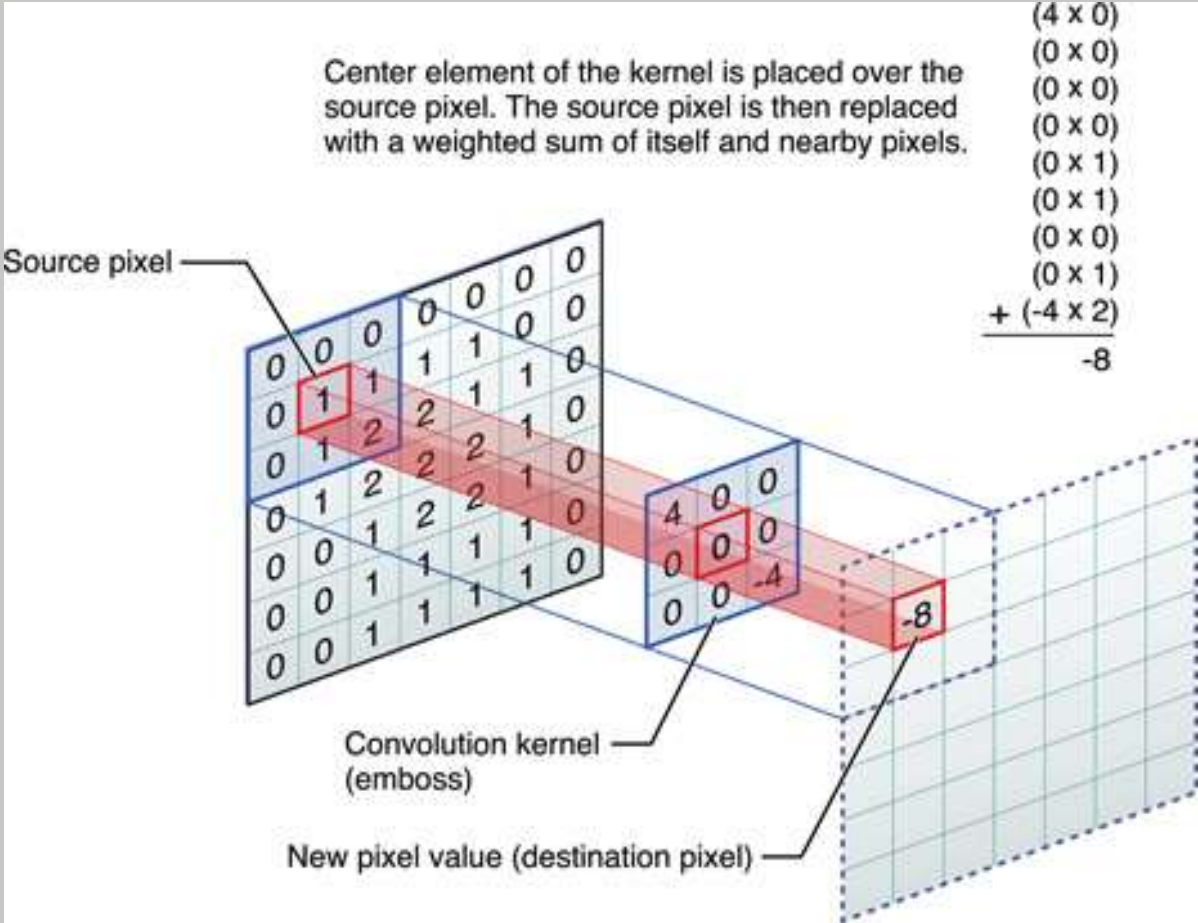
```
end
```

```
imtool(uint8(I));
```

```
imtool(uint8(out));
```

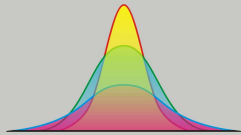


Filter convolution：滤波 卷积



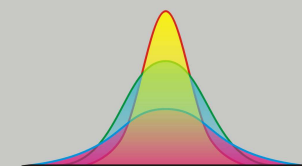
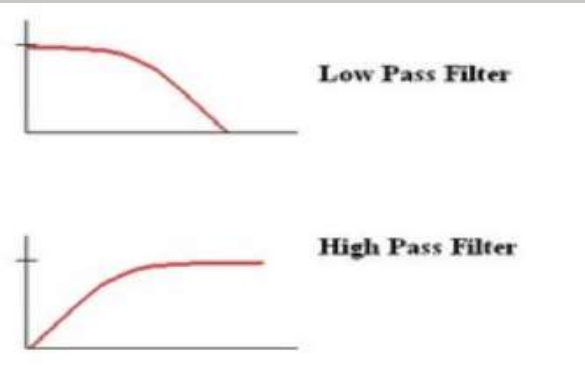
Operation	Kernel	Image result
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	

[https://en.wikipedia.org/wiki/Kernel_\(image_processing\)](https://en.wikipedia.org/wiki/Kernel_(image_processing))



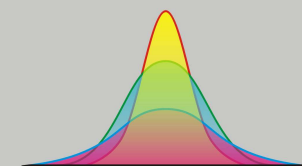
Filter 练习：低通，高通滤波器

```
h = ones(3,3)./9;  
%h=[-1 -1 -1;-1 9 -1;-1 -1 -1];  
ff = imfilter(image,h);  
imtool(ff);
```



THANKS

本课程由 Maver Jiang提供



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内容目录

1. 数字成像系统介绍
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32. 画质调优

