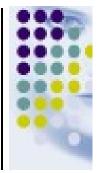
Image Transformation

Short quiz

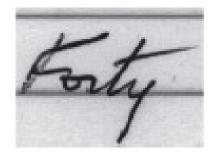
- This is MRI image of brain
- Target is tumor detection (It can be seen at the center)
- Problem: Data size reduction is necessary before process
- Question: Reduce resolution or bit depth or any other suggestion?
- Notice: There is not only one correct answer (as well as there is not only one wrong answer!)



Image enhancement



 Improve the image properties for specific application

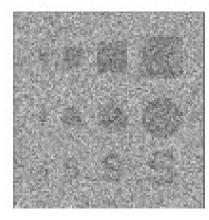


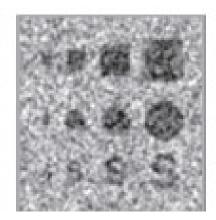






- Two main categories:
 - Spatial
 - Point operation
 - Local operations
 - Frequency

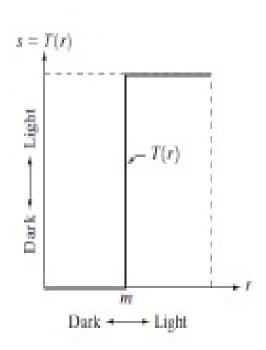


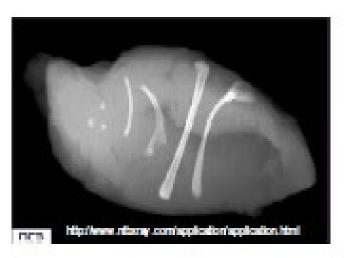


Thresholding



Example in food inspection

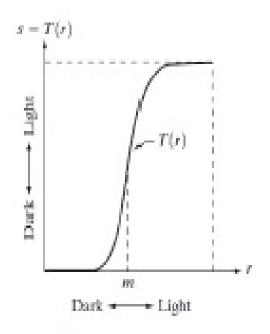






Contrast stretching



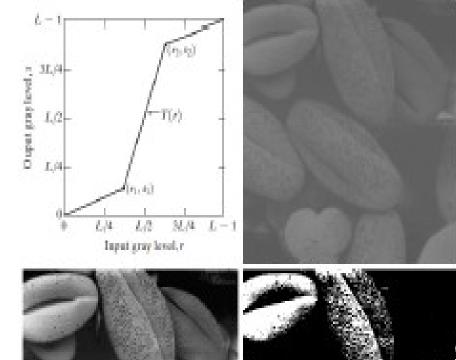






Contrast stretching





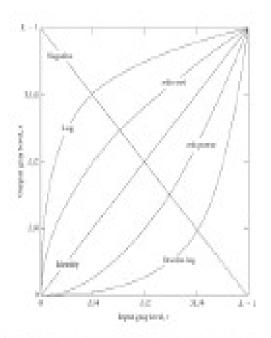
a b c d **FIGURE 3.10** Contrast. stretching. (a) Form of transformation function.(b) A. low-contrast. image, (c): Result of contrast stratching. (d) Result of thresholding. (Original image countery of Dr. Roger Heady, Research School of Biological Sciences. Australian National University, Canbena, Australia.)

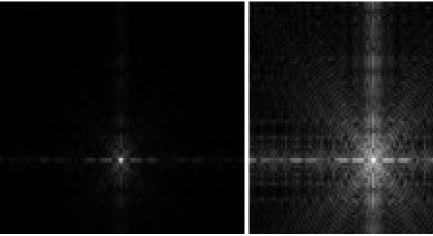
Log transform

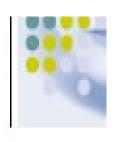
 Expand the dark dynamic range

$$s = c \log(1 + r)$$

 Inverse log will do the opposite way





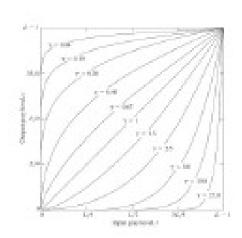


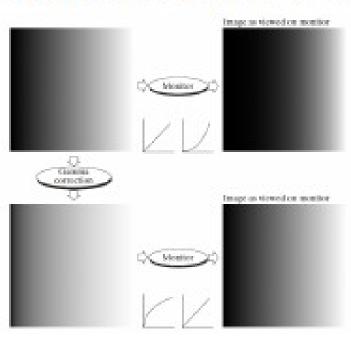
Power-law transform



- Is similar to Log transform
- Referred as Gamma transform too because of its notation
- Many of imaging devices have power-law response and

need Gamma correction

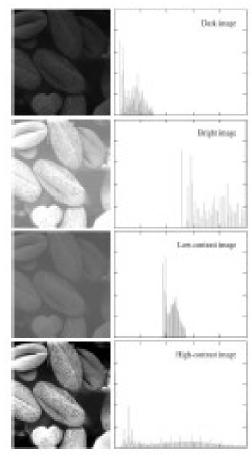




Histogram

 h(L) = number of pixels with gray level L



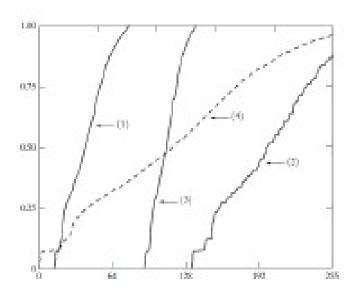


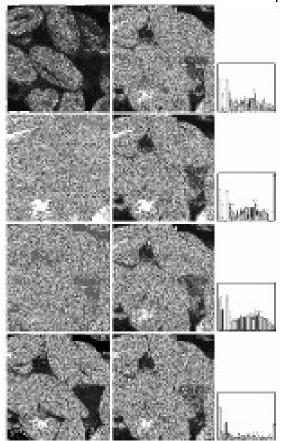
Histogram equalization



$$s_k = T(r_k) = \sum_{j=0}^k p_r(r_j)$$

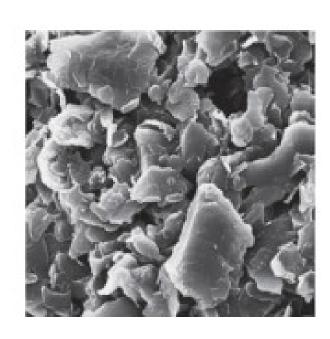
= $\sum_{j=0}^k \frac{n_j}{n}$ $k = 0, 1, 2, ..., L - 1$.











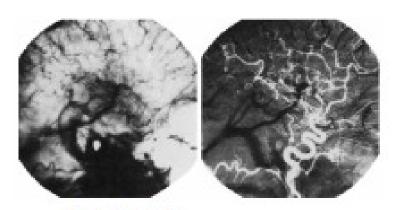




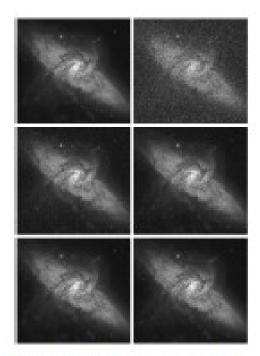
Arithmetic calculation



Add, Subtraction, Average, AND, OR, ...



Subtraction: Mask mode radiography



Averaging: Noise removal in astronomy

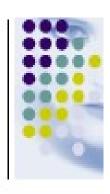


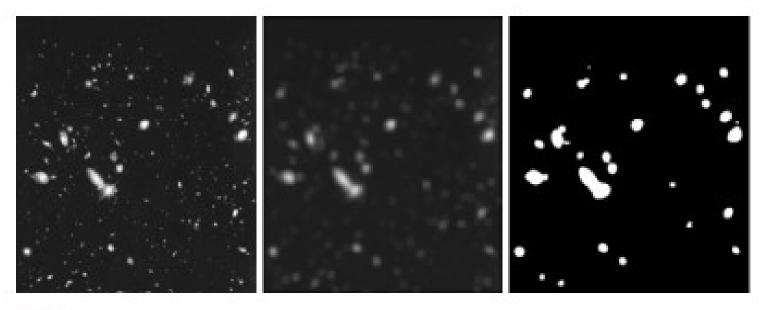


- Average / low pass filters
- Usually noise is unwanted sharp transitions in gray level
- By local averaging we reduce sharp transitions (irrelevant details)
- The side effect would be loosing desired sharp transitions like edges
- Example of smoothing filters: Box filter, and Weighted average filter

$\frac{1}{9}$ ×	1	1	1
	1	1	1
	1	1	1

Average filter example





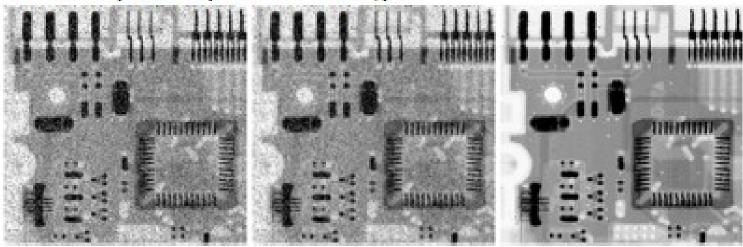
abc

FIGURE 3.36 (a) Image from the Hubble Space Telescope. (b) Image processed by a 15 × 15 averaging mask. (c) Result of thresholding (b). (Original image courtesy of NASA.)

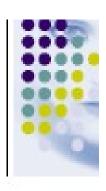
Order-statistic filters



- Median, min, max, and similar filters
- Select the result value based on one statistical property of the gray level distribution of pixels under the mask
- Good for removing some know type of noises like impulse or saltand-pepper
- Example of reducing salt-and-pepper noise by Mean and Median filters respectively from left to right



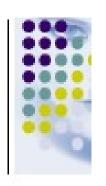
Sharpening spatial filters

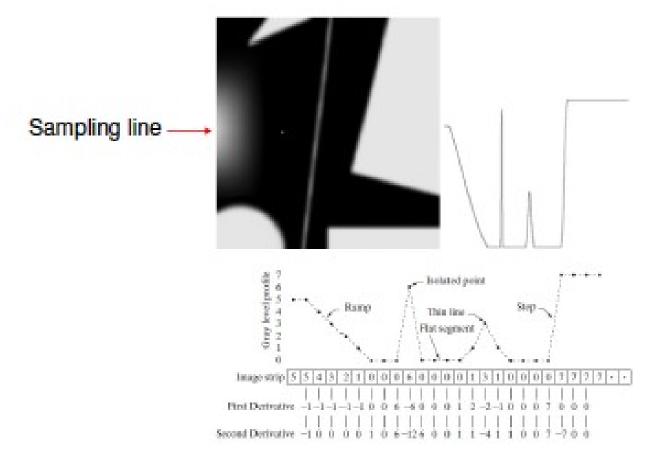


- Edge / High-pass filters
- Enhance the details of the image
- Improve sharp transitions
- The side effect can be increasing undesired details like noise
- The basic idea is that sharp transitions cause good response in the first or second derivative

$$\frac{\partial f}{\partial x} = f(x+1) - f(x). \qquad \qquad \frac{\partial^2 f}{\partial x^2} = f(x+1) + f(x-1) - 2f(x).$$

Effect of image derivative







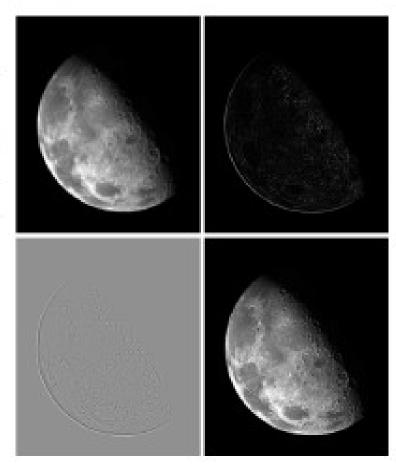


0	1	0	1	1	1
1	-4	1	1	-8	1
0	1	0	1	1	1
0	-1	0	-1	-1	-1
-1	4	-1	-1	8	-1
0	-1	0	-1	-1	-1

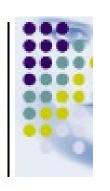
Sharpening by Laplacian

a b
c d

RGUNE 3.48
(a) Image of the
North Pole of the
moon.
(b) Laplacianfibered image
(c) Laplacian
image scaled for
display purposes.
(d) image
enhanced by
using Eq. (3.7-5).
(Original image
countery of
NASA.)

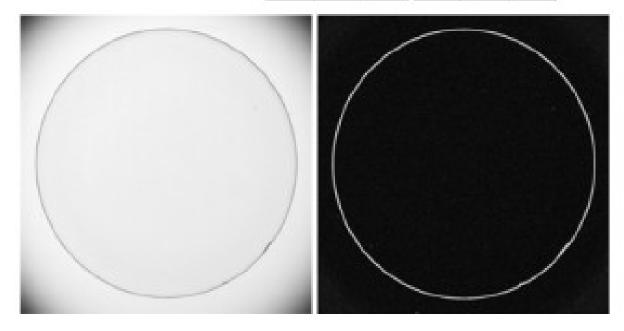


First derivative as edge detector (Gradient)

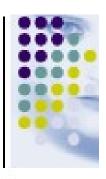


Sobel filter:

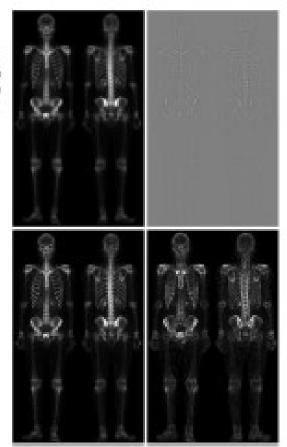
-1	-2	-1	-1	0	
0.	0	0	-2	0	1
1	2	1	-1	0	1

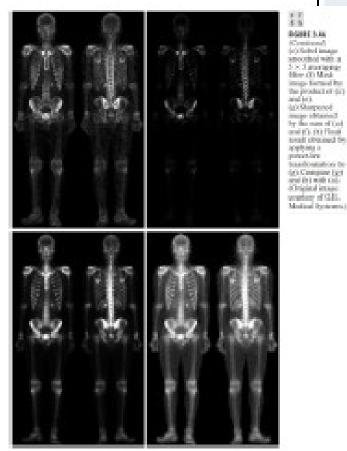






10 PROJECT 3-44 trick Drone of reducts block from a SHIP. OH Explories of Oil to Marponet belong of Carped hy salding blossed the sald Selected





0.00015.00 Continued (a) Sobol lange. stroothed with a 5 × 3 assertances Ober (0) Mach image forward but The product of (iii) and box lab Sharpered maps obtained. by Norman of Codand the por Please. total channel by Applying to probability. manifement on the (g) Company (g)