Image Processing Lecture-3

Image Enhancement
(Point Operations)

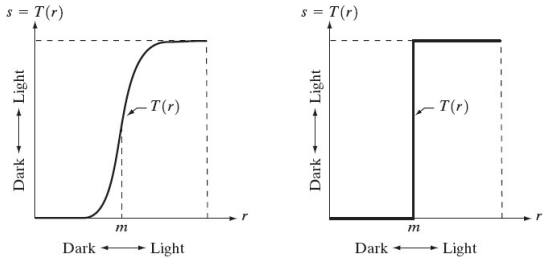
KULIS Kocaeli University Laboratory of Image and Signal Processing
Kocaeli Üniversitesi İşaret ve Görüntü İşleme Laboratuvarı

(Prof. Dr. Sarp ERTÜRK)

Point Operations

- T: *grayscale-level transformation function*.
- Called *(point operations)*

$$s = T(r)$$



Brightness adjustment

$$g(x,y) = T\left[f(x,y)\right]$$
$$= f(x,y) + b$$

b>0 increase brightness

b<0 decrease brightness

$$s = r + b$$

original

b = -50

b = +50

Contrast Adjustment

$$g(x,y) = T\left[f(x,y)\right]$$
$$= af(x,y)$$

a>1 increase contrast

a<1 decrease contrast

$$s = ar$$

original

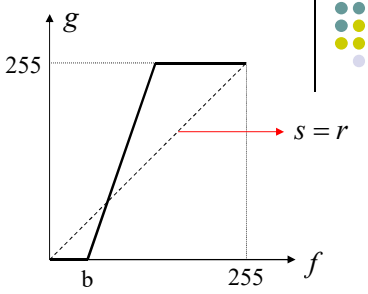
a = 0.5

a = 2

Brightness + Contrast

$$g(x,y) = T\left[f(x,y)\right]$$
$$= af(x,y) + b$$

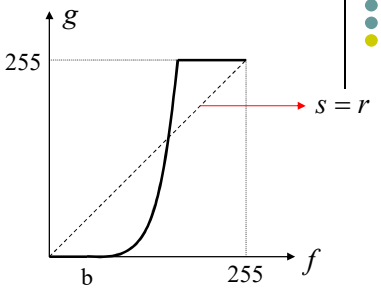
$$s = ar + b$$



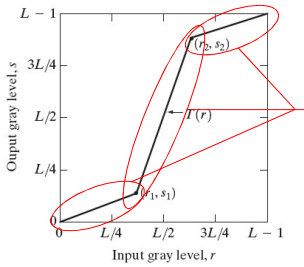
Brightness + Contrast

$$g(x,y) = T\left[f(x,y)\right]$$

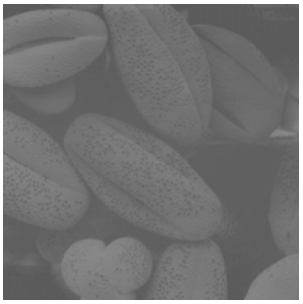
MATLAB **imadjust**

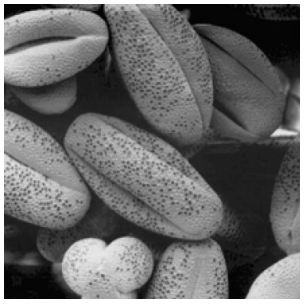


Brightness + Contrast

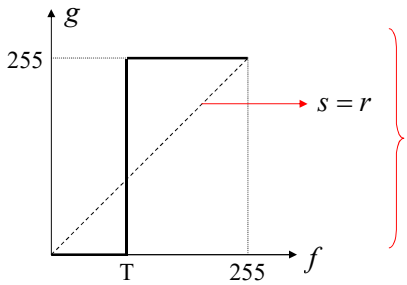


Partly-Linear Transform



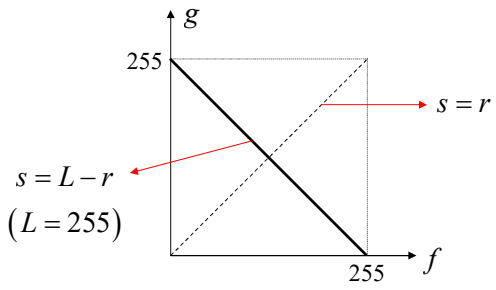


Thresholding



Binary Image

Negate



Histogram

- Frequency (occurence of each level)

- Normalized histogram gives probability

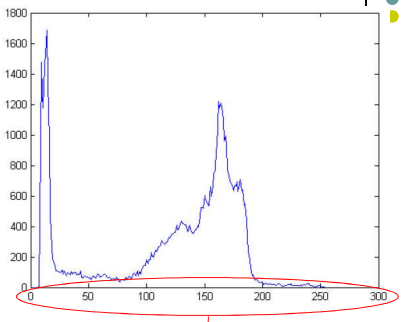
probability

No. of total pixels

$$p(r_k) = n_k / n$$

$$k = 0, 1, \ldots, L-1$$

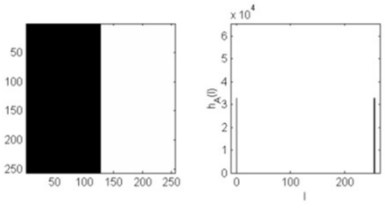
Histogram

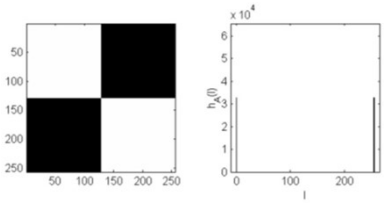


Grey level

MATLAB **imhist**

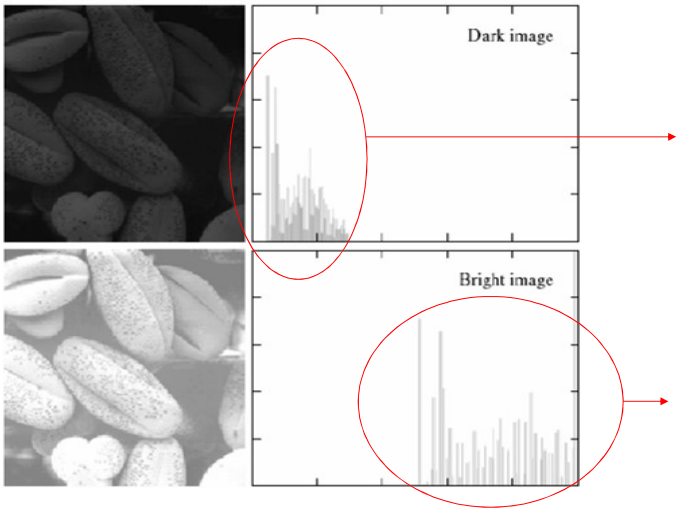
Histogram



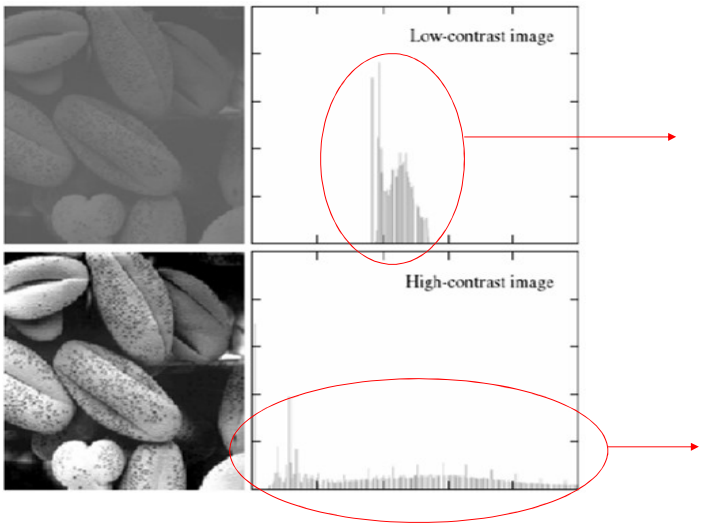


Does not have location info.!

Histogram



Histogram



Histogram Equalization

- Improve Visiblity

$$cdf(v) = round\left(\frac{cdf(v) - cdf_{\min}}{(M \times N) - cdf_{\min}} \times (L-1)\right)$$

Histogram Equalization

$$\begin{bmatrix} 52 & 55 & 61 & 66 & 70 & 61 & 64 & 73 \\ 63 & 59 & 55 & 90 & 109 & 85 & 69 & 72 \\ 62 & 59 & 68 & 113 & 144 & 104 & 66 & 73 \\ 63 & 58 & 71 & 122 & 154 & 106 & 70 & 69 \\ 67 & 61 & 68 & 104 & 126 & 88 & 68 & 70 \\ 79 & 65 & 60 & 70 & 77 & 68 & 58 & 75 \\ 85 & 71 & 64 & 59 & 55 & 61 & 65 & 83 \\ 87 & 79 & 69 & 68 & 65 & 76 & 78 & 94 \end{bmatrix}$$ blok

Value	Count	Value	Count	Value	Count	Value	Count	Value	Count
52	1	64	2	72	1	85	2	113	1
55	3	65	3	73	2	87	1	122	1
58	2	66	2	75	1	88	1	126	1
59	3	67	1	76	1	90	1	144	1
60	1	68	5	77	1	94	1	154	1
61	4	69	3	78	1	104	2		
62	1	70	4	79	2	106	1		
63	2	71	2	83	1	109	1		

histogram

Value	cdf	Value	cdf	Value	cdf	Value	cdf	Value	cdf
52	1	64	19	72	40	85	51	113	60
55	4	65	22	73	42	87	52	122	61
58	6	66	24	75	43	88	53	126	62
59	9	67	25	76	44	90	54	144	63
60	10	68	30	77	45	94	55	154	64
61	14	69	33	78	46	104	57		
62	15	70	37	79	48	106	58		
63	17	71	39	83	49	109	59		

cdf

$$cdf(v) = round\left(\frac{cdf(v) - cdf_{\min}}{(M \times N) - cdf_{\min}} \times (L-1)\right)$$

$$cdf(v) = round\left(\frac{cdf(v) - 1}{64 - 1} \times 255\right)$$

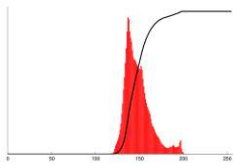
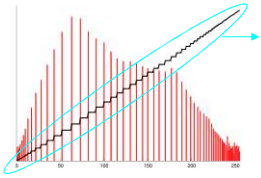
$$cdf(78) = round\left(\frac{46 - 1}{63} \times 255\right) = 182$$

$$cdf(154) = round\left(\frac{64 - 1}{63} \times 255\right) = 255$$

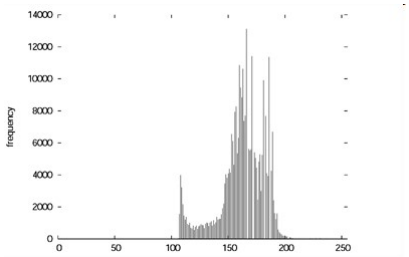
Histogram Equalization

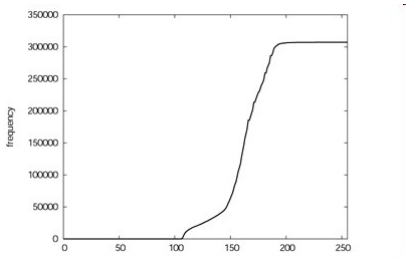
- Provides linear probability distribution function.



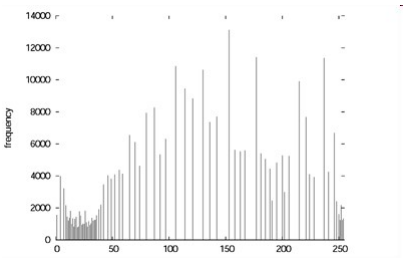



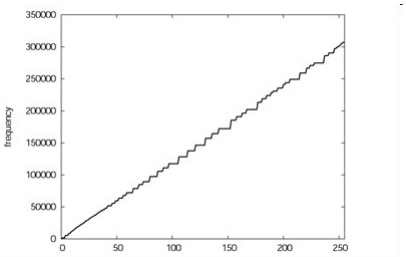
Histogram Equalization

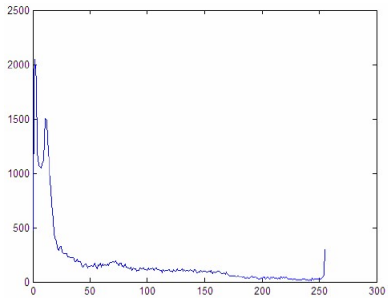


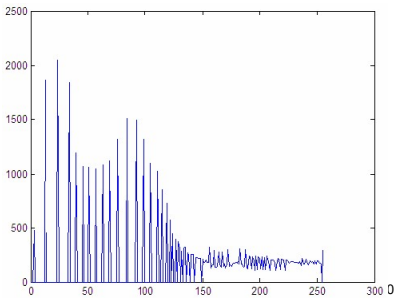
Histogram Equalization





Histogram Equalization





Histogram Equalization