Point Processing

image processing operations may be divided into into three classes based on the information required to perform the transformation.

1. **Transforms**: We require a knowledge of all the grey levels in the entire image to transform the image. In other words, the entire image is processed as a single large block. This may be illustrated by the diagram shown in figure (1)
2. **Spatial filters**: To change the grey level of a given pixel we need only know the value of the grey levels in a small neighborhood of pixels around the given pixel.
3. **Point operations**: A pixel's grey value is changed without any knowledge of its surrounds.

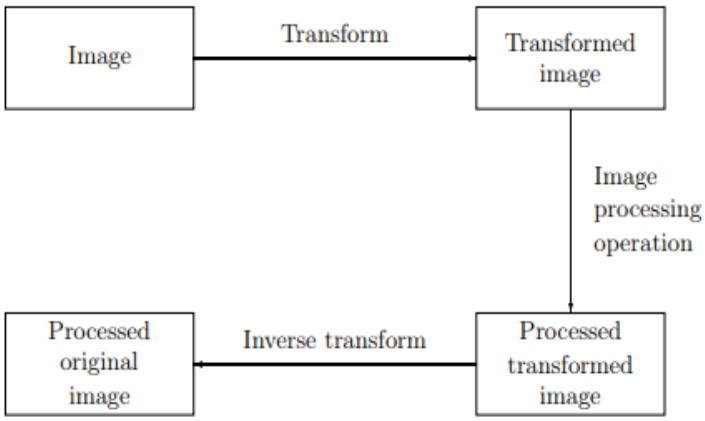


Figure (1): Schema for transform processing.

Arithmetic operations:

These operations act by applying a simple function

$Y=f(x)$

to each grey value in the image. Thus f(x) is a function which maps the range 0…….255 on to itself.
Simple functions include adding or subtract a constant value to each pixel:

1-Linear gray scale transformation:

Y=x+c or y=x-c
" or multiplying each pixel by a constant:
Y=cx
the values by setting:
y=255 if y>255, y=0 if y<0

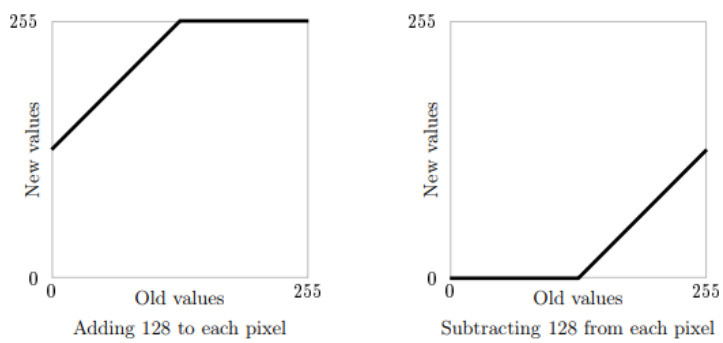
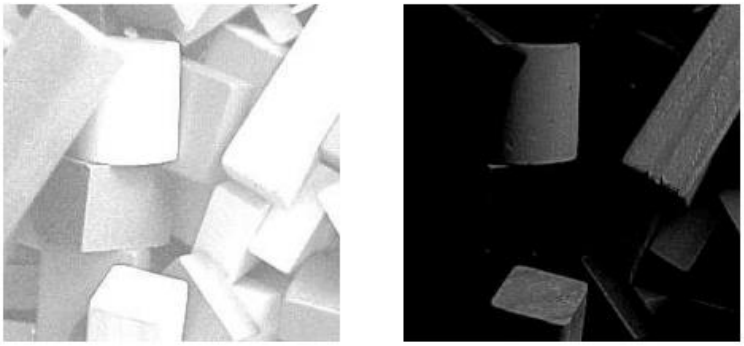


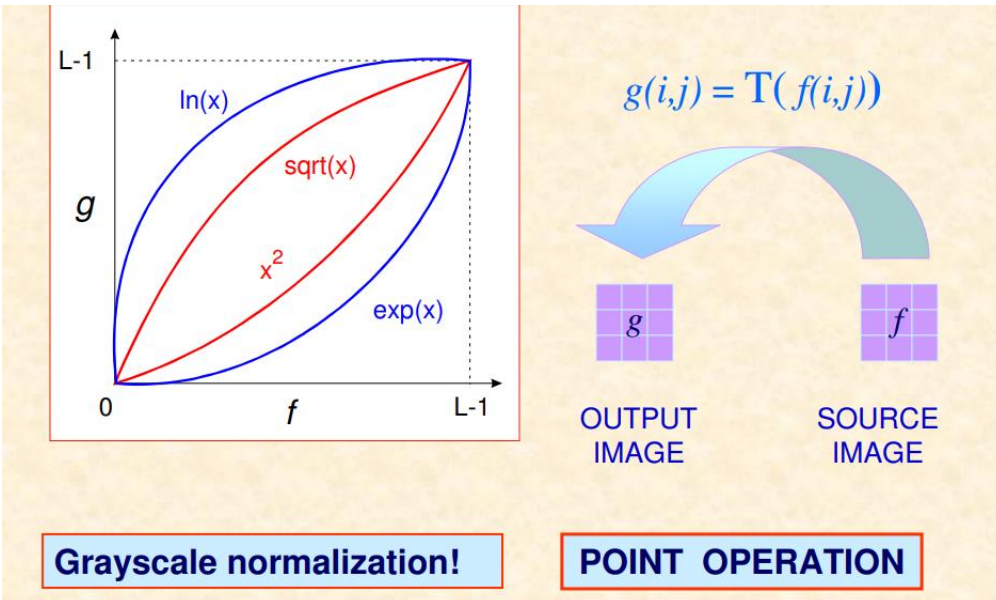
Figure (2): Adding and subtracting constant.

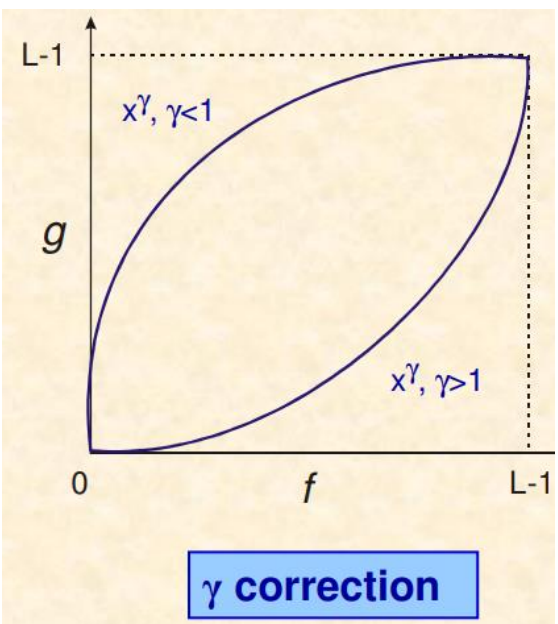


b1: Adding 128 b2: Subtracting 128

Figure 3: Arithmetic operations on an image: adding or subtracting a constant.

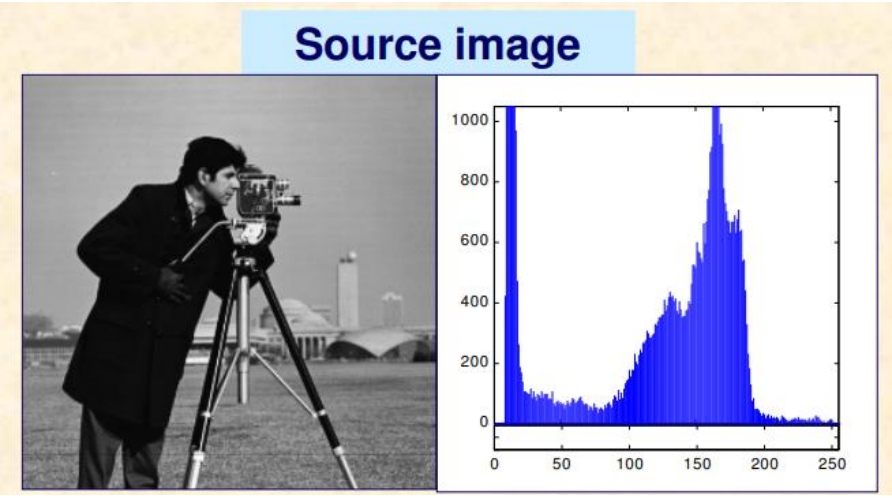
2-Non Linear gray scale transformation:

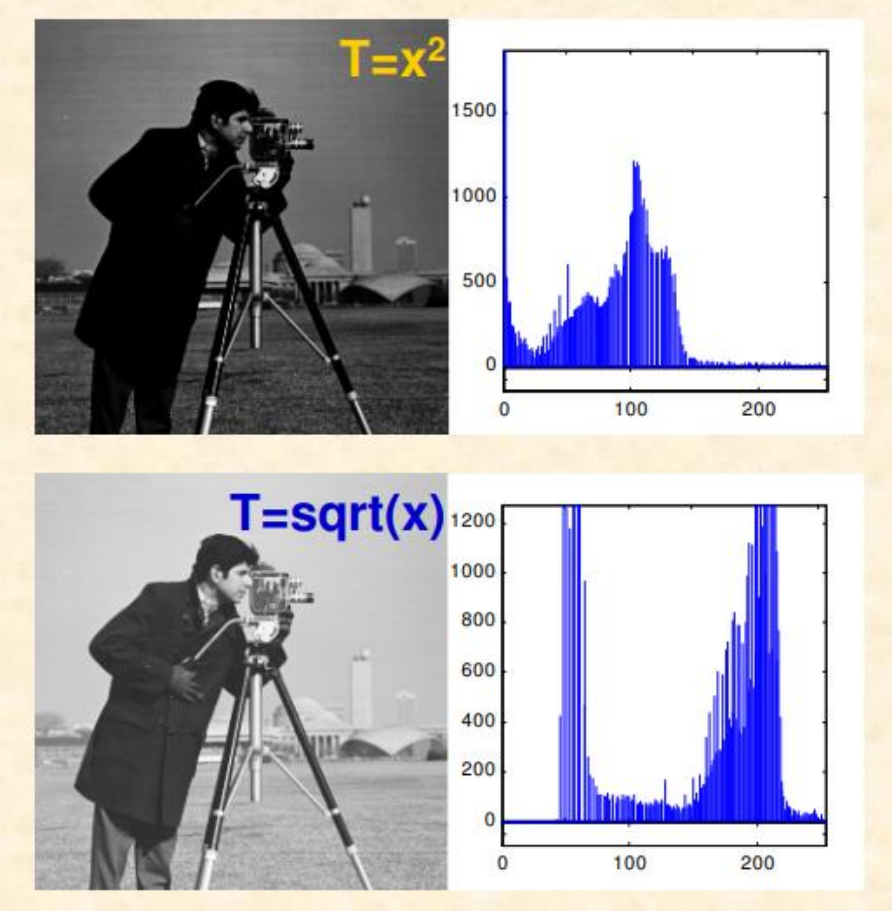




Lect.9

Examples





Histograms:

Given a greyscale image, its histogram consists of the histogram of its grey levels; that is, a graph indicating the number of times each grey level occurs in the image.

- In a dark image, the grey levels (and hence the histogram) would be clustered at the lower end:

- In a uniformly bright image, the grey levels would be clustered at the upper end:

- In a well contrasted image, the grey levels would be well spread out over much of the range.

There are **two** ways to enhance its contrast, by spreading out its histogram:

1- Histogram stretching (Contrast stretching):

Example :Suppose an image with the histogram shown in figure (4):

Gray level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	15	0	0	0	0	70	110	45	70	35	0	0	0	0	0	15

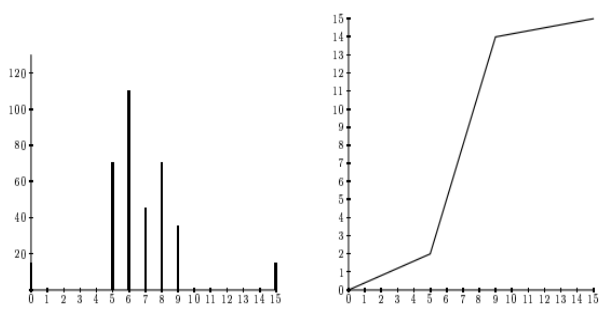


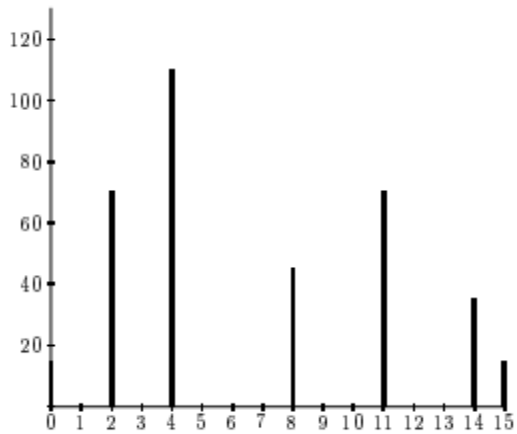
Figure 5: A histogram of a poorly contrasted image, and a stretching function.

The gray level 5-9 according the gray level 2-14. Apply the equation to get the new gray level.

J=[(14-2)/(9-5)](i-5)+2
where i is the original grey level and j its result after the transformation

I	5	6	7	8	9
j	2	5	8	11	14

and the corresponding histogram:



2-Histogram Equalization:

Sometimes a better approach is provided by histogram equalization. To transform the grey levels to obtain a better contrast image, we change gray level I to

$$1/n \quad (n_0 + n_1 + n_2 + n_3 + \ldots\ldots\ldots\ldots\ldots\ldots + n_i)(L-1)$$

And this number is rounded to the nearest integer.

Example

Suppose our images

Gray level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
n_i	15	0	0	0	0	0	0	0	0	70	110	45	80	40	0	0

n_i=15+0+0++0+0+0+0……+80+40+0+0=360

L-1=15

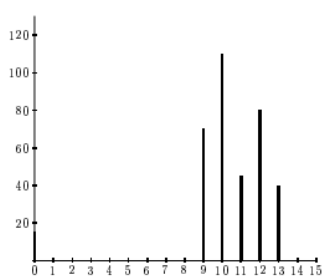
To equalize this histogram, we form running totals of the n_i ,

15/360=1/24

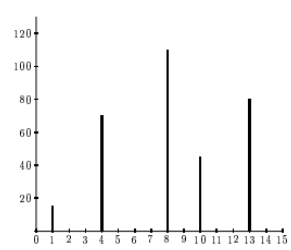
Grey level i	n_i	Σn_i	$(1/24)\Sigma n_i$	Rounded value
0	15	15	0.63	1
1	0	15	0.63	1
2	0	15	0.63	1
3	0	15	0.63	1
4	0	15	0.63	1
5	0	15	0.63	1
6	0	15	0.63	1
7	0	15	0.63	1
8	0	15	0.63	1
9	70	85	3.65	4
10	110	195	8.13	8
11	45	240	10	10
12	80	320	13.33	13
13	40	360	15	15
14	0	360	15	15
15	0	360	15	15

We now have the following transformation of grey values, obtained by reading off the first and last columns in the above table:

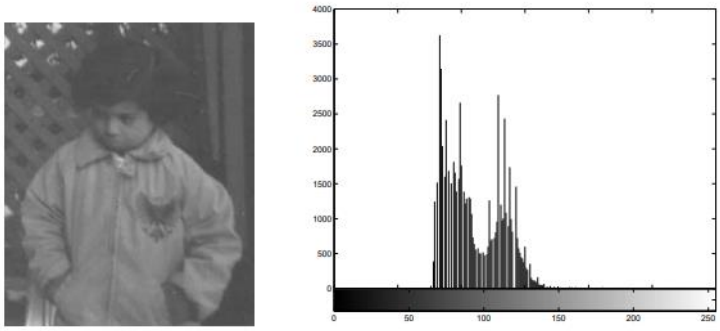
Original grey level i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Final grey level j	1	1	1	1	1	1	1	1	1	4	8	10	13	15	15	15



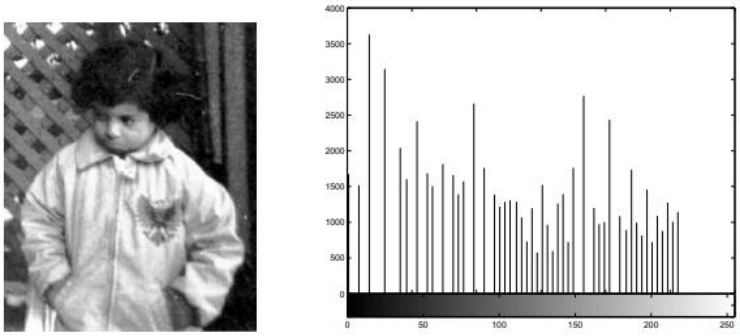
Before Histogram Equalization



After Histogram Equalization



Before Histogram Equalization



After Histogram Equalization

Thresholding :

1 -Single thresholding: A greyscale image is turned into a binary (black and white) image by first choosing a grey level in the original image, and then turning every pixel black or white according to whether its grey value is greater than or less than T:

A pixels become becomes white if its gray level > T.

A pixels become becomes black if its gray level <=T

Thresholding is a vital part of image segmentation, where we wish to isolate objects from the background. It is also an important component of robot vision.

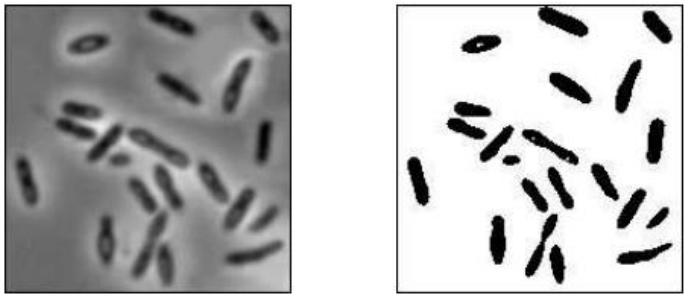


Figure (6): Thresholded image of bacteria at T>100

Thresholding provides a very simple way of showing hidden aspects of an image. For example, the image paper as shown in figure (7):

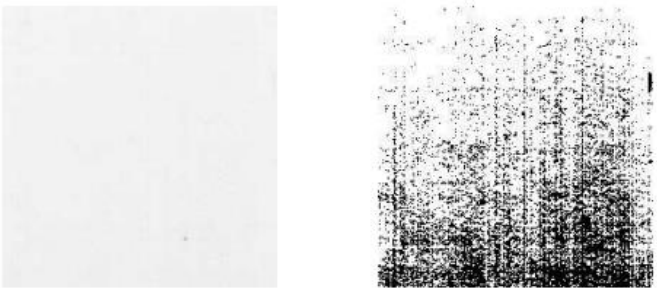


Figure (7): The paper image and result after thresholding.

2- Double thresholding:

Here we choose two values and T_1 and T_2 apply a thresholding operation.

A pixels become becomes white its gray level between T_1 and T_2.

A pixels become becomes black if its gray level is otherwise.

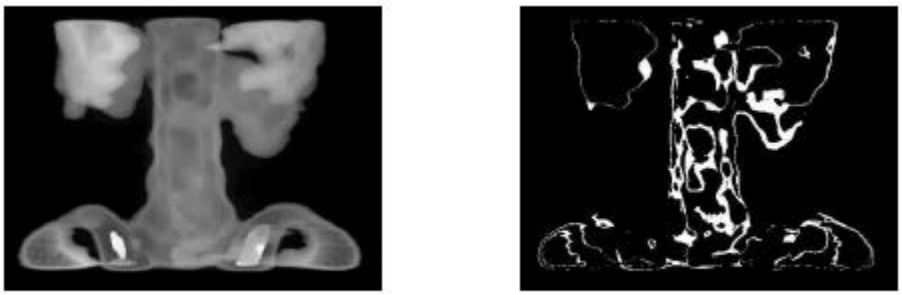


Figure (8): The image spins the result after double thresholding.

Applications of thresholding:

1-To remove unnecessary detail from an image, to concentrate on essentials. But this information may be all we need to investigate sizes, shapes, or numbers of blobs.
2-To bring out hidden detail. This was illustrated with paper and spine images. In both, the detail was obscured because of the similarity of the grey levels involved.
3-When we want to remove a varying background from text or a drawing. We can simulate a varying background by taking the image text as shown figure (9).

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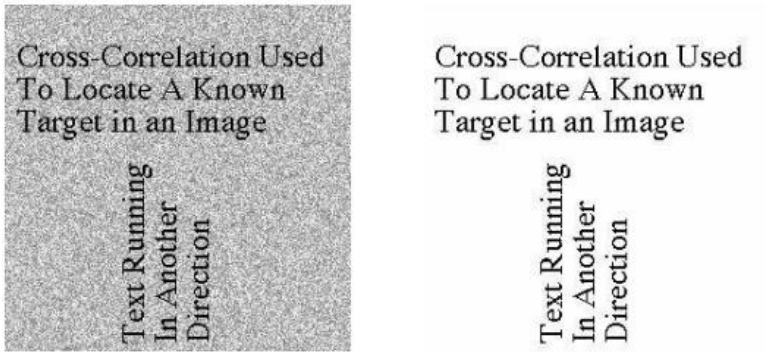

Figure (9): Text on a varying background, and threshold

Exercises :

1- Consider the following 8x8 image.

3	148	117	148	145	178	132	174
2	176	174	110	185	155	118	165
0	100	124	113	193	136	146	108
0	155	170	106	158	130	178	170
9	196	138	113	108	127	144	139
6	188	143	183	137	162	105	169
9	122	156	119	188	179	100	151
8	176	137	114	135	123	134	183

Threshold it at

(a) level 100

(b) level 150

2,3

The following table gives the number of pixels at each of the grey levels 0–7 in an image with those grey values only:

0	1	2	3	4	5	6	7
3244	3899	4559	2573	1428	530	101	50

Draw the histogram corresponding to these grey levels, and then perform a histogram equalization and draw the resulting histogram.

The following tables give the number of pixels at each of the grey levels 0–15 in an image with those grey values only. In each case draw the histogram corresponding to these grey levels, and then perform a histogram equalization and draw the resulting histogram.

(a)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	40	60	75	80	75	65	55	50	45	40	35	30	25	20	30

(b)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	40	80	45	110	70	0	0	0	0	0	0	0	0	15

9. The following small image has grey values in the range 0 to 19. Compute the grey level histogram and the mapping that will equalize this histogram. Produce an 8×8 grid containing the grey values for the new histogram-equalized image.

12	6	5	13	14	14	16	15
11	10	8	5	8	11	14	14
9	8	3	4	7	12	18	19
10	7	4	2	10	12	13	17
16	9	13	13	16	19	19	17
12	10	14	15	18	18	16	14
11	8	10	12	14	13	14	15
8	6	3	7	9	11	12	12