UNIT-2

IMAGEENHANCEMENT TECHNIQUES

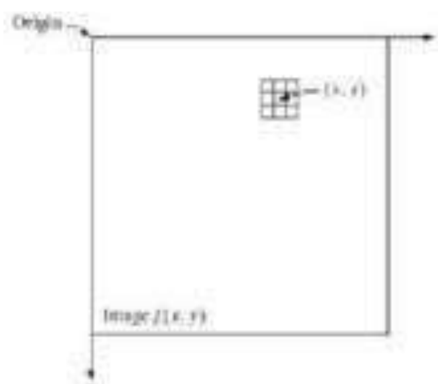
1.1 Enhancement by Point Processing

The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application. Image enhancement approaches fall into two board categories

- Spatial domain methods
- Frequency domain methods

The term spatial domain refers to the image plane itself and approaches in this categories are based on direct manipulation of pixel in an image. Spatial domain process are denoted by the expression

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



f(x,y) – input image T- operator on f, defined over some neighborhood of f(x,y) g(x,y) - processed image. The neighborhood of a point (x,y) can be explain by using as square or rectangular sub image area centered at (x,y).

The center of sub image is moved from pixel to pixel starting at the top left corner. The operator T is applied to each location (x,y) to find the output g at that location . The process utilizes only the pixel in the area of the image spanned by the neighborhood.

It is the simplest form of the transformations when the neighborhood is of size I x I. In this case g depends only on the value of f at (x,y) and T becomes a gray level transformation function of the forms

$$S=T(r)$$

r- Denotes the gray level of f(x,y)

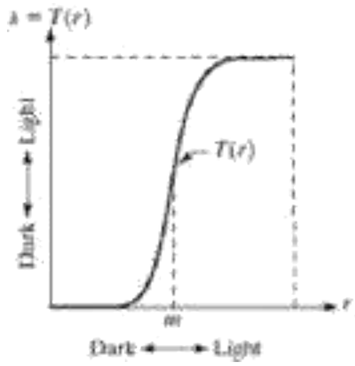
s- Denotes the gray level of g(x,y) at any point (x,y)

Because enhancement at any point in an image deepens only on the gray level at that point, technique in this category are referred to as point processing.

There are basically three kinds of functions in gray level transformation.

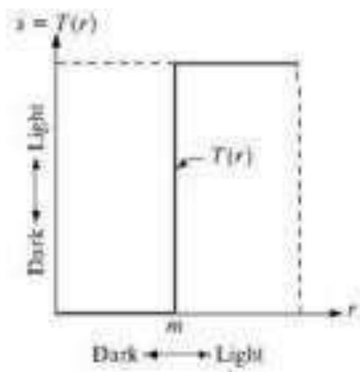
Point Processing:

Contract stretching – It produces an image of higher contrast than the original one. The operation is performed by darkening the levels below m and brightening the levels above m in the original image.



In this technique the value of r below m are compressed by the transformation function into a narrow range of s towards black .The opposite effect takes place for the values of r above m.

Thresholding function: It is a limiting case where T(r) produces a two levels binary image. The values below m are transformed as black and above m are transformed as white.



1.2 Basic Gray Level Transformation:

These are the simplest image enhancement techniques.

1.2.1 Image Negative: The negative of in image with gray level in the range [0, l-1] is obtained by using the negative transformation.

The expression of the transformation is

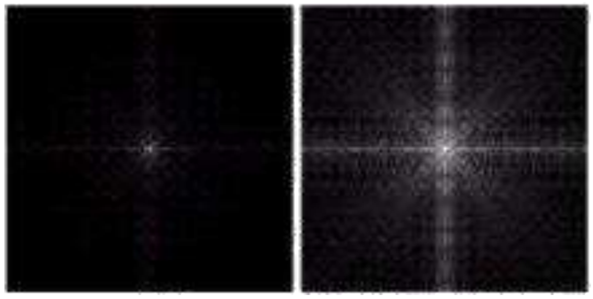
$s = L - 1 - r$

Reverting the intensity levels of an image in this manner produces the equivalent of a photographic negative. This type of processing is practically suited for enhancing white or gray details embedded in dark regions of an image especially when the black areas are dominant in size.

1.2.2 Log transformations:

This transformation maps a narrow range of gray level values in the input image into a wider range of output gray levels. The opposite is true for higher values of input levels. We would use this transformations to expand the values of dark pixels in an image while compressing the higher level values. The opposite is true for inverse log transformation. The log transformation function has an important characteristic that it compresses the dynamic range of images with large variations in pixel values.

Example – Fourier spectrum



1.2.3 Power Law Transformation:
Power law transformations has the basic form

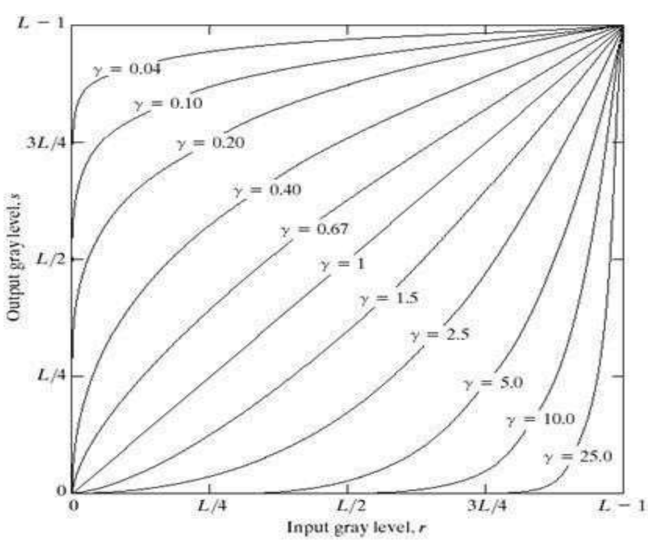
$$s = cr^{\gamma}$$

Where c and γ are positive constants.

It also sometime written as:

$$s = c(r + \varepsilon)^{\gamma}$$

Power law curves with fractional values of y map a narrow range of dark input values into a wider range of output values, with the opposite being true for higher values of input gray levels. We may get various curves by varying values of γ.



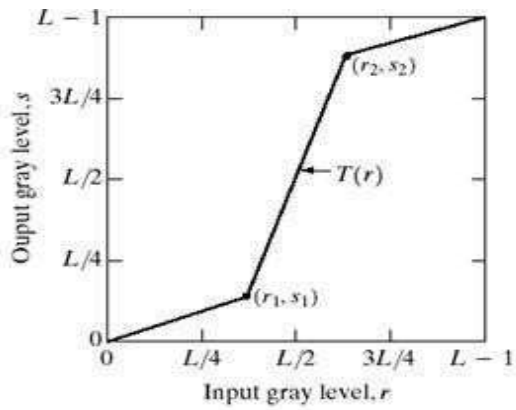
A variety of devices used for image capture, printing and display respond according to a power law. The process used to correct this power law response phenomenon is called gamma correction.
For eg. – CRT devices have intensity to voltage response that is a power function.
Gamma correction is important if displaying an image accurately on a computer screen is of concern. Images that are not corrected properly can look either bleached out or too dark. Color phenomenon also uses this concept of gamma correction. It is becoming more popular due to use of images over the internet. It is important in general purpose contract manipulation. To make an image black we use γ >1 and γ <1 for white image.

1.2.4 Piece wise linear transformation functions

The principal advantage of piece wise linear functions is that these functions can be arbitrarily complex. But their specification requires considerably more user input.

- **Contrast Stretching**

It is the simplest piecewise linear transformation function. We may have various low contrast images and that might result due to various reasons such as lack of illumination, problem in imaging sensor or wrong setting of lens aperture during image acquisition. The idea behind contrast stretching is to increase the dynamic range of gray levels in the image being processed.



The location of points (r1,s1) and (r2, s2) control the shape of the curve.

a) If r1=r2and s1=s2, the transformation is a linear function that deduces no change in gray levels.

b) If r1=s1, s1=0 , and s2=L-1, then the transformation become a thresholding function that creates a binary image

c) Intermediate values of (r1, s1) and (r2, s2) produce various degrees of spread in the gray value of the output image thus effecting its contract. Generally r1≤ r2 and s1 ≤ s2 so that the function is single valued and monotonically increasing.

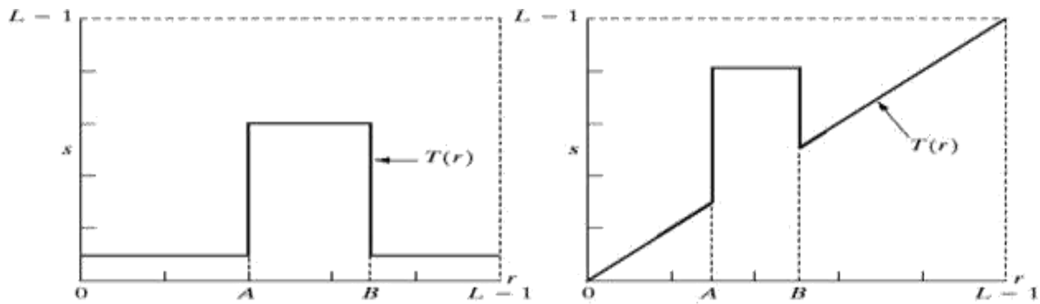
- **Gray Level Slicing**

Highlighting a specific range of gray levels in an image is often desirable For example when enhancing features such as masses of water in satellite image and enhancing flaws in x- ray images.

There are two ways of doing this-

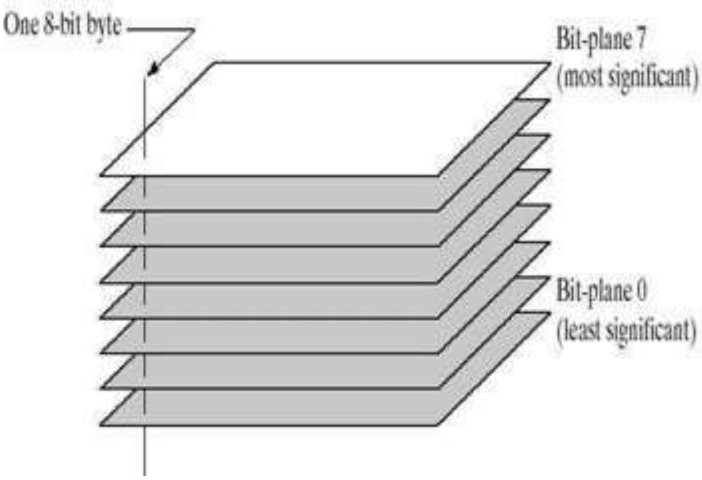
(1) One method is to display a high value for all gray level in the range. Of interest and a low value for all other gray level.

(2) Second method is to brighten the desired ranges of gray levels but preserve the background and gray level tonalities in the image.



- **Bit Plane Slicing**

Sometimes it is important to highlight the contribution made to the total image appearance by specific bits. Suppose that each pixel is represented by 8 bits. Imagine that an image is composed of eight 1-bit planes ranging from bit plane 0 for the least significant bit to bit plane 7 for the most significant bit. In terms of 8-bit bytes, plane 0 contains all the lowest order bits in the image and plane 7 contains all the high order bits. High order bits contain the majority of visually significant data and contribute to more subtle details in the image. Separating a digital image into its bits planes is useful for analyzing the relative importance played by each bit of the image. It helps in determining the adequacy of the number of bits used to quantize each pixel. It is also useful for image compression.



1.3 Histogram Processing:

The histogram of a digital image with gray levels in the range [0,L-1] is a discrete function of the Form

$H(r_k) = n_k$

Where r_k is the kth gray level and n_k is the number of pixels in the image having the level r_k.

A normalized histogram is given by the equation

$p(r_k)=n_k/n$ for $k=0,1,2,\ldots,L-1$

$P(r_k)$ gives the estimate of the probability of occurrence of gray level r_k. The sum of all components of a normalized histogram is equal to 1.The histogram plots are simple plots of

$$H(r_k)=n_k \text{ versus } r_k.$$

In the dark image the components of the histogram are concentrated on the low (dark) side of the gray scale. In case of bright image the histogram components are biased towards the high side of the gray scale. The histogram of a low contrast image will be narrow and will be centred towards the middle of the gray scale.