CLASS : T.E. E&TE **SUBJECT: DIP**

EXPT. NO. : 2 **DATE:**

TITLE : POINT PROCESSING OPERATIONS ON AN IMAGE.

CO 1:	Apply the fundamentals of digital image processing to perform various image-enhancement and Image segmentation operations on gray scale image.

AIM :

To implement:

1. Negative of an image
2. Log transformation
3. Power Law Transformation
4. Image Flipping

SOFTWARES REQUIRED: Google Colaboratory / Jupyter Notebook

THEORY:

2.1 Image Enhancement.

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 broad categories: spatial domain methods and frequency domain methods. The term spatial domain refers to the image plane itself, and approaches in this category are based on direct manipulation of pixels in an image. Frequency domain processing techniques are based on modifying the Fourier transform of an image.

2.1.1 Spatial Domain Transformations.

The term spatial domain refers to the aggregate of pixels composing an image. Spatial domain methods are procedures that operate directly on these pixels. Spatial domain processes will be denoted by the expression:

$$\mathbf{g(x, y) = T[f(x, y)]}$$

where f(x, y) is the input image, g(x, y) is the processed image, and T is an operator on f, defined over some neighborhood of (x, y). In addition, T can operate on a set of input images.

The principal approach in defining a neighborhood about a point (x, y) is to use a square or rectangular sub image area centered at (x, y), as Fig. 2.1 shows. The center of the sub image is moved from pixel to pixel starting, say, at the top left corner. The operator T is applied at each location (x, y) to yield the output, g at that location. The process utilizes only the pixels in the area of the image spanned by the neighborhood. Although other neighborhood shapes, such as approximations to a circle, sometimes are used, square and rectangular arrays are by far the most predominant because of their ease of implementation.

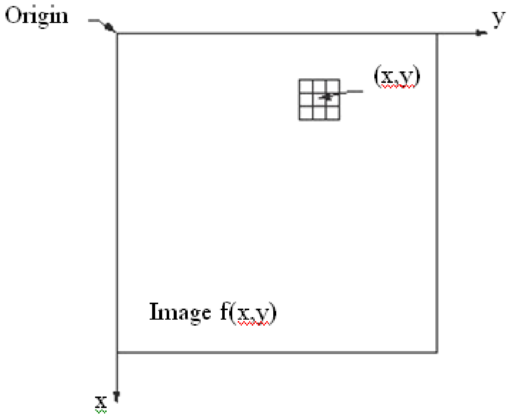

Fig 2.1: A 3x3 neighborhood about a point in an image f(x,y)

The simplest form of T is when the neighborhood is of size 1*1 (that is, a Single pixel). In this case, g depends only on the value of f at (x, y), and T becomes a gray-level (also called intensity or mapping) transformation function of the form:

$$s = T(r)$$

Where, for simplicity in notation, r and s are variables denoting, respectively, the gray level of f(x, y) and g(x, y) at any point (x, y).

2.2 Basic Gray Level Transformations:

2.2.1 Image Negative:

The negative of an image with gray levels in the range [0,L-1]is obtained by using the negative transformation, which is given by the expression,

$$s = L - 1 - r$$

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

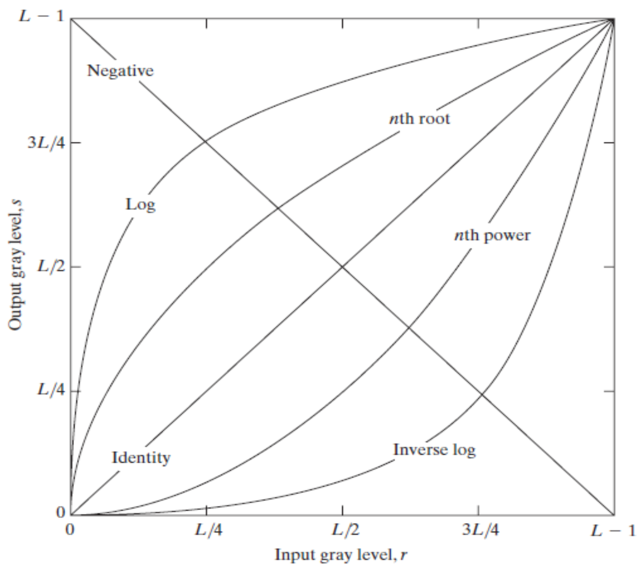

Fig 2.2: Some Basic Gray level Transformations

2.2.2 Log Transformation:

The general form of the log transformation shown in Fig. 2.2 is

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

where c is a constant, and it is assumed that r >= 0.The shape of the log curve in Fig. 2.2 shows that this transformation maps a narrow range of low gray-level values in the input image into a wider range of output levels. The opposite is true of higher values of input levels. We would use a transformation of this type to expand the values of dark pixels in an image while compressing the higher-level values. The opposite is true of the inverse log transformation. Any curve having the general shape of the log functions shown in Fig.2.2 would accomplish this spreading/compressing of gray levels in an image. In fact, the power-law transformations discussed next are much more versatile for this purpose than the log transformation. However, the log function has the important characteristic that it compresses the dynamic range of images with large variations in pixel values. A classic illustration of an application in which pixel values have a large dynamic range is the Fourier spectrum. At the moment, we are concerned only with the image characteristics of spectra. It is not unusual to encounter spectrum values that range from 0 to or higher .While processing numbers such as these presents no problems for a computer, image display systems generally will not be able to reproduce faithfully such a wide range of intensity values. The net effect is that a significant degree of detail will be lost in the display of a typical Fourier spectrum. In such scenarios, log transformation is used.

2.2.3 Power - Law (Gamma) Transformation:

Power-law transformations have the basic form

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

Plots of s versus r for various values of γ are shown in Fig. 2.3 on the next page. Here c and γ are positive constants. As in the case of the log transformation, power-law curves with fractional values of gamma 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 levels. Unlike the log function, however, we notice here a family of possible transformation curves obtained simply by varying γ. As expected,we see in Fig. 2.3 that curves generated with values of γ >1 have exactly the opposite effect as those generated with values of γ<2. Finally, we note that eq. $s=cr^{\gamma}$ reduces to the identity transformation when c= γ =2. A variety of devices used for image capture, printing, and display respond according to a power law. By convention, the exponent in the power-law equation is referred to as gamma. The process used to correct the power-law response phenomena is called gamma correction. Gamma correction is important if displaying an image accurately on a computer screen is of concern.

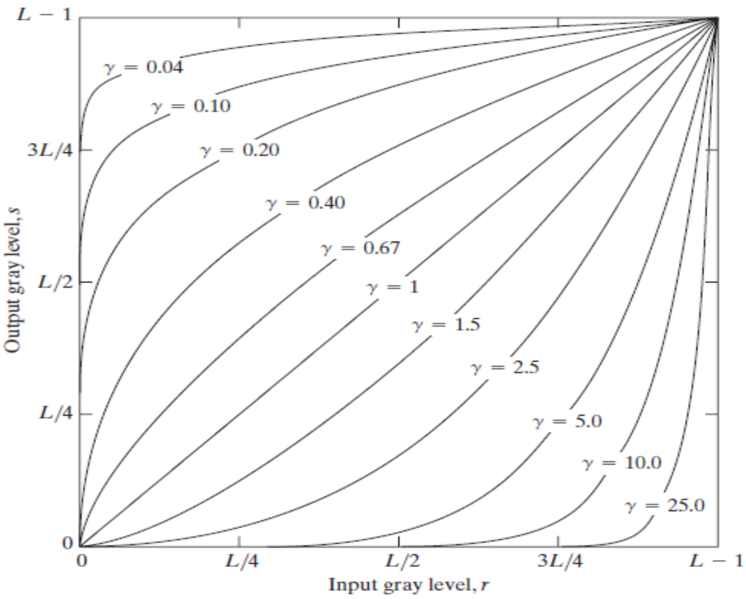

Fig 2.3: Plots of the curve $s=cr^{\gamma}$ for various values of γ and c=2.

Images that are not corrected properly can look either bleached out, or, what is more likely, too dark. Trying to reproduce colors accurately also requires some knowledge of gamma correction because varying the value of gamma correction changes not only the brightness, but also the ratios of red to green to blue.

2.2.4 Image Flipping

A static or moving image created by mirror-reversing an original over a horizontal axis is referred to as a flipped image or reversed image. A flip (mirror effect) is done by reversing the pixels horizontally or vertically. For instance, for an horizontal flip, the pixel situated at coordinate (x, y) will be situated at coordinate (width - x - 1, y) in the new image.

For Example: -

127	255	220	112	255
110	90	0	190	110
0	127	100	255	120
27	45	91	127	0
255	200	190	185	140

Original Image

255	200	190	185	140
27	45	91	127	0
0	127	100	255	120
110	90	0	190	110
127	255	220	112	255

Vertically flipped Image

2.3 Algorithms for Basic operations and gray transformations on Image:

2.3.1 Image Negation:

2.3.2 Log Transform:

2.3.3 Power Law Transform:

2.3.4 Image Flipping

2.4 Conclusion:

2.5 References:

i. Gonzalez R, Woods R, “Digital image processing”, Pearson Prentice Hall, 2008.

ii. Gonzalez R, Woods R, Steven E, “Digital Image Processing Using MATLAB®”, McGraw Hill Education,2010.

iii. Jayaraman S, Esakkirajan S and Veerakumar T,“Digital Image Processing” Tata McGraw Hill, 2010

iv. Joshi, Madhuri A. “Digital Image Processing: an algorithm approach”, PHI Learning Pvt. Ltd., 2006.

v. Pictures taken from: http://www.imageprocessingplace.com/root_files_V3/image_databases.html

(Course Teacher)