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Different Approaches of Image Enhancement

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Abstract-In this recent period, the image processing plays a primary role in different fields of engineering and research. Perhaps to increase the value of this field, quality of an image should be improved to support the human sensitivity or machine visualization. The contrast of an image is the difference between the lowest & highest intensity areas of the image. In this paper different methods available for image contrast enhancement like grey level slicing, Image Subtraction, contrast stretching, histogram equalization etc for gray image contrast enhancement. Among the image enhancement techniques, contrast enhancement is an important quality factor for providing better experience of image perception to viewers. This paper shows the performance of some of existing image enhancement algorithms. The performance of algorithms is evaluated both qualitatively and quantitatively.

Index Terms- Image contrast enhancement, Histogram Equalization, Spatial Filtering

1. INTRODUCTION

Digital images play a important role in daily life applications such as satellite television, magnetic resonance imaging, computer tomography as well as in areas of research and technology such as geographical information systems and astronomy [2]. The conversion from one form of image to another form such as digitizing the image some form of degradation occurs at output. Improvement in quality of these degraded images can be achieved by using application of enhancement techniques The main objective of image enhancement is to provide details that are hidden in an image, or to increase the contrast in a low contrast image. Image enhancement produces an output image that subjectively looks better than the original image by changing the pixel's intensity of the input image. Generally, image enhancement enlarges the intensity differences among objects and background. There are various image enhancement techniques that have been proposed and developed [1]. In this paper, some image enhancement techniques have been discussed with their mathematical understanding [3]. This paper will provide an overview of underlying concepts with focus on spatial domain techniques and spatial filtering.

2. IMAGE ENHANCEMENT TECHNIQUES

2.1 Contrast Stretching

Contrast stretching enhances image by enhancing contrast
Between various parts of the original image. The basic idea is to improve the image quality by increasing the dynamic range of gray levels [4].A typical change in contrast enhancement can be seen from the Figure 1.

. Figure 1: Contrast Stretching

2.2 Grey Level Slicing

A grey level slicing technique enhances all the gray levels by using high values and all other gray levels using low values (Figure 2). This function is mostly useful to enhance flaws in X-ray images and enhancing features such as masses of water in satellite imagery. Figure 2 shows the transformation function for the range of pixels of interest and also showing the effect on image.

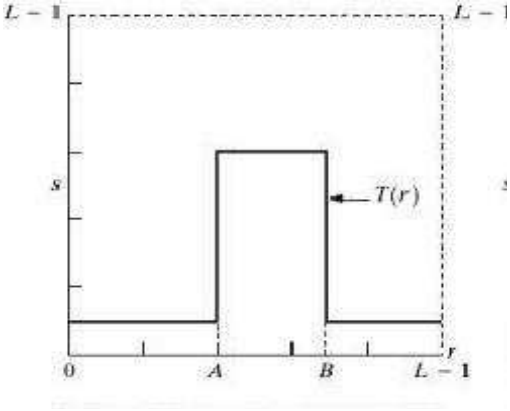

Figure 2: Grey Level slicing

2.3 Histogram Processing

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

$$h(r_k) = n_k \quad (1)$$

where r_k is the k^{th} intensity values & n_k is the number of pixels in the image with intensity r_k

Histograms are frequently normalized by the total number of pixels in the image. Assuming an M x N image, a normalized histogram.

$$P(r_k) = \frac{n_k}{MN} \quad (2)$$

Where k =0,1,…….L-1

2.3.1 Histogram Equalization (HE)

Histogram equalization is a technique by which the vibrant
range of the histogram of an image is increased. It flattens and stretches the dynamic range of the image's histogram and resulting in overall contrast improvement [7]. Histogram equalization assign the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities. It improves contrast by obtaining a uniform histogram (Figure 3). This technique can be used on a whole image or just on a part of an image [5].

Figure 3: Histogram Equalization

2.3.2 Local Enhancement Equalization (LHE) Technique.

The Histogram Equalization discussed above is based on global method, means it increases the overall contrast of the image. So this method is appropriate for overall enhancement. This method can be easily adapted to local enhancement. The method is to define the neighborhood and move the centre of this area from pixel to pixel. At each location, calculate histogram of the points in the neighborhood, Obtain histogram equalization/specification function. Finally this function is used to map gray level of pixel cantered in neighborhood [6]. It can use new pixel values and previous histogram to calculate next histogram [3].

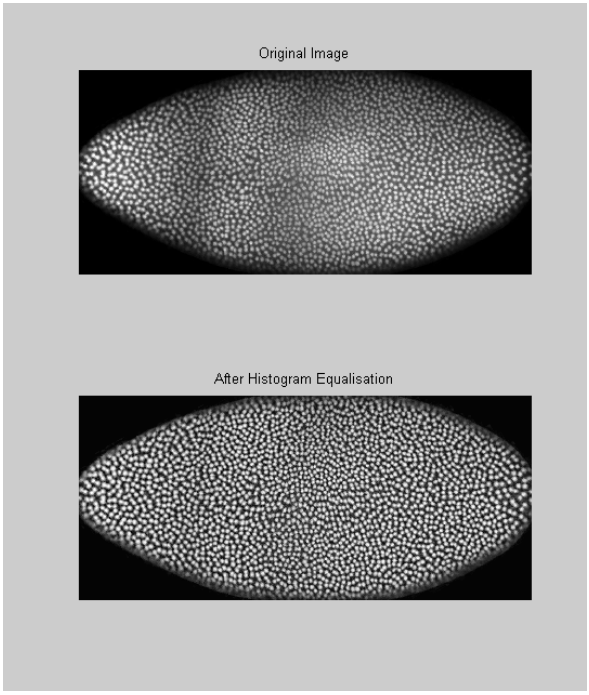

Figure 4: Local Histogram Equalization

2.4 Image Subtraction

This technique play key role in medical applications. The most important application is mask mode radiography. The main use of image subtraction includes background removal and illumination equalization. The image difference between two images f(x,y) and g(x,y) can be expressed as

$$Z(x,y)=f(x,y)-g(x,y)$$

By analyzing the image obtained by subtraction, the doctor is in a position to decide the actual location of blood blockage [6].

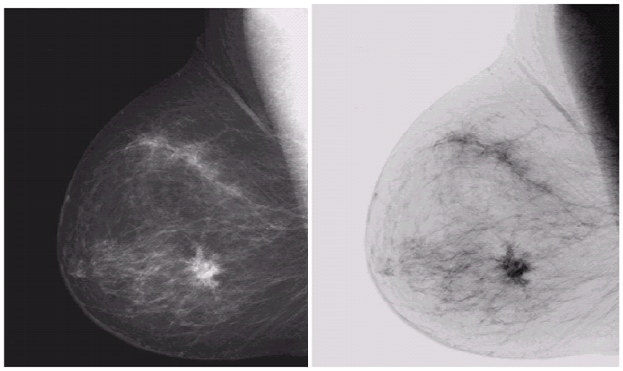

Figure 5: Image Subtraction

3. SPATIAL FILTERING

The purpose of spatial filters is to remove unwanted noise from the image. It is one of the main tools used in this field for broad spectrum of applications [2].Spatial filters is of two types:

1 Smoothing Spatial Filters
2 Sharpening Spatial Filters

3.1Smoothing Filters

These filters are used for blurring and for noise reduction. These filter changes each pixel by the average of pixels contained in the neighbourhood (filter mask). They are also called averaging or low-pass filters. It reduces the noise such as bridging of small gaps in the lines or curves in the image [6].

Figure 6: Smoothing Filter

There response is based on ordering the pixels contained in the image area encompassed by the filter, and then replacing the centre with the value determined by the ranking result[2].The well known median filter is a Non-Linear filter.

3.2 Sharpening Spatial Filters

The principle purpose of sharpening is to highlight transitions in intensity. Its applications ranging from electronic printing and medical imaging to industrial inspection [2]. It can provide more visible details that are poor, hazy and of hidden focus in the original image [6].The well known sharpening filter is High pass filter.

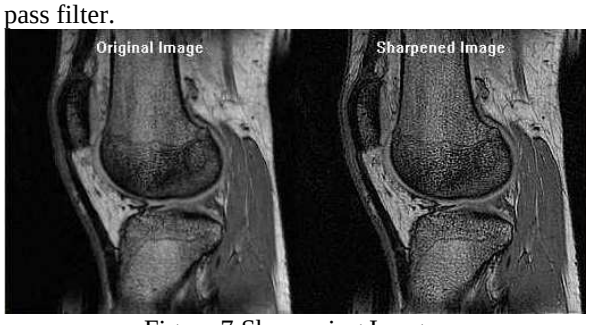

Figure 7:Sharpening Images

4 COMPARISON

The comparison is made between various spatial domain
techniques by studying these methods .The quantitative metrics used for comparison are SNR, PSNR [8-11].

Signal-to-Noise Ratio (SNR) =

$$SNR = 20\log 10\frac{signal}{RMSnoise}$$

Peak Signal-to-Noise Ratio (PSNR) =

$$PSNR = 20\log 10\frac{MAXf}{\sqrt{MSE}} \quad \text{.....(i)}$$

Where f is the original image

$$MSE = \frac{1}{mn}0\sum_{0}^{m-1}\sum_{0}^{n-1}\| f(i,j) - g(i,j\| \text{.....(ii)}$$

The PSNR compute the peak signal-to-noise ratio, in decibels,between two images. This ratio is frequently used as a quality measurement between the original and an enhanced image. The higher the PSNR, the better the quality of the enhanced image. From the study, it was concluded that contrast stretching gives higher values of the metrics. By visual inspection of output images (enhanced) (Figure 6) of different methods, one can easily determine the difference between the input image and the enhanced image.

5. CONCLUSION

In this paper, various techniques of enhancement is compared. From the visual, it is found that contrast stretching yields best among the methods under study. In future, for the enhancement purpose more images can be taken from the different application fields so that it becomes clearer that for which application which particular technique is better.

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