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## IMAGE ENHANCEMENT USING SPATIAL TECHNIQUES



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### Abstract

Image Enhancement is a process to improve the visual appearance of original image. It results in more pleasing image for human and machine analysis for some specific applications such as forensics field, biology field, X-ray etc. Image enhancement is used as a preprocessing step in digital image processing in some specific applications. Image enhancement can be done in two domains. Spatial domain and Frequency domain. Spatial domain techniques are those which directly operate on pixels in an image and frequency domain techniques operate on Fourier transform of an image. Image acquired through devices suffer from low contrast and noise. Low contrast images can be due to the poor illumination, lack of timing range in the imaging sensor, or due to the wrong setting of the lens. Low contrast affects the image visual quality. These problems are removed by image enhancement techniques. This paper focuses on different image enhancement techniques in spatial domain

## INTRODUCTION

Image enhancement is a method of modifying the appearance of acquired image through some device in a better way, so that resultant image is better than original image in looks<sup>1</sup>. Image enhancement is used as a preprocessing step in digital image processing before the image segmentation step. The main aim of image enhancement is to make the original image better so that the enhanced image can be used as input in further digital image processing steps. By using this method, image can be enhanced in various ways like, we can improve the contrast, remove the noise etc. image enhancement is used in various fields. For example medical, remote sensing, biology, automated vision inspection, military.

Image enhancement can be broadly categorized into two domains that are as follow:

**Spatial Domain**-spatial domain techniques are those which directly operate on pixels in an image. Pixel values of the input image are manipulated to get the output image. Spatial domain methods are denoted by the expression<sup>2</sup>.

$$G(x, y) = T[F(x, y)] \quad (1)$$

Where  $G(x, y)$  is the output image,  $T$  is the Operation performed on  $F(x, y)$ ,  $F(x, y)$  is original image that undergoes enhancement process. Grey level transformation function can be written as

$$S = T(r) \quad (2)$$

Where  $r$  and  $s$  are intensity of pixels of  $f(x, y)$  and  $g(x, y)$ .

**Frequency Domain**-frequency domain techniques operate on Fourier transform of an image. The image is first transferred into frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image In the frequency domain the image enhancement can be done as follows[3]:

$$G(u, v) = H(u, v) F(u, v) \quad (3)$$

Where  $G(u, v)$  is enhanced image,  $F(u, v)$  is input image and  $H(u, v)$  is transfer function.

But here we will discuss only some of the spatial domain methods.

## Spatial Domain techniques

### Contrast stretching

Contrast is the difference of the brightness between objects and their backgrounds. In the digital image processing, contrast enhancements can be done by the contrast stretching enhancement technique. Contrast stretching is a point processing enhancement technique in which we stretch the range of intensity value of the pixels in an image. This technique improves the brightness difference uniformly across the dynamic range of the image as a result of this low contrast images look clear and sharp<sup>4</sup>. The Contrast set to stretching is also called as normalization. Before the stretching can be performed it is necessary to specify the upper and lower pixel value limits over which the image is to be normalized. Often these limits will just be the minimum and maximum pixel values that the image type concerned allows. Let  $a$  and  $b$  be the lower and upper limits respectively for example: 8-bit gray level images have 0 as the lower limit and 255 as the upper limit. The simplest sort of normalization then scans the image to find

the lowest and highest pixel values currently present in the image. call this  $c$  and  $d$ . Then for each pixel, the original value  $r$  is mapped to output value  $s$  using the function<sup>4</sup>:

$$s = (r - c) \left( \frac{b - a}{d - c} \right) + a \quad (4)$$

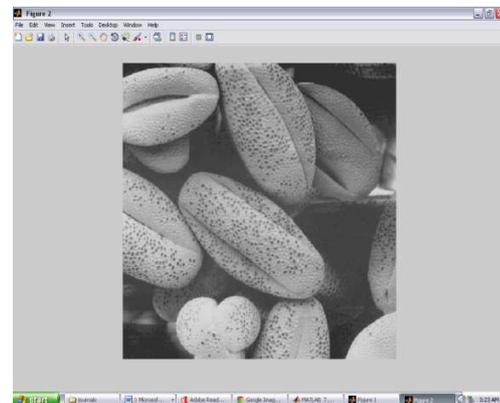
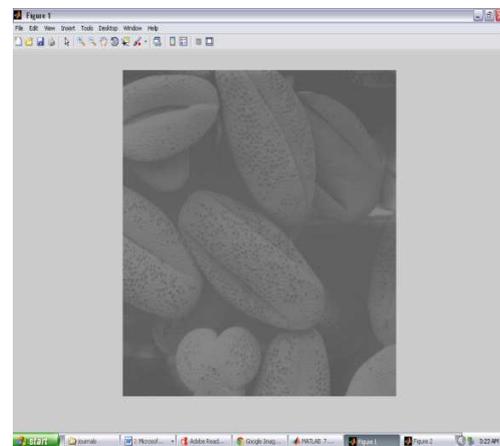
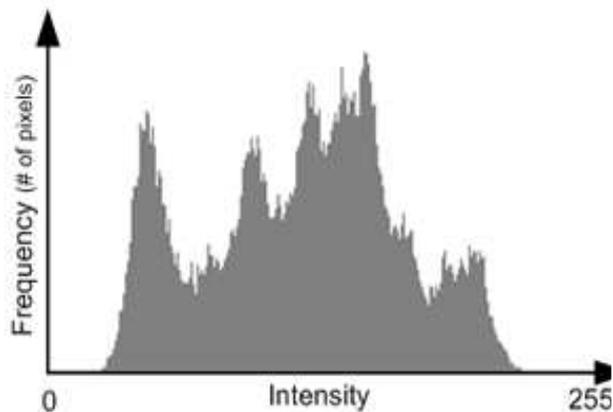


Figure 1 showing the result of contrast stretching

### Histogram Equalization

An image histogram is a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. The horizontal axis of the graph represents the tonal variation, while the vertical axis represents the number of pixel in the particular area. The left side of the horizontal axis represents the black and dark areas, the middle represent medium grey and right hand side represent light and pure white areas.



Histogram equalization is a non-linear contrast enhancement method for modifying the dynamic range and contrast of the image by altering that image so that the histogram of the resultant image is equalized to become a constant. When an image histogram is equalized, all pixel values of the

image are redistributed so there are approximately an equal number of pixels to each of the user specified output grayscale classes[5].The Histogram of digital image with the intensity levels in the range  $[0,L-1]$  is a discrete function[5]

$$H(r_k) = n_k \quad (5)$$

Where  $r_k$  is the intensity value,  $n_k$  is the number of pixels in the image with intensity  $r_k$  and  $H(r_k)$  is the histogram of the digital image with Gray Level  $r_k$

Histograms are frequently normalized by the total number of pixels in the image. Assuming a  $M \times N$  image, a normalized histogram.

$$P(r_k) = n_k/MN \quad K=0,1,2,3,\dots,L-1 \quad (6)$$

is related to probability of occurrence of  $r_k$  in the image.

Where  $p(r_k)$  gives an estimate of the probability of occurrence of gray level  $r_k$ .The Sum of all components of a normalized histogram is equal to 1

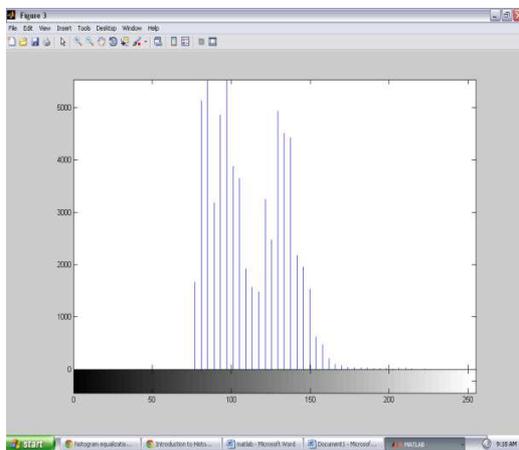
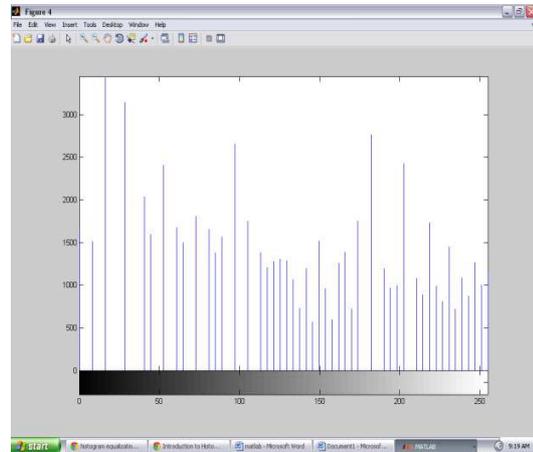


Figure 2 showing the effect of histogram equalization

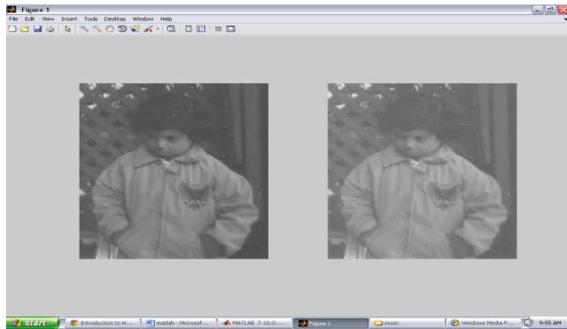
### Gamma correction

Gamma correction operation is used for brightness adjustment. Brightness for the darker pixels are increased but it is almost the same for the bright pixels<sup>6</sup>. Gamma correction is also known as power law transformation. Power-law transformations have the basic form<sup>1</sup>.

$$s = cr^{\gamma} \quad (7)$$

Where  $c$  and  $\gamma$  are positive constants.

For the various values of gamma different level of enhancements can be obtained.



### **Applications of image enhancement**

- In forensics field, to improve the evidence photographs and videos that is not very clear and unidentifiable.
- In biology field, to analyze the forms and structure of animals and plants.
- In automated visual inspection of manufactured goods to inspect for their missing parts.
- In x-ray imaging, ultrasonic and magnetic resonance imaging that is quite Often seen in daily life.

### **CONCLUSION**

Image enhancement techniques provide different approaches for modifying the appearance of an image. The choice of enhancement techniques depends upon various factors such as image content, viewing conditions, characteristics by observer and particular application. Like,

Image Negation is used for highlighting the white details embedded in dark regions and has its uses in medical imaging. Contrast Stretching techniques are applied by stretching the grey levels of an image. Histogram equalization is used by maximize the image contrast by applying a gray level transform which tries to flatten the resulting histogram. Gamma correction improves the brightness of the acquired image.

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