Image Quality Assessment: A Review

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ABSTRACT

Image enhancement is the task of applying certain alterations to an input image like as to obtain a more visually pleasing image. Image enhancement is to improve the image quality so that the resultant image is better than the original image for a specific application or set of objectives. Extensive research has been done on image enhancement and hence it has become essential to categorize the research outcomes and provide an overview of the available enhancement techniques. In this review paper we have done the comparative analysis of various image enhancement techniques like histogram, histogram equalization, RGB to grayscale conversion, spatial and frequency domain, image negative and log transformation. Thus finally it is concluded that Histogram is the best technique for image quality assessment.

Keyword: Histogram, Histogram Equalization Image enhancement, Image quality assessment, Contrast Stretching.

1. INTRODUCTION

Image enhancement is used for improving the visual quality of an image. The fundamental goal of image enhancement is to process the input image in such a way that the output image is more suitable [1].Image Quality Assessment aims to use computational models to measure the image quality consistently with subjective evaluations. Digital image processing plays a vital role in the analysis and interpretation of remotely sensed data. Digital Image Processing involves the modification of digital data for improving the image qualities with the aid of computer .It is a broad subject and often involves procedures which can be mathematically complex, but central idea behind digital image processing is quite simple. The digital image is fed into a computer and computer is programmed to manipulate these data using an equation, or series of equations and then store the results of the computation for each pixel (picture element).

The need of image enhancement arises as the digitized images usually suffer from poor image quality, particularly lack of contrast and presence of shading and artifacts, due to the deficiencies in focusing, lighting, specimen staining and other factors. Because some features are hardly detectable by eye in an image, we often transform images before display Image enhancement is a digital

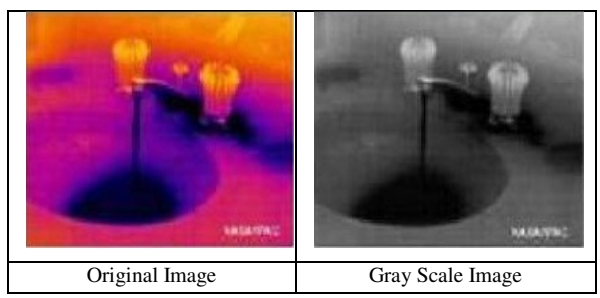
processing method which does its best to improve image vision and makes the image adapt to be processed by computer. It reallymenhances some information inside the image selectively and restrains the other ones. In this way, it is easy to detect and recognize useful information. Thus, the image enhancement is needed in order to improve the quality of image.

2. REVIEW OF LITERATURE

Image-processing methods may be grouped into three functional categories:

Image Restoration compensates for data errors, noise and geometric distortions introduced during the scanning, recording, and playback operations. It basically performs restoring periodic line dropouts, restoring periodic line striping, filtering of random noise, correcting for atmospheric scattering and correcting geometric distortions. Image Enhancement alters the visual impact that the image has on the interpreter in a fashion that improves the information content. It includes the contrast enhancement, intensity, saturation transformations, density slicing, and edge enhancement, making digital mosaics and producing synthetic stereo images. Information Extraction utilizes the decision-making capability of the computer to recognize and classify on the basis of their digital signatures, producing principal-component images, producing ratio images, multispectral classification, producing change-detection images.

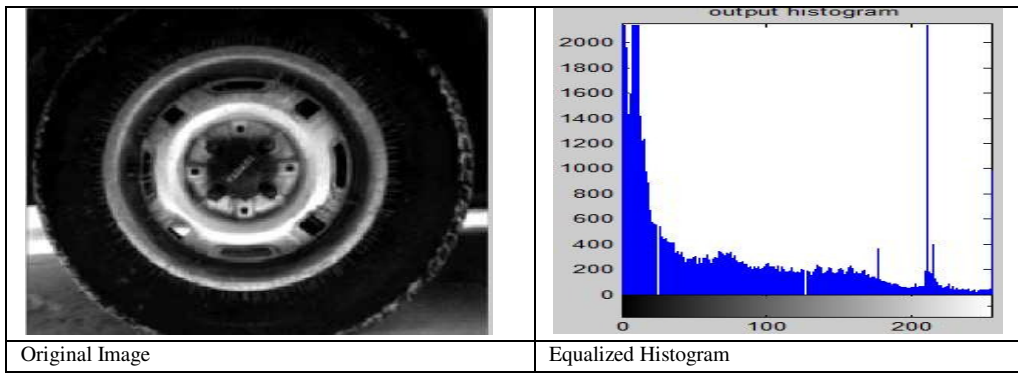
A. Conversion of the RGB image into GRAYSCALE image: In RGB images each pixel has a particular color; that color is described by the amount of red, green and blue in it [2]. If each of these components has a range 0–255, this gives a total of 256^3 different possible colors. Such an image is a "stack" of three matrices; representing the red, green and blue values for each pixel. This means that for every pixel there correspond 3 values. Whereas in grayscale each pixel is a shade of gray, normally from 0 (black) to 255 (white). This range means that each pixel can be represented by eight bits, or exactly one byte. Other grayscale ranges are used, but generally they are a power of 2. Thus, it is concluded that gray image takes less space in memory in comparison to RGB images. Figure 1 clearly depicts the RGB to grayscale conversion.



Original Image	Gray Scale Image

Fig1: RGB to Gray Scale

B. Histogram and Histogram Equalization: The histogram of an image shows us the distribution of grey levels in the image massively useful in image processing; especially in segmentation [3].The shape of the histogram of an image gives us useful information about the possibility for contrast enhancement. Figure 2 shows the image along with its equalized histogram. The histogram of a narrow shape indicates little dynamic range and thus corresponds to an image having low contrast. Histogram equalization is used to enhance the contrast of the image it spreads the intensity values over full range. Histogram equalization involves finding a grey scale transformation function that creates an output image with a uniform histogram. This is the process of equalizing all the grey levels in a digital image. The purpose is to equally utilize all the available grey levels present in the image.



Original Image	Equalized Histogram

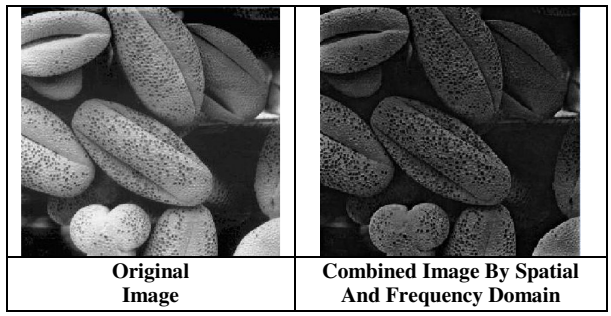
Fig 2: Equalized Histogram

C. Spatial domain Techniques: 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 g(x,y)= T[f(x,y)].

Where g(x,y) is an output image, f(x,y) is an input image and T is an operator on f (or a set of input images), defined over neighborhood of (x,y). Figure 3 depicts the enhancement in the spatial domain.

D. Frequency domain techniques: Frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the image itself. Frequency domain techniques are suited for processing the image according to the frequency content [1]. Figure 3 clearly shows the combined approach of spatial and frequency domain. The principle behind the frequency domain methods of image

enhancement consists of computing a 2-D discrete unitary transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator M, and then performing the inverse transform.



Original Image	Combined Image By Spatial And Frequency Domain

Fig 3: Combined Image By Spatial and Frequency Domain

E. Contrast Stretching: Contrast Stretching is one of the simplest piecewise linear function. Low contrast images can result from poor illumination, lack of dynamic range in image sensor or even wrong setting of lens aperture during image acquisition. The idea behind this technique is to increase the dynamic range of gray levels in the image being processed [5] . This is the technique that is used to stretch the dynamic range of an image. Dynamic range is the range between the minimum intensity value and the maximum intensity value of an image. This transformation will provide good visual representation of the original scene but some of the detail maybe loss due to saturation and clipping as well as due to poor visibility in-exposure regions of the image. In Contrast Stretching we have 2 coordinates-(r1, s1) and (r2, s2).When r1=s1 and r2=s2, we get Linear Transformation. When r1=r2, s1=0 and s2=l-1, we get Threshold Transformation. And intermediate values of (r1, s1) and (r2, s2) gives various degrees of spreads in the transformation.

3. METHODOLOGY ADOPTED

The methodology adopted in the image enhancement is very simple and easy to understand. In the method, the image which is to be enhanced is inserted so that operations can be performed on the image. If the image is colored then the RGB to gray scale conversion is used in order to reduce the number of pixels. The reduced number of pixels requires lesser memory storage so it is a useful conversion to perform. After this conversion the histogram of original image is constructed. Now the histogram equalization technique is applied to equalize the pixels of the grayscale image. When the equalization is done the equalized histogram is also constructed. After all the process is done the comparison is made between the grayscale histogram and equalized histogram. If changes are found in histogram after the comparison then the image is said to be enhanced.[6] Thus, it can be

said image is enhanced using the simple method of histogram equalization. The figure 4 depicts the flow of activites which clearly shows image enhancement by using the histogram equalization technique. The flowchart is used to depict the flow of activities.

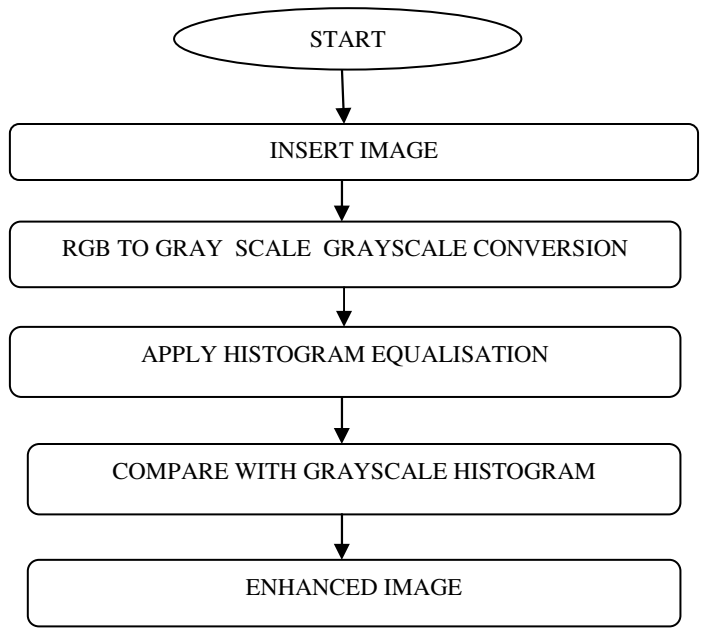


Fig4: Flow of Activities

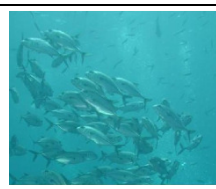
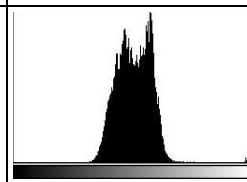
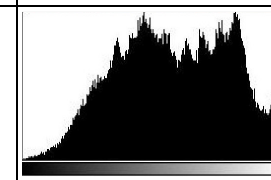
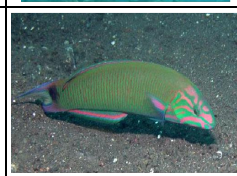
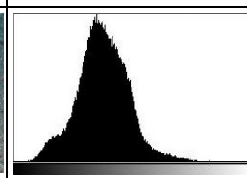
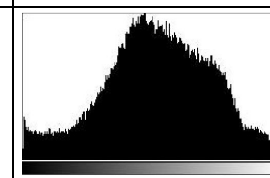
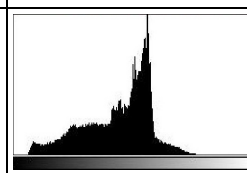
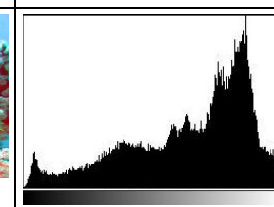
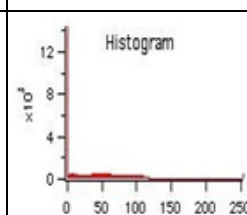
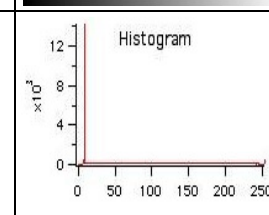
Table 1:Comparative Analysis

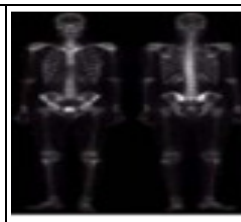
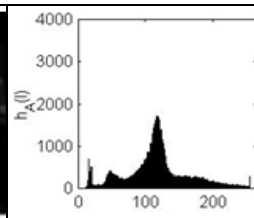
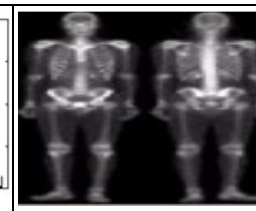
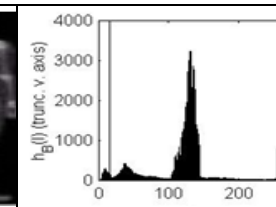
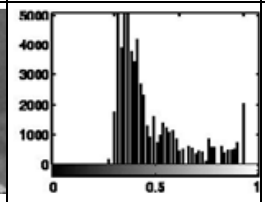
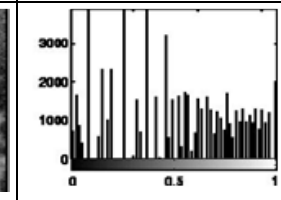
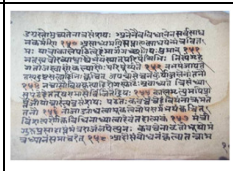
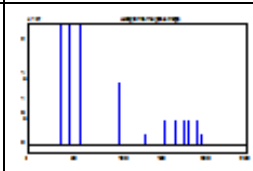
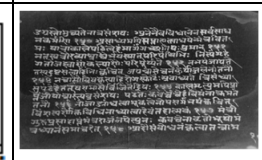
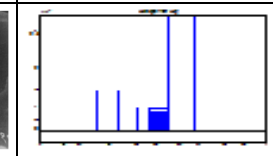
TECHNIQUE	ADVANTAGES	DISADVANTAGES
Histogram Equalization [5]	• Uniform histogram • Fast • Produce optimal contrast	• Uneven illumination
Adaptive Histogram [5]	• Enhance local contrast	• Discontinuity between regions
Image Negative	• Ease of shooting	• Printer limitation
Contrast stretching [5]	• Increases dynamic Range	• Requires more user input
Image Quantization	• Uniform in nature	• Lossy nature
Histogram Matching	• Offers good image contrast	• Computation is slow • High number of operations per pixel

The comparative analysis uses the various techniques like:

Adaptive histogram is used to improve contrast in images. Image quantization is used to compress a range of values to a single quantum value. It is used in audio production. It is opposite to sampling and it is done on y axis. So digitizing the amplitudes is known as quantization. Image negative is a method that reproduces the bright portions of the photographed subject as dark and dark areas appear light. Negative image is an image that has been formed on a transparent material that can be likened to a plastic or glass. Histogram Matching is a method of color adjustment of two images using the image histogram. It is also known as Histogram specification. The comparative analysis gives the overall description of the various techniques for the image enhancement. Table 1 depicts the comparative analysis among the different image enhancement techniques for the quality assessment of an image. While going through the analysis the advantages and disadvantages are easily understandable.

Table 2:Comparative Analysis Result

TECHNIQUES	*ORIGINAL IMAGE*	*HISTOGRAM*	*ENHANCED IMAGE*	*EQUALIZED HISTOGRAM*
Contrast stretching.[18]				
Image Enhancement [18]				
Histogram Equalization [18]				
Adaptive Histogram				

Histogram matching[17]				
Image Quantization[17]				
Image Negative				

4. RESULTS & DISCUSSIONS

The result obtained from the enhancement of the images is the improvement of the image in which we get the useful information. The histogram obtained from these images is also improved which shows that image is enhanced, the intensity range is also better. Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images. The result can be discussed using the table 2. Table 2 shows the image enhancement techniques along with histogram construction. Here the original image is shown along with histogram of that image. Later on after applying the enhancement technique the enhanced image is constructed along with its histogram. Now if there are changes in original histogram and the enhanced histogram thus it is concluded that image is enhanced.

5. CONCLUSION AND FUTURE RESEARCH

Image enhancement techniques for gray scale images in spatial domain have been successfully implemented and also discussed the results for each method. The quality of the images is statistically illustrated through the histograms. There is ample scope for future work in this research work to further improve the performance of the Image Enhancement Method. Automation of this method will help getting the of satisfactory parameters faster and there is Adaptive approach to neighborhood calculation increase the efficiency of image enhancement process. The concept of age progression can be implemented. The future scope will be the development of adaptive algorithms for effective image enhancement using Fuzzy Logic and Neural Networks.

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