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Contrast Enhancement and Brightness Preservation of Radiography Images using Gamma Correction

Toshi Patel[1]
Department of Computer Science
SRMSCET, Bareilly
[1]*toshipatel16@gmail.com*

Prabhakar Gupta[2], Mukesh Azad[3]
Department of Computer Science
SRMSCET, Bareilly
[2]*prama63@yahoo.com*,[3]*mukeshazad1985@gmail.com*

Abstract— In this Research paper, the purpose of Image enhancement is to process an image so that result is more suitable than original image for particular application. Digital image enhancement techniques provide a multitude of choices for improving the visual quality of images. Appropriate variety of such techniques is greatly influenced by the imaging modality, undertaking at hand and viewing situation. This paper will provide an overview of underlying concepts, along with algorithms normally used for image enhancement. An image can have low contrast or undesirable quality due to a number of reasons like reduced quality of imaging device, unfavorable external conditions at the time of image preprocessing and many more. Image enhancement is used to improve the usual effects and clarity of image or to make the original image more favorable for computer to process. In proposed method, full image has been divided into two parts in low contrast and high contrast on the basis of their threshold value. We have applied large gamma values only on low contrast image using gamma correction which will be more informative. With the help of merging we get the resultant radiography image. The results will be compared on the basis of histograms, mean, standard deviation, variance and average gradient values and compared with existed gamma correction techniques using matlab.

Keywords- *Image Enhancement, Histogram Thresholding, Gamma Correction Measurement*

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I. INTRODUCTION

In today's scenarios health concern services or practices and the development of the common platforms for radiography images have resulted data in efficient way. Digital Image Processing is a rapidly evolving field with the growing applications in science & engineering. Image Processing holds the possibility of developing an ultimate machine that could perform visual functions of the entire living beings. An image can have low contrast or bad quality due to a number of reasons like low quality of imaging device, adverse external environment at the time of image acquisition and many more [1]. The image processing is a visual responsibility, the foremost step is to get an image i.e. image acquisition then enhancement and lastly to process. In this, there are information for image enhancement for the purpose of image processing. Image enhancement is mainly improving the digital image quality.

Contrast is an important feature in any objective evaluation of image quality. Contrast is produced by the difference in luminance reflected from two adjacent surfaces. In additional words, contrast is the difference in visual properties that display an object distinguishable from other objects and the background. In visual perception, contrast is determined by the difference in the color and intensity of the object with other objects. Our visual system is more perceptive to contrast than complete luminance; therefore, we can perceive the world similarly regardless of the considerable changes in illumination conditions. Contrast enhancement is a process in which change the image value distribution to cover a wide range [2]. Contrast enhancement is one of the mainly common methods of low-level digital image processing.

The Paper is organized as: first part covers introduction including subparts as Radiography Images, Segmentation and Gamma Correction. Second part includes existing techniques. Third part comprise of proposed algorithm. Fourth part covers experiment and result discussion. At last, conclusion and future work.

A. RADIOGRAPHY IMAGES

A radiography image is basically used in the medical science. Radiology is a branch of medicine that uses imaging technology to diagnose and treat disease. Radiology may be categories into two different areas, diagnostic radiology and interventional radiology. The branch of therapeutic radiation, which uses more powerful x-rays to treat cancer, is now called radiation oncology. It is an imaging technique that uses electromagnetic radiation other especially X-rays to view the internal structure of a non-uniformly collected and difficult object (i.e. a non-transparent object of unreliable density and composition) such as the human body.

B. SEGMENTATION

Image segmentation is the method of isolating an image into various parts. Segmentation refers to the process of partitioning a digital image into the different segments (set of pixels as known as super pixels). The goal of segmentation is basically segment an image into something that is more meaningful and easier to analyze [3].This is usually used to recognize objects or extra relevant information in digital images. The following categories are used:

Threshold based segmentation: It is basically used to segment an image on the basis of their threshold value. Thresholding methods replace each pixel in an image with a black pixel if the image intensity $I_{i,j}$ is less than some fixed constant T (that is, $I_{i,j} < T$), or a white pixel if the image intensity is greater than that constant [4].

Edge based segmentation: The edge-based segmentation can simplify the study by considerably minimizing the amount of pixels from an image to be processed, while still preserving adequate object structures. It is also used to find the object boundaries and then locate the object itself by filling them.

Region based segmentation: Region growing is an easy region-based image segmentation method. It is also classified as a pixel-based image segmentation technique since it involves the selection of initial seed points. These approaches to segmentation determine neighboring pixels of initial starting points and determine whether the pixel neighbors should be added to the region.

Clustering Techniques: Clustering is basically used where the gray-level samples are clustered in two parts as background and foreground (object), or alternately are modeled as a combination of two Gaussians.

Here, we use threshold based segmentation to find the threshold value to divide an image into two parts contain low contrast and high contrast regions.

C. GAMMA CORRECTION

The Gamma correction is based on a non-linear multiplication based conversion and it overcomes the effect of light [5]. Gamma correction, gamma nonlinearity, gamma encoding, or often simply gamma, is the name of a nonlinear operation used to code and decode luminance or tristimulus values in video or still image systems. Gamma correction is, in the simplest cases, defined by the following power-law expression-

$$Vout = AVin^{\gamma}$$

Where A is a constant and the input and output values are non-negative real values; in the common case of A = 1, inputs and outputs are typically in the range 0–1. A gamma value $\gamma < 1$ is sometimes called an encoding gamma, and the process of encoding with this compressive power-law nonlinearity is called gamma compression; conversely a gamma value $\gamma > 1$ is called a decoding gamma and the application of the expansive power-law nonlinearity is called gamma expansion. The concept of gamma can be applied to any nonlinear relationship.

II. EXISTING TECHNIQUES

A number of techniques which are available to improve the contrast and preserve the brightness of an image. These are Histogram Equalization, Gamma Correction, Multi Histogram Equalization, Homomorphic Filtering, Brightness Bi-Histogram Equalization (BBHE) and many more.

Histogram equalization is a way for adjusting image intensities to enhance contrast. It can improve the contrast of the image but the area appeared too light enhancement and used for contrast enhancement in a variety of application due to its simple function and effectiveness [6]. Histogram indicates that most of the pixels are too dark only the minority of pixel is light. This technique work by construction the histogram and stretching the dynamic range of the grey intensity by using the cumulative density function of the image. There is a still one problem of the histogram equalization is that brightness of an image is changed later than the histogram equalization, hence not suitable for consumer electronic products, where control the original brightness and enhancing contrast are essential to avoid frustrating artifacts.

The Gamma correction is depending on a non-linear multiplication-based conversion and has been used to gray-intensity image analysis [5]. A proper estimation of gamma value improves the contrast of the image. Gamma correction is luminance based non-linearity presented by imaging device can often explain with simple point-wise operation called gamma correction. Luminance is the area of light. They evaluate the luminance intensities per unit area of light traveling in a given direction .It describes the amount of light that passes through or it emitted from particular area. Gamma correction method has a number of advantages to overcome the effect of light. Gamma correction controls the overall brightness of an image.

Multi Histogram Equalization decompose the image into numerous sub-images, such that the image contrast enhancement provided by the HE in each sub image is less intense, most important the output image to have a more natural look. The image decomposition process is depending on the histogram of the image. The histogram is divided into classes, determined by threshold levels, where every histogram class represents a sub-image. The decomposition process can be seen as an image segmentation process executed during multi-threshold selection [8].

Brightness Bi-Histogram Equalization (BBHE) is a novel extension of typical histogram equalization. The BBHE utilizes independent histogram equalization over two sub images obtained by decomposing the input image based on its mean [9]. This method divides the image histogram into two parts. In this method, the separation intensity is presented by the original mean brightness value, which is the average intensity of all pixels that construct the input image. After this partition process, these two histograms are alone equalized.

III. PROPOSED ALGORITHM

The proposed method basically works to improve the contrast of the original image. It basically controls the brightness of an image. The algorithm is basically explaining the low contrast part of the image to reach the high contrast. When the low contrast part of the image is improved in high contrast then resultant image will give better information. The steps of presented algorithm are:

1. Firstly, initialize a low contrast radiography image. Then apply preprocessing technique.
2. Plotting histogram of an original image. After that we will find threshold value of the image.
3. With the help of segmentation, we will segment an image into low contrast and high contrast on the basis of their threshold value.
4. Apply high gamma values only on the low contrast of an image.
5. Show resultant output image and histogram of an image.

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6339 - 6343

6. Calculate mean, standard deviation, variance and average gradient for the resulted image and compare with gamma correction technique.

IV. EXPERIMENT AND RESULT DISCUSSION

To verify the efficiency of the method, in the present paper to improve contrast and preserve brightness of an image.

Figure 1. Original Image

As we have seen in figure 1, this is the original radiography image which is implemented to improve the contrast and preserve brightness.

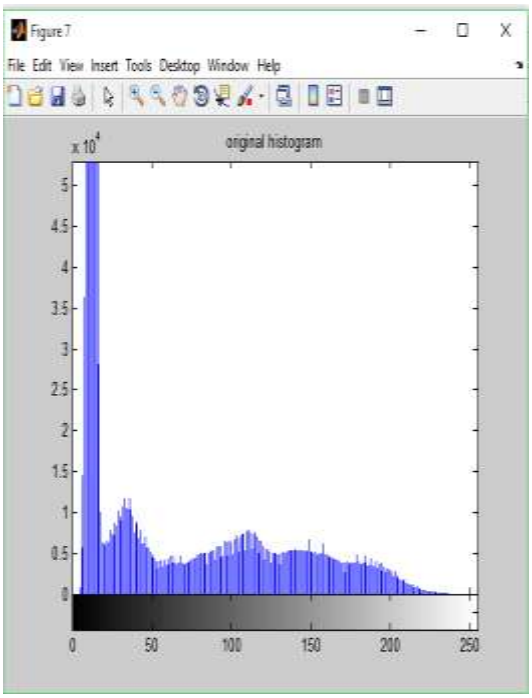

Figure 2. Histogram of original Image

As we above seen figure 2, this is the histogram of the original radiography image. By which we can see the difference between resultant image. Histogram is a bar graph, whose X-axis represents the tonal scale (black at the left and white at the right), and Y-axis represents the number of pixels in an image in a certain area of the tonal scale.

Figure 3. Gamma Corrected Image

As we above seen, this is gamma corrected image which is generated when we apply gamma correction to the original image. In the traditional Gamma Correction algorithm improve the low contrast images.

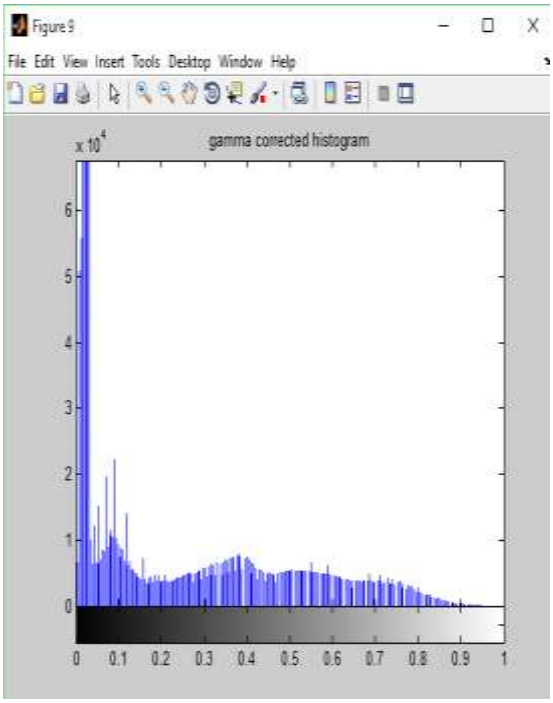

Figure 4. Histogram of Gamma Corrected Image

This is the histogram of the Gamma Corrected Image. By which we use use this to find out the results and compare with the proposed method.

 ISSN: 2321-8169
6339 - 6343

Figure 5. Proposed Method Image

The Proposed method shows the result where low contrast radiography image regions increases. Algorithm basically enhances the contrast and improves the visual quality of radiography images that captured under insufficient lighting conditions. It enhances the quality in terms of their features which is mean, standard deviation, Variance and average gradient.

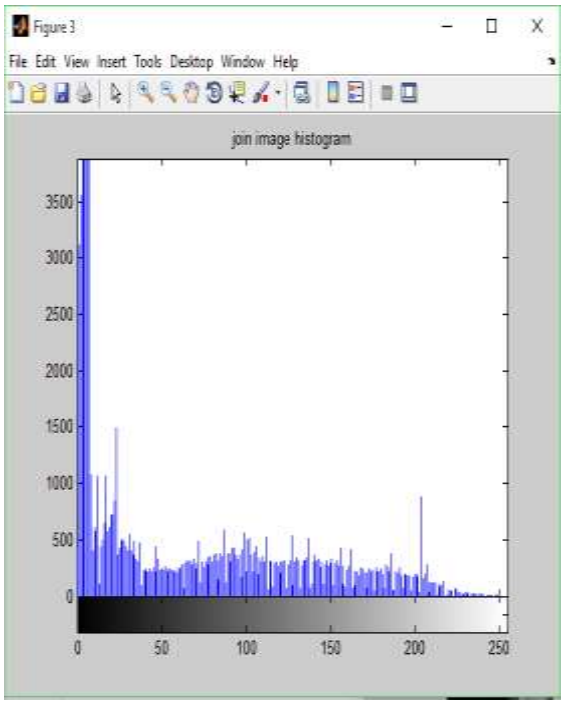

Figure 6. Histogram of Proposed Method

This is the histogram of proposed method which is used to find out the results comparison.

Table 1. Showing mean, standard deviation, variance and average gradient for image 1 (T=22)

Techniques	Mean	Standard Deviation	Variance	Average Gradient
Gamma Correction	51.7882	62.1971	85.9247	2.453
Proposed Method	52.5420	65.1953	86.9976	3.581

The Table 1 shows the result of the proposed method will be compared with the traditional method on the basis of performance measurement. A mean is function can be used to evaluate the image contrast. Over the region what is the contrast value after the reconstruction of image. Standard deviation provides fewer rounds off noise and greater computational efficiency. Average gradient can express the ability of small details. Can be used to evaluate the clarity of the image, the greater its value, the more clear that the image. A variance is function can be used to measurement of the spread between numbers in data set. The variance measure how far each no.in the set is from mean.

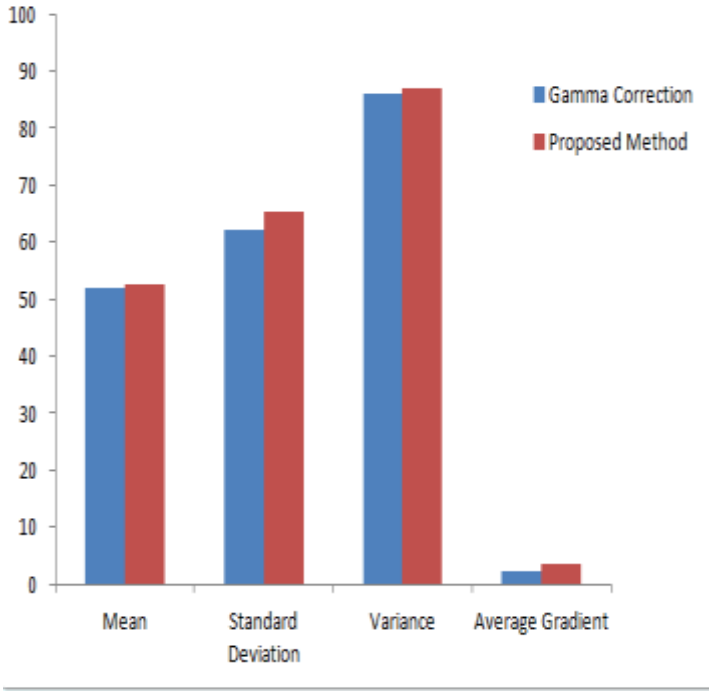

Figure 7. Bar graph of table 1

This Bar Graph is basically shows the comparison between the traditional Gamma correction technique and proposed method for the radiography images.

V. CONCLUSION AND FUTURE WORK

In the proposed method can decrease the loss of low contrast in local regions by applying high value gamma correction to that portion. The ultimate goal behind the proposed method is to allow higher level of brightness preservation to avoid unpleasant artifacts and unnatural enhancement due to extreme equalization while improving the contrast of a given image as much as possible. In future work, algorithm can use to other images.

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