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Low Contrast Image Enhancement Using Fuzzy Logic Techniques

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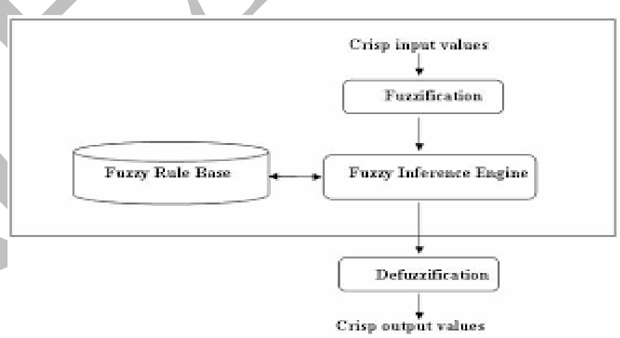
ABSTRACT—
Most of application in use display picture on limited bandwidth to not clarity and user to difficult in this condition verifies who's. So we use The Image Enhanced to clarity/quality (Contrast, Brightness and remove noise etc) to use difficult techniques in image research. In Image we have to difficulties like Social site image, medical image, satellite image and real life photographs due to noise and poor contrast. So it is essential to improve the contrast and remove the noise to enhance image value. We have to provide a better transform representation for prospect robotic image processing the clarity/ quality of images for human screening, sharpening edges, remove blurring and noise, growing contrast, and helpful details. In this paper, we present an overview of low contrast image enhancement processing techniques in Fuzzy logic. Thus the part of this paper is to categorize and analysis image enhancement processing technique, endeavor an evaluation of shortcoming and universal requirements in this field of active research and in last we will point out promise instructions on research for Low contrast image enhancement for prospect research.

Keywords:— Fuzzy logic Techniques, Histogram equalization and Matlab R2008b **.**

1. INTRODUCTION

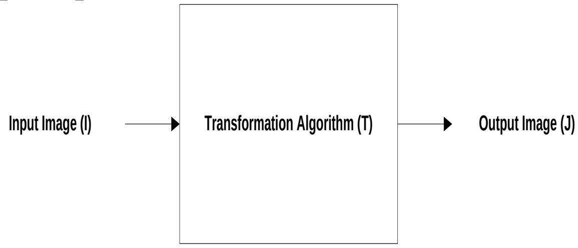
Image Enhancement depends upon to the input image to give appropriate output. Which I can acquire resultant in this paper. Good contrast images with preserving details are required for many important areas namely machine vision, remote sensing, dynamic and traffic scene analysis, biomedical image analysis and autonomous navigation. It provides better input image for further image processing task [1].

In Paper Also discuss to fuzzy inter face and fuzzy rule based.



The values of pixels in images I and J are denoted by p and q, respectively. As said, the pixel values p and q are related by the expression,

$$q = T(p) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

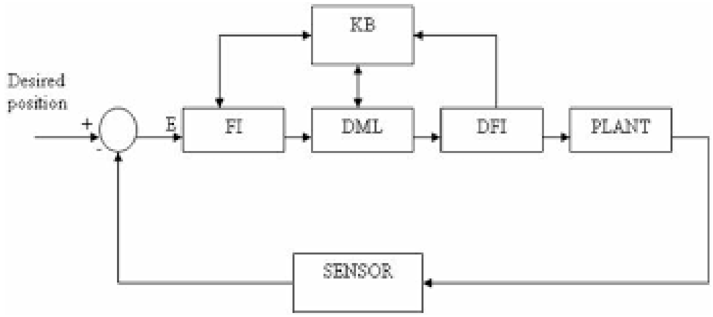


Where T is a transformation algorithm that maps a pixel value p into a pixel value q. for example an 8-bit image the range of pixel values will be [0, 255]. The same theory can be extended for the color images too [2].
The paper is organized as follows:
Section II. Describes the Literature analysis.
Section III. Describes the Proposed method of this paper
Section IV describes the Performance Analysis technique Image.
Section V. Conclusion & Future Scope.

2. LITERATURE ANALYSIS

There are many image enhancement methods have been proposed. A very popular technique for image enhancement is histogram equalization (HE). This technique is commonly employed for image enhancement because of its simplicity and comparatively better performance on almost all types of images. The operation of HE is performed by remapping the gray levels of the image based on the probability distribution of the input gray levels. It stretches the dynamic range of the image's histogram and resulting in overall contrast enhancement [4]. In addition, due to the poor and low contrast nature of the acquired image, vagueness and ambiguity are introduced and have led to the increment of uncertainty in the image information. This vagueness in the image appears in the form of imprecise boundaries and intensities during image digitization.
Therefore, fuzzy sets theory [3] has been proposed as a problem solving tool between the precision of classical mathematics and the inherent imprecision of the real world. The imprecision possessed by the acquired image can be perceived qualitatively by human reasoning. However, there is no specific quantification to describe the imprecision and thus machine may not understand them. Realizing this limitation to a great extent, fuzzy logic tools empower a machine to mimic human reasoning.

Image enhanced presented a new approach for the enhancement of color images using the fuzzy logic technique[5-7]. And proposed image enhancement operation that used the value of grey entropy in the neighborhood window as parameters to measure the level of current pixel being edge point [8-10]. A fuzzy grayscale enhancement technique for low contrast image. Most of the developed contrast enhancement techniques improved image quality without considering the no uniform lighting in the image[11-13]. Here, the fuzzy grayscale image enhancement technique is proposed by maximizing fuzzy measures contained in the image. Then, to enhance the image, membership function is modified by using power-law transformation and saturation operator. Their proposed method produced better quality enhanced image and required minimum processing time than the other methods. Finally, The new enhancement technique using fuzzy set theory has been developed for grayscale non-uniform illumination image. Findings signified that the proposed method produced better image quality and defeated other methods in terms of image contrast and measure of fuzziness without enhancing existing noise in the image. The proposed algorithm only required minimum processing time (i.e approximately 62ms) and thus made it as suitable approach to be used in the real time application.



3. PROPOSED APPROACH

In this paper wide variety of approaches for modifying images to achieve visually acceptable images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. In this paper, a survey on various techniques for image enhancement ,one of the most important and difficult component of digital image, is carried out with the existing methods like histogram equalization, fuzzy based methods and other optimization techniques those used for image contrast enhancement. Histogram equalization method leads to excess enhancement in-order to overcome it fuzzy is used. Fuzzy rule based technique and its computation gives very ample improvement in contrast enhancement whereas better results can be obtained by using optimization techniques.

3.1 Image representation in fuzzy set notation

An image X of size M*N having gray levels ranging from [L]min to max can be modeled as an array of fuzzy singletons. Each element in the array is the membership value representing the degree of brightness of the gray level l (l= Lmin, Lmin +1 ,…, ,Lmax). In the fuzzy set notation, we can write

$X = \bigcup\{\mu(m_{i,j})\} = \{\mu_{i,j} / m_{i,j} \quad i = 1,2,...,M$ and j=1,2,...,N}

where $\mu(m_{i,j})$ denotes the degree of brightness possessed by the gray level intensity $m_{i,j}$ of the (i,j)th pixel.

3.2. Define the Membership Function

The shape of S-function is commonly used for the representation of the degree of brightness or whiteness of pixels in the grey levels images.

$$\mu(m) = \begin{cases} 0 & for\ m \le a \\ \dfrac{m-a}{(b-a)(c-a)} & for\ a<m \le b \\ 1-\dfrac{(m-c)^2}{(c-b)(c-a)} & for\ b<m \le c \\ 1 & for\ m \ge c \end{cases}$$

Where m is the intensity of the image and a, b and c are parameters that determined the shape of the S-function. The parameters a, b and c are specified to ensure the membership function maximizes the information contained in the image. Therefore parameters a, b and c are calculated as follows:

Assume the image has gray levels from Lmin to Lmax.

1. Obtain the histogram Hist(x).

2. Find the local maxima of the histogram,Max(Hist(x1)), Max(Hist (x2)),…, Max(Hist(xk)).
3. Calculate the average height of the local maxima.

$$\overline{Hist_{\max}(X)} = \frac{1}{k}\sum_{i=1}^{k} Hist_{\max}(Xi)$$

4. Select a local maximum as a peak if its height is greater than the average height $\overline{Hist_{\max}(X)}$ otherwise, ignore it.
5. To determine the value of parameter a and c, select the gray level of first peak P(x1) and the last peak P(xk) that is,
a=P(x1) and c=P(xk);
6. Determine parameters b the midpoint of the interval [a, c].

The calculated membership function transformed the image intensity levels from the spatial domain to fuzzy domain. The original image has been transformed and most of the regions in the image contained mixed region of overexposed and underexposed regions.

3.3 Adaptive fuzzy contrast enhancement using defuzzification

The goal of our proposed method is to take care of the fuzzy nature of an image and the fuzziness in the definition of the contrast to make the contrast enhancement more adaptive and more effective, and to avoid over-enhancement/under-enhancement.so for adaptive fuzzy contrast enhancement defuzzification is applied that transforms the membership value $\mu(m)$ to the gray level by using the following formula:

$$\mu_{enh} = \begin{cases} \sqrt{\tau\mu(m)} & \text{for } \mu(\text{m})<\text{T} \\ \mu(m)^2 & \text{for } \mu(\text{m}) \geq \text{T} \end{cases}$$

Where τ is the enhancement factor that is used to enhance the image .

It is known that the gray levels of the image are heap near the maximum gray level and minimum gray level for overexposed and underexposed regions respectively. A power-law transformation operator is defined for the improvement of the overexposed region of the image. The intensities of the membership function in overexposed region are improved by modifying their membership function in this region.

Meanwhile the underexposed regions have the exposure values less than 0.5 and thus only need a gradual amount of saturation enhancement. It transforms the membership values that are above 0.5(default value) to much higher values and membership values that lower than 0.5 to much lower values in a nonlinear manner to obtain good enhancement image otherwise show the not enhancement image.

4. PERFORMANCE ANALYSIS

The proposed method has been implemented on Intel Core 2 CPU 2GHz using Matlab R2008b. 100 standard images (size: 400x264) obtained from California Institute of Technology database which consist of underexposed and overexposed regions are considered as test images.

The enhanced image is analyzed in terms of its output quality and quantitative analysis such as index of fuzziness (IOF), peak signal to noise ratio (PSNR) and processing time.

In order to demonstrate the performance of the proposed method, we compared qualitatively and quantitatively the experimental results of the proposed approach with other state of the art
methods namely fuzzy set theory [35], conventional approach of NINT [38], application of fuzzy IF-THEN rules (fuzzy rule-based) [39], fuzzy quantitative measure [40] and fuzzy local enhancement [41], are widely used in image enhancement.

The enhanced images produced by the proposed methods are presented in Figures 5.1 to 5.4. For the subjective qualitative analysis of processed image appearance, the test images namely 'lena, 'papper', 'Man' and 'Baboon' are shown in these figures. The original images have poor brightness in the underexposed regions and brightness is higher in the overexposed regions

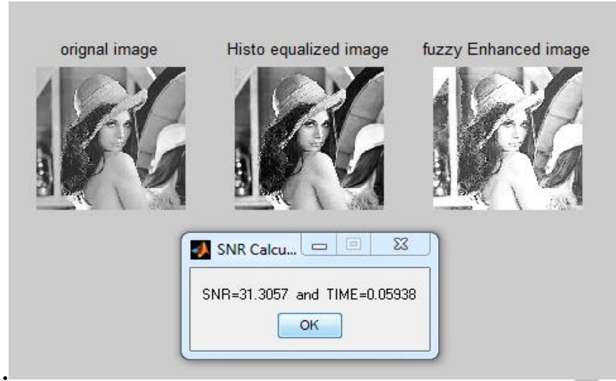


FIGURE 5.1: (A) ORIGINAL IMAGE (LENA), ENHANCED IMAGE WITH (B) HISTOGRAM EQUALIZATION (C) PROPOSED METHOD WITH SNR AND TIME CALCULATION

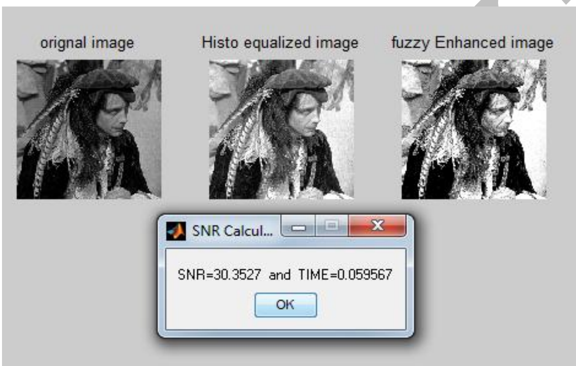


FIGURE 5.2: (A) ORIGINAL IMAGE (MAN), ENHANCED IMAGE WITH (B) HISTOGRAM EQUALIZATION (C) PROPOSED METHOD WITH SNR AND TIME CALCULATION

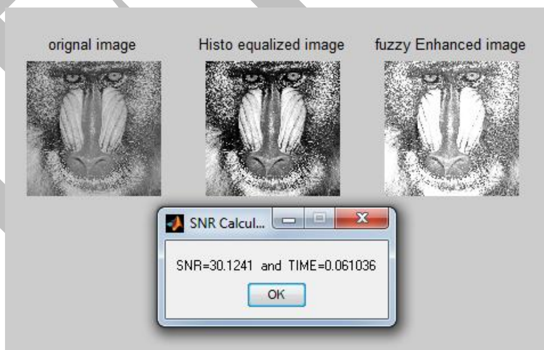


FIGURE 5.3: (A) ORIGINAL IMAGE (BABOON), ENHANCED IMAGE WITH (B) HISTOGRAM EQUALIZATION (C) PROPOSED METHOD WITH SNR AND TIME CALCULATION

FIGURE 5.4: (A) ORIGINAL IMAGE (PAPPER), ENHANCED IMAGE WITH (B) HISTOGRAM EQUALIZATION (C) PROPOSED METHOD WITH SNR AND TIME CALCULATION.

The qualitative analysis presented in the Figures 1 to 4 can be supported by quantitative analysis presented in Table 5.1. The average analysis for 100 standard images of proposed method, NINT, fuzzy rule-based, fuzzy quantitative analysis and fuzzy local enhancement presented in Table 5.1 are discussed. For each analysis, the best results obtained are made bold.

Table 5.1 indicates that the proposed method has the best performances in terms of smallest IOF, highest PSNR and obtained good contrast. However, in terms of the average execution time, NINT has the fastest processing time because NINT is less complex and treated the whole image as mixed region without considering overexposed and underexposed regions.

Table 5.1 Quantitative Enhancement Analyses For 100 Standard Images (Average Values)

Method\Analysis	Processing Time T(s)	IOF	PSNR (dB)
Proposed Method	0.059	0.402	**30.77**
Fuzzy Set Enhancement	0.062	**0.349**	22.039
NINT	**0.050**	0.443	13.947
Fuzzy rule-based	11.921	0.367	19.096
Fuzzy Quantitative Measure	0.063	0.410	15.417
Fuzzy Local Enhancement	11.163	0.584	19.063

Figure 5.5 shows the computational time of the proposed method with other enhancement methods . Figure 5.5 shows comparison graph of the IOF among proposed method and other enhancement methods. Figure 5.5 shows comparison graph of the proposed method and other enhancement methods with respect to PSNR Calculation

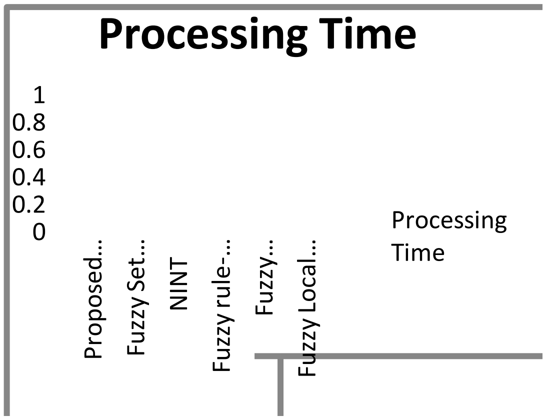


FIGURE 5.5: THE EXECUTION TIME(SEC) COMPARISON OF OUR PROPOSED METHOD WITH OTHER EXISTING METHOD

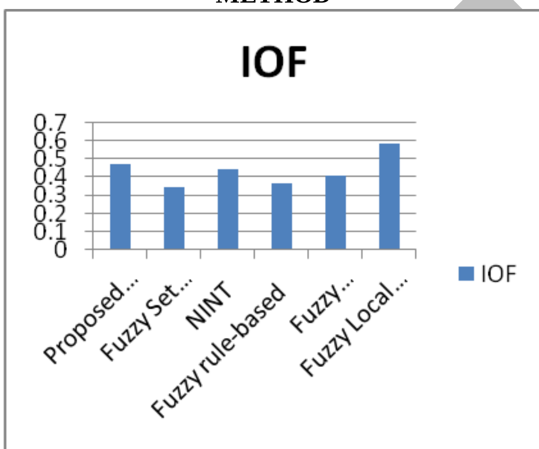


FIGURE 5.6: THE IOF COMPARISON OF OUR PROPOSED METHOD WITH OTHER EXISTING METHOD

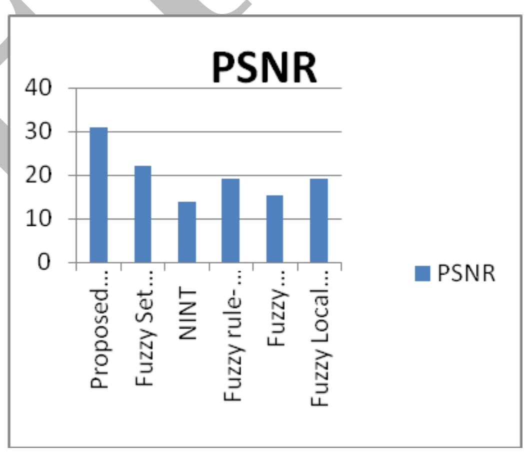


Figure 5.7: The PSNR comparison of Our proposed Method with other existing method

5.Conclusion & Future Scope

Image enhancement techniques used in future for many areas such that Forensics, Astrophotography, Fingerprint matching and robotics etc. many researchers have applied the fuzzy logic to develop image processing algorithms to calculate exact value and recognize.

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