# Contrast Modification In Image Using Fuzzy Based Methodology

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***Abstract:***

The aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide 'better' input for other automated image processing techniques. Fuzzy techniques can manage the vagueness and ambiguity efficiently (an image can be represented as fuzzy set). Fuzzy logic is a powerful tool to represent and process human knowledge in form of fuzzy if-then rules. The manipulation of these concepts leads to theory of approximation using fuzzy systems in image processing. In recent years, many researchers have applied the fuzzy logic to develop new image processing algorithms. The fuzzy image processing is one of the important application areas of fuzzy logic. The proposed algorithm is using fuzzy membership function. This algorithm enhances image contrast very effectively. If the observed data are disturbed by random noise then the intensifier operator should convert the probabilistic data into fuzzy data. Some images are not available to good quality, so proposed fuzzy algorithm can be used for image enhancement to improve the quality of images.

## I.INTRODUCTION

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or a machine. Enhancement of noisy image data is a very challenging issue in many research and application areas. Image enhancement techniques can be divided into three broad categories:

1) Spatial domain methods, which operate directly on pixels.
2) Frequency domain methods, which operate on the Fourier transform of an image.
3) Fuzzy domain methods, which involves the use of knowledge-base systems that are capable of mimicking the behavior of a human expert.

Fuzzy logic represents a good mathematical framework to deal with uncertainty of information. Fuzzy image processing is the collection of all approaches that understand represent and process the images, their segments and features as fuzzy sets. In the last few years, nonlinear filters based on fuzzy models have been shown to be very effective in removing noise without destroying the useful information contained in the image data.

The proposed algorithm is using fuzzy membership function. This algorithm enhances image contrast very effectively. If the observed data are disturbed by random noise then the intensifier operator should convert the image data into the fuzzy domain and process some morphological operation. So apply proposed algorithm then find the good contrasted image compare to the original image, preserving the all the image data.

Image can be defined as a two dimensional light intensity function f(x, y), where x and y denotes spatial co-ordinates and the value of „f „at any point is directly proportional to the brightness (gray level) of the image at that point.

Digital image processing an image may be defined as two dimensional function f(x y) where x and y are spatial (plane) coordinates and amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of image at that point. Where x, y and amplitude values of f are all finite, discrete quantities then it called digital image processing. Digital image processing starts with one image and produces a modified version of that image. Digital image analysis is a process that transforms a digital image into something other than a digital image, such as a set of measurement data, alphabet text, or a decision. Image digitization is a process that converts a pictorial form to numerical data. Spatial domain: spatial domain methods are procedures that operate directly on these

pixels spatial domain process will be denoted by the expression. g(x, y) = T[f(x, y)] where f(x, y) input image, g(x, y) is processed image and T is an operate on f defined over some neighborhood of (x y).

There are several noises that may degrade the quality of an image.

- Amplifier noise (Gaussian noise)
- Salt-and-pepper noise
- Quantization noise (uniform noise)

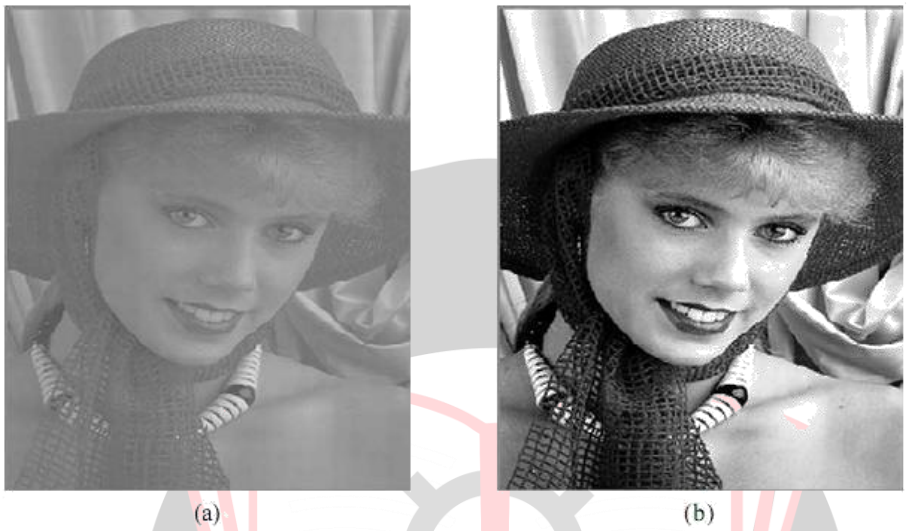



**Fig.1: Difference between Each Noise**

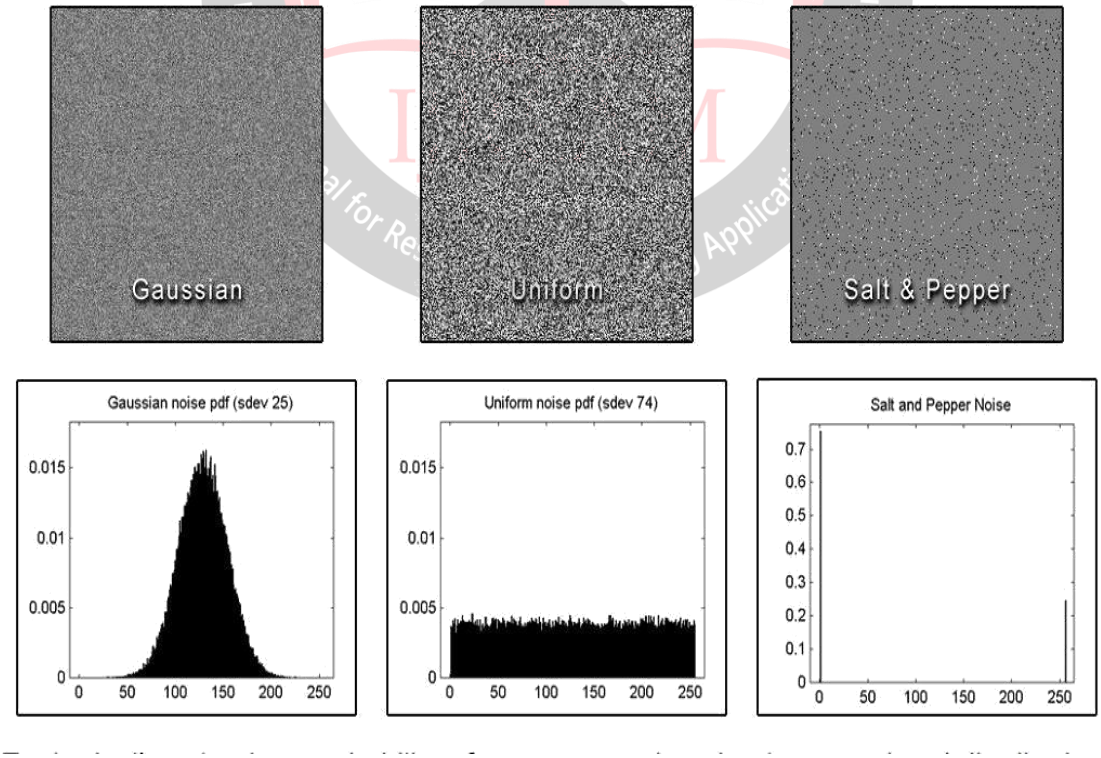



**Fig2. Original Image (b) Enhancement Image**

Image enhancement means getting a clearer image. Image enhancement can be treated as transforming one image to another so that the look and feel of an image can be improved or machine analysis or visual perception of human being.

## II. LITERATURE SURVEY

### 2.1 Enhancement

Image enhancement processes consist of a collection of techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a human or a machine. The principle objective of image enhancement techniques is to process an image so that the result is more suitable than the original image for a specific application. It is often used to increase the contrast in images that are substantially dark or light. Image enhancement entails operations that improve the appearance to a human viewer, or operations to convert an image to a format better suited to machine processing.

Image enhancement refers to those image processing operations that improve the quality of input image in order to overcome the weakness of the human visual system.

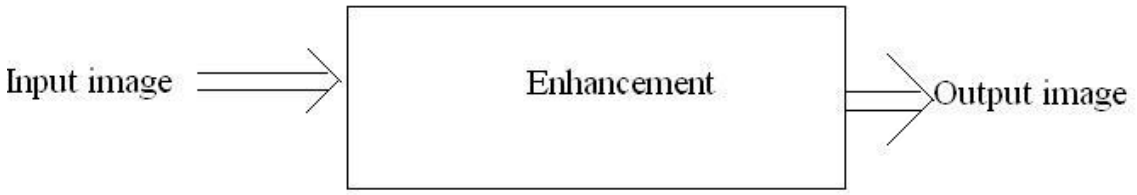



**Figure 2.1: Image Enhancement Operation**

**Image enhancement techniques can be divided into three broad categories:**

2.1.1 Spatial domain methods.
2.1.2 Frequency domain methods (DFT).
2.1.3 Fuzzy Domain.

#### 2.1.1 Spatial domain methods

Spatial domain methods which are operate directly on pixels. Spatial domain method pixel values may be modified according to rules that depend on the original pixel value (local or point processes). Alternatively, pixel values may be combined with or compared to others in their immediate neighborhood in a variety of ways.

Consider the input image f(x,y) and processed image g(x,y) then the transformation g(x,y)=T[f(x,y)], Where T is an operator on f defined over some neighbourhood of (x,y). The operator T is applied at each location (x,y) to yield output g at that location. The process uses pixels in the area of image spanned by neighbourhood. Example: Thresholding

#### 2.1.2 Frequency domain methods (DFT)

Frequency domain which operate on the Fourier transform of an image.

- Edges and sharp transitions (e.g., noise) in an image contribute significantly to high-frequency content of Fourier transform.
- Low frequency contents in the Fourier transform are responsible to the general appearance of the image over smooth areas.

The concept of filtering is easier to visualize in the frequency domain. Therefore enhancement of image f(x,y) can be done in the frequency domain based on DFT. This is particularly useful in convolution .if the spatial extent of the point spread sequence h(x,y) is large then convolution theory.

$$g(x,y)=h(x,y)*f(x,y)$$ Where g(x,y) is enhanced image.

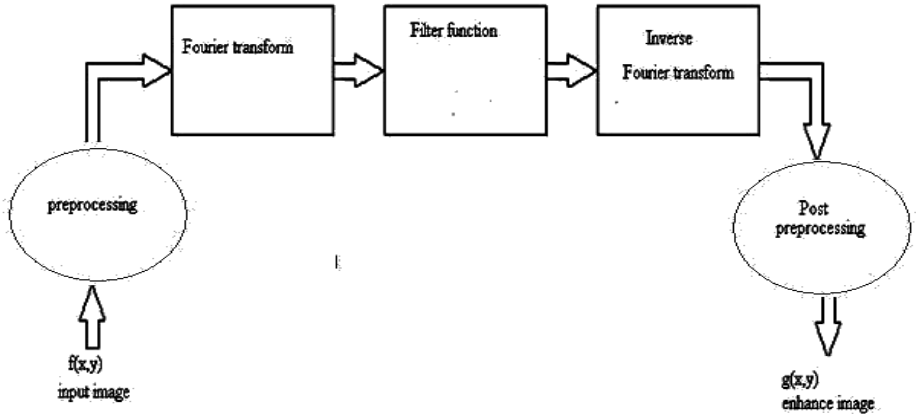
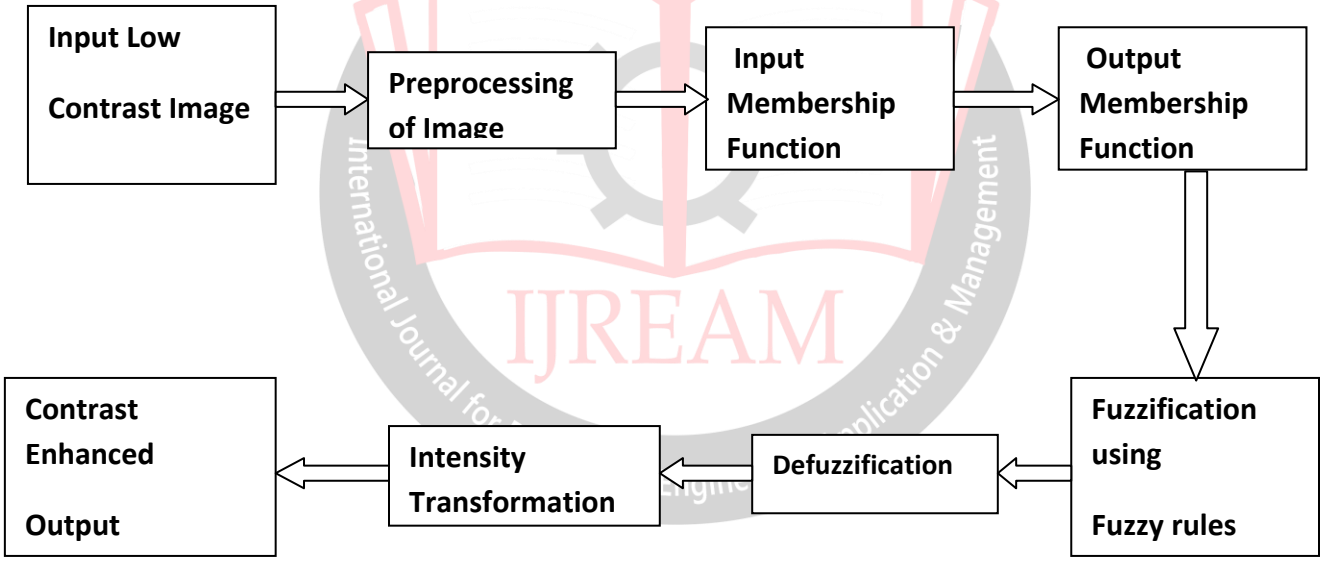



**Figure 2.2: Basic steps for Frequency Domain**

### 2.1.3 Fuzzy domain

Fuzzy set theory is thus useful in handling various uncertainties in computer vision and image processing applications. Fuzzy image processing is a collection of different fuzzy approaches to image processing that can understand, represent, and process the image. It has three main stages, namely, image fuzzification, modification of membership function values, and defuzzification. Fuzzy image enhancement is based on gray level mapping into membership function. The aim is to generate an image of higher contrast than the original image by giving a larger weight to the gray levels that are closer to the mean gray level of the image that are farther from the mean




**Block Diagram of Proposed Work**

1. **Image Acquisition**: Low contrast image from medical domain are preferably used as input image. Standard available low contrast test images are also used as database. Apart from it real time low contrast image captured using digital camera with VGA (640x480) resolution can be applied to proposed algorithm.
2. **Preprocessing**: Generally preprocessing of image includes following tasks according to requirement of input image.
   a. Gray Scale conversion
   b. Image resizing
   c. Image denoising/deblurring
   d. Morphological operations like Dilation, Erosion, Thickening or Thinning etc.
3. **Input Membership Function:** After the preprocessing of image, the input membership function is needed to be specified. Following membership function might be used as input membership function.
   a. Sigma membership function
   b. Triangular membership function

c. Trapezoidal membership function

4. **Output Membership Function:** Once input membership functions are specified, the output membership functions are needed to be specified. Following membership function might be used as output membership function.
   a. Bell membership function b. S-shaped membership function
5. **Fuzzification using Fuzzy rules:** Fuzzification is the first step in the fuzzy inferencing process. This involves a domain transformation where crisp inputs are transformed into fuzzy inputs i.e input membership function are transformed to output membership function using fuzzy rules (IF –THEN rules).

   For each input and output variable selected, we define two or more membership functions (MF), normally three but can be more. We have to define a qualitative category for each one of them, for example: low, normal or high. The shape of these functions can be diverse but we will usually work with triangles and trapezoids. For this reason we need at least three (for triangles) or four (for trapezoids) points to define one MF of one variable.

6. **Defuzzification:** It is the process of producing a quantifiable result in fuzzy logic, given fuzzy sets and corresponding membership degrees. Fuzzified content is defuzzified using fuzzy rules(IF-THEN) before applying to intensity transformation function.

   A common and useful defuzzification technique is center of gravity. First, the results of the rules must be added together in some way. The most typical fuzzy set membership function has the graph of a triangle. Now, if this triangle were to be cut in a straight horizontal line somewhere between the top and the bottom, and the top portion were to be removed, the remaining portion forms a trapezoid. The first step of defuzzification typically "chops off" parts of the graphs to form trapezoids (or other shapes if the initial shapes were not triangles). For example, if the output has "Decrease Pressure (15%)", then this triangle will be cut 15% the way up from the bottom. In the most common technique, all of these trapezoids are then superimposed one upon another, forming a single geometric shape. Then, the centroid of this shape, called the fuzzy centroid, is calculated. The x coordinate of the centroid is the defuzzified value.

7. **Intensity Transformation:** Defuzzified output is applied to intensity transformation function where intensities are transformed in such way that contrast of the image is enhanced which will result in contrast enhanced output image. Following are the transform function to be used:
   a. Negative Transformation
   b. Log Transformation
   c. Gamma Transformation
   d. Contrast stretching Transformation

## IV. MATHEMATICAL FORMULATION & PROPOSED ALGORITHM

### Fuzzy Set

In classical set theory, a set is defined as a collection of element having a certain property, each of belongs to the set. So the characteristic function takes either the value of 0 or 1 [25].

Let us consider a classical set, X, called the universe, whose elements are denoted as x, that is, X= { , ,…….. }. Consider a subset A of the set X such that an element x of X is a member of A if

$$\mu_A(x)=1 \quad \text{If } x \in A$$

$$\mu_A(x)=0 \quad \text{Otherwise}$$

So fuzzy set A is defined as $A= \{(x, \mu_A(x)) : x \in X\}$

Where $\mu_A(x)$ is a membership function for fuzzy set. Examples of membership

functions (triangular, trapezoidal, Gaussian, [16]) can be seen in figure 2.3 and described with the following formulas:

**Triangular Membership Function:** Triangular membership function is defined as a following equation:

$$\text{Triangular}(x; a, b, c) = \begin{cases} 0 & \text{if } x \le a \\ \frac{x-a}{b-a} & \text{if } a \le x \le b \\ \frac{c-x}{c-b} & \text{if } b \le x \le c \\ 0 & \text{if } c \le x \end{cases}$$

**Trapezoidal Membership Function:** Trapezoidal membership function is defined as a following equation

$$\text{Trapezoidal}(x; a, b, c, d) = \begin{cases} 0 & \text{if } x \le a \\ \frac{x-a}{b-a} & \text{if } a \le x \le b \\ 1 & \text{if } b \le x \le c \\ \frac{d-x}{d-c} & \text{if } c \le x \le d \\ 0 & \text{if } d \le x \end{cases}$$

**Gaussian Membership Function:** Gaussian Membership Function is defined as following equation:

$$\text{Gaussian}(x; m, \sigma) = e^{-\left(\frac{(x-m)^2}{2\sigma^2}\right)}$$

Where m = mean, and  is the standard deviation.

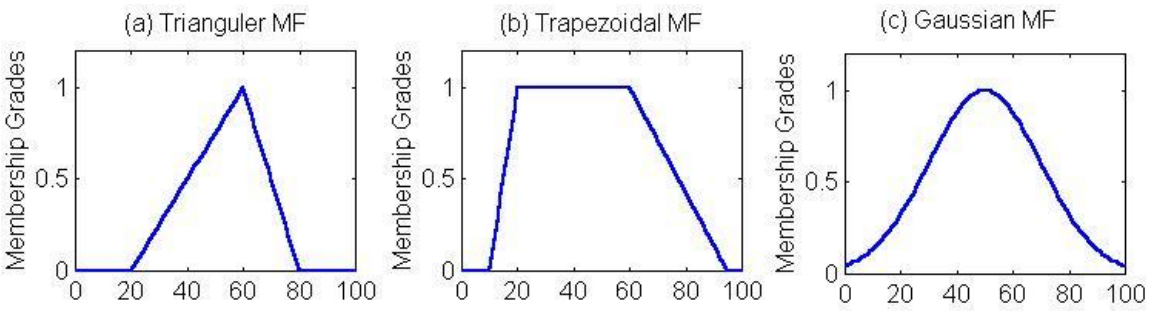


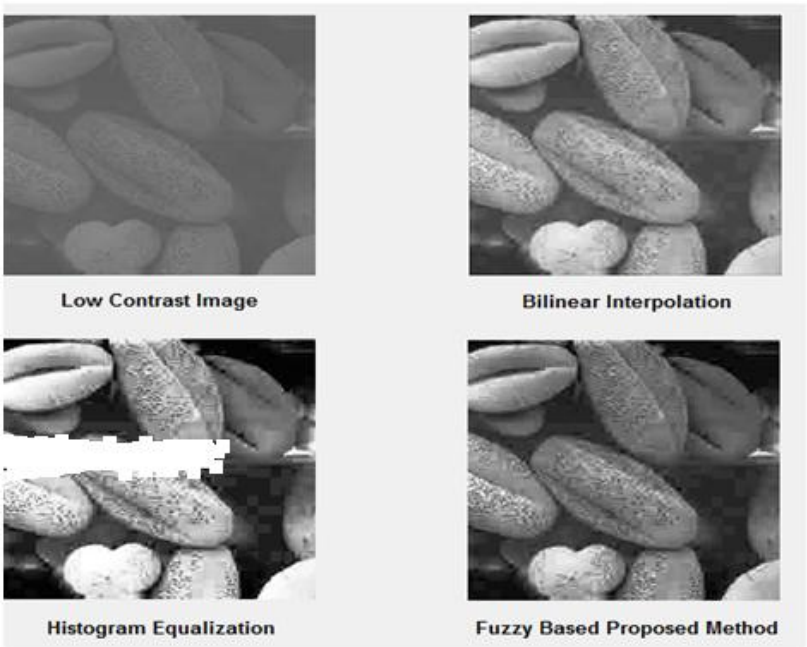
**Figure: Examples of Membership Function**

**Algorithm:**

1. Image Acquisition (Real time/standard database)
2. Read the Poor contrast input image
3. Convert the image into gray scale if input image is true color image.
4. Apply the preprocessing technique for denoising, deblurring and resizing the image. Morphological operations can be applied if required.
5. Specify the input membership function like sigmamf, triangmf and trapezmf.
6. Specify the output membership function like bellmf and smf.
7. Fuzzification to transform specified input membership function into output membership function using fuzzy rules like IF-THEN.
8. Fuzzified output is converted into non crisp output using defuzzification technique.
9. Intensity transformation is applied to defuzzifed output with any one of transformation function like neg, log, gamma or stretch.
10. Contrast enhanced output image is obtained.

## V. EXPERIMENTAL RESULTS AND DISCUSSIONS

We have applied the proposed algorithm to a variety of images. As mentioned before, the commonly used techniques for contrast enhancement can be categorized as(1) indirect methods of contrast enhancement and (2) direct methods. Histogram speci**fi**cation and histogram equalization are two most popular indirect contrast enhancement methods [9]. Laxmikant Dash and Chatterji [8],Dhnawan et al. [9], and Beghdad and Negrate [10] have discussed and shown that the direct contrast en-hancement approaches are better than indirect contrast enhancement approaches.




## VI. CONCLUSION

The commonly used techniques for contrast enhancement fall into two categories: (1) indirect methods and (2) direct methods. Direct approach to contrast enhancement is more useful because it has considered both global and local information of the image. Fuzzy logic has been found many applications in image processing and pattern recognition, etc. In this paper, we propose a novel,

adaptive,direct, fuzzy contrast enhancement method basedon the fuzzy entropy and fuzzy set theory. The experimental results have demonstrated that the proposed algorithm is more adaptive and e!ective for contrast enhancement compared to other method. Moreover, it significantly reduces the over enhancement/under-enhancement due to its better adaptive capability. The proposed approach may find wide applications in image processing, pattern recognition and computer vision.

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