International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 6, June - 2013

Image Enhancement Using Fuzzy Technique

Tarun Mahashwari and Amit Asthana (Assistant Professor)

Computer Science and Engineering Department

S.I.T.E, S.V.S.U Meerut

***Abstract*- Image enhancement means to enrich the perception of images for human viewers. It can reduce impulsive noise, sharpen the edges with the help of different image enhancement techniques. Fuzzy techniques can manage the uncertainty and imperfection of an image which can be represented as a fuzzy set. Fuzzy logic can be used to process human knowledge in the form of fuzzy if-then rules. The accumulation of all these approaches come up to the theory of fuzzy image processing, which is divided into 3 phases: Image fuzzification, membership values modification, and image defuzzification. In most cases, images available are not in fine quality. In this paper an image enhancement technique based on fuzzy logic is discussed and then implemented in MATLAB 7.14.0 (R2012a).**

***Index Terms*-- Image, Fuzzy Image Processing, Fuzzy Inference System, Linguistic variable.**

I. INTRODUCTION

An image with high contrast and brightness is called fine quality image while a poor quality image is identified by low contrast and poorly defined boundaries between the edges. Image enhancement can be considered as transformation of poor quality image into good quality image to make its meaning clearer for human perception or machine analysis. In figure 1(a) and (b) show the Lena image and fingerprint image respectively. Implement the image enhancement with fuzzy techniques and enhance the image. This paper presents a research to improve the quality of image by enhancing the minute details of the degraded image using fuzzy techniques.

Fig 1(a)

Fig 1(b)

FUZZY LOGIC

The concept of fuzzy logic was introduced in the 1965 proposal of Fuzzy Set Theory by Lotfi A.

Zadeh, a professor of computer science at the University of California, Berkeley. Fuzzy logic is a form of many-valued logic or probabilistic logic, it deals with approximate (rather than fixed and exact) reasoning. It has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false. Fuzzy logic has proven to be an excellent choice for many control system applications since it mimics human control logic. It does not require precise inputs, is inherently robust, and can process any reasonable number of inputs. Fuzzy sets are sets whose elements have varying degrees of membership (This idea is in contrast with classical or crisp set, because membership value of a crisp set member is always 1). Let **X** be a space of points, with a generic element of **X** denoted by ***x***. Thus **X** = {*x*}. A fuzzy set Ã in X is defined by a membership function μ_A**(x)** which map each point in X in the interval [0,1], with the values of μ_A**(x)** at ***x*** representing the "degree of membership" of ***x*** in **Ã.** Thus large value of the membership function represents the high degree of the membership. Example of membership functions are Gaussian, Sigmoid, Trapezoidal and Generalized bell MF.

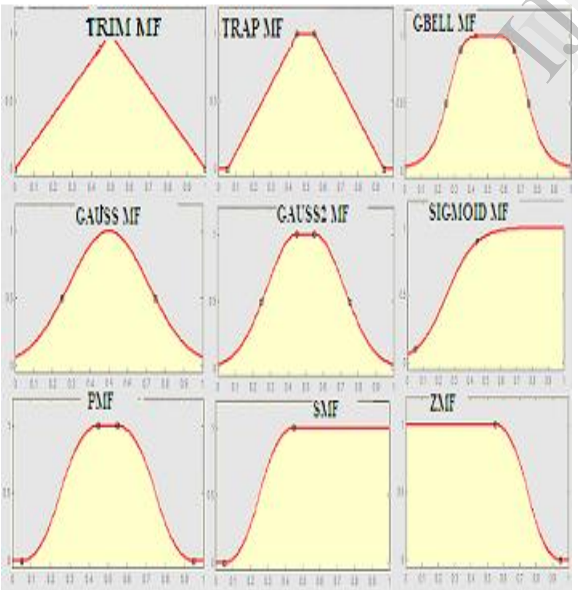

Figure 2: Membership function

A. Linguistic variables

Linguistic variables are used to express fuzzy rules, which facilitate the construct of rule-based fuzzy systems. A linguistic variable can be defined as a variable whose values are words or sentences. For example a linguistic variable such as *age* may have a value such as *young*, very young, old, *very old rather than 30, 36, 18 etc*. However, the advantage of linguistic variables is that they can be changed via hedges (fuzzy unary operators).

B. Fuzzy if-then rules

Fuzzy logic operates on the basis of rules which are expressed in the form of If-Then rules, which are written as:

If <fuzzy proposition> *then* <fuzzy proposition>

A fuzzy proposition can be an atomic or a compound sentence. For example:
"Sky is blue" is an *atomic* fuzzy proposition.
*"*Sky is gray and wind is strong*"* is a c*ompound* fuzzy proposition.

C. Fuzzy Image Processing

Fuzzy image processing is a form of information processing for which input and output both are images. It is a collection of different fuzzy approaches which understand, represent and process the images, their segments and features as fuzzy sets. Fuzzy image processing is divided into three main stages: image fuzzification, modification of membership values, and image defuzzification (if necessary) (see Figure 3)

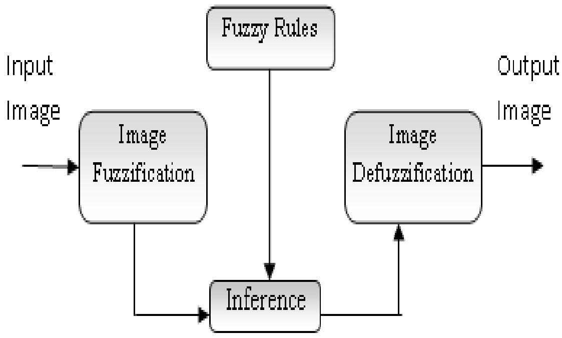

Figure 3: Fuzzy Image Processing

Due to the absence of fuzzy hardware we have to perform fuzzification and defuzzification steps. Therefore, we encode image data (fuzzification) and decode the results (defuzzification) to process images by means of fuzzy techniques. Power of fuzzy image processing lies in the intermediate step (modification of membership values) after first phase (image fuzzification), appropriate fuzzy techniques (such as fuzzy clustering, fuzzy rule-based approach, fuzzy integration approach and so on) modify the membership values.

II. FUZZY IMAGE ENHANCEMENT METHODS

Many kinds of fuzzy image enhancement methods have been proposed [1][3][5][6]. For example:

- Fuzzy Contrast Adjustment
- Subjective Image Enhancement
- Fuzzy Image Segmentation
- Fuzzy Edge Detection
- Image enhancement

Most of these methods are based on image binarisation, while others enhance the image directly from gray-scale images. Gray-scale images enhancement approach include following steps [9]:

(i) Normalization
(ii) local orientation estimation
(iii) local frequency estimation
(iv) Filtering by designed Filters.

In first step, an input image is normalized to decrease the dynamic range of the gray scale between ridges and valleys of the image estimation and the tuning of the filter parameters. Following are some of the methods used for enhancement of fingerprint images,

(i) Enhancement algorithm based on Image Normalization and Gabor filter [4].
(ii) Fourier domain filtering of fingerprint images [5].
(iii) Image enhancement using CNN Gabor-type Filters [6].
(iv) Enhancement of image using M-lattice [1].

III. IMPLEMENTATION

On the basis of following fuzzy rules, an image enhancement algorithm has been developed and implemented:

- If pixel intensity is dark then output is darker.
- If pixel intensity is gray then output is gray.
- If pixel intensity is bright then output is brighter.

Figure 4, 5 and 6 shows implementation of these rules in fuzzy inference system:

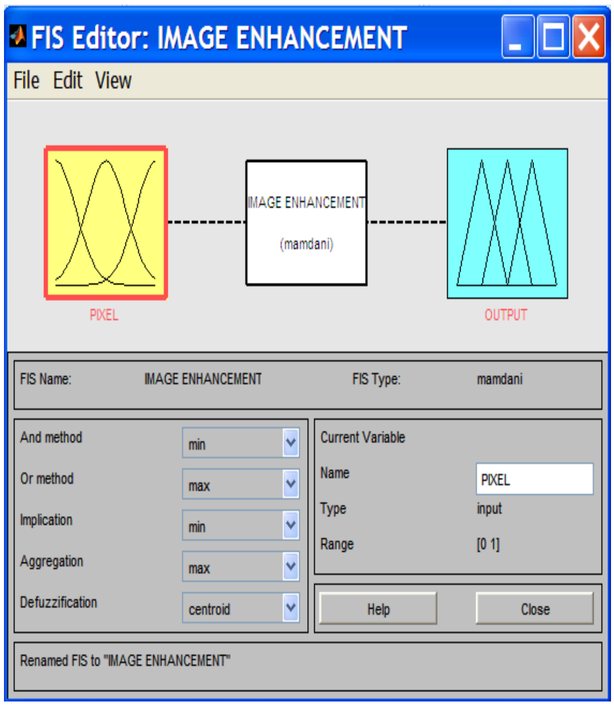

Figure 4: FIS Editor for image enhancement.

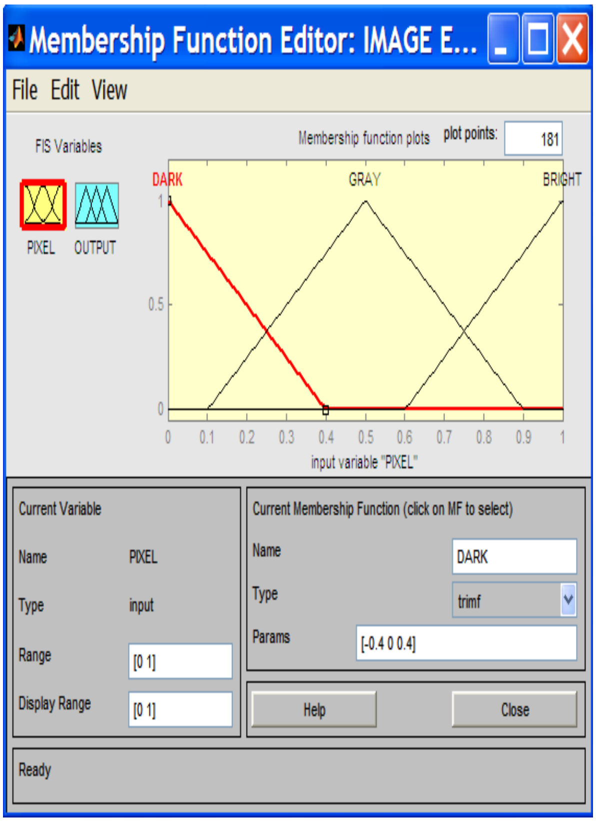

Figure 5: FIS Membership Function Editor

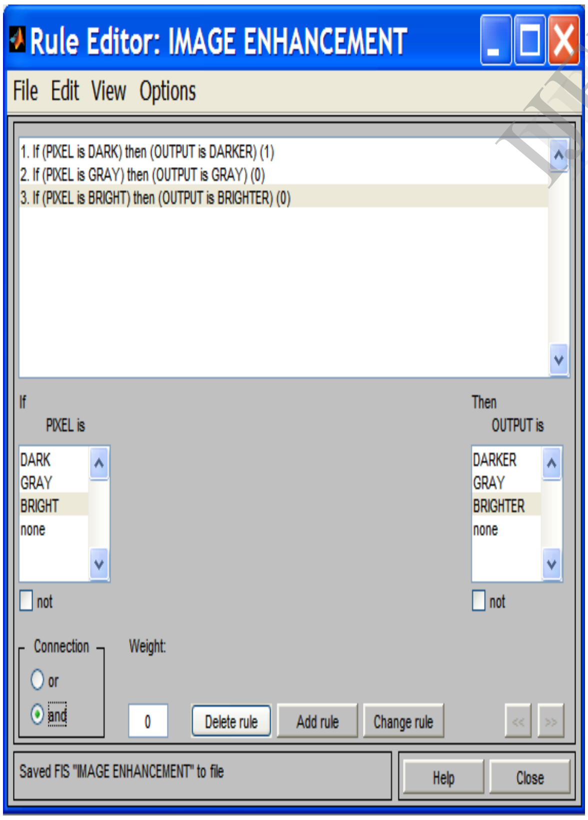

Figure 6: FIS Rule Editor

The image enhancement algorithm we developed contain following steps:

1. Take an input image and set membership function for each gray level as:

$$\mu(x, y) = e^{-\left(\frac{\left(L-\frac{f(x,y)}{s}\right)}{2}\right)^{2}}$$

Where L, F(x, y), S denote max gray level, any gray level, variance between gray values respectively.

2. Get new membership values by putting:

$$V(x, y) = 2*((\mu(x, y))^2 \text{ if } \mu(x, y) <= 0.5$$

$$V(x, y) = 1-2*(1-\mu(x, y))^2 \text{ if } 0.5 <= \mu(x, y) <= 1$$

3. Get final enhanced image by setting the Method as:

$$g(x, y) = L - s(\sqrt{-2\log(\mu(x, y))}$$

IV. RESULTS

We write a code in MATLAB to implement our proposed algorithm and then run this code after saving it as an m file in MATLAB workspace. Experiment was done on several poor quality images. Some of the results are as follows:

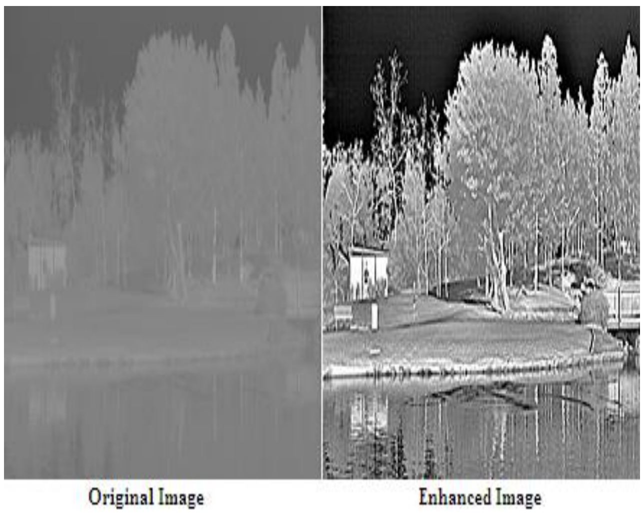

Figure 7: Image Enhancement by Fuzzy Technique

Figure 8: Lena Image Enhancement

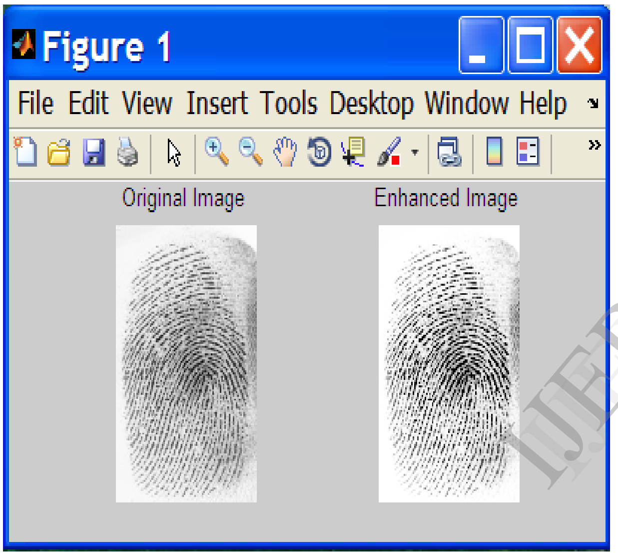

Figure 9: Fingerprint Image Enhancement by Fuzzy Technique

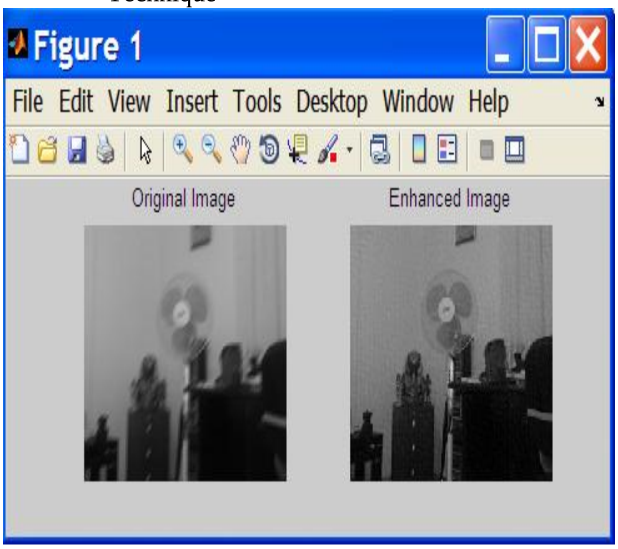

Figure 10: Image Enhancement by Fuzzy Technique

V. CONCLUSION AND FUTURE WORK

This paper presents a fuzzy method for image enhancement. Although the method for image enhancement based on fuzzy logic is sufficient but in future efficient methods can be develop for image enhancement which can give more accurate result.

REFERENCE

[1] Alex Sherstinsky and Rosalind W. Picard, "Restoration and Enhancement of Fingerprint Images using M-Lattice –A Novel Non-linear Dynamical System", IEEE Pattern Recognition, Vol.2,p.p 195-200,1994

[2] Anil K.jain, Salil Prabhakar, Lin Hong, and Sharath Pankanti, "Filterbank- Based Fingerprint Matching," IEEE transactions on image processing, Vol.9,NO.5,MAY 2000.

[3] Approximation Studies on Image Enhancement Using Fuzzy Technique by Sasi Gopalan, Madhu S Nair and Souriar Sebasti. International journal of Advanced Science and Technology Vol. 10. September, 2009.

[4] Ertugrul Saatchi and Vedat Tavsanoglu, "Fingerprint Image Enhancement using CNN Gahor –type filters Cellular Neural Networks and their Applications, proceedings, 7th IEEE International workshop, p.p 377-382, 2002.

[5] Faisel Saeed, K.M. George, Huizhu Lu "Image Contrast Enhancement Using Fuzzy Set Theory".

[6] H.C.Lee and R.E.Gaensslen, Eds., Advances in Fingerprint Technology, New York: Elsevier, 1991.

[7] H R.Tizhoosh, "Fast fuzzy edge detection," in proceedings NAFIPS 2002 Annual Meeting of the

North American Fuzzy Information Processing Society,pp. 239-242, 27-29 June 2002.

[8] K. Pringle. "Visual perception by a computer," *In Automatic Interpretation and Classification of Images*, pages 277-284. Academic Press, New York, 1969.

[9] L. Zadeh, 'Fuzzy Sets', Information Control, pp. 338-353, 1965.

[10] Lin Hung, Yifei Wan, Anil Jain: "Fingerprint Image Enhancement: Algorithm and Performance Evaluation" IEEE Transaction on panem analysis and machine intelligence", Vol 20 N.8, p.p. 777-789, 1998.

[11] L. O. Hall and A. Namasivayam, "Using adaptive fuzzy rules for image segmentation", in IEEE World Congress on Computational intelligence, Vol. 2, pp. 808-825, 1997.

[12] M. Hanmadlu, D. Jha, and R.Sharma, "Color image enhancement using fuzzy intersification", Pattern recognition Letters, Vol.24 (1-3), p.p. 81-87, 2003.

[13] Milind Kumar V.Sarode, Dr. S.A.Ladhake, Dr.Prashant R.Deshmukh " Fuzzy system for color image enhancement" proceedings of world academy of science, engineering and technology volume 36 December 2008.

[14] S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Fuzzy Logic using MATLAB".

[15] The MathWorks, Inc. (1999) Fuzzy Logic Toolbox. The MathWorks Inc.

[16] Vijayaprasad. P and Ashraf Gasim Elsid Abdalla "Applying Neuro-Fuzzy Technique to the Enhanced Fingerprint image" 2003.

[17] Y. Mizukami and K. Tadamura, "Optical Flow Computation on Compute Unified Device Architecture," In *Image Analysis and Processing, 2007. ICIAP 2007. 14th International Conference on*, 10-14Sept. 2007 pp. 179-184.