A Comprehensive Review of Various Image Enhancement Techniques

Er.Arun Begill, Er.Nishi Madaan
Department of Computer Science and Engineering
DAV University, Jalandhar

***Abstract* — Image Enhancement is one of the most crucial and hard to manage techniques in image research. Wide research has been done on image enhancement and hence it has become necessary to categorize the research outcomes and provide a profitable enhancement techniques overview. One of the popular parts of medical images disguised and analysis in image enhancement techniques which ameliorate the clarity of images for human. In this paper, we present a brief summary of image enhancement processing techniques in spatial domain, Fuzzy technique, Histogram equalisation. Such that its major applications of medical images with Log Gabor filter, Unsharp Mask Filter.**

***Index Terms* – Fuzzy technique, Histogram equalization, Image enhancement, , Medical imaging and spatial domain methods.**

I. INTRODUCTION

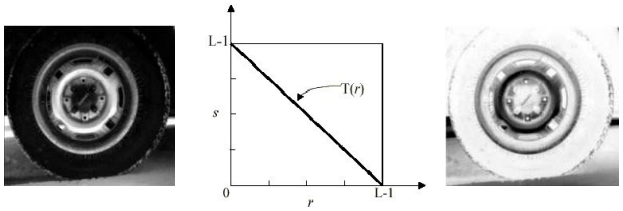
Digital image processing is an ever spread and dynamic area with applications into our everyday life such as authentication, space exploration, medicine, automated industry inspection and many more areas [1]. Image Enhancement is the processing of image to improve the quality and some features of an image. Fundamentally, the idea behind enhancement techniques is to bring out detail that is out of sight [2]. Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to make the image is suitable by modify their attributes for a given task and a particular observer [3]. Basically, image enhancement is the transformation or mapping of one image to another. It is not necessarily to this transformation for one-to-one, so two different input images may also transform into the same or identical output images after enhancement [4].

II. IMAGE PROCESSING TECHNIQUES

A. Spatial Domain Methods

Spatial domain methods are procedures which exactly operate on the pixels. To achieve required enhancement pixel values are manipulated. Spatial techniques are particularly use for directly modifying the grey values and hence overall contrast of the whole image. Some methods of spatial domain which are come under pixel operation which operate in single pixel only are:

1) Image Negative Transformation: In which gray level values of pixel of original image are converter to get its negative. For example: Consider 8 bit digital image of size M*N, where M and N are number of rows and columns then original digital image subtracted from 255 as g(x, y) =255-f(x, y) for $0 \leq x < M$ and $0 \leq x < N$. In a normalized gray scale, s = 1.0 – r. Fig 1 shows image negative [5].



(a) (b) (c)

Fig 1: (a)Original image (b)negative image and (c)Image Negative transformation function.

2) Image Thresholding Transformation: In this transformation pixel values is either in 0s or 1s in binary form. g(x,y) also called binary image. Fig 2. Shows the threshold image[6].

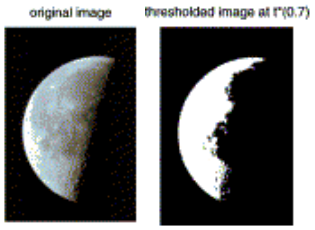


Fig 2. Original Image and its threshold Image

3) Log Transformation: in this type of transformation to spread out the dark pixels of image while compressing the higher values. It is achieved as s= clog (1+r). Fig 3 shows Log transformation.

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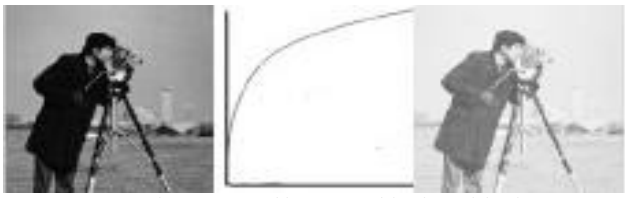

Fig. 3 DFT of image and its logarithmic

4) Power law Transformation: relation of g(x,y) and f(x,y) pixel values of this transformation have basic form:

$$s = cr^{\gamma} \quad \text{- (1)}$$

Where c and γ are constants. Fig 4 and 5 shows the various values of γ and gamma corrected images.

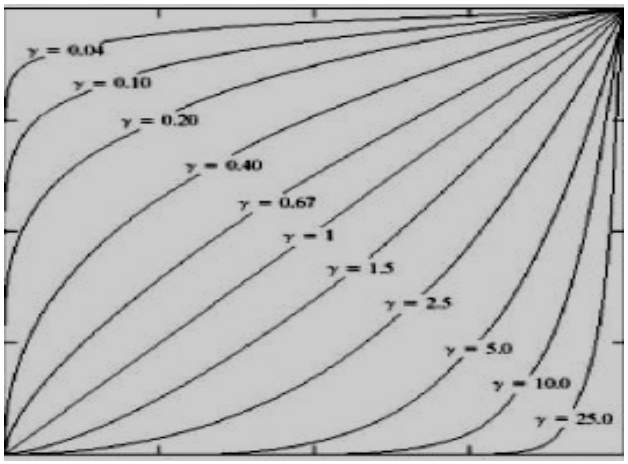

Fig 4. γth power and γth root curves for c=1.

Fig 5. Different Gamma corrected images

5) Piece wise Linear Transformation: it is an arbitrary defined by user's transformation as shown in figure6. Based on position of (r1, s1) and (r2, s2) distinct types of transformation can be obtained.

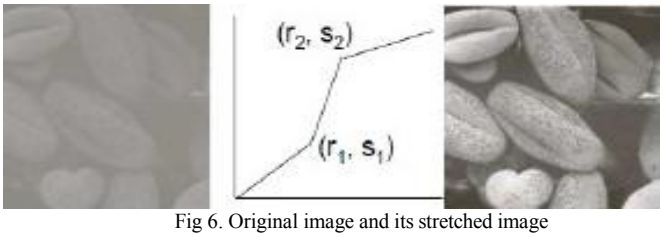

Fig 6. Original image and its stretched image

6) Gray level slicing Transformation: Highlight particular intensity range of an image. This is also called intensity level slicing and have two approaches[7].one approach is to explain in one value(say, white) all the values in range of interest and rest of all (say, black)all other intensities. The second approach brightens the particular range of intensities but leaves the all other intensities unchanged.

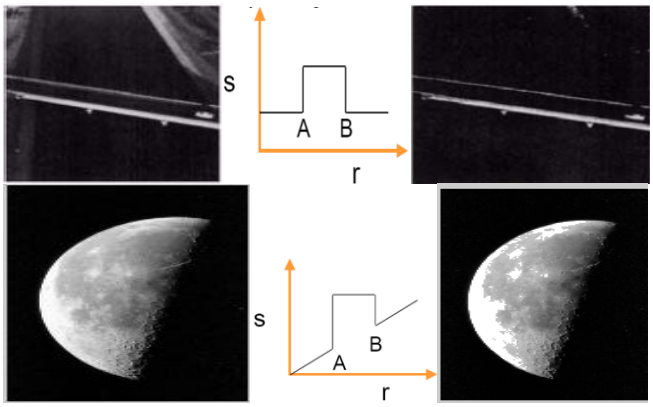

Fig 7. Original images and their sliced images

7) Bit plane slicing: This transformation contribute the total image of appearance highlights by specific bits for gray level pixels[8].

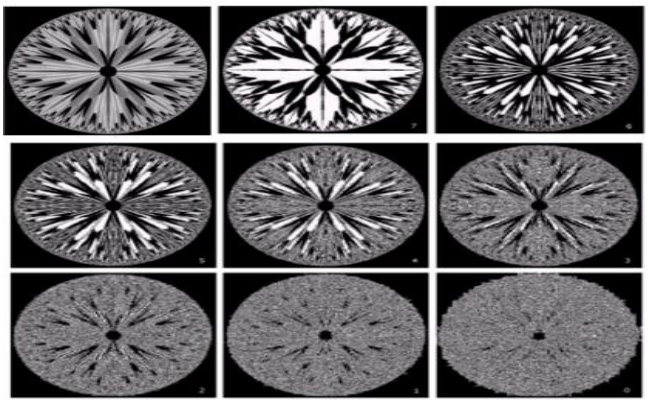

Fig 8. Original image and eight bit plane images

B. *Image Enhancement with Fuzzy technique*

Fuzzy logic[9] 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 techniques can manage the uncertainty and imperfection of an image which can be represented as a fuzzy set. Fuzzy if-then rules can be used to process human knowledge. Using fuzzy technique to improve the quality of image by enhancing the minute details of the degraded image.

1. Fuzzy if-then Rules

Fuzzy logic operates on some basic if-then rules, which are written as:

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

2. Fuzzy image processing

When process the image with fuzzy technique then it is divided into three stages:

- Image fuzzification
- Modification of membership values
- Image defuzzification(if necessary)

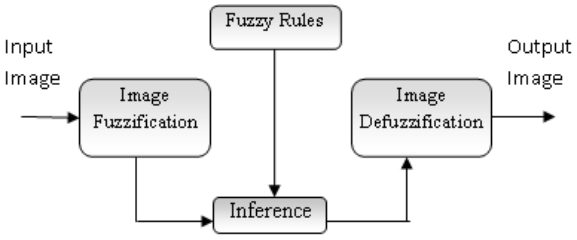

Fig. 9: Fuzzy Image Processing

3. *Fuzzy Image Enhancement Methods*

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

Most of these methods based on binary image and some methods are based on gray scale images.

4. Implementation

On fuzzy rule basis, image enhancement has been 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 bright.

Fig 9, 10, 11 shows implementation of fuzzy rules:

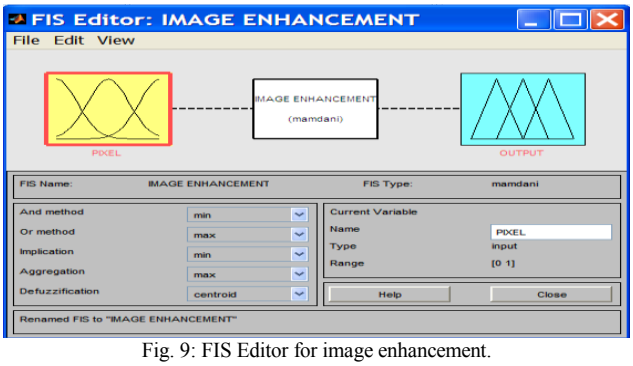

Fig. 9: FIS Editor for image enhancement.

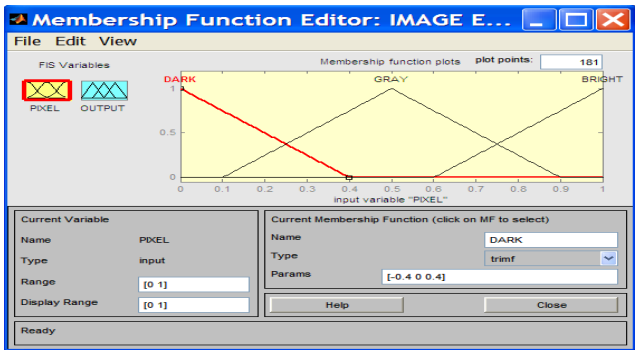

Fig. 10: FIS Membership Function Editor

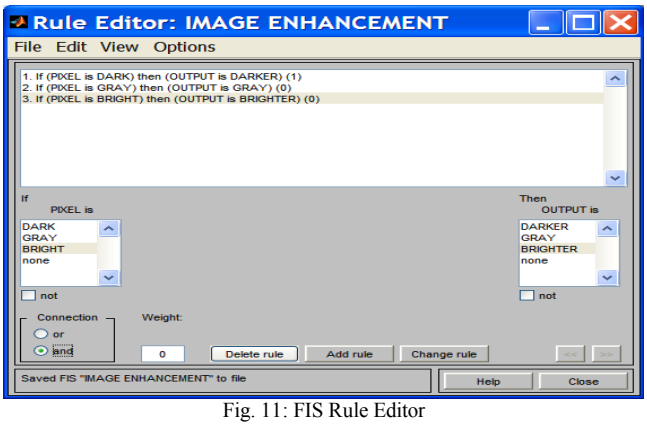

Fig. 11: FIS Rule Editor

C. Histogram Processing

The histogram of any digital image with the range of intensity levels [0, L-1] is a discrete function[10].

$$h(r_k)=n_k \quad (2)$$

k^{th} Intensity value, n_k number of pixel with intensity r_k Total numbers of pixels are frequently normalized histograms. Assuming an M*N image, a normalized histogram.

$$p(r_k)=\frac{n_k}{MN}, \quad K=0, 1,.....L-1$$

Where r_k is the probability of occurrence of an image.

1. *Histogram Equalization*

In equalization method it improves the appearance and spread the quality of gray levels so that they are evenly distributes across their range[11,12] as shown in fig12.

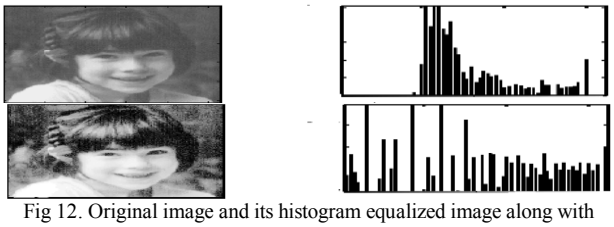

Fig 12. Original image and its histogram equalized image along with histograms

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2. Histogram specification

It is also called histogram matching which is required to produce an output automatically determine a transformation function with a uniform histogram.

Fig 13. Histogram matching of two different images

D. Applications in Medical Images using Classical Unsharp Mask Filter and Log Gabor Filter

In these filters which are not only preserve the edge but also maintain the contrast that is suitable for body part. Unsharp filter plays a crucial role in medical images. Medical image enhancement gives more rich information to doctors about diagnostic especially to exam diseases and find injury, fractures significantly.so unsharp masking is a good tool for sharpness [13]. Log Gabor filter is best use for localized frequency information. It works simultaneously on spatial domain as well as frequency domain. Log Gabor filter are two important characteristics:

- Because of no DC component, which enhance and contributes the edges of images and contrast ridges.
- It has spread tail at the high frequency end, which helps to preserve true ridge structures of images and obtain wide spectrum with localized spatial extent.

Table 1:Critical Analysis

Spatial domain methods	Description	Advantages	Disadvantages	Application
Image negative	This is invert of identity transformation. s=L-1-r	Particularly suited for improve the gray or white detail embedded in dark regions of an image, especially when the black areas are dominant in size [14].	Not enhance a pseudo-colors	
Log transformation	Improve the values of dark values. s=c log(1+r)	It compresses the dynamic range of images with large variations in pixel values.		
Power law transformation	Use of gamma correction monitors automatically corrects all image display on it.	Family of possible transformation curves obtained simply. Rapidly used in commercial purposes.		
Piece wise linear transformation		Form of piece wise functions can be arbitrary complex.	Specification requires considerably more user input.	
Intensity level slicing	Highlight the image with specific range of intensities			Improve features of masses of water in satellite imagery. Enhancing flaws in x-ray images.
Bit plane Slicing	Pixels are digital numbers composed of bits.	Highlight the contribution made to total image appearance by specific bits.		
Fuzzy technique	Manage the uncertainty and imperfection of an image.	Poor image quality into good quality to make its meaning clearer for human perception.	Although fuzzy method is good but some other method which produce accurate result.	
Histogram processing	Graphical representation distribution of data.	Fast, simplicity and elegancy.	Only use in several cases which require higher brightness and not handled well.	Real time image processing.

III. CONCLUSION

In modern era, Image enhancement techniques of Digital Image Processing are wide used in different field mostly

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used in medical images to give information to doctors to find lesion significantly. in this paper the various types of

techniques are covered. Spatial Domain which operate directly on the pixels and also discuss their various types such as image negatives, image thresholding , Piece wise transformation, histogram equalization, fuzzy techniques etc. all techniques are used for enhance the images and improve their qualities.Although we did not discuss about computationally cost for algorithms which are used in many real time applications .all the methods in this paper are sufficient but in future efficient methods can develop which can give more accurate results.

REFERENCES

[1] Ms. Shivani Gupta, Mr. Satyajit Sen Purkayastha, "Image Enhancement and Anlaysis of Microscopic Images using various Image Processing Techniques," *International Journal of Engineering Research and Applications(IJERA),* vol. 2,no. 3, pp. 44-48,May-Jun 2012.

[2] Snehal O.Mundhada, Prof. V.K. Shandilya, "Image Enhancement using a Combined Approach of Spatial and Transformation Domain Techniques," *International Journal of Emeging Research in Management and Technology* ,pp. 1-4,Decmeber2012.

[3] Himashu Aggarwal,Raman Maini, "Comprehensive Review of Image Enhancement Techniques,"*JOURNAL OF COMPUTING,* vol. 2,no. 3,pp. 8-13,March 2010.

[4] Govind N Sarage, "Medical Image Enhancement Using Pixel Operation," *International Journal of Advanced Research in Computer Science and Software Engineering,* vol. *2*,no. 7,pp. 391-394,July 2012.

[5] S.S. Bedi, Rati Khandelwal, "Various Image Enhancement Techniques - A Critical Review," *International Journal of Advanced Research in Computer and Communication Engineering,* vol.2,no. 3,pp. 1605-1609,March 2013.

[6] Ms.Seema Rajput, Prof.S.R.Suralkar, "Comparative Study of Image Enhancement Techniques, *International Journal of Computer Science and Mobile Computing*,vol. 2,no.1 ,pp. 11-21,January 2013.

[7] Nirmala S.O, T.D. Dongale, R.K. Kamat, "Review on Image Enhancement Techniques: FPGA Implementation perspective, " *International Journal of Electronics Communication and Computer Technology*,vol. 2,no. 6,pp. 270-274,November 2012.

[8] Suneetha, Dr. T. Venkateswarlu, "Enhancement Techniques for Gray scale Images in Spatial Domain, " *International Journal of Emerging Technology and Advanced Engineering*,vol. 2,no.4 ,pp. 13-20,April2012.

[9] Tarun Mahashwari, Amit Asthana, "Image Enhancement Using Fuzzy Technique," *International Journal of Research in Engineering Science and Technology,*vol. 2,no. 2,pp. 1-4,June 2013.

[10] Ruchika Mishra, Utkarsh Sharma, " Review of Image Enhancement Techniques, " *International Journal of Engineering Research and Technology* ,vol.2,no.8 ,pp. 846-851,August 2013.

[11] Mandeep Kaur, Kiran Jain,Virender Lather, "Study of Image Enhancement Techniques: A Review, " *International Journal of Advanced Research in Computer Science and Software Engineering* ,vol.3,no.4, pp. 846-848,April 2013.

[12] Mr. Sandeep R. Somkuwar, Asst. Prof. Sudha Nair, " A Review Paper on: Various Contrast Enrichment Techniques and Their Improved Factors, " *International Journal of Advanced Research in Computer Science and Software Engineering* , vol. 3,no. 9,pp. 356-361,September 2013.

[13] Gurpreet kaur,Gagan Jindal, "An Enhancement of Medical Images using Classical Unsharp Mask Filter and Log Gabor Filter," *International Journal of Innovations in Engineering and Technology,*vol. 2,no. 3,pp. 45-47,June 2013.

[14] Gonzalez, R. C, "*Digital Image Processing,"* Pearson Education, India,2009.

Er.Arun Begill is doing Mtech CSE from DAV University,Jalandhar.He completed BTECH CSE from CT Institute of Engineering and Technology.His area of interest is digital image processing.

Er. Nishi Madan is an assistant Professor in DAV University,Jalandhar.She served one and half year at Dr. B. R. Ambedkar NIT Jalandhar as an assistant professor. Prior to that she worked as lecturer at B.M.S.C.E, Sri Muktsar Sahib. Her area of interest is digital image processing and parallel computing.

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