ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 5, May 2017

Improving Quality of Satellite Images Using Enhancement Filters and Fuzzy Based Contrast Enhancement Technique

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ABSTRACT: Image enhancement is a technique to improve the quality of an image. The aim of image enhancement process 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. In this paper we are presenting different techniques for satellite image enhancement. For removal of noise and blur different instinctive procedure suggested in this paper that pre-processes poorly concentrated or degraded satellite images by composing numerous consecutive autonomous processing phases which overturn noise, enrich contrast& up turn the clearness of the image and it also lessens the effect of blur and noise. Contrast improvement are being aided by the universal data content of an input image by enlarging the dynamic variety of intensity levels, utilized by Conversion functions. Certain conversion functions utilize local substantial content for modifying image details, such as quality &boundaries. An effective method for improving the image quality is also introduced, in which a plotting utility, blend of universal and local conversion functions, is utilized which preserves the intensity and fine facts of the input image in addition. Contrast widening and Image intensity is preserved completely by universal conversion function.Fuzzy based enhancement is also applied to enhance the image. Sharpening filters are used in order to highlight fine details within an image. They are based on first and second order derivatives. Finally output of each stage is compared by using PSNR parameters.

KEYWORDS: Preprocessing, Satellite images, Contrast setting, Fuzzyfication, PSNR.

I. INTRODUCTION

Most of images like medical images, satellite images and even real life photographs may suffer from poor contrast due to the inadequate or insufficient lighting during image acquiring. So there is a necessity of contrast enhancement of images.The aim of image enhancement is to improve the interpret-ability or perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques. Image enhancement process is needed in every image process applications. The satellite images are needed to be enhanced both in terms of edges and resolution so that the enhanced image looks better in terms of quality.

Transform techniques are used to improve the edges, contrast and visual appearance of an image. Image resolution is moreover an important constraint for enrichment of images; this can be carried out by means of interpolation in which number of pixels in an image is increased. Various techniques for image enhancement are classified as spatial/pixel-based approaches which are-linear contrast adjustment, histogram equalization and adaptive filtering.

II. LITRATURE SURVEY

Here, we are discussing some previous papers from which authors view and proposed methods. P. Suganya, N. Mohanapriyaet. al. [1] in this work author proposed method for satellite image enrichment which includes Haar filter for pre-processing, Multi Wavelet Transform, Interpolation Process, Inverse Process of Multi Wavelet Transform for the low

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Vol. 5, Issue 5, May 2017

resolution image. The Multi Wavelet Transform and Interpolation method used to produce fewer artifacts. Limitation of this method is not effective method to reduce distortion and for losing of high frequency content.

Abdullah-Al-Wadud et al., 2007 [2] proposed one method which uses global histogram modification method. Generally local histogram modification method performs equalization over small patches so that the small scale details becomeclear. However it can create several artifacts. Histogram Equalization and specification A good contrast enrichment method should specifically address several significant properties, some of which are listed below. (1) Noise tolerance: The contrast enrichment method should exhibit appropriate noise immunity. (2) Uniform contrast: The contrast enrichment method should provide uniform contrast of the entire image. (3) Brightness preservation: The contrast enrichment technique should enhance the contrast of the image without losing brightness. (4) Convenient implementation: The contrast enrichment method should be able to be set up quickly and reliably.

Pavithra C, Dr. S. Bhargavi [3] author proposed a method for fusing two dimensional multi-resolution 2-D images using wavelet transform by using the combine gradient and smoothness criterion. Basically it decompose each registered image into sub-images by using forward wavelet transform which have same resolution at that same level and different resolution at different levels. Image fusion is performed based on the high frequency sub-images and final image is obtained using inverse wavelet transform. Using the inverse wavelet transform it can reconstruct the image. Thisreconstructed image has information gather from all the different images sources so this is more informative.

For the images interpolation HasanDemirel&GholamrezaAnbarjafari[3] suggested a DWT procedure. However as equated to other procedures, the images acquired from DWT and IDWT procedure have low PSNR and are not sharp. Hasan and Gholamreza[4] enclosed the Discrete &stationary wavelet decomposition method based on interpolation of high frequency sub band images resulting from DWT .In this technique, Stationary wavelet transform are utilized for enhancement of the high frequency image components. Comparatively great results are produced by this technique. HasanDemirel and GholamrezaAnbarjafari[5].Satellite images are needed to be upgraded both intermsof resolution and edges so that the quality of improved image looks enhanced than original image. In image processing Complex Wavelet Transform (CWT)is utilized which gives two complex-valued sub-band images of low frequency and six complex valued sub-band imagesofhighfrequencyoforiginalimage.MSE and PSNR of the super resolved image also improved. Image enrichment procedures are applied for the modification of band intensities and lessening the noise which cover substantial information, about contrast-based feature extraction from satellite images of high resolution. Wavelet transform, Fourier decomposition, and discrete cosine transform are alternative approaches that belong to the frequency-domain techniques, [6], [7]. Intricate diffusion methods similar to normalized shock filter for the improvement of image and a ramp maintaining de-noising process were utilized [8]. A nonlinear technique for noisy data improvement is utilized by F. Russo which accepts fuzzy webs for combining contrast enhancement and noise reduction [9].

A method in which three different edge detection approaches based on search, zero-crossing, and fuzzy logic is equated [10].Dr. G. Sudhwani proposed three enhancement techniques namely fuzzy rule based contrast enhancement, contrast enhancement using intensification (INT) operator, and contrast enhancement using fuzzy expected value (FEV) for the low contrast gray scale images [11]. NutanY.Suple, Sudhir M. Kharad proposed Fuzzy image enhancement based on gray level mapping into membership function. The aim is to generate an image of higher contrast than the original image by giving alarger weight to the gray levels that are closer to the mean gray level of the image than that are farther from the mean [12].

In most of the image processing applications, there is a need of expert knowledge to overcome the difficulties (like object recognition, scene analysis). Fuzzy set and fuzzy logic offers a powerful tool to process and represent human knowledge as fuzzy if-then rules. Because of the data uncertainty due to randomness, ambiguity and vagueness many difficulties arise in image processing. Fuzzy method can manage ambiguity and vagueness efficiently [13]. Most of the mentioned techniques target the betterment of the visual inspection of the image and commonly involves manual parameter tuning.

In [15], satellite images are firstly enhanced by using DWT-SVD method and then segmentation is applied on the enhanced using MRR–MRF Model. 3-level DWT method for image enrichment has been implemented in [16].

III.PROPOSED METHODOLOGY

Transformation functions utilizing the global information content of an input image have been long serving contrast enhancement by stretching the dynamic range of intensity levels. Other transformation functions focus on local information content to correct image details, such as edges and texture. In this work, an effective method for image contrast enhancement is presented with a mapping function, which is a mixture of global and local transformation functions that improve both the brightness and fine details of the input image. The global transformation function preserves the overall image brightness and

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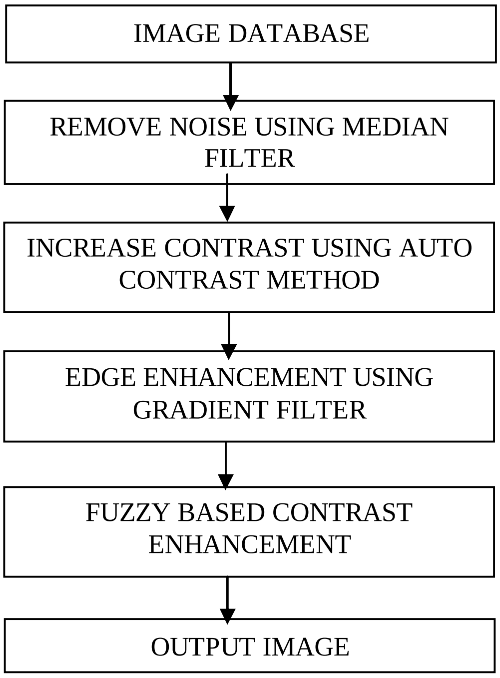
Vol. 5, Issue 5, May 2017

contrast stretching. Whereas, the local transformation function uses to Preserve the edges and fine details of the satellite images. The algorithm proposed in this work I propose an automatic algorithm to pre-process such bad focused or corrupted satellite images. It reduces the effect of blur and noise and composed of several successive independent processing steps which suppress noise, enhance contrast, preserves the edge and increase the resolution of the image. Finally to enhance the fine details of input image we design a fuzzy inference system based contrast setting which will provide an enhanced output then existing methods. To compare the results from existing methods we will use PSNR and MSE parameters.

With following objectives I want to develop this method:

1. Enhance the global information of bad focused satellite image.
2. Enhance the local information like edges and fine details by applying different filtration techniques and algorithms
3. Enhance the contrast of image using fuzzy inference system



A. Image Database

Image database used in this study is taken from National Aeronautics & Space Administration (NASA) website www.nasa.gov. then images are converted into same size, same data type by applying following steps:

The database preparation steps are as follows:

- Input Images from various sources.
- Resize all the images into 512*512 sizes
- Convert all the Images into same Format (.JPG)
- Store into Database

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B. Noise Removal

Here, for Noise removalwe are applying median filter. The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

Median flter can be applied by following equation

$$F(x,y)=\text{median}(g(s,t) \qquad \ldots. \qquad (1)$$

Here, f(x,y) is output gray value ,were as g(s,t) is input gray value.

C. Contrast Enhancement

In the process of contrast enhancement, pixels with lower pixel value than a specific value are displayed as black, whereas the pixels having higher pixel value are displayed as white, and pixels having pixel value in between these two values are displayed as tint of gray. For best output different upper and lower limits are analyzed.
The contrast stretching algorithm is used by stretching the range of the colorvalues to use all possible values to enhance the contrast. For preserving the accurate colorproportion when the contrast stretching algorithm is used, similar scaling is applied for stretching all channels.
Then, PSNR is calculated by using equation (3). PSNR is well-defined simply via the mean squared error (MSE). Noise free m×nmonochromeimages I and its noisy approximation K is given then MSE is defined as:

$$\text{MSE} = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \qquad (2)$$

The PSNR (in dB) is defined as:

$$\text{PSNR} = 10.\log_{10}\left(\frac{\text{MAX}_1^2}{\text{MSE}}\right) \qquad (3)$$

Here, MAX1 represents the extreme probable pixel value of the image. If the pixels are characterized by using 8 bits per sample, it is 255, and m, n is the number of rows and columns of input image respectively. Higher value of PSNR shows good results.

The PSNR values are higher for upper limit near about 0.96 and lower limit 0.04.

D. Edge Enhancement

Sharpening filters are the most used and abused post processing filters. But sharpening can boost the image by making it look crisper and more defined, if utilised correctly. Though, there is a trend to overboard this and the image can look unnatural and over sharpened. A misconception is also there that if you sharpen a blurry image, it will mysteriously look clearer. What does happen is that the blurry image will just look more terrible. Sharpening works by exaggerating the contrast of the object’s edges, giving the viewer the impression of distinct delineation. There are many ways to do this. We can sharpen the entire image in one click with the Sharpen filter or we can use the un-sharp Mask for sharpening the image as defined as you want. If we sharpen the image too much then it can make abnormal looking

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image with distorted pixels, to avoid this only certain areas in the shot should be sharpen instead of the whole image. For example, if the image is of a bird flying against the cloudy sky, sharpen only parts of the bird while leaving the sky untouched to keep it looking smooth.

Sharpening filters are used in order to highlight fine details within an image. They are based on first and second order derivatives. Since in image processing, we deal with discrete quantities, the definitions for the discrete first and second derivatives should be used. The basic equation of a Gradient filter for one-dimensional is given by:

$$df/dx = f(x+1)-f(x) \quad (4)$$

Similarly, the discrete form of a second order derivative in one dimension is given by:

$$d^2f/dx^2 = f(x+1)-f(x-1)-2f(x) \quad (5)$$

To produce thicker edges in an image and for edge extraction first order derivatives are utilized. On the other hand for a stronger response to fine details and for better image enhancement second order derivatives are used. Laplacian, a sharpening filter, is a linear operator and it forms an isotropic filter. The Laplacian highlights gray level incoherence and will output an image with a black background and gray lines. For getting a sharpened image, the resulting Laplacian filtered image (or a weighted version of it) is added to the original image. In practice, a mask is typically used that will carry out both steps at once. The Laplacian is given by

$$\frac{\partial^2 f}{\partial y^2} = f(x, y+1) + f(x, y-1) - 2f(x, y) \text{ in x-direction} \quad (6)$$

$$\frac{\partial^2 f}{\partial x^2} = f(x+1, y) + f(x-1, y) - 2f(x, y) \text{ in y- direction} \quad (7)$$

On adding equation (4) and (5)

$$\Delta^2 f(x, y) = f(x+1, y) + f(x-1, y) + \quad f(x, y+1) + f(x, y-1) - 4f(x, y) \quad (8)$$

On applying gradient and laplacianfilters .we found that output of gradient filter was better then the laplacian filter.

E. Fuzzy Based Contrast Enhancement:

Gray scale transformations, with the image contrast enhancement as a main application, are among the most frequent areas in which fuzzy techniques for image processing are applied. This rule based approach includes the following steps.

Step 1: Specifying the input membership functions.
Step2: Specifying the output membership functions.
Step3: Obtaining the fuzzy system response function F using following rules.
IF a pixel is dark, THEN make it darker
IF a pixel is gray, THEN make it gray
IF a pixel is bright, THEN make it brighter
Step 4: Construct the intensity transformation function T using fuzzy system response function F. Step 5: Transform the intensities of input image using T.

Fuzzy Inference System Tools for Image Enhancement: We can use five GUI tools for building, editing and observing fuzzy inference systems, which are as follows:
1 .Fuzzy inference system editor
2 .Membership function editor
3. Rule editor

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International Journal of Innovative Research in Computer and Communication Engineering

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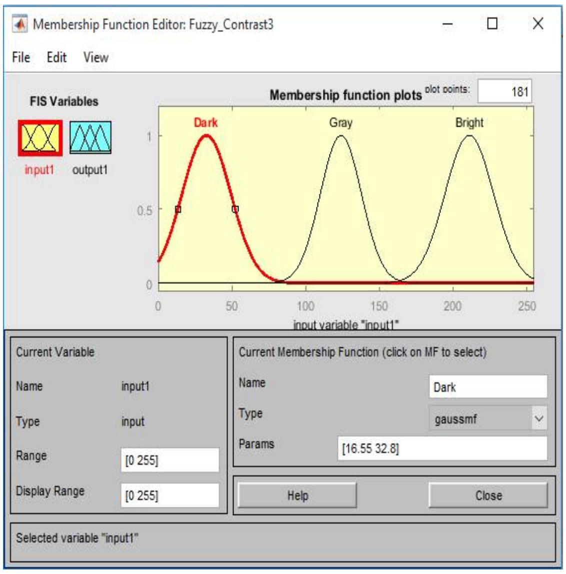
Vol. 5, Issue 5, May 2017

4 .Rule viewer
5. Surface viewer

Fuzzy Inference System: **Output membership function:**



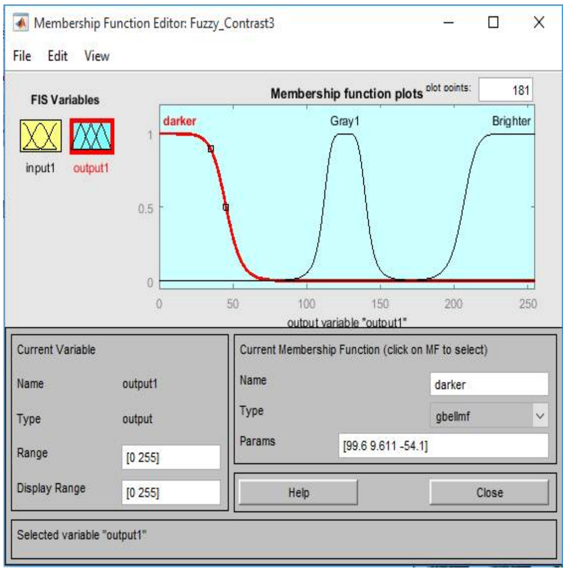


Figure.1. FIS Membership function for contrast Enhancement

Figure.2. Output membership function

Figure1. shows FIS editor, which displays the general information about a fuzzy inference system. The names of each input variable are on the left, and those of each output variable are on the right. Input variable is Gray Level Image and output variable is Enhanced Image.

Figure.2 shows the Surface Viewer. Surface Viewer presents a two dimensional curve that represent the mapping from gray level image to enhanced image.

IV.RESULT ANALYSIS

Output of all the above mentioned techniques is compared on the basis of their corresponding PSNR values and following figures and table show the output after applying following operations at different stages:
1. Input image is selected from database. NASA does a lot of different things. NASA makes satellites. The satellites help scientists learn more about Earth. NASA sends probes out into space. NASA scientists study things in the solar system, and even farther away. A new program will send humans to explore asteroids, Mars and beyond. People at NASA work on ways to make air travel better for everyone on Earth, too. People at NASA also share the things they learn with others. This can help make life on Earth better.

2. We can use linear filtering to remove certain types of noise. Certain filters, such as averaging or Gaussian filters, are appropriate for this purpose. For example, an averaging filter is useful for removing grain noise from a photograph. Because each pixel gets set to the average of the pixels in its neighborhood, local variations caused by grain are reduced.For preprocessing of an underwater image we apply following filters to analyze their performance:

1. Blind Convolution filter
2. Weiner filter

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ISSN (Print): 2320-9798

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3. Regularized Filter
4. Lucy Richardson Filter
5. Median Filter

. Preprocessing stage contains the removal of noise from input image done by median filter, which has the highest PSNR than other filters.

3. The contrast stretching algorithm is used to enhance the contrast of the image. This is carried out by stretching the range of the color values to make use of all possible values. When the contrast stretching algorithm is applied to color images, each channel is stretched using the same scaling to maintain the correct color ratio. The first step is to balance the red and green channel to be slightly the same to the blue channel. This is done by stretching the histogram into both sides to get well-spread histogram. For stretching the contrast values, lower limit of contrast stretching is tested between range 0 to 0.10 with interval of 0.01, and upper limit is tested between range 0.9 to 1.0 with interval of 0.01, and effect of different limits shows in figures.

Finally output of each lower and upper bond is tested on the basis of their PSNR values, and it is found that best value for lower limit is 0.04 and upper limit is 0.96 for satellite images.

4.One sharpening filter is the Laplacian. The Laplacian is a linear operator and it forms an isotropic filter. The Laplacian highlights grey level discontinuities and will output an image with a black background and grey lines where the edges of an object in the image are. In order to get a sharpened image, typically, the resulting Laplacian filtered image (or a weighted version of it) is added to the original image. In practice, a mask is typically used that will carry out both steps at once. The Laplacian is given by:

$$\frac{\partial^2 f}{\partial y^2} = f(x, y+1) + f(x, y-1) - 2f(x, y)$$

in x-direction (1)

$$\frac{\partial^2 f}{\partial x^2} = f(x+1, y) + f(x-1, y) - 2f(x, y)$$

in y- direction (2)

On subtracting equation (1) and (2)

$$\Delta^2 f(x, y) = f(x+1, y) + f(x-1, y) + f(x, y+1) + f(x, y-1) - 4(f(x, y))$$

Edge enhancement is done by applying Gradient filter as it gives PSNR values more than Laplacian filter.

5. Finally fuzzy based contrast enhancement is applied to enhance the contrast of image and it is observed that it provide better results for image enhancement rather than other techniques.

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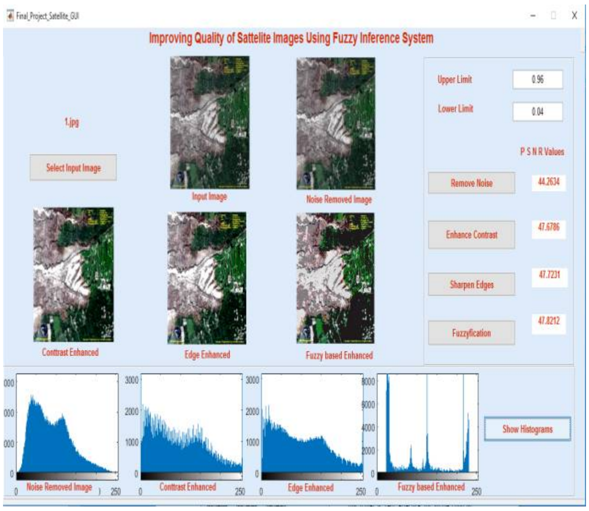
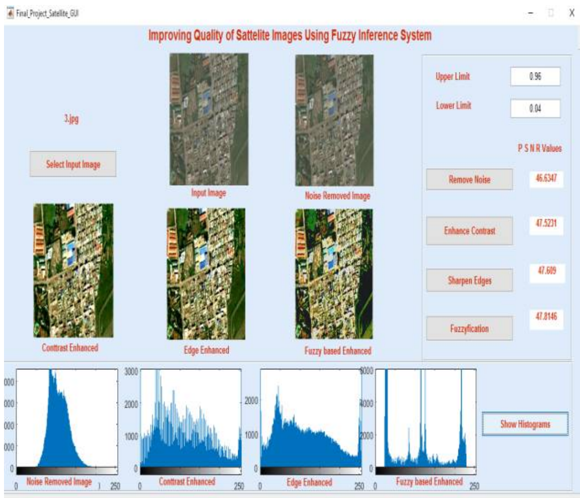
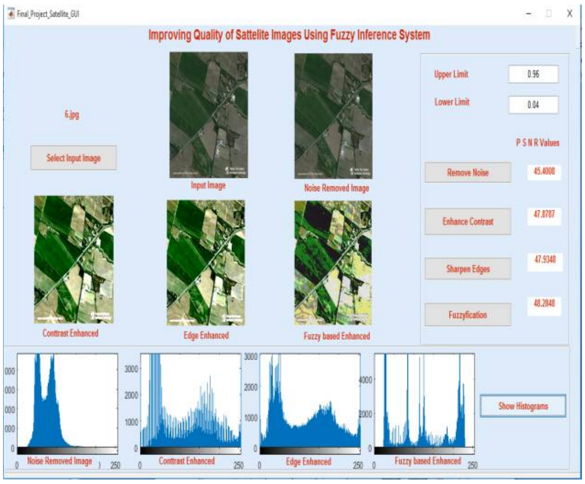


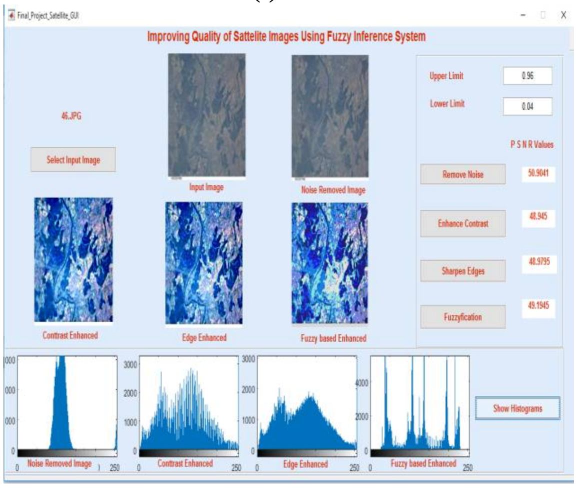
(e)



(f)



(g)



(h)

Figure (e),(f),(g)and (h) shows the comparison of different Enhancement Techniques

TABLE 1.1 PSNR COMPARISION AFTER EACH STEPS

Image	PSNR Values (Input image Vs. Output of Each Stage)			
	Pre-processing	Contrast Setting	Edge Sharpness	Fuzzyfication
1.jpg	44.26	47.39	47.44	47.67
2.jpg	42.40	46.59	46.72	46.61
3.jpg	46.63	47.26	47.34	47.51
6.jpg	45.40	47.49	47.55	47.99
10.jpg	43.75	47.62	47.72	47.98

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 5, May 2017

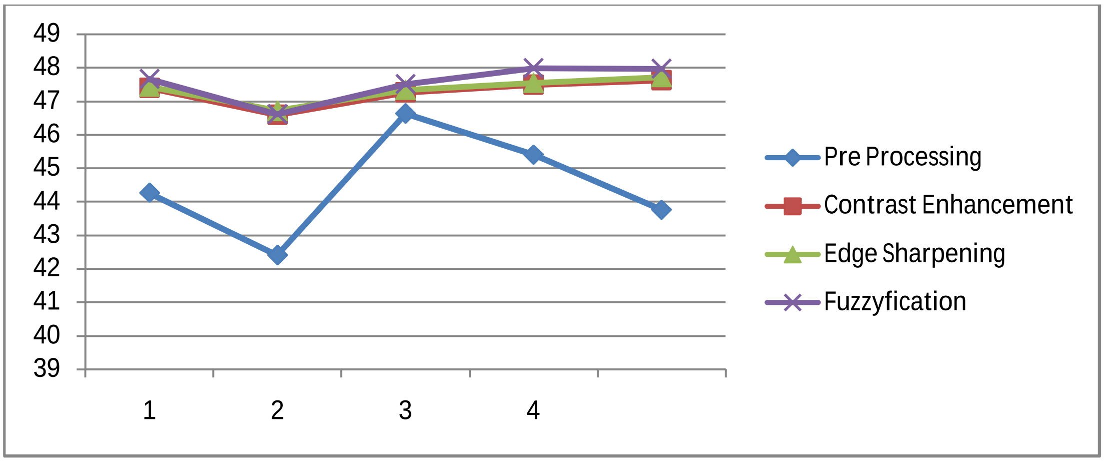

Figure.4.PSNR comparison after each steps

From table1.21 and Figure 4 .it is very clear that PSNR values are increasing after each step of enhancement and fuzzy based contrast enhancement of input image generates highest PSNR i.e. best result.

V. CONCLUSION

Different Image improvement algorithms produce many different methodologies for image amendment to attain visually accepted images. The techniques of Contrast enhancement are utilized broadly for betterment of visual quality of low contrast images. Here, after taking the image database, we applied Median filter for noise remove as it gives highest PSNR than others. Contrast enhancement is done by using auto contrast method where upper limit is set to 0.96 and lower limit is set to 0.04 concluded as best. Fro edge enhancement we have applied gradient and Laplacian filter, here, gradient filter is selected based on PSNR comparision. Finally, fuzzy base contrast enhancement is applied and from table 1.2 and Figure 4.it can be easily observed that PSNR values are much greater after fuzzyfication. Most of the present techniques do not give adequate results in low contrast and light variation areas. The method proposed in this paper is very effective for image contrast enhancement with a membership function that recovers both the brightness and fine details of the input image and also reserves the complete image brightness and contrast stretching.

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