

Efficient Technique to Improve Quality of Satellite Images using Discrete Wavelet Transform and Fuzzy 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 give 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 and increase contrast of the image. 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. For edge enhancement DWT based algorithm is applied where high level component which contains the edge information of image are extracted using DWT and enhanced using sharpening filter. Finally, using inverse DWT operation enhanced image is generated..Fuzzy contrast enhancement is also applied for setting contrast level at last stage. Finally output of each stage is compared by using PSNR parameters.

Index Terms: Preprocessing, Satellite images, Fuzzy Contrast Enhancement, DWT Image Enhancement, PSNR.

I. INTRODUCTION

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. Here, we are discussing some previous papers from which authors view and proposed methods. P. Suganya, N. Mohanapriya et. 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 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 become clear. 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 give 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.

II. LITERATURE SURVEY

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. This reconstructed image has information gather from all the different images sources so this is more informative.

For the images interpolation Hasan Demirel & Gholamreza Anbarjafari [4] 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. Satellite images are needed to be upgraded both interms of 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 images of high frequency of original image. 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 denoising 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]. Nutan Y. 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 a larger weight to the gray levels that are closer to the mean gray level of the image than that are farther from the mean [12].

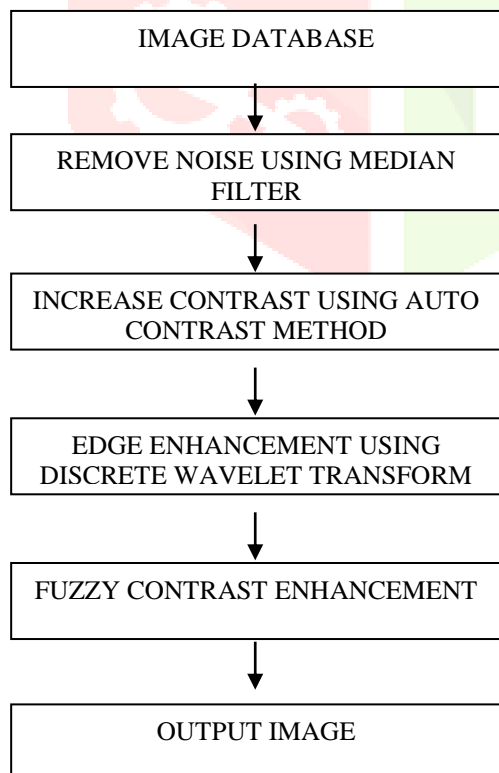
In most of the image processing applications, there is a need of expert knowledge to overcome the difficulties (like object recognition, scene analysis). Fuzzy set and fuzzy logic offers a powerful tool to process and represent human knowledge as fuzzy if-then rules. Because of the data uncertainty due 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].

Thriveeni R. et. al. they propose a DWTPCA based fusion and Morphological gradient for enhancement of Satellite images. The input image is decomposed into different sub bands through DWT. PCA based fusion is apply on the low-low sub band, and input image for contrast enhancement. IDWT is used to reconstructs the enhanced image. To achieve a sharper boundary discontinuities of image, an intermediate stage estimating the fine detail sub bands is required. This is done by the success of threshold decomposition, morphological gradient based operators are used to detect the locations of the edges and sharpen the detected edges[17]. Jadhav B. D. et. al. proposed a satellite image enhancement algorithm based on interpolation of the high-frequency subbands obtained by discrete wavelet transform (DWT) and the low resolution input image is proposed. This method uses a DWT and high frequency subband image interpolation into the low resolution input images. The sharpness of image is obtained by the estimation high frequency subband. Inverse DWT is performed to reconstruct the resultant image [18]. Sharma A. et. al. proposed a technique which decomposes the input filtered image into the four frequency sub-bands by using DWT and then the high frequency subband images and input image have been interpolated along with this the technique also estimates the singular value matrix of the low– low sub band of histogram equalized image and input filtered image then normalize both singular value matrices to obtain brightness enhanced image[19].

M. Ekta et. al. compare lots of enhancement techniques for satellite image enhancement [20].

III. METHODOLOGY



3.1 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

3.2 Noise Removal

Here, for Noise removal we 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 filter can be applied by following equation

$$F(x,y)=\text{median}(g(s,t)) \quad \dots(1)$$

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

3.3 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 color values to use all possible values to enhance the contrast. For preserving the accurate color proportion 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 $m \times n$ monochrome images I and its noisy approximation K is given then MSE is defined as:

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

(2)

The PSNR (in dB) is defined as:

$$PSNR = 10 \cdot \log_{10} \left(\frac{MAX_1^2}{MSE} \right)$$

(3)

Here, MAX_1 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.

3.4 Enhancement Using Discrete Wavelet Transform

2-D Discrete Wavelet Transform (DWT) Wavelets have been used pretty commonly in image processing. Images can be represented both in terms of local spatial and frequency contents using wavelet transforms. The Fourier transform and DCT gives global frequency characteristics of an image, but they be unsuccessful to give local frequency characteristics. This drawback is overcome in wavelet transforms. A discrete wavelet transforms (DWT) for which the wavelets are discretely sampled for numerical analysis and functional analysis. This is overcome by DWT, it captures both frequency and time information. Discrete wavelet transform (DWT) decompose signals into sub-bands with smaller bandwidths and slower sample rates namely Low-Low (LL), Low-High (LH), High-Low (HL), and High High (HH). With this, it is obtained four sub-bands from one level of transform – first low pass sub-band having the coarse approximation of the source image called LL sub-band, and three high pass sub-bands that exploit image details across different directions – HL for horizontal, LH for vertical and HH for diagonal details.

The 2-D wavelet decomposition of an image is performed by applying 1-D DWT along the rows of the image first, and, then, the results are decomposed along the columns. The luminance component (V) from HSV is used here for obtaining the wavelet transform. The frequency components of those sub-band images cover the frequency components of the luminance components value (V) is as shown in Fig. 2. Hence, discrete wavelet transform (DWT) is a suitable tool to be used for designing an image enhancement system.

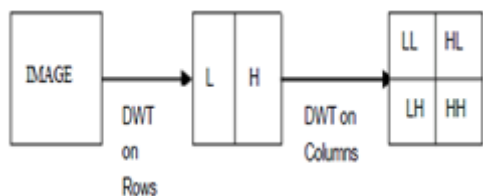


Figure.1. DWT Operation on Image

Here, high level component which contains the edge information of image are extracted using DWT and enhanced using sharpening filter. Finally, using inverse DWT operation enhanced image is generated.

3.5 Fuzzy 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

editing and observing fuzzy inference systems, which are as follows:

- 1 .Fuzzy inference system editor
- 2 .Membership function editor
3. Rule editor
- 4 .Rule viewer
5. Surface viewer

Enhancement: We can use five GUI tools for building,

Fuzzy Inference System:

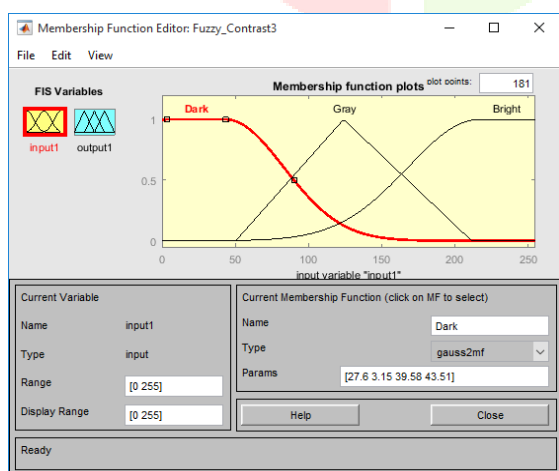


Figure.2. Input FIS Membership function for contrast Enhancement

Figure2 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.

Output Membership Function:

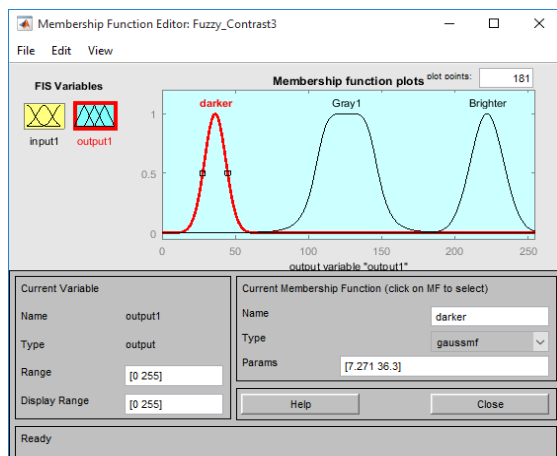


Figure3. Output membership function

Figure3 shows the Surface Viewer. Surface Viewer presents a two dimensional curve that represent the mapping from gray level image to enhanced image.

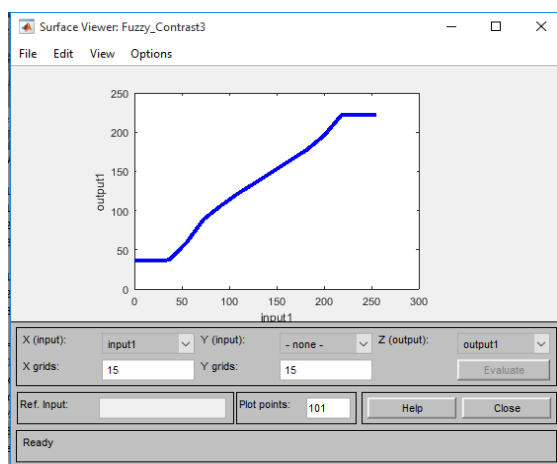


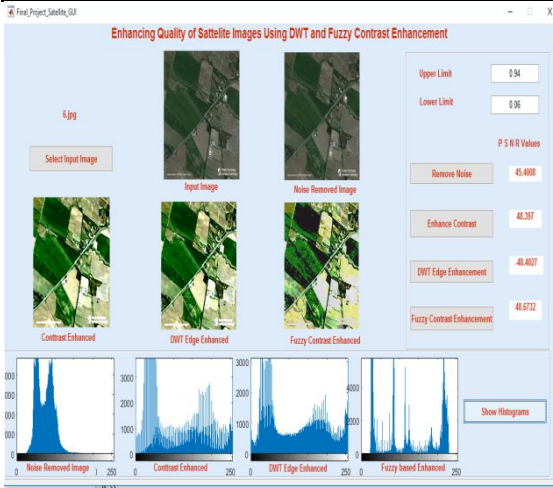
Figure4 Input-Output Relationship

Figure4 shows the input output relationship x-axis shows the input gray value and y-axis shows the corresponding output gray values .

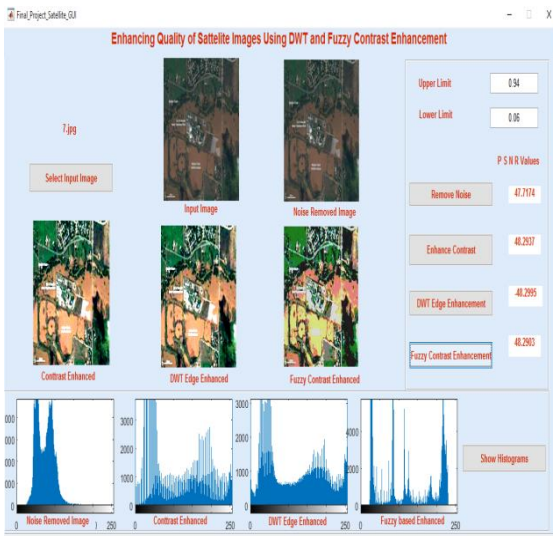
IV. RESULT ANALYSIS

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:

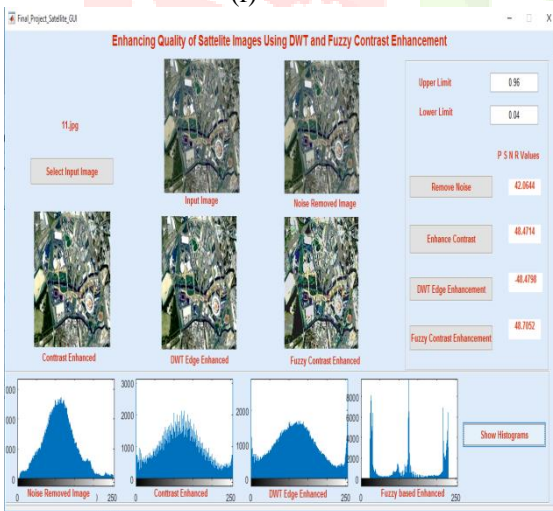
1. Select Input Image from database.
2. Remove noise from input image by median.
3. Enhance contrast using auto contrast method where upper limit is set to 0.96 and lower limit is set to 0.04 resulted as best.
4. DWT based edge enhancement where high level component is extracted from image and edge enhancement is done.
5. Finally fuzzy contrast enhancement is applied to enhance the contrast of image and it is observed that it give better results for image enhancement rather than other techniques.



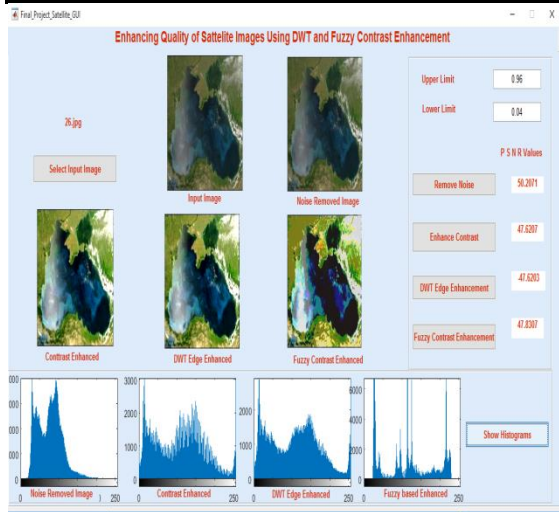
(e)



(f)



(g)



(h)

Figure 5 (e),(f),(g)and (h) shows the comparison of different Enhancement Techniques

TABLE 1.1 PSNR COMPARISION AFTER EACH STEPS

Image	PSNR Values			
	Median Filter	Contrast Enhancement	DWT edge Enhancement	FCE
6.jpg	45.40	48.39	48.40	48.67
7.jpg	47.71	48.30	48.30	48.31
11.jpg	42.06	48.47	48.48	48.71
79.jpg	49.85	50.15	50.17	50.24

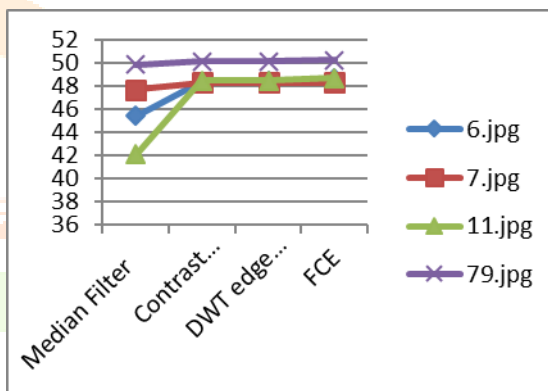


Figure.5.PSNR comparision after each steps

From table1.21 and Figure 5 .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.

IV.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. For edge enhancement DWT based edge enhancement method is applied. 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. Table 1.1 also shows that after all steps average PSNR value is near to 49 which shows good for enough for enhancement algorithm. 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.

REFERENCES

[1] P. Suganya, N. Mohanapriya, B. Kalaavathi, "Satellite image resolution enrichment using multi wavelet transform and comparison of interpolation methods", International Journal of Research in Engineering and Technology,May-2014.

[2] Abdullah-Al-Wadud, M., Kabir, M.H., Dewan, M.A.A., Chae, O.,"A dynamic histogram equalization for image contrast enrichment", IEEE Trans. Consum. Electron. 53, pp. 593-600, 2007.May,2007

- [3] Pavithra C , Dr. S. Bhargavi, “Fusion of two images based on wavelet transform”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 5, May 2013.
- [4] Hasan Demirel and Gholamreza Anbarjafari, “Image Resolution Enhancement by Using Discrete and Stationary Wavelet Decomposition”, IEEE Transaction. On Image Processing, vol. 20, no.5, 2011.
- [5] R.Vani, Dr. R. Soundararajan, “DWT and PCA Based Image Enhancement with local Neighborhood filter Mask”, IOSR Journal of Computer Engineering, 8727 Volume9, Issue2, PP67-70, 2013.
- [6] H. Demirel, C. Ozcinar, and G. Anbarjafari, “Satellite image contrast enhancement using discrete wavelet transform and singular value decomposition,” IEEE Geosci. Remote Sensing Lett, vol. 7, no.2, pp. 333–337, Apr.2010.
- [7] G. Srilekha, V. K. Kumar ,and B. Jyothi, “Satellite image resolution enhancement using DWT and contrast enhancement using SVD,” International Journal Engineering .Research Technology (IJERT), vol.2, no.5, pp.1227–1230, May2013.
- [8] G. Gilboa, N. Sochen, Y.Y. Zeevi, “Image enhancement and denoising by complex diffusion processes, ”IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.26, Aug.2004.
- [9] F. Russo, “An image enhancement technique combining sharpening and noise reduction, ”IEEE Transaction on Instrumentation and Measurement, vol. 51, Aug.2002.
- [10] Alexey Saenko, Galina Polte, Victor Musalimov, “Image enhancement and image analysis using fuzzy logic techniques,” IEEE, international conference on Communication, Aug. 2012.
- [11] Dr. G. Sudhavan, “K Enhancement of Low Contrast Images Using Fuzzy Techniques,” SPACES-2015.
- [12] Nutan Y. Suple , Sudhir M. Kharad , “Basic Approach to Image Contrast Enhancement with Fuzzy Inference System,” International Journal of Scientific and Research Publications, Volume 3, Issue 6, June 2013.
- [13] E. E. Kerre, Fuzzy sets and Approximate Reasoning, Xian, China: Xian Jiaotong Univ. Press, 1998
- [14] P. Pratibha, D. Kranti Kumar, D. Deepak Kumar, “Enhancing the Quality of Satellite images by Pre processing and Contrast Enhancement,” ICCSP17, 2017.
- [15] S. Brindha, “Satellite Image Enrichment Using DWT – SVD and Segmentation Using MRR –MRF Model”, Journal of Network Communications and Emerging Technologies, Volume 1, Issue 1, March ,2015.
- [16] Neeraj Varma, “IMAGE ENRICHMENT USING DWT”, International Journal of Computer Science and Mobile Computing , Volume 3, Issue 12, pp. 514 – 520, December, 2014.
- [17] R. Thriveni and Ramashri, “Edge preserving Satellite image enhancement using DWT-PCA based fusion and morphological gradient,” Proc. 2015 IEEE Int. Conf. Electr. Comput. Commun. Technol. ICECCT 2015, 2015.
- [18] B. D. Jadhav, “An Effective method for Satellite Image Enhancement,” Int. Conf. Comput. Autom., pp. 1171–1175, 2015.
- [19] A. Sharma and A. Khunteta, “Satellite Image Enhancement using Discrete Wavelet Transform, Singular Value Decomposition and its Noise Performance Analysis,” 2016 Int. Conf. MicroElectronics Telecommun. Eng., pp. 594–599, 2016.
- [20] M. Ekta, S. Ankita, “Survey on Various Wavelets Based and Fuzzy Based Methods for Satellite Image Enhancement”, International Journal of Computer Trends and Technology (IJCTT) – Volume 57 Number 2- March 2018