
A Flexible Scheme of Fault Sensing in Power Transmission Line Using Artificial Intelligence Technics

Deepak Kumar^{1, *}, Amit Kumar¹, Abhay Yadav²

¹Department of Electrical and Electronics, C.B.S College of Engineering and Management, Agra, India

²School of Engineering, Gutam Buddha University, Greater Noida, India

Email address:

deepu1796@gmail.com (D. Kumar), abes.amit@gmail.com (A. Kumar), abhayadav@outlook.com (A. Yadav)

*Corresponding author

To cite this article:

Deepak Kumar, Amit Kumar, Abhay Yadav. A Flexible Scheme of Fault Sensing in Power Transmission Line Using Artificial Intelligence Technics. *American Journal of Remote Sensing*. Vol. 4, No. 6, 2016, pp. 33-39. doi: 10.11648/j.ajrs.20160406.11

Received: November 2, 2016; **Accepted:** March 14, 2017; **Published:** March 21, 2017

Abstract: This paper approaches a technique that helps to find and diagnosing faults in transmission lines using image process technique. Image processing technique is widely used in all area for solving the problems. In this paper, Digital image processing wavelet shrinkage function is use for fault identification and diagnosis. In the other word, take a faulty image from the source like thermo vision camera and real time recording instrument with the co-ordinates of transmission line. Uses the algorithm of digital image processing for segmentation of the image, segmentation divides the image in set of parts and objects, and then apply the wavelet shrinkage function to read the image and give the result. The proposed method provides results that are in terms of PSNR and visual quality. ANFIS is very useful tool to identify the fault condition of the transmission line where this is used the IF-THEN rule by this condition can be easily learn and take best action to remove the fault.

Keywords: Image Processing, Fault Detection, Neuro-Fuzzy Approach, Transmission Line

1. Introduction

The conversion of an image into digital form is possible when used image processing method and apply some operation which is helpful to extract useful information from image. Image have important information for people But noise in the image reduces the image quality that causes fatal errors shown in the image. In image processing, image denoising is an important task. Wavelet analysis is the popular method for reduction the image noise. The wavelet transform function applied to the image at different point for noise reduction. During the acquisition process the noise is occurred in images, because of some intrinsic and thermal fluctuation of source device. Image processing also use in the medical field of the essence. During the disease diagnosis, many types of equipment that are used in the medical field are in digital format. For the fault detection and diagnosis, image taken by the source with the input variable which are very helpful for fault identification. First collect the data from the source then apply the image processing. Used

diagnosis developed tool strategy known as bagging strategy for raises the generalization power of faulty system. This technique has been used in all areas to solve the problems.

The Digital Image Processing has the set of techniques for make transfiguration in many images with the function to improve the information from machines [1]. The function is utilized to intuit the most ideal number of Neuro-fuzzy systems in the thermo vision analysis expressed a summed up image denoising procedure using neighboring wavelet coef. in Signal, Image and Video Processing methods [2]. Many methods related to fault detection on transmission line using neural network technique by the researcher. Novizon et al. [3] presented neural network technique and image processing technique to monitoring the surge arrester prevent by the leakage current.

Hyunuk Ha. et al. [4] proposed a technique for transmission lines utilizing a receiver array to recognize the area of a fault and thermal imaging and charge coupled cameras to confirm the issue and store the image, individually. By identifying these patterns utilizing the microphone array, the area of the faulty insulator can be assessed. Z. Dengwen et al. [5] proposed Some Technique

used for image de-noising which is based on DWT(discrete wavelet transform) and give performance in the terms of peak signal to noise ratio.. In digital image processing W. Fan et al. [6] proposed SPIHT method to reduce the distortion in images. Lifeng Pan [7] presented a remote monitoring on transmission lines using image processing. Li Jun et al.[8] presented to thermal image processing which is very useful in power station to detect the heating range of electrical equipment, read the image pixels that contains the higher value then the other pixel of image.

B. Chinnarao el al.[9] use the mythology to reduce the noise from the image without affecting important features of image and content, use the dual tree complex wavelet transform function for thresholding between noisy feature and important feature of image. Hari Om el al. [11] presented the algorithm for improve and enhance the image quality by using wavelet and other transform function. R. Kumar et al.[12] provide better technique to reduce the noise from the image and enhance the image quality and gives batter views.

2. Process of Fault Detection and Diagnosis

This can be divided in the following steps as,

- Image acquisition
- Image segmentation
- Image edge detection
- NeighShrinkSURETransformation Method

2.1. Image Acquisition

For theany vision system, the first stage is the image acquisition stage after the image has been obtained, various functions are applied to the image to perform the fault analysis and diagnosis. The parameters of the image are shown in table.

Table 1. Imageing Performance.

Spatial Resolution	1.3 mrad
Digital Image Enhancement	Normal and enhanced
Detector type	Focal plane array uncooled micro bolometer
Spectral range	7.5 to 13 μ m
Focus	Automatic or Manual
Thermal sensitivity@50/60Hz	0.08°C at 30°C

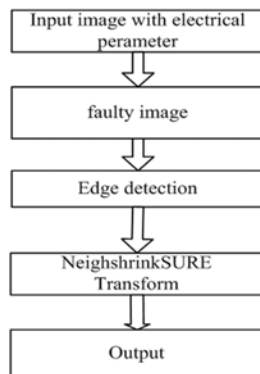


Figure 1. Process of identification of fault.

2.2. Wireless Sensors

A WSN (wireless sensor network) is a wireless network which consists of sensors. The CMOS and CCD cameras are widely used in field of wireless sensor network. Sensors are used to monitor physical and environmental conditions. The WSN are for the electrical system monitoring. The image will be taken from the transmission end and transmitted to receiving end terminal for the analysis the image.

2.3. Image Segmentation

The location of object and image borderline are to be determine by the image segmentation process. Dividing an image into multiple parts that is the process of image segmentation. This is used to determine objects or other important information in digital images. The destinations of image segmentation that is appropriate the image in its arrangement of parts and objects and need to utilize the entire data that temperature, voltage, current, of the symmetrical transmission line is given to the input parameter is set in the image for transmission. The most useable function utilized for the division are: Point or Line discovery, Edge identification, Gradient administrators, Laplacian, Hough light Simple or Adaptive Threshold, district developing and watershed change [5]. This paper uses the edge detection that is the part of process called segmentation method for better edge preservation.

2.4. Image Edge Detection

The image will be prepared and study the image with the input values. Edge detection is the most useable operations in image analysis, the image have some feature like line, edge, points and detection of edge can be possible when do small change in gray level. an edge is basically known as the border line between two or more different regions. this implies if edge in an image can be found for diagnosis process, all the fundamental properties can be found such as region, shape and border can be measured. the common algorithms used for edge detection are sobel, canny, prewitt and garident operators. Sobel and Prewitt are also known as directional edge detector so these edge two operation are mostly used. The image functions can be identified and it is compared with various PSNR values.

2.5. Image De-noising

Despite being more suitable to low bit rate environments, such as mobile and wireless channels suit, it is desirable to remove the noise if possible. It shows that if any fault occurs in the transmission line the voltage, current and temperature level will get as faulty values. And the faulty images will get reclaim to the initial values by thresholding the values. The principle behind this is that when noise occurs as fault during transmission it will be suggested the other node. The recapture of the fault can be done by Wavelet Shrinkage function.

2.6. Edge Reconstruction for Image

The image will be reconstructed by using the image

masking and diagnosis method to retrieve the input values. The shrinkage images suffer from distortions around sharp edges. To enhance the image quality of distorted image, used an edge reconstruction algorithm for improve and recover the edge in coded image. The input voltage, current and temperature change in values can be monitored by this image processing techniques. Mutilation around these edges is perceptually harmful and can't be just kept away from if image are required to be transmitted at low piece rates Edge distortion is simply seen in the tested images.

2.7. Wavelet Shrinkage Transform

NeighshrinkSURE transformation is one of the way in wavelet shrinkage function, used to spot the faults in transmission line. This is a best method for image noise reduction. A non-excess, orthogonal, wavelet change is being connected to the blunder data, took after by the (sub-band ordinate) vector-esteemed thresholding of individual multichannel wavelet coefficient that square measure at long last conveyed back to the picture area by converse wavelet change. The NeighShrink is useful algorithms for image denoising. The neighshirnk, threshold and neighboring window size can be determined by following algorithm as;

$$(\lambda^S, L^S) = \arg_{\lambda, L} \min \text{SURE}(W_s, \lambda, L) \quad (1)$$

Where, λ is optimal threshold, L is neighbouring window size, s is sub-band and sure.

$$(w_s, \lambda, L) = N_s + \sum \|gn(w_n)\|_2^2 + 2 \sum (g_n / w_n) \quad (2)$$

N_s noisy wavelet coefficients from subband s

$$W_s = \{W_{jk} : j, k \in \text{Indices corresponding sub band } s\}$$

Into the 1-D vector

$$g_n(w_n) = \begin{cases} -\frac{\lambda^2}{S_n^2} W_n (\lambda < S_n) \\ -W_n (\text{otherwise}) \end{cases} \quad (3)$$

In this equation (3) $g_n(w_n)$ wavelet coefficient.

Image Thresholding is a simple, useful, way of separation an image into a foreground and background. This image analysis mode is a type of image segmentation that isolates items by transforming grayscale images into binary images. Image thresholding is most useful in images with high levels of contrast. this technique specifies an edge esteem for every level in wavelet transform to indicate the level of universal thresholding system and giving some mathematical statement. it is characterized as [5, 6].

$$g(j, k) = \begin{cases} 1, f(j, k) > T_d \\ 0, f(j, k) \leq T_d \end{cases} \quad (4)$$

Where T_d is threshold, the image background and object pixels replace by 0 and 1.

$$T = \sigma \sqrt{2 \log M} \quad (5)$$

Where, σ is standard deviation which is used the wavelet coefficient sub-band

$$\sigma = \frac{\text{median}(|w_s|)}{0.6745} (w_s \in \text{subband}) \quad (6)$$

In all wavelet subbands, NeighShrink used the universal threshold $\lambda = \sigma \sqrt{2 \log(512)} \approx 3.23\sigma$

The limit and neighboring window size of the proposed technique in each sub-band were computed with Eq.(1).

3. Results and Discussion

In order to estimate the execution of the proposed method, the observation represents set of 8 bit standard gray scale CVG-UGRdatabase, such as House, Barbara, Pepper, mandrill each of size 512x512, 256x256 corrupted by simulated additive white Gaussian noise with a standard deviation equal to 5, 10, 15, 20. The noisy image filtered by these several techniques. Calculate the PSNR values as follows.

$$PSNR = 10 * \log_{10} \frac{255^2}{MSE} (dB) \quad (6)$$

The performance of this method is compared with other scheme. Where MSE(Mean square error) is defined as

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} \|I(j, k) - f(j, k)\|^2 \quad (7)$$

By these equations, calculate the peak signal to noise ration value and the mean square error with the elapsed time. The image takes from the source, applied edge detection then NeighShrinkSURE transformation. The results by the edge detection segmentation process image are shown Below as Fig. (2) Shows input image, Fig. (3) Shows Faulty image. Fig.. (4) Shows dilated gradient image and Fig. (5) Shows Diagnosis image.



Figure 2. Input image as gray image.

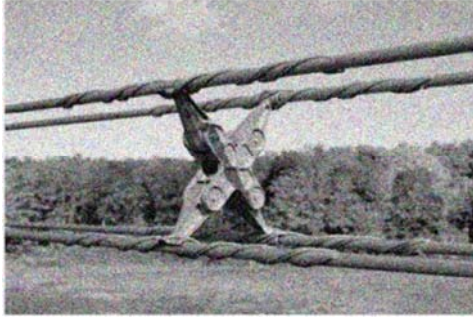


Figure 3. Faulty image.

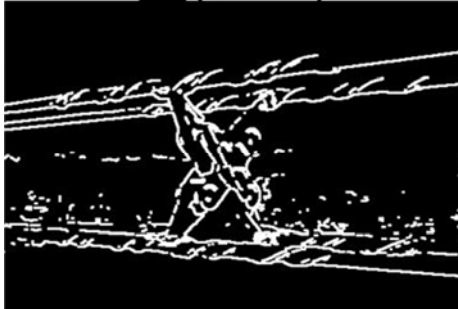


Figure 4. Dilated gradient mask image.



Figure 5. Diagnosis image.

Table 2. Calculation The PSNR Value And Elapsed Time.

Noise level	PSNR	MSE	ELAPSED TIME
5	38.0733	10.1334	12.035249
10	34.7204	21.9303	14.353844
15	32.8676	33.5985	14.500361
20	31.5302	45.7144	13.737332

The comparison of PSNR and MSE obtained with these different images can be seen in table 2, and clear seen that if the noise level (standard deviation) increases the peak signal to noise ratio are decreases and the mean square error is increases.

4. ANFIS Implementation

For improving network monitoring system need to an automatic diagnosis method and decision making process. an artificial intelligence method is requiring. a hybrid system is used for monitoring and diagnosis for system. hybrid intelligent system is known as the combination of fuzzy logic and the neural network system it is also called neuro-fuzzy

system. This system model uses the IF-THEN fuzzy rule for to find the membership function for input and output variable of the system.

Artificial neural network take as a learning algorithm. For the identification of curve parameter based on the weighted value which is multiplies between the created learning rules. Calculate the ratio of weight value between individual and overall weighted [16]. When ratio is gained by the output membership function then finally ANFIS predict the target by applying the all gained value as an output. To find the targeted values adjust the learning process of input and output sides of membership function parameter. ANFIS have to use the hybrid algorithm that consist back propagation and least square estimation techniques.

4.1. ANFIS Learning Process

The trained data that is given to the ANFIS model have at least two columns of data and more than two columns data can be taken. The last column called the target data and also called the output data, while the other rest columns data are the input data. So an ANFIS model has at least one column of input and single output.

For best prediction and reliability of ANFIS performance, the system has to need more elements in input column data. The value of input data in each row is called data variable and have linguistic value to apply IF-THEN rule, which are directly proportional to the membership function. In ANFIS model fuzzy inference system used for given the rules to training and target data.

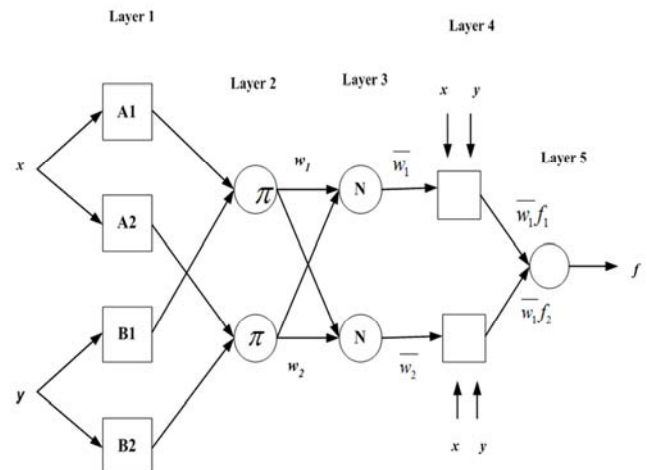


Figure 6. ANFIS structure.

Rule 1: IF (x is Q_1) and (y is P_1)

THEN ($f_1 = a_1x + b_1y + c_1$)

Rule 2: IF (x is Q_2) and (y is P_2)

THEN ($f_2 = a_2x + b_2y + c_2$)

- Layer 1 is fuzzification stage.
- Layer 2 is IF-THEN rule stage
- Layer 3 is Normalization stage
- Layer 4 is Defuzzification stage
- Layer 5 Desired output

In the ANFIS the selection of the fuzzy membership

function, type of parameter and rules are difficult to achieve the required performance and it is most difficult in many situations.

The basic structure of fuzzy inference system is shown in fig. 7.

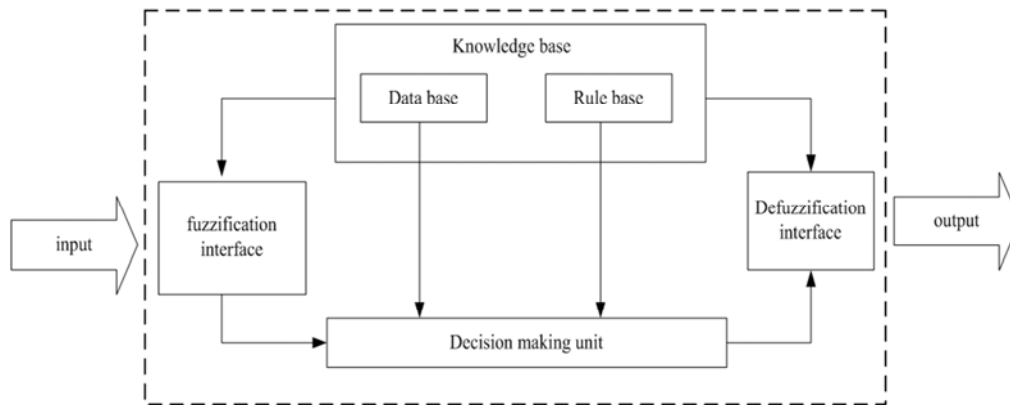


Figure 7. Fuzzy inference system.

The basic components of the fuzzy inference system are fuzzyfication, knowledge base, decision making unit and the defuzzification inference. There are the following steps to define fuzzy inference system

- Fuzzyfication is the first stage to receiving the input signal and convert to fuzzy signal which is input of the membership function.
- In second stage give the fuzzy IF-THEN rule to the output signal of fuzzyfication stage.
- The outputs from the data base and rule base give to the decision making unit where it is performs inference operation on the rules.
- The output from the decision making unite and the knowledge base system is given to as input of the defuzzification stage where the signal is gained by linear equation which is shows membership function as output.

Table 3. Input (Noise Level) And Output (PSNR Value) Value Of Image.

Noise level	PSNR(dB)	Noise level	PSNR(dB)	Noise level	PSNR(dB)
1	48.54	11	33.9	21	31.02
2	43.34	12	33.5	22	30.78
3	40.69	13	33.1	23	30.54
4	39.02	14	32.8	24	30.32
5	37.83	15	32.4	25	30.12
6	36.90	16	32.1	26	29.92
7	36.14	17	31.8	27	29.71
8	35.51	18	31.5	28	29.50
9	34.94	19	31.2	29	29.31
10	34.44	20	31.0	30	29.10

The table shows the input and output value of image. There data value given to the ANFIS MATLAB software and the system gives the output. For the fault identification by image processing and Neuro-fuzzy approach, when the input increases the output will decreases means that the pixel of an image is corrupted and the noise increased.

5. Results from the ANFIS

The ANFIS system takes the first order sugeno type fuzzy inference system which has three inputs with two triangular type membership functions and one output with constant membership function. Therefore 60 rules are to be generated by the FIS. So there are 60 outputs of membership function and have only one output.

The fuzzy inference system output where three input value taken from the range one to thirty and one output, when the input value range taken from 1 to 11.4 and 21 the output value is 37.4 this shows the normal condition of fault and this output also shows the image quality which is good.

When the input range increases which is shown in the as suspicious condition referred by the output it means that if the input ranges from 6.58 by first input and 19.2 by the second input and 27.9 by the third input the result will be change which is shown as 28.6, hence the output is decrease which is shows the suspicious condition of fault.

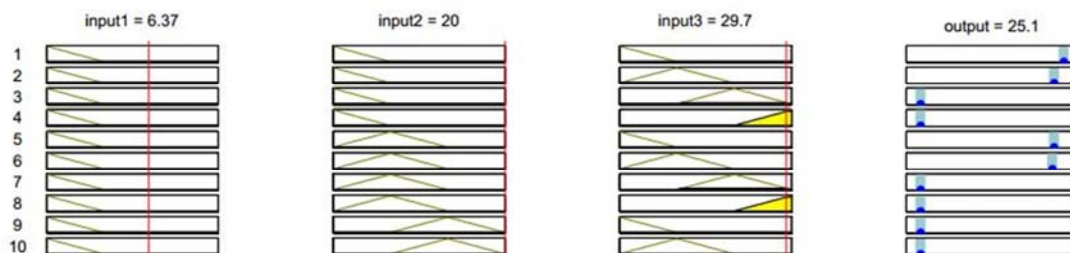


Figure 8. Faulty condition.

The fig. 8 shows the faulty condition, when increase the second input and the third input as 20 to 29.7 and the first input are 6.37 the output is completely change as 25.1 which is shows the bad quality of image it means that noise level is high or increase.

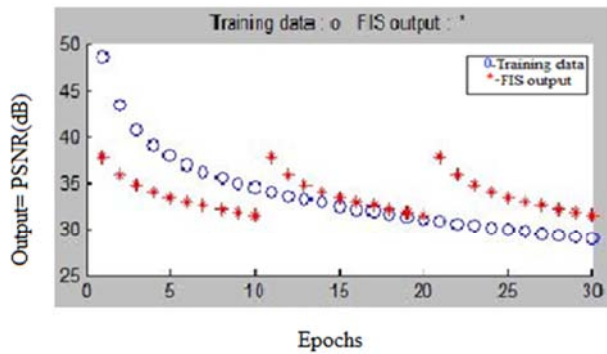


Figure 9. Graph between training data and FIS output.

The fig. 9 shows the graph between training and FIS output, the red line shows the output and the blue circle shows the training data line. The training data which have the three input and one output taken from the table 3. The first red line which is from 1 to 10 shows the normal condition and second line from 11 to 20 shows the suspicious condition and the third line shows the faulty condition from 21 to 30.

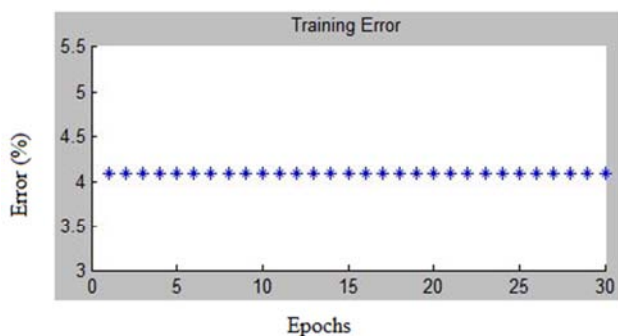


Figure 10. Training error plot by ANFIS.

The figure 10 shows the training error which is calculated by the difference between desired output and input and the error is 4.0908% which means that the input data is 96.01% accurate. The ANFIS is best tool for correlate the data and give the best result that can be easily to learn.

6. Conclusion

This paper presents a scheme for fault analysis and diagnosis in transmission line. Input values of the transmission line are injected in the image and it is transmitted in a network. The obtained image values are processed by the Neigh Shrink SURE function. And if a fault is observed or any noise is occurred in the image it tends to change the characteristics of the image. Thus the changes can be proceeding by the Neigh Shrink SURE function and the

original values of the input are obtained. Thus it assured that the location fault can be identify and diagnosed. The diagnostics tool complete showed itself as a powerful tool to identify fault. The operation process speed is very fast, reliability about 95-98%, human factor 5%.

The ANFIS function is very accurate to define the process of fault and used in many applications, here the data set which is used in ANFIS and gives the some rule to detect the condition by increasing or decreasing the input parameter. If the input increases step by step the output of FIS system reduced and data is image noise level and the PSNR output value.

References

- [1] Hari Om and Mantosh Biswas, "A generaliz. Image denoising mtd. Using neighbr. waveletcoef.," Signal, Image and Video Processing Springer -SVIP March, 2013.
- [2] C. A. Laurentys Almeida at el., "Intelligent thermo graphic Diagnostic Applied to Surge Arresters: A New Approach", IEEE Trans. On the power delivery, vol. 24, april 2009.
- [3] Novizon, Z. A. Malek, N. Bashir, N. Asilah, "Thermal Image and Leakage Current Diagnostic as a Tool for Testing and Condition Monitoring of arrester", jurnalteknologi 2013.
- [4] Hyunuk Ha, Sunsinihan, and Jangmyung Lee, "fault Detection on Transmission Lines Using a Microphone Array and an Infrared Thermal Imaging Camera", IEEE tran. on instrumentation and measurmant, vol. 61, no. 1, pp.267-275, january 2012.
- [5] Z. Dengwen and C. Wengang, "Image denoising with an optimal threshold and neighbouring window", Pattern Recognition Letters, Elsevier-2008.
- [6] W. Fan, J. Chen, and J. Zhen, "SPIHT Algorithm Based on Fast Lifting Wavelet Transform in Image Compression", springer publication-2005.
- [7] Lifeng Pan, "Intelligent Image Recognition Research on Status of Power Transmission Lines", Sensors & Transducers, IFSA publication, Vol. 179, pp. 174-179, September 2014.
- [8] Li Jun and Liu Xinyu, "Heating defect detection system scheme design based on infrared image processing for high voltage plant of substation", advance in control engineering and information science, Elsevier-2011.
- [9] B. Chinnarao and M. Madhavilatha, "Improved Image Denoising Algorithm using Dual Tree Complex Wavelet Transform", International Journal of Computer Applications, Volume-44, April 2012.
- [10] Yu Hancheng, Li Zhao, and H. Wang, "Image Denoising Using Trivariate Shrinkage Filter in the Wavelet Domain and Joint Bilateral Filter in the Spatial Domain", IEEE Trans. On image processing, vol. 18, no. 10, pp.2364-2369, october-2009.
- [11] Hari Om, M. Biswas, "An Improved Image Denoising Method Based on Wavelet Thresholding", Journal of Signal and Information Processing, science direct, February-2012.

- [12] R. Kumar and B. S. Saini, "Improved Image Denoising Technique Using Neighboring Wavelet Coefficients of Optimal Wavelet with Adaptive Thresholding", International Journal of Computer Theory and Engineering, Vol. 4, No. 3, June 2012.
- [13] R. Syahputra, "A Neuro-Fuzzy Approach For The Fault Location Estimation of Unsynchronized Two Terminal Transmission Line", International Journal of Computer Science & Information Technology (IJCSIT) Vol 5, No 1, February 2013.
- [14] V. G. Reju, Soo Ngee Koh, Ing Yann Soon, "Convolution using discrete sine and cosine transform", IEEE Signal Processing Letters, Vol. 14, pp.445-448, July 2007.
- [15] A. Ahmad, G. Rudrusamy, R. Budiarto, A. Samsudian and S. Ramadass, "A Hybrid Rule Based Fuzzy-Neural Expert Syatem For Passive Network Monitoring", International Joint Conference on Artificial Intellifence, Vol.-5, pp 85-92, 2001.
- [16] D. R. Srinivasa, M. Seetha, K. Prasad, "Comparision of Fuzzy and Neuro Fuzzy Image Fusion Technique and Its Application", International Journal of Computer Application, Vol.-43, pp 31-37, April 2012.
- [17] S. N. Shitole, O. Zahran and W. Al-Nuaimy, "Advance Neural -Fuzzy and Image Processing Technique In The Automatic Detection and Iterpretation of Weld Defects Usinf Ultrasonic Time of Diffraction", International conference on NDT, Vol.-4, october 2007.
- [18] A. Bhardwaj, K. K. Siddhu, "An Approach to Medical Image Classification Using Neuro-Fuzzy Logic And ANFIS Classifier", International Journal of Computer Trends and Technology, Vol.-4, pp 236-240. 2013.
- [19] Suryakant, R. Dhir, "Novel Adaptive Neuro-Fuzzy Based Edge Detection Technique", International Journalof Computer Application, Vol-49, pp 23-27, July 2012.