RESEARCH ARTICLE

ORTHOGONAL WAVELET DECOMPOSITION WITH MULTI-LEVEL THRESHOLDING FOR IMAGE ENHANCEMENT.

G.Kalpana[1] and G.Karuna[2].

1. Assistant Professor, Department of MCA, CBIT, Hyderabad.
2. Associate Professor, Department of CSE, GRIET, Hyderabad.

………………………………………………………………………………………………………....

Manuscript Info	*Abstract*

…………………………………………………………………

The image enhancement techniques have been widely used to improve the quality of images with respect to human visual appearance, contrast and provide the better transform representation for future automated image processing. Image segmentation is the process of partitioning a 2D digital image into multiple segments. Different image segmentation techniques are available and they are mainly focused on representation of an image into more significant and easier to analyze. The quality of segmentation results are evaluated using PSNR and MSE values. Histogram equalization is used for image enhancement that improves the contrast in an image, in order to stretch out the intensity range. This method is useful in images with backgrounds and foregrounds that are both bright or both dark. However Histogram Equalization suffers from poor contrast and with noise. In the present work, a novel Multi-Level Threshold based algorithm for image segmentation is proposed. The main objective of proposed method is to reduce uneven contrast, unwanted noise, and unnecessary effects.

………………………………………………………………………………………………………....

Introduction:-
Image Processing is a method to enhance original images captured from cameras/sensors placed on artificial satellites, military and aircrafts or the images taken from real life for different applications. The general steps in image processing are image scanning, storing, enhancing and interpretation.

Image enhancement is a process that improves the definition of a video image by a program written in computer, so that it reduces the lowest gray-values in to black and highest gray-values into white. Mostly the images found from satellites and from traditional digital cameras lack in contrast and brightness due to the limited conditions during capturing of images. There are different types of noise obtained from the images. In image enhancement, the goal is to emphasize certain image features for subsequent analysis or for image display. Examples include contrast and edge enhancement, pseudo-colouring, noise filtering, sharpening and magnifying. Image enhancement technique is valuable in image analysis, extraction of image features, and displaying image. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics. Enhancement algorithms are generally interactive intensive and application dependent. Some of the enhancement techniques are Contrast Stretching, Noise Filtering and Edge Enhancement. An image enhancement technique that works well for X-ray topographic images may not work well for MR images [1]. The enhancement methods can broadly be divided in to the following two categories [2]. Spatial Domain Methods and Frequency

Corresponding Author:- G.Kalpana.
Address:- Assistant Professor, Department of MCA, CBIT, Hyderabad.

Domain Methods. In spatial domain techniques [3], directly deal with the image pixels. The wavelet transform [4, 5] has a long and successful history as an efficient image processing method. Mixing problem can be improved with the directional extension for wavelets proposed in [6].

Contrast Stretching:-
Some images (e.g. snow, clouds, forests, deserts, other hazy conditions of heterogeneous regions) are homogenous i.e., they do not have much change in their levels. In terms oSf histogram representation, they are characterized as the occurrence of very narrow peaks. This similarity is because of the scene incorrect illumination.

Ultimately the images hence obtained are not easily interpretable due to poor human perceptibility. This is because there exists only a narrow range of gray- levels in the image having provision for wider range of gray-levels. The contrast stretching methods [8] are designed exclusively for frequently encountered situations. Different stretching have been developed to stretch the narrow range to the whole of the available dynamic range.
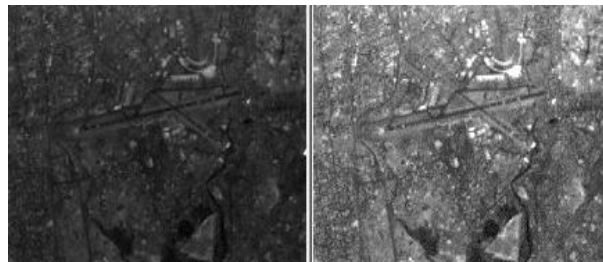

Fig 1:- Contrast stretching

Noise Filtering:-
Noise filtering is mainly advantageous to filter the excessive and unwanted information from an image. It is used to remove different kinds of noises also from the images. Mostly this feature is interactive. The filters such as high pass, low pass, mean, median are widely used.
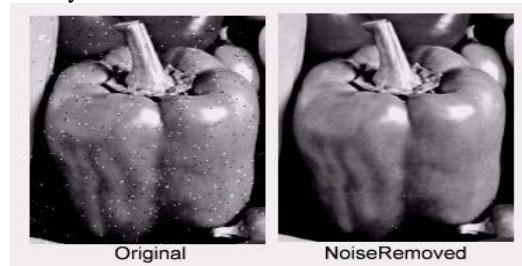

Fig 2:- Noise Removal

Edge Enhancement:-
Edge enhancement is one of the image processing filter [9, 10] which enhances the edge contrast of an image in an attempt to improve its seeming sharpness. The filter works by identifying sharp edge boundaries in the image, such as the edge between a subject and a background of a contrasting color, and increasing the image contrast in the area immediately around the edge.
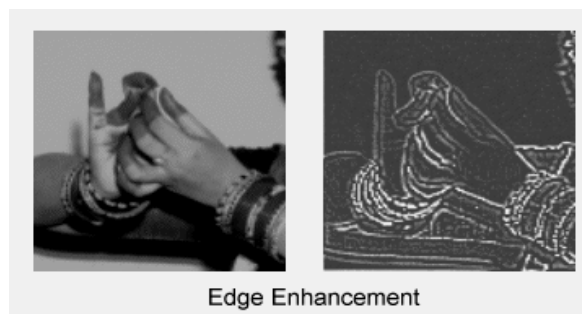

Fig 3:- Edge Enhancement

Related Work:-
Histogram Equalization:-
Histogram equalization [7] is a method in image processing of contrast adjustment using the image's histogram.
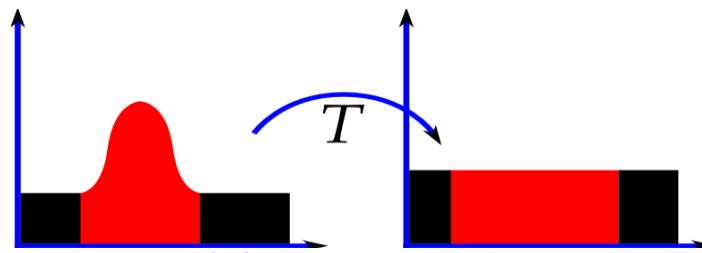

Fig 4:- Histogram Equalization

In general this technique improves the global contrast of most of the images, particularly when the usable data of the image is depicted by its close contrast values. The intensities can be distributed in good manner using this adjustment on the histogram. This permits the image areas of lower local contrast to obtain higher contrast. Histogram equalization does this by efficiently distributing the most frequent occurred intensity values. The method is helpful in images with backgrounds and foregrounds that are both bright and dark. Meticulously, this method can achieve the best views of x-ray images of bones structure. One of the beneficial from this method is that it is a reasonably straightforward process and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered. The calculation is not computationally intensive.

There are considerable limitations in Histogram equalization. This method is indiscriminate. This method may increase the background noise contrast and decreasing the usable signal. In scientific imaging where spatial correlation is more important than intensity of signal (such as separating DNA fragments of quantized length), the small signal to noise ratio usually hampers visual detection. Histogram equalization is useful for scientific images such as satellite, thermal, x-ray images but it produces unexpected effects in most of the photographs. Histogram equalization can produce unwanted effects (i.e. visible image gradient) when applied to images with low color depth. This technique is is well suited for the images having brighter colors than palette size such as 6-bit gray-scale images.

Proposed Method:-
The proposed method can take advantage of all existing enhancement techniques for plain images and achieve excellent performance with respect to the removal of unwanted noise and to reduce unnecessary contrast. A Novel Multilevel thresholding Image enhancement technique has been proposed which is mainly based on orthogonal wavelet decomposition.
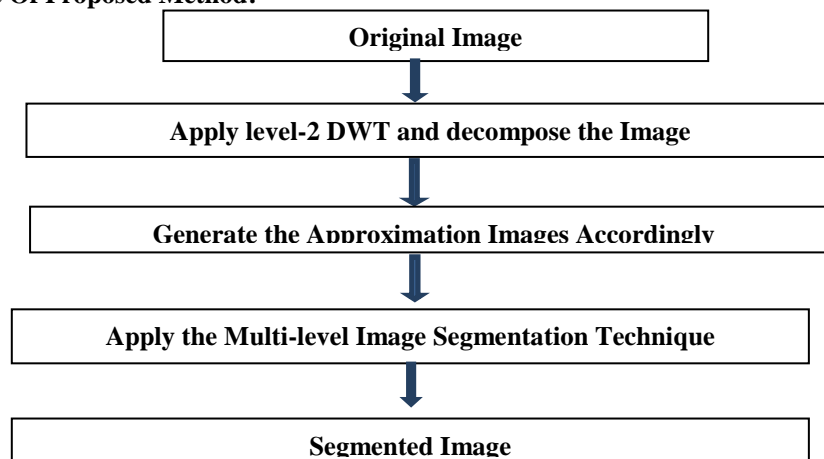
Structure Of Proposed Method:-

**Fig 5:-** Proposed Methodology

Proposed Algorithm:-
begin
Step 1:- select original input image
Step 2:- Apply level-2 DWT and decompose input image
Step 3:- Generate the Approximate images
Step 4:- Apply Multilevel image segmentation technique
Step 5:- Segmented image as output
end

Proposed Methodology:-
Discrete Wavelet Transform To Decompose An Image:-
Apply 2-level discrete wavelet transform to decompose the given original input image. For decomposing an image, also used orthogonal wavelet decomposition technique. In 2- level discrete wavelet transform, the high pass filters and low pass filters are used. For this module, Band pass filter is used. The image is divided into 4 blocks. That is, Approximation image (Low-Low band), Horizontal (Low-High), Vertical (High-Low), Diagonal (High- High) images.   Frequency based domain image enhancement is mainly focused to designate the exploration of mathematical functions in order to frequency and operate directly on the transform coefficients of the image, like discrete wavelet transform.

The Discrete Wavelet Transform [11, 12] is used the low pass and high pass filter to find the desire information. The most important information in the signal appears in high amplitudes and the least important information in the signal appears in very low amplitudes. Appropriate high pass and low pass filters are applied to the data at each level and also there is down sampling done at each level. The discrete wavelet transformation initially subdivided the image into four main areas[13]. The filtered data depends on the level of DWT where LL1 (Low-Low) sub band is depicted as an approximation data area and other sub bands are depicted as more detail information. The present sub bands are as follow: high-low (HL1), low high (LH1) and the high-high (HH1).

LL1 (Approximation)	LH1 (Horizontal)
HL1 (Vertical)	HH1 (Diagonal)
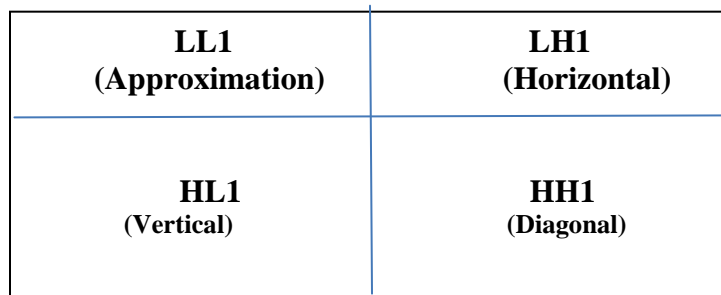
Fig 6:- Level-1 DWT.
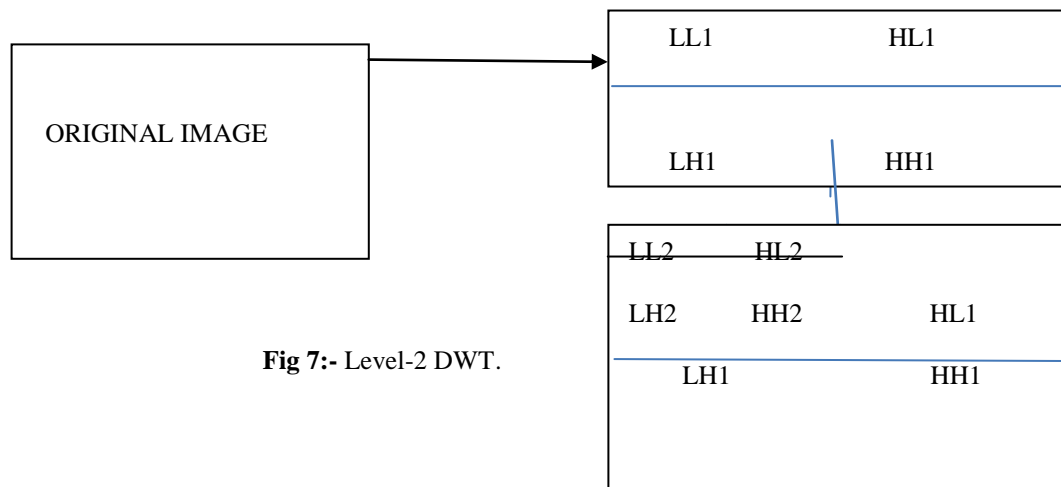
Fig 7:- Level-2 DWT.

Orthogonal Wavelet Decomposition To Generate The Approximation Images:-
Orthogonal wavelets used for discrete wavelet transform development. The DWT returns a data vector of the equal length as the input is. Generally, even in this vector many data are almost zero. i.e. the DWT decomposes the image into a set of wavelets or functions and they are orthogonal to its translations and scaling. Therefore we decompose such a signal to a same or lower number of the wavelet coefficient spectrum as is the number of signal data points. And this wavelet spectrum is appropriate for signal processing and compression.

The way the decomposition is shown below. Started with the original signal and fit the mother wavelet to it at the smallest scale. This produces what is called the first wavelet "detail" and a remainder called the "approximation"[14]. Then double the timescale of the mother wavelet (called dilation) and fit that to the first approximation. And so the process continues until the mother wavelet has been dilated to such an extent that it covers the entire range of the signal. The result is a set of details, each corresponding to an average timescale that doubles at each level, and an approximation. These details have an exceptional property called orthogonality and it means that they are completely independent of each other and therefore can be added together in any sequence. Furthermore, the variances can be added together to obtain the variance of the original signal.

Apply The Multi-Level Image Segementation Technique:-
Finally a novel Multi- level thresholding technique is applied. In this technique, a thresholding value is taken as a reference and the pixel values are compared to this thresholding value. In general for a global thresholding technique, a single threshold value is taken. The pixel values less than the threshold value are shown as black and the pixel values more than threshold value are shown as white. In multi- thresholding technique, many values can be taken as reference. Here, two values are taken as reference and the pixel values are compared with these two values. Multilevel thresholding is a method which divides a gray level image into many small regions. This technique finds more than one threshold for the given input image and segments the image into some brightness regions, and it corresponds to one background and several objects. This technique is well suited for color images having complex backgrounds.

Experimental Results:-
Taking an original input image is shown in Fig 4(a) below. The command "imread" or "uigetfile" is used in order to read a file. "imread" is used when an image is directly mentioned. "uigetfile" is used to give an input for a specific type of image such as .jpg, .png.
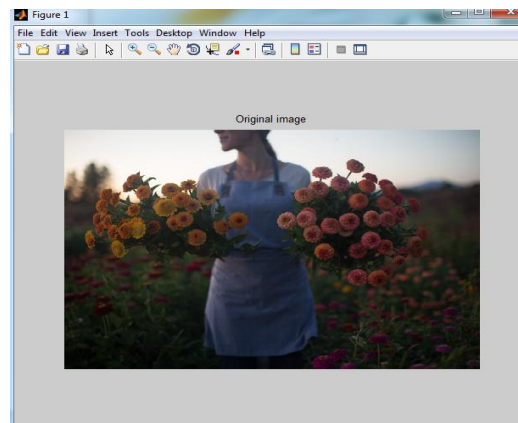

Fig 4 a:- Original input image.

The below Fig 4(b) shows the grayscale image and histogram equalized image and their corresponding histograms. An RGB image is converted into grayscale image in order to reduce the complexity of the technique used in the project. To find the histogram of the image, "imhist" command is used. In order to find the histogram equalized image, "histeq" command used. And found that the histogram of the equalized image is stretched when compared to the grayscale image, stating that the image contrast has increased. Fig 4(c) shows the wavelet decomposition technique. In this technique, the image is being divided into four. They are: Approximation image, Horizontal image, Vertical image, Diagonal image.
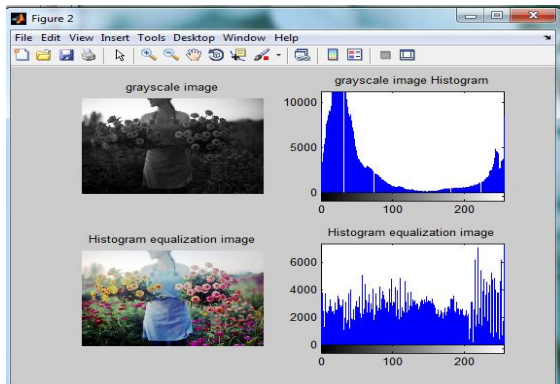
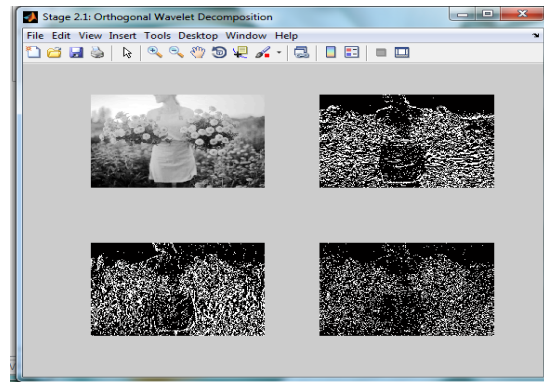**Fig 4 (b):-** Histograms of the grayscale image and histogram equalization image

Fig 4(c):- Orthogonal Wavelet decomposition for image

The below fig 4(d) shows the global thresholding technique. Thresholding technique is used in order to convert all the pixels less than the thresholding value as black and pixel values greater than threshold value as white. The fig 4(e) shows the multi-level thresholding technique. In this technique, multiple threshold values can be taken. Here, two threshold values are considered in order to have a better result.
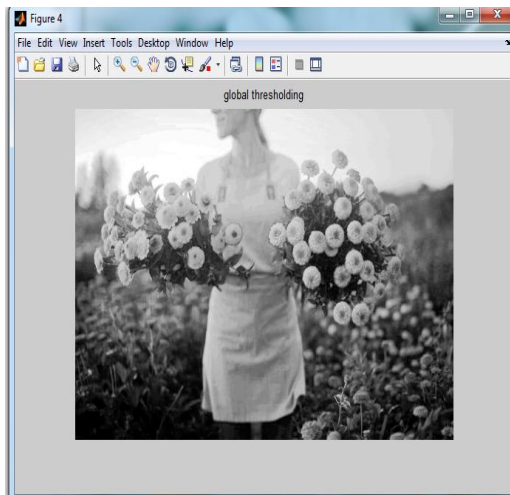

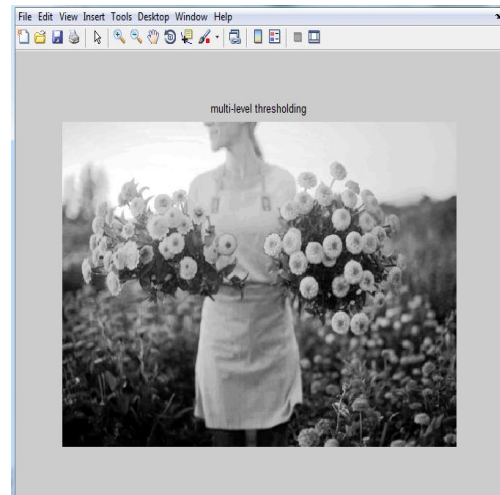**Fig 4 (d):-** Global Thresholding for image

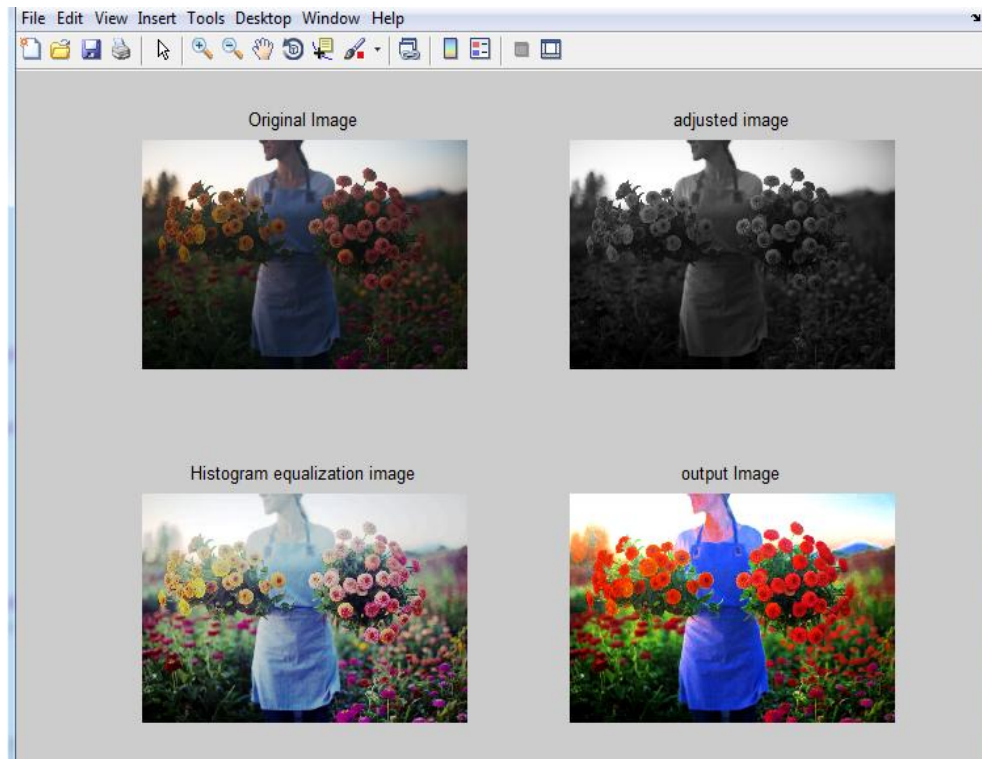**Fig 4 (e):-** Multi-level thresholding technique

Fig 4 (f):- Final Output

In the fig 4(f) the final output of the proposed method depicted. In this figure all the images are displayed such as the original input image, the adjusted or grayscale image, Histogram equalized image and output image after applying the proposed method.

Conclusion:-

As an initial attempt, here is the motivation and solution for the problem of poor contrast, noise in the image. Initially a basic scheme is given and followed by existing Histogram Equalization applied. However it is very inefficient to achieve image enhancement and also fails to removal noise and reduce contrast. Wavelets have their energy concentrated in time and are well suited for the analysis of transient, time-varying signals. The wavelet transformations are well suited because most of the real life signals come upon time varying in nature. Further investigated enhancement techniques have been applied. The Orthogonal Wavelet Decomposition used first and combined this with multi-level thresholding technique. The thorough analysis indicated that, the proposed system is successful in achieving image enhancement than the existing methods in terms of removal of unnecessary noise and reduced unwanted contrast and Extensive experimental results demonstrate the efficiency of our solution.

References:-

1. Dr. Muna F. Al-Samaraie, Dr. Nedhal Abdul Majied Al Saiyd, "Medical Colored Image Enhancement Using Wavelet Transform Followed
2. By Image Sharpening," Ubiquitous Computing and Communication Journal Volume 6 Number 5 pp.1.
3. Raman Maini , Himanshu Aggarwal, "A Comprehensive Review of Image Enhancement Techniques," Journal Of Computing, Volume 2,
4. Issue 3, March 2010, Issn 2151-9617.
5. Bhabatosh Chanda ,Dwijest Dutta Majumder, "Digital Image Processing and Analysis", 2002.
6. M. N. DO, "Directional Multiresolution Image Representation", Ph.D. Thesis, 2001.
7. S. Mallat, "A Wavelet Tour of Signal Processing 2nd Ed. San Diego", Academic Press; 1999.
8. Y. LU, M. N. DO, "A Directional Extension for Multidimensional Wavelet Transforms", IEEE Transactions On Image Processing,
9. submitted; 2005.

10. B.T.P. Madhav, P. Pardhasaradhi, R.K.N.R. Manepalli, V.G.K.M. Pisipati, "Histogram equalisation technique to analyse induced

11. Cholesteric phase in nanodoped liquid crystalline compound", Liquid Crystals, 2015, http:// dx.doi.org /10.1080 /02678292. 2015.1012752.

12. B.T.P. Madhav, P. Pardhasaradhi, R.K.N.R. Manepalli, P.V.V. Kishore, V.G.K.M. Pisipati, Image enhancement using virtual contrast image

13. fusion on Fe3O4 and ZnO nanodispersed decyloxy benzoic acid, Liquid Crystals, ISSN 0267-8292, http://dx.doi.org/

14. 10.1080/02678292.2015.1050704, pp 37-41.

15. Jorge Lira and Alejandro Rodriguez; ‗Edge enhancement in multispectral satellite images by means of vector operators. Published on line:

16. July 01, 2014.

17. Shehna Jaleel, V.Bhavya, N.C.Anu Sree and P.Sajitha ‗Edge Enhancement Using Haar Mother Wavelets for Edge Detection in SAR

18. Images', International Conference On Innovations & Advances In Science, Engineering And Technology [IC - IASET 2014]

19. Time E. 1992. Discrete Wavelet Transforms: Theory and Implementation. Draft 2.

20. Shripathi D. 2003. Discrete Wavelet Transform. Chapter -2.

21. V. Ramya1, G.P.Rameshkumar "An Efficient MR Image Brain Tumor Segmentation Based On Discrete Wavelet Transform and Region

22. Growing Algorithm, International Journal of Engineering Sciences & Research Technology ISSN: 2277-9655 December, 2013.

23. Ali A. Yassin, Rana M. Ghadban, Salah F. Saleh, Hikmat Z. Neima" Using Discrete Wavelet Transformation to Enhance Under Water

24. Image", IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 5, No 2, September 2013.