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# Image Segmentation using Normalized Cut & Dual Wavelet Segmentation

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**Abstract:- Image segmentation is an important image processing technique used to analyze the images. Image segmentation is used to separate an image into several "meaningful" parts. Segmentation of image is an old research topic to segmenting the image by its pixel and edge. The main reason to segmenting the image is contain large image variety and the best performance. In this project we develop a novel based approach to segment the image in a better way. We use the RGB color model to get a better segmented image. The Goal of this project is a theoretical and experimental comparison of two popular image segmentation algorithms. The first method is N-Cut method and second is Dual Wavelet Segmentation. On The theoretical side our emphasis will be on describing a common framework in which both of these methods can be expressed. The comparative study is done by using N-cut method and Dual Wavelet Segmentation. The Adaptive Filter and Mean Filter methods are used to filtering the images. N-cut methods lead to over segmentation and it is time consuming for segmenting the images. The Dual Wavelet segmentation give quick result and proper segmentation is done. This confirmed by Graphical representation.**

*Keywords:- Image processing, graph cut, Normalized cut, Dual Wavelet, Adaptive Filter.*

## I. INTRODUCTION

Image processing is one of the best processes to vision the image in computer. The steps of image processing are show in following figure:

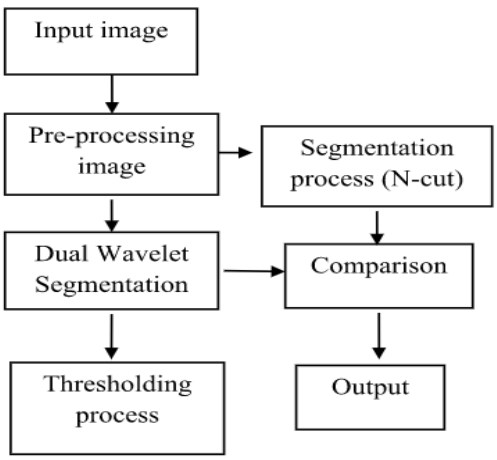


Fig. 1:- Segmentation process

In image segmentation image is divided into some regions and in that region each pixel is similar with respect to some of the characteristic such as the color, intensity, ortexture [1]. Adjacent regions are different with same property of all regions. Segmented the image by using many techniques but only some techniques gives the better results in image segmentation [2].Firstly collect the raw images and pre-processed. The raw image consist noise and disturbance, which is removed by using Adaptive filter algorithm [3].In this paper the graph cut technique is used to solve the segmentation problem [4]. Here we represent the image in the format of the graph that means it will contain the vertices and the edges like a graph and here each vertices or a node can be taken as the pixels of the image.

The color or intensity difference between any two pixels can be taken as the edge [5].The graph cut technique efficiently solve a wide variety of low-level computer vision problems, such as image smoothing and many other computer vision problems and the stereo correspondence problem, can be solved in terms of energy minimization [6]. The Normalized cut method was proposed by J. Malik and J. Shi. [7] In their view, the image segmentation problem can be seen as a graph theory problem. Graph theory is an interesting math topic which models math problems into edges and vertexes. Here we represent the each pixel as a vertex or node and the distance between those nodes as the edges. This model could be used for Colouring problems (give each county a color, while connected county should have different colors. Each edge contains the weight that is used as flow of the edge. The Graph where each edge has weight is called weighted graph. In This paper the N-cut method not gives the proper result and it is time taken so we use the Dual wavelet Segmentation method to avoid this contradiction. Wavelets may possibly provide a useful basis for the numerical solution of differential or integral equations [8], in particular when they model processes which operate on very different space or time-scales (turbulence, boundary layers, shocks, for instance). Our aim in this paper is to provide introduction to the basic steps of multire solution and wavelets, accessible to the signal processing, quantum theory, or numerical analysis. A dual wavelet is dual to wavelet and generated the series by square integral function and the sense of resize representation.

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## II. LITERATURE REVIEW

Segmentation is the prior step in image processing. It divides a digital image into multiple regions. It is also used to distinguish different objects in the image. Several image segmentation techniques have been developed by the researchers in order to evaluate the images to easy and smooth presentation. This project presents a literature review of basic image segmentation techniques from last five years. Recent research in each of image segmentation technique is presented in this project.

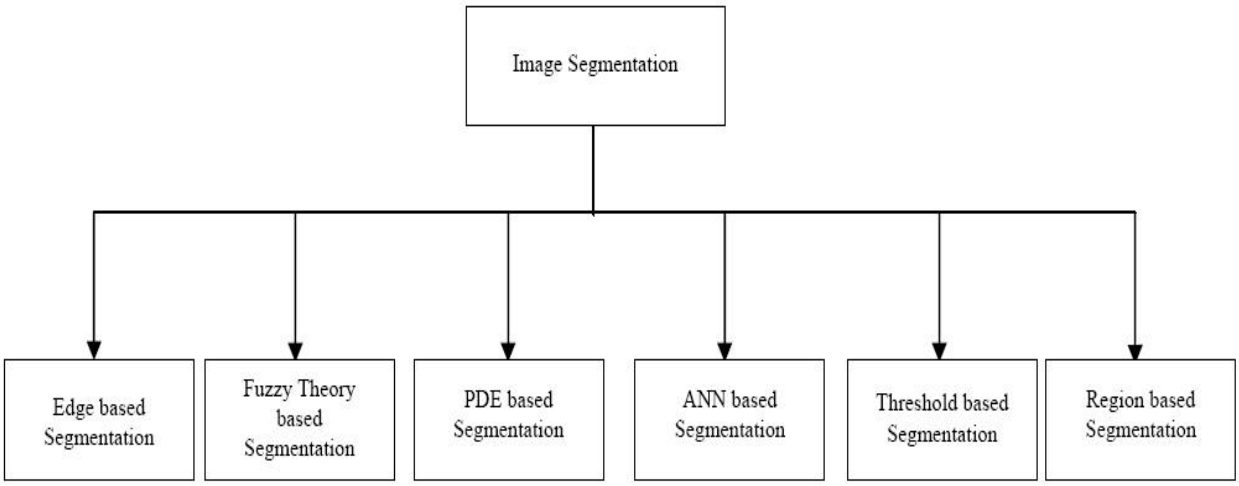



Fig. 2:- Types of Segmentation

*A. Edge Based Image Segmentation*

A new image segmentation method comprises of edge and region based information with the help of various morphological methods [9]. Firstly, they reduce the noise from image using bilateral filter as a pre-processing step, secondly, region merging is used to perform preliminary segmentation, region similarity is generated and then graph based region grouping is perform using Multi-class Normalized Cut method. Berkley segmentation dataset is use as a dataset. Proposed technique has outperformed other methods and produce better results.

*B. Fuzzy Theory Based Image Segmentation*

Liu Yucheng proposed [10] a new fuzzy morphological based fusion image segmentation algorithm. Algorithm has used morphological opening and closing operations to smooth the image and then perform the gradient operations on the resultant image After compare the proposed fusion algorithm with Watershed algorithm and Prewitt methods, it is found that fusion approach solve the problem of over-segmentation of Watershed algorithm.

*C. Partial Differential Equation (PDE) Based Image Segmentation*

A new non-linear discontinue partial differential equation (PDE) that models the level set method of gray images. Results have shown that image edges and boundaries are remained blurred and can be shifted by using Close operator. More information can be saved by using the proposed scheme.

*D. Artificial Neural Network (ANN) Based Image Segmentation*

Dataset of micro-CT images are used. De-noising filter is used to remove noise from image as a pre-processing step, Feature extraction is performed next, and then Back Propagation Neural Network is created, and lastly, it modifies the weight number of network, and save the output. Proposed algorithm is compared with Thresholding method and Region Growing method.

*E. Threshold Based Image Segmentation*

Shiping Zhu [11] proposed a new threshold based edge detection and image segmentation algorithm. They calculate the threshold of each pixel in the image on the basis of its neighbouring pixels. They also find the edges of image with the help of proposed algorithm. They implement their algorithm in Visual C++. Results outperform the Canny Operator results, because it performs edge detection and segmentation simultaneously. Anping XU [12] proposed a threshold-based level set approach comprising both threshold based segmentation and Fast Marching Method (FMM) for medical image segmentation.

*F. Region Based Image Segmentation*

In this techniques joins the edge and region based information with spectral method using Morphological Watershed algorithms.

## III.RELATED TERMS AND DEFINITION

### A. Normalized Cut

The normalized cut method was proposed by J. Malik and J. Shi. In their view, the image segmentation problem can be seen as a graph theory problem. Graph theory is an interesting math topic which models math problems into edges and vertexes. Here we represent the each pixel as a vertex or node and the distance between those nodes as the edges. This model could be used for colouring problems (give each county a color, while connected county should have different colors. Each edge contains a value (weight), which could be used as flow or importance of it. This kind of graph is called "weighted graph.

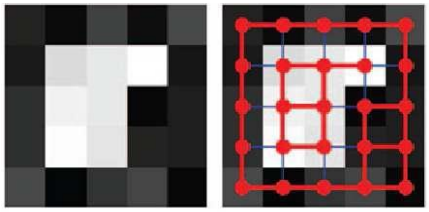


Fig. 3:- Normalized Cut

In the above two images first image is the original image and the second one is represented in the form of graph. Here images in the pixels are represented as the as the nodes and the difference between the I1, I2, I3 are called the edges of the image. In the above image thick edges represent the strong similarities between two pixels and thin edges represent the week similarities between two pixels.

### B. Filtering Techniques

Most images are affected by noise that is unexplained variation in data: disturbances in image intensity which are either uninterruptable or not of interest. Image analysis is often simplified if this noise can be *filtered out*. Image filters may be used to emphasise edges that is, boundaries between objects or parts of objects in images. Filters provide an aid to visual interpretation of images, and can also be used as a precursor to further digital processing, such as segmentation.

### C. Dual Wavelet Transform

Wavelets provide a useful basis for the numerical solution of differential or integral equations, when they model processes which operate on very different space or time-scales. Our aim in this project is to provide introduction to the basic theory of multire solution and wavelets, accessible to the numerical analyst who knows nothing of signal processing, quantum theory, or any of the other established Fields of application. A dual wavelet is dual to wavelet and generated the series by square integral function and the sense of resize representation.

## IV. IMPLEMENTATION

### A. Formula for Finding Normalized Cut

A graph G= (V, E) can be partitioned into two disjoint sets, A, B, A U B =V, A∩B =Φ, by simply removing edges connecting the two parts. Weight of an edge can be calculated as the similarities between two nodes in a graph so, if there are no similarities in between two nodes then we

$$cut(A,B) = \sum_{u\in A, v\in B} w(u,v)$$

The *normalized cut* then could be defined as:

$$N_{cut}(A,B) = \frac{cut(A,B)}{asso(A,V)} + \frac{cut(A,B)}{asso(B,V)}$$

can cut that edge this is called graph cut.

$$cut(A,B)$$

Here,

Sum of all the edge weights associated with the cut

$$assoc(A,V)$$

sum of all the edge weights associated with the cut and all the points in the graph. Where asso(B, V)=Σ W(u, t) is the total connection from nodes in B toall nodes in the graph, and asso(A, V) is similarly defined. In the same way, we can define a value for the total normalized association within groups (a measure for similarities inside each group for a given partition of the image. Assume now we want to separate an image V with size M-by-N into two parts, we need to define two matrices: *W* and *D*, both of size (MN)-by-(MN). The matrix *W* is the similarity matrix with element $w_{i,j}$ as the similarity between the $i^{th}$ pixel and the $j^{th}$ pixel. The matrix *D* is a diagonal matrix and each diagonal element $d_i$ contains the sum of all the elements in the i th row in *W*. With these two matrices, finding the

$$\min N_{cut} = \min_y \frac{y^T(D-W)y}{y^T Dy}$$

minimum normalized cut of image V into two parts A and B is equal to solve the equation as followed:

### B. N-Cut Algorithm

- *Compute matrices Weight & Diagonal (W & D)*

In the normalized cut method we use eigen values and eigenvectors to find out the cut in the graph that means to find out the week edges in the image.

Solve the equation for getting eigenvectors and smallest eigenvalues. From the equation above stated we can find out the eigenvalues and eigenvectors.

Use the eigenvector with the second smallest eigenvalues to bipartition the graph.

$$cut(A,B) = \sum_{u\in A, v\in B} w(u,v)$$

The ***normalized cut*** then could be defined as:

$$N_{cut}(A,B) = \frac{cut(A,B)}{asso(A,V)} + \frac{cut(A,B)}{asso(B,V)}$$

Here to bipartition the image we need to use the eigenvector of the second smallest eigenvalues. The reason for this to use the second smallest is we need to minimize the Rayleigh quotient so that we can minimize the normalized cut.

Recursively partition the segmented parts if it is necessary.

After we cut the graph by using normalized cut method we need to cut the two parts of the image if it is necessary to cut.

*C. Dual wavelet transform*

Given a square integral function $\psi \epsilon L^2(R)$ define the series $\{\Psi_{jk}\}$ by

$$\Psi_{jk}(x) = 2^{j/2}\Psi\,(2^j x - k)$$

For integers j, k $\epsilon$z

Such a function is called an R-Function if the linear span of $\{\Psi_{jk}\}$is dense in $L^2(R)$, and if there exist positive constants A,B with $0<A\leq B<\infty$ such that

$$A||C_{jk}||^2_{l^2} \leq ||\sum_{jk=-\infty}^{\infty} C_{jk}\,\Psi_{jk}||^2_{L^2} \leq B||C_{jk}||^2_{l^2}$$

For all bi-infinite square summable series $\{C_{jk}\}$. Here ||. $||_{l2}$denotes the square-sum norm:

$$||C_{jk}||^2_{l^2} = \sum_{jk=-\infty}^{\infty} |C_{jk}|^2$$

And ||. $||_{l2}$denotes the usual norm on $L^2(R)$

$$\|f\|^2_{L^2} = \int_{-\infty}^{\infty} |f(x)|^2 dx$$

By the Riesz representation theorem, there exists a unique dual basis$\psi^{jk}$ such that

$$\langle \Psi^{jk} | \Psi_{jm} \rangle = \delta_{jl}\delta_{km}$$

Where $\delta_{jk}$is the Kronecker delta and $\langle f|g\rangle$ is the usual inner product on$L^2(R)$.Indeed, there exists a unique series representation for a square integral function f expressed in this basis:

$$F(x) = \sum_{jk}\langle \Psi^{jk}|f\rangle \Psi_{jk}(x)$$

If there exists a function$\tilde{\Psi}\epsilon L^2(R)$

$$\tilde{\psi}_{jk} = \psi^{jk}$$

Then $\tilde{\Psi}$ is called the dual wavelet or the wavelet dual to ψ. In general, for some given R-function$\Psi$the dual will not exist. In the special case of$\Psi = \tilde{\Psi}$the wavelet is said to be an orthogonal wavelet.

## V. EXPERIMENTAL RESULT

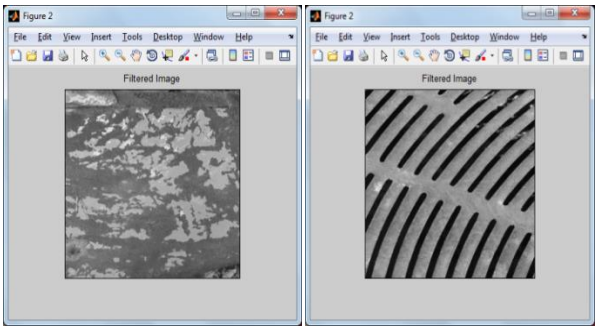
In this project the Raw Images is used to perform the experiment. In Fig: 4.1(a)The Name of the image 1.Jpeg, Dimension of the image 1944*2592, Size of the image 1.02MB, Fig: 4.1(b) The name of the imge is 2.Jpeg Dimension of the image is 2000*3000, Size of the image is 1.75MB, Fig:4.1(c) The name of the image 3.Jpeg Dimension of the image is 2000*3000, Size of the image 2.33MB, Fig:4.1(d) The Name of the image is4.Jpeg , Dimension of the image 2000*3000, Size of the image 878KB and all the images are taken by www.Media.militia.com.

4.1(a) 4.1(b)

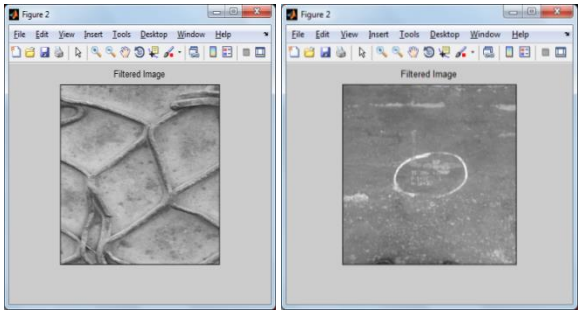
4.1(c) 4.1(d)

Fig. 4.1:-Raw Images

Then the pre-processing is performing by using Adaptive filter to remove the noise and the disturbance of signal and we got the filtered images.



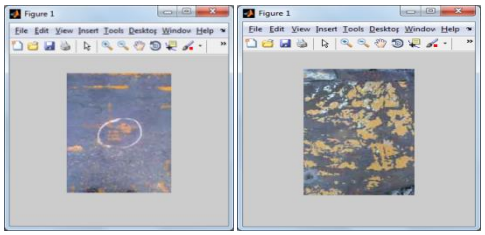
4.2(a) 4.2(b)



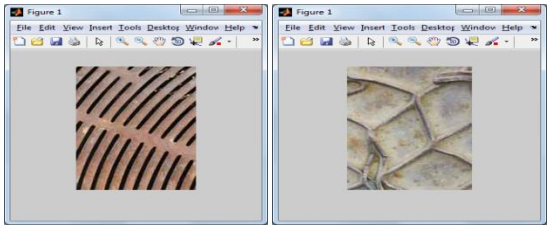
4.2(c) 4.2(d)

Fig. 4.2 :-Filtered Images

The test was performed on the Normalised cut criterion is indeed able to partition the point set in a desirable way, in this type of segmentation the image with added noise and also have undefined boundaries, which would make edge detection poorly and has over segmentation problem. Normalised cut algorithm takes about 2 minute to segment the image size of 200×300 approximate. The segmentation was not giving the proper output result.



4.3(a) 4.3(b)



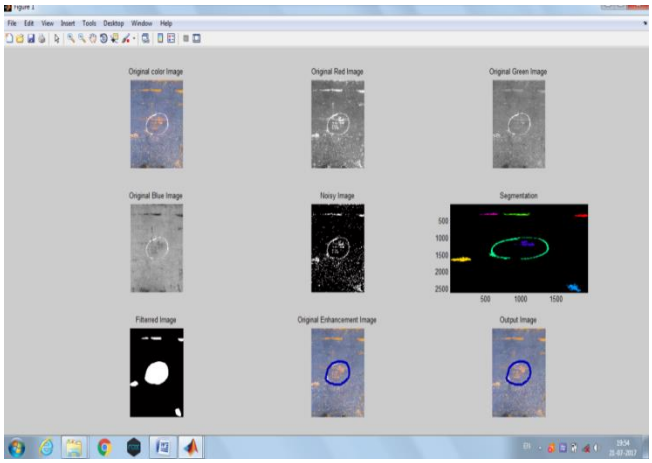
4.3(c) 4.4(d)

Fig. 4.3:- N Cut Segmentation

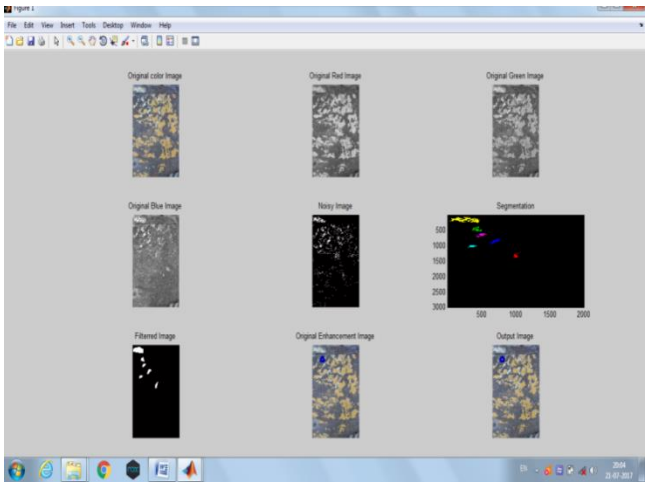
FIG: 4.3(a) For N-cut segmentation the result is Root. N-cut=0.23100, Elapsed time=45.5082 FIG: 4.3(b) N-cut the result is Root. N-cut=0.077369, Elapsed time=41.2528 FIG: 4.3(c) For N-cut the result is Root. N-cut=0.0.023146, Elapsed time=12.8591 FIG: 4.3(d) For N-cut the result is Root. N-cut=0.152002, Elapsed time=53.3666

To improve the performance for large scale images, noise removing and less computing time used Dual Wavelet segmentation on the same metallic images. For original N × N images, noise are formed in the regions of high difference feature and removed by applying to global thresholding and using filters. This computation can be reduce the running time and give appropriate result and evaluate the effectiveness. Dual Wavelet segmentation used Adaptive filter for removing the disturbance of signal and noise.

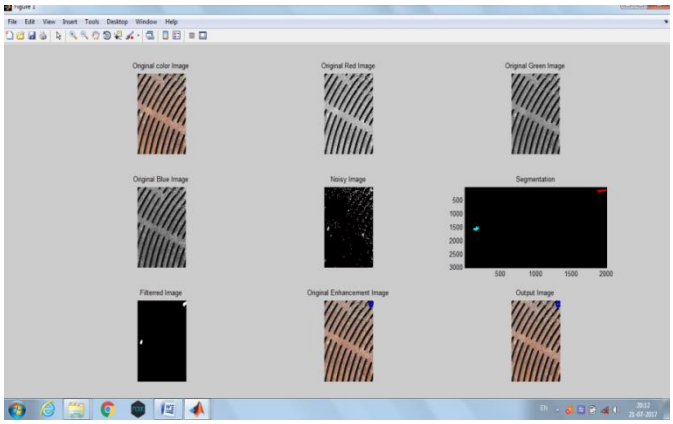
The Experiment used Matlab2016a software and gives the fast result.In Dual Wavelet segmentation the original image was converted in green, red, blue colour variance. Than the filter was apply for removing the noise and the disturbance of signal and got the filtered image. Enhancement was done in the filtered image and got the final segmentation result.



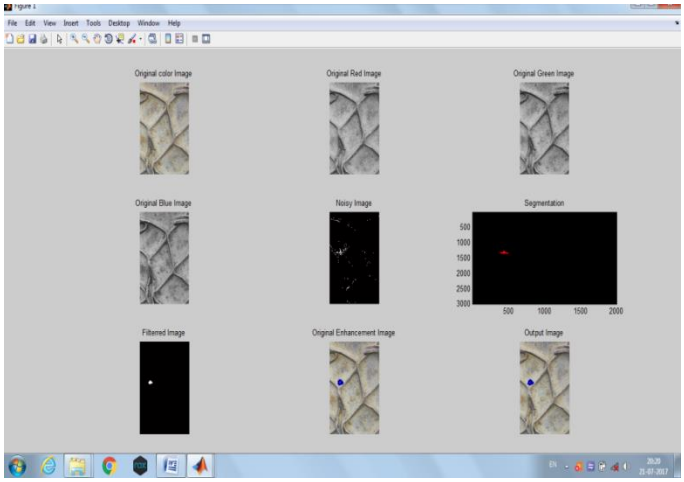
4.4(a)



4.4(b)




4.4(c)




4.4(d)

Fig. 4.4:- Dual Wavelet Segmentation

FIG: 4.4(a),4.4(b), 4.4(c), 4.4(d)In Dual Wavelet segmentation the original image was converted in green, red, blue colour variance. Than the filter was apply for removing the noise and the disturbance of signal and got the filtered image. Enhancement was done in the filtered image and got the final segmentation result.

Fig: 4.4(a)Thereshold value is 156, allBlobECDs is 20.434, all Blob Solidities is 0.684, roudent ECD is 1.773, Roundest Index is 3 , Elapsed time=1.2528

Fig:4.4(b)Thereshold value is 186, allBlobECDs is 40.2742, allBlobSolidities is 0.5452, roudentECDs is 1.3456, Roundest Index is 3, Elapsed time=2.348 Fig: 4.4(c)Thereshold value is 178, allBlobECDs is 10.0545, allBlobSolidities is 0.7345, RoundestECD is 1.3252, Roundest Index=1, Elapsed time=2.0755 Fig: 4.4(d)Thereshold value is 203, allBlobECDs is 30.360, allBlobSolidities is 0.5013, RoundestECD is 1.3772, Roundest Index=1, Elapsed time=3.2528

Above result shown the pre-processing of the image with pixel weight, highest threshold and lowest index is represent the best segmentation and noise free images.

*A. Graph Representation of Comparison Between N-Cut and Dual Wavelet Methods for Segmentation*

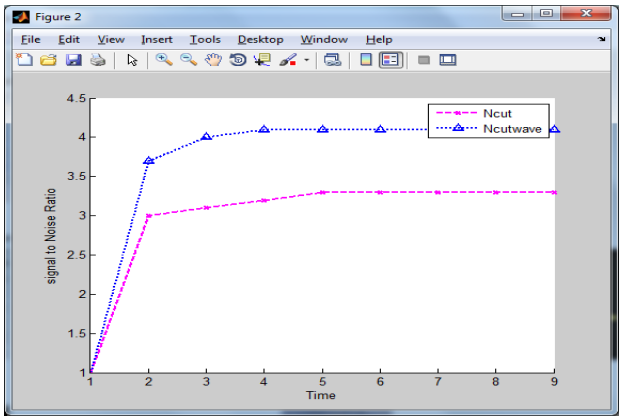



Fig.4.5:- Graph Representation

In the N-cut more elapsed time as compared to Dual wavelet segmentation and the comparison is shown in the above graph. Time is taken in X axis unit (second). Signal and noise ratio is taken in Y axis (db) and the graph plotted. The N-cut method takes more time approximately (1 minute) and has more noise to segmenting the image. The Dual Wavelet method gives the result quickly approximately (30 second) and accurate. From the above calculation the results is easily understood that the Dual wavelet method is best for segmenting the metallic images. This is graphically shown in Fig: 4.5

## VI. CONCLUSION

By comparing Normalized cut and Wavelet N-cut method. It is concluded that, Normalized cut method gives quite good result for image segmentation even through time consuming and image size problem persist and in Wavelet N-cut based segmentation, though there is the problem ofselection optimal threshold value for thresholding. Wavelet based segmentation make the image more robust against noises from various sources than compared with N - cut techniques. The Wavelet transform is one of the emerging tools for segmentation in various fields, so the wavelet transform give the better result in term of computation time, efficiency and accuracy of images quality index.

8 metallic images data set has been used for demonstration of the forecast of theoretical behaviour via experiment conduct.

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