Brain Image Fusion using DWT and Laplacian Pyramid Approach and Tumor Detection using Watershed Segmentation

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Abstract— *Image fusion is the process of combining important information from two or more images into a single image. The resulting image will be more enhanced than any of the input pictures. The idea of combining multiple image modalities to furnish a single, more enhanced image is well established, special fusion methods have been proposed in literature. This paper is based on image fusion using laplacian pyramid and Discreet Wavelet Transform (DWT) methods. This system uses an easy and effective algorithm for multi-focus image fusion which uses fusion rules to create fused image. Subsequently, the fused image is obtained by applying inverse discreet wavelet transform. After fused image is obtained, watershed segmentation algorithm is applied to detect the tumor part in fused image.*

Keywords— Image Fusion, Laplacian Pyramid Algorithm, Discreet Wavelet Transform.

I. INTRODUCTION

Image fusion is the system of combining significant information from two or more images into a single image. The resultant image will be more enhanced than any of the input images. The concept of fusion image has been utilized in wide style of functions like remedy, remote sensing, machine vision, automotive changes detection, bio metrics etc. With the emergence of various image capturing devices, it's not possible to acquire an image with all the information. Generally, an entire image is probably not consistently feasible since optical lenses of imaging sensor primarily with long focal lengths, only have a restricted depth of field.

Image fusion helps to receive an image with all the expertise. Image fusion is a concept of combining multiple images into composite products, by way of which extra information than that of individual input image will be revealed. A brain tumour is a group (or mass) of abnormal cells in the brain. The skull is very rigid and the brain is enclosed, so any progress within the sort of limited area can cause problems. Brain tumours can also be cancerous (malignant) or non-cancerous (benign). Symptoms of a brain tumour can also be general or specific. A common symptom is caused by the strain of the tumour on the mind or spinal cord. Particular symptoms are cased when a designated a part of the mind is not working mainly in view that of the tumour. To determine the sort of tumour, imaging of the brain is predominant. The reply to which imaging modality is better for imaging the brain is based on the rationale of the examination.

The paper uses wavelet based image fusion procedure for brain tumor detection. Wavelet analysis is commonly used method for solving difficult issues in mathematics, physics and engineering in the present day times. It has diverse applications within the fields of wave propagation, data compression, signal processing, image processing, pattern recognition and medical imaging technologies. Wavelet analysis decomposes complex information to fundamental varieties at different positions and scales, which can be conveniently reconstructed with high precision. Wavelet transform is a powerful tool within the analysis of indicators in comparison with Fourier transform, given that the later approach fails in the evaluation of non stationary signals.

The paper is organized as follows: Section 2: explains literature survey, different methodologies on brain tumor detection using DWT and Laplacian Pyramid algorithm; Section 3: contains methodology of proposed system which includes pre-processing, fused image creation, post processing and segmentation to detect the brain tumor. Section 4: depicts the experimental results obtained from the evaluation of the proposed methods. Section 5: finally, conclusions are drawn in.

II. RELATED WORK

Ambily P.K, Shine P.James and Remya R.Mohan proposed a system which detects the brain tumor part in a fused image. Fused image and neural network is segmented to extract the tumor part in image. Initially MRI image and CT images are pre-processed and de-compose the image using discreet wavelet transform. The fused image is segmented to detect the tumor part. In this paper [2], Vivek Angoth, CYN Dwith and Amarjot Singh proposed an efficient tumor detection algorithm which uses complementary and redundant

information from the computer tomography (CT) and Magnetic resonance imaging (MRI).

S.L. Jany Shabu, Dr.C. Jayakumar and T. Surya reviewed different image fusion techniques [3] for brain tumor detection. This paper presents the review and comparison of various image fusion methods. They have find out various issues in different techniques and to remove that Genetic Algorithm is used. A. P. Jamesa and B. V. Dasarathyb [4] have surveyed on image fusion approach, they Characterize the medical image fusion study based on (1) the extensively used image fusion ways, (2) imaging modalities, and (3) imaging of organs which are under study. This review concludes that despite the fact that there exists a number of open ended technological and scientific challenges, the fusion of scientific images has proved to be useful for advancing the scientific reliability of using medical imaging for medical diagnostics and analysis, and is a scientific self-discipline that has the expertise to vastly develop in the coming years.

S. Anbumozhi and P. S. Manoharan [5] proposed a methodology to classify the tumors such as benign and malignant. This paper integrates two images of same type to get the fused image; fuzzy logic is used to fuse the images. Multilevel Adaptive Neuro was used as a classifier. S.M. Mukane, Y.S. Ghodake and P.S. Khandagle [6] described a methodology to enhance the image by combining wavelet transform and Laplacian Pyramid algorithm. Performance of image fusion technique is measured by mean square error, normalized absolute error and peak signal to noise ratio. From the performance analysis it has been observed that MSE is decreased in case of both the methods where as PSNR increased, NAE decreased in case of laplacian pyramid where as constant for wavelet transform method.

III. PROPOSED SYSTEM

Accurate detection of size and location of brain tumor plays a vital role in the diagnosis of tumor. An efficient wavelet based algorithm is used for tumor detection which utilizes the complementary and redundant information from the Computed Tomography (CT) image and Magnetic Resonance Imaging (MRI) images. Hence this algorithm effectively uses the information provided by the CT image and MRI images there by providing a resultant fused image which increases the efficiency of tumour detection. Figure 1 shows the architecture of proposed system. Block-wise explanation of the system is given below.

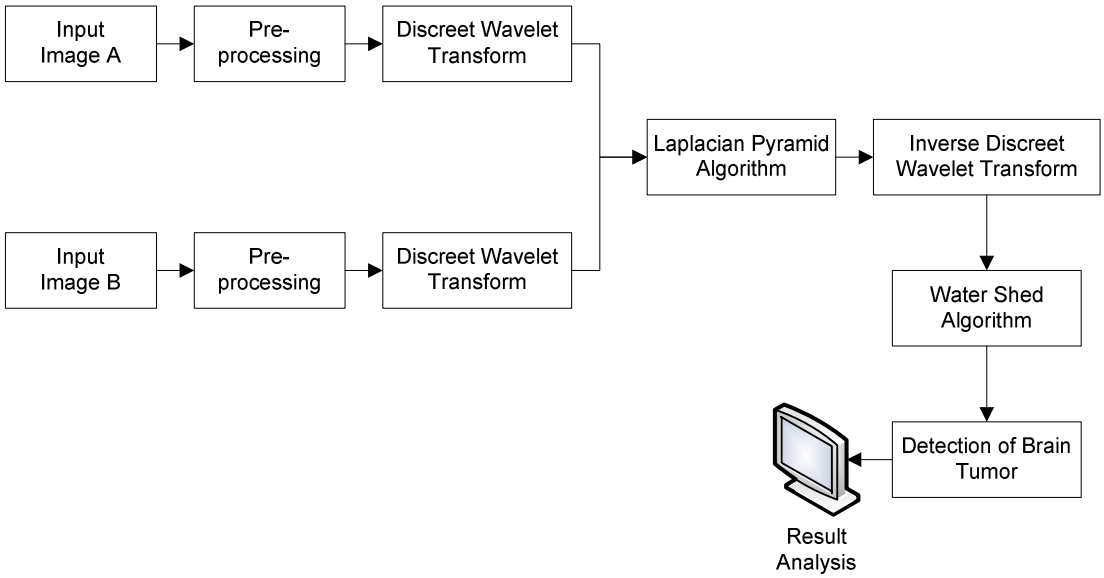


Fig.1: Block Diagram of Proposed Work

The algorithm decomposes the input image using 2D-Disreet wavelet transform. The lower approximations are subjected to Laplacian pyramid algorithm. The SF algorithm combined with wavelet fusion algorithm is used for higher approximations. The new sets of detailed and approximate coefficients from each image are then added to get the new fused coefficients. The final step performs Inverse DWT with the new coefficients to construct the fused image. The two main components of the proposed algorithm are the Laplacian Pyramid algorithm and the wavelet algorithm and are explained in the following sub-sections.

A. Pre-processing

A MRI and a CT image is pre processed and taken as source images A and B. Both the images are subjected to wavelet decomposition which decomposes into approximation, horizontal detail, vertical detail and diagonal detail respectively. This is a stage where the input image taken and resized to 265x256 standard size. Input

image is in RGB color format; such images have to be converted to gray scale images using rgb2gray command.

B. Discreet Wavelet Transform

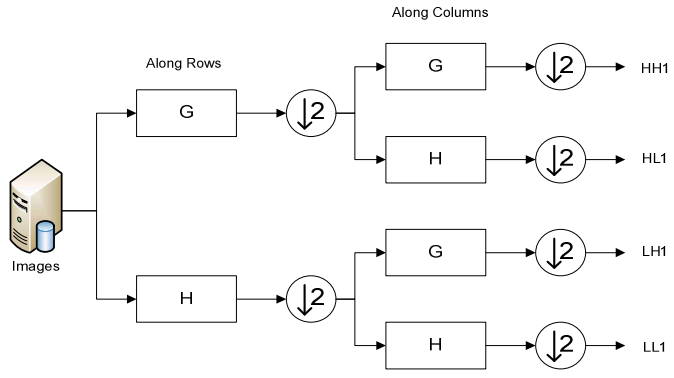
The mathematical basis of the wavelet transform is the Fourier transform. In the wavelet analysis, the size of the window is constant while the shape is changeable, as well as the time window and the frequency windows. As a result, wavelet analysis has respectively better resolution but yet worse time resolution in low frequency band，and vice versa. Discrete wavelet transform (DWT) is likely one of the most widespread methods for the decomposition of an image, which has been widely used in a large number of researches.

The preceding result is applied to the next stage of 2-D DWT decomposition and this process is going to be repeated recursively in each stage. The low-pass filter h and high-pass filter g correspond to a particular type of wavelet used.

Image fusion using wavelet scheme decomposes source images $I_1(a,b)$ and $I_2(a,b)$ into approximation and detailed coefficients at required level using DWT. The approximation and detailed coefficients of both images are combined using fusion rule. The fused image could be obtained by taking the inverse discrete wavelet transform (IDWT) as eq. (1):

$$I(a,b) = \frac{DWT\{I_1(a,b)\} + DWT\{I_2(a,b)\}}{2}$$

The fusion rule used here is simply averages the approximation coefficients and picks the detailed coefficient in each sub band with the largest magnitude.



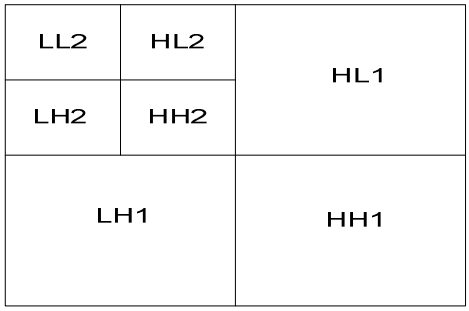
(a)

G- High Level Filter

H- Low Level Filter

C. Laplacian Pyramid Algorithm

The Laplacian Pyramid [7] implements a pattern selectivel process for image fusion, so that the composite image is built not based on a pixel at a time, but a feature at a time. The fundamental suggestion is to participate in a pyramid decomposition on every source image, then combine all these decompositions to form a composite representation, and subsequently reconstruct the fused image by way of performing an inverse pyramid transform.



(b)

Fig.2: Decomposition of Image using DWT

The overall algorithm is proven in figure 1. The first step is to assemble a pyramid for each source image. The fusion is then applied for each and every level of the pyramid using a feature decision mechanism. The feature selection process selects essentially the most salient sample from the source and copies it to the composite pyramid, at the same time discarding the least significant salient pattern. In this way, the entire locations the place the source images are distinctly selected. The salient aspect is selected using Equation (1).

$$F_i(x,y) = \begin{Bmatrix} A_i(x,y) & if\ |A_i(x,y)| > |B_i(x,y)| \\ B_i(x,y) & Otherwise \end{Bmatrix} \quad (1)$$

Where A and B are input images and F is the fused image and $0 \le i \le N-1$

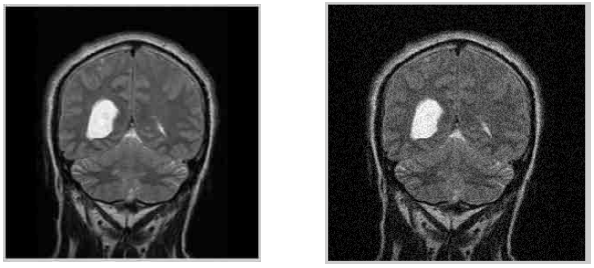
D. Segmentation: Watershed Algorithm

This is one of the best methods to group pixels of an image on the basis of their intensities. Pixels falling under identical intensities are grouped together. It is an excellent segmentation approach for dividing an image to separate a tumor from the image Watershed is a mathematical morphological operating device. Watershed is normally used for checking output rather than using as an input segmentation method since it in general suffers from over segmentation and under segmentation [8].

For using watershed segmentation specific approaches are used. Two common principle approaches are given under: 1) the computed local minima of the image gradient are chosen as a marker. In this system an over segmenta.tion happens. After making a choice on marker region merging is completed as a second step; 2) Watershed transformation using markers utilizes particular defined marker positions. These positions are either outlined explicitly by using a user or they can be decided mechanically with the help of utilizing morphological tools.

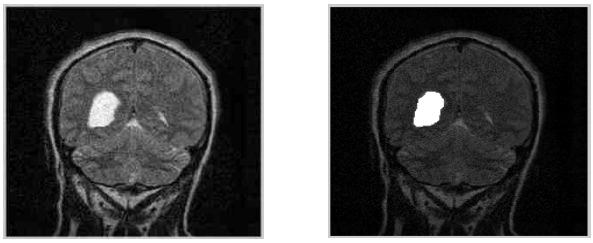
IV. RESULTS AND DISCUSSION

The experimental results of our proposed work are shown in the figure below.



(a) (b)

Fig.3 (a) Input Image A (b) Input Image B



(a) (b)

Fig.4 (a) Fused Image, (b) Segmented Image

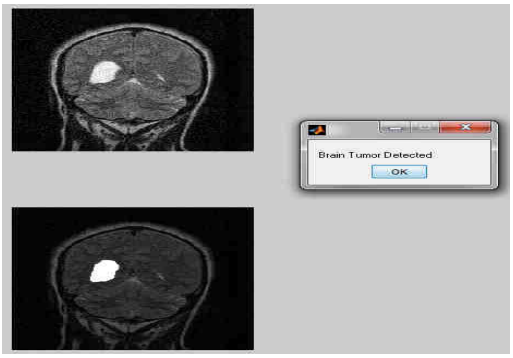


Fig.5:Tumor Detected Image

V. CONCLUSION

An efficient methodology is proposed to detect tumor part in an image using fusion based methods. Initially we take two images and produce the fused image using discreet wavelet transform and laplacian pyramid algorithm. Inverse DWT applied to get back fused image. Finally watershed algorithm is applied to detect the tumor part in an MRI image.

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