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MRI Brain Image Quantification Using Wavelets for Tumor Detection

Authors
Shivani Garg[1], Er. Navdeep Singh[2]
[1]Research scholar, Master of Technology, Department Of Computer Engineering, Punjabi University, Patiala
[2]Assistant Professor, Department Of Computer Engineering, Punjabi University, Patiala
Email-[1]*shivanigarg26@gmail.com* , [2]*navdeepsony@gmail.com*

ABSTRACT:
Over the past few years, a brain tumor segmentation in magnetic resonance imaging (MRI) has become an important research area in the field of medical imaging system, as it helps in finding the exact size and location of tumor. An efficient algorithm is proposed in this paper for Automatic tumor detection based on segmentation using Daubechies Wavelet and Fuzzy C Means(FCM) Clustering. Then Quantification of the segmented portion is done showing the tumor area in pixels and the time elapsed to detect and calculate the area in seconds. The algorithm developed is accurate and fast to detect and quantify the tumor. This paper expresses a well-organized technique for automatic brain tumor segmentation for the detection and quantification of tumor tissues from MR images

Keywords: *Quantification, MRI, tumor, Wavelet, FCM, Segmentation*

INTRODUCTION

Medical imaging is a warm research area in image processing with the development of efficient digital signal processing hardware. Imaging has transformed the practice of medicine since the first X-rays were produced more than a 100 years ago. Since then medical imaging techniques have continued to evolve in their capabilities and have grown their importance to medical practice. X-ray,
X-ray CT, MRI, ultrasound, nuclear imaging and optical imaging techniques have all been adapted for specific applications in medicine[2].Medical diagnostics can easily provide image in digital formats. But with this provision researchers are now trying to automate the said diagnostics, giving support to doctors and practitioners to extract accurate and easy information [1]. The aim of medical imaging is to give information about inner system of human body which can help doctors to detect diseases. It is normally used for detection of different abnormalities like tumor, identifying bone fractures inside the body. Medical images provide thorough detail regarding the human organs and methods that are used for identifying and

investigating diseases consist of computed tomography (CT) scans, magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA). Two of the most widely used models among all above techniques are MRA and MRI. These methods are ideal due to their painless property and less exposure to the radiation. MRI is a fast growing medical imaging technique and capture high resolution images of soft tissues [3]. MRI is a non-invasive technique for classifying cells composed of tissues in human body [4]. In the soft tissues of the human body MRI provides thorough detail about abnormalities that may not be identified by X-rays and CT scan. Many techniques have been developed for feature extraction from MRI but wavelet transform is the best method among them [5, 11]. Wavelet is a non statistical method which gives local frequency information and detail coefficients of the image at various levels. There are many types of wavelets that can be used but all have certain limitations and out of for better edges. Ingrid Daubechies, one of the brightest stars in the world of wavelet research, invented what are called compactly supported orthonormal wavelets — thus making discrete wavelet analysis practicable. The names of the Daubechies family wavelets are written dbN, where N is the order, and db the "surname" of the wavelet. The db1 wavelet, as mentioned Daubechies been the best.In the proposed method Daub-5 Wavelet is used, which is the best feature extraction method. Daub-5 gives good contrast to an image. Due to good contrast Daub-5 even extracts very low signals of MRI. Fuzzy c means is applied for the segmentation of the infected area based on the region of interest as intensity.

The aim of this task is to detect tumor and its quantification from MRI scan of the brain image using techniques of digital image processing. In the field of medical imaging a great effort was focused on brain tumors segment over the few years. It has great potential in clinical medicine by eliminating physicians from manual labeling burden. The biggest challenge in field of automatic tumor segmentation is that the brain tumors are very heterogeneous in terms of shape, color, texture and position and their ability to deform other nearby anatomical structures. The comparison between the healthy and ill hemisphere is used to detect the tumor. One of the motivations to make the substandard segmentation is the occurrence of artefact in the MR images. Additional cranial tissues (skull) is one such artefact. These additional cranial tissues hamper repeatedly with the ordinary tissues throughout the segmentation which accounts for the substandard segmentation. The images obtained are used to examine human brain development and indicate abnormalities. Nowadays, there are many methods for classifying MR images. Among all, image segmentation is best.

A tumor is a mass of tissue which grows out of control of the forces that regulates growth. They can be divided into two categories on the basis of tumors beginning, their enlargement prototype and malignancy. A brain tumor is an intracranial mass produced by an uncontrolled growth of cells either normally found in the brain such as neurons, lymphatic tissue, blood vessels, pituitary and pineal gland, skull, or spread from cancers primarily located in other organs [1]. Brain tumors are classified based on the type of tissue involved, the location of the tumor, whether it is benign or malignant, and other considerations. Primary (true) brain tumors are the tumors that originated in the brain and are named for the cell types from which they originated. They can be benign (non cancerous), meaning that they do not increase in a different place or attack neighbouring tissues. They can also be malignant and invasive (spreading to neighbouring area). Secondary or metastasis brain tumors take their origin from tumor cells which increase to the brain from a different position in the body. Most frequently cancers that increase to the brain to reason secondary brain tumors begin in the lumy, breast, and kidney or from melanomas in the skin. The aim of this work is to develop a framework for a robust and accurate segmentation of a large class of brain tumors in MR images.

RELATED WORK

E.A.El-Dahshan and T. Hosney [5] proposed a hybrid system for tumor detection in MR images and categorize them using artificial neural networks (ANN) and k-nearest neighbor (KNN). In this method features were extracted using discrete wavelet transform (DWT) and principle component analysis (PCA) method was used for selection of best extracted features. These features selected were given as input to classifiers as KNN and ANN. It involved two phases of testing and categorized MR images as normal and abnormal images.

A. Kharrat et.al [11] proposed a system for brain tumor classification using genetic algorithm and support vector machine (SVM). There are two methods of feature extraction. Firstly, extraction of features from both normal and abnormal images is carried out by spatial gray level dependence method (SGLDM). Secondly, the image is decomposed at second level by applying Daubechies wavelet transform. The optimal features were selected by genetic algorithm. Those optimal features were given as an input to classifiers SVM.

H. Selvaraj et.al [6] uses wavelet features to propose a system for classification of Magnetic Resonance Images that were given as input to SVM and ANN. In this method neural network Self Organizing Maps (SOM) were used as classifiers for tumor recognition and it simply captures non linear computation and reached precision rate of 94% as evaluated to SVM which captures linear and non linear computation and precision rate attained was 98%.

S. Chaplot and L. M. Patnaik [7] proposed brain tumor identification using wavelets transformation method and SVM. It included two phases. In processing phase noise was detached from the signal and through wavelet method features were extracted and then these were given as input to SVM for classification as normal and abnormal brain.

A.E. Laskhari [10] proposed a technique based on neural Network for brain tumor detection in MR images using geometric and Zernike moments. For input images Magnetic Resonance images were used. Feature extraction phase occupies statistics features collection by mean, median, entropy and standard deviation as well as a non-statistic feature by geometric moment's invariants. Selection of features was carried out by kernel F-score technique and given as input to Artificial Neural Network classifier. ANN classifies it into two classes as normal and cancer brain tissues.

A. E. Laskhari [9] proposed a technique based on artificial neural network for brain tumor detection in MR images using Gabor Wavelets. This technique used PD, T1 and T2 weighted as input images. To obtain excellent results preprocessing is performed for noise reduction. Feature extraction stage has two categories i.e. statistical features extraction by median, mean and variance wherever non-statistical feature extraction by Gabor wavelet technique. Feature selection stage is carried out by kernel F-score technique that is used to calculate the variation between two classes. Whilst features were chosen, these features were given as input to ANN for normal and abnormal brain tissues.

S.Roy et al[12] proposed a fully automatic algorithm to detect defects preferably tumors by using symmetry analysis. In this firstly the defect is detected, segmented using morphological operations and then area is calculated. It was an automatic segmentation, it frees physicians from manual labeling thus saving time and was valid for dissimilar types of tumors with MRI images.

R. Mishra [4] used wavelet packet aspect and Artificial Neural Networks in MR images to propose tumor identification system. He classified them using Artificial Neural Network as normal and abnormal images. The advantage of using wavelet packet over wavelet transformation method is that it gives wealthy investigation by decomposing estimation as well as detail component every time.

Theodosios et al [13] presented an advanced image analysis tool quantification of cancer and apoptotic cells in microscopy images utilizing adaptive thresholding. In this, a combination vector machine and majority voting and watershed algorithm was proposed to characterize and quantize different types of cells. The image is enhanced using adaptive thresholding segmentation and noise generated is removed by adopting morphological operations.

Anandgaonkar et al[14], proposed method for the same using Fuzzy C-Means algorithm and an algorithm to find area of tumor which is useful to decide type of brain tumor. They developed algorithm in which segmentation of the tumor is done by using FCM. On the extracted cluster adaptivethresholding is applied and area is calculated.

METHODOLOGY

The present work focuses on the improved detection of brain tumor using various processing steps. The implemented work can be useful for biomedical early and improved brain tumor detection.The basic concept to detect tumor that is the component of image holding the tumor as extra concentration than other segment is used and we can guess area, shape of the tumor in the image. Area is calculated in pixels.In addition to area,time taken is also shown.Fig1 shows the flow chart where the steps taken for quantication are shown.similarly in the result section figures are shown.Fig 2 showns how the image would look after applying pre-processing techniques for resizing it and converting it to grayscale image .The images taken by MRI are generally in 2D,here the images on which the algorithm is tested are all in 2D.Fig 3 shows the multilevel decomposition of the image.Discrete wavelet transformation has been applied for the smoothening of image and denoising it.The use of applying wavelets is that a separate filter is not required to be applied for the image smoothening.Fig 4 shows the approximate and the detailed horizontal,vertical and diagonal coefficients of the image.Fig 5 shows the energy retained and null coefficients value in percentage after applying both types of thresholding techniques which includes global and adaptive thresholding.Fig 6 shows the tumor region in the image.Detection of tumor from the brain MRI is quite a simple task to identify manually also since the intensity of defected region is more as compared to other regions.Fig 7 shows the segmented area only.The defected portion is taken out and then apply operations on the segmented portion to calculated the area.For this,a direct command used for the percentage calculation of affected region based on the intensity for which region of interest command is applied.The algorithm developed is tested on a set of images and the results are shown in table I where tumor size,percentage and tme elapsed for each image is shown.

For implementation a set of images of different patients in our database is required. The MRI image is stored along with main file from various sources. The images are in 2D format.Choose an MRI image from the dataset and various pre-processing steps are applied which includes converting the image into grayscale and resizing it. These techniques of pre-processing helps in the enhancement of image by increasing its contrast. Then discrete wavelet transform with symmetric extension mode is applied.

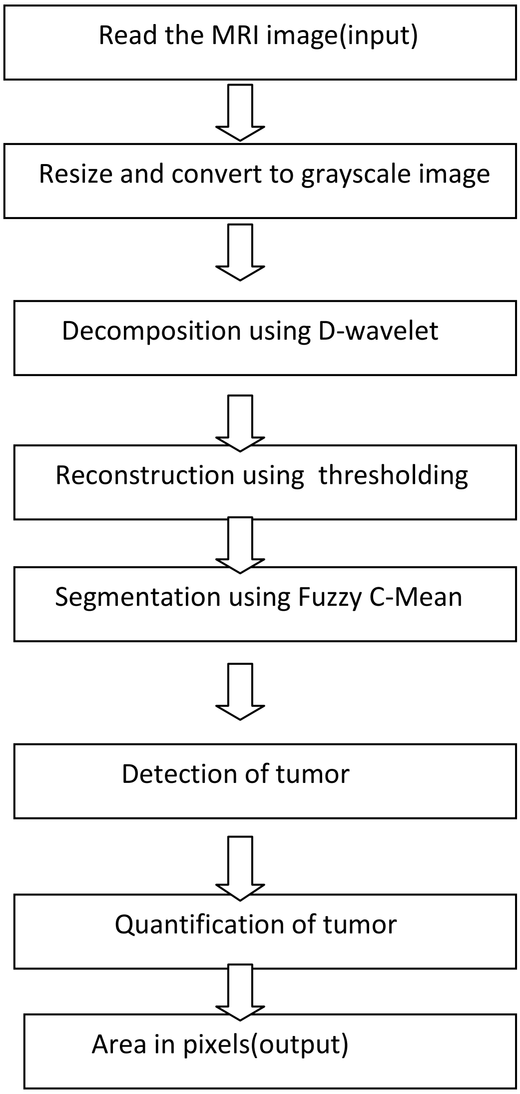

Fig1:steps taken for quantification of tumor

Daubechies discrete wavelet transform with ‘sym’ mode is applied for the decomposition.When the decomposition is done, the image is reconstructed using hard and soft global and adaptive thresholding techniques. In thresholding basically the noise is removed from the image, the image is compressed and a smooth image is obtained which helps in easy segmentation of tumor. Thresholding provides an easy and the most convenient way to separate the foreground and the background. After thresholding segment the image using fuzzy C-Mean clustering on the basis of intensity.The tumor portion is detected and segmented from the original image. Output is shown only in the colored portion of the image with tumor.Tumor area is calculated. From the value the sensitivity of the tumor can be assumed. The size of tumor is calculated in pixels. The time elapsed is also calculated and percentage of area of having tumor is also given.

Algorithm for quantification of Brain Tumor

Input:MRIimage

Output: Tumor portion of the image in pixels

Step1:- Read the input color or grayscale image.

Step2:- Converts input color image in to grayscale image which is done by forming a weighted sum of each three (RGB) component, eliminating the saturation and hue information while retaining the luminance and the image returns a grayscale colormap.

Step3:- Resize this image in 256*256 image matrix.

Step4:-Compute a multilevel 2D wavelet decomposition of image.

Step5:-apply global and adaptive thresholding.

Step6:- Segmentation using FCM.

Step7:- Apply fuzzy logic to detect region of interest basedon,intensity.

Step8:-for i=1:1:m

```
for j=1:1:n
if,B(i,j)==ROI
counter1= counter1+1;
seg1(i,j)=X(i,j);
seg2(i,j)=145;
else
seg1(i,j)=0;
seg2(i,j)=0;
end
end
end
```

Step 9 :-Tumor is detected and segmented.

Step10:-area can be calculated by applying formula

Area=(no of infected pixels/total of pixels)*100

RESULTS

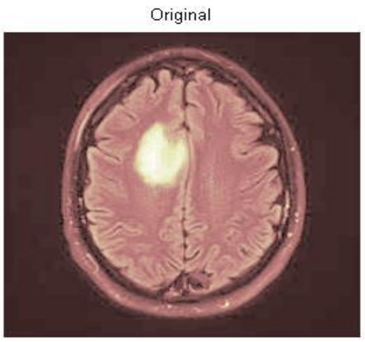

Fig.1.Original image after pre-processing

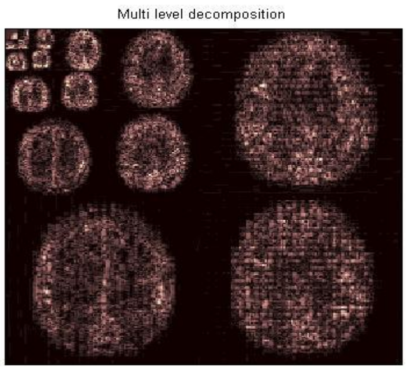

Fig.2.Decomposition of image after applying wavelets

Fig.3.Approximate and detailed horizontal, vertical and diagonal coefficients

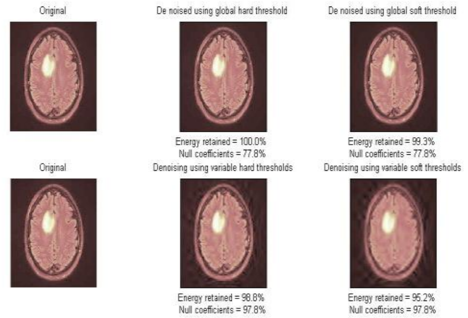

Fig.4.Energy retained as compared to original image after,global and adaptive thresholding

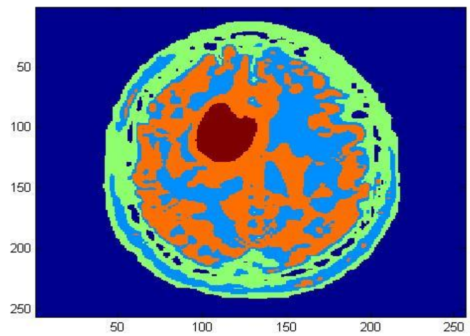

Fig.5.Tumor detected highlighted

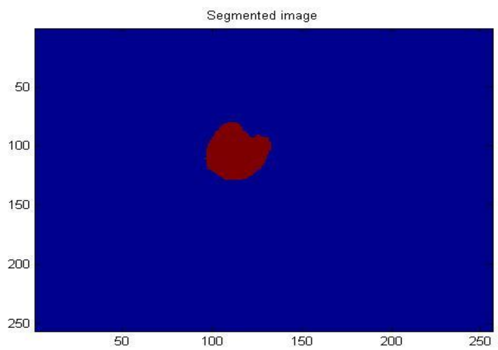

Fig.6. Tumor segmented out.

Table I

Image Name	Image Size	Tumor Size	Percentage of tumor	Time Elapsed
BT1	256*256	4339	6.62	12.7
BT2	256*256	3850	5.87	13.7
BT3	256*256	2257	3.42	10.5
BT4	256*256	5997	9.15	09.5
BT5	256*256	2842	4.33	12.2
BT6	256*256	1273	1.94	10.5
BT7	256*256	3698	5.64	09.7
BT8	256*256	3698	5.64	09.0
BT9	256*256	2654	4.05	09.0
BT10	256*256	2757	4.20	08.4
BT11	256*256	3684	6.07	11.8
BT12	256*256	2702	4.12	11.5
BT13	256*256	3986	6.08	10.5
BT14	256*256	1529	2.33	11.6
BT15	256*256	4627	7.06	10.8

Table: Contains image size with tumor size in pixels i.e tumor area in pixels with percentage and time elapsed

CONCLUSION AND FUTURE SCOPE

We proposed an automated segmentation method that enables users to quickly and efficiently segment and quantify the tumor from the MRI of Brain. We proposed a new method that in addition to show the affected area in pixels we can calculate the percentage and the time elapsed in its calculation.This algorithm developed is tested on a set of images and it shows 60%-70%accuracy. Since tumor is rather a general concept in medicine, limitations of the proposed approach might become apparent as soon as unforeseen pathologic tissue types that could not properly be captured by the MRI image. Since,detection of tumor in brain is based on intensity as compared to oMRi of other body parts so it can be possible that this method calculates that region also.Our future work will focus on better, fast, efficient and more accurate results and better segmentation.

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