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An Efficient MR Image Brain Tumor Segmentation Based on Discrete Wavelet Transform and Region Growing Algorithm

V. Ramya[*1], G.P.Rameshkumar[2]

[*1]Research Scholar, Department of Computer Science, S.N.R. Sons College, India, Coimbatore-641046, India

[2] Assistant Professor, Department of Computer Science, S.N.R. Sons College, India, Coimbatore-641046, India

vramyamphil@gmail.com

Abstract

Brain Tumor Segmentation in Magnetic Resonance Imaging (MRI) has become an emergent research area and it plays an important role in the field of medical imaging system and it is most significant. This research paper proposes a method for MR image brain tumor segmentation based on dual tree Discrete Wavelet transform and Region Growing algorithm. The given MR image is converted to grayscale after that it performs a de-noising process for grayscale image by using median filter. The MR image has been enhanced using the filter and apply the dual tree DWT. Discrete Wavelet Transform is applied to MRI images because wavelets provide frequency information as well as time-space localization. In this process, the tumor part is segmented using region growing algorithm. This segmentation algorithm provides exact detection of tumor, since it involves seeding process. Finally the tumor image has been segmented which shows the efficiency of the output. The experimental results shown by the proposed method is effective in segmentation of MR image. In this paper, evaluate the well-known purpose image quality metrics, like Mean, Median and Standard Deviation.

Keywords: MR Images, Median Filter, Dual tree DWT, Region Growing algorithm, Tumor Segmentation.

Introduction

Image Processing is a technique to convert an image into digital form and make some operations on it to get an enhanced image or to extract some useful information from it [1]. It is a type of signal exemption in which input is image, like photograph or video frame and output may be image or characteristics associated with that image. In medical field, brain plays a vital role in every aspect. In the last decade one of the precarious diseases is brain tumor and also prediction of tumor in brain is a very difficult process. One of the primary diagnostic and treatment assessment tools for brain interpretation has been Magnetic Resonance Imaging (MRI). It has been a widely-used technique of high quality Medical Imaging, particularly for brain imaging where MR's soft tissue contrast and non invasiveness are obvious advantages. MR images can also be used to find out normal and abnormal types of brain [9]. A brain tumor is a cluster of abnormal cells growing in the brain. Primary brain tumors are those that begin in the brain and tend to stay in the brain. There are several methods which have been used for Brain MRI resolution enhancement. The proposed work have used wavelet to decompose image into sub bands, the aspect of DWT is that it input of low-resolution image is given it decomposes the image into different sub band, which are the LL (Lower resolution version of image), LH (Horizontal edge data), HL (Vertical edge data) & HH (Diagonal edge data) sub bands representing approximation, horizontal, vertical and sloping mechanism in the form of coefficients, respectively. Region Growing is a simple region-based image segmentation method. Since it involves assortment of first seed points it is also called as pixel based segmentation [4]. The addition of pixel to the region is determined by examining the neighboring pixels. The process is iterated on, in the same manner as general data clustering algorithms. Region-growing determines the fact that the closer pixels have similar gray values. These are methods and algorithm used in the proposed tumor segmentation.

Methodology

The proposed methodology is given here

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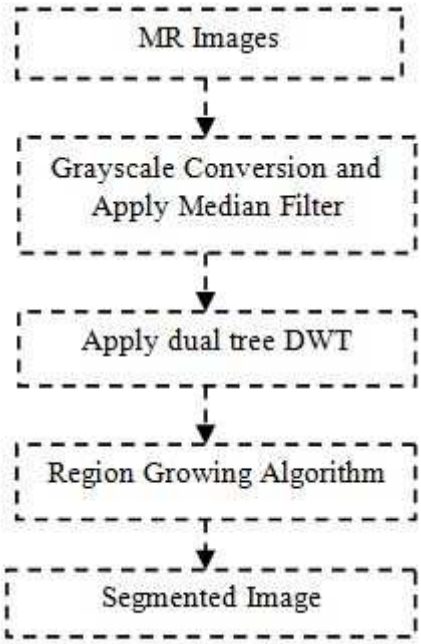

Fig1.System Architecture

A. MR IMAGES

Magnetic resonance imaging is a medical imaging method used in radiology to imagine interior structures of the corpse in detail. MRI makes use of the assets of nuclear magnetic resonance (NMR) to image nuclei of atoms in the body. MRI can make additional full images of the person remains than are probable with X-rays. MRI provides high-quality contrast connecting the dissimilar yielding tissues of the body, which makes it mainly useful in imaging the brain, muscles, the heart, and cancers compared with additional medical imaging techniques such as computed tomography (CT) or X-rays [7]. Unlike CT scans or traditional X-rays, MRI does not use ionizing radiation [4].

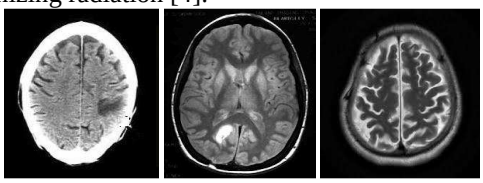

Fig1. Sample MR Images

B. MEDIAN FILTER

Region averaging can control distant out-of-range noise, but the elevation result is that it also blurs unpredicted changes (corresponding to high spatial frequencies) such as sharp edges [5]. The median filter is an expensive method that can restrain remote noise with no blurring sharp edges. Specifically, the median filter replaces a pixel by the median of all pixels in the neighborhood:

$$y[m,n] = median\{[i,j],(i,j)\epsilon\omega\}$$

Where w represents a neighborhood centered on location (m, n) in the image.

Dual Tree Discrete Wavelet Transform

The main objective of using DWT is that it allows maximum flexibility while maximizing the memory efficiency. Any wavelet can be used because of its flexibility made in DWT design. Hence the DWT is preconfigured with set of lifting and scaling steps. In order to configure the DWT core for a particular wavelet the lifting and scaling steps are used. An arbitrary number of lifting steps can be used for the same. A DWT core is defined for performing both the forward DWT and reverse DWT.

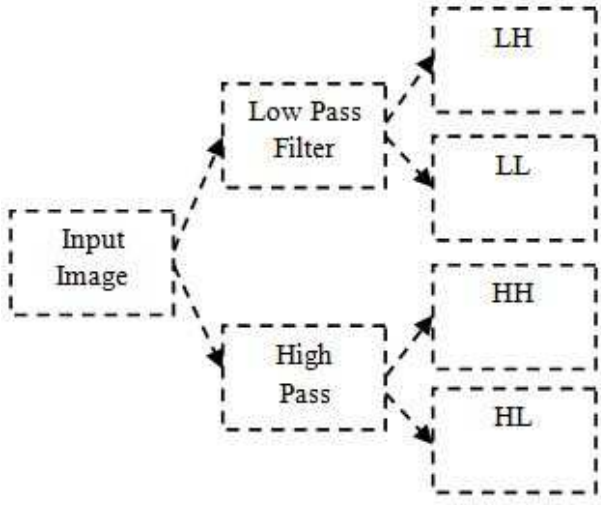

Fig2. Methodology Diagram for dual tree DWT

There are different types of wavelets which have been used in DWT; some of them are haar, Daubechies etc. In the proposed work the haar wavelet in DWT is applied because of some specialization in it. If the input consists of list of 2 power n numbers, pair up input values, storing the difference and passing the sum. This process is recurring recursively, pairing up the sums to give the next scale: finally resulting in (2 power n) -1 differences and one final sum. First, it can be performed in o(n) operations. Second, it captures a notion of the frequency content of the input and temporal content by examining it at different scales.

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Region Growing Algorithm

The ultimate goal of image segmentation is to partition of an image into a set of disjoint regions that are visually different, homogeneous where this form is termed as domain independent portioning. The aim of segmentation is to partition an input image into pixels of two or more values through comparison of pixel values with the predefined threshold value T individually [8]. Selection of threshold values plays a vital role. Only if proper threshold values are selected the segmentation would be proper else will result in following cases

1. The region of segmented part will be smaller of larger than the original segmented output
2. Non Connectivity of Edges
3. Some edges misses under segmentation

Region growing methods can correctly separate the regions that have the same properties. It provides the original images which have clear edges and the good segmentation results. To represent the property of the image it needs only a small numbers of seed point, then grow the region. The user can determine the seed point and the multiple criteria at the same time. It performs well with respect to noise. The steps of the region growing segmentation algorithm are written bellow:

Step 1: The output from IDWT is given as the input for segmentation
Step 2: Selection of seed point is made depending upon the value of threshold
Step 3: First threshold value is set to zero after finding divergence peaks
Step 4: Automatic threshold is done by calculating the divergence measures
Step 5: Selection of region is done by selecting 1st seed pixel
Step 6: The region is by iteratively grown comparing all unallocated neighboring pixels to the region
Step 7: Measure of similarity is calculated by the difference values between region intensity and region mean.
Step 8: Steps 3 to 5 is repeated until there are no more seed pixel that does not belong to any segmented region.

Performance Measurements

A. MEAN

The arithmetic mean is what is usually called the standard: When the word "mean" is used with no a modifier, it can be understood that it refers to the arithmetic mean. The mean is the amount of all the scores alienated by the digit of scores. The formula in outline notation is:

$$\mu = \sum \frac{X}{N}$$

B. MEDIAN

The median is one of a digit of behavior of abbreviation the typical values linked with members of an arithmetical population; thus, it is a probable location restriction [3]. When the median is used as a place parameter in expressive statistics, there are more than a few choices for and calculate of variability: the range, the inter quartile range, the mean complete deviation, and the median complete deviation. Since the median is the same as the next quartile, its sum is illustrated in the item on quartiles. For any prospect allocation on the real line R with increasing distribution function F, despite of whether it is any kind of constant probability distribution, in particular an absolutely constant distribution (and therefore has a probability bulk function), or a discrete probability distribution, a median is by definition any real number m that satisfy the inequality [4]

$$P(x \leq m) \geq \frac{1}{2} and\ P(x \geq m) \frac{1}{2}$$

C. STANDARD DEVIATION

The standard deviation of a arbitrary variable, arithmetical population, data set, or likelihood distribution is the square origin of its variance. It is algebraically simpler though almost less healthy than the regular absolute deviation. A useful assets of standard deviation is that, unlike variance, it is articulated in the same units as the data. Note, however, that for capacity with percentages unit, the standard deviation will have percentage points as unit. Let X is a random variable with mean value μ:

$$E[X] = \mu$$

Here the operative E denotes the normal or predictable value of X. Then the standard deviation of X is the quantity

$$\sigma = \sqrt{(E[X - \mu]^2)} \sigma = \sqrt{(E[X]^2 - (E[X])^2}$$

That is, the standard deviation σ (sigma) is the rectangle root of the difference of X, i.e. it is the square root of the standard value of (X − μ)2.The standard deviation of a (univariate) probability allocation is the same as that of a arbitrary variable having that distribution. Not all arbitrary variables have a standard deviation, since these predictable values require not exist.

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Experimental Result

In this paper dual tree DWT and Region Growing algorithm are implemented for MR Image. The input image was first converted into the Gray scale. The median filter is applied to the image. In this work the dual tree DWT is used to improve the effectiveness of the segmentation. Finally Region Growing algorithm is used to segment the brain tumor region. This work is implemented in Mat lab. The experimental figure is shown

Input Image	Total Mean	Total Median	Total Standard Deviation
1	55	70	49
2	62	62	47
3	77	54	51
4	44	20	37
5	32	31	34

Table1. Performance Metrics like Mean, Median, and Standard Deviation

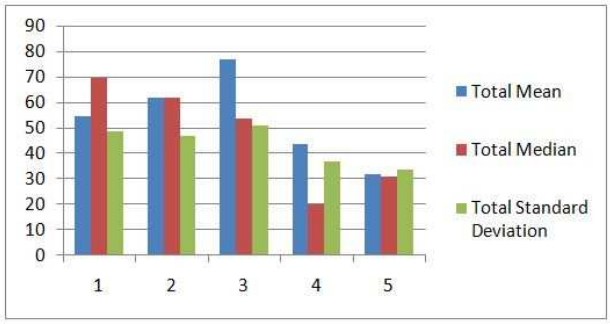
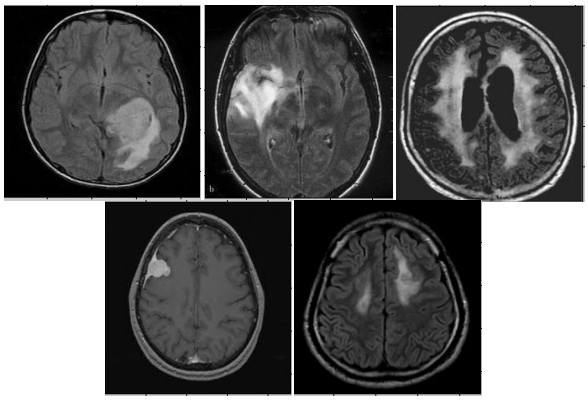
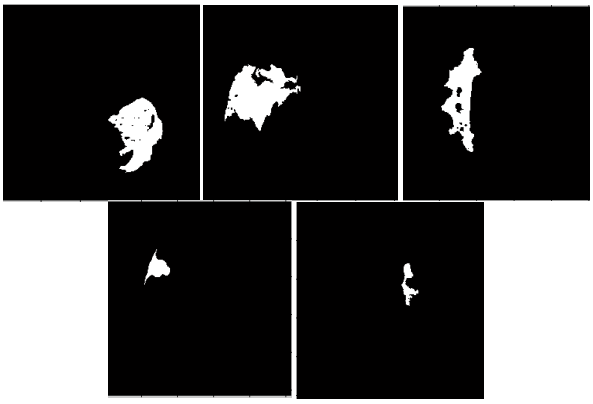


Fig3. Chart of Performance metrics



A) Input Images



B) Segmented Output Images

Fig4. MRI input Images and Region Growing Applied Segmented Output Images

Conclusion

In this proposed research work, the Brain MR Images are segmented using Discrete Wavelet Transform with region growing algorithm. Region growing segmentation algorithm provides exact detection of tumor, while it involves seeding process. Finally the tumor image has been segmented which shows the effectiveness of the output. The experimental result exposed by the proposed method is effective in segmentation of MR image. In this paper, calculate the well-known purpose image quality metrics, like Mean, Median and Standard Deviation. The proposed method is significantly lower computational complexity and it is feasible to real-time image processing which is more stable and faster.

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