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MRI Brain Tumor Segmentation Using Genetic Algorithm With SVM Classifier

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Abstract: *In medical image processing, fully automatic brain tumor segmentation has a vital role in segmenting brain image more accurately and precisely. Segmentation is the process to accomplish these tasks by dividing an image into meaningful parts which share similar properties. Magnetic Resonance Imaging (MRI) is a primary diagnostic technique to do image segmentation. It is challenging due to poor contrast and artifacts that result in missing or diffuse organ/tissue boundaries. Firstly, this paper describes the genetic algorithms, evolution process.The main methodology involves are 1) Pre-processing, 2) Segmentation, 3)Feature Extraction and Selection using Genetic Algorithm,4)Classification using SVM.The present work segments the tumor using Genetic Algorithm and classification of the tumor by using the SVM classifier.*

Key words: *Pre-processing, Segmentation, Genetic algorithm, Support vector machine*

I. Introduction

Brain tumor is any mass that outcomes from unusual developments of cells in the brain. It might influence any individual at any age. Brain tumor impacts may not be the same for every individual, and they may even change from one treatment session to the next.Brain tumor occurs due to an abnormal and uncontrolled cell division, usually in the brain itself. This may cause damage by increasing pressure in the brain, thereby shifting the brain or pushing it against the skull, thereby invading and damaging nerves and healthy brain tissue. Brain tumor is of two type benign (non cancerous) and malignant (cancerous). Identification of brain tumor is done by neurological examination, which in-turn measure the function of the patient is nervous system and physical and mental alertness. CT (computed Tomography) and MRI (Magnetic Resonance Imaging) scan are used by the radiologist to examine the patient, of this MRI is often used due to its challenges in imaging property. It providespictures from various angles and also helps to create a 3 D view of tumor image. MRI images help the radiologist to identify the tumor location and area more accurately and precisely compared with other scanning method thereby making surgical approach easier. There are over 128 types of brain and central nervous system tumors. Brain and spinal cord tumors are different for everyone. They form in different areas, develop from different cell types, and may have different treatment options.

II. Method Overview

This section explains the proposed system design and methodology. The proposed method consists of a number of phases which are dataset acquisition,preprocessing, segmentation using the Expectation Maximization (EM) algorithm and level set, feature extraction and feature selection from MRI dataset using genetic algorithm and finally the classification stage in which SVMis used for classification of brain images as normal or abnormal. Fig 1 shows the basic flow diagram of the proposed method.

2.1 Data Acqusition

The dataset needed for experimental evaluation is obtained from various hospitals in India and few from various websites. The database consists of 50 MR images, out of which 30 images have tumor and theremaining 20 images are normal. The age of the patients in the database taken is in the range between 30-70 years. The size of each image is 512 x 512 having the DICOM format. The dataset consists of multi-spectral (T1, T2, FLAIR) MRI scan images.

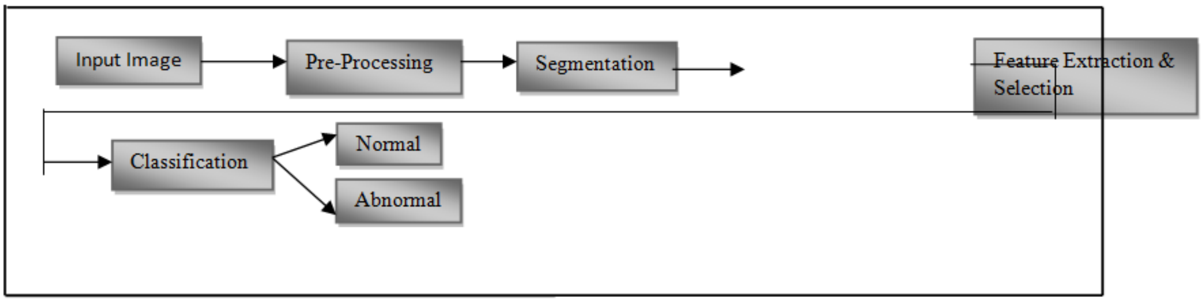


Fig 1: Basic block diagram for image segmentation

2.2 Pre-processing

Mostly medical images appear to be inhomogeneous and poor contrast, hence it require pre-processing for image enhancement so as to get most accurate and precise segmentation. The main aim of the pre-processing is to improve the quality of images and to make it ready for further processing, thereby removing or reducing the unrelated and surplus parts in the background of the input images. Pre-processing is essential to be done to improve the quality for processing the image so as to get accurate output.By pre-processing noise and high frequency components can be removed by filters.In this proposed method we are using high pass and low pass filter for preprocessing.The high pass filter can be used for removing a small amount of low frequency noise from an N dimensional signal. The cutoff frequency of the filter used is fixed at 0.1. The median filtering is used to remove the high frequency components in MR images. The median filter is the most used method to reduce noise and improve image quality as it preserves the edges of the input image. The median is calculated by first sorting all the pixel values from the encompassing neighborhood in numerical order and then changing the pixel being considered with the middle pixel value. A 3×3 square matrix neighborhood is used here. The linear transformationmethod is applied to the processed image in order to enhance image contrast.

2.3 Segmentation

The Segmentation of an image entails the division or separation of the image into regions of similar attribute. The main objective of image segmentation is to extract various features of image which can be merged or split in order to build object of interest on which analysis and interpretation can be performed. It includes clustering, thresholding etc. In our proposed method we are using a combination of expectation maximization and the levelset method for segmentation of the MRI images.EM algorithm is most widely used for the reconstruction of the input image, whereas the level set method is a numerical tool which help to get accurate boundary values thereby helping to getaccurate segmentation of the input image.

Algorithm for EM& Level Set

Step 1:Image I consist of the number of classes M .

Step 2 :Φ(0) is initially estimated based on the histogram and the number of classes.

Step 3: Iteratively performing the E-step and M-step until convergence.

Step 4:Generate the classification matrix C.

Step 5:Based on the classification matrix C assigns colour or label to each class then the segmented image is generated.

Step 6: Initializing a level set function ϕ ,from the output obtained by EM algorithm

Step 7:Calculate local means using.$Ui(x)=\frac{\int \omega(y-x)I(y)Mi,\epsilon(\varphi((y))dy}{\int \omega(y-x)Mi\varepsilon(\varphi((y))dy}$ *(2)*

Step 8:Caculate local variances using$\sigma i(x)2 = \frac{\int \omega(y-x)(Ui(x)-IcMi\varepsilon(\varphi((y))dy}{\int \omega(y-x)Mi\varepsilon(\varphi((y))dy}$ *(3)*

Step 9: Update the level set function ϕ.

$$\frac{\partial \phi}{\partial t} = -\delta\varepsilon(\phi)(e1 - e2) + \nu\delta\varepsilon(\phi)div\left(\frac{\nabla\phi}{\nabla\emptyset}\right) + (\nabla^2\emptyset - div\left(\frac{\nabla\phi}{\nabla\emptyset}\right) \quad (4)$$

Step 10:Return to step2 until the convergence criteria met

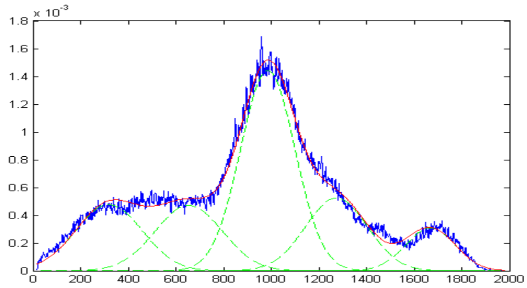


Fig2: histogram of the segmented image after EM segmentation.

2.4 Feature Extraction and Selection

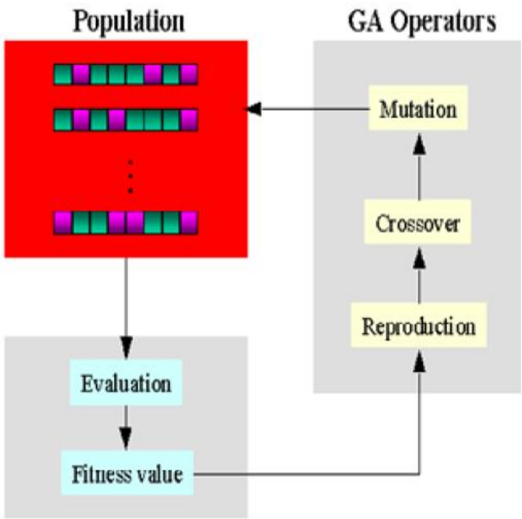
Feature extraction is a method of capturing visual content of images for indexing and retrieval. Feature extraction is used to denote a piece of information which is relevant for solving the computational task related to a certain application. Transforming the input data from the database into a set of features is called features extraction of an image. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task. There are two types of texture feature extraction measure ie. first order and second order. In the first order, texture measures on the statistical base is calculated from an individual pixel and they don't consider neiglhboring pixe relationships. The intensity histogram and intensity features are first order calculation. In the second order, measures consider the relationship between neighbor relationships.In this proposed work we are using genetic algorithm for feature extraction.

2.5 Genetic Algorithm

Genetic Algorithm (GA) is an optimization method that utilizes Darwinian criterion of population evolution for solving optimization problems based on natural selection. The process of natural selection is used to raise the effectiveness of group of possible solutions to meet an environment optimum . Genetic algorithm is based on the principle of "Survival of the fittest". A typical genetic algorithm requires: 1. A genetic representation of the solution domain. 2. A fitness function to evaluate the solution domain. Once these functions are defined GA proceeds to initialize a population of solution randomly, then it is improved by repeated application of GA operators like selection, crossover and mutation.

Algorithm for Genetic Algorithm:

Step 1. Select a randomly generated population of n bit Chromosome.
Step 2. Calculate the fitness function f(x) of each chromosome x in the population.
Step 3. Repeat the following steps until 'n' offspring has been created.
Step4.Select a pair of parental chromosomes from the current population, the probability of selection being an increasing function of fitness. Selection is done with replacement, meaning that the same chromosome can be selected more than once to become a parent.
Step 5. With probability, Crossover the pair at a randomly chosen point to form two offspring. If no crossover takes place, form two offspring that are exact copies of their respective parents.
Step 6. Mutate the two offspring at each locus with probability and place the resulting chromosome in new population.
Step 7. Replace the current population with new population.
Step 8. Go to step 2.



Evolution Environment
Fig 2: Basic Diagram for Genetic Algorithm

2.6 Classification

Classification technique, classify the brain tissues into two classes, namely Normal and Abnormal (tumor) tissue. Classification is performed by starting with the more discriminating features and gradually adding less discriminating features, to classification performance no longer improved. Various classification techniques like SVM, Artificial neural network, k-Nearest Neighbor (k-NN) etc. are used for this purpose.[1]. In our proposed paper we are using SVM method for classification,which is one of the latest and most accurate method presently used for the classification of brain tumor tissue.Support Vector Machines (SVM) , classification system is derived from statistical learning theory. The SVM separates the classes with a decision surface that maximizes the margin between the classes. The surface is often called the optimal hyperplane, and the data points closest to the hyperplane are called support vectors. The support vectors are the critical elements of the training set. The output of SVM classification is the decision values of each pixel for each class, which are used for probability estimates. The probability values represent "true" probability in the sense that each probability falls in the range of 0 to 1, and the sum of these values for each pixel equals 1. Classification is then performed by selecting the highest probability.

SVM has two stages; training and testing stage. SVM trains itself by features given as an input to its learning algorithm. During training SVM selects the suitable margins between two classes. Features are labeled according to class associative with particular class. Artificial neural network has a few issues having local minima and number of neurons selection for each problem. In order to resolve this problem SVM occupies no local minima and overhead to neurons selection by initiating the idea of hyper planes.

III. Experimental Analysis

MRI brain image segmentation based on EM and level set was implemented using MATLAB 7.10.0. EM algorithm helps to get the segmented ouput of brain tumor whereas level set method helps to get the countour region more accurately thereby helping to get most accurate segmentation result. Here feature extraction and selection is done with the help of genetic algorithm,there by helping to fiter the most accurate feature for classification.SVM method is used for classification of tumor image in to benign or malignant. We are using MRI of mutimodaity image database of 50 patients,of size 512 X 512. Fig 1 shows the basic block diagram of the proposed system. Histogram of the segmented image is shown in fig 2.Fig 4 shows the semented output after EM segmentation and fig 5 gives the segmented output after the execution of levelset algorithm

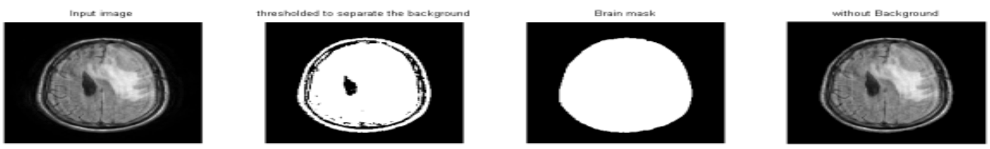


Fig 4: segmented images after EM algorithm

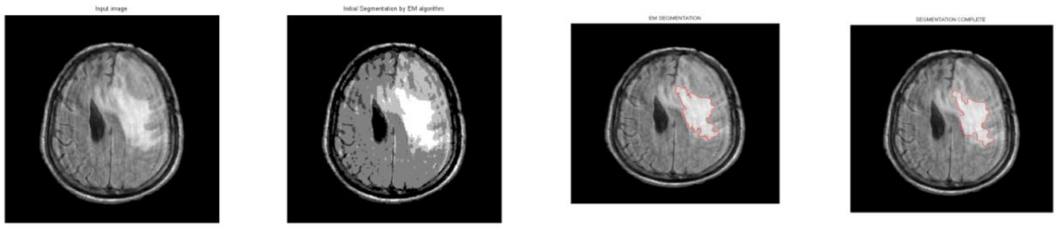


Fig 5: Final segmented image after level set method.

IV. Conclusion

In this proposed work, we have tried to give a solution for the problems associated with the brain tumour segmentation in a fully automatic way. Proposed method gives the importance of Genetic Algorithm and it's a searching technique to find out an approximate solution to optimize and search problems by using the genetics as its model of problem solving.Genetic algorithm is very helpful when the developer doesn't have precise domain expertise; GAs possesses the ability to explore. The experimental results show that the propose work gives the less convergence, good accuracy, sensitivity & specificity for the segmentation of MRI brain abnormalities.

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