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Research Article

BRAIN TUMOR DETECTION AND CLASSIFICATION BY IMAGE PROCESSING TECHNIQUES

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A B S T R A C T

Brain tumor is characterized by the abnormal growth of cells in the human brain. Tumor detection and segmentation has become one of the recent researches in medical field. Diagnosis of brain tumor is done with the help of Computed Tomography (CT) scanner, Magnetic Resonance Imaging (MRI) and Angiogram. In this paper, brain tumor detection is done by MRI images. Brain tumor images are acquired, filtered, enhanced and processed by using K-Means Cluster technique and classification of normal and abnormal images are done using Support Vector Machine (SVM) Algorithm. By using the processed image, different parameters of tumor cell such as location, shape and size can be determined precisely.

INTRODUCTION

Brain tumor is the unusual and uncontrolled growth of cells. Brain tumor segmentation using MRI is one of the recent areas of research in medical field, since it gives a better result than other brain imaging techniques. Manual segmentation of brain tumor requires human experts and it takes a lot of time, which makes the computer aided system for brain tumor detection and segmentation a desired method (Akram and Usman, 2011; Sudharani, 2016). In automated medical diagnostic systems, MRI (Magnetic Resonance Imaging) gives better results than computed tomography (CT) and provides greater contrast between different soft tissues of human body. Hence MRI is much more effective in brain and cancer imaging (Bhandarkar and Nammalwar, 2001).

Tumors are classified into two categories: malignant and benign. Benign tumors have homogeneous structure and do not spread to other parts of the body while malignant tumors have heterogeneous structure and have the ability to spread to the other parts of the body by the process known as angiogenesis. Benign tumors are either radiologically or surgically crushed and have uncommon odds of become back. Malignant tumors can invade the surrounding normal cells and can be removed by surgery, chemotherapy, radiotherapy or their combinations. In order to deal with brain tumor, MRI is a useful technique which provides us all fine details of brain such that we can easily detect the area of tumor (Kumar *et al*., 2017).

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Human brain is typically made of 3 types of tissues: the white matter, the grey matter and the cerebrospinal fluid. The goal of brain tumor segmentation is to detect the location and extension of the tumor regions, namely active tumorous tissue (vascularized or not), necrotic tissue, and edema (swelling near the tumor). This is done by identifying abnormal areas when compared to normal tissue (Mohan and Subashini, 2018).

Different brain tumor detection algorithms have been developed in the past few years. Normally, automatic segmentation problem is very challenging and it is yet to be fully and satisfactorily solved. The main aim of this system is to make an automated system for detecting and identifying tumor from normal MRI. It takes into account the statistical features of the brain structure to represent it by significant feature points. Most of the early methods obtainable for tumor detection and segmentation may be largely divided into three groupings: region-based, edge-based and fusion of region and edge-based methods (Telrandhe *et al*., 2016).

MATERIALS AND METHODS

Processing

In processing stage, the MRI Brain images are acquired and binarized. Initially, the acquired images are converted into grayscale images followed by using Otsu binarization. The various steps involved in processing of MRI images are shown in the fig. 1.

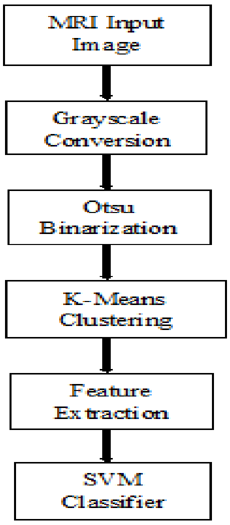

Fig 1 Flowchart for the Proposed System

Pre-processing

K-means algorithm is a method of vector quantization, originated from signal processing, which is popular for analysis in segmentation. K-means aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster (Aggarwal and Kaur, 2014). Clustering is one of the data analysis techniques which are used to determine the data point in the subgroup (cluster) of data. It is an iterative algorithm which divides the datasets in k predefined subgroup where each data point belongs to only one group. This algorithm collects the similar data point into cluster as close as possible. Each cluster has a defined k centre. Different centres provide different results due to different locations. Hence, the centres should be placed as far away from each other to obtain the exact results.

The above procedure is repeatedly by forming different centres with same data point. Finally, the aim is to minimize the sum of squared distance between the data point and cluster which is determined by the objective function *J(V).*
The objective function is:

$$J(V) = \sum_{i=1}^{c} \sum_{j=1}^{ci} (\left\|x_i - v_j\right\|)^2$$

where,

'$||x_i - v_j||$' is the Euclidean distance between x_i and v_j.
'c_i' is the number of data points in i^{th} cluster.
'c' is the number of clusters centers.

Classification

Support Vector Machine is one of the most popular supervised learning algorithms which is used for classification of data into two groups. It is capable of giving higher performance in terms of accuracy as compared to other classification algorithms. SVM is used for classification of both linear and non-linear type of data. SVM has the special property of simultaneously minimizing the classification error and maximizing the geometric margin. For the non-linear data, it maps the input vector into a higher dimensional space where a maximal hyperplane is built (Kumar *et al*., 2017). For example, if there are two classes, then the hyperplane or the decision boundary in between them that separate these two are found. There may be more than one line that separates them into two classes. And then leave a maximum margin from the support vectors of the two classes. Support vectors are the coordinates of training examples which are closest to the classifying hyperplane. They are most difficult to classify. The best separating hyperplane is that which has the greatest distance with its associated data (Aggarwal and Kaur, 2014). However, it allows classifying data that is linearly separable.

RESULTS AND DISCUSSIONS

After acquiring the MRI images, it is converted to grayscale images. During the conversion process, the 8-bit images to are converted to intensity values ranging from 0 to 255. The intensity values are calculated by the formula, 2^n, where n represents the number of bits. The grayscale converted images of normal and abnormal brain are shown in the fig 2 (a) and fig 3(a). Then thresholding is done by Otsu binarization. Otsu's binarization creates a histogram of the grayscale data (from 0 to 255) and creates two classes of images to produce background and foreground of the input images respectively. The maximal value of variance is found to get the threshold value. The Otsu's binarized images of normal and abnormal brain are shown in the fig 2(b) and fig 3(b).

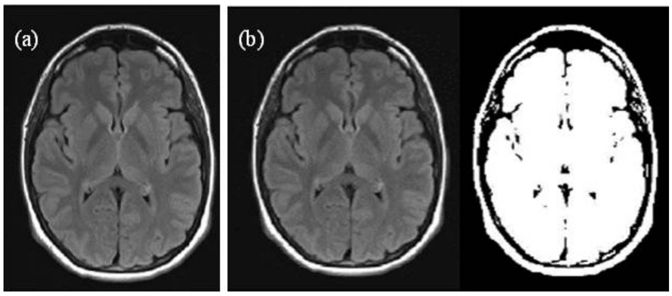

Fig 2 Output image of Normal Brain (a) Grayscale Image (b) Otsu Binarization

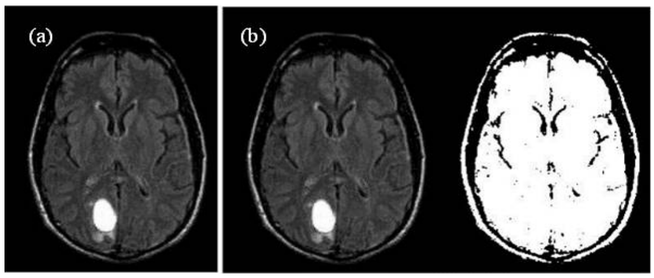

Fig 3 Output image of Abnormal Brain (a) Grayscale Image (b) Otsu Binarization

K-means clustering is one of the important segmentation techniques used in image processing. This technique is used to identify the abnormal regions in the MRI image and separate the affected region alone. Segmentation of tumor image by k-means clustering is shown in fig 4(b), (c) & (d). The index image of the input MRI image is shown in fig 4(b). Clustered formed from the input is shown in fig 4(c). The separated tumor image is shown in the fig 4(d).

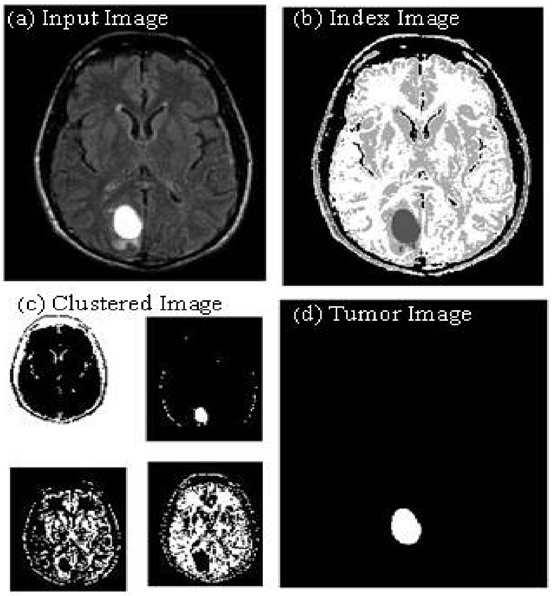

Fig 4 Segmentation of Abnormal Brain by K-Means Clustering

SVM classifier is used to classify the normal and abnormal images separately. The abnormal regions are separated and classified by using SVM classifier as shown in fig 5(b) and 5(c).

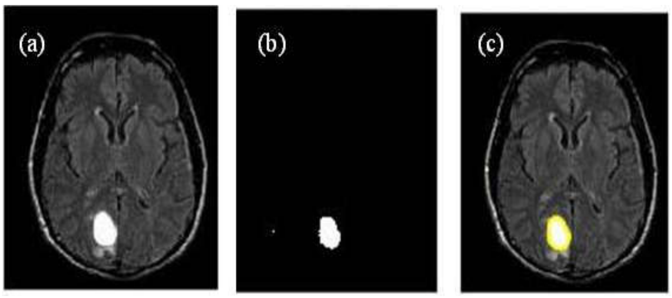

Fig 5 SVM classifier of (a) Input image (b) Tumor image and (c) Input image with tumor

CONCLUSION AND FUTURE WORK

In this paper, the tumor images are initially converted to grayscale image and Otsu binarization is done. Then, the tumor images are segmented using K – Means Clustering. Finally, the images are classified into normal and abnormal images by using Support Vector Machine (SVM). By this method, the shape size and location of the brain tumor can be determined. In future, the shape, size and location of the tumor can be identified in earlier stage which will avoid the surgeries and reduce the mortality rate.

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