BRAIN TUMOR DETECTION USING IMAGE PROCESSING: A SURVEY

[1]AMRUTA PRAMOD HEBLI, [2]SUDHA GUPTA

[1,2]Department of Electronics Engineering,
K.J.Somaiya College of Engineering,Vidyavihar, Mumbai,400077
E-mail: [1]amruta.hebli@somaiya.edu, [2]sudhagupta@somaiya.edu

Abstract— The Brain Tumor is affecting many people worldwide. It is not only limited with the old age people but also detected in the early age . Brain Tumor is the abnormal growth of cell inside the brain cranium which limits the functioning of the brain. Early detection of the brain tumor is possible with the advancement of machine learning (ML) and image processing (IP) .In this paper stages of image processing are discussed and overview of the analogous papers are quoted by analyzing several research papers. This paper provides gist of technologies which can be used to predict brain tumor.

Keywords — Brain Tumor, Segmentation methods, MRI.

I. INTRODUCTION

Brain tumor develops because of unusual cell growth within the brain. Brain Tumor generally classified into two types benign and malignant tumors[1]. Malignant Tumors are fast growing cancerous tissues. Benign are slow growing, stagnant cancerous tumor. Most of the tumors are life threatening , brain tumor being one among them. Primary brain tumors originates in the brain. In the Secondary type of brain tumor the tumor expansion into the brain results from other parts of the body. Imaging tumors with more accuracy plays pivotal role in the diagnosis of tumors. It involves high resolution techniques like MRI , CT ,PET etc. MRI is a important mean for studying the body's visceral structures [2]. MRI is widely used because it gives better quality images of the brain and cancerous tissues compared with the other medical imaging techniques such as X-Ray or Computed Tomography (CT). As being a non-invasive technique MRI are majorly used[13]. The basic principle behind MRI is to generate images from MRI scan using strong magnetic field and radio waves of the body which helps in investigating the anatomy of the body.

The entire paper is organized as, Existing methodologies in section II , comparison of K-means and Fuzzy clustering in section III, comparison of GA and PSO in section IV, survey of different methods used until now are quoted in section V.

II. EXISTING METHODOLOGY

Image Processing techniques are used to detect tumor that has mainly following steps – Pre Processing, segmentation, Feature Extraction and Classification. The flowchart of the steps followed in tumor detection and classification is shown in figure 1. Initial stage includes collection of MRI samples. MRI has different weighted images T-1 Weighted, T-2 Weighted and Flair -Weighted.

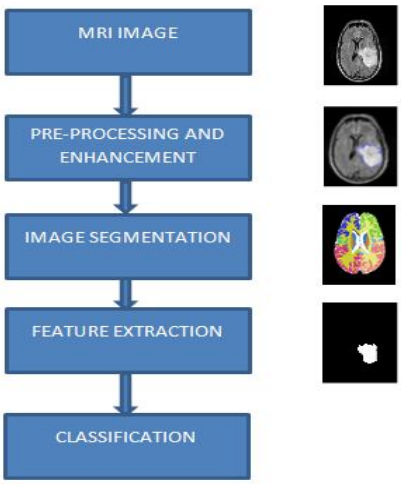

Figure 1.Steps for image processing

A] Preprocessing and Enhancement of an Image

This is the first step of image processing it is used to enhance the chances of detecting the suspicious region. Finer details of the image are enhanced and noise is removed from the image. Clinical MRI when corrupted by noise reduces the accuracy of the image. Various filters are used to remove this noise . Anisotropic filter is used to remove background noise, weighted median filter is used to remove salt and pepper noise. Wavelet based de-noising method makes wavelet and scaling coefficient biased. The original image and image after enhancement is shown in figure 2.

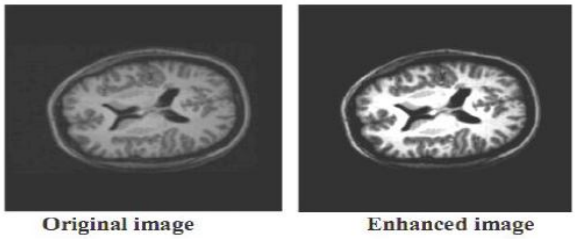

Figure 2. Image enhancement

B] Segmentation methods

Image segmentation is the method of breaking down an image into small parts.segmentation is performed to make the analysis easier. There are following types of image segmentation.

1] Boundary approach or Thresholding

It is the most commonly used segmentation method . It is the gray valve remapping method where if p is considered as an operation then as shown in equation (1),

$$p(v)=\begin{cases}0 & \text{if } v< t\\ 1 & \text{if } v\geq t\end{cases} \quad .....(1)$$

where v is the gray valve and t is the threshold value . In the thresholding method the gray image is converted to binary image . After thresholding the image has segmented into two values 0 and 1.

2] Edge approach

In edge-based segmentation method , the detected edges in an image are assumed to represent object boundaries and used to identify these objects. Edge based segmentation very rarely gives the absolute distinct and closed boundaries needed for a direct segmentation. Chances are more that false edge detection and many of the times it requires edge linking to joint the partial edges into an object boundary.

3] Region approach

Region based approach depends on the assumption that the bordering pixels within one region have similar values. It focuses on finding object region instead of it's edges.It compares one pixel with its neighbors,if the congruence criteria satisfies then the pixel can be set to belong to the cluster as one or more of its neighbors. Different clustering algorithms are used in this type of approach .

a)K-means algorithm

K-means algorithm is widely used clustering technique. Which is also known as hard clustering algorithm, it partitions a given dataset into c or k clusters . This algorithm is simple fast and robust to implement . It has some disadvantages as it may not be successful to find overlapping clusters and it also fails to cluster noisy data and non-linear datasets.

b)Fuzzy clustering

Fuzzy clustering also known as soft clustering . In this an object is a member of a single cluster as well as a member of many clusters . i.e. objects which are located on the boundaries of the clusters are not forced to belong to a certain cluster, rather they can be member of many clusters. Comparison between K-means and Fuzzy is given in Table 1.

c)Genetic Algorithms

GA and it's many versions are well received in academe and industry because of it's advantages such as it is ease of implementation, ability to solve higher nonlinearities and it's intuitiveness. GA has three main operators as recombination, mutation and selection operator.

In this algorithm , at the start number of solutions or populations are available , the solution from one population is utilized to form a new population which is superior than the old one . As long as some condition satisfies this process is repeated.Expensive computational cost is the drawback of GA.

d)PSO (Particle swarm optimization)

It is a population based search algorithm which is initiated with the randomly selected populations , also called as particles. All the particles in the PSO have their individual fitness value , which can be calculated by the fitness function. They also have velocity which directs the flying of the particle in search space. Unlike GA ,PSO does not have a direct recombination operator. Drawback of PSO is , the swarm may prematurely converge as there is rapid information flowing between particles. It is also problem reliant as the output rely on the parameter setting of the algorithm.Comparison between GA and PSO is given in Table 2.

C) Feature Extraction

Extracting the exact tumor is a crucial task in case of brain tumor because of the complex structure of brain. Certain parameters are taken into account for feature extraction as size , shape, composition , location of the image . As per the results obtained from the feature extraction the classification of the tumor is done .

III. COMPARISON OF K-MEANS AND FUZZY CLUSTERING

Table 1. Comparison of K-means and Fuzzy clustering

K-means algorithm	Fuzzy c means algorithm
It is referred as Hard clustering.	It is referred as extended from of hard c means clustering .
This algorithm is applied to analyze data and treat observations of the data . The objects are based on the location and distance between various input data points .	This algorithm is applied for analysis based on distance between various input data points .
Each cluster is has a centre point i.e known as centroid .	Cluster has a cluster centre based on the distance between the data points .
May not be successful to find overlapping clusters .	Objects may be associated with different clusters .

IV. COMPARISON OF GA AND PSO

Table 2. Comparison of GA and PSO

Genetic algorithm	Particle swarm optimization
GA can implements its three main operations i.e selection, crossover and mutation in a number of ways.	Analogies exist in PSO though it does not label its operations like GAs.
GA is theoretically ergodic but practically there exists a non zero probability . An evolutionary programming system i.e EP is truly ergodic because of finite probability that an individual can reach to any point by one jump .	The behavior of the PSO system falls between GA and EP. This might be because PSO particle can not reach any point in problem space in just one iteration.

V. SURVEY OF DIFFERENT METHODS

Table 3. Different methods used and their conclusions

Year	Method	Remark	Ref
1992	1)Unsupervised Fuzzy C-means approach 2)Supervised Feed Forward Cascade Correlation	Both the methods where tried on set of images and compared . Unsupervised FCM showed better results as compared with the supervised FFCC .	[6]
2005	One class support vector machine (SVM)	One class SVM achieved better image segmentation results for tumor segmentation than fuzzy clustering method	[8]
2005	Alignment based feature encoding	This method evaluates four different types of AB feature for image segmentation . These AB features are combined using machine learning.	[10]
2009	Mathematical Morphology, Wavelet Transform and K-means technique	In the first step of enhancement process Mathematical Morphology is applied , In second step image segmentation is done using wavelet transform and the last step for extraction of tumor uses unsupervised K-means clustering algorithm.	[7]
2010	Clustering algorithm – Fuzzy C-means along with intelligent optimization tools: 1) GA , 2) PSO	GA and Fuzzy C-means require more time than the proposed algorithm of PSO with Fuzzy C-means. Also the PSO with Fuzzy C-means provides better accuracy.	[9]
2010	Adaptive Threshold approach and Canny Edge detection method	Adaptive threshold and Canny edge both are compared with the four rates 1) Misdiagnosing a healthy brain as a brain with tumor. 2) Misdiagnosing a brain with tumor as a healthy brain. 3) Misdiagnosing a benign tumor with malignant. 4) Misdiagnosing a malignant tumor with benign.	[11]
2010	SVM	In this method feature extracted using spatial gray level dependance method (SGLDM)) along with a hybrid technique which classifies the result in normal brain , benign or malignant tumor.	[12]
2014	K-means , Fuzzy c means and histogram thresholding	Comparison of these three methods are discussed . And the results are stated as the combination of the three methods gives better performance	[15]
2015	Expectation Maximization	This includes the study and histogram analysis . The proposed method is claimed to be fast ,easy and very simple to program also the time taken for simulation is less , approximately 5 to 8 secs.	[14]
2016	Classification using two tier classifier.	Proposed system uses adaptive pillar K-means algorithm for segmentation and for classification its uses two-tier classifier. The performance of the system is compared with SVM in terms of statistical measure such as sensitivity , specificity and classification accuracy is analyzed which is found to be superior than SVM.	[13]

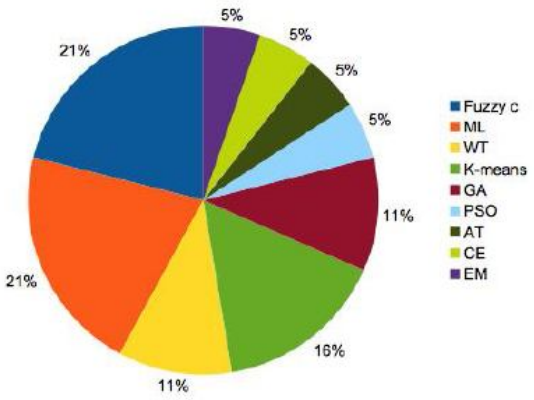

Figure 3. Methodologies studied in the survey

CONCLUSION

In this work, several methodologies are examined to denote the conventional stages of MRI image processing also analyzed individual segmentation approach. In conjunction with this different methodologies proposed by the researchers are considered to conclude that machine learning shows an important role in brain tumor detection and classification together with appropriate segmentation approach. Along with this comparison between K-means and fuzzy c, GA and PSO has also being drafted.

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