Brain tumor from MR Images: A Review

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ABSTRACT

Brain tumors are abnormal and uncontrolled spreads of cells. The brain is the anterior most part of the central nervous system. Brain tumor is one of the major causes of death among people. It is evident that the chances of survival can be increased if the tumor is detected and classified correctly at its early stage. Magnetic resonance (MR) imaging is currently an indispensable diagnostic imaging technique in the study of the human brain. Computer aided diagnosis systems for detecting Brain tumor for medical purpose have been investigated using several techniques. In this Review paper, it is intended to summarize and compare the methods of automatic detection of brain tumor through Magnetic Resonance Image (MRI) used in different stages of Computer Aided Detection System (CAD). Various segmentation approaches are reviewed with an emphasis placed on revealing the benefits and drawbacks of these methods for medical imaging applications. Our main concentration is on the review on various computerizes techniques which use image segmentation to detect brain tumor.

Keywords: Brain tumor, MR images, Computer Aided Detection System, Segmentation.

I. Introduction

A tumor can be defined as a mass which grows without any control of normal forces or simply a brain tumor is a mass or growth of abnormal cells in your brain. Brain cancer is a very serious type of malignancy that occurs when there is an uncontrolled growth of cancer cells in the brain. Any brain tumor is inherently serious and life-threatening because of its invasive and infiltrative character in the limited space of the intracranial cavity.

The brain is a complex organ as it contains 50-100 billions neurons forming a gigantic network. Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. Brain tumor can be benign or malignant, benign being non cancerous and malignant are cancerous. Malignant tumors are classified into two types, primary and secondary tumors benign tumor is less harmful than malignant as in malignant tumor it spreads rapidly invading other tissues of brain, progressively worsening the condition causing death. Brain tumor detection is very challenging problem due to complex structure of brain[1].

Brain cancer is caused by a malignant brain tumor. Not all brain tumors are malignant (cancerous). Some types of brain tumors are benign (non-cancerous).Malignant brain tumors (or) cancerous brain tumors can be counted among the most deadly diseases. In Figure 1 one normal and abnormal Brain image has been showed.

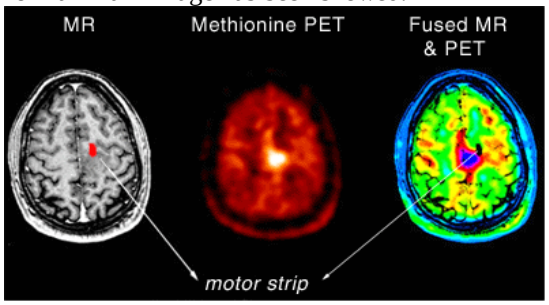

Fig.1 brain tumor detection

- Primary brain tumors can be either malignant (contain cancer cells) or benign (do not contain cancer cells). A primary brain tumor is a tumor which begins in the brain. If a cancerous tumor which starts elsewhere in the body sends cells which end up growing in the brain, such tumors are then called secondary or metastatic brain tumors. This discussion is focused on primary brain tumors.
- Brain tumors can occur at any age.
- The exact cause of brain tumors is not clear.
- Physicians group brain tumors by grade (the way the cells look under a microscope). The higher the grade number, the more abnormal the cells appear and the more aggressively the tumor usually behaves.
- Brain tumors are classified as grade I, grade II, or grade III, or grade IV
- The most common type of primary brain tumors among adults are astrocytoma, meningioma, and oligodendroglioma.
- The most common type of primary brain tumors in children are medulloblastoma, grade I or II astrocytoma, (or glioma) ependymoma, and brain stem glioma.
- Studies have found risk factors for brain tumors to include ionizing radiation from high dose X-rays (for example, radiation therapy where the machine is aimed at the head), and family history.

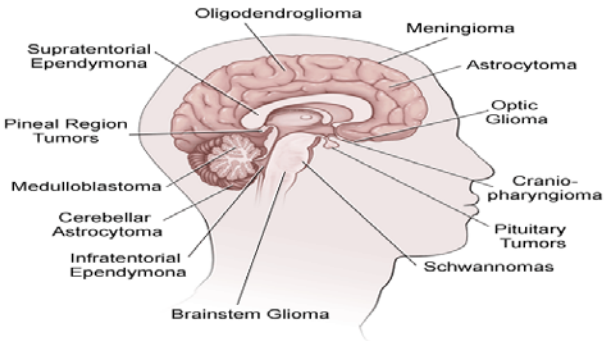

Fig. 2 : Overall information of Brain Tumor

According to the World Health Organization, brain tumor can be classified into the following groups:

Grade I: Pilocytic or benign, slow growing, with well defined borders.

Grade II: Astrocytoma, slow growing, rarely spreads with a well defined border.

Grade III: Anaplastic Astrocytoma, grows faster.

Grade IV: GlioblastomaMultiforme, malignant most invasive, spreads to nearby tissues and grows rapidly.

Many diagnostic imaging techniques can be performed for the early detection of brain tumors such as Computed Tomography (CT), Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI). Compared to all other imaging techniques, MRI is efficient in the application of brain tumor detection and identification, due to the high contrast of soft tissues, high spatial resolution and since it does not produce any harmful radiation, and is a non invasive technique. Although MRI seems to be efficient in providing information regarding the location and size of tumors, it is unable to classify tumor types, hence the application of invasive techniques such as biopsy and spinal tap method, which are painful and time consuming methods. Biopsy technique is performed where, the surgeon makes a small incision in the scalp and drills a small hole, called a burr hole, into the skull and passes a needle through the burr hole and removes a sample of tissue from the brain tumor, to check for cancerous cells (Or) the spinal tap method, where the doctor may remove a sample of cerebrospinal fluid and check for the presence of cancerous cells. This inability related to invasive technique requires development of new analysis techniques that aim at improving diagnostic ability of MR images.

Computer Aided Diagnosis is gaining significant importance in the day-to-day life. Specifically, the usage of the computer aided systems for computational biomedical applications has been explored to a higher extent. Medical image analysis is an important biomedical application which is highly computational in nature and requires the aid of the automated systems. These image analysis techniques are often used to detect the abnormalities in the human bodies through scan images. Automated brain disorder diagnosis with MR images is one of the specific medical image analysis methodologies.

The automated diagnosis involves image segmentation step which is used to extract the abnormal tumor portion which is essential for volumetric analysis. This volumetric analysis determines the effect of the treatment on the patient which can be judged from the extracted size and shape of the abnormal portion. Over the last decade various approaches have been proposed for the same. Some regarded the segmentation task a tissue recognition problem, which meant using a well-trained model that can determine whether a pixel/voxel belongs to a normal or abnormal tissue based on classification methods such as neural network approach.

II. Literature Review

Image segmentation and classification techniques are increasingly being used on MR images to properly identify abnormal lesions from normal regions of the brain. Broadly speaking segmentation is a technique which reveals the region of-interest [ROI] in the images by suppressing background and the rest. In this paper, we will discuss an illustrate a number of approaches and show improvements in segmentation performance that can be achieved by combining methods from distinct categories such as techniques in which edge detection methods combined with thresholding. The segmentation approaches were studied under 5 categories. These are as follows- 1) Thresholding approaches, 2) Region growing approaches, 3) Genetic Algorithm approaches,4) Clustering approaches ,5) Neural network approaches. Several authors suggested various algorithms for segmentation [2].

The threshold technique is by making decision based on the local raw pixel information and Edge based method is centered on contour. Manoj K Kowar, SourabhYadav**,** proposed a method based on histogram thresholding [5]. They follow a concept that after dividing the image into two equal halves, histograms are compared to detect the tumor and cropping method is used to find an appropriate physical dimension of brain tumor.

In the Region based technique the images are partitioned by organizing the nearest pixel of similar kind. N. Senthilkumaran and R. Rajesh proposed region-based techniques with an assumption that adjacent pixels in the same region have similar visual features such as grey level, color value, or texture. Split and merge approaches were used & its performance largely depends on the selected homogeneity criterion [6]. Instead of tuning homogeneity parameters, the seeded region growing (SRG) technique is controlled by a number of initial seeds. If the number of regions were approximately known & used it to estimate the corresponding parameters of an edge detection process., it is possible to combine region growing and edge detection for image segmentation.

The important process in the automated system is brain image classification. The main objective of this step is to differentiate the different abnormal brain images based on the optimal feature set. An interactive tool to classify the healthy and the tumorous MR brain images is proposed by Michael R, Simon K, Nabavi A, Peter M, Ferenc A, Kikinis R [7]. Though this approach claimed a faster convergence rate, it may not be much useful because of its low accuracy than Artificial Intelligent (AI) techniques. Ahmed Kharrat & Karim Gasmiproposed a hybrid approach for classification of brain tissues in MRI based on genetic algorithm [11]. The optimal texture features are extracted from normal and tumor regions by using spatial gray level dependence method. It is concluded that, Gabor filters are poor due to their lack of orthogonality that results in redundant features at different scales or channels. While Wavelet Transform is capable of representing textures at the most suitable scale, by varying the spatial resolution and there is also a wide range of choices for the wavelet function.

A survey on different clustering techniques to achieve image segmentation is performed in[9]. In order to increase the efficiency of the searching process, only a part of the database need to be searched. For this searching process clustering techniques can be recommended. Clustering can be termed here as a grouping of similar images in the database. Clustering is done based on different attributes of an image such as size, color, texture etc. The purpose of clustering is to get meaningful result, effective storage and fast retrieval in various areas. Amir EhsanLashkar [10] used neural network-based method using Zernike and Geometric moments using 200 MRI images. Yu Sun et al [8] employed the technique of symmetry integration in several steps associated with segmentation, clustering and classification. However, use of small and unstructured dataset restricts the generality and clinical applicability.

The application of Kohonen neural networks for image classification is explored by [12]. Some modifications of the conventional Kohonen neural network are also implemented in this work which proved to be much superior to the conventional neural networks. J. Zhou et al [10] carried out image segmentation using one-class support vector machine (SVM). A hybrid approach such as

combination of wavelets and Support Vector Machine (SVM) for classifying the abnormal and the normal images is used by [11]. This report revealed that the hybrid SVM is better than the Kohonen neural networks in terms of performance measures. But the major drawback of this system is the small size of the dataset used for implementation.

Mohd Fauzi Bin Othman, Noramalina Bt Abdullah [12] in 2011, performed classification of brain tumor using wavelet based feature extraction method and Support Vector Machine (SVM). Feature extraction was carried out using Daubechies (db4) wavelet and the approximation coefficients of MR brain images were used as feature vector for classification. Accuracy of only 65% was obtained, where, only 39 images were successfully classified from 60 images. It was concluded that classification using Support Vector Machine resulted in a limited precision, since it cannot work accurately for a large data due to training complexity.

Application of various artificial neural networks for image classification is analyzed by [16]. The lack of faster convergence rate of the conventional neural networks is also explained in the report. This lay an emphasis on the requirement of modified neural networks with superior convergence rate for image classification applications. The modified Probabilistic Neural Network for tumor image classification is used by [17]. Abnormal images such as metastase, glioma and meningioma are differentiated using the least square feature transformation based PNN. A comparative analysis is also performed with SVM. This work inferred that the transform based PNN is superior to the SVM in terms of classification accuracy. Various research works have been performed in classifying MR brain images into normal and abnormal Whereas, classifying MR brain images into normal, cancerous and non cancerous brain tumors in particular, is a crucial task, a wavelet and co occurrence matrix method based texture feature extraction and Probabilistic Neural Network for classification has been used as new method of brain tumor classification[18].

R. Ganesan and S. Radhakrishnan proposed a novel method for automatic segmentation of Computed Tomography (CT) brain images. Their method consists of two major phases. In the 1st phase, the original images are enhanced by using Selective Median Filter (SMF) and in the 2nd phase the GA is used to segment the image. They applied their proposed method to real patient CT images [19]. Akabar Shahrzad Khashandarag, Mirkamal Mirnia and Aidin Sakhavati proposed a new method combining genetic algorithm and K-Means algorithm for clustering medical images. In this combined technique, variable string length genetic algorithm (VGA) is used for the determination of the optimal cluster centres [20].Following are the classification of review system [3]

Author(s)	Technique	Results
T.Logeswari and M.Karnan(2010)	Self-OrganizingMap (SOM) algorithm	new unsupervised MR image segmentation
G.M.N.R. Gajanayake, R. D. Yapa and B. Hewawithana(2009)	using standard image segmentation techniques to isolate a brain tumor from the other regions of the brain	Otsu's thresholding method is the most suitable image segmentation method to segment a brain tumor from a Magnetic Resonance Image
A. Padma and R. Sukanesh(2013)	SVM with dominant run length feature extraction method	improve the computing efficiency
R. Ganesan and S. Radhakrishnan (2001)	using Selective Median Filter (SMF) and in the GA is used to segment the image	automatic segmentation of Computed Tomography (CT) brain images
Minakshi Sharma and Dr. Sourabh Mukherjee (2013)	Grey level Co-occurrence Matrix for texture feature extraction, ANFIS and Genetic Algorithm for feature selection and FCMfor segmentation of Astrocytoma	improved Accuracy, Sensitivity and Specificity

III. Future Scope

After evaluation of well-known segmentation techniques it is clearly shown the various methods which can detect the tumor efficiently and provide accurate results. These can be further improved by incorporating discrete and continuous-based segmentation methods. Computational time will also be considered to compare this technique efficiently. Segmentation methods have proved their utility in research areas and are now emphasizing increased use for automated diagnosis and radiotherapy. These will be particularly important in applications such as computer integrated surgery, where envision of the anatomy is a significant component.

IV. Conclusion

We reviewseveral methods and techniques for identifying and segmenting the brain tumor from scanned MRI images. Discussing various techniques on which can detect the brain tumor with improved Accuracy.

Computerized techniques are used a key step for finding application in computer aided diagnosis, medical studies and treatment planning. A review of brain tumor detection has done based on several segmentation

approaches. The use of computer technology in medical decision support is now widespread and universal across a wide range of medical area.MRI plays an important role in liberalresearches. First we have seen region or edge based methods, and then we have done a complete analysis of segmentation algorithms proposed so far are based on classification or clustering approaches. Finally, it is concluded that the results of the present study are of great importance in the brain tumor detection which is one of the challenging tasks in medical image processing. The accurate identification is crucial otherwise the wrong credentials of disease can lead to several consequences.

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