A Review on Brain Disorder Segmentation in MR Images

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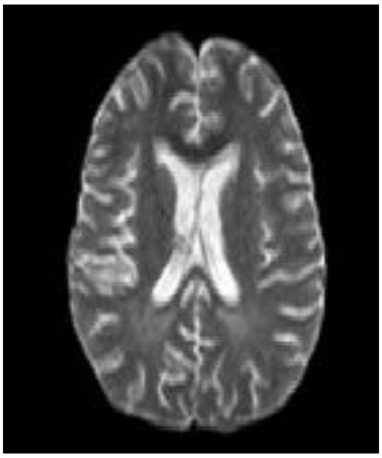
ABSTRACT: *Brain tumor is one of the major causes of death among people. It is evident that the chances of survival can be increased if the tumor is detected and classified correctly at its early stage. Magnetic resonance (MR) imaging is currently an indispensable diagnostic imaging technique in the 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 advantages and disadvantages of these methods for medical imaging applications. The use of image segmentation in different imaging modalities is also described along with the difficulties encountered in each modality.*

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

I. Introduction

Brain cancer is a very serious type of malignancy that occurs when there is an uncontrolled growth of cancer cells in the brain. 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.



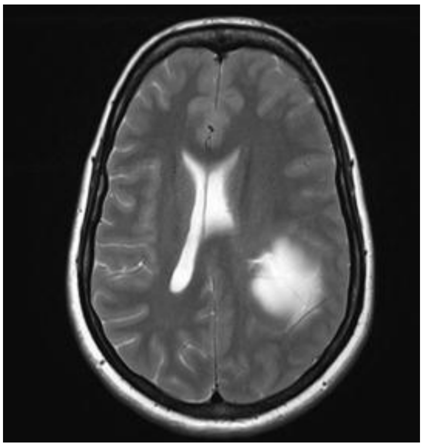


Fig.1 (a). Normal, 1(b) abnormal

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: Glioblastoma Multiforme, 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.

The **threshold technique** is by making decision based on the local raw pixel information and Edge based method is centered on contour. Jaskirat Kaur, Sunil Agrawal & Renu Vig.'s paper presented thresholding and edge detection being one of the important aspects of image segmentation comes prior to feature extraction and image recognition system for analyzing images. It helps in extracting the basic shape of an image, overlooking the minute unnecessary details. In this paper using image segmentation (thresholding and edge detection) techniques different geo satellite images, medical images and architectural images are analyzed. [1]. Manoj K Kowar, Sourabh Yadav**,** proposed a method based on histogram thresholding [2]. 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 [3]. 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 [4]. 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 Gasmi proposed a hybrid approach for classification of brain tissues in MRI based on **genetic algorithm [5]**. 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[6]. 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 Ehsan Lashkar [7] 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 [9]. 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 [13]. 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 [14]. 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[15].

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

Computer-aided segmentation is a key step for finding application in computer aided diagnosis, clinical studies and treatment planning. A survey of brain tumor detection has done based on several segmentation approaches. The use of computer technology in medical decision support is now widespread and pervasive across a wide range of medical area.MRI plays an important role in progressive researches. First we have seen Region- or edge-based methods, and then we have done a detailed 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. This work will be extended for new algorithm for brain tumor detection which will provide more efficient results than existing methods in near future.

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