

A Review on Brain Tumour Detection Using Image Segmentation

Amrutha Ravi¹, Sreejith S.²

^{1,2}Department of ECE, Government College of Engineering Kannur, Kannur, India

Abstract—Tumour is an uncontrolled growth of tissues in any part of the body. Tumours are of different types and characteristics and have different treatments. Detection of tumour in the earlier stages makes the treatment easier. Here a brief review of different segmentation methods used for detection of tumour from Magnetic Resonance Imaging (MRI) of brain has been discussed. Finally we propose an automatic tumour detection system using image segmentation technique.

Keywords— Brain Tumour, Image Segmentation, Magnetic Resonance Imaging

I. INTRODUCTION

Brain tumour, occurs when abnormal cells form within the brain. There are two main types of tumours: malignant or cancerous tumours and benign tumours. Malignant tumour involves abnormal cell growth with the potential to invade or spread to other parts of the body. Benign tumours do not spread to other parts of the body. Fig. 1 shows the presence of tumour in human brain. Normally brain tumour affects CSF (Cerebral Spinal Fluid). It causes strokes. The physician gives the treatment for the strokes rather than the treatment for tumour. So detection of tumour is important for that treatment. Medical imaging techniques play an important role in diagnosis and early detection of tumour. MRI, computed tomography (CT), digital mammography, and other imaging processes give an efficient means for detecting different types of diseases. From the MRI images the information such as tumours location provides radiologists, an easy way to diagnose the tumour and plan the surgical approach for its removal. MRIs use radiofrequency and magnetic field without ionised radiations.

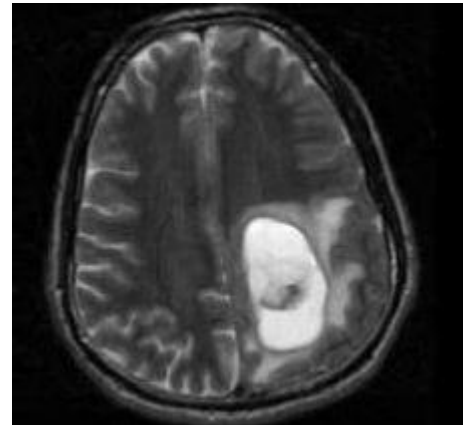


Figure 1. Mri Of Human Brain. Note The Presence Of A Tumour Towards The Bottom Left

Tumour segmentation from MRI data is an important but time consuming manual task performed by medical experts. Brain tumour analysis is done by doctors but its grading gives different conclusions which may vary from one doctor to another. Also the tumour size, position, texture and appearance are very different in different patient images as shown in fig.2

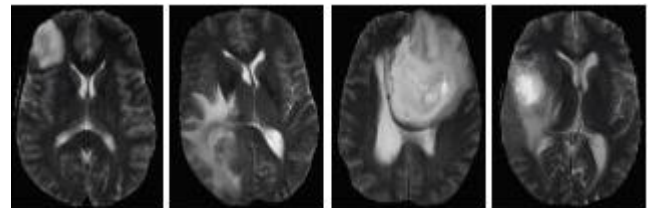


Figure 2. Mri Depicting Tumours In Brain Images Of Different Patients.

II. CURRENT STATE OF THE ART

The image segmentation is entailed with the division or separation of the image into regions of similar features. The definitive aim in image processing applications is to extract important attributes from the image data, from which a descriptive, interpretative, or understandable prospect can be obtained by the machine. Several literatures are available in this field of study.

Jianping Fan et al. [1] paper presents an automatic imagesegmentation method using thresholding technique. This is based on the assumption that adjacent pixels whose value(grey level, colour value, texture etc) lies within a certain range belong to the same class and thus, good segmentation of images that include only two opposite components can be obtained. Jaskirat Kaur et al. 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 geosatellite images, medical images and architectural images are analyzed. To quantify the consistency of our results error measure is used [2].

V. Dey et al. proposed a method based on histogram thresholding [3]. They followed a concept that there is a uniform background and objects are irregularly placed on it. This makes image histogram the choice for object delineation and finding an appropriate threshold between object and background fulfils the task of object identification. Dzung L. Pham et al. proposed the basics that thresholding approaches segment scalar images by creating a binary partitioning of the image intensities. It attempts to determine an intensity value, called the threshold, which separates the desired classes. Segmentation is achieved by grouping all pixels with intensity greater than the threshold into one class, & all other pixels into another class. Determination of more than one threshold value is a process called multi thresholding. Fan & Yau 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. Instead of tuning homogeneity parameters, the seeded region growing (SRG) technique is controlled by a number of initial seeds.

Mohd Fauzi Bin Othman et al. in 2011, performed classification of brain tumour 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 SVM resulted in a limited precision, since it cannot work accurately for a large data due to training complexity.

Nagesh Subbanna et al. proposed a fully automated segmentation system [7] in which an initial Bayesian tumour classification based on Gabor texture features permits subsequent computations to be focused on areas where the probability of tumour is deemed high. An iterative, multistage Markov Random Field (MRF) framework is then devised to classify the various tumour subclasses.

Mark Schmidt et al. introduced a procedure which quantitatively evaluates the performance of 4 different types of Alignment-Based (AB) features encoding spatial anatomic information for use in supervised pixel classification [4]. This is the first work to compare several types of AB features, explore ways to combine different types of AB features and explore combining AB features with textural features in a learning framework.

Andac Hamamci et al. in their paper [5] a cellular automata (CA) based seeded tumour segmentation method on contrast enhanced T1 weighted MRI, which standardizes the volume of interest (VOI) and seed selection, is proposed. S.M. Ali, Loay Kadom Abood, and Rabab Saadoon Abdoon proposed a method in which Gray level stretching and Sobel edge detection, K-Means Clustering technique based on location and intensity. Fuzzy C-Means Clustering, and An Adapted K-Means clustering technique and Fuzzy CMeans technique with morphological operations have been applied to extract the tumour region [6].

III. METHODS OF TUMOUR SEGMENTATION

There are various methods used for image segmentation. Some of them are thresholding, region growing, classifier, clustering, artificial neural networks, deformable models, atlas-guided approaches, level set methods.

A. Thresholding

For image segmentation this is one of the oldest methods. The segmentation is done by grouping all pixels with intensity between two such thresholds into one class.

On the identification of a good threshold, this method relies and failing of such threshold may guide to poor segmentation. A process to determinate more than one threshold value is called multithresholding [9]. In a sequence of image processing operations [8] thresholding is used as an initial step. In digital mammography it has been used in which two classes of tissue are present; one is healthy and other is tumorous [10],[11].

B. Region Growing

For image segmentation region growing method is a well developed technique. Based on some predefined criteria this method extracts image region. This is based on intensity information or edges in the image. An operator manually selects a seed point and extracts all pixels that are connected to the initial seed based on some predefined criteria. An algorithm called as split-and-merge which is related to region growing algorithm, but it does not require a seed point. Region growing can also be sensitive to noise, causing extracted regions to have holes or even become disconnected. These problems can be removed using a homotopic region-growing algorithm.

C. Classifier

Classifier methods (supervised methods) are pattern recognition techniques that partition a feature space derived from the image by using data with known labels. A simple classifier is the nearest-neighbor classifier, in which each pixel is classified in the same class as the training datum with the closest intensity. The k-nearest-neighbor classifier is a generalization of this approach. The k-nearest-neighbor classifier is considered a nonparametric classifier because it makes no underlying assumption about the statistical structure

D. Clustering

Clustering(unsupervised methods) can be defined as the process of organizing objects into groups whose members are similar in some way. Without using training data they normally performs as classifiers. To compensate for the lack of training data, this iteratively alternate between segmenting the image and characterizing the properties of each class. There are three commonly used clustering algorithms; kmeans algorithm, the fuzzy c-means algorithm, and the expectation-maximization algorithm [12]. Assume that there are three types of classes; WM, GM and CSF. FCM algorithm generalizes the k-means algorithm which allow soft segmentations based on fuzzy set theory. Expectation Maximization(EM) algorithm applies the same clustering principles with that the data follow a Gaussian mixture model.

1) *Fuzzy c-means algorithms*: The goal of a clustering analysis is to divide a given set of data or objects into a cluster, which represents subsets or a group. The partition should have two properties one of them is the homogeneity inside clusters data, which belongs to one cluster, should be as similar as possible and another one is heterogeneity between the clusters data, which belongs to different clusters, should be as different as possible. The membership functions do not replicate the actual data distribution in the input and the output. They may not be suitable for fuzzy pattern recognition. To build membership functions from the data available, a clustering technique may be used to partition the data, and then produce membership functions from the resulting clustering. The FCM algorithm is an improvement of earlier clustering methods. The objective function of FCM algorithm is defined as the sum of distances between the patterns and the cluster centers.

2) *K-means algorithms*: K-Means clustering generates a specific number of disjoint, flat(non-hierarchical) clusters. It is well suited to generating globular clusters. The KMeans method is numerical, unsupervised, non-deterministic and iterative. K-Means Algorithm are i)always K clusters, ii)always at least one item in each cluster, iii)The clusters are non-hierarchical and they do not overlap, iv)Every member of a cluster is closer to its cluster than any other cluster because closeness does not always involve the center of clusters.

E. Artificial Neural Networks

Artificial neural networks(ANNs) are parallel networks of processing elements or nodes that simulate biological learning. Each node in an ANN is capable of performing computations. Learning is achieved through the adaptation of weights assigned to the connections between nodes. It is most widely used in medical imaging as a classifier in which the weights are determined by using training data and the ANN is then used to segment new data. ANNs can also be used in an unsupervised method as a clustering method as well as for deformable models.

F. Morphology-based

Morphological image processing (or morphology) describes a range of image processing techniques that deal with the shape (or morphology) of features in an image and morphological operations are typically applied to remove imperfections introduced during segmentation, and so typically operate on bi-level images i.e. binary images. Using some simple technique it has looked at so far we can begin to consider some more interesting morphological algorithms.

It use morphological operation in boundary extraction, Region filling, extraction of connected components, thinning/thickening, skeletonisation. All morphological processing operations are based on these simple ideas like Fit:

All on pixels in the structuring element cover on pixels in the image and Hit: Any on pixel in the structuring element covers an on pixel in the image with structuring element. Structuring elements can be any size and make any shape. However, for simplicity it uses rectangular structuring elements with their origin at the middle pixel.

IV. PROPOSED SYSTEM

In the previous section we discussed various methods that are used for tumour segmentation. In our project we are proposing an automatic brain tumour detection system selecting a suitable segmentation method. But there are several difficulties that cause poor segmentation results. The main difficulties in segmenting an image are i)Noise, ii)Blur Low Contrast, iii)The bias field(the occurrence of smoothly varying intensities within tissues), iv)The partialvolume effect (a voxel contributes in multiple tissue types). Therefore a preprocessing stage is most obvious stage of a medical image processing. Pre-processing mainly involves those operations that are normally necessarily prior to the main goal analysis and extraction of the desired information and normally geometric corrections of the original actual image. These improvements include correcting the data for irregularities and unwanted atmospheric noise, removal of non-brain element image and converting the data so they correctly reflected in the original image. The proposed brain tumour detection will be as shown in fig.3

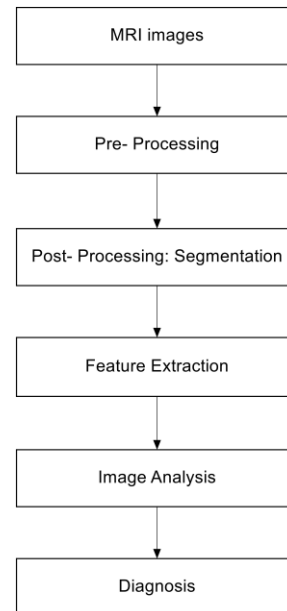


Figure 3. Tumour Detection Steps

V. APPLICATIONS

Early detection of brain tumour has got a very important role in the treatment and its cure. Brain tumour detection is a tedious job because of the complex structure of brain. From the MR Images the information such as tumour location, can be understood. It provides an easier way to diagnose the tumor and plan the surgical approach for its removal. Doctors dont have method that can be used for brain tumour detection and standardization which leads to varying conclusions between one doctor to another. There comes the requirement of an automated system. For locating tumour in magnetic resonance image (MRI) segmentation of MRI plays an important role. The existing classification methods has limitation in accuracy, exactness and requires manual interactions.

International Journal of Emerging Technology and Advanced Engineering

Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 6, June 2015)

So designing an automated system using image segmentation techniques helps the detection accurate and efficient. Tumour subclasses can also be detected using segmentation, which makes the diagnosis easier. Introducing such system has various application in the field of cancer treatments.

VI. CONCLUSION

Image processing plays vital role in today's world. Nowadays the applications of image processing can be found in areas like electronics, remote sensing, bio-medical and so on. In this paper various existing segmentation methods for brain MR image have been discussed. Using the knowledge from the above discussions our M. Tech project is proposed as Tumour Detection from MRI Images using Image Segmentation.

REFERENCES

- [1] M. S. Atkins and B. T. Mackiewicz, J. C. Bezdek, "Fully Automatic segmentation of the brain in MRI," IEEE Transaction on Medical Image processing., 2000.
- [2] Jaskirat Kaur, Sunil Agrawal and Renu Vig., "Comparative Analysis of Thresholding and Edge Detection Segmentation Techniques. International Journal of Computer Applications," Published by Foundation of Computer Science, New York, USA, pp. 29-34, 2012.
- [3] H. D. Cheng, Y. H. Chen, and X. H. Jiang, "Thresholding using two dimensional histogram and fuzzy entropy principle, IEEE Trans. Image Processing, vol. 9, pp. 732-735, 2000.
- [4] Mark Schmidt, Ilya Levner, Russell Greiner, Albert Murtha, Aalo Bistritz, "Segmenting Brain Tumors using AlignmentBased Features," Proceedings of the Fourth International Conference on Machine Learning and Applications, IEEE, 2005.
- [5] Andac Hamamci, Nadir Kucuk, Kutlay Karaman, Kayihan Engin, and Gozde Unal, "Tumor-Cut: Segmentation of Brain Tumors on Contrast Enhanced MR Images for Radiosurgery Applications," IEEE Transactions on medical imaging, 2012.
- [6] S. M. Ali, Loay Kadom Abood, and Rabab Saadoon Abdoon, "Brain Tumor Extraction in MRI images using Clustering and Morphological Operations Techniques," International journal of geographical information system and applications and remote sensing, vol. 4, June 2013.
- [7] Nagesh Subbanna, Doina Precup, Tal Arbel, "Iterative Multilevel MRF Leveraging Context and Voxel Information for Brain Tumour Segmentation in MRI," Conference on Computer vision and Pattern Recognition, IEEE, 2014.
- [8] Singleton H. R, Pohost G. M "Automatic cardiac MR image segmentation using edge detection by tissue classification in pixel neighborhoods," Magn Reson Med, 1997.
- [9] Sahoo PK, Soltani S, Wong AKC, "A survey of thresholding techniques," Computer Vision Graphics Image Processing, 1988.
- [10] Polakowski W. R, Cournoyer D. A, Rogers S. K, et. al., "Computer-aided breast cancer detection and diagnosis of masses using difference of Gaussians and derivative-based feature saliency," IEEE Transaction on Medical Imaging, 1997.
- [11] Cheng H. D, Lui Y. M, Freimanis R.I, "A novel approach to microcalcification detection using fuzzy logic technique," IEEE Transaction Medical Imaging, 1998.
- [12] Engr. V. C. and Chijindu, "Medical Image Segmentation Methodologies A Classified Overview," African Journal of Computing & ICT., 2012.