A Review on MRI Brain Tumor Detection Techniques using Deep Learning Algorithms

Mrigana Walia[1], Nazima Yousuf[2]

[1]Assistant Professor, [2]M. Tech Scholar

[1,2]Universal Group of Institutions, Mohali, Punjab, India

[1]mrigana9@gmail.com,[2]nazimayousuf60@gmail.com

ABSTRACT

Brain tumor is a tissue community which is prearranged by the gradual introduction of abnormal cells. This happens when cells within the brain get an irregular structure. It is becoming a major cause of death for many people recently. Among all the variety of cancers, the severity of brain tumor is very high, so to save a lifetime of immediate diagnosis and proper treatment. Detection of these cells is a difficult issue, due to tumor cell formation. Comparing brain tumor from MRI therapy is very significant. Vision of irregular human brain structures using basic imaging techniques is very difficult. In this paper we present a summary of the methods used for segmentation of the brain MRI image. The analysis includes a description of several segmentation algorithms ranging from simple threshold methods to high-level approaches to segmentation as deformable methods, classifier methods and graph-based approaches.

Keywords: Magnetic Resonance Imaging (MRI), image segmentation, graph cut, Edge detection, Thresholding, Clustering, Region Growing.

INTRODUCTION

Digital image processing has many recent uses in the areas of remote sensing, medicine, photography, creation of films and videos, and security monitoring. New innovative technologies are emerging in the fields of image processing, especially in the domain of image segmentation[1].

For subsequent quantitative analysis and qualitative visualization, image segmentation where regions of interest are delineated is important. Segmentation is the method of separating an image into sections that have a strong correlation with areas of image interest. The segmentation aim is to simplify or alter an image's representation into something that is more meaningful and easier to interpret. A variety of techniques exist for segmenting an image into homogeneous regions. Due to difficulty and inaccuracy not all of the methods are appropriate for medical image analysis. Difficulty and inaccuracy for medical image analysis are not all approaches suited. Brain is a part of the body's heart. Brain's composition is very complex. The brain is a fragile, sensitive and unreplaceable brain. MRI Magnetic Resonance Imaging is a method in medical imaging[2]. It was used by radiologists for the depiction of the internal body structure. MRI offers valuable knowledge about anatomy of human soft tissues and assists with brain tumor diagnosis. Where we can use MRI-obtained images to examine and study brain behavior. There is no standard technique for image segmentation that can yield satisfactory results for all imaging applications, such as brain MRI, brain cancer diagnosis etc. Optimum selection of characteristics, tissues, brain and non-brain elements are considered major obstacles for segmentation of the brain picture. The segmentation of MR brain image in the field of medical image processing is important because MRI is particularly suitable for brain studies due to its excellent comparison of soft problems, non-invasive characteristics and high spatial resolution. The challenge is accurate segmentation over the entire field of view. Operator control and manual thresholding are other obstacles to brain image segmentation. Verification of results is another source of difficulty during the segmentation process. Segmentation of the brain structure from magnetic resonance imaging (MRI) has been of paramount importance because MRI separates itself from other modalities and MRI can be used in the volumetric study of brain tissue such as multiple sclerosis, autism, depression, Parkinson's disease, Alzheimer's disease, cerebral atrophy, etc. There are many segmentation techniques available for medical imaging, particularly for brain MRI, such as mean shift, region growth, water shed, graph cuts, fuzzy connectivity etc.

Segmentation Methods:

There are many methods for segmentation of object / background which predate graph cuts. The block diagram of segmentation methods is shown in Fig.1:

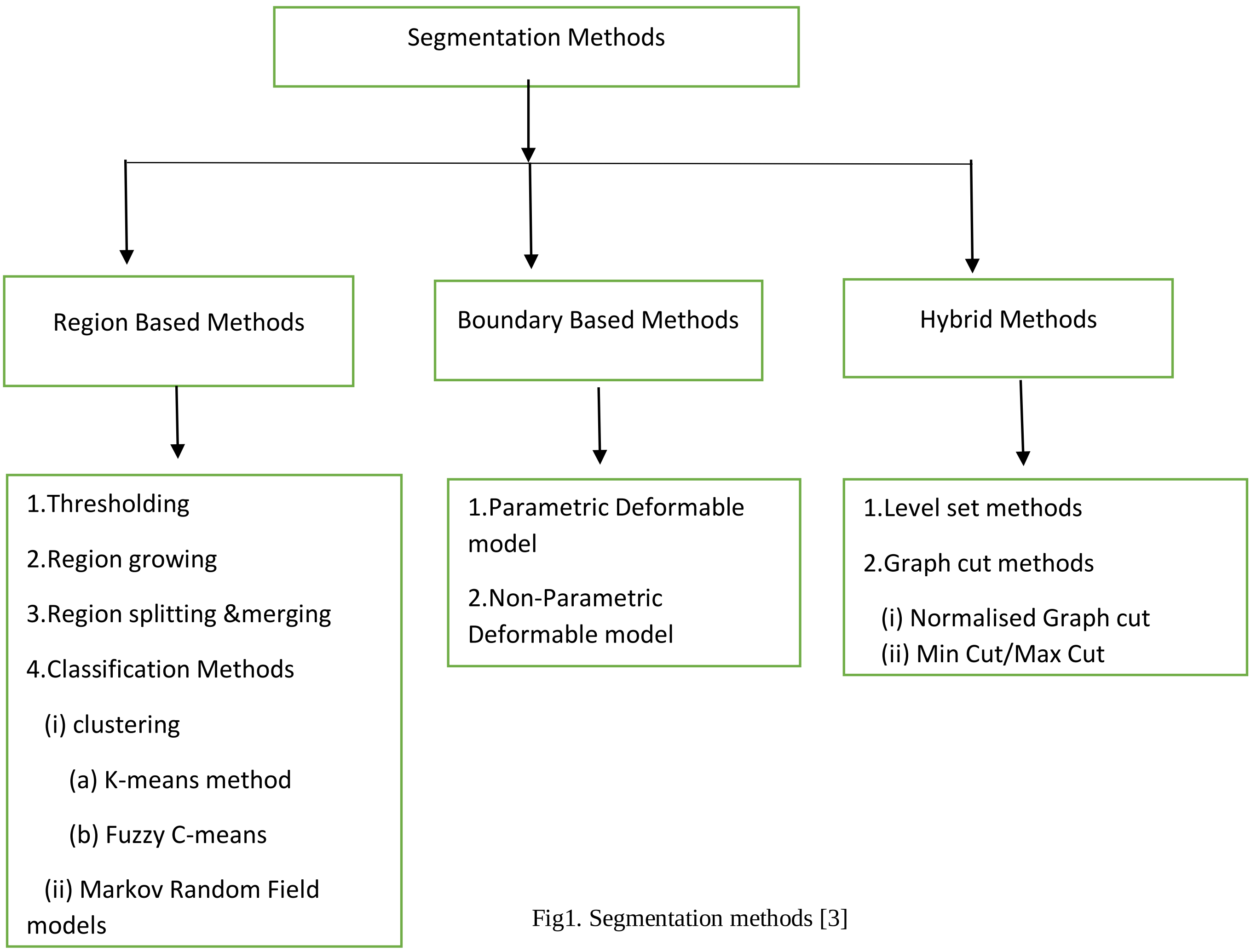

Fig1. Segmentation methods [3]

Methods based on region

Thresholding: Thresholding is one of the oldest Image segmentation techniques. This means that pictures are composed of regions of varying levels of gray. A thresholding technique defines a value of severity called the threshold, which distinguishes the groups desired. The segmentation is done by grouping all pixels in one class with intensity within two of these thresholds.

Thresholding is the easiest and fastest form of segmentation, often used to pre-process medical images and problems with pre-registration.

Growing Area: Growing region is a technique used to isolate a region of the picture that is connected based on certain predefined parameters. This criterion may be based on information about the strength and/or the edges of the image. In its simplest form, increasing region requires a seed point that is selected manually by an operator, and extracts all pixels connected to the initial seed with the same intensity value as thresholding, with a pixel or group of pixels known as seeds belonging to the focusing structure, the first step of this technique is started.

The primary drawback is that achieving the seed point requires manual intervention. Therefore, one seed must be planted for each area that needs to be harvested. An area can also be sensitive to noise, leading to holes in extracted regions or even disconnected.

Dividing and combining regions: The splitting and combining of regions is a hierarchical approach to image segmentation based on region. The method's dividing portion begins with the entire image considered as a single region. If the criterion of homogeneity for this region is not met, it is then divided into four sub-regions. On each sub-region, the homogeneity criterion is then evaluated, and those that do not meet the criterion are divided into four sub-regions.

Ways to classify: Classifier methods are pattern recognition techniques which use data with known labels to partition a feature space derived from the image. A characteristic space is the range space of any image object, with the image intensities themselves being the most common feature space.

A classifier is a type of inference engine that implements effective strategies for calculating subsumption relationships between pairs of concepts, or for calculating instance of relationships between a concept and a collection of instances.

A classifier drawback is that they do not generally perform any spatial modeling. In recent work extending classifier methods to segment images that are tainted by in homogeneities of strength, this limitation was discussed.

Clustering: In essence, clustering algorithms perform the same role as classifier methods without the use of training data. Therefore, they are called methods which are not supervised. Clustering methods iterate between segmenting the image and characterizing the properties of each class, to compensate for the lack of training data. The measure of similarity such as distance, connectivity and power, defines how the clusters form, depending on the nature of the data and the purpose for which clustering is being used.

K-means: We use the K-means clustering algorithm, which is an unsupervised method to provide us with a primary image segmentation. It is ideal for the segmentation of biomedical images as the number of clusters (K) is usually known for images of specific regions of human anatomy.

K-means algorithm is an unsupervised clustering algorithm which classifies the data points input into multiple classes based on their inherent distance from each other. The algorithm assumes the vector space is created by the data features and tries to find natural clustering within them.

Fuzzy c-means: Fuzzy c-means (FCM) clustering approach is a commonly used unattended pattern recognition tool for segmentation of multi-spectral MRIs. An image can be interpreted in various function spaces, and the FCM algorithm classifies the image by grouping similar data points into clusters in the function space. Such clustering is accomplished by minimizing iteratively a cost function that depends on the distance between the pixels and the cluster centers in the feature domain [4]. Fuzzy c-means (FCM) is popular method for segmentation of medical images due to few benefits.

Models of Markov Random Field: A Markov random field (MRF) is a model for the complete joint probability distribution of fixed random variables with the property of Markov. A Markov network resembles a Bayesian network in its dependency representation. It may represent certain dependencies which a Bayesian network cannot represent. On the other hand, it cannot represent certain dependencies which a Bayesian network can represent These are usually used in medical imaging, because most pixels belong to the same class as their neighboring pixels.

Limiting for MRF models is proper selection of parameters regulating the intensity of spatial interactions. A setting that is too large may result in overly smooth segmentation and a loss of important structural information.

Boundary related methods

Parametric deformable model: Deformable model is a powerful tool for segmentation of biomedical images. Medical images and volumes usually contain complex and irregular structures; thus it is more difficult to segment and depict these structures by local descriptors. Deformable models are used widely in medical imaging segmentation. We are used in MRI reconstruction of the cerebral cortex.

ADVANTAGES:

The main advantages of deformable models are their ability to generate directly closed parametric curves or surfaces from images and their inclusion of a smoothness constraint that provides noise and spurious edges with robustness.

DISADVANTAGES:

A downside is that they require manual intervention to position an initial model and pick the parameters that are necessary.

Non-Parametric deformable model: On the other hand, non-parametric deformable models are based on the theory of curve convolution and level set methods [5]. Curve and surface evolution is independent of parameterization and thus the topology changes can be done automatically, but they are more computationally expensive.

Hybrid methods

Level set methods: Level set methods provide a strong medical image segmentation and shape recovery solution because they can manage any of the cavities, concavities, convolution, separating, or merging. probability density function parameters can also be handled without the need for training data. Nonetheless, the method has shown impressive results for brain image segmentation; this method requires initial curves to be defined and can only produce good results if these curves are precisely symmetrical.

Graph cutting method: Graph cut optimization in the field of early vision has become widely accepted since it was introduced as an efficient means to minimize a larger class of energy functions [6]. Solving the problem of pixel marking is one of the most important energy minimization techniques in Computer Vision.

Graph-cutting is one of the advanced techniques of segmentation to efficiently address a wide range of brain tissue recognition. The graph cuts approach conducts energy minimization along with image smoothing.

The graph based segmentation approaches are based on the basic principle of graph partitioning. Where each approach treats an image as a graph G in which vertices consist of pixels, each edge has a commonly defined weight based on its vertices.

Uniform graph cut: The uniform cut is a global standard for segmenting graph used in image data instead of relying on local characteristics and consistencies. This algorithm is used as a criterion for the measurement of total dissimilarity among different groups and total similarity within groups. It can be applied to static general and medical imaging.

Min-cut / max-flow algorithm for graph cuts: Two redundant and non-overlapping search trees S from source s and T from sink t are provided with the min-cut / max flow algorithm. Tree S has path from parent node to kids and tree T has direction from kids to parent node. In S or T respectively, there may be active or passive nodes depending on the outer border and the inner border, free nodes being those not in S or T.

LITERATURE REVIEW

Sudharani, et al. [2015] The present paper proposed brain tumor scores for c1 classification and recognition using k-NN algorithm based on k training. In this work the c1assifier distance has been applied and measured by Manhattan metric. The algorithm was implemented using the View from the Bench.

Parveen and Singh [2015] proposed a new hybrid strategy for the classification of brain tumors based on support vector machine (SVM) and fuzzy c-means. The aim algorithm is a combination of vector supporting machine (SVM) and fuzzy c-means, a hybrid technique for brain tumor prediction. The picture is improved in this process using enhancement techniques such as contrast enhancement, and mid-range stretch. Fuzzy c-means (FCM) clustering is used to identify the suspect area in brain MRI image for image segmentation.

Bhima and Jagan[2016] demonstrated superior precision in the identification of brain tumors compared to the methodologies presented. The main defined bottleneck of recent research findings is also restricted to the identification of brain tumor and the overall study of the brain's internal structure is largely ignored as one of the most important factor for the diagnosis of disorders**.**

Pereira S, et al. [2016] Proposed an adaptive, deeper-architecture segmentation technique based on CNN. Early treatment leads to increased human life span. With this inspiration the author used MRI imaging technique to incorporate this automated technique. Intensity normalization was performed at the pre-processing level, applications were made on the BRATS 2013 database and CNN with data increase to effectively identify the images.

Mathew, A. R, et.al [2017] Proposed a system for the diagnosis and classification of brain tumors. Preprocessing of the MRI brain images was performed using Anisotropic Diffusion Filters. Tumor boundary identification was carried out using Otsu thresholding and morphological operators. In this study, extraction of the function was carried out using the Discrete Wavelet Transforms (DWT). The author has categorized the segmented area of the brain tumor into three categories: benign, mild, malignant, using the classifier Support Vector Machine (SVM). Standard algorithm doesn't yield satisfactory results.

Litjens G, et al. [2017] The study of deep learning methods used in the analysis of medical images was presented. In this study, the author summarized about more than 200 contributions which include breast, cardiac, neuro, gastrointestinal, retinal, musculoskeletal, pulmonary, etc. cancer studies.The review paper also dealt with the open problems and future research work.

J. Sachdeva, et al. [2017] The methodology was developed that used two datasets. The main purpose of this study was to establish an interactive method for classifying brain tumors to assist the radiologist in recognizing it.In this, the Genetic Algorithm was combined with SVM to find the preliminary likelihood of defining the tumor class as well as faster execution, and the results were compared with naïve ANN and SVM with ANN to improve the accuracy. 71 Elements include GLCM, LoG, DGTF, RICGF, SBF etc. GA was then used for selection of functions, and both GA-ANN and GA-SVM classifiers labelled the tumor regions. Improved precision has been obtained as a result.

Havaei M, et al. [2017] Presented an automated method for segmenting images of brain tumors using Deep Neural Networks (DNNs). CNN's methodology manipulated local characteristics as well as global contextual features. 2-phase training protocol for treating imbalances of tumor image labels was used. BRATS 2013 has been used as dataset to test the proposed methodology's architecture. This technique has been in the literature 30 times faster than other current methods.

Saed Khawaldeh, et al. [2017] Discussed the process for splitting brain MRI images into two groups using the Convolutional Neural Network (CNN or ConvNet). The abnormal brain images are further sub-classified into high-grade and low-grade images of the tumors. Though this method was useful for classifying the brain tumor, it needed more data images, which was one of CNN's drawbacks. At last, an accuracy rate of 91.16 per cent was reached.

Mohan G, et al. [2018] Had studied tumor segmentation and brain tumor MRI image grading techniques. Different approaches to machine learning were explored for diagnosing the brain tumor. The author also spoke about the hybrid approaches to improve the diagnostic accuracy. This addressed future developments, state-of - the-art, recent tumor segmentation patterns and classification.

Archa, S. P. et.al [2018] Suggested brain tumor segmentation strategy in MRI images. In this approach, the method of intensity normalization and the Median filter were used as a technique for pre-processing. The critical step was precise edge detection to work for applications such as nano robotic surgery and keyhole. To increase the accuracy rate of edge detection, canny method of edge detection was used. For the purpose of classification, the Convolutional Neural Network was used. To eliminate the intensity-inhomogeneity from the entire system, the author used histogram equalization. Edge detection was used to remove contours from objects. Efficient treatment preparation and diagnosis in this proposed method will improve the health of oncological patients.

Reddy, D, et.al [2018] Suggested unconstrained growth of abnormal brain cells known as Brain Tumor. Magnetic Resonance Imaging (MRI) was used as an imaging of the data. Photo pre-processing technique was used to avoid noise type. The MRI images were preprocessed with Median Filter. During the segmentation process K-Means Clustering and Thresholding was used to segment the images. This technique was effective when identifying the tumors and the irregular cells were bounded in images of MRIs other than the complicated tumor form as shown in the experimental results. It is also possible to extract additional features to make the device more texture-sensitive and other variables.

Islam, M. R, et.al [2018] Proposed a method for detecting brain tumors using an integrated HOG thresholding and morphological operation procedure. A computer-aided image processing based approach was used in this, which enhanced the accuracy in brain tumor detection. This technique is suitable only for pictures which are less noisy and clear. The accuracy rate was also improved as compared to previous researches.

Adriano Pinto, et.al [2018] Proposed an approach to hierarchical classification by segmenting brain tumors found in MRI images. Because of the heterogeneity of MRI images, the sensitivity normalization method and bias field correction were applied inside the pre processing. Data augmentation technique was applied for the Low-Grade Glioma (LGG) subjects. The tumor segmented area was classified using the Extremely Randomised Forest (ERT) method. Better tumor recognition and delineation were accomplished with the aid of applying a two-step classification method along with large tumor tissue differentiations.

D. Jude Hemanth, et.al [2019] Proposed development of the general GA strategies so as to enhance the random nature of the conventional GA. The Grey Level Difference Method (GLDM) extracted higher order statistical features (contrast, cluster hue, energy, entropy, variance, correlation, similarity, skewiness, etc.). Back Propagation neural network was used for the purpose of classifying tumours. And measuring precision, sensitivity and specificity was done. The updated GA techniques were rendered with misunderstanding matrix like TP, TN, FP, and FN.

Mohammad Hesam Hesamian[2019] Deep learning-based segmentation of images is now firmly established as a robust tool for segmenting images. It has been commonly used as the first and essential portion of the diagnosis and treatment pipeline to distinguish homogeneous areas. In this article we present a critical assessment of popular methods that used deep-learning techniques for segmentation of medical images. In addition, we 're summarizing the most common challenges and suggesting possible solutions.

Shervin Minaee[2020] Image segmentation is a key topic in image processing and computer vision with, among many others, applications such as scene understanding, medical image analysis, robotic perception, video surveillance, augmented reality and image compression. Diverse image segmentation algorithms have been developed in the literature. Recently, due to the success of deep learning models in a wide range of vision applications, a large number of works have been conducted to establish approaches to image segmentation using deep learning models.

PROPOSED WORK

Brain tumor extraction and its analysis are challenging tasks in Medical image processing because brain image is complicated. Segmentation plays a very important role in the medical image processing. MRI has become a useful medical diagnostic tool for the diagnosis of brain

& other medical images. Manual segmentation of brain tumors for cancer diagnosis from a large number of MRI images produced in the clinical routine is a complex and time-consuming process. Automatic segmentation of the brain tumor image is required. Automatic segmentation using deep learning methods has recently proved popular, as these methods deliver state-of-the-art results and can address this problem better than other methods. Deep learning methods may also allow effective analysis and unbiased evaluation of large quantities of MRI-based image data. In this research work, we are working on deep learning approaches for segmentation of sub tumoral region including complete, core and enhance tumor.

OBJECTIVES

(1) Select MRI image from image database.
(2) MRI image filtering using wavelet Transform.
(3) Create optimized classifier with different deep learning approaches for segmentation of sub tumoral region including complete, core and enhance tumor.

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 given below:

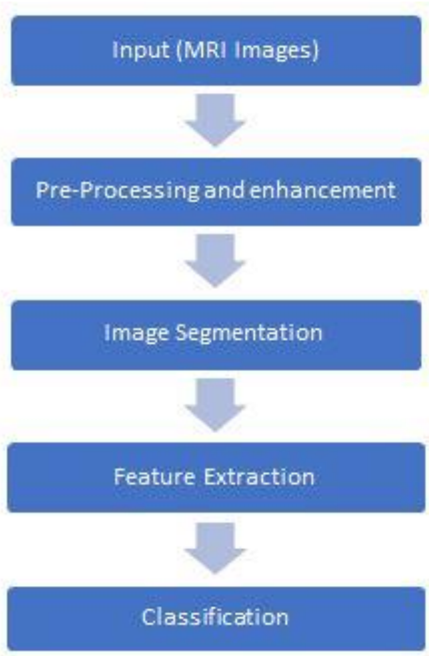

Fig2. Flow chart of the methodology

CONCLUSION AND FUTURE WORK

For the last few decades, segmentation of images has been an active research area. No particular process that can best handle all the anatomical structures in the segmentation of medical images. In this paper a study addressed the methods of segmentation. Every approach may use other methods in order to serve an intermediate function. Medical image segmentation can be divided into two classifications: a) manual, semi-automatic, and automatic; b) local method based on pixels and global method based on region. Brain MR Image is a complex system with an efficient method for allowing variable tissue types to be segmented.

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