BRAIN TUMOR SEGMENTATION AND QUANTIFICATION FROM MRI OF BRAIN

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Abstract: Detection of Brain tumour is the most common fatality in the current scenario of health care society. Computational applications are 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. Automated brain disorder diagnosis with MR images is one of the specific medical image analysis methodologies. Image segmentation is used to extract the abnormal tumour portion in brain. This paper explores a method to identify tumor in brain disorder diagnosis in MR images.

Keywords: Tumor Detection, Segmentation, Diagnosis techniques, and Brain MRI

INTRODUCTION

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 detection of the abnormalities in medical images is an important and sometimes necessary procedure in medical diagnostics, planning, and treatment.

While detection of abnormalities such as tumor is possible by experts, manual segmentation is usually tedious and time consuming and subject to error. There are many methods that find a tumor in MR images (MRI) semi automatically. In such methods, human intervention is required, which again makes the process time consuming and expensive. The critical problem is finding the tumor location automatically and later finding its boundary precisely. An important factor in detecting tumor from healthy tissues is the difference in intensity level. However, relying only on the intensity level is usually not enough. The spatial information available in clusters of pixels that form a tumor should also be used in the detection process.

Segmentation of MR images into different tissue classes, especially gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF), is an important task.

A tumor or tumor is the name for a neoplasm or a solid lesion formed by an abnormal growth of cells which looks like a swelling. Tumor is not synonymous with cancer. A tumor can be benign, pre-malignant or malignant, whereas cancer is by definition malignant. A benign tumor is a tumor that lacks all three of the malignant properties of a cancer. Thus, by definition, a benign tumor does not grow in an unlimited, aggressive manner, does not invade surrounding tissues, and does not spread to non-adjacent tissues (metastasis). Common examples of benign tumors include moles and uterine fibroids.

Malignancy (from the Latin roots mal- = "bad" and -ignis = "fire") is the tendency of a medical condition, especially tumors, to become progressively worse and to potentially result in death. It is characterized by the properties of anaplasia, invasiveness, and metastasis. Malignant is a corresponding adjectival medical term used to describe a severe and progressively worsening disease. The term is most familiar as a description of cancer.

A precancerous condition (or premalignant condition) is a disease, syndrome, or finding that, if left untreated, may lead to cancer. It is a generalized state associated with a significantly increased risk of cancer. 

Brain tumor segmentation and quantification from MR images is a challenging task. The boundary of a tumor and its volume are important parameters that can have direct impact on surgical treatment, radiation therapy, or on quantitative measurements of tumor regression rates. The location of tumors in the brain is one of the factors that determine how a brain tumor affects an individual's functioning and what symptoms the tumor causes. The part of the image that has the tumor has more intensity in that portion and we can make our assumptions about the radius of the tumor in the image, these are the basic things considered in the algorithm.

First of all some image enhancement and noise reduction techniques are used to enhance the image quality, after that...
some morphological operations are applied to detect the tumor in the image. The morphological operations are basically applied on some assumptions about the size and shape of the tumor and in the end the tumor is mapped onto the original gray scale image with 255 intensity to make visible the tumor in the image. The algorithm has been tried on a number of different images from different angles and has always given the correct desired result.

**REVIEW WORKS**

There have been significant efforts to develop automated computer algorithms for locating tumors in brain MRI. A review of pattern recognition methods for MRI segmentation is presented in [1], and methods and applications of MRI segmentation can be found in [3]. Among supervised methods, the work [6] combines information from a registered atlas template and user input to train a supervised classifier. The method in [7] detects tumors based on outlier detection and uses affine transformation for the registration. However, this method fails in case of large tumors. The method described in [8] is based on training on healthy brain images instead of training on pathology. Torecognize deviations from normalcy, a multi-layer Markov random field is used which is computationally expensive. In the work reported in [4], the authors employ an atlas based pathological segmentation using affine transformation. They assume tumor growth has a radial expansion from its starting point. All of the above methods are time consuming, and also need expert input for large set of data. Supervised pattern recognition methods have exhibited problems with reproducibility [2], due to significant intra and inter-observer variance introduced over multiple training trials.

The unsupervised method reported in [9] divides the T2 weighted images into few blocks, and calculates the number of edges, the intensity and the contrast parameter in each block. It assumes the abnormalities occupy less than 10% of all pixels, and that the blocks containing tumor pixels exhibit fewer edge pixels. However, tumor may fall in different blocks, making parts of the tumor un-detectable. In another method, colour-based clustering is used [10]. The MR image is translated to RGB, and RGB to L*a*b* planes. K-means clustering [12] is used on a* and b* planes to find thresholds and mark the tumor. The issue with such methods is that they rely on intensity level classification, which is susceptible to misclassification. In this paper, an approach toward tumor detection and segmentation is introduced.

An analysis on filtering techniques such as Gabor & QMF filters for noise reductions performed by [11]. These primitive methods along with reducing the noise blur the important and detailed structures necessary for subsequent steps. The colour ray casting method to differentiate the region of interest from the background is implemented by [12]. But this technique is image dependent and not applicable for gray level images. Expectation maximization segmentation (EMS) software package is also used for image pre-processing [13]. The main advantage of this technique is that it is a fully automatic technique. Diffusion filtering combined with simple non-adaptive intensity thresholding is used to enhance the region of interest [14]. The main drawback of this technique is the non-adaptive nature of the threshold value. Fuzzy connectedness-based intensity non-uniformity correction has been implemented by [15]. A sequential approach with fuzzy connectedness, atlas registration and bias field correction is used in this approach. The conclusions revealed that the proposed technique can be used only if the intensity variations between the images are of a limited range. The effect of inter-slice intensity variations minimized with the weighted least square estimation method [16]. The selection of weights for the least square method is the major disadvantage of this approach. The noise removal technique using wavelets and curvelets is implemented in [17]. Hybrid approaches involving Variance Stabilizing Transform (VST) are also used in this work. But this technique is applicable for images with Poisson noise. Tracking algorithm based de-noising technique is performed by [18].

Since the seed point for tracking is random in nature, this technique is not much efficient. A contrast agent accumulation model based contrast enhancement is implemented by [19]. This improves only the contrast of the image and the unwanted tissues are not eliminated. The wiener filtering technique for noise removal in MR brain images is used in [20]. Apart from noise removal, several other pre-processing steps are also reported in the literature.

This includes image format conversion, image type conversion etc. The combination of three modalities of MR images for further processing is proposed in [21]. All the above mentioned techniques remove only specific artifacts which is not sufficient for high classification accuracy and segmentation efficiency. Apart from eliminating the noises, for the removal of unwanted tissues such as the skull tissues in MR images are highly essential for accurate identification of the diseases.

Pathology identification is performed by the image classification technique and then the treatment is planned based on the nature of abnormality. After treatment, it is highly essential to estimate the response of the patient to the treatment. In case of brain tumor abnormalities the size of the tumor may decrease which indicates a positive effect and sometimes it may increase which shows a negative effect. In any case, it is important to perform a volumetric analysis on MR brain tumor images. Image segmentation covers this objective by extracting the abnormal portion from the image which is useful for analysing the size and shape of the abnormal region. This method is also called as “pixel based classification” since the individual pixels are clustered unlike the classification techniques which categorizes the whole image. Several research works are reported in the area of medical image segmentation.

**PROPOSED WORK**

The part of the image containing the tumor normally has more intensity then the other portion and we can assume the area, shape and radius of the tumor in the image. We have used these basic conditions to detect tumor in our code and the code goes through the following steps:
In preprocessing some basic image enhancement and noise reduction techniques are implemented. Apart from that different ways to detect edges and doing segmentations have also been used. The purpose of these steps is basically to improve the image and the image quality to get more surety and ease in detecting the tumor. The basic steps in preprocessing are the following:- Image is converted to gray scale image in first step. Noise is removed if any. The obtained image is then passed through a high pass filter to detect edges. Then the obtained image is added to original image to enhance it.

In processing the following steps are followed:-

Segmentation is done on basis of a threshold, due to which whole image is converted into binary image. Basic matlab commands for threshold are used for this segmentation.

It is the best method to segment an image to separate a tumor but it suffers from over and under segmentation, due to which we have used it as a check to our output. We have not used watershed segmentation on our input, rather it is only used on our output to check of the result is correct or not and it give the correct answer every time as is shown below.

Morphological operations are applied on the image after converting it into binary form. The basic purpose of the operations is to show only that part of the image, which has the tumor that is the part of the image having more intensity and more area. The algorithm is given below.

**Algorithm**

**Input:** MRI Gray Scale Image

**Output:** Isolation of Tumor

Step1: Convert MRI scan image into grayscale image.

Step2: Next the image passed through a high pass filter for removing noise and other spike in the image.

Step3: Now filtered image is added to the grayscale image.

Step4: Convert the enhanced image (image of step3) in to binary image with a threshold value.

Step5: Separate the tumor from segmented image by Watershed - Method.

Step6: Select only that part of the image from step4 which has the tumor with the part of the image having more intensity and more area.
Step 7: Obtained image from step 6 are added to the original gray scale image from step 1 and the resultant image is output.

**RESULTS**

Watershed segmentation uses the intensity as a parameter to segment the whole image data set. Moreover, the additional complexity of estimation imposed to such algorithms causes a tendency towards density dependent approaches.[2]. Three-dimensional-segmentation is a reliable approach to achieve a proper estimation of tumor volume. Among all possible methods for this purpose, watershed can be used as a powerful tool, which implicitly extracts the tumor surface. Watershed segmentation based algorithm has been used for detection of tumor in 2D and in 3D.

Recent advances in medical image analysis often include processes for an image to be segmented in terms of a few parameters and into smaller sizes or regions, to address the different aspects of analysing images into anatomically and pathologically meaningful regions. Classifying regions using their multi parameter values makes the study of the regions of physiological and pathological interest easier and more definable. Here, multi parameter features refer to the following three specific values for the edges (E), gray values (G), and local contrast (H) of the pixels.

As watershed segmentation technique segregates any image as different intensity portions and also the tumorous cells have high proteinaceous fluid, which has very high density and hence very high intensity, therefore watershed segmentation is the best tool to classify tumors and high intensity tissues of brain. Watershed segmentation can classify the intensities with very small difference also, which is not possible with snake and level set method.

We have mapped the resultant tumor image onto the original grayscale image for presentation purposes. The method presented here is user friendly and doctor can select the brain image from the menu screen and find out enhanced image and portion of the tumor.
CONCLUSIONS

The results show that Watershed Segmentation can successfully segment a tumor provided the parameters are set properly in MATLAB environment. This paper explores a method to identify tumor in brain disorder diagnosis in MR images.

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