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Tumor Identification Using Binary Thresholding in MRI Brain Images

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Abstract

Imaging plays a very important role in diagnosis and treatment planning of brain tumor. Accurate segmentation is critical, especially when tumor morphological changes remain subtle, irregular and difficult to assess by clinical examination. Traditionally, tumor segmentation from magnetic resonance imaging data is important but time consuming task which is manually performed by medical experts. Here, automating this process is a challenging task because of high diversity in the appearance of tumor tissues among different patients and in many cases it has similarity with normal tissues. Magnetic resonance imaging is an advanced medical imaging technique which provides rich information about human soft tissue anatomy. The automatic tumor segmentation in MRI tumor poses many challenges with regard to characteristics of an image. Homogeneity criterion method is undertaken to analyze and evaluate whether the tumor is malignant or non-malignant.

Keywords: Homogeneity criterion.

Introduction

Brain tumors are the second leading cause of cancer death in children under the age of 15 and young adults up to age of 34 and these tumors are also the second fastest growing cause of cancer death among humans older than age of 65.

A brain tumor is an intracranial solid neoplasm, a tumor with in the brain or the central spinal cord. Brain tumors include all tumors inside the cranium. These tumors are created by an abnormal and uncontrolled cell division usually in the brain itself. Brain tumor takes up space with in the skull and can interfere with normal brain activity. It can increase pressure in brain, shift the brain and push it against the skull , invade and damage nerves and healthy brain tissue. There are more than 120 different types of brain tumors [1]. Today, the most medical institutions use the World Health Organization (WHO) classification system to identify the brain tumors. The WHO classifies brain tumor by cell origin and how the cells behave. The classification starts from the least aggressive (benign) to the most aggressive (malignant) [1-2].

The location of brain tumor influences the different types of symptoms that occur. Brain tumors may have different types of symptoms ranging from headache to stroke. The possible symptoms of brain tumor include change in behavior, headache, infertility, troubles that seem to be caused by other diseases. Early detection and correct treatment based on accurate diagnosis are the most important steps to improve disease outcome. The type of brain scan that doctor performs if patient has brain tumor is called MRI scan or CT scan [5]. Currently, magnetic resonance imaging (MRI) is the most important tool to identify the location, size and type of brain tumor. Tissue usually becomes dense when diseased. The surrounding tissues are pulled towards the cancerous region, resulting in distortion. Tumors are examined for location, shape, size, density and margins. Higher density is usually indicator of malignancy, while lucent- centered lesions are usually of type benign. Cancerous lesions generally have more irregular shape than the benign lesions. Mostly, benign tumors are circumscribed, compact and roughly elliptical and malignant lesions usually have a blurred boundary and an irregular appearance [2].

The brain tissue and tumor segmentation in magnetic resonance images has been an active area of research in present day. Segmentation is the process of partitioning digital image into multiple segments. The segmentation task becomes more challenging to derive common decision boundaries on different object types [6]. The complex structure of different tissues such as white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF) in the brain images, extraction of useful feature is a fundamental task. Intensity is the important feature in discriminating different tissue and it also segments complex brain structure [5-6].

Nowadays, detection of anatomical brain structures with their exact location is an important task in the diagnosis of brain tumor. The anatomical

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brain structure plays an important role in analysis of various treatments including radiation therapy and surgery. Currently, in most of hospitals, the radiologists performs the diagnosis of brain tumor manually on MR images, this process is error prone, in particular because of large number of image slices of single patient and due to large variation in the intensity of various images representing different brain structures. In past 20 years, several techniques have been developed by researchers to identify anatomical brain structures. But most o them have their own limitations and none of them has gained wide popularity in this field. Some of the techniques are histogram based, compression based, edge detection, clustering and basic watershed segmentation [8-10].

Histogram based technique is very efficient when compared to other image segmentation methods, it is used to locate clusters in the image. The main disadvantage of this technique is it is difficult to identify significant peaks and valleys in this image. Compression based method postulate that optimal segmentation is the one that minimizes, overall possible segmentations, the coding length of the data. Edge detection technique works effectively on high contrast images and this method fails in low contrast images due to weak gradient magnitude [1-2].Similarly, the clustering based method (K- means algorithm) has a fast speed which allows it to run on large datasets and disadvantage of this is it does not produce same result with each run, because resulting clusters depend on initial random assignments. Morphological watershed segmentation method produces over segmentation. A new marker based watershed algorithm requires less processing time and minimize the over segmentation problem. The level set approach is used as another powerful tool for MRI brain tumor segmentation to achieve accurate estimation of the area [7-10].

The manual method is gold standard approach for MRI quantitative measurements. The main disadvantage of this manual method is that it is labour intensive and time consuming. In the case of MRI segmentation, the uncertainty is introduced due to factors such as partial volume effects, integration of multi-protocol image data and observer variability. The challenging problem in medical images is segmentation of region of interest. The technique used to remove partial volume effects and to incorporate gradient information for more accurate boundary detection is Homogeneity criterion technique [5-7] .

Types of noises such as irregularities and these noises may degrade the quality of the image, consequently it cannot provide correct information for subsequent image segmentation and edge

The segmentation task can be of region based or edge based. The majority of MRI- based segmentation methods in the literature are region-based. The recent methods involving the deformable models also come under edge based category. In the case of MRI segmentation, uncertainty is introduced because of the factors such as partial volume effects and integration of multi – protocol image data and observer variability. Most of the segmentation methods appear in statistical framework, providing a classification of image data into different tissue types, whereas there exist only a few using deterministic approach. It is difficult to find which is the best method for tumor segmentation results which is made available from MRI data [8-9].

Angelini et al proposed a longitudinal method for quantification of low- grade glioma evolution by resorting to nonlinear image normalization and direct difference comparison and the need for specific tumor segmentation to be avoided. Alternatively, notions for fuzzy segmentation are used in recent works of khotanlou et al and Dou et al. The physicians dream of clicking a point to run a software tool for the dynamic parameters of the tumor of each and every patient from two or more successive MRI data sets [1-2]. The passage from dream to reality demands that the process must pass through three steps. They are determination of the real tumor growth by semi-automated or automated segmentation, registration with the virtual brain and resolution of the inverse problem. Currently, the clinical and mathematical analysis of glioma dynamics is still in its infancy, but given the advances in both clinical imaging and computer modelling, it should play a important role in the future neuro - oncological practice [6-7] .

M. Sato et al., developed a suitable modification in the region growing technique. Current survey proves that region growing is the effective approach for image segmentation especially for the homogenous regions. The main disadvantage of region growing is the partial volume effect and this limits the accuracy of MRI brain image segmentation. This blurs the intensity distinction between tissue classes at the border of the two tissue types because the voxel may represent more than one kind of tissue types. This method is called Homogeneity criterion [7-10].

The proposed scheme includes Data processing, Image smoothing, Image contrast enhancement [1-2]. In data processing MRI images are subject to various

detection. Preprocessing is also needed in order to homogenize and separate the intensity distributions of the malignant and benign tissues. Image smoothing acts as pre-processing step for image

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segmentation, as almost all of the image suffers from problem of noise effects. Poor contrast is usually one of the most common defects found in acquired image and this improves the visualization of original image and thus makes the object of interest more clearly visible [6-8].

Methodology

The Homogeneity criterion method should be done stepwise. In the first step proper threshold is chosen in order to distinguish the interior area from the other organs in the MR image dataset. The Homogeneity criterion method is applied, in which gradient magnitude is computed by Sobel operator and employed as definition of homogeneity criterion. This implementation allows stable boundary detection when the gradient suffers from the intersection variations and gaps. The accuracy of segmentation is increased by analyzing gradient magnitude, the sufficient contrast present on the boundary region. To calculate the size of segmented tumor the relabelled method based on remaps the labels associated with object in a segmented image such that the label numbers are made consecutive with no gaps between the label numbers used [3-4].
The extraction of any object can be done from the relabelled output using a binary threshold. The algorithm is adjusted to extract and relabelled the tumor and then find its size in pixels. The algorithm works well in two stages. The first stage is to determine the input image labels and find the number of pixels in each label. The second stage is to find the output requested region to get total number of pixels accessed. Segmented areas are automatically calculated to get the desired tumor area per slice [3-5}.

Algorithm

Homogeneity criterion

1. First take MRI scan image and convert it into gray scale image.
2. Creates a flat, disk-shaped structuring element SE, where R specifies the radius.
3. Next, performs morphological opening on the grayscale or binary image IM with the structuring element SE.
4. Take the size of processed image in the [m n] matrix form.
5. Now choose one threshold value.
6. Do for all pixel values as following
   a. Collect the pixel values.
   b. If pixel value is less than threshold
      then
      make it pixel value as 'zero'.
      else
      make it pixel value as '255' .
      end if
7. Display the final image (threshold) using 'imshow'.
8. Display the grayscale image I using imtool (I) for pixel information of ROI (Region Of Interest).

Results

Datasets

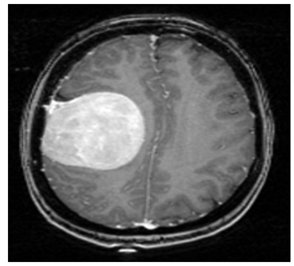


Fig.1

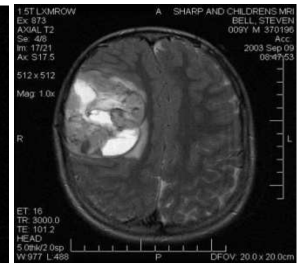


Fig.2

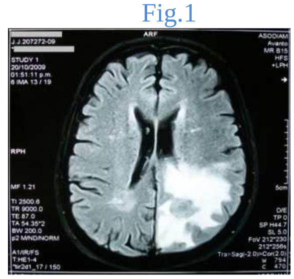


Fig.3

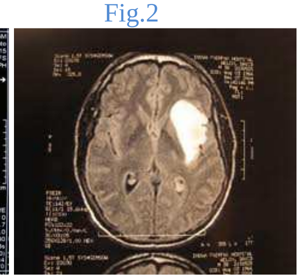


Fig.4

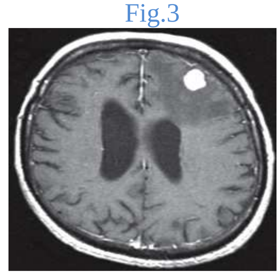


Fig.5

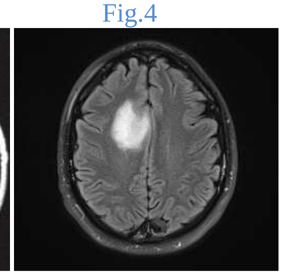
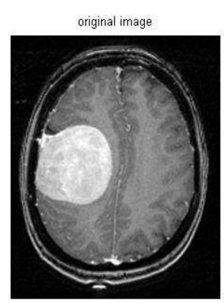
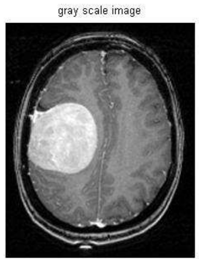


Fig.6

Analysis of Dataset

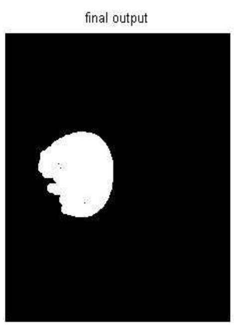


A



B

C



D

Here we considered the result of Fig.1 in dataset.

A. Input image
B. Gray Scale converted Image
C. Morphological opening of the image
D. Location of the tumor and ROI

Discussion

The image A is the original dataset, image B is the gray scale converted image. Gray scale is an image in which each the value of each pixel is a single image which carries only intensity information. Image C shows the morphological opening of the image. Morphology is a broad set of image processing operations that process images based on their shapes. In morphological operations structuring element is applied to an input image, creating an output image of the same size. The morphological operation shows that the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. Image D shows the exact location of the tumor and ROI(Region Of Interest).

The algorithm is implemented on personal computer (2.53 GHz, 3GB RAM). The original image is semi automatically segmented and the results are shown below. We have introduced this segmentation approach for MR images and investigate its application to the detection of region of interest in MR images.

Conclusion

Imaging plays a very important role in the diagnosis and treatment planning of brain tumor. Tumor area is an important diagnostic indicator in treatment planning and results assessment for the brain tumor. The measurement of the brain tumor area can assist tumor staging for effective treatment surgical planning. The measurement of tumor area using manual method is although gold standards approach but it is labour intensive and time consuming. It involves tracing the tumor outline and tumor area is derived by the summation of total slices area. If the process is done by radiologists or by a technologist, there is always and important element of subjectivity that results in both intra and inter-operator performance. The Computer- aided diagnosis system of brain tumors has great clinical significance for alleviating doctor’s pressure and reducing misdiagnosis rate.

The Homogeneity criterion technique is a semi-automatic segmentation method. In the study of reliability of brain tumor area measurements, we quantitatively compare the expert manual trace method with semi automatic segmentation method. The semi- automatic segmentation technique required very less time to generate tumor area measurements than the manual method. Manual method is highly labour intensive and required more concentration to do well than semi- automatic method. This is the main benefit of method and this method gives better results of all.

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