International Journal of
Emeraina Research in Manaaement &Technoloav

Research Article | **April 2014**

Detection of Brain Tumor Using Different Edge Detection Algorithm

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Abstract:

Although edge information is the main clue in image segmentation, it can't get a better result in analysis the content of images without combining other information. The segmentation of brain tissue in the magnetic resonance imaging (MRI) is very important for detecting the existence and outlines of tumors. In the paper, an algorithm about segmentation based on the symmetry character of brain MRI image is presented. Our goal is to detect the position and boundary of tumors automatically. Experiments were conducted on real pictures, and the results show that the algorithm is flexible and convenient.

Keywords: Brain, Image segmentation, MRI spatial atlas, Bilateral Symmetry, Tumor

I. INTRODUCTION

During the image processing, edge information is the main clue in image segmentation. But, unfortunately, it can't get a better result in analysis the content of images without combining other information. So, many researchers combine edge information with some other methods to improve the effect of segmentation. Nowadays, the X-ray or magnetic resonance images have became two irreplaceable tools for tumors detecting in human brain and other parts of human body [4][5]. Although MRI is more expensive than the X-ray inspection, the development of its applications becomes faster because of the MR inspection does less harm to human than X-ray's. Segmentation of medical images has the significant advantage that interesting characteristics are well known up to analysis the states of symptoms. The segmentation of brain tissue in the magnetic resonance imaging is also very important for detecting the existence and outlines of tumors. But, the overlapping intensity distributions of healthy tissue, tumor, and surrounding edema makes the tumor segmentation become a kind of work full of challenge. Supported by the National Natural Science Foundation of China, under Grant No. 40471101 and Jiang Suprovince Education Foundation of China, under Grant No. 05KJD170109. In this paper, we make use of symmetry character of brain MRI to obtain better effect of segmentation. Our goal is to detect the position and boundary of tumors automatically based on the symmetry information of MRI.

II. RELATED WORK

In most of time, the edge and contrast of X-ray or MR image are weakened, which leads to produce degraded image. So, in the processing for this kind of medic image, the first stage is to improve the quality of images. Many researchers have developed some effective algorithms about it [4] [5] [6].

After the quality of image been improved, the next step is to select the interesting objects or special areas from the images, which is often called segmentation. Many techniques have been applied on it. In this paper, we mainly discuss the brain tumor segmentation from MRI.

For now, there are also some very useful algorithms, such as mixture Gaussian model for the global intensity distribution [7], statistical classification [8], texture analysis [9], neural networks [10] and elastically fitting boundaries [11], etc. An automatic segmentation of MR images of normal brains by statistical classification, using an atlas prior for initialization and also for geometric constraints was introduced in [12].

Even through, Brain tumors is difficult to be modeled by shapes due to overlapping intensities with normal tissue and/or significant size. Although a fully automatic method for segmenting MR images presenting tumor and edema structures is proposed in [13] [14], but they are all time consuming in some degree. As we know, symmetry is an important clue in image perception. If a group of objects exhibit symmetry, it is more likely that they are related in some degree. So, many researches have been done on the detection of symmetries in images and shapes [15] [16] [17].

In our applications, we developed an algorithm based on bilateral symmetry information of brain MRI. Our purpose is to detect the tumor of brain automatically. Compared with other automatic segmentation methods, more effective the system model was constructed and less time was consumed.

- **Some Research Work:**
  - In the quantitative analysis of brain tissues, in magnetic resonance (MR) brain images, segmentation is the preliminary step. In this paper first we analyzed and compared various techniques used for Brain Image segmentation. Further it introduces an automatic model based technique for brain tissue segmentation from cerebral magnetic resonance (MR) images by using support vector machine (SVM) based classifier. A new and powerful kind of supervised machine learning with high generalization characteristics, is employed SVM. An iterative process is used for brain segmentation, so that the probabilistic maps of brain tissues will be updated at any iteration.[3]

- Manual segmentation of brain tumors from magnetic resonance (MR) images is a challenging and time-consuming task. The authors have developed an automated system for brain tumor segmentation that provides objective, reproducible segmentations that are close to the manual results. Additionally, the method segments white matter, grey matter, cerebrospinal fluid, and edema. The segmentation of pathology and healthy structures is crucial for surgical planning and intervention. The method performs the segmentation of a registered set of MR images using an Expectation-Maximization scheme. The segmentation is guided by a spatial probabilistic atlas that contains expert prior knowledge about brain structures. This atlas is modified with the subject specific brain tumor prior that is computed based on contrast enhancement.[7]
- A new approach for detection of brain tumor boundaries in medical images using a Hopfield neural network. The boundary detection problem is formulated as an optimization process that seeks the boundary points to minimize an energy functional based on an active contour model. A modified Hopfield network is constructed to solve the optimization problem. Taking advantage of the collective computational ability and energy convergence capability of the Hopfield network, our method produces the results comparable to those of standard "snakes"-based algorithms, but it requires less computing time. With the parallel processing potential of the Hopfield network, the proposed boundary detection can be implemented for real time processing. Experiments on different magnetic resonance imaging (MRI) data sets show the effectiveness of our approach.[11]
- A color image edge detection algorithm is proposed in this paper using Pseudo-complement and matrix rotation operations. First, pseudo-complement method is applied on the image for each channel. Then, matrix operations are applied on the output image of the first stage. Dominant pixels are obtained by image differencing between the pseudo-complement image and the matrix operated image. Median filtering is carried out to smoothen the image thereby removing the isolated pixels. Finally, the dominant or core pixels occurring in at least two channels are selected. On plotting the selected edge pixels, the final edge map of the given color image is obtained. The algorithm is also tested in HSV and YCbCr color spaces. Experimental results on both synthetic and real world images show that the accuracy of the proposed method is comparable to other color edge detectors. All the proposed procedures can be applied to any image domain and runs in polynomial time.[18]
- Symmetry detection and analysis in 3*D* images is a fundamental task in a gamut of scientific fields such as computer vision, medical imaging and pattern recognition to name a few. In this work, we present a computational approach to 3*D* symmetry detection and analysis. Our analysis is conducted in the Fourier domain using the pseudo-polar Fourier transform. The pseudo-polar representation enables to efficiently and accurately analyze angular volumetric properties such as rotational symmetries. Our algorithm is based on the analysis of the angular correspondence rate of the given volume and its rotated and rotated-inverted replicas in their pseudo-polar representations. We also derive a novel rigorous analysis of the inherent constraints of 3*D* symmetries via groups-theory based analysis. Thus, our algorithm starts by detecting the rotational symmetry group of a given volume, and the rigorous analysis results pave the way to detect the rest of the symmetries. The complexity of the algorithm is $O(N^3\log¿(N))$, where $N\times N\times N$ is the volumetric size in each direction. This complexity is independent of the number of the detected symmetries. We experimentally verified our approach by applying it to synthetic as well as real 3*D* objects.[15].
- Combining image segmentation based on statistical classification with a geometric prior has been shown to significantly increase robustness and reproducibility. Using a probabilistic geometric model of sought structures and image registration serves both initialization of probability density functions and definition of spatial constraints. A strong spatial prior, however, prevents segmentation of structures that are not part of the model. In practical applications, we encounter either the presentation of new objects that cannot be modeled with a spatial prior or regional intensity changes of existing structures not explained by the model. Our driving application is the segmentation of brain tissue and tumors from three-dimensional magnetic resonance imaging (MRI). Our goal is a high-quality segmentation of healthy tissue and a precise delineation of tumor boundaries. We present an extension to an existing expectation maximization (EM) segmentation algorithm that modifies a probabilistic brain atlas with an individual subject's information about tumor location obtained from subtraction of post- and pre-contrast MRI. The new method handles various types of pathology, space- occupying mass tumors and infiltrating changes like edema. Preliminary results on five cases presenting tumor types with very different characteristics demonstrate the potential of the new technique for clinical routine use for planning and monitoring in neurosurgery, radiation oncology, and radiology.[10]
- Digital subtraction is useful for carrying out embossed radiography by shifting an x-ray source, and energy subtraction is an important technique for imaging target region by deleting unnecessary region in vivo. X-ray generator had a 100-μm-focus tube, energy subtraction was performed at tube voltages of 40 and 60 kV, and a 3.0-mm-thick aluminum filter was used to absorb low-photon-energy bremsstrahlung x-rays. Embossed radiography was achieved with cohesion imaging using a flat panel detector (FPD) with pixel sizes of 48×48 μm, and the shifting distance of the x-ray source in horizontal direction and the distance between the x-ray source and the FPD face were 5.0 mm and 1.0 m, respectively. At a tube voltage of 60 kV and a tube current of 0.50 mA, x-ray intensities without filtering and with filtering were 307 and 28.4 μGy/s, respectively, at 1.0 m

from the source. In embossed radiography of non-living animals, the spatial resolution measured using a lead test chart was approximately 70 µm, and we observed embossed images of fine bones, soft tissues, and coronary arteries of approximately 100 µm.[4]

- **The various methods of image segmentation are mentioned below.**

✓ **Clustering methods**

Image segmentation can be performed effectively by clustering image pixels. Cluster analysis allows the partitioning of data into meaningful subgroups and it can be applied for image segmentation or classification purposes. [18]

✓ **Histogram Thresholding**

Ohlander proposed a thresholding technique that is very useful on segmenting outdoor color images. This is based on constructing color and hue histograms. The picture is threshold at its most clearly separated peak. The process iterates for each segmented part of the image until no separate peaks are found in any of the histograms.[19]

✓ **Edge Based Method**

Edge detection is a well-developed field on its own within image processing. Region boundaries and edges are closely related, since there is often a sharp adjustment in intensity at the region boundaries. Edge detection techniques have therefore been used as the base of another segmentation technique. [19]

The types of edge detection techniques are

- *Gradient Based Edge Detection*

  The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The assumption is edges are the pixels with a high gradient. These are implemented with convolution mask and based on discrete approximations to differential operators. The quality of the edge image depends on the threshold. These are sensitive to noise and inaccurate.

- *Laplacian*

The Laplacian method searches for zero crossings in the second derivative of the image to find edges. An edge has the one-dimensional shape of a ramp and calculating the derivative of the image can highlight its location. The Laplacian may be used when we are interested only in edge magnitudes without regard to their orientations. The Laplacian has the same properties in all directions and is therefore invariant to rotation in the image. The disadvantage is malfunctioning at the corners, curves and where the grey level intensity function varies. Not finding the orientation of edge because of using the Laplacian filter.

- *Canny Edge Detector*

Canny specified three issues that an edge detector must address. They are:-

i). Error rate:-The edge detector should respond only to edges, and should find all of them; no edges should be missed.

ii). Localization:- The distance between the edge pixels as found by the edge detector and the actual edge should be as small as possible.

iii). Response:- The edge detector should not identify multiple edge pixels where only a single edge exists.

✓ **Region growing methods**

A range of image segmentation algorithms are based on region growing. We review some relevant studies that have used region-growing algorithms. Region growing algorithms take one or more pixels, called seeds, and grow the regions around them based upon a certain homogeneity criteria. If the adjoining pixels are similar to the seed, they are merged with them within a single region. The process continues until all the pixels in the image are assigned to one or more regions.[15]

III. PROPOSED WORK

In the proposed work, the over segmentation problem of simple method is reduced by creating the markers around concerned brain region. The markers can be selected interactively. Before applying the marker controlled segmentation method on any MR image, the noise and other local irregularities from the noisy images has to be removed using any efficient filtering method in order to improve the image quality. For this purpose, the image smoothing using Gaussian filter etc. and image contrast enhancement are carried out as preprocessing step before implementation of this approach.

- Image analysis for detecting brain diseases by applying segmented method.
- Comparative analysis of different segmentation technique.
- Implementation of Prototype for Image Analysis and Identify best technique in different scenario for Disease Detection.

IV. EXPERIMENTAL ANALYSIS

Several simulated experiments are carried out to demonstrate the validity and feasibility of the segmentation method for segmenting regions from brain images. Measures reflect the effectiveness of a image segmentation method. The system has been implemented using MATLAB because of powerful inbuilt mathematical and image processing functions.[8]

In the first step, the color image is transformed from RGB to gray scale. Although, traditionally, RGB is the most commonly used model for fMRI images. All of our data are acquired on Phillips/Siemens/Wipro 1.5T scanners for brain image segmentation. Table 5.1 show detail description about the patient with their disease and grade which contains original MRI images with tumor used for this study. The input images are of patient ID's 397384 (High Grade) 19430618 (Low Grade)[11]

Table 3.1: Initial Testing - Number of detected edges

Patient ID	**Grade**	**Number of Detected Edges**		
		Robert	**Prewitt**	**Canny**
397384	High	5259	4382	1997
19410407	High	5120	4323	1836
19530428	High	6807	5757	2302
19790628	Low	1491	649	317
19560416	Low	2509	1080	433
19430618	Low	2567	1072	417

V. CONCLUSIONS

A new system that can be used as a second decision for the surgeons and radiologists is proposed. It determines whether an input MRI brain image represents a healthy brain or tumor brain. High grade tumor have more true edges than low grade. MRI of healthy brain has an obviously character almost bilateral symmetrical However, if there is macroscopic tumor, the symmetry characteristic will be weakened. According to the influence on the symmetry by the tumor, we develop a segment algorithm to detect the tumor region automatically.

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