Automatic Segmentation of Brain Tumors in MRI Images using Fast Bounding Box Algorithm

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Abstract- *Magnetic Resonance images are used to detect presence of any brain tumor but it is very time consuming and difficult. This paper presents a completely automated way to detect brain tumor. It consists of three stages to detect and segment brain tumor. In the first stage, image pre-processing is done to remove any noise and sharpen image. In second stage, bounding box method using symmetry is used to automatically detect location of tumor in any part of the brain. In the third stage, one class Support Vector Machine is used to finally segment the tumor portion from the whole image. Several experiments show that our technique in spite of being completely simple detects tumor correctly.*

Keywords- tumor segmentation; brain tumor; fast bounding box; anisotropic diffusion filter; support vector machine(SVM);magnetic resonance imaging (MRI);

I. INTRODUCTION

By the increasing age population, cancer has become a world wide health problem. In accordance to the most recent Figures of World Cancer Research Fund, the first reason of death in world is cancer [1]. Nobody knows the exact reason of brain tumours creation. Doctors can barely explain about how someone is overtaken by brain tumour and someone else isn't.

While most of the natural cells are getting old or damaged, they disappear and new cells are replaced with them. Sometimes, this process goes wrong; New cells are produced when body doesn't need them and the old and damaged cells don't disappear. Therefore, the illimitable and incontrollable increase of cells causes the brain tumour creation. If the brain tumours are not diagnosed immediately, they could either cause a serious brain damage or even death. In all of treatment methods, any information about position and size of the tumour for successful treatment is essential [2].Awareness of the tumour position and size, especially changes About tumour size, can provide very important information to find the most effective regime for the patients during the treatment, including surgery, radiotherapy and chemotherapy[2].

Recently MRI imaging technique is taken in to consideration. MRI provides a view from inside human body. High spatial resolution and excellent soft tissue diagnosis are the advantages of MRI over other medical imaging techniques. Also there are no means to entrance and no drug for injection into the human body in MRI imaging process. The entire process has not any radiation damage and is completely safe [3]. Also Computed Tomography (CT), Positron Emission Tomography (PET), CT/PET are other techniques for medical imaging.

The traditional explanation of MRI images by a Proficient is a very difficult and time-consuming task. Also the result directly depends on the experience of them Proficient. Accordingly, finding an accurate and fully automatic method to provide the information to the doctors is Consequential [2].

There are many proposed techniques for automatic and semi-automatic detection and segmentation of brain tumours. The proposed techniques can be mainly divided into two groups; Intelligent based and non-intelligent based. Most of the leading intelligent based systems are artificial neural networks [4], fuzzy c-means (FCM) [5,6,7], fuzzy connectedness [2], support vector machine (SVM) [8,9],particle swarm optimization (PSO) [10], genetic algorithm [11] and hybrid methods. On the other hand, the leading non intelligent techniques include thresholding [12,13] and region growing [14,15] and etc. Usually the combination of these algorithms are used to achieve better results [16,17].

Purpose of image segmentation is to segment an image into regions which are meaningful for a particular task. So its a widespread field not only in medical imaging, but also in computer vision and satellite imagery. The choice of a particular method among various methods and approaches are used, depends on the characteristics of the case [18].

There are many problems and challenges about brain tumors segmentation. Brain tumors may appear in any size, shape and location. One challenge in tumor detection and segmentation is how to investigate the real data's nonlinear distribution issue. To decide whether some data are in target

class or not is the goal of the one-class classification [9]. Owing to its ability of learning the nonlinear distribution of the real data without using any prior knowledge, one-class support vector machines (SVMs) have been applied in tumor segmentation [8].

II. METHODOLOGY

A novel approach is presented for brain tumor segmentation on MRI images which is fully automatic and does not need any user interaction. Fig. 1 shows the block diagram of the proposed algorithm.

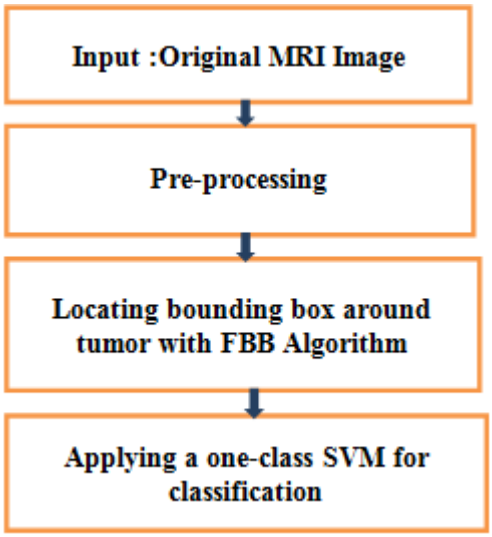


Figure 1. Block diagram of the proposed approach

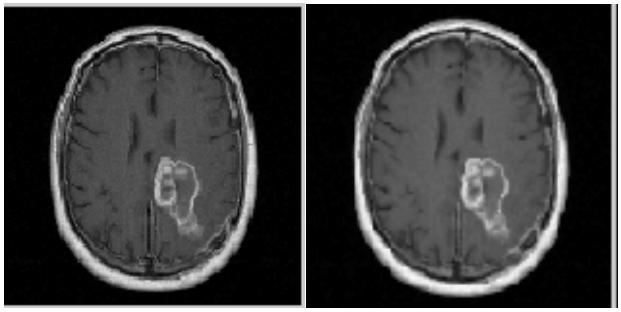
A. Pre-processing

The pre-processing phase has a great importance in the applications of image processing and specially segmentation. Generally in the pre-processing phase, the main goal is to remove the noise from the images. Undoubtedly MRI images have noises which have to be removed. But the noise deletion shouldn't destroy the edges of the image and decrease the clarity and quality of it. There are several methods for removing noise, including: Gaussian filter, contour let transform approach and wavelet thresholding approach, median filter [6], anisotropic diffusion filter [2].

Anisotropic diffusion filter is a method for removing noise which is proposed by Persona and Malik. This method is for smoothing the image by preserving needed edges and structures. Fundamental idea is to adjust the smoothing level in a region based on the edge structure in the neighbourhood . Homogenous regions are highly smoothed and strong edge regions are barely smoothed (to preserve the structure).

The pre-processing phase has two steps:

1) In the first step the extra and useless parts outside the skull are removed. For this task, at first the boundary of the skull is determined by automatic global thresholding, then with creating a binary image which is head mask indeed, the extra regions from outside of the skull are removed. With this operation, the required calculations in later steps and total time of segmentation are decreased.
2) This step is to remove the noise. MRI images include image and some noise. This noises cause some disorders in image. They should be removed for segmentation process improvement without destroying the edges of the image and decreasing its clarity. Here, anisotropic diffusion filter with 8- connected neighbourhood is applied on the image for removing noise.

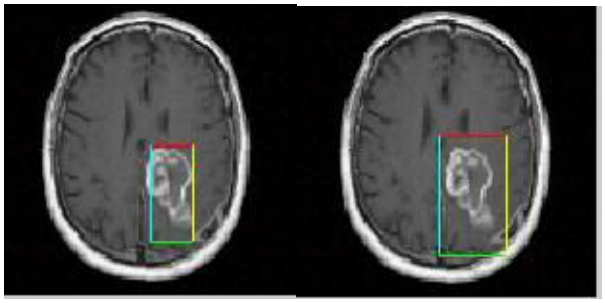


a) b)

Fig 2. Preprocessing a) Original image b) Enhanced image

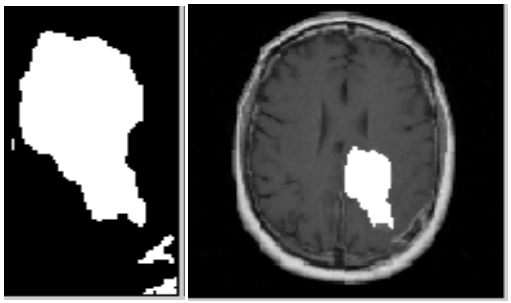
B. Fast Bounding Boxes algorithm

In each input MRI slice (axial view), there is a left–right axis of symmetry of the brain. A tumor which is considered an abnormality in the brain, typically perturbs this symmetry. Thus an axis-parallel rectangle on the right side that is very dissimilar from its reflection about the axis of symmetry on the left side—i.e., the gray level intensity histograms of the inside of the two rectangles are most dissimilar and the outside of the rectangles are relatively similar. A novel score function utilize that can identify the region of change with two very rapid searches along the vertical and horizontal direction of the image. Bhattacharya coefficient (BC) measures similarity between two normalized gray level intensity histograms. When two normalized histograms are the same, the BC between them is 1 and when two normalized histograms are completely dissimilar, the associated BC value is 0 .



a) b)

Fig 3. Region of Interest
a) Original fast bounding box tumor detection
b) Enhanced fast bounding box tumor detection



a) b)

Fig 4. a) Segmented tumor b) Tumor extracted image

C. Support Vector Machine (SVM*)*

Support Vector Machines is a special family of learning machines that were first proposed by Vapnik. SVM is a classification algorithm for analysing high-dimensional data, and has the ability to learn the nonlinear distribution of there al data without using any prior knowledge [3]. As in the Statistical Learning Theory, optimum efficiency of SVM can be obtained by forming the optimum classification level with the greatest classification margin [23].One-class SVM forms a classifier just from a collection of labeled positive templates called "positive training samples" .

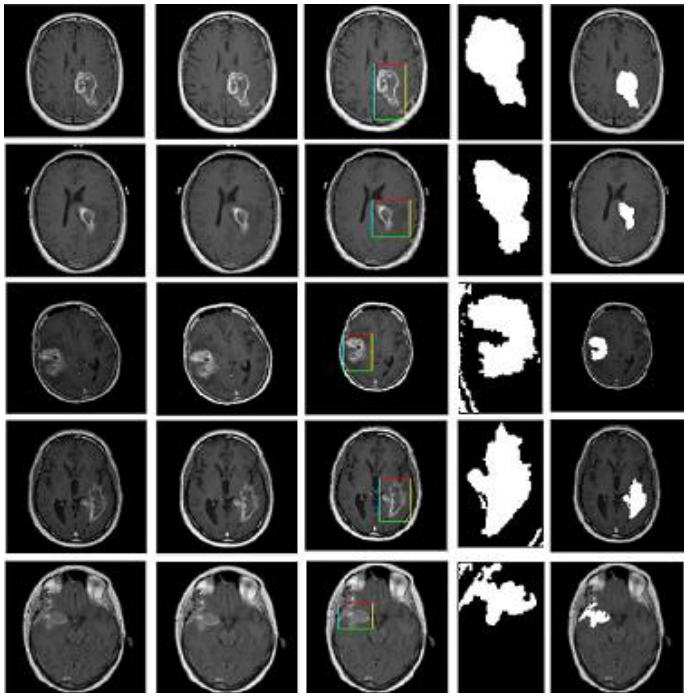
Brain has a left-right natural symmetry and with appearance of tumor, this symmetry is disarranged. In FBB approach with considering similarity and dissimilarity of gray level intensity histogram of symmetrical regions, then Bhattacharya coefficient is calculated and the region of tumor is automatically marked by a bounding box.

In this method one class SVM is chosen as classifier and tumor pixels is used as training set. Since tumors are detected in different shapes the parts that is extracted by bounding box may include pixels of healthy part of brain in order to overcome this drawback, just the central part is selected as sample points. Here, the radius basis function (RBF) was chosen as the learning kernel.

Another point to be taken in to account, is that SVM simplifies well in high-dimensional spaces and feature extraction can be accomplished in the training step of SVM. Consequently no special feature extraction technique is needed in this approach.

III. RESULTS

The test of proposed technique to detect and segment brain tumor is performed using 100 MR images of different patient. The images used for testing are of size 256x256 pixels, eight bits per color channel. Each test image has brain tumor of different size, shape and intensity. Manual inspection is used to check the accuracy of automated segmented tumor area. Figure 5 shows the experimental results for different MR images containing tumors of different shapes, sizes and intensities.



a) b) c) d) e)

Fig 5. Experimental results a) Original images b) Preprocessed images c) Tumor detected Images d) Segmentation Images e) Tumor extracted images

IV. CONCLUSION

In this paper brain tumor segmentation and detection is done using MR images. The proposed method uses an easy

and completely automated way to detect and segment tumor with good accuracy. Experimental results show that our proposed method produces very good results in enhancing, detecting and segmenting brain tumor from a MR image.

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