Brain Tumour Detection using Anisotropic Diffusion

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Abstract— The brain is a vital structure that serves many necessary functions. This structure provides a meaning to the events of the world. The brain receives various messages from the sensory organs at the same time. An Image segmentation is one of the most vital and active research field in the medical imaging domain. It can be defined as the delineation of one or more structures of interest within the image. An automated techniques are sought in order to prevent the time taking burden of manually contouring the structures. MRI (Magnetic Resonance Imaging) is an advanced medical imaging method giving rich information about the human soft tissue anatomy. The primary objective of this research paper is to study, analyse and implement the Brain Image segmentation procedure. Thereafter the implementation of an effective system which will facilitate the automatic detection of brain tumors from the MRI images will be envisaged.

Key words: MRI, Brain Tumor, Human Brain, Anisotropic Diffusion, Brain Tumour Segmentation

I. INTRODUCTION

Magnetic resonance (MR) imaging is a non-invasive medical imaging method providing high resolution 3D volumetric data which have high intensity contrast between soft tissues. It is hence very well adapted for examining and analyzing human brain anatomy. The MR imaging utilizes a powerful magnetic field to align the nuclear magnetization of hydrogen atoms present in water in the body. A sequence of magnetic fields systematically changes the alignment of this magnetization, occurring the hydrogen nuclei to yields a rotating magnetic field detectable by the scanner. The MR imaging can be applied to an image not only the anatomy of the brain, but also the vasculature as well as microstructure of the brain tissues.

MR imaging allows the distinction of different tissue types in the brain, e.g. white matter (WM), grey matter (GM) and cerebrospinal fluid (CSF), based on their intestines. In T1-weighted MR images (MRI) the intensity distributions of the tissues in the normal adult brain are as follows: WM has the highest intensity, GM has a medium intensity and CSF has the lowest intensity. In T2-weighted MR images the intensity distributions are inverted with CSF having the highest intensity and WM the lowest intensity. An automated techniques are sought in order to prevent the time taking burden of manually contouring the structures. The main problem is specifically difficult in the context of brain tumors. Actually, there are many tumors that have heterogeneous appearances and their range of intensity superimpose with the healthy tissues. The existence of a necrotic core is outputting with a strong contrast on the "active" tumor. An advance information regarding the shape of the tumor cannot be utilized as they have variable shapes and sizes. The Tumor cells have very fuzzy and irregular boundaries because of their infiltrative nature. Edema (swelling of brain tissue around the tumor) and mass effect (tissue displacement induced by the tumor) are quite abnormal due to their slow-growing nature. In this framework, the simplest segmentation techniques such as thresholding or region growing are deficient. Despite an extensive and assuring work in the tumor segmentation field, gaining accurate, précised and reliable segmentations of brain tumors remains a tough task.

MRI (Magnetic Resonance Imaging) is an advanced medical imaging method giving rich information about the human soft tissue anatomy. MRI has several advantages over different imaging techniques allowing it to give a 3-dimensional data with very high contrast between the soft tissues. However, the amount of data is too much for manual analysis/interpretation, and this has been one of the largest hurdles in the effective use of MRI.

The segmentation methods for a brain MRI can be classified into two types:

1) Registration based Methods
2) Intensity Based Methods

In registration-based methods, often referred to as atlas-based segmentation methods, a deformable atlas is elastically warped to an image and the tissue or anatomical labels are then transferred. In an intensity-based methods, classify intensities of individual voxels usually only into WM, GM and CSF. A more detailed classification is not possible, unless spatial priors are included in classification process, as the intensity profiles of different brain structures overlap.

II. LITERATURE REVIEW

The image segmentation is a challenging problem that has received an enormous amount of attention by many researchers [1, 2, 3, 4]. Pham et al. and James et al. have presented various techniques used in medical image segmentation and analysis [5, 6]. The segmentation problem can be categorized as supervised and unsupervised problem. For appropriate analysis, different image models have been proposed for taking care of spatial intrinsic characteristics. The popular stochastic model, provides the better framework for many complex problem in image segmentation is Markov Random Field (MRF) model [7, 10]. MRF model and its variants have been successfully used for brain MR image segmentation [12, 13].

The brain tumor symptoms based on the tumor size and location. These symptoms exhibits by the tumor growing in a limited regions, a pressure in the brain, and damage to the necessary tissues. The tumor can cause hydrocephaly (water accumulation in the brain) as a problem to the formation and flow of the cerebrospinal fluid. If the tumor evolves slowly, it takes time for the symptoms to appear. The most typical symptoms of the brain tumor involves a headache, lacks in hearing and sense of smell, swelling in the skull, loss of sensation in the arms and legs, vision problems or various eye movements, fainting, nausea or vomiting, insomnia, personality and memory changes and problem in speaking can occur. These symptoms of the brain tumors can also be observed in other diseases. Various symptoms such as growth retardation, increased appetite, weakness and movement, mood changes can be observed in the children with brain tumor symptoms. If more than one of these symptoms are present, a neurologist must be consulted immediately. By performing the vital examinations and early diagnosis is extremely important for the success of the treatment. The brain contains two cells. These two cells are neurons and glial cells (they are also referred to as neuroglia or glia). The work of neurons is to send and receive nerve signals. The Glial cells are un-neuronal cells. It works to supply nourishment and support, guard homeostasis, form myelin and simplify signal transduction in the nervous system.

A. Structure of the Brain

The brain structure is classified into five main parts. These works in the coordination, provide to a sensing reason, emotional life, and events that present in the world. Additionally, each one has its own specific functions [14].The main parts of the brain are analyzed in detail below. Figure 1 represent the main parts of the brain and their locations.

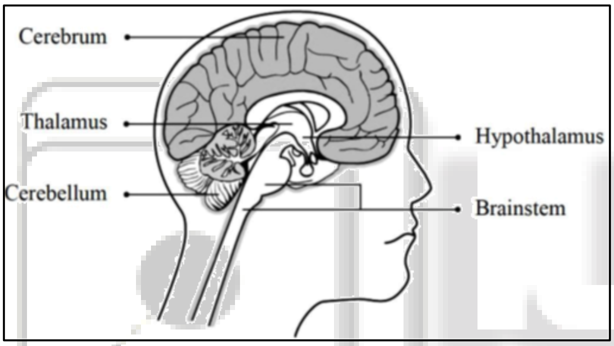

Fig. 1: Main Parts of Brain

III. SYSTEM IMPLEMENTATION

The system implementation details are proposed in this section. This system can be characterised into three stages. First stage is the pre-processing which improves the brain MRI image and make it more suitable to analyse. An Enhanced images are acquired utilizing morphological operations, pixel subtraction and image filtering. Second stage is the intensity adjustment dependent segmentation which segments the region of the tumour from the enhanced image. Third stage is addition of pixel which shows the location of the tumour on an original image. Figure 2 shows the flowchart of the proposed system.

The Proposed work utilizes the technique of Anisotropic Diffusion. The image is obtained from MRI Machine. After obtaining the image from the MRI machine. Then it is applied to Anisotropic Diffusion to eliminate the noise from the image then we apply binary conversion technique to convert the image to binary so that we can apply some morphological functions for detecting the tumour and then we obtained the coordinate position of tumour and plot it on the coordinate. And also we obtain the cropping point and also crop the tumour to display alone from the MRI images.

Mathematical morphology is also known as a non-linear effective method that has been used to recognize the boundaries of the tumor part in the brain image. Besides, this technique is used to extract components of objects. Morphological operations create a small shape or template called a structural element on an image. The Flow Diagram has been shown below in figure 2:

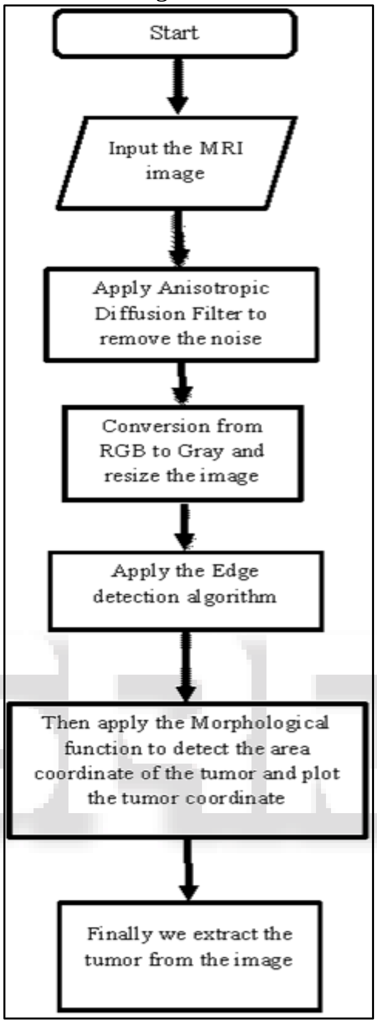

Fig. 2: Flowchart of the Process

IV. RESULT & DISCUSSION

The algorithm has been implemented using MATLAB 2013a software tool. Following are the details of the simulation results obtained.

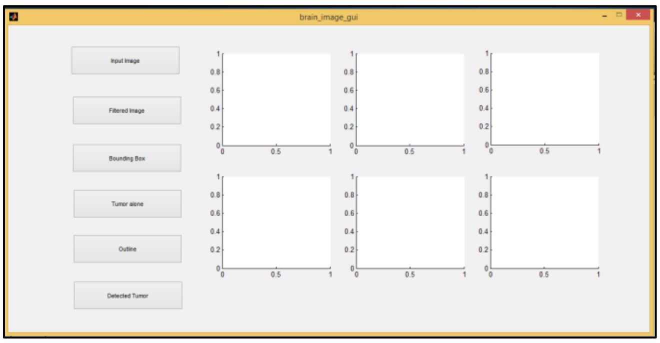

Fig. 3: GUI for the Tumor Detection

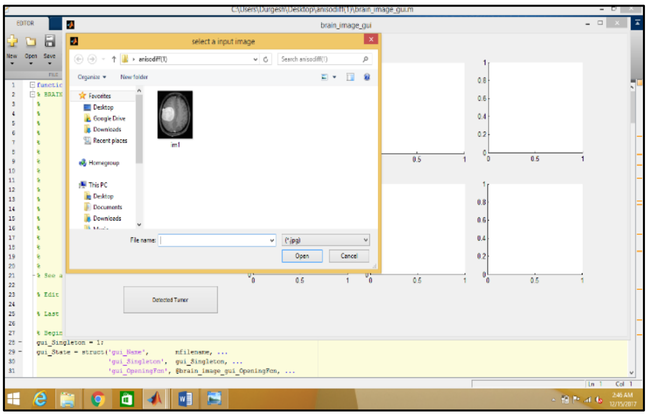

Fig. 4: Show Result after the Pressing the Input Image Push Button

Figure 5 shows the result after Anisotropic Diffusion conversion

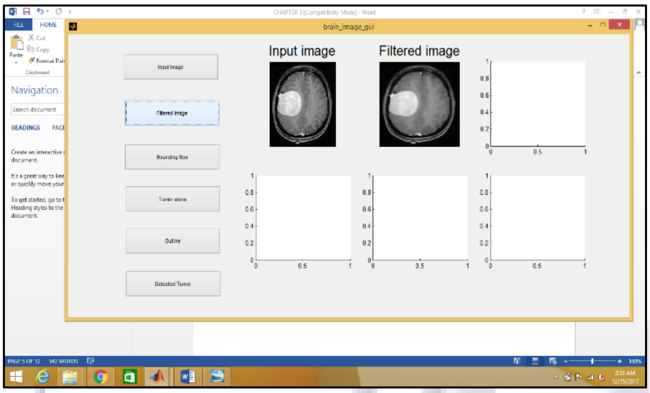

Fig. 5: Image after Anisotropic Diffusion

Figure 6 shows the result after pressing push button Bounding box which result show in the image.

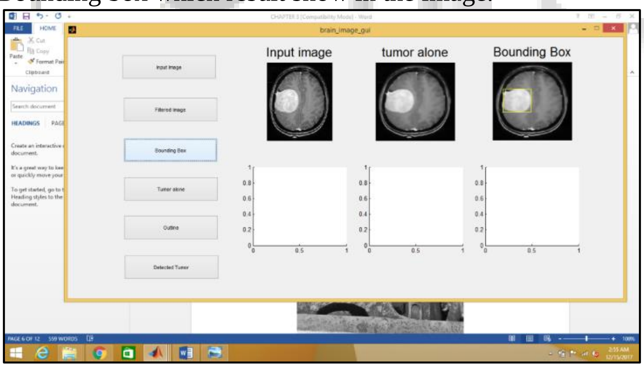

Fig. 7: Image after Pressing Bounding Box button

Figure 4.5 shows the result after pressing push button Tumour alone, results are shown

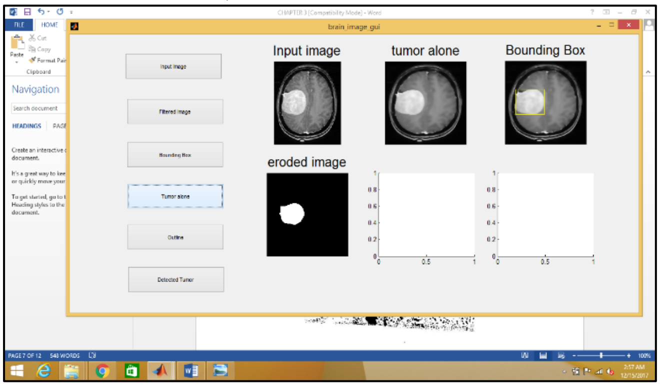

Fig. 8: After Pressing Tumour alone push button

Figure 4.7 shows the result after pressing push button Detect Tumour which result show in the image.

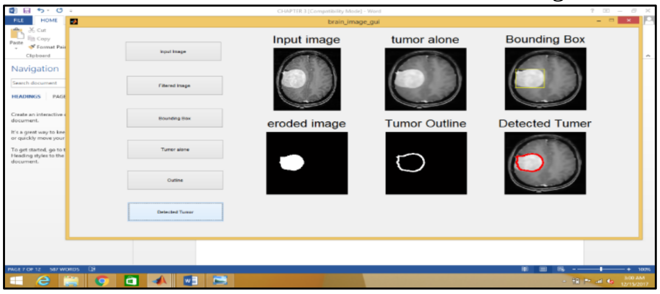

Fig. 9: Image after Pressing Detect Tumour Button

In the above figure we see that after several operation we get the result on red line mark on the Tumour of image which is show in the previous figure of image whose show the red circle on the tumour.

V. Conclusion

A novel approach towards the brain MRI segmentation and tumor area detection has been proposed in this research work. Automatic Image Processing methods have been recently been used widely in various techniques based on visual identification. The techniques used in this work are based on anisotropic diffusion method to filter out the noise characteristics of the image followed by segmentation of the image based on intensity of black and white pixels. The segmented image is then processed to find out the tumor area. The tumor area is calculated further to give an approximation of the level of effect of the tumor. Several images have been used for testing the algorithm suggested in this research work having different portions affected by tumor presence. The algorithm has been observed to work extremely well for different kind of brain tumor images and is able to locate the tumor area effectively.

References

[1] S. Geman and D. Geman, “Stochastic relaxation, Gibbs distributions, and the bayesian restoration of images,”IEEE Trans. Pattern Analysis and Machine Intelligence, vol.6, no. 6, pp 721-741, 1984.

[2] Julian Besag, “On the statistical Analysis of Dirty pictures,”Royal Statistical Society, 48, no. 3, pp. 259-302, 1986.

[3] Nikhil R. Pal and Sankar K. Pal, “A review on image segmentation techniques,” Pattern Recognition, vol. 26, no. 9, pp. 1277-1294, Sept. 1993.

[4] Todd R. Reed and J. M. Hans Du Buf, “A review of recent texture segmentation and feature extraction techniques,” CVGIP: Image Understanding, vol.57, no.3, pp.359- 372, 1993.

[5] D. L. Pham, C. Xu, and J. L. Prince. “Current methods in medical image segmentation,” Annual Review of Biomedical Engineering,vol.2 pp. 315-337, 2000.

[6] James S. Duncan and Nicholas Ayache, “Medical Image Analysis: Progress over Two Decades and the challenges Ahead,” IEEE Trans. Pattern Analysis and Machine Intelligence, vol.22, no.1, pp. 85-106, 2000.

[7] S.A.Barker and P.J.W.Rayner, “Unsupervised image segmentation using Markov random field models,”

Pattern Recognition vol. 33, no. 4, pp. 587-602, April. 2000.
[8] P. K. Nanda, “MRF model learning and application to image restoration and segmentation,” Ph.D Dissertation, IIT Bombay , 1995.
[9] J.Zhang, J.W.Modestino and D.A.Langan, “Maximum Likelihood parameter estimation for unsupervised stochastic model-based image segmentation,”IEEE Trans. Image Processing, vol.3, no. 4, pp. 404-420, 1994.
[10] Stan Z. Li, “Markov Random Field Modelling in Image Analysis,” Springer-Verlag, 2001.
[11] A. P. Dempster, N. M. Laird and D. B. Rubin, “Maximum Likelihood from Incomplete Data via the EMalgorithm,”J.Royal Statistical Society, vol. 39, pp. 1-38, 1977.
[12] Padhraic Smyth, “Belief networks, hidden Markov models and Markov random fields:A unifying view,”Pattern Recognition Letters, vol. 18, no. 11, pp. 1261-1268, Nov. 1997.
[13] Yongyue Zhang,Michael Brady and Stephen Smith, “A hidden markov random field model for partial volume classification,”Neuro Image, vol. 13, no. 6, pp.291, June 2001.
[14] Apuzzo, M. L., Liu, C. Y., Sullivan, D., & Faccio, R. A. (2009). Surgery of the human cerebrum a collective modernity. Neurosurgery, 61(1), SHC-5.

