IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ICRAESIT - 2015

B V Raju Institute of Technology, Narsapur

Vol. 2, Special Issue 2, December 2015

Medical Application of Bounding Box Technique

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Abstract: Medical image processing is one of the most emerging and challenging field now-a-days. Magnetic Resonance Imaging (MRI) is an imaging technique which uses a magnetic field and radio-frequency waves to create detailed images of the organs and tissues within the body. Important diagnostic information can be obtained by processing of MRI images. Brain tumours are generally an abnormal intra-cranial growth caused by cells reproducing themselves in an uncontrolled manner. Early detection of cancers caused due to tumours can be helpful in curing the disease completely. The proposed technique is used to detect brain tumour and oedema from MRI scans using bounding box symmetry method. This technique incorporates noise removal functions (High-pass and Median filters), segmentation and morphological operations. This method is generally used to know the severity of the disease in terms of size of the tumour. This technique is also applied for detecting oedema in tissues.

Keywords: Magnetic Resonance Imaging, Brain Tumour, Oedema, Bounding Box Technique, Threshold Segmentation, Morphological Operation.

I. INTRODUCTION

Detection of brain tumors and oedema from Magnetic Resonance Images play an important role in prognosis and diagnosis of diseases. This requires segmenting brain tumors and oedemas within images from different MR modalities. Automated brain tumors or oedemas segmentation from MR modalities remains a computationally intensive as well as challenging task [1]. In this paper, a fast, novel automated and approximate segmentation technique has been introduced. The input used for study is set of MR image. The output is a corresponding MR image with the tumor or oedema detected with an axis-parallel bounding box. Tumor is detected by unsupervised method that searched for the most dissimilar regions between the left and right halves of MR image. This process uses a novel score based on Bhattacharya coefficient computed with gray level intensity histograms. This score function gives a very fast search to locate the bounding box [2].

A. Brain Tumour:
The brain is the center of speech, memory, emotions and thoughts. Brain functions include interpretation and control of sensory information, skeletal and muscle movements. A brain tumor is a localized intracranial lesion which occupies the space within skull and it tends to cause a rise in intracranial pressure. Tumors can be affected at any part of the brain and depending on which part(s) of the brain it has been affected can have a number of symptoms [3].

- Seizures
- Language Difficulties (communication)
- Change in mood of the person
- Personality changes (weight)
- Changes in sensation, vision and hearing.
- Difficulty in muscle movement
- Difficulty with the coordination control

Brain cancer is one of the deadliest and intractable diseases. Tumors may be embedded in some parts of the brain that are critical to manage the person's body vital functions, while they shed cells to invade other regions of the brain, forming more tumors which are too small to detect using conventional imaging techniques. In past few years, the occurrence of a brain tumor has been increasing. Unfortunately, many of the tumors will be detected too late, after the symptoms appear. It is much safer and easier to remove a small tumor than the larger one. Advanced image-guided technology and Computer-assisted surgical planning have become increasingly popular in neuro surgeries [4]. Tumors are defined as the abnormal growth of a diseased tissues. Brain tumor is an abnormal mass of tissue in which cells grow rapidly and multiply uncontrollably, unchecked by the mechanisms that control normal cells.

B. Types of Brain Tumours
Brain tumors are classified into benign and malignant. Benign tumors do not invade or harm the tissues around them. They also do not spread to the other organs in the body. They can be surgically removed. But sometimes depending on their location they can put pressure on the surrounding tissues and cause serious problems. Malignant tumors are more

serious. Sometimes they can be life threatening. They may be primary or secondary. The primary tumor originates from the brain tissue and secondary is metastasis from others tumors elsewhere in the body.

C. Oedema

Oedema is an abnormal accumulation of fluid located beneath the skin and in the cavities of the body. It is also known as oedema and hydrops. Clinically, oedema is manifest as swelling. The common type of oedema is cutaneous oedema. When pressure is applied to a small area of oedema indentation persists even after the release of the pressure. Water retention is the common cause of oedema. It can caused by pregnancy, heart problems, varicose veins, insect bites etc.

II. DETECTION METHODS

A. Seeded Region Growing

Segmentation carried out based on few set of point known as seeds, the grouping of pixels into regions based on seed points in which region grow by appending seeds to the neighboring pixels [5], [6]. For the accurate segmentation of regions every connected component of the region should meet exactly one seed [7]. Region growing would not stop till all the pixels are grouped into the regions by comparing seed pixel with all neighboring pixels [8]. The major issue encountered, is the selection process of the seed point that is selected manually or by automatic seed selection criteria, also region growing involves high level of knowledge for semantic image segmentation to explore the seed selection to get more accurate segmentation of regions [9]. For the interpretation, image should be partitioned into meaningful regions which are related to objects in the targeted image. Pixels corresponding to object in image are grouped together and marked. If there are number of seeds grouped up into n regions R1, $R2$, $R3$ ….. Ri during each iteration there is an addition of one pixel into these regions.

B. Fuzzy C-Mean

The Roman Fuzzy c-Mean algorithm is a very popular technique for brain tumor segmentation in area of unsupervised image segmentation [10]. FCM provides high degree of membership to every pixel that is close to the threshold point. As in Otsu [10] method output relies on input for which a proper initial threshold is required. Initial threshold could be calculated using following formula

$$T = max\ (grayValue)/2 \qquad (1)$$

After selection of initial threshold Fuzzy c-Mean algorithm thresholding is performed to detect and extract the tumour region and then posts processing using morphological operations are applied. This algorithm takes the gray values as feature.This technique is found to be very useful in case where there is large number of objects clustered in image. As this algorithm is robust and complex than simple thresholding algorithms therefore it performs better for segmentation of intense part in brain images. The major reason for choosing this algorithm is that it divides the brain structure into types of tissue sets, and degree of belongings will be assigned to pixels constrained in specific tissue sets having similarity between regions containing fuzzy c-Mean membership functions in range 0 and 1. If the value is close to 1 and accurate estimation of cluster centres, the algorithm could converge faster and clustering results comes out better.

III. BOUNDING BOX SYMMETRY METHOD

Many tumor segmentation methods used for tumor detection are not fully automatic. These methods need a seed to be placed in the tumor region. Tumor detection techniques based on region growing method are very complex. Statistical pattern recognition can be used as the intracranial tissues undergo large deformations due to the growth of the tumor. These statistical methods use a registered model of healthy brain to detect abnormal regions. [11]. However, these techniques typically lead to poor results as they need to significantly modify the brain structure to accommodate the tumors. Fuzzy models work well only for fully enhanced tumors and not reliable for detecting non-enhanced tumors. This is because these fuzzy models mostly use thresholding techniques or morphological operations-processing of the image and this leading to low enhancing tumors. Many researchers are now using Markov Random Field by taking small neighborhoods so that the computation time is reduced. To make the tumors detection robust and faster the symmetry technique is used. Accurately finding the axis of symmetry is a challenging and time consuming task. It presents a fast, automatic, and approximate segmentation technique which avoids the problems by locating a bounding box, an axis-parallel rectangle, around the brain tumor or edema on an MR slice. The score function is based on gray scale intensity histograms. This score function gives a very fast linear time search technique for locating the bounding boxes. The advantages of FBB are it is convenient, easy to use and can be implemented in real time. Image registration is not required and it is an unsupervised technique, so there is no requirement of training set of data.

IV. METHODOLOGY

The present technique is implemented in two stages. The Magnetic Resonance Image is preprocessed and later the image is segmented and morphologically operated. Fig. 4.1 shows the flowchart of the working methodology.

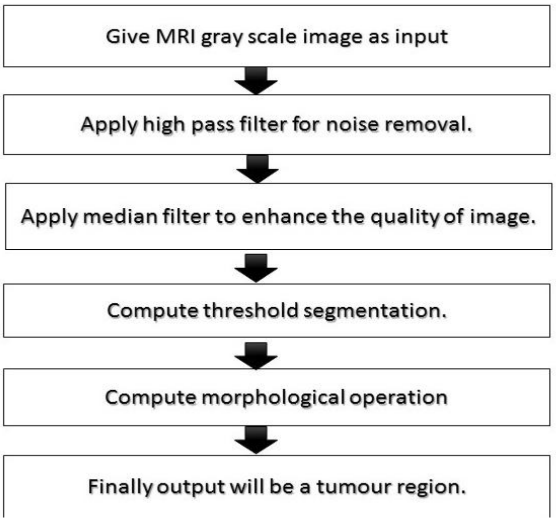

Fig-4.1 Flow chart of the working methodology

A. Grayscale Imaging

The magnetic resonance image of the part of the body which is under test is acquired. The image has 8-bit resolution, so it contains 256 shades of gray. It is called a gray scale image. It consists of shags from white to black which indicate the percentage of transmitted or reflected light. So the image is pre-processed into gray scale image.

B. High Pass Filter

The gray scale image is sharpened using a high pass filter. The sharpening is done by enhancing the contrast of adjoining pixels with little variation in intensity. By this the low frequency information is reduced and the high frequency information is preserved. For this a mask which contains a positive value in the center and negative values at all other locations is used.

C. Median Filter

Median filter is used later to enhance the image by removing the noise. Median filter is preferred because it preserves the edges in the image. Median filter is applied by taking a window. The window is a pattern of pixels, which can be 3x3 or 5x5. The pixel values in the window and sorted. The center value in the window is replaced by the median value of the sorted array. In the present technique we used a median filter by selecting a 3x3 window.

D. Threshold Segmentation

The image is partitioned into different segments by segmentation. By segmenting an image, we are assigning a label to pixels with similar visual characteristics. We used the simplest method of image segmentation called the thresholding method. In this method, the gray image is converted to binary image by choosing a threshold value. The selection of threshold value is important to segment the image in the required manner. We are separating the skull from the soft tissue by thresholding.

E. Morphological Operations

Non- linear operations related to the shape or morphology of features in an image is Morphological Image Processing. They are suited for processing the binary images, as they consider the relative ordering of pixel values, not on their numerical values. A structuring element, which is a small shape or template is used to probe an image. The structuring element is compared with the pixels by locating it in the image at all possible locations. The element should either fit or hit the neighborhood. We created a new binary image by performing morphological operation by placing a non-zero value at that location if the test is successful. The element used is a binary matrix containing zeros or ones. The structuring element shape is decided by the pattern of zeros and one.

V. RESULTS

The input image we used is shown in Fig. 5.1 [12] this is used for tumour detection. In order to extract better results edge detection has performed on the given input image. Fig.5.2 shows the image after edge detection. Segmentation of MRI image is performed in order to compare the right and left axis of the brain as test and reference images respectively. Fig.5.3 shows the MRI segmented image. After segmentation we highlighted the tumour in an axis bounding box. Fig.5.4 shows the detected tumour region. Number of pixels covered in the tumour region is displayed in the command window of MATLAB.

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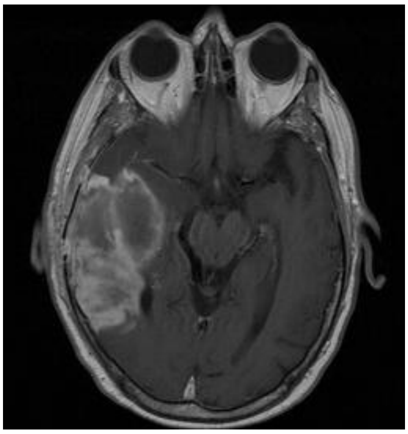

Fig-5.1 MRI Input Image

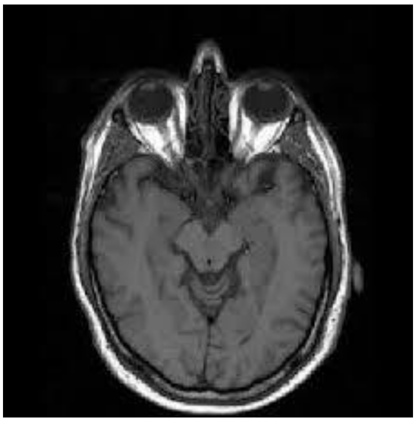

Fig-5.2: MRI Image with Skull Detected

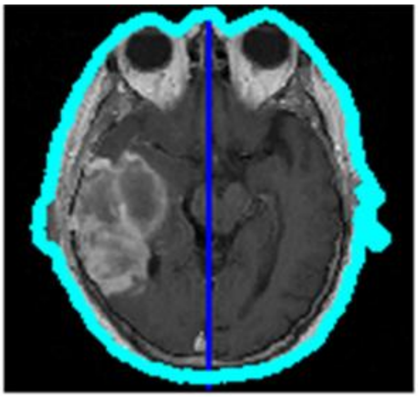

Fig-5.3: Segmented MRI image

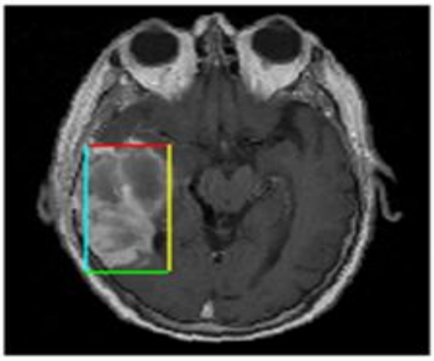

Fig-5.4: MRI Tumour Region Detected

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We applied the bounding box symmetry technique to detect oedema region in different body tissues. Figure 5.5 shows the MRI image of bone pitting oedema. Figure 5.6 is the image obtained after edge detection and segmentation process. Finally figure 5.7 is the output image where the oedema section in bone is highlighted in a boundary box.

Fig-5.5: Pitting oedema during and After the Application of Pressure to the Skin.

Fig-5.6: MRI Image Input

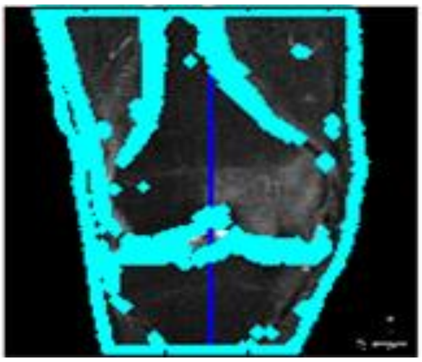

Fig-5.7: Detected and Segmented MRI Image

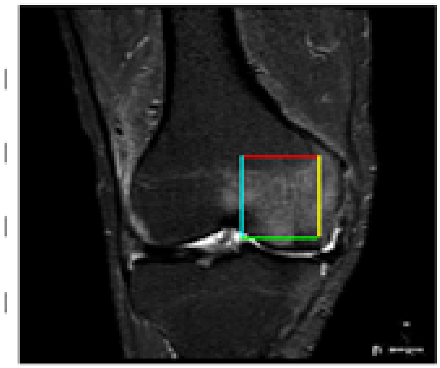

Fig-5.8: MRI Oedema Region Detected.

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ISSN (Print) 2394-1588

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VI. CONCLUSIONS & FUTURE SCOPE

A. Conclusions

The current method uses a computer aided system for brain MR image segmentation for detection of tumour location using bounding box symmetry. We were able to segment tumour from different brain MRI images from our database. The approach was analyzed and shown to have a very high confidentiality due to the sharpness of information.This is a novel and fast technique and uses symmetry to enclose the tumour by a bounding box in the image. This technique does not need any kind of training images and can be implemented in real time. So, we conclude that this is a robust and reliable technique and can be used for diagnostic purpose.

B. Future Scope

In future the present technique can be developed to classify the tumours based on feature extraction. Images can be acquired over a time period and the tumour growth can be analyzed by using graphical method. This method can be used to detect cysts and tumours in different organs.

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BIOGRAPHIES

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