BRAIN TUMOR DETECTION using OTSU for DICOM images, using WATERSHED and ACTIVE CONTOURS for multi-parameter MRI Images.

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Abstract- Brain is the centre of nervous system. Brain can be very complex. It can be said that most important function of the brain is serve as the physical structure underlying the mind.

There is a lot of research being done on the brain and its functionality. To understand the functionality we need to know how can the brain function ? How this is controlled? We attempt to answer some of these questions by studying the brain.

The functionality of brain can be studied by segmenting the white matter from the gray matter of the brain fMRI images which helps you find which part of the brain is active at a particular point in time for different activities.

Keywords- MRI, segmentation, DICOM, fMRI(functional Magnetic Resonance images),white matters,gray matters .

I. INTRODUCTION

fMRI is a non-invasive form of imaging. It is a special type of MRI scan. It is a collection of MRI images taken over an interval of time. Functional Magnetic resonance imaging can be used to map changes in brain hemodynamic that corresponds to mental operations extends traditional anatomical imaging to include maps of human brain function. With fMRI imaging one can observe both the structures and also which structures participate in specific functions. The fMRI provides high resolution, non invasive reports of neural activity detected by a blood oxygen level dependent signal.

The main advantages to fMRI technique to image brain activity related to a specific task or sensory process include:

- The signal does not require injections of radioactive isotopes.
- The total scan time required can be very short, i.e., on the order of 1.5 to 2.0 min per run
- The in-plane resolution of the functional image is generally about 1.5 x 1.5 mm although resolutions less than 1mm are possible.

Gray matter

It is a major component of the central nervous system. It is made up of neural cell bodies. Gray matter actually has a gray-brown color which comes from capillary blood vessels and neuronal cell bodies.

The function of gray matter is to route sensory or motor stimulus to inter- neurons of the CNS in order to create a response to the stimulus through chemical synapse activity. Gray matter structures process information is conveyed via specialized nerve cell extensions, which from the bulk of the cerebral, cerebellum, and spinal white matter.

White matter

It is one of the two components of the central nervous system. It is composed of bundles of myelinated nerve cell processes, which connect various gray matter areas of the brain to each other, and carry nerve impulses between neurons.

White matter forms the bulk of the deep parts of the brain and the superficial parts of the spinal cord. The white matter is white because of the fatty substance that surrounds the nerve fibers.The white matter is the tissue through which messages pass between different areas of gray matter within the nervous system. Using computer network as an analogy, the gray matter can be thought as the actual computers themselves, whereas the white matter represents the network cables connecting the computers together.

Segmentation of white matter from non-white matter

Segmentation is a process of extracting subject or structures of interest from background and each other.Segmentation of fMRI images involves separating the white matter from non-white matter. The white matter is segmented because it is clearly differentiable from the other parts of the brain. The gray matter is then drawn on top of the white matter.

II. METHODOLOGIES

Segmentation is a process of extracting subject or structures of interest from background and each other. Segmentation application include: identify/ evaluate anatomical areas of interest preprocess for surface extraction.

The segmentation of MRI involves separating the white matter from non white matter. The white matter is segmented because it is clearly differentiable from the other parts of the brain. The gray matter is then drawn on top of the white matter. This process is done for all brain images in three views coronal, sagittal and axial views.

Functionality

This section describes the functional requirements of the system for those requirements which are expressed in the natural language style.

Where application development tools (requirements tools, modeling tools, etc) are employed to capture the functionality, this section document will refer to the availability of that data and indicate the location and name of the tool which is used to capture the data

2.1 Segmentation:

The MRI image when fed into the system, the user should be able to segment the white matter from the brain MRI image. This feature of the product is assigned the highest priority as it the main scope of the project.

2.2 Accurate Result

The segmented image i.e. the output is very accurate and shows the segmented location of the distributed white matter in the brain MRI images. This feature is rated to have high priority as it the critical parameter required for further examination.

2.3 Performance

The performance characteristics of the system are outlined in this section.

- **Response time:** The important performance aspect of segmentation of the white matter from the brain MRI images is the time constraint. The system is real time. Since there is user intervention to perform the segmentation is required It depends on the user to perform the segmentation processing of the image.
- **Throughput**: The number of trials possible depends on the system type. It also depends on the hardware configuration used for the system where the application is run.
- **Capacity**: This application can be used by only one user at a time.
- **Degradation modes:** The accuracy is a vital feature and this could only be assured if the system is working in full capability.

2.4 Supportability

This section indicates any requirements that will enhance the supportability or maintainability of the system being built, including coding standards, naming conventions, class libraries, maintenance access, maintenance utilities.

2.5 Maintainability

Whenever a need for modification or repair arises the system provides facility to the technician to perform the associated task. This feature is of high priority as in real time system the need for changes occur frequently. The system should adapt to the changes made by the technician and resume the operation.

III. DESIGN

Design provides an overview of a solution, platform, system, product, service, or process. Such an overview is important in a multi-project development to make sure that each supporting component design will be compatible with its neighbouring designs and with the big picture.

Fig.1 depicts the data flow diagram for segmentation process. The input image that needs to be processed is given to segmentation process. Thresholding is performed on the input image. The final segmented image hence obtained represents the white matter of the brain.

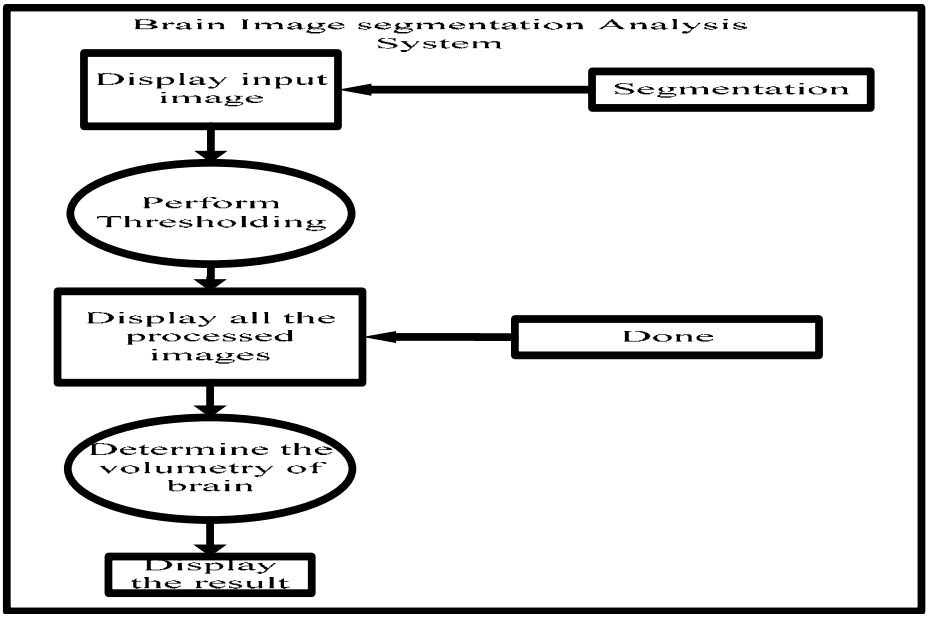

Fig.1 data flow diagram for segmentation process.

1V. RESULTS

As explained earlier the expected result of this project is extracting white matter from brain image. From the output image Fig.2, physician can segment the white matter by moving the vertical line. As shown in analysis the value or the result can be obtained in the command prompt.

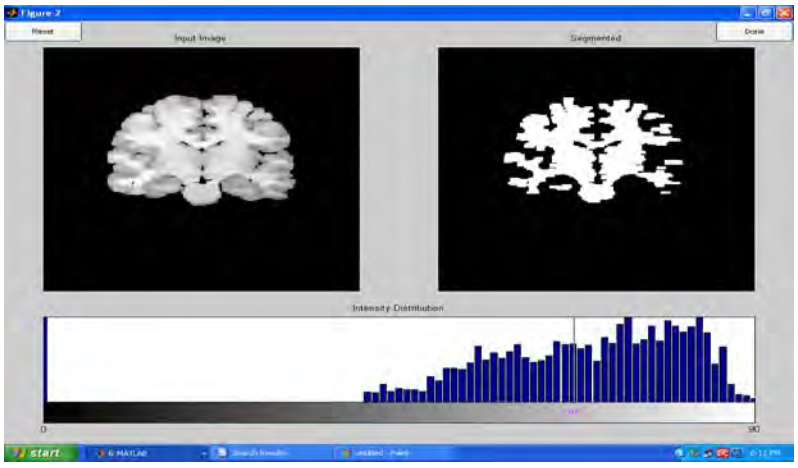

Fig.2 showing the result for segmented DICOM image.

4.1 EDGE PARAMETER

'Edge' command in takes an intensity image I as its input, and returns a binary image BW of the same size as I, with 1's where the function finds edges in I and 0's elsewhere.

The Canny method applies two thresholds to the gradient: a high threshold for low edge sensitivity and a low threshold for high edge sensitivity. Edge starts with the low sensitivity result and then grows it to include connected edge pixels from the high sensitivity result. This helps fill in gaps in the detected edges.

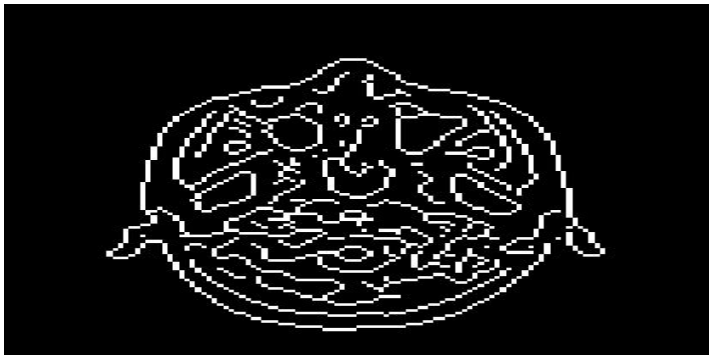

Fig.3 .Edge detected image

4.2 GRAY PARAMETER

Gray parameter value is set to the default value 0.0001. Then binary image is generated from the original image using the command 'im2bw' in matlab. 'im2bw' produces binary images from indexed, intensity, or RGB images. To do this, it converts the input image to grayscale format (if it is not already an intensity image), and then uses thresholding to convert this grayscale image to binary. The output binary image BW has values of 1 (white) for all pixels in the input image with luminance greater than level and 0 (black) for all other pixels. For the convenience of the user of our software we have used red and blue instead of black and white in the binary image.

Algorithm for gray parameter calculation can be written as follows:

Step 1: Set gray parameter value to 0.0001.

Step 2: Generate the binary image using 'im2bw' command.(fig.3.5)

Step 3: Display the binary image using red and blue colours.(fig(3.6)

Fig 4. Binary image after application of 'im2bw'

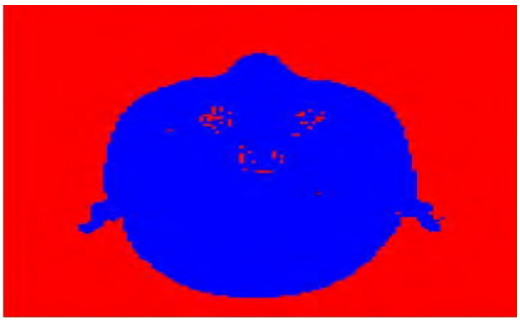

Fig.5.Binary image using red and blue colours.

4.3 WATERSHED SEGMENTATION

First step prior to Watershed segmentation is finding the distance transform of the complement of the binary image. The distance transform provides a metric or measure of the separation of points in the image. The Image Processing Toolbox in matlab provides a function, 'bwdist', that calculates the distance between each pixel that is set to off (0) and the nearest nonzero pixel for binary images. Then the distance transform is complemented and to ensure proper watershed segmentation the pixels which doesn't belong to the object in the image are forcefully set to minus infinity. Then watershed segmentation is carried out on the obtained image. The result of watershed segmented image is converted into a rgb image using 'label2rgb' command in image processing toolbox of matlab. 'label2rgb' converts a label matrix returned by watershed, into an RGB color image for the purpose of visualizing the labeled regions. The 'label2rgb' function determines the color to assign to each object based on the number of objects in the label matrix and range of colors in the colormap. Here we have select a color map called 'jet' in order to get more appealing results.

We can summarize the above steps into an algorithm as shown below:

Step 1: Convert the input grayscale image into binary image.

Step 2: Complement the binary image.

Step 3: Find the distance transform of the complement.(fig 3.7)

Step 4: Complement the distance transform.

Step 5: Set the pixels that doesn't belong to the object to minus infinity.

Step 6: Perform watershed segmentation.(fig.3.8)

Step 7: Convert the segmented image to rgb image with required colormap.(fig.3.9)

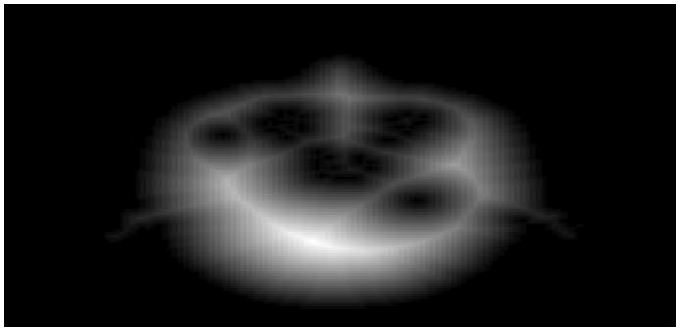

Fig.6. Distance transform of complemented image

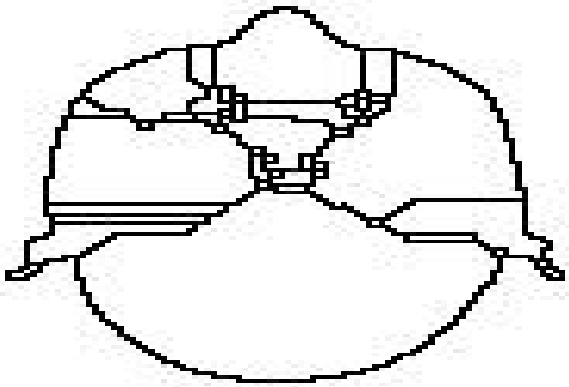

Fig 7. Watershed transformed image

Fig.8 Segmented image transformed to an rgb image

As we know that malignant tumor cells contain highly proteinaceous fluid, which is represented as high signal intensity on MRI images of the brain. Usually the watershed transformation is applied to a boundary map, which is a gray scale function, derived from the input image, which has low values within the regions and high values along region boundaries. The gradient magnitude of an intensity based image is oftenly used as the boundary map, as well as higher order features such as curvature. Watershed segmentation can be used for segregating the different intensity portions and this can be achieved by executing the algorithm in MATLAB.

4.4 DETERMINING THE ROI AND CALCULATING TUMOR AREA

We select the tumor region from the watershed segmented image by using 'roipoly' command in matlab. We use 'roipoly' to select a polygonal region of interest within an image. 'roipoly' returns a binary image that we can use as a mask for masked filtering. Here we select the tumor region and then generate a binary image where tumor area is represented by white and other regions by black. After that we used the 'bwarea' command which computes the area of the objects in a binary image. The result is a scalar whose value corresponds roughly to the total number of on pixels in the image, but might not be exactly the same because different

patterns of pixels are weighted differently. As display settings are 1028 X 768 pixels on the monitor of the computer being used for the work and the dimensions of the monitor are 280mm X 210mm, thus the dimensions of the one pixel comes out to be 0.2734mm X 0.2734mm (=0.0747 sq.mm approx.).

The algorithm for above procedure can be written as follows:

Step 1: Find rgb version of watershed segmented image.

Step 2: Select the tumor portion using 'roipoly' command.

Step 3: Obtain the binary mask of the selected region of step 2.

Step 4: Calculate the area of the mask in terms of pixels using 'bwarea' command.

Step 5: Calculate the area in square millimeters by multiplying the value obtained in step 4 with the area of one pixel.

4.5 Local Gaussian distribution fitting

In this section, we propose an implicit active contour model based on local intensity distribution.To effectively exploit information on local intensities.

V. CONCLUSION

Image segmentation plays a vital role in medical imaging by facilitating the explanation of regions of interest. The objective of this project is to segment the White matter from the gray matter of the brain fMRI images, to study the various functional aspects of the brain. The system is also used in determining various volumetric measurements such as brain volume, gray matter fraction and white matter fraction. Thus allowing the end-users to analyze the brain both qualitatively and quantitatively. The development of the GUI became important. It should be completely opaque to the backend and should also be user-friendly. This automation would certainly take process of segmentation at a higher level and allow the doctors to perform the same task within few hours.

Future Enhancement

There are certain enhancements that can be done to improve the results and add extra features to the GUI. To diagnose brain haemorrhage, brain tumor and other such diseases. The system should be developed to support multiple user access. Making the GUI customized, as per the requirement of the user.

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REFERENCES

[1] "Image Processing, Analysis and Machine Vision"- Milan Sonka, Vaclav Hlacav and Roger Boyle, 2nd edition, Thomson Learning, 2011.
[2] "Digital Image Processing "– Rafel C Gonzalez and Richard E Woods, 2nd Edition, Pearson Education, 2003.
[3] Kenneth R. Castleman. Digital Image Processing.Prentice Hall, 2008.
[4] Ashley R. Clark and Colin N Eberhardt.Microscopy Techniques for Materials Science. CRC
[5] Press, Boca Raton, Fl, 2002.
[6] James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, and Richard L. Phillips. Introduction to Computer Graphics.Addison-Wesley, 2009.
[7] http://en.wikipedia.org/wiki/Gray-matter
[8] http://en.wikipedia.org/wiki/Segmentation_(image_processing)
[9] http://searchwindevelopment.techtarget.com/sDefinition.html
[10] http://en.wikipedia.org/wiki/Mri
[11] http://en.wikipedia.org/wiki/Eeg
[12] http://en.wikipedia.org/wiki/Fmri
[13] http://en.wikipedia.org/wiki/Functional_magnetic_resonance_imaging
[14] http://en.wikipedia.org/wiki/White_matter

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