BRAIN TUMOR SEGMENTATION USING EDGE DETECTION TECHNIQUES THROUGH MATLAB

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Abstract— Image segmentation plays a crucial role in image analysis and computer vision which is also regarded as the bottleneck of the development of image processing technology applications. Medical Resonance Image (MRI) plays an important role in medical diagnostics and different acquisition modalities are used. Major goal of fMRI data analysis is to recognize activated brain areas and one of the major steps has segmentation. The edge detection method is most developed field on medical image processing. Region boundaries and edges are closely related to each other.Several methods for edge detection such as Canny, Prewitt, Sobel, Maar Hildrith, Robert. Experimental study shows that the canny operator is giving better results for compared with other operators such as the nature of adaptive, works better for noisy images and providing the sharp edges with low probability of false detection edges. MATLAB R2011a software was used. The texture features of each class gives high efficiency rate. The quantification of result demonstrates the effectiveness of the proposed method.
Keywords—***Brain tumor, MRI Scan, Segmentation, Edge detection, MATLAB.***

1. INTRODUCTION

In the vast area of medical image processing, segmentation of Magnetic Resonance Imaging (MRI) of a brain is particularly suitable for brain studies, because of its excellent contrast of soft tissues, non-invasive characteristics, and a high spatial resolution. In medical imaging for analyzing anatomical structures such as brain, bones, muscles, tissue types, blood vessels, pathological regions such as cancer, multiple sclerosis (MS), lesions and for dividing an entire medical image into sub-regions such as the white matter (WM), grey matter (GM) and cerebrospinal fluid (CSF) spaces of the brain automated delineation of different medical image components are used. An MRI is used to detect problems from the brain without surgery and also used to examine the brain, heart, liver, pancreas, reproductive organs and other soft tissues.

Brain image segmentation is used in research to characterize neurological diseases such as multiple sclerosis, epilepsy, Parkinson's disease, schizophrenia, Alzheimer's disease, cerebral atrophy. Different acquisition modalities obtain the medical images, including Ultrasounds (US), X-ray, Computed tomography (CT), magnetic resonance imaging (MRI), Single Photon Emission Tomography (SPECT), Positron Emission Tomography (PET).

Brain magnetic resonance images possess some features, images have the relatively high contrast between different tissues. The fundamental principle of MRI is to place the subject in an MRI machine which creates a powerful magnetic field (measured in Tesla units). The MRI field strength of the magnet is measured in Tesla. The early MRI scanners made use of magnetic fields in the range from 0.5 to 0.1 Tesla. Current human MRI scanners use 1.5-3.0 or even to 7 to 9 Tesla. The commercial systems are available between 0.2T–7T. An example of the MRI machine is Siemens Avanto 1.5T.

Functional magnetic resonance imaging has become an essential method for the investigation of human brain function, both for clinical purposes and for research. Functional areas identified by motor, sensory and language tasks have been shown to correspond well with intra-operative mapping and also with classically defined anatomical regions responsible for these functions. MRI studies the brain anatomy. But fMRI has taken many images in every 2 sec for fivemins. fMRI signal is calculated based on the blood oxygen level dependent (BOLD) contrast and neural activity.

Segmentation process is subdivides an entire image into its different objects or regions of components and an important tool in medical image processing. As an initial step, segmentation could be used for visualization and compression. Through identifying all the pixels (for two-dimensional image) or voxels (for three-dimensional image) belongs to an object, the segmentation of that particular object is achieved.

2. LITERATURE REVIEW:

This literature review provides a brief study of the segmentation techniques used in medical image analysis. In medical imaging, segmentation is an important analysis for which lots of algorithms and methods are developed. Variability of data is quite high in medical image processing especially for analyzing the anatomical structure and tissue types. Hence, segmentation techniques that provide flexibility, accuracy and convenient automation of paramount importance.

Balafar et al., 2010, presented the denoising methods to remove the noise from MRI images and state-of art methods in removing the noise are substantial. Methods vary from standard filters to more advanced filters, from general methods to specific MRI denoising methods such as linear filtering methods, nonlinear filtering methods, anisotropic nonlinear diffusion filtering, the Markov random field (MRF) models, wavelet models, non-local means models (NL-means) and analytically correction schemes.

Oikonomou and Blekas, 2013, studied functional MRI for the brain activation, to detect the activated brain regions and implemented a clustering approach for addressing this issue using an adaptive regression mixture model. Thus, the clustering approach is converted into a maximum a posteriori (MAP) estimation approach, where the expectation-maximization (EM) algorithm is applied for an incremental training procedure is presented.

Gursangeet and Jyoti, 2016, proposed for medical image processing and its segmentation is an active and very interesting area for researchers. It has reached at the exceptional place in diagnosing tumors after the discovery of MRI and CT. MRI is a useful device to detect the brain tumor and segmentation is performed and provide an overview of different image segmentation methods like watershed algorithm, morphological operations, thresholding, K-means clustering, fuzzy C-means, using MR images.

Charutha and Jayashree, 2014, proposed automated tumor detection techniques on medical images. An automated and efficient brain tumor detection technique implementing on MRI images, which integrates two image segmentation methods region growing and cellular automata edge detection.

Ramana et al., 2017, presented that edge detection is important step in that applications of image segmentation, image enhancement, image detection and recognition. The goal of edge detection is to localize the variation in the intensity of an image to identify the physical properties which produced by the capturing device. An edge might be characterized as a set of neighborhood pixels that forms a boundary between two different regions.

Zhenghao Shi et al., 2009, employed neural networks used for medical image processing, includes the key features of medical image pre-processing, segmentation, object detection and recognition. Problematic issues of neural network application for medical image processing and the major strengths and weakness of applying neural networks (NN) for solving medical image processing tasks.

3. METHODOLOGY:

The sequence of operations for detection of tumor area in MRI images of brain contain various steps like preprocessing, post-processing, classification and volume calculation and these are shown in following figure:

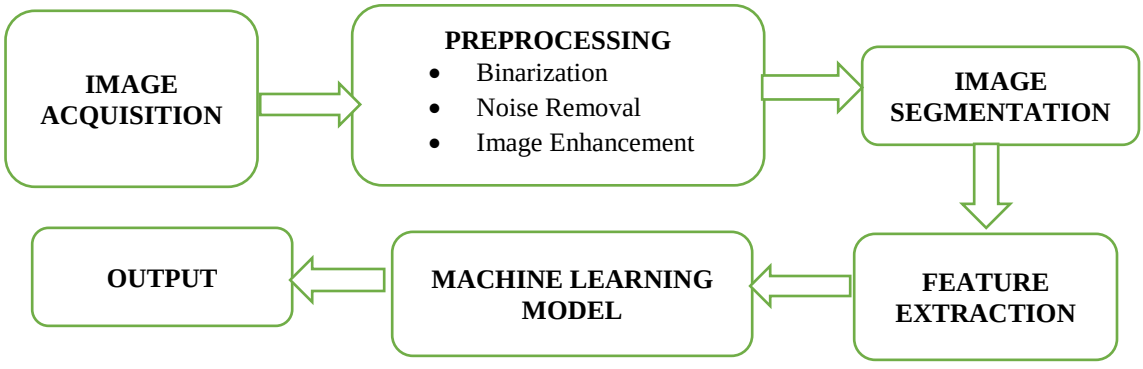


Fig.3.1 Proposed System

3.1 PRE-PROCESSING

To identify the small and sometimes variable signal change in the functional images, there are several pre-processing steps before going into statistical analysis of the functional changes. The pre-processing step includes number of steps is as follows: reading the medical image is loaded by using the computer with MATLAB software.

This step is come under pre-processing. Because RGB image consists of Red, Green and Blue color three matrix and it is difficult to work with it. Hence, Gray conversion is made, and it is also useful and convenient for thresholding. Grayscale = R+G+B/3, 3bit image means 23, 8 gray level (range 0 to 7). It means the image consists of the pixel intensity ranges from 0 to 7 in the brain images.MRI scan produces the medical images and the output of MRI provides gray level images. A gray scale image is a data matrix whose value represents shades of gray. The elements of gray scale matrix are with integer values or intensity values in range [0 to 255].

The digital images are acquired from MRI are stored in matrix form in MATLAB. Different formats of digital images like jpg, png, used in various algorithms. The MRI scan of patient suffering from tumor shows some region having high intensity. The objective of the algorithm is to detect the exact the location and size of this high intensity region. MRI images can involve some noises. So the further step is to remove this noise and to get an enhanced image for better detection.

3.2 IMAGE ENHANCEMENT

Poor contrast is one of the defects found in acquired image. The effect of that defect has great impact on the contrast of image. When contrast is poor the contrast enhancement method plays an important role. In this case the gray level of each pixel is scaled to improve the contrast. Contrast enhancements improve the visualization of the MRI images. Contrast enhancement technique is used for enhance the MRI image.

3.3. SEGMENTATION

In medical imaging, segmentation is important for feature extraction, image measurements and image display.Segmentation can be primarily classified as partial and complete.Image segmentation is frequently treated as a pattern recognition problem, since segmentation requires classification of pixels. The edge detection method is one of the segmentlation technique and we applied edge detectors are implemented in MR images.

3.3.1 EDGE DETECTION

In segmentation various methods are available. In important edge detection techniques were applied in brain tumor segmentation. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to:

- Discontinuities in depth,
- Discontinuities in surface orientation,
- Changes in material properties and
- Variations in scene illumination.

In the result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings as well as curves that correspond to discontinuities in surface orientation. Thus, applying an edge detection algorithm to an image may significantly reduce the amount of data to be processed and may therefore filter out information that may be regarded as less relevant, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent task of interpreting the information contents in the original image may therefore be substantially simplified. However, it is not always possible to obtain such ideal edges from real life images of moderate complexity.

The edge detection method is a well-developed field on medical image processing. Region boundaries and edges are closely related to each other, since there is generally a sharp adjustment in intensity at the region boundaries. The edge detection techniques have therefore been used as the base of another segmentation techniques.

Types of edge detection techniques are:

i. Gradient based Edge Detection, and,

ii. Laplacian based Edge Detection.

Edge detection is an essential component in computer image processing operations. Many edge detectors have been introduced for different purposes, using different approaches. The figure 1.3 shown the detailed information about the edge detectors.

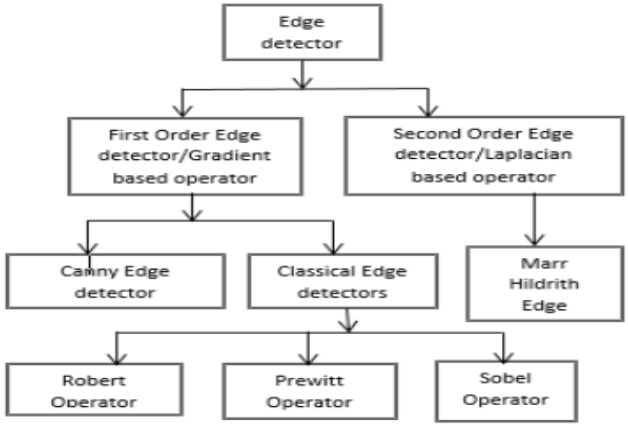


Fig.1.2 Edge detection techniques

The edge detection method is a well-developed field on medical image processing. Region boundaries and edges are closely related to each other, since there is generally a sharp adjustment in intensity at the region boundaries. Detecting the edges is an essential for segmenting the image into various regions based on their discontinuity in the pixels. It is broadly used technique and quick feature extraction technique hence used in various feature extraction and feature detection techniques.

The optimization adaptive thresholding techniques based on edge detection method in MRI brain images is used. The method presents the various edge detection methods like canny edge detector, Sobel edge detector, Prewitt edge detector, Laplacian of Gaussian, Robert edge detector are implemented in brain images.Filtering method is used to detect the edges on the actual pictures or fact to find the edges of a high-resolution and this filter has been created by Laplace filter and Markov Basis. It has been realised that the proposed edge detection method performs better than Sobel, Roberts Prewitt, and Canny's edge detection algorithms.

Roberts edge detection

The Roberts edge detection performs a quick to compute, simple, 2-dimensional spatial gradient measurement on an image. This method emphasizes the regions of high spatial frequency which often correspond to edges. The input to the edge detection operator is a grey-scale image the same as to the resultant output is the most common usage for this technique.

+1	0
0	-1

G_X

0	+1
-1	0

G_Y

The pixel values are presesnted in every point in the output represents the approximate calculation for whole magnitude of the spatial gradient of the input image at that point.According to Roberts, an edge detector should have the following properties: the produced edges should be well-defined, the background should contribute as little noise as possible, and the intensity of edges should correspond as close as possible to what a human would perceive.

Sobel edge detection:

Sobel edge detection method was proposed by Sobel. This method of edge detection for image segmentation process, to find the edges are using the Sobel approximation to the derivative. It precede the edges at those points where that gradient values are higher.

Sobel edge detection performs a two-dimensional spatial gradient quantity on the entire image and highlighted the regions of high spatial frequency that corresponds to an edges. In generic, it is used to find the estimation for the absolute gradient magnitude at each point in n number of input grey-scale images. In speculation at least the operator consists of a pair of 3x3 complication kernels. In one kernel is simply the other rotated by 90°. This is similar to the Roberts Cross operator.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these Gx and Gy). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient.

The gradient magnitude is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

Typically, an approximate magnitude is computed using:

$$|G| = |Gx| + |Gy|$$

which is much faster to compute.

The angle of orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by:

$$\theta = \arctan(Gy/Gx)$$

Prewitt edge detection:

The Prewitt edge detection estimate the magnitude and orientation of an edge in a correct way. Even though the different gradient edge detection wants a quiet time consuming computation to estimate the direction from the magnitudes in the y and x-directions, the compass edge detection acquires the direction directly from kernel with the greatest response. It is limited to 8 all possible directions; however knowledge shows that most direct direction estimates are not much more perfect.

-1	-1	-1
0	0	0
+1	+1	+1

G_X

-1	0	+1
-1	0	+1
-1	0	+1

G_Y

The Prewitt operator is similar to the Sobel operator and is used for detecting vertical and horizontal edges in images. This gradient based edge detector is calculated in the 3x3 neighborhood pixels for all possible directions. All the eight possible directions of convolution masks are calculated. In this edge based segmentation, there is no need for the detected edges to be closed. There are various edge detectors that are used to segment the image.

IMAGE SEGMENTATION TECHNIQUES	**ADVANTAGES**	**DISADVANTAGES**
Active contour method	1. Use active contour Models. 2. Preserves global line shapes efficiently.	1. Should find strong image gradients to drive the contour. 2. Lacking accuracy with weak image boundaries and image noise.
Watersheds Method	1.Based on mathematical morphology 2.Helps to improve the capture range	Over segmentation
Threshold method	1.Try to find edge pixels. 2.The detected edges are consisted while eliminate the noise influence.	1. Use gradient magnitude to find the potential edge pixels of discrete pixels and may be Incomplete or discontinuous. 2. Computationally Expensive
Seed region growing	1.Correctly separate the regions that have the same properties 2. determine the seed points	1. it requires manual interaction to obtain seed point
Marker based Watershed	It remove the over segmentation problem, which occur in watershed segmentation	

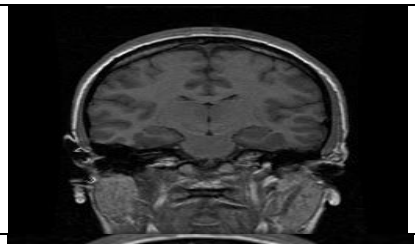
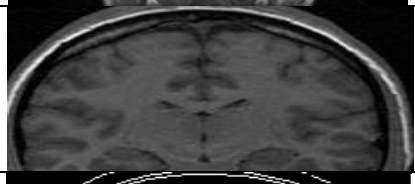
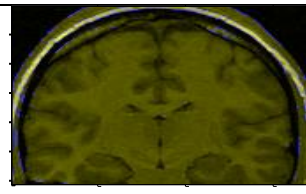
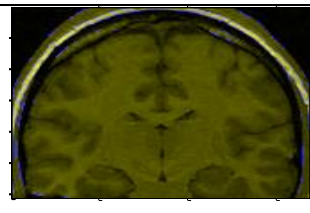
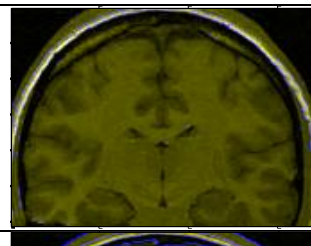
The above table shown that the various segmentation algorithms are described and pros and cons are mentioned.

5. SIMULATION TOOL

MRI images are best suitable for brain tumor detection. In this study Digital Image Processing Techniques are important for brain tumor detection by MRI images. The preprocessing techniques include different methods like Filtering, Contrast enhancement, Edge detection is used for image smoothing. The preprocessed images are used for post processing operations like; threshold, histogram, segmentation and morphological, which is used to enhance the images. The various edge detection techniques are Prewitt, Canny, Sobel, Robert and Log. Those algorithms are implemented by using the simulation tool (**MATLAB 2012a**)

Segmentation Image segmentation is the process of partitioning a digital image into multiple segments. The different edge detectors are used for segmentation techniques are shown in table 2.

6. EXPERIMENTAL RESULTS

EDGE DETECTION TECHNIQUES	ORIGINAL IMAGE	ORIGINAL IMAGE AFTER EDGE DETECTION
Original Image		ORIGINAL IMAGE
Cropped Image		SEGMENTED IMAGE
SOBEL		
PREWITT		
ROBERTS		
CANNY		

Several methods for edge detection such as Canny, Prewitt, Sobel, Maar Hildrith, Robert. We have studied and compared Prewitt, Sobel, and Canny detection operators. Experimental study shows that the canny operator is giving better results for compared with other operators such as the nature of adaptive, works better for noisy images and providing the sharp edges with low probability of false detection edges.

7. CONCLUSION AND FUTURE WORK:

In this paper, we have presented Image Enhancement for brain MRI image segmentation for tumor detection. The MRI image dataset that we have utilized in our proposed image segmentation technique is taken from the publicly available sources. In future the work can be extended to segmentation using Modified fuzzy C-means algorithm, Feature extraction of the region like mean, standard deviation, range and pixel orientation and final classification using the support vector machine.Many future works are possible to make this segmentation more effective. A combination of features can be generated by considering three to four successive slices in order to segment the volumetric information of fMRI. The number of features can be increased from 3 to 10 to represent the different properties like density, change in greyscale and change in contrast in the successive slices. For the purpose of enhanced segmentation the GLCM properties can be used combined with genetic algorithm for decreasing the false positive rate.

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