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Brain Tumor Segmentation using Image Enhancement of MRI Brain Images

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ABSTRACT: Magnetic Resonance Images (MRI) processing is one of very important parts of the image processing technology in medical field. It is the most developing field from past few days. Manual segmentation of human brain tumor is time very consuming and also a challenging task. The detection of tumor is often an initial phase to solve the segmentation problem. This paper explains the detection of the brain tumor by segmenting and extracting the tumor region.
The aim of this project is to identify and establish a method for segmentation of brain tumor of MR images of the head. The primary goal of this project is to extract the brain MR image that contains white matter, gray matter, and intracerebral CSF, and to notice the convolutions of the brain as well as possible. Thus, the purpose is to obtain a more detailed geometrical explanation of the brain. The method should be proper for patient individual modeling, which implies that a method of minimum user interactivity is needed, i.e. a completely automatic method.

KEYWORDS: MRI Images; histogram; segmentation; image morphology; k-mean cluster.

I. INTRODUCTION

The human body is made up of many cells which have their own special characteristics. Most of the cells in the human body grow and split to form a new cell of the same kind as they are required for proper functioning of the human body. When those cells lose control and develop in an uncontrollable way, it rises to a mass of undesired tissue forming a tumor.

At KTH, Division of Neuronic Engineering, a finite element model inside the human head has been developed (Kleiven, 2002). The model is used to create biological tissues to be able to notice how they are affected by for example the trauma to the head. The model can be used to calculate injuries by performing some numerical calculations of for example strain and pressure within the brain tissues.

The FEM, see Figure 1.1, includes for example white matter, gray matter, cerebrospinal fluid (CSF), bone, major blood vessels, and meninges. However, the model does not contain a very detailed geometry.

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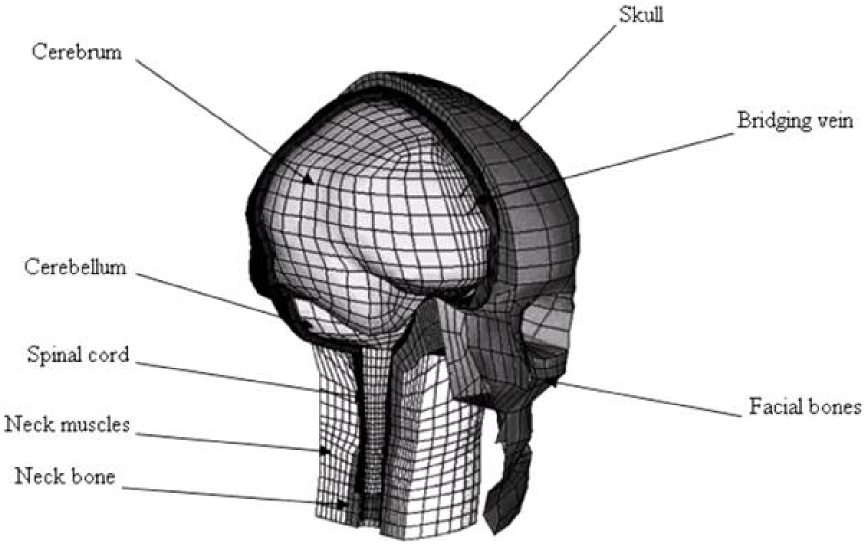

Figure 1: Finite element model of the head.

Brain tumor is the human mass of tissue in which cells grow and multiply uncontrollably. These brain tumors may be embedded in the areas of the brain that provides the sensitive functioning of the body to be disabled. Its location and dynamic spreading capacity provides its treatment very complex and risky.

Tumors may be classified into three types:

1) Benign, 2) Pre Malignant, 3) Malignant tumor.

Benign tumors are those that are incapable of unexpected expanding and affecting the other healthy brain tissues. Premalignant tumors are the pre-cancerous stage, if not treated accurately it might lead to cancer. It is generally considered as disease tumor. Malignant tumors grow fast with time an ultimately leads to death of patient. Malignant is the medical term that describes a sever growth of a disease.

MRI is mostly used in the biomedical to detect and envisage finer details in the internal structure of the human body. This method is basically used to detect the differences in the tissues which have a far improved method as compared to computed tomography. So this makes this procedure a very special one for the brain tumor detection and cancer imaging. [1]

II. RELATED WORK

M. Masroor Ahmed and Dzulkifti Bin Mohammad [4] proposed an algorithm for detection of brain tumor using K-means algorithm. It is observed that tumor is spotted along with non-tumor region. Also, Greg Hamerly and Charles Elkan have established an algorithm using K-means clustering [5]. This algorithm may be used for better result in image segmentation. J. Selvakumar et al. [3] have developed an algorithm for brain tumor detection with K-means clustering and finally they have used FCM for better result. An adaptive K-means algorithm is considered in [6] to notice micro calcifications in digital mammograms for breast cancer detection. FCM technique is used in [7] to remove WM, GM and CSF from MRI image. M. Shasidhar, V. Sudheer Raja, B. Vijay Kumar [8] have improved FCM for fast convergence of the algorithm. In [9] a technique named Cohesion Based Self Merging (CSM) is used to refine the detected tumor area.

In addition, algorithm using threshold based segmentation have also been considered in tumor detection problem in [10]. Kiran Thapaliya and GooRak K won [11] has detected tumor from MRI image using techniques based on morphological operations. In [12] the template matching approach had quoted to detect the tumor. A. Elamy, M. Hu [13] has prophesied the growth of the tumor using similarity measure method by combining Bayes Classifier. In this paper, a brain tumor detection algorithm has been developed for T2-weighted MRI images, T2-weighted MR images brain tumor seems as hyper-intense with respect to normal brain tissue. The present brain tumor detection algorithms are based on different unsupervised learning algorithms (K-means, Fuzzy C-means (FCM) etc.). K-means is subdivided clustering approach and in FCM, membership value of each pixel is calculated so that a specific pixel can belong to a

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cluster center. Threshold is an exact intensity value that satisfies a predefined intensity value, it is used to separate object or Region of Interest (ROI) from the background image, choosing in the range of 0 to 255. But it is detected that clustering approaches followed by threshold cannot sense tumor properly from MRI image, because the image contains several non-brain tumor tissue. For that reason, a proposed method has been formulated using K-means algorithm followed by Object labeling algorithm also, some preprocessing steps (median filtering and morphological operation) is used for tumor detection purpose..

III. Proposed Algorithm

Segmentation of the brain MRI images have been proposed for recognition of tumors using clustering techniques. A cluster can be well-defined as a group of pixels where all the pixels in certain group demarcated by a similar relationship [14]. Clustering is also known as unsupervised classification procedure. The name unsupervised classification because the algorithm automatically classifies objects based on user given criteria. Here K-means clustering process for segmentation of the image tracked by morphological filtering is used for tumor detection from the brain MRI images. The proposed block diagram is shown in figure 2.

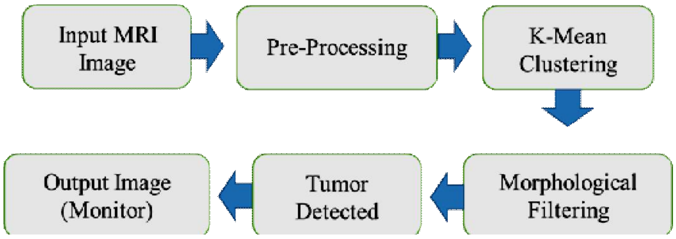

Figure 2: Proposed Block Diagram

MRI scans of the human brain forms the input images for our method where the grey scale MRI input images are taken as the input. The preprocessing stage will transform the RGB color input image to grey scale image. Noise present if any, is being removed using the median filter. The preprocessed image is taken for image segmentation using K-means clustering method. As there are risks of occurrence of misclustered regions after the application of K-means clustering algorithm [15], a morphological filtering have been proposed which is executed after the image is segmented by using K-means clustering algorithm.

Image Acquisition:

Images are achieved using MRI scan and these scanned images are showed in a two dimensional matrices having pixels as its elements. These matrices are related to matrix size and its field of view. Images are kept in MATLAB and displayed as a gray level image of size 256*256. The entries of a gray level image are ranging from 0 to 255, where 0 shows complete black color and 255 shows completely pure white color. Entries within this ranges vary in intensity from black to white. For experimental purpose 30 female and 30 male patients were examined, all patients have ages ranging from 20 to 60 years. Their MRI scans were stored in database of images in JPEG image formats.

Preprocessing:

In this step image is enhanced so that finer details are improved and noise is reduced from the image. Most frequently used enhancement and noise reduction methods are applied that can give best possible results. Enhancement will result in more prominent edges and a sharpened image is acquired, noise will be removed thus reducing the blurring effect from the image. In addition to enhancement of image, the image segmentation will also be applied. This enhanced image will help to detect edges and improving the quality of the whole image. Edge detection will lead to find the particular location of tumor. Following steps will be monitored in the preprocessing stage: 1) The developed MRI scanned images, kept in database is transformed to gray scale image of size 255*255; 2) image is processed to remove any noise present. Visual quality of noisy image will not be acceptable; 3) the less noisy, high quality image is then operated by a high pass filter to sharpen and to detect the edge; 4) The sharpened image is then added to original image for further enhancement.

a) Noise Removal: Many filters are used to extract the noise from the images. Linear filters can also help the purpose like Gaussian, averaging filters. For example average filters are used to eliminate salt and pepper noise from

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the image. Because in this filter, pixel's value is substituted with its neighborhood values. Median filter is also used to extract the noise like salt and pepper and weighted average filter is the deviation of this filter and can be executed easily and give good results. In the median filter the pixel value is determined by the median filter of the neighboring pixels. This filter is less sensitive than the outliers.

b) Image Sharpening: Sharpening of the image can be accomplished by using different high pass filters. As now noise is been extracted by using different low pass filters, we need to sharpens the image as the sharp edges is necessary because this will help to detect the border of the tumor.

Processing:

Segmentation: Image segmentation is based on the division of the image into some regions. Division is done on the basis of parallel characteristics. Similarities are detached out into groups. Basic need of segmentation is the removal of important characteristics from the image, from which data can easily be perceived. Brain tumor segmentation from MRI images is a motivating but quite challenging task in the field of medical imaging.

Post Processing:

In processing segmentation is done using following methods.

1. Threshold Segmentation: Threshold segmentation is one of the easiest segmentation methods. The input gray scale image is transformed into a binary one. The method is based on a threshold value that will transform gray scale image into a binary image format. The main logic is the choice of a threshold value. Some common methods used under this segmentation comprise maximum entropy technique and k- means clustering process for segmentation. [17].

Watershed Segmentation: It is one of the best approaches to group pixels of an image on the basis of its intensities. Pixels falling under alike intensities are gathered together. It is a good segmentation procedure for dividing an image to distinct a tumor from the image Watershed is a scientific morphological operating tool. Watershed is generally used for checking output rather than using as an input segmentation method because it usually writhes from over segmentation and under segmentation [18]. To use watershed segmentation different approaches are used. Two basic principle approaches are given below: 1) the calculated local minima of the image gradient are chosen as a marker. In this technique an over segmentation happens. After choosing marker region merging is done as a second step; 2) Watershed transformation using markers develops the specifically well-defined marker positions. These positions are either defined clearly by a user or they can be determined automatically by using morphological tools.

2. Morphological Operators: After transforming the image in the binary format, some morphological operations are applied on the transformed binary image. The purpose of the morphological operators is to separate the tumor part of the image. Now only the tumor portion of the image is noticeable, shown as white color. This portion has the highest intensity than other regions of the image.

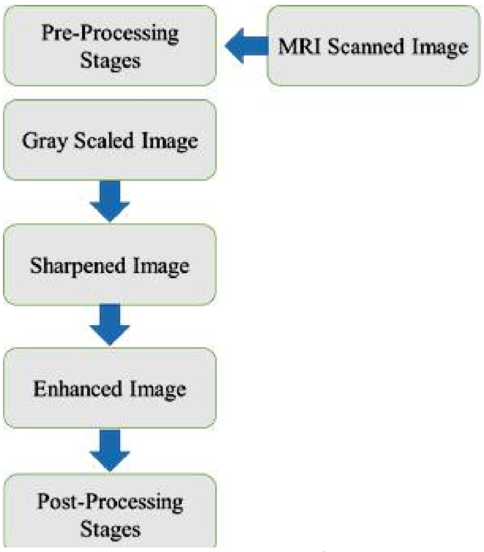

Figure 3: Pre-processing Stages of Tumor Detection

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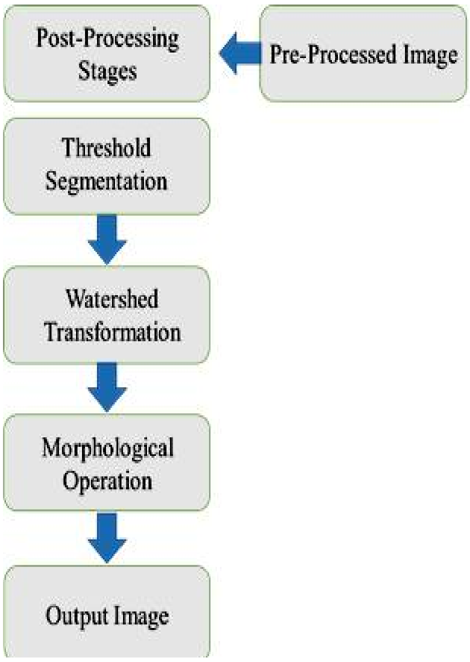

Figure 4: Post-Processing Stages of Tumor Detection

IV. RESULTS

The every steps of experimental result is shown in figure 5.

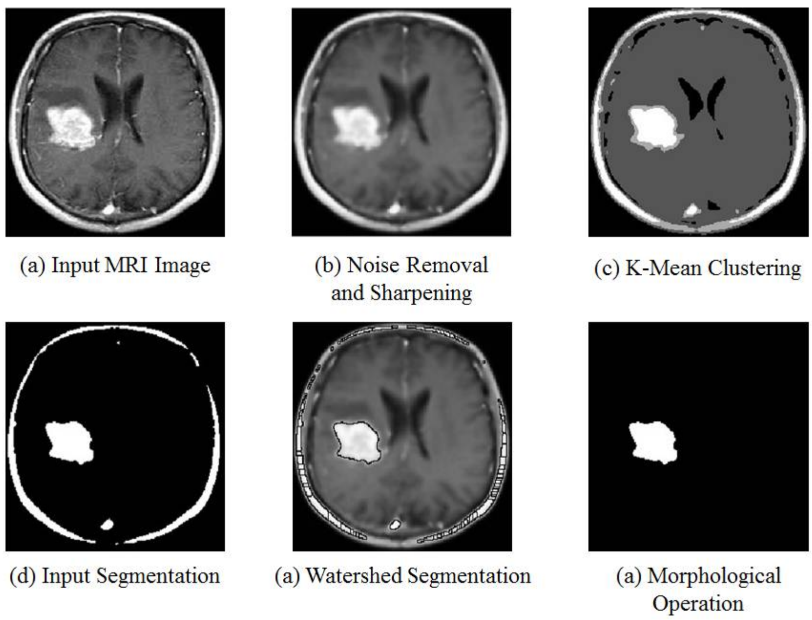

Figure 5: Result showing every steps respectively for Tumor Segmentation

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Here in this case the shape of the spotted tumor is irregular. So it is a malignant tumor. The area of the tumor portion is approximately 1504.63 square pixels. As the area is not quite large and there is no remark of dead cells, it is not in critical stage yet.

The proposed technique is applied on different types of tumor affected T2 weighted MRI images (20 images). The shape and size of the tumor is dissimilar and changing from image to image. The results (tumor detection) of the dissimilar MRI images using Noise removal and Sharpening filters followed by K-means clustering, Threshold segmentation, Watershed segmentation and Morphological operation are shown in the figures (6).

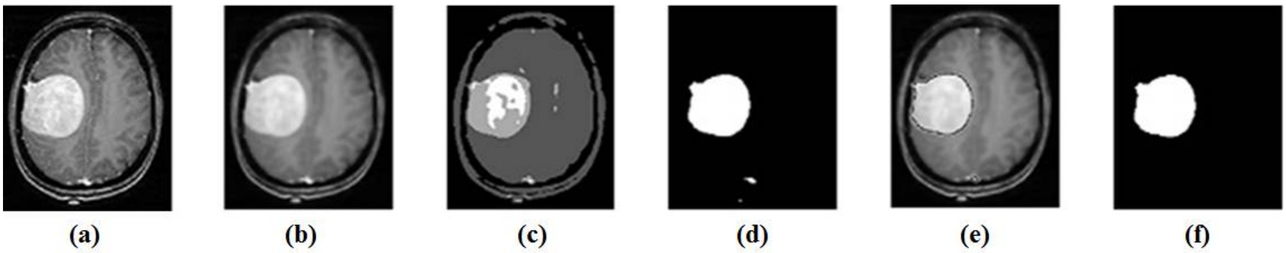

Figure 6: (a) Loaded MRI image, (b) After removing noise and sharpening, (c) K-means clustering, (d) Threshold segmentation and obtaining binary image, (e) Watershed segmentation, (f) Morphological operation and detection of tumor.

In case of figure 6, the tumor shape is round i.e. regular. So it is a benign tumor. The area of the tumor portion is approximately 3450.38 square pixels. There is a slight mid-line shifting detected, so it is in critical stage.

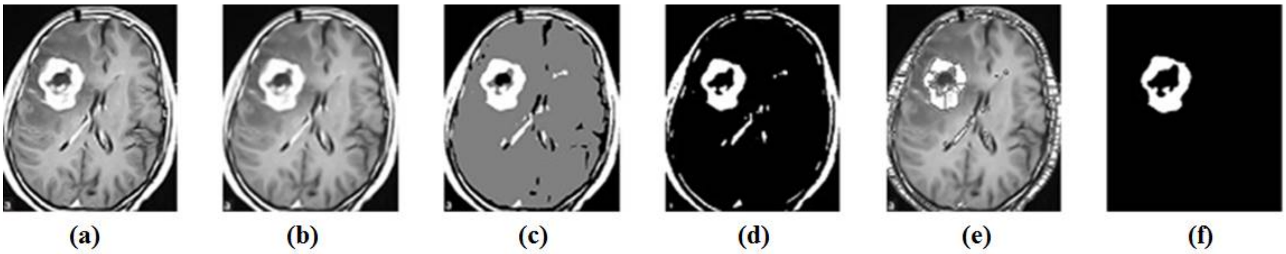

Figure 7: (a) Loaded MRI image, (b) After removing noise and sharpening, (c) K-means clustering, (d) Threshold segmentation and obtaining binary image, (e) Watershed segmentation, (f) Morphological operation and detection of tumor.

In case of figure 7, the tumor shape is quite irregular. So it is a malignant tumor. The area of the tumor portion is approximately 2707.13 square pixels. There is some dead cells detected in the tumor and there is also minor mid-line shifting, so it is in very critical stage.

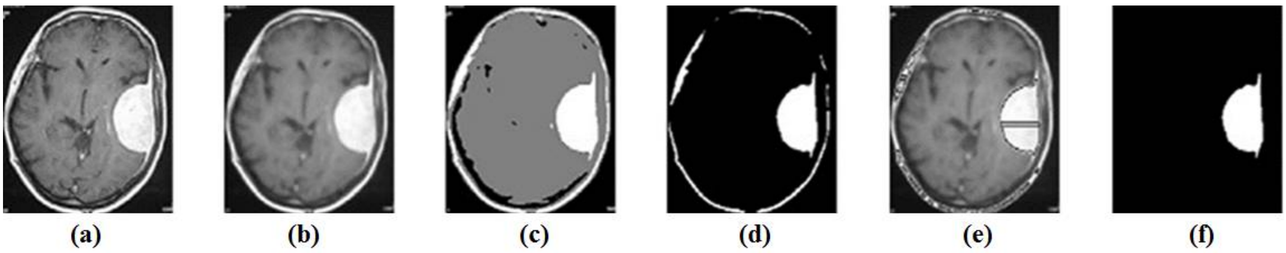

Figure 8: (a) Loaded MRI image, (b) After removing noise and sharpening, (c) K-means clustering, (d) Threshold segmentation and obtaining binary image, (e) Watershed segmentation, (f) Morphological operation and detection of tumor.

Here in case of figure 8, the tumor shape is round i.e. regular. So it is a benign tumor. The area of the tumor portion is approximately 3090.13 square pixels. As the tumor is quite large so it is in pre critical stage.

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V. Conclusion and Future Work

The executed technique segments the brain tissues from the other tissues of the human head in an automatic way. The convolutions of the brain are noticed and white matter, gray matter, and CSF are separated. The process compensates for intensity in homogeneities. However, developments can be made to the algorithm to make it more robust and automated. The initialization of the algorithm must be upgraded to make the process completely automated. The bias field correction could also be developed to obtain better results.

This method gives efficient results as compared to previous researches. Experiments are applied on various images and results were unexpectedly good. Our proposed research is easy to implement and thus can be managed easily.

Our future work is to extend our recommended method for color based segmentation of 3D images. For this case we need a classification method to establish three dimensional objects into distinct feature classes, whose characteristics can help in diagnosis of brain diseases.

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