ILLUMINATING BRAIN TUMOR IN MRI METAPHORS BY USING SVM CLASSIFIER

Mr.A.Muruganandham, Research Scholar, Department of Computer Science, Nallamuthu Gounder Mahalingam College, Pollachi, Tamil Nadu, India.
muruganandham24@gmail.com
Dr. R.Nandhakumar, Assistant Professor, Department of computer Science, Nallamuthu Gounder Mahalingam College, Pollachi, Tamil Nadu, India.
nkumarram@gmail.com

Abstract:
The field of medical imaging is gaining importance with an increase in the demand for automated, reliable, fast and efficient diagnosis which can provide insight to the image better than human eyes. Brain tumor is the second leading cause for cancer-related deaths in men in age 20 to 39 and fifth leading cause cancer among women in same age group. Brain tumors are painful and may result in various diseases if not cured properly. Diagnosis of tumor is a very important part in its treatment. Identification plays an important part in the diagnosis of benign and malignant tumors. A prime reason behind an increase in the number of cancer patients worldwide is the ignorance towards treatment of a tumor in its early stages.

Key words: Benign, Malignant, SVM, Image Segmentation

INTRODUCTION:

This project discusses such an algorithm that can inform the user about details of tumor using basic image processing techniques. These methods include noise removal and sharpening of the image along with basic morphological functions, erosion and dilation, to obtain the background. Subtraction of background and its negative from different sets of images results in extracted tumor image. Plotting contour and c-label of the tumor and its boundary provides us with information related to the tumor that can help in a better visualization in diagnosing cases. This process helps in identifying the size, shape and position of the tumor. It helps the medical staff as well as the patient to understand the seriousness of the tumor with the help of different color-labeling for different levels of elevation. A GUI for the contour of tumor and its boundary can provide information to the medical staff on click of user choice buttons. The SVM classifier algorithm can be implemented in four major steps as shown in Fig1. First step is pre-processing & Image acquisition of given MRI image in MATLAB then second is filtering the image to reduce the noise and third is image resizing and finally fourth step is tumor extraction using SVM classifier.
The aim of the project is tumor identification in brain MRI images. The main reason for detection of brain tumors is to provide aid to clinical diagnosis. The aim is to provide an algorithm that guarantees the presence of a tumor by combining several procedures to provide a foolproof method of tumor detection in MRI brain images. The methods utilized are filtering, contrast adjustment, negation of an image, image subtraction, erosion, dilation, threshold, and outlining of the tumor. The focus of this project is MRI brain images' tumor extraction and its representation in simpler form such that it is understandable by everyone. Humans tend to understand colored images better than black and white images, thus, we are using colors to make the representation simpler enough to be understood by the patient along with the medical staff. The objective of this work is to bring some useful information in simpler form in front of the users, especially for the medical staff treating the patient. Aim of this project is to define an algorithm that will result in extracted image of the tumor from the MRI brain image. The resultant image will be able to provide information like size, dimension and position of the tumor, plotting contour and c-label of the tumor and its

boundary provides us with information related to the tumor that can prove useful for various cases, which will provide a better base for the staff to decide the curing procedure. Plotting contour-f plot and c-label plot of the tumor and its boundary will give easy understanding to the medical staff because human comprehend images better with the help of different colors for different levels of intensity, giving 3D visualization from a 2 D Image.

IDENTIFY, RESEARCH & COLLECT IDEA

The algorithm is a set of image processing fundamental procedures. A set of noise- removal functions accompanied with morphological operations that result in clear image of tumor after passing through high pass filter is the basic idea behind the proposed algorithm.

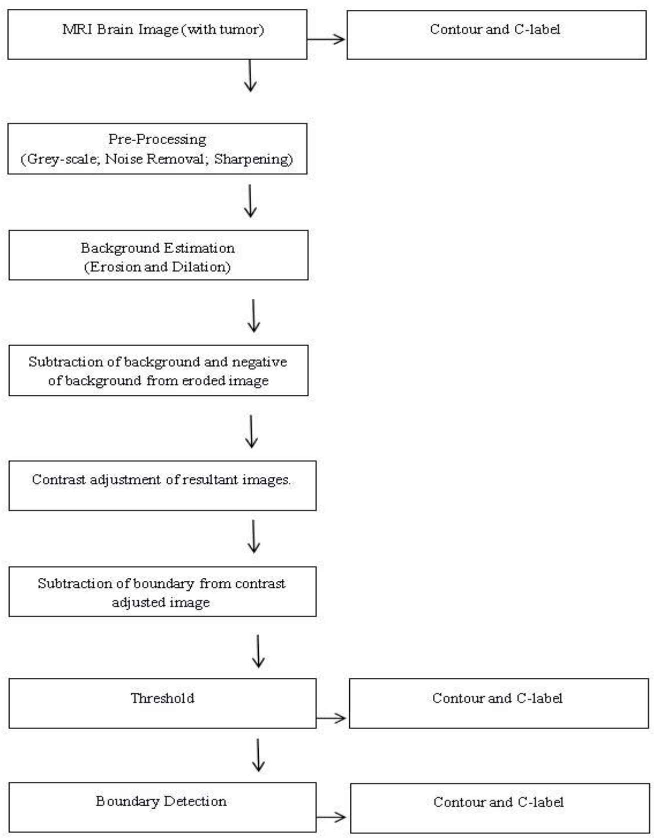


Figure 1: Tumor image using MATLAB

The set of morphological operations used will decide the clarity and quality of the tumor image. A GUI is created in the MATLAB offering the proposed application of extracting the tumor from selected brain image and its visualization using contour plot. Without having to deal with the code, medical staff can select the MRI image and study the extracted tumor along with its boundary from contour and c-label options. The GUI also contains options for zoom-in, zoom- out, data cursor for co-ordinates, and prints the selected image.

SVM Classifier for Image Segmentation

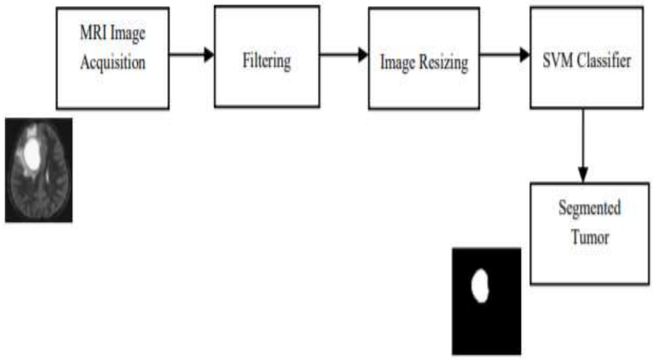


Figure 2: SVM Classifier for Image Segmentation

SVM classifier is used for image segmentation. The SVM classifier algorithm can be implemented in four major steps as shown in Fig2. First step is pre-processing & Image acquisition of given MRI image in MATLAB then second is filtering the image to reduce the noise and third is image resizing and finally fourth step is tumor extraction using SVM classifier.

MRI Image Acquisition:
The input MRI images have been collected in DICOM (Digital Imaging & Communications in Medicine) and JPEG (Joint Pictures Expert Group) format. All images are of type T2. Majority of the images collected was in DICOM format. The MATLAB does not support DICOM format therefore we have to convert these images in JPEG format using MicroDicom tool. The images acquired from different MRI machines may vary in size. Therefore input image size has to be normalized to 256×256 pixels and a bit depth of 8.

Filtering:
Filtering is done using anisotropic diffusion. In image processing and computer vision, anisotropic diffusion is a technique aiming at reducing image noise without removing significant parts of the image content, typically edges, lines or other details that are important for the interpretation of the image.

Image Resizing:
When image acquired in MATLAB, its initial size is 256×256 with unit8 class. To enhance the speed of operation or processing image is resized by 50%, now new dimensions become 128×128 with class as double.

SVM Classifier:
Support vector machine is a machine learning method that is widely used for data analyzing and pattern recognizing. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features we have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

SIMULATION RESULTS
In the simulation the input signal is an image of brain MRI having 256×256 pixels with bit depth of 8 and in JPEG format. First of all input image is filtered using anisotropic diffusion technique which smooth the image without changing the edges as shown in Fig3. To

increase the image processing speed the size of filtered image is reduced by 50% by using resize command in MATLAB.

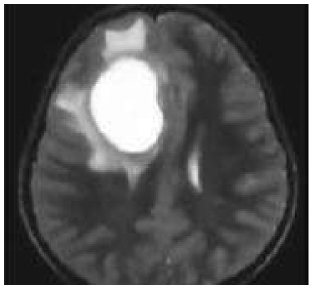


Figure 3: Input Image

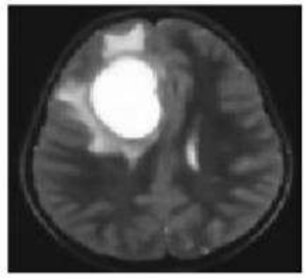


Figure 4: Filter Image

The SVM classifier algorithm is applied over the resized filtered image. The initial output of the algorithm, which is further refined by the algorithm in successive iterations. And finally the tumor portion is segmented.

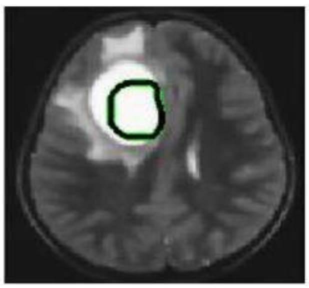


Figure 5: SVM classification Result

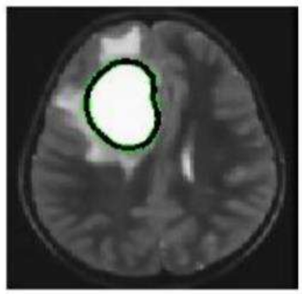
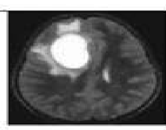
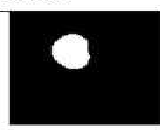
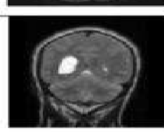
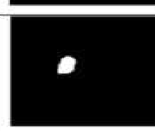
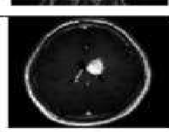
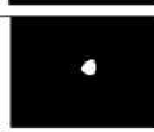
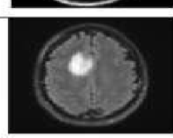
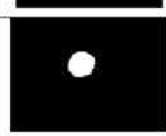


Figure 6: SVM classification Final Result

Figure 7: Segmentation Tumor image

SIMULATION RESULT DATA

Table 1: Simulation Result Data

S.No	MRI Image with tumor	Segmented Tumor	Tumor size in pixels	Tumor size in mm	Processing time
1.			949	34.32 mm	45.22s
2.			242	17.32 mm	45.66s
3.			161	14 mm	46.19s
4.			466	24 mm	44.50s

IMPLEMENTATION

A. Noise Removal and Sharpening

As a grayscale or colored image maybe the inputted image, the first step is to convert the given image into a grayscale image [4]. On procuring the grayscale image, the aim then is to filter [4] it so as to sharpen it and remove any noise [4], if present. In the algorithm, unsharp [1][14] filtering of fspecial[2][14] filter is applied in order to sharpen the image by removing the low intensity values. For noise-removal 'Gaussian' [1][9] filters is used from f special filters.

B. Erosion and Dilation

After pre-processing, next step is to estimate the background [14]. In order to do so we make use of the basic morphological operations, erosion and dilation. More erosion [14] and less dilation [14] will result in decrease in skull bones' image size. To accomplish this we will keep the eroding structural element's radius bigger than that of dilating structural elements. The structuring element used is 'diamond'.

C. Negation

The estimated background, obtained by the previous step, will contain the eroded tumor region as our aim was to remove the skull boundary and radius of structuring element was kept as such. Negative of the image can be calculated by subtracting [11] the image from 255 which the highest value any pixel can have.

D. Subtraction

Subtracting background and negative of background from eroded image will result in images with and without tumors [11]. These images will contain skull's boundary along with the tumor region and thus will be imperfect for use [6].

E. Contrast Adjustment

In order to provide a clear and well-defined image to work upon, this operation is further applied to the result of subtracting images in previous step. This operation involves increasing the contrast of the filtered image, which is accomplished by performing contrast adjustment techniques [6]. These contrast images will further be subtracted from dilated image [6][11].

F. Threshold

Next step in this algorithm is to calculate global image threshold using Otsu's method [10], which chooses the threshold to minimize the intra-class variance of the black and white pixels. Thus we will get a clear image of the tumor region [6].

G. Boundary Detection

In earlier times without aid of medical imaging tumors were identified manually and boundaries were drawn around it by an expert which always contained issues related to manual-error. Thus, to remove this error, the next step includes producing a clear boundary of the identified tumor using the morphological operation 'remove', which removes all the interior pixels, thus leaving only the boundary pixels on.

H. Contour and C-label

Contour is a curve along which the function has a constant value. A contour line (often just called a "contour") joins points of equal elevation (height) above a given level. These different levels are represented by different colored boundaries. Contour-f function gives a better view of the system by each level with different colors. C-label adds height labels to a 2-D contour plot, providing a better insight to the image.

RESULT

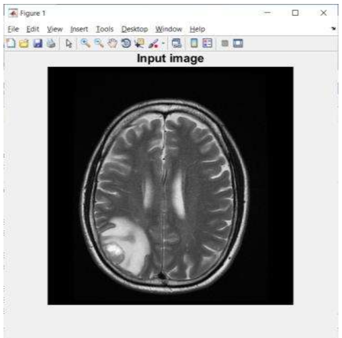


Figure 8: Input image

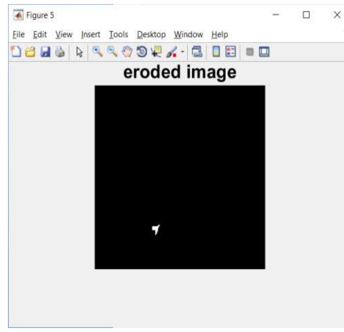


Figure 12: Eroded image

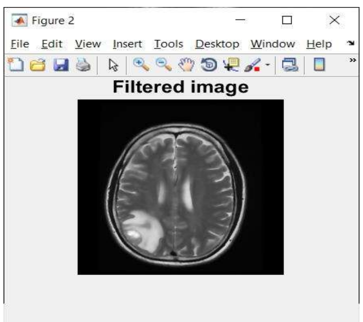


Figure 9: Filter image

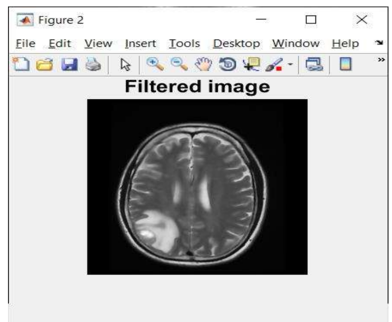


Figure 11: Filter image

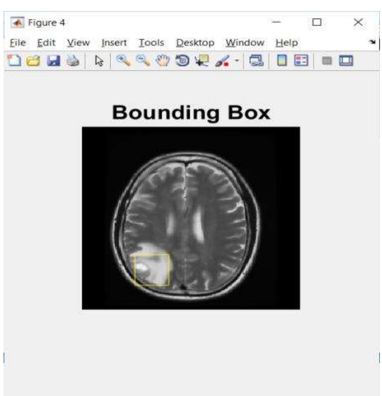


Figure 10: Boundary box

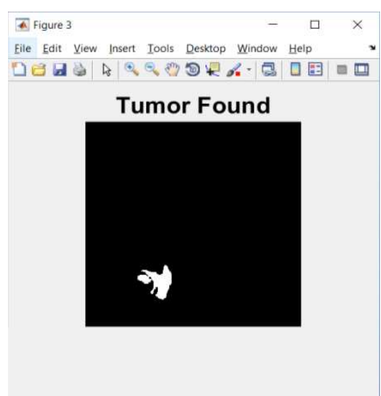


Figure 13: Tumor Result

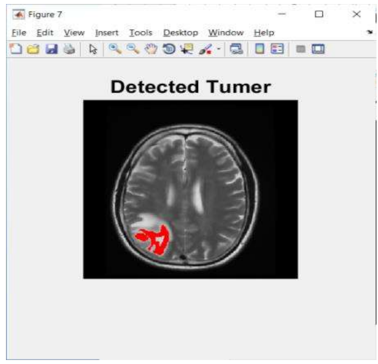


Figure 14: Final Detection

CONCLUSION

The proposed System is fulfilling the needs of people during MRI scans and detecting brain tumors. This algorithm is inputted with gray scale images of brain that contain tumor/s. The image is processed through various stages of morphological operations like filtering, contra adjustment, erosion, dilation etc. through MATLAB programming. Hence, the tumour is outlined in the original image and clearly demarcated. Contour plot and c-label plot is created to provide 3D visualization from the 2D image. A GUI is also developed which enables the above application with a user friendly interface.

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