Brain Tumor Detection And Segmentation

Ms.Ghuse Pallavi D.[1] , Ms. Patil A.G.[2], Ms. Patil Sayali S.[3],Ms.Pooja Ambatkar[4]

[1]B.E E&TC Budhgaon,[2]Associate Prof. E&TC Budhgaon,[3]B.E E&TC Budhgaon,[4]Asst.Prof.AVBIT,Wardha

[1]pallavi.ghuse@gmail.com,[2]agpatil112@gmail.com,[3]sayalipatil1112@gmail.com,[4]poojaambatkar@gmail.com

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Abstract :

Generally brain tumor detection and segmentation is a time consuming and challenging task from MRI image.MRI is a high contrast image that indicates the regular and irregular tissues that differentiate the margin of each limb overlapping. The information about the area of tumor is beneficial for the treatment of tumor. This per developed by using histogram thresholding along with the edge detection mechanism. This will help to obtain the geometrical dimension and contour of the tumor. The required time for segmentation in this method is less comparable to other conventional techniques. The results are 100% satisfying as it gives the area of the tumor which will be helpful for the further treatment of the tumor. Image segmentation is used to extract the abnormal tumor portion in brain. Histogram thresholding plays an important role to detect the location of the tumor whereas canny edge detection for the contour and area. This paper explores a method to identify tumor in brain disorder diagnosis in MR images.

Index Terms—

MRI, Histogram, Thresholding, Segmentation, Edge detection, Area calculation.

INTRODUCTION

Brain tumor is nothing but the unrestricted growth of the brain cells This is a neuron disorder. Diagnosis of neuron disorders has always been challenging for medical sciences. Because the anatomical structure of brain is highly complex, large variation of size, location and form of tumor. The factors like patient’s age, pathological history and symptoms demands highly specialized skill of radiologist. Such group of radiologist is limited, and image processing tool provides more accuracy. Although the WHO grading scheme provides accurate definitions for tumor grade determination, every pathologist gives different relative importance to each of the grading criteria. Thus, there is significantly high inter and intra observer variability in diagnosis. hence it significantly influence the quality of diagnosis. Computer based techniques, today remains an active research area.Hence imaging plays an important role in diagnosis and treatment planning of brain tumor .It provides automatic and accurate way of brain tumor detection and also gives the location and idea of tumor size. Proposed project is based on the image processing .Here we are going to use MRI imaging database. Here one of the segmentation methods is introduced for the detection of the brain tumor. The use of the image processing technique provides the automation, and reduces the manual efforts. By using this technique we get the size of the tumor and its location within few seconds with accuracy.

Various image processing techniques are able to provide the type of tumors within less computation time also. Though there are various method of the brain imaging we are going to choose MRI database Here we are going to use MRI scan images. Reason behind this is that it is an effective tool that provides detailed information about targeted brain tumor anatomy; hence we can effectively diagnose and provide treatment. It makes us able to detect difference between types of tumors and edema, deformation of volume and anatomic features within tumor using different image processing techniques. It also provides best tissue contrast and resolution.

EXISTING METHOD FOR BRAIN TUMOR DETECTION

Since last decade, some brain tumor detection mechanisms have been proposed to identify the location and the type of tumor (i.e.Belign or malignant) by MRI scanning. There are so many methods that are implemented for the detection of tumor in image processing. Some of them are as follows:

1. Brain Image Segmentation based on Bilateral Symmetry Information.
2. Brain Tumor Detection and Segmentation Using Histogram Thresholding
3. Brain Tumor Segmentation and quantification for MRI of brain.
4. Automated Brain Tumor Detection and Identification Using Image Processing and Probabilistic Neural Network Techniques.
5. A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing.

These are the method used for the implementation for the brain tumor detection. The proposed paper gives the simplest but the fastest method for the brain tumor detection and segmentation which gives the location and the area of tumor of the infected part of the brain. This proposed paper has the easiest step of image processing. The method is easily implemented simply by using MATLAB 7.9 with the simple image processing toolbox.

PROPOSED METHOD:

The methodology implemented is entirely based on the symmetric structure of the brain, here in this method histograms which is nothing but the plot of pixel verses pixel intensity is plotted for two halves of the brain and then compared. If the histograms of two halves of brain found to be asymmetric then presence of brain tumor is detected. The steps involved in this methodology are as follows:

PREPROCESSING

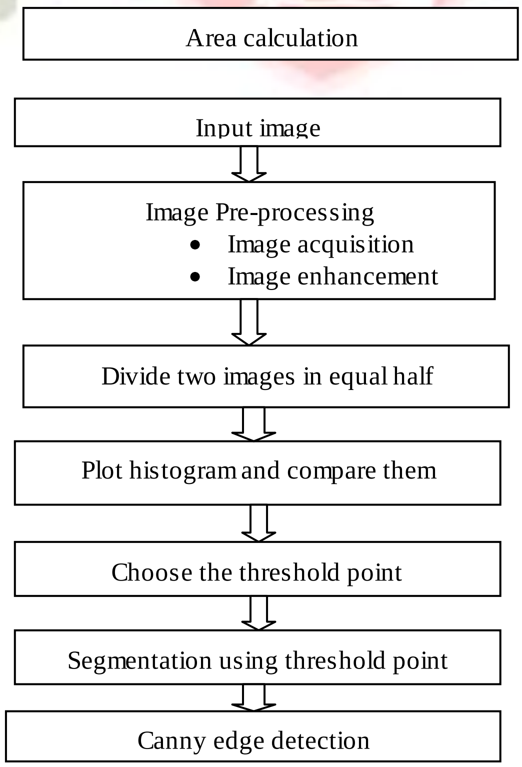


IMAGE ACQUISITION:

Scanning involves digitalization. Digitalization is nothing but sampling and quantization. Here sample is expressed with xand y co ordinates and corresponding quantized value. And entire image is stored in form of matrix with each element expressed as f(x,y) where f represents quantization value and x and y are co-ordinates of the sample. Each element of matrixis nothing but pixel. The image of the brain obtained through MRI is loaded by using the command 'IMREAD' in MATLAB**.** The image is then converted into gray color image.

In gray color images the intensity lies between 0-255 with 0 indicating for black and 255 is assigned for the white color . As a result each pixel has a 8 bit value. The blood cells (RED color in RGB) are represented by white color and 255 pixel intensity. All the gray matter is having a pixel intensity less than 255. First part of the present work is for detecting the position of the tumor, i.e., whether the tumor is on the left or right side of the brain. This is achieved with the knowledge of which part of the brain contains more numbers of the pixels having intensity around 255.entire algorithm is based on this concept.

As all gray matter has intensity less than 255,the part of brain image having more no of pixels around 255 will contain the tumor.(fig 1.2)

IMAGE ENHANCEMENT:

Before dividing the brain image into two equal halves it is important to remove all the noise components from the brain image. After noise removal sharpening operation is implemented to improve the contrast so that the edges are highlighted. Noise removal is nothing but the part of image enhancement. Here enhancement is done in two domains, first in spatial domain using linear filter and in frequency domain using Gaussian filter. Enhancement is given by

F1(x,y)=T[F(x,y)]

Here F1(x,y)=modified pixel

F(x, y)=original pixel

T=transformation applied. Here neighborhood transformation is done.

1. Smoothing by linear filters:

As noise is low frequency component, linear filter which is low pass filter used, enhancement in spatial domain is carried out here .The output of a linear spatial filter is simply the average of the pixels contained in the neighborhood of the filter mask. Hence these filters are called' AVERAGING FILTERS' Linear operations calculate the resulting value in the output image. Centre pixel intensity is modified such that it is a linear combination of intensities of pixel present in its neighborhood. How many neighborhood pixels are to be taken decided by the size of mask matrix..Mask matrix is convolved with original image to get transformed image. In this filtering ,pixel IA(i , j) as a linear combination of brightness in a local neighborhoods of the pixel I(i , j) in the input image.

In this algorithm we assumed I as an N×M image, m is an odd number smaller than both N and M, and A is the convolution kernel or the filter mask of the linear filter that is an m×m mask. The filtered version of I is given by the discrete convolution as follows:

IA(i , j)=I*A

Where i=1 to N and j=1 to M. This filter replaces the value,I (i , j) with a weighted sum of I values in a neighborhoods of (i , j). If all entries of A are non-negative, the filter performs average smoothing (fig.1.3)

2. Smoothing using Gaussian filter:

This is done to get noise reduction to acceptable level. This is also low pass filter and enhancement in Frequency domain is carried out here. It is used to avoid the ringing effect which may arise in ideal low pass filter or Butterworth low pass filter.

Gf, is a nonnegative, real-valued column matrix defined by,

$$G_f(x,y) = \frac{1}{c}\exp\left(\frac{-\left[x^2+y^2\right]}{2\sigma^2}\right)$$

Where,

$$c = \sqrt{2\pi\sigma^2}\ .$$

3. Smoothing using sharpening filer:

This is high pass filtering and it sharpens the edges in the image after noise removal. The principle objective of sharpening is to highlight transitions in intensity. Sharpening can be accomplished by spatial differentiation. Differentiation enhances edges and other discontinuities and deemphasizes areas with slowly varying intensities.(fig 1.4)

4. Dividing the image into two equal halves:

As we know that brain has symmetric structure about its vertical axis, this can be used for detecting the location of tumor if it is present at right half or left half. For this purpose it is necessary to divide brain image into two equal halves about vertical axis.

Steps used:-

1. First it is necessary to know the number of rows and columns present in an image, so it can be calculated initially.
2. Then by keeping no. of rows constant original brain image matrix is divided into two equal halves.
3. The first half contains rows same as in original image but column starting from 1 to half of the columns present in the image (say c/2).
4. The second half contains the rows same as in original image but columns starting from c/2 to c.
5. This two matrices are nothing but two halves of image and can be shown using 'IMSHOW ()'command.

Plotting of histogram

Histogram of the image is the graph which gives the information about relative frequency of occurrence of gray levels in image . It can be plotted in two ways:

1. x axis has gray levels and y axis has no of pixels in each gray level'

2. xaxis represents gray levels while y represents the probability of occurrence of that gray level. This is called as the normalized histogram. The advantage of second method is that the max value plotted will be one always.

Just by looking at the histogram detailed information of the image can be obtained

The algorithm steps involve are:

1. First row matrix having 256 elements with each one having value 0 is formed.

2. Next 1st pixel amplitude is calculated say[a(x,y)]

3. The element of row matrix having index equal to a(x,y) is incremented by 1.
4. Then same procedure is repeated for all pixels in first half of the brain.
5. After this bar () command graph is plotted which gives the histogram of first half of the image.
6. Repeat the above steps to obtain the histogram of another half.

Comparison of two histograms:

Two histograms of two halves of the brain are compared then. If the histograms of the two halves vary considerably that is at some intensity levels, there is considerable difference in number of pixels for two halves of the brain then we can conclude the presence of tumor in the brain. If this is not so then brain is normal.

If we conclude the presence of tumor in the brain then for getting the location and size of tumor segmentation is necessary. For this purpose the subtraction of histograms of two halves of the brain is carried out.

The intensity level at which we get the maximum number of pixels in resulting histogram is chosen as the threshold point for the segmentation.

Segmentation using threshold point:

Segmentation as the name suggest subdivides an image into its constituent regions or objects. Segmentation is used when some decision is to be taken.Segmentation is mostly used for extracting important features from image data.

Image segmentation algorithms are generally based on one of the two basic properties:

1. Segmentation based on discontinuities in intensity.
2. Segmentation based on similarities in intensity.

In the first method the approach is partition an image based on abrupt changes in intensity such as edges ,while in second method, we partition an image into region that are similar according to predefined criteria.

Here in proposed project segmentation based on discontinuity in intensities is used. Segmentation is done using threshold point. Thresholding is one of the important techniques of segmentation because of its simplicity. Steps involved:

After choosing the threshold point segmentation is done, all the intensity values above the threshold point are set to 255, while those below threshold point given value 0.After this segmentation only the region of interest is obtained which is nothing but the region where tumor is present.

Canny's edge detection:

Edge detection plays an important role to obtain the detailed information about the infected area of brain. It gives the contour of a region of interest which is beneficial to get the location of tumor.

Canny edge detector is most efficient edge detector in function edge.

Algorithm for edge detection:

1. The image is smoothed by applying Gaussian filter with the specific standard deviation for reduction of noise.
2. The local gradient [g(x)*g(x)+g(y)*g(y)] and edge direction tan inv[g(x)/g(y)]. Where, g(x) and g(y) are partial derivatives of image in X and Y direction respectively.
3. Edge point is defined as the point consists of local maximum strength in direction of gradient.

4. The determined edge point in step 3 gives rise to ridges in gradient magnitude image. The algorithm tracks along top of these ridges and sets all the pixels that are not on top of ridges to zero. Therefore we get thin line output.
5. Ridge pixels are then threshold using two threshold points T1 & T2 with T1<T2.Ridge pixels with values greater than T2 are said to be strong edge pixels. Ridge pixels with values between T1 & T2 are said to be weak edge pixels.
6. After that algorithm takes into consideration only those weak pixels which are connected to strong pixels. Others are set to zero.

Area calculation:-

Area of an image is calculated by knowing the vertical and horizontal resolution of an image. It depends on the three key factors

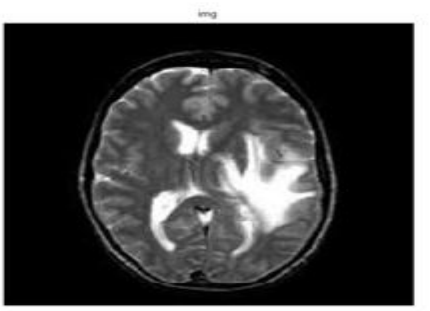
1. Total no of pixel in region of interest
2. Horizontal resolution
3. Vertical resolution

The dimension of the single pixel can be determined from vertical and horizontal resolution. From which area of that pixel can be calculated. Then the required area can be calculated by knowing the no of pixels in infected region the area can be calculated by following formula:

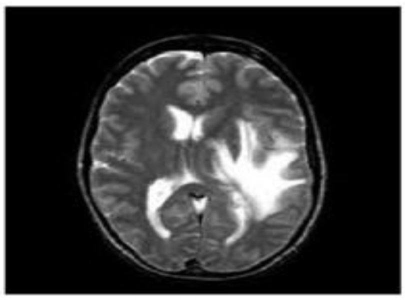
Area of tumor =vertical resolution *horizontal resolution*total no of pixels in infected area

RESULTS :

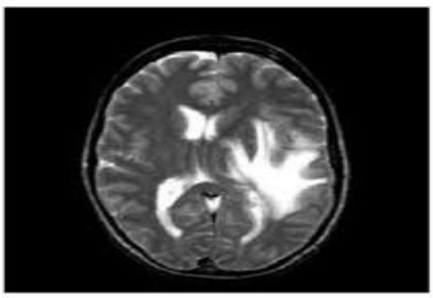
Input image



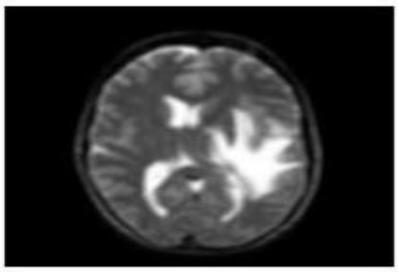
Gray scale image



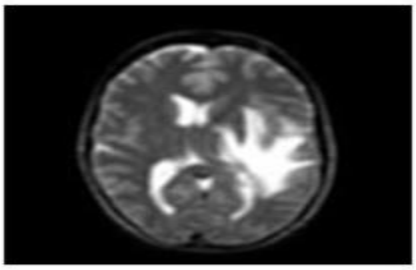
Output of averaging filter



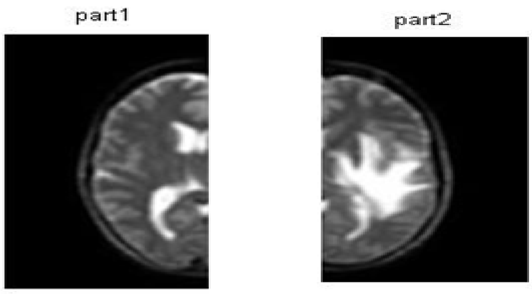
Output of Gaussian filter



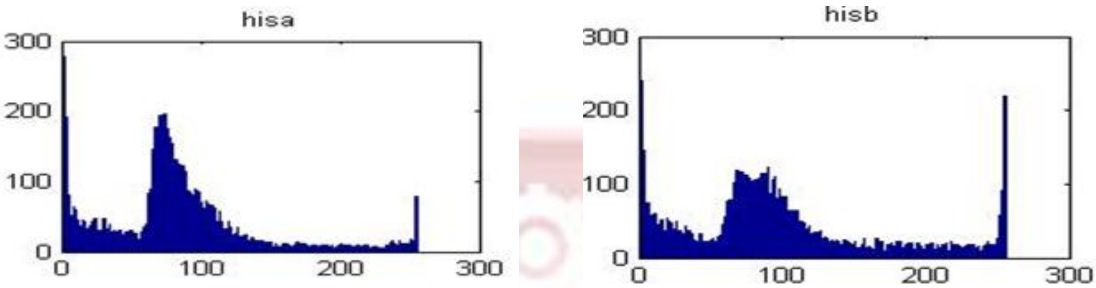
Output of sharpening filter



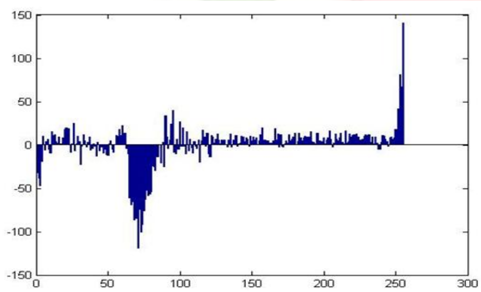
Left and Right half of the brain



Histogram of two halves of brain

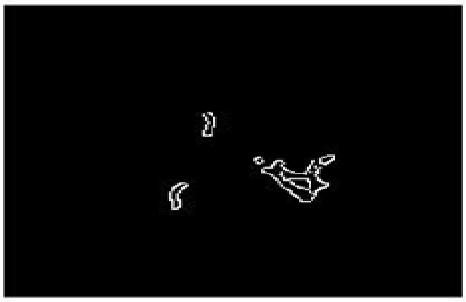


Subtraction of two histograms

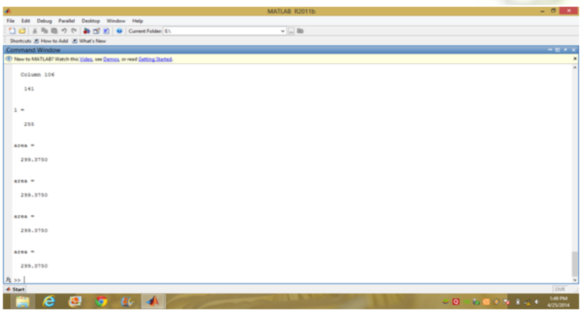


Segmentation output

Edge detection output



Area calculation in command window



CONCLUSION :

In this study a technique to detect presence of brain based on thresholding technique and edge detection technique has been developed. The processing time for implementing this method is less as compared to existing methods and easy to implement. The accuracy is about 99%. The segmentation of the brain is also being done while detecting the presence of the tumor. The physical dimension of the tumor which is almost importance to the physicians can also be calculated using the present technique.

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