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Improved Brain Diseases Detection Using Watershed Segmentation

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Abstract: The motivation of the research is to provide an efficient a complete algorithm for detecting the brain diseases and calculating its growth. This research describes the proposed strategy to detect and extraction of brain diseases from patient's MRI (Magnetic Resonance Imaging) scan images of the brain. This method in corporates with some noise removal functions, segmentation and morphological operations which are the basic concepts of image processing. Detection and extraction of brain diseases from MRI scan images of the brain is done by using MATLAB Software.

Key words: MRI, brain disease, digital image processing, segmentation, morphology, MATLAB

INTRODUCTION

Digital Image Processing (DIP) is an emerging field in which doctors and surgeons are getting different easy ways for the analysis of complex disease such as HIV, cancer, brain diseases, breast cancer, kidney stones, etc. There are adequate of researches are done on medical imaging system in this field brain diseases extraction in Magnetic Resonance Imaging (MRI) is a standard process. The detection of brain and their allied diseases is a very challenging task in which special care is taken for image segmentation. Aparticular part of a body is scanned in the discussed applications of the image analysis and techniques such as MRI, CTS can and X-rays. MRI technique helps in collecting the best information about the human soft tissue anatomy. Here is adoptive histogram equalization technique for image improvement for better picture quality (Kavitha *et al*., 2012; Mehena and Adhikary, 2015). The watershed technique is using for image segmentation which is used to extract various features of the image. Image segmentation isa technique of portioning of an image into groups of pixels or images which are homogenous with respect to some criterion. Different groups must not interact with each other and adjunct groups must be heterogeneous (Grau *et al*., 2004). Segmentation algorithms are area oriented instead of pixel oriented. The result of segmentation is the splitting up into several of the image into connected areas. Thus, segmentation is concerned with dividing an image into meaningful regions (Logeswari and Karnan, 2010a, b).

In medical imaging, many image analysis applications developed for medical diagnosis involves segmentation of tissues and structures. Image segmentation helps in diagnosis of brain diseases like Parkinson's and Alzheimer's Diseases and helps in quantitative analysis of Magnetic Resonance Images (MRI) such as measuring correct size and volume of extracted portion (Rajeswari and Anandhakumar, 2011). Exact identification in brain diagnosis is complicated because of different shapes and sizes of affected area in the MRI images. There will be loss and abnormalities during treatment plans and evaluation of Parkinson's and Alzheimer's diseases progression of that disease affect specific tissues or structures. Manual segmentation is boring and time consuming but it is accurate but can't use it practically (Logeswari and Karnan, 2010ab). For clinical applications automatic segmentation techniques will be useful if they have ability to segment like an expert of this fields, excellent performance for diverse datasets and reasonable processing speed for large datasets because it is tedious and time consuming (Fig. 1 and 2).

Literature review: Mehena and Adhikary (2015) had proposed an effective modified region growing technique for detection of brain tumour. They modified region include comparative for modified region growing using both the Feed Forward Neural Network (FFNN) and Radial

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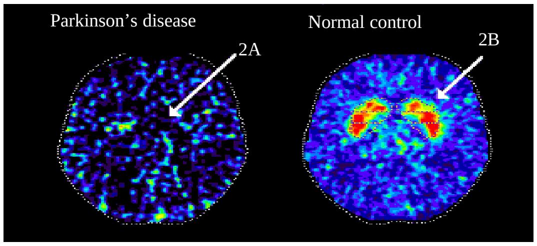


Fig. 1: Parkinson's affected MRI image

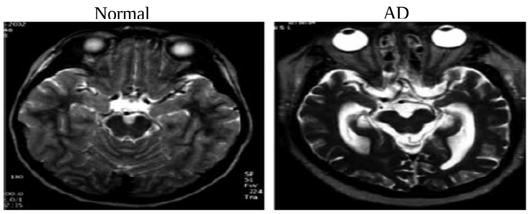


Fig. 2: Alzheimer's diseases affected MRI image

Basis Function (RBF) neural network. The MRI image dataset taken from the publicly available sources contains 40 brain MRI images in which 20 brain images with tumour and the other 20 brain images without tumour.

Grau *et al*. (2004) has proposed a model on brain brain diseases segmentation and extraction of Medical Resonance (MR) images based on improved watershed transform. In this research they have done improvement to the watershed transform and this study for the extraction of brain brain diseases based on segmentation and morphological operator. The brain diseases may be premalignantor malignant benign and it needs medical support for further classification.

Logeswari and Karnan (2010a, b) has proposed a good systemon improved watershed transform for medical image segmentation using prior information. In this they have considered watershed transform to detect the medical image and for segmentation, there will be a less efficiency in the proposed system, so they enhanced the technique which they used.

Prabhu *et al.* presented an integrated hybrid segmentation approach to classify the MRI on the basis of local independent projections. The hybrid PAM is used to partition and to determine the cluster centers, along with enhanced fuzzy C-means approach.

Shenbagarajan *et al*. proposed MRI analysis makes use of the region based Active Contour Method to segment and Artificial Neural Network (ANN) based Levenberg-Marquardt (LM) algorithm to classify the MR images into normal and tumourous.

Ali *et al.* used four types of techniques in the extraction of the brain diseases region. They are gray level stretching and Sobel edge detection, K-means clustering technique based on location and intensity, Fuzzy C-means clustering and an adapted K-means clustering technique and Fuzzy C-means technique (Khadem, 2010).

Pabitra Roy *et al.* has presented an automated method for detecting brain abnormalities and brain diseases edema segmentation from brain MRI. This algorithm uses thresholding technique that uses standard deviation average intensity to find the threshold intensity value which is near the intensity value of brain diseases border.

Kavitha *et al*. (2012) introduces an proficient detection ofbrain brain diseases from analytical MRI images. It consists of three steps; enhancement, segmentation and classification. To recover the superiority of images and bound the threat of different regions fusion in the segmentation phase an enhancement process is applied. Then Wavelet transform is applied in the segmentation method to decompose MRI images. At very last, the K-means algorithm is implemented to take out the suspicious regions or brain diseases (Hossam *et al*., 2010).

Grau *et al*. (2004) described that specific demarcation of brain Brain diseases in the MRI is a challenging problem due to the inconsistency of brain diseases geometry, advent properties and the resemblance between brain diseases and normal tissue. Automating the method of segmentation is another challenge because manual segmentation is a mostly time-consuming task.

MATERIALS AND METHODS

Proposed algorithm: The most of existing methods has ignored the poor quality images like images with noise or poor brightness. Most of the existing researchers have neglected the use of object based segmentation to detect Parkinson's and Alzheimer's diseasesin the brain. Neural network based brain Parkinson's and Alzheimer's diseases detection may provide better results but due totraining and testing phase it will comes up with some possible overheads, i.e., poor in case of time complexity. The Parkinson's and Alzheimer's diseases detection is a very important application of medical image processing. The literature survey from the existing study has shown that the most of existing methods has ignored the poor quality images like images with noise or poor brightness. Also, the most of the existing work particularly on Parkinson's and Alzheimer's diseases detection has neglected the use of object based segmentation. The overall objective of this research work is to propose an efficient brain Parkinson's and Alzheimer's diseases detection using the object detection and roundness metric. To enhance the Parkinson's and Alzheimer's diseases detection rate further thishas integrated the proposed objectbased Parkinson's and Alzheimer's diseases detection with the decision based median filter.

Algorithm for detecting Parkinson's and Alzheimer's diseases:

Input: MRI of brain image
Output: Affected portion of the image
Step 1: Read the input grayscale image
Step 2: Resize this image in to 200×200 image matrix
Step 3: Filters the multidimensional array with the multidimensional filter Here, show salt and pepper noise in our image using imnoise command
Step 4: Now here are reducing the noise in our image using imfilter command, i.e., by using median filter to get the resultant enhanced image
Step 5: Computes a global threshold that can be used to convert an intensity image (Step 4) to a binary image with a normalized intensity value which lies in between range 0 and 1
Step 6: Compute the morphological operation by two MATLAB command imerode and strel with arbitrary shape
Step 7: Store the size of the step 6 image into var1 and var2 i.e., no. of rows and column in pixels by: [var1 var2] = size(step 6 image)
Step 8: For I = 1:1:var1
Step 9: For j = 1:1:var2
Step 10: If step 6 image (i, j) == 1
Step 11: step 1 image (i, j) = 255
Step 12: Else
Step 13: step 1 image (i, j) = step 1 image (i,j) * 0.3
Step 14: End
Step 15: End
Step 16: End
Step 17: Convert in to binary image
Step 18: Compute edge detection using sobel edge detection technique

Algorithm for area calculation:

Input: Parkinson's and Alzheimer'sportion of the image
Output: Area of the brain diseases
Step 1: Read the input grayscale image
Step 2: Resize this image in to 200×200 image matrix
Step3: Compute numbers of rows and column in pixels by: [r2 c2] = size (J)
Step 4: Initialize a variable a = 0
Step 5: For I = 1:1: r2
Step 6: For j = 1:1:c2
Step 7: If I (i,j)==255
Step 8: a = a+0
Step 9: else do
Step 10: a = a+1
Step 11: End
Step 12: End
Step 13: End
Step 14: Display the area a

Proposed approach: The proposed framework is shown in Fig. 3 and 4 with detailed internal architecture for the detection and extraction of the brain diseases from MR images. The approach consists of three phase such that during first phase input image is being pre-processing followed by second phase th reshold segmentation with

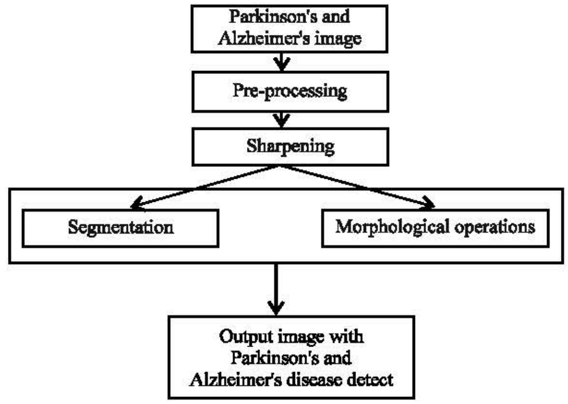


Fig. 3: Proposed framework

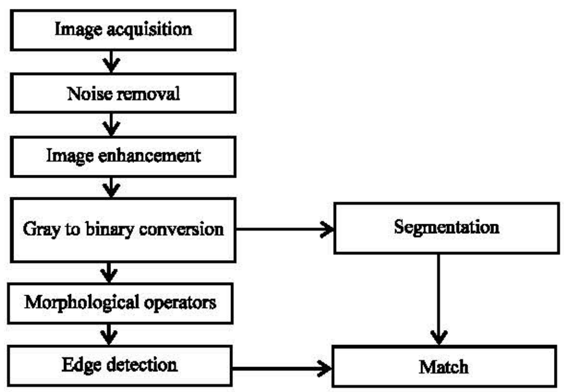


Fig. 4: Steps involved in the detection process

further application of morphological operations, finally Parkinson's and Alzheimer's diseases detected and extracted and image is given as output.

Noise removal: Many of the filters are used to remove the noise from the MRI images. Linear filters can also serve the purpose like Gaussian, averaging filters. For example, average filters are used to remove salt and pepper noise from the MRI image. Because in this filter pixel's value is replaced with its neighborhood values. Median filter is also used to remove the noise like salt and pepper and weighted average filter is the variation of this filter and can be implemented easily and give expected good results. In the median filter value of pixel is determined by the median of the neigh boring pixels. This filter is less sensitive than the outliers.

Image sharpening: Sharpening of the MRI image can be attained by using different high pass filters. As now image noise is been removed by using different low pass filters, here to need to sharpen the image as need the sharp edges because this will help us to detect the boundary of the brain disease growth. Gaussian high pass filter is used to improve the boundaries of the objects in the image. Gaussian filter gives very high valued results and used very extensively to enhance the finer details of the objects.

Image enhancement: Enhancement will result in more protuberant edges and a sharpened MRI images is obtained, noise will be reduced thus reducing the blurring or shade effect from the MRI images. This improved and enhanced image will help to detecting edges and improving the quality of the overall MRI images. Edge detection will lead to finding the exact location and size of brain diseases. For enhancing MRI images, sharpening filters have to be used as these filters highlight exact details. These filters remove blurring or shade from image and highlight edges. Sharpening filters are based on spatial differentiation. The Laplacian filter is a sharpening filter. After applying in the Laplacian filter to the MRI image a new image is obtained high lighting edges and other incoherence. The result of Laplacian filter is not an enhanced image. The Laplacian result needs to be subtracted from original image for generating final sharpened enhanced MRI image. Sobel filters also available for edge detection and there are also various other filters like Prewitt, Gaussian, etc. Successful enhancement is attained when range of techniques are joint in order to achieve final result and not by single operation. In our proposed novel algorithms, many filters like Laplacian have been applied. The result obtained from Laplacian filter was much better than the other filters. After getting the enhanced MRI image, the process of detection of exact location and size of brain diseases begins. For achieving this aim, first of all, the gray image has to be converted to binary MRI image.

Data source: In the research, the images are collected from the website in internet and some samples are taken from the radiologists. The images collected from the radiologists are converted into normal RGB images to any version of DICOM software converter. A gray scale image is a data matrix whose value represents shades of gray. The elements of gray scale matrix have integer values or intensity values in range [0 255]. For applying different techniques, the digital images obtained from MRI are stored in matrix form in MATLAB. Different formats of digital images like jpg, png, bmp, etc. have been used in the proposed algorithm. The MRI scan of patient suffering from brain diseases 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 noise also. So, the next step is to remove this noise and get enhance image for better detection. The above flowchart shows the various steps involved in our algorithm. Also, watershed function is applied for verifying the output. Figure 5 and 6 are the samples of MRI brain image without brain diseases and Fig. 7 and 8 are the samples of MRI brain image with brain diseases (Fig. 9 and 10).

Fig. 5: MRI scan of brain images

Fig. 6: Enhanced image

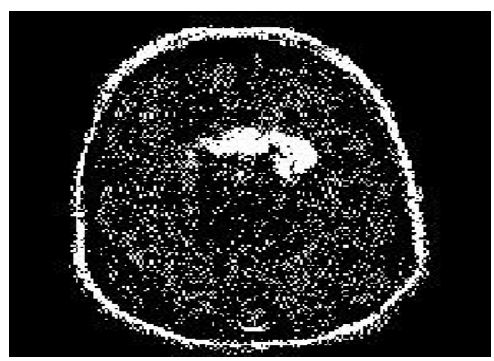


Fig. 7: Binary to gray image

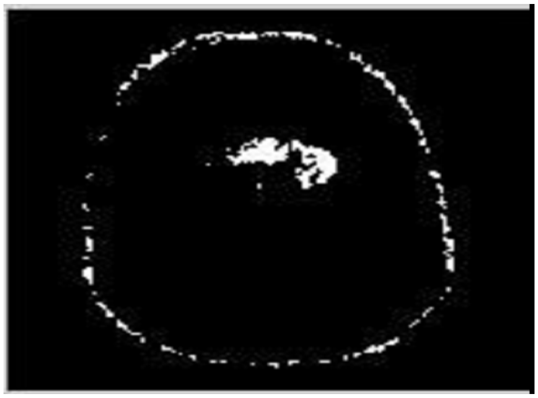


Fig. 8: Result after erosion applied on image 7

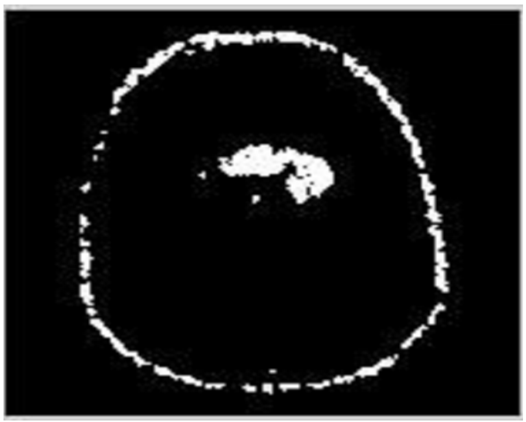


Fig. 9: Result after dilation on image 7

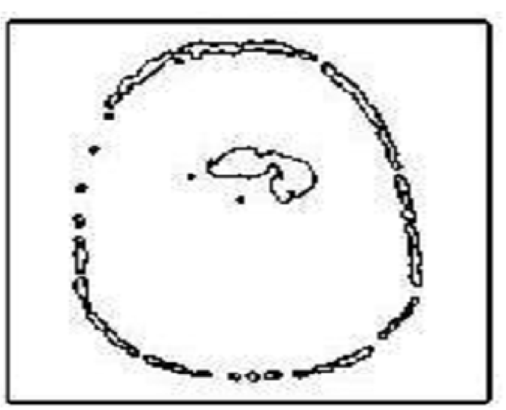


Fig. 10: Detected edges of the brain diseases

RESULTS AND DISCUSSION

In this study, had demonstrated various methods and discussed merits and demerits of each method. The algorithms are implemented on our personal computer

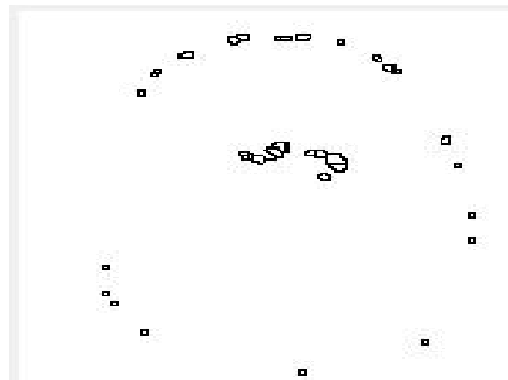


Fig. 11: Segmentation process

3 GHz CPU, 4 GB Ram using MATLAB 8.0.0.783. In this study, the results of each stage are shown and how result obtained is better and accurate. Figure 5 shows the MRI scan of brain.

As it can be seen that the image is noisy, so different noise filters are needed to be applied for noise removal and then apply enhancement techniques. The result obtained after applying step 2 and 3 was obtained as: the output obtained after converting image to binary image using DICOM method; now the result obtained after applying morphological operations, i.e., dilation and erosion is shown as: the last step is the detection of edges of these brain diseases. The detected edges of the brain diseases was obtained as follows: as explained in Fig. 2, here it also apply segmentation for grouping cells according to their intensity. Table 1 output was obtained as Fig. 11.

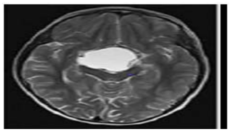
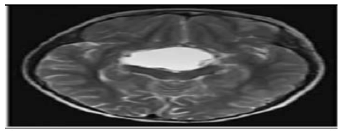
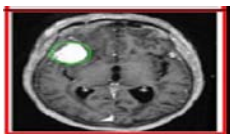
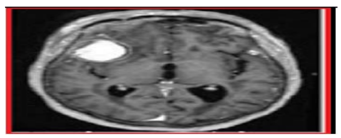
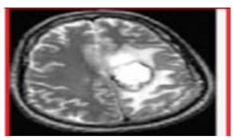
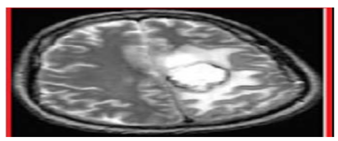
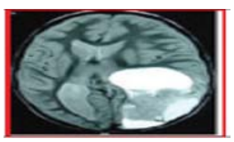
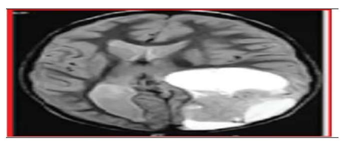
Overall error and the accuracy of the approach: The overall error is calculated from false alarm and miss alarm. Finally, accuracy of this approach is measured with the help of the following Eq. 1 and 2:

$$\text{Overall error} = \text{False alarm+miss alarm} \quad (1)$$

$$\text{Accuracy} = \frac{\text{1-overall error}}{\text{image dimension}} \times 100 \quad (2)$$

Finally here it can show the overall error in Fig. 12 and the accuracy in Fig. 13 and 12 shows the overall error obtained using approach based morphological operations. Figure 12 and 13 show the accuracy and overall error rate of different images.

Table 1: Results after segmentation of various MRI datasets of brain

Input MRI of brain	Image after watershed segmented brain	Segmented tumor
		
		
		
		
		

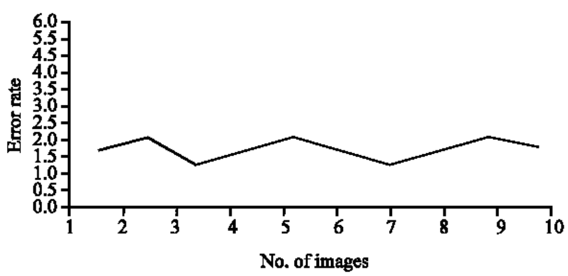


Fig. 12: Overall error obtained using approach based morphological operations

Fig. 13: Accuracy obtained using approach based morphological operations

CONCLUSION

Some of the features of the Parkinson's and Alzheimer's diseases are detected which will be helpful in medical applications. The future research involve the segmentation and detection of more images with more features which help in classifying several types of the brain Parkinson's and Alzheimer's diseases. The main contribution of the work is to explore various techniques to detect brain diseases in an efficient way. The literature survey has shown that the most of existing methods has ignored the poor quality images like images with noise or poor brightness. Also, the most of the existing work on brain disease detection has neglected the use of segmentation. This research has proposed a new technique based brain disease detection.

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