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ANALYSING MORPHOLOGICAL FEATURES OF CORPUS CALLOSUM TO IDENTIFY NEURAL DISORDER BASED ON CONTOUR AND MASS USING BACK PROPAGATION NEURAL NETWORK

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ABSTRACT

In this paper we focus on development of automated image analysis techniques for precisely measuring regions of corpus callosum based on contour and mass. We divided our work into two modules: (i) develop a framework to measure various regions of the corpus callosum area (ii) develop a methodology to analyze corpus callosum based on contour and mass to classify various subjects using machine learning techniques. This application was developed using Visual C++ and Mat lab.

KEYWORDS: Corpus callosum, Contour, Magnetic resonance imaging, Multilayer neural network

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INTRODUCTION

Magnetic Resonance Imaging has been used in the last few years to detect various neural disorders such as autism, multiple sclerosis, Alzheimer's diseases etc. An MRI technique plays a major role for in depth analysis of human anatomy. The use of MRI in analyses of autism is predominantly interest because without clinical symptoms autism may cause substantial change to anatomical organs such as corpus callosum. For clinicians MRI acts as a key tool to detect an autism that may be clinically silent. The changes in the neuron connectivity, neuron functions and structures can be perceived through diffusion tensor MRI, Functional MRI. The augmented use of MRI techniques to detect anatomical changes in the brain leads to development of efficient algorithms for computation, illustration and significant measurement.

CORPUS CALLOSUM

The two hemispheres of the brain are connected by the largest collection of white matter called corpus callosum. This neural tissue enables communication between two hemispheres of the brain. The size and shape of corpus callosum are important gauges in analysis of many neurological diseases. The morphological differences observed in the anterior (responsible for the primary motor function) and mid body (responsible for somatosensory cortex) of corpus callosum segments may leads to severe neural disorder. An automatic segmentation approach was proposed in this paper to extract anterior and mid body of CC. The regions of corpus callosum were analysed using neural network to classify subjects into various classes.

RELATED WORK

In this subsection, a list of related works will be briefly described. Kathleen T Quach[1] discussed a method to distinguish toddlers having ASD or not using multilayer perception with a back propagation neural network. For optimal classification of subject author proposed to use only minimal input set. To reduce the noise in gene dataset the gene minimization algorithm is applied. The classifier obtained 72.22 % success rate. Shiou-Ping Lee, Jie-Zhi Cheng, Chung-Ming Chen, Wen-Yih Isaac Tseng[2] provides an outline on new automatic segmentation approach for boundary delineation of corpus callosum. They proposed algorithm to perform segmentation on red component of colour coded map of diffusion tensor magnetic resonance image. Their result shows the boundaries of corpus callosum delineate successfully. Ye Duan1, Qing He1, Xiaotian Yin, XianfengGu, Kevin Karsch and Judith Miles[3] have introduced progressive techniques to extract 3D models of the corpus callosum (CC).Also they examine local shape discrepancies in a homogeneous group of autistic children. Using permutation test the shape differences of corpus callosum between autistic and normal subjects are analyzed.

PROPOSED METHOD

The proposed framework alienated into two phases: Applying conventional method for image acquisition and pre-processing followed by developing a neural structure for classifying neural disorder. The input to image acquisition model is diffusion tensor magnetic resonance image in standard format. The data of the image are stored in 2x2 matrixes for further computation. Noise in input image was minimized by applying a Gaussian filter. To perform threshold the initial value of T is fixed. The threshold function is given by

f(x,y) = $0 < T < 55$ (Black) and $T > 55$

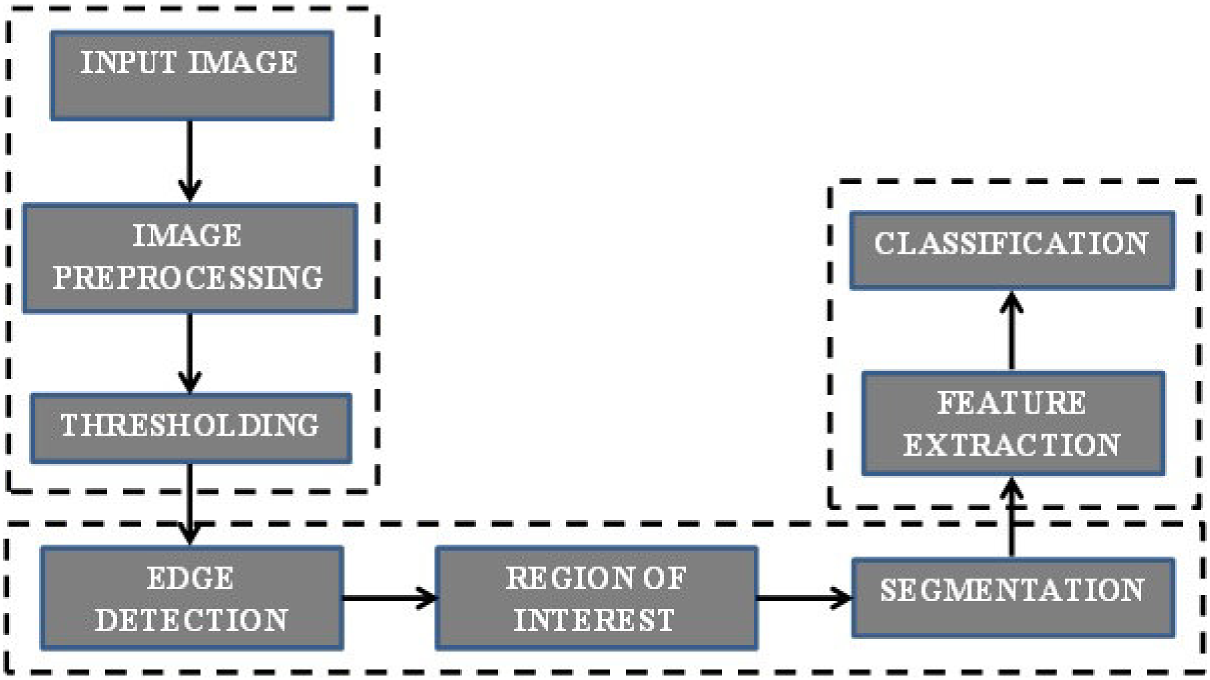

Figure 1
Proposed Framework

After threshold we got a binary image which holds two groups of pixel. Group M1 contains gray value > T and group M2 consisting of pixel value < T. We are interested only in regions of corpus callosum. Using region labelling technique, whenever new pixel is found label it and unlabelled pixels are stored in the queue. Continue the process until queue become empty. At the end we obtain only corpus callosum area (white pixels)

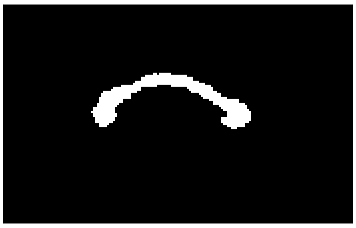

Figure 2
Binary image

The anterior and mid body regions are segmented from corpus callosum. Various features such as area of each region, size of CC are calculated from these regions which will be later used as input to neural model.

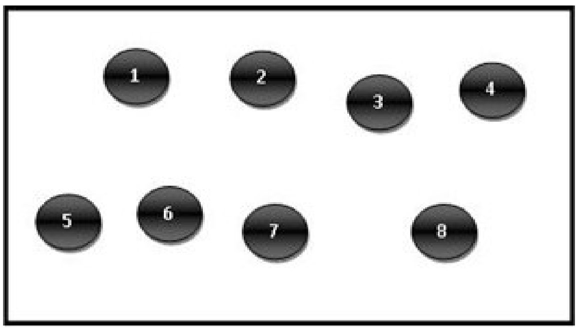

Figure 3
Regionlabel

NEURAL NETWORK MODEL

To solve non-linear classification problems multilayer neural network model is efficient. In our proposed method input layer had five principal components such as the total area of CC (A), area of anterior region (B), area of mid-body region (C), area of posterior region (D) and total area of B,C,D to receive input. Two output neurons classify subjects as normal (value < 0.5) (or) as disorder (value ≥ 0.5). Each input from the input layer is multiplied with weight matrix (W1) of input node which yields output of hidden layer. The output node value is calculated by multiplying weighted matrix of hidden layer by output values of hidden layer.

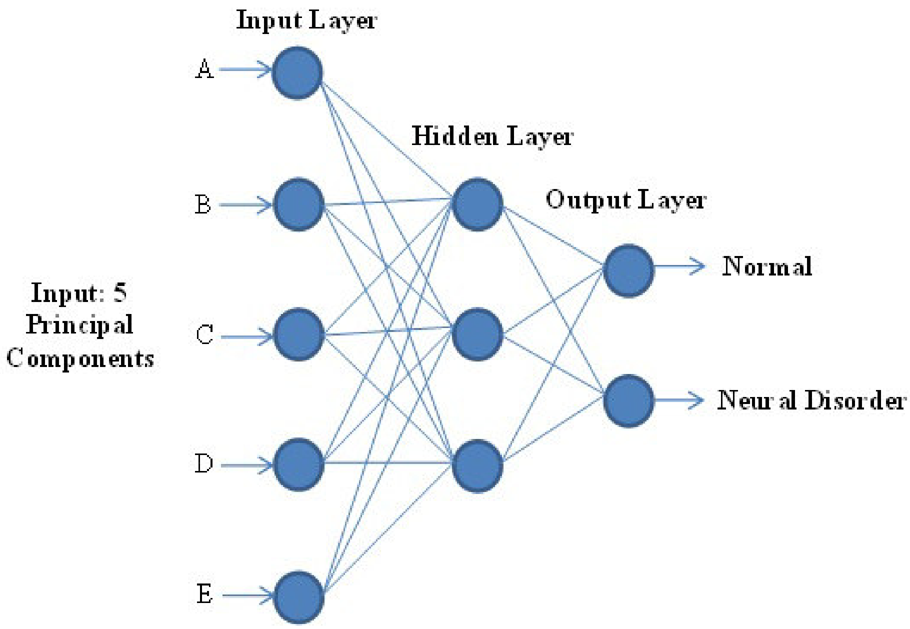

Figure 4
Neural network architecture

The hyperbolic tangent sigmoid transfer function was preferred for hidden layer because the output results can have very small numerical differences. The tansig (n) calculates its output according to: n=2 / (1+exp (-2*n))-1

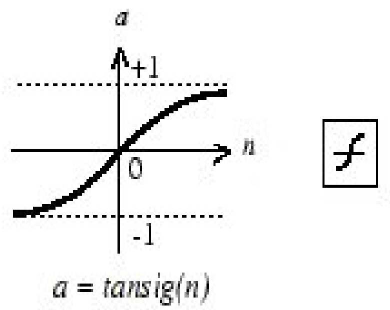

Figure 5
Tan-sigmoid transfer function

To train the network feed forward network with back propagation algorithm is applied. Using this algorithm the local minima of error function is calculated. To correct the initial weights gradient of the error function is computed. The result of output layer is determined based on a formula

$\frac{x1}{x2} > W(avg)$

Where X1 = Total area of B,C,D ; X2 = CC total area; W(avg) = Average weight

$\frac{y1}{x2} \leq W(avg)$

Where y1 = Number of regions ; X2 = CC total area; W(avg) = Average weight

RESULTS

The application was tested with 30 subjects. 12 of which of normal subjects and 18 were examples of neural disorder. The neural network is trained on the training set and a test set. For subjects with neural disorder and normal we calculate the mean accuracy, standard deviation and overall accuracy. Our application attained 83.3 % accurateness when categorize normal subjects and 88.8 % accurateness for Neural disorder.

Table 1
Percentage of subjects classified correctly

Data Set	Percentage of correctness
Normal Subject	83.3% (10 out of 12)
Disorder Subject	88.8% (16 out of 18)
Total	**86.05 %**

Table 2
Time taken to run each module

Algorithm	Time taken to run (in Sec)
Load the Image	0.02
Threshold	0.12
Find Region of Interest	0.43
Segmentation	0.49
BP Neural Algorithm	2.1
Total	**3.16**

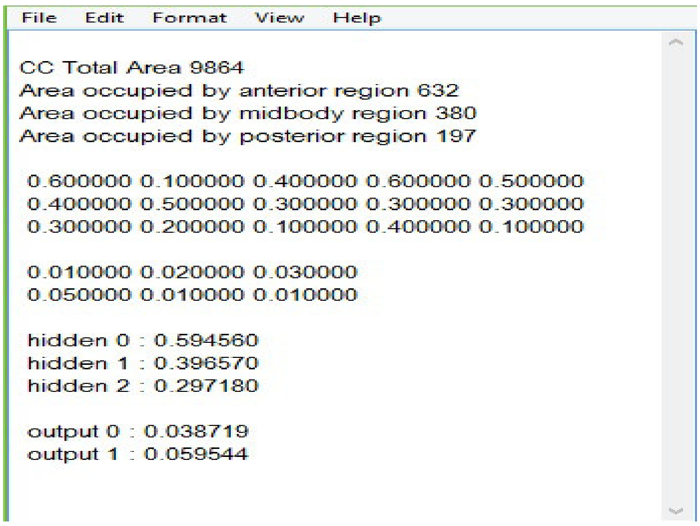

Figure 6
Feature set values

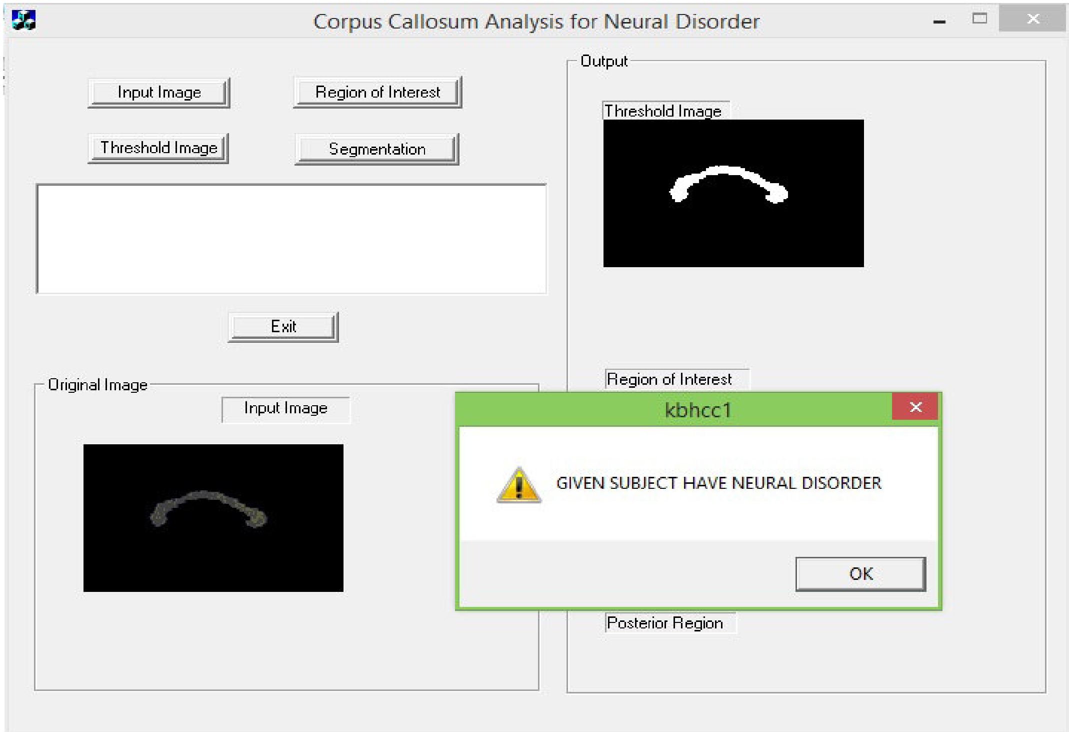

Figure 7
Sample screen shot

CONCLUSION

We presented a framework for precisely measuring regions of corpus callosum based on contour and mass. Also we developed a methodology to accurately classify various neural disorders using back propagation neural networks algorithm. The proposed approach is less complex and it outperforms in classifying neural disorder subjects versus normal subjects. The future challenge will be the development of computer assisted automated systems to identify a substantial change of anatomical organs such as corpus callosum and associates them to explicit brain diseases.

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