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Detection and Classification of Brain Tumor Images Using Back Propagation Fuzzy Neural Network

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Abstract— Artificial Neural networks are a substantial research area in medical image classification. The Bio Medical image recognition techniques have been generally applied in various diagnosis diseases to predict the result most accurate result. This paper illustrates the structure of the maintenance for the image classification process stages of a brain tumor as well as to detect brain tumors in the MRI images by using Back Propagation Fuzzy Neural Network (BPFNN) and it can be used to find brain tumors in MRI images in its previous stages. The brain tumor is a very hazardous disease due to the complex structure of the brain. The conventional method for the classification of the brain is the detection of the brain structure. The Computer tomography images in humanoid detection having lots of inaccuracies and it does not give the better perfect result. Hence this proposed method is implemented to detect and classify the brain tumor images. The processed images will act as a base of Computer Aided Diagnosis (CAD) system in early recognition of brain tumor. In this work neural network, fuzzy cluster method is used to identify the abnormal brain tumor region in MRI brain images. The spatial fuzzy clustering method is applied for, to detect the brain tumor part in the MRI scanning images. In the classification stage, BPFNN has been implemented to find brain tumors in images. This proposed Back Propagation Fuzzy Neural Network classifier technique has been used to classify benign and malignant brain tumor images. The result shows that BPFNN classifier gives fast and accurate classification than the other neural network method and it can be effectively used for classifying brain tumor with high level of accuracy.
Keywords— Image Classification, Computerized Tomography, Brain Tumor Images, Fuzzy Clustering Method, Back Propagation Neural Network (BPNN), Spatial Fuzzy Cluster, Classification Accuracy.

I. INTRODUCTION

Brain tumor is one of the most deadly disease in the world, which is the abnormal growth of cells in the brain structure. There are many different types of brain tumor, which make the decision very complicated. Hence the classification of brain tumor images is very essential to classify the brain tumor, which affects the lives of the people. The classification of tumor process can lead to the right decision and provide correct and appropriate treatment. Treatment of the brain tumor mostly depends on its size and its types. Treatment can be different for the two types of the tumor, which mostly depends on the factors like Age, overall health, medical history, Tumor type, Location of the tumor and its size. The memory requirement for the brain tumor dataset is much less than MRI images. Produced dataset is endangered to several clustering and classification approaches [1]. Many canvassers have recommended dissimilar techniques for the classification of brain tumors based on discrete wavelet transform, Bayesian neural network, K-Nearest Neighbor, PCA and probabilistic neural network. The comprehensive features and the fuzzy rules are implemented to classify an abnormal brain image to the corresponding tumor [2]. In this paper, we propose an approach for building a classification model for brain tumors. Regions of interest (tumor) are first segmented. Then, it is based on the abnormality of the tumor classification and segmentation are done. In this paper, we took the training samples from other sources. This leads to improved classification accuracy. In brain MR images, after appropriate segmentation of brain tumor classification of tumor into malignant and benign is difficult task due to the complexity and variations in tumor tissue characteristics like its gray level of the image, the shape of the image and size of the image [3].

The benign brain tumors composed of innocuous cells and it has clearly divergent the boundaries. It can eliminate the complete improbable recur cells. The benign tumor is essentially doesn't come back and doesn't spread to other parts of the body. Benign tumors tend to produce more slowly than malignant tumors and are less likely to cause fitness difficulties. Cancers are of dissimilar categories and they have different Characteristics and multiple type of treatment. The brain tumor is intrinsically serious and lifethreatening because of its character in the limited space of the intracranial cavity. Most Research in establishing countries spectacle that the number of people who have brain tumors were dying due to the fact of erroneous detection. Usually, CT scan or MRI images that are focused into intracranial cavity produces a complete brain image. This image is basically observed by the physician for detection & diagnosis of brain tumor [4]. There are four major steps in the proposed approach for brain tumor classification: (a) ROI segmentation: delineating the boundary of the tumor (ROI) in an MR image; (b) feature extraction: getting meaningful features of the ROI identified in the previous step; (c) feature selection: removing the redundant features; (d) classification: learning a classification model using the features [5]. The non-tumor brain structures, such as blood vessels, and soft tissues, are often misidentified as tumors, leading to many false positives (FPs). Most existing techniques for tumor segmentation are not fully involuntary. Henceforth, the remaining physical tumor dissection approaches are not fully accurate in detecting tumors [6].

Which consisted of three stages: segmentation, enhancement and classification. The enhancement process was applied to enhance the image quality before the segmentation phase. The authors used mathematical morphology to increase the contrast in the MRI images. Then, a wavelet transform was applied to the segmentation process to crumble the MRI image. Finally, a k-means algorithm was executed to extract the tumor region. The experimental results were analyzed. Pixel level variation was used to detect abnormalities in the brain region. The brain abnormalities were diagnosed using the pixel distribution surrounding the abnormal tissues in the brain image [7]. The tumor detection can be better by dual reading the medical images but, the cost of dual reading process is extremely high. So, a good software is needed to assist humanity in medicinal institutions is required these days [8]. Three-dimensional (3-D) processing and visualization of medical images is a rapidly area of research and MRI has provided a means for imaging tissue at very high resolutions providing the desired information for use in fields like radiotherapy planning, operative surgery and stereotactic neurosurgery [9,10].

II. RELATED WORKS

Shafab Ibrahim et al. [11] in their work proposed an implementation of evaluation method known as image mosaicking in evaluating the MRI brain abnormalities segmentation study. 57 mosaic images are formed by cutting various shapes and size of abnormalities and pasting it onto normal brain nerve. FCM, PSO and ANFIS are used to fragment the mosaic images formed. Statistical analysis method of receiver operating characteristic (ROC) was used to calculate the accuracy.

S. Karpagam et al. [12] in their work proposed detection of tumor growth by an advanced diameter technique using MRI image data. To identify the volume of brain tumor they suggested diameter and graph based techniques. The result displays tumor evolution and volume.

Padilla et al. [13] in their work proposed on currently there are several algorithms, methods, and techniques are proposed to predict and classify the tumor regions in functional brain images. The Non-negative Matrix Factorization (NMF) techniques are used in normalized data where the features of each subject's relevant components are extracted. Curse of dimensionality, which related to large dimensionality of the input data, gets reduced. To reduce the number of features, the NMF method is used and by using Support Vector Machine the reduced features are classified. This method gives up to 94% of accuracy in high specificity and sensitivity values.

Alvarez Illan et al. [14] in their work proposed on Association Rules (AR) and Neural Network (NN) techniques are implemented in brain images.

Murat et al. [15]. The dimension of dataset gets reduced by using AR method and for efficient classification, NN technique is used. The AR+NN System performance is compared with that of other feature selection and classification methods is done, which gives 98.61% of accuracy. To extract the relevant features from the image database, the Independent Component Analysis (ICA) is used and also it helps to reduce the features of space dimension. These methods detect the error below 9% and detect the pattern in an unsupervised manner.

Shu-Ren Zhou et al. [16] in their work proposed on the local low-resolution face images are not robust and also not adequate, so GLL method is proposed. The GLL fuses on Gabor filter, Local Binary Pattern (LBP), and Local Phase Quantization (LPQ). Gabor filter, operates on Gabor wavelet functions where two scales and eight orientations are used to capture the face image's salient visual properties. By using Gabor features, to get blur invariant property the LBP features and LPQ features are extracted. The information in the spatial domain the different scales and orientations which provide better accuracy in discriminating areas.

Vijay Kumar et al. [17] proposed early prediction of brain tumor cancer based on texture feature and neuro classification logic. Nine separate topographies along with least distance are used for brain tumor detection in specified MRI images. Mined district is predictable using neuro fuzzy approach.

Andac Hamaci et al. [18] presented cellular automata (CA)-based seeded tumor segmentation method for contrast-enhanced T1 weighted magnetic resonance (MR) images. The CA-based segmentation method was established according to graph-theoretic methods to show that the iterative CA framework solves the shortest path problem. A sensitivity parameter is introduced to adopt the heterogeneous tumor segmentation problem was also implemented. Then, a tumor probability map was constructed from the CA states for spatial efficiency. Suitable data are collected from the user to initialize the algorithm. The experimental results of the brain tumor dataset show an overlapping performance of 80-90% with respect to several tumor types.

Bauer et al. [19] adapted a healthy brain atlas to MR images of tumor patients. To establish correspondence between a healthy atlas and a pathologic patient image, tumor growth modelling was combined with registration algorithms. The tumor has grown in the atlas based on a new multi-scale, multi-physics model that including growth simulation from the cellular level to the biomedical flat, secretarial for cell proliferation and tissue deformations. Large-scale deformations are handled using an Eulerian approach for finite element calculations, which can control unswervingly on the image voxel mesh.

Sarbani Datta et al. [20] explained pre-process the two-dimensional magnetic resonance images of the brain and subsequently detect the tumor using edge detection technique and colour based segmentation algorithm.

In this paper colour-based segmentation using K-means clustering for brain tumor detection is proposed. The advantage of this technique is that developed algorithm shows better results than Canny based edge uncovering. The algorithm will support the surgeons for diagnosis in a better way by reducing the subjectivity and miss rate in brain MR images and thereby will enhance the tumor detection accuracy in less time.

Rakesh et al. [21] Elaborated Image Segmentation and Detection of Tumor Objects in MR Brain Images Using Fuzzy C-Means Algorithm. The modified FCM algorithm is based on the concept of compression where the dimensionality of the input is highly reduced. The modified FCM algorithm uses an abridged dataset, the merging rate is extremely improved when compared with the conventional FCM. But the foremost hitch is that FCM method is time consuming.

Tamije Selvy et al. [22] Presented clustering algorithms in the brain tumor detection of MRI Images. The Clustering algorithms used are K-means, SOM, Hierarchical Clustering and Fuzzy C-Means. The execution time was less when compared k-means and SOM technique. K-means and Hierarchical clustering achieved about 95% result. But the drawback is that SOM and FCM achieved a result of about 80%.

III.PROPOSED WORK

A. Fuzzy Clustering Method

This paper to suggest back propagation fuzzy neural network. In this technique to detect and classification of brain tumor images very effectively. BPNN used for finding classification Accuracy and fuzzy cluster used to find segmentation and detection of particular brain tumor images. In this both methods to find benign and malignant brain tumor images. The structure of the maintenance for the image classification process stages of a brain tumor as well as to detect brain tumors in the MRI images by using Back Propagation Fuzzy Neural Network (BPFNN) and it can be used to find brain tumors in MRI images in its previous stages. In this work neural network and fuzzy cluster method is used to identify the abnormal brain tumor region in MRI brain images. The spatial fuzzy clustering method is applied for, to detect the brain tumor part in the MRI scanning images. In the classification stage, BPFNN has been implemented to find brain tumors in images. This proposed Back Propagation Fuzzy Neural Network classifier technique has been used to classify benign and malignant brain tumor images. The result shows that BPFNN classifier gives fast and accurate classification than the other neural network method and it can be effectively used for classifying brain tumor with high level of accuracy.

The division is the procedure of apportioning a computerized picture into numerous portions. The objective of the division is to improve and change the representation of the picture into something that is more important and simpler to investigate. The division is an unsupervised bunching calculation that arranges the information that focuses into various classes in light of their inborn separation from one another. Many researchers implemented the following methods k-means clustering, threshold method and manual analysis which is time consuming, inaccurate and it requires an intensive trained person to avoid diagnostic errors in threshold method. This method specially used for binary images, it is not used in several images. The k-means clustering method is used for clustering the image data.

MRI brain image classification is mostly based on Fuzzy Clustering and the structural analysis of the brain structure. BPNN is the supervised learning with non-knowledge based will be used for image classification. The back propagation neural network method is used here to identify the brain tumors with function for network activation. Fuzzy clustering is specially used for separating the

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data. It is an unofficial clustering procedure that classifies the input data into multiple data based on their inherent distance from each other. Fuzzy clustering help in segmenting the digital images into multiple segments which make easy to get the information rapidly.

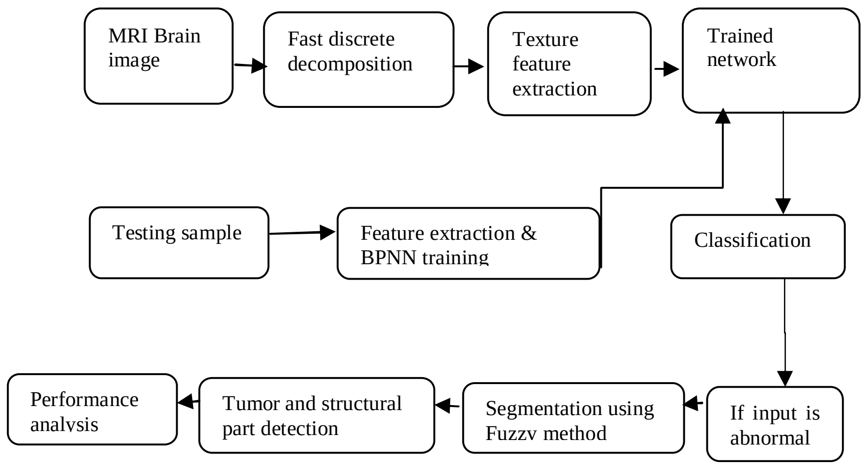

Fig. 1 Architectural Diagram of Proposed Method

B. Architecture of Artificial Neural Network

The artificial neural network has three layers such as input layer, hidden and output layers. The hidden layer simulation in order to determine the optimal number of hidden nodes. The input layer is used to select the parameter to the training data and it take the values from highest range value. Once the input layer process completed, then the process moved to the hidden layer. The hidden layer range value varied based on the validation data. If the hidden layer process is completed, then the process is moved to the output layer. The weights in the hidden node need to test using training data. The training data is used to find the neural networks input and output of the weights of the hidden nodes.

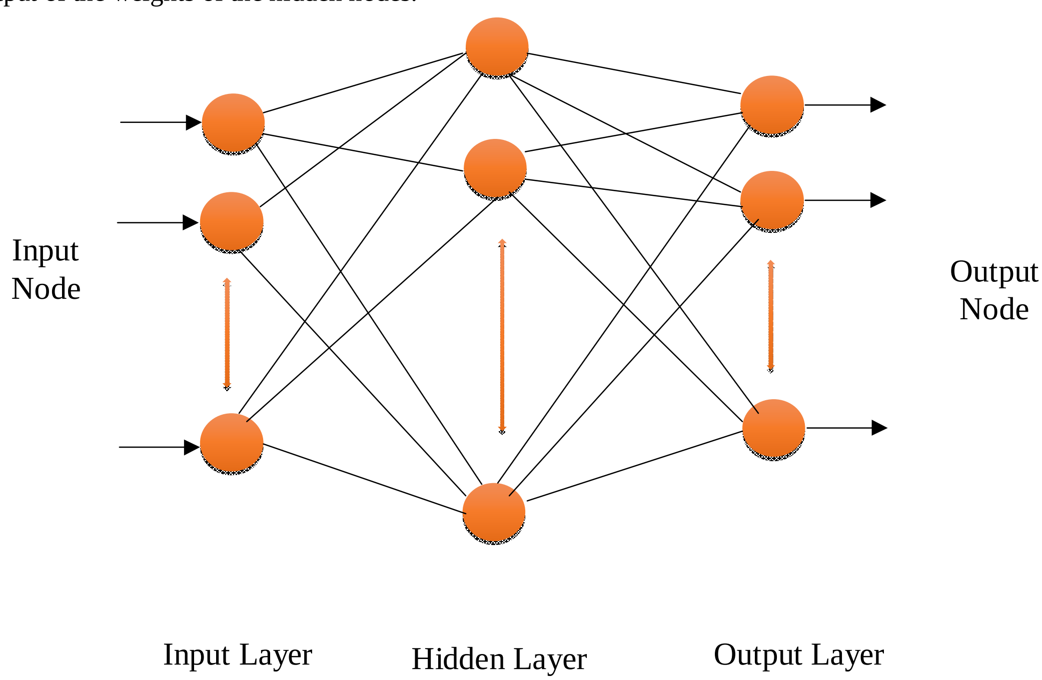

Fig. 2 Architecture of Artificial Neural Network

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C. Back Propagation Neural Network Classifier

Back propagation network (BPN) is a systematic method for training multi-layer artificial neural network. Back propagation provides a computationally efficient method for changing the weights in a feed forward network with differentiable activation function units to learn a set of input-output examples. The multi-layer feed forward BPN for classification of tumor consists of three layers such as production layer, secret layer and participation layer. The total number of nodes in the input layer is 9 representing features extracted from the ROI. The number of nodes in the hidden layer is 5 was decided experimentally as the network produced good results. The output of BPN is a single value, hence one node in the output layer. The nodes in one layer connect to the nodes in the next layer by means of directed communication links, each with as an associated arbitrary burden. The BPNN has three types of layer such as input layer, hidden layer and output layer. The hidden layer and output layer having results in two weight matrices is w1 and w2. The weight matrices w1 used to connect the input layer to be hidden layer. The weight matrices w2 is used to connect the hidden layer to the output layer. The network is trained using log-sigmoid activation function with a learning rate of 0.1 to evaluate the feature vectors based on the current network state. The processing time taken by the network is less than a minute.

IV. EXPERIMENTAL RESULTS AND SIMULATION

A. Inference And Forecasting

The brain tumor image is given as input to the subsystem. The input brain tumor image is pre-processed and then feature extracted and the ROIs are segmented by using the PCA method. Then the proposed back propagation fuzzy neural network method is applied to predict the brain tumor as either benign or malignant.

Some of the existing methodology is very difficult to find the accurate results in brain tumor images because it loss of edge details due to the shift variant property. On the other hand, through the proposed methodology accurate detection of the classification of the images can be done. The high compatibility texture characterization method is fast and flexible training and classification can also be done through proposed methodology.

B. Calculation Process

All classification results could have an error rate and on occasion will either fail to identify the normal and abnormal images. It is common to describe this error rate by the terms true and false positive and true and false negative.

$$\text{Classification Accuracy (CA)} = \frac{TP + TN}{(TP + TN + FP + FN)}$$

$$\text{Sensitivity} = TP / TP + FN$$

$$\text{Specificity} = TN / TN + FP$$

Finally Classification result calculated based on the accuracy formula.

Usually the Accuracy Measure is used

$$\text{Accuracy} = \frac{\text{No of Correctly Classified record}}{\text{Total Records in the test set}}$$

True Positive (TP): The test result is positive in the presence of the clinical abnormality.

True Negative (TN): The test result is negative in the absence of the clinical abnormality.

False Positive (FP): The test result is positive in the absence of the clinical abnormality.

False Negative (FN): The test result is undesirable in the presence of the clinical abnormality

FP= False Positive value pixel number/tumor size

FN= False Negative value pixel number/tumor size

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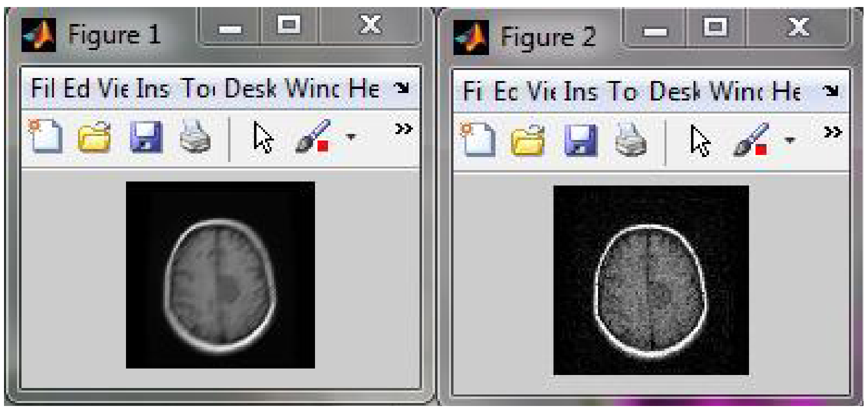
Correct rate= FP+FN

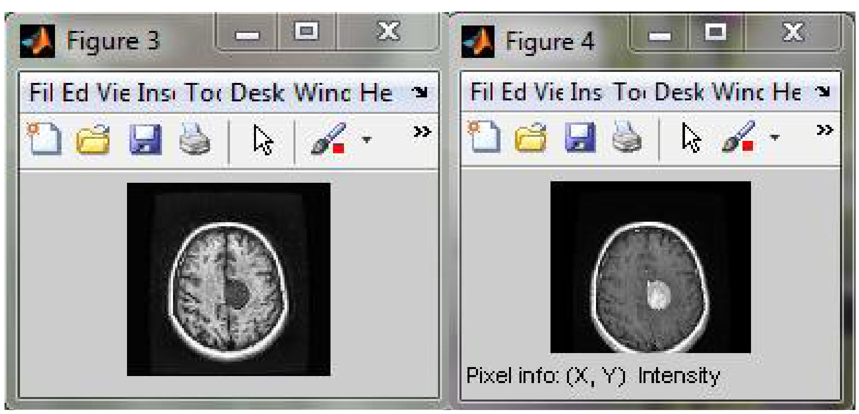
C. Results

Various experiments were performed and the training and the testing sets were determined by taking into consideration the classification accuracies. The data set was divided into two separate data sets –the training data set and the Testing data set. The training process is used to train the data set and the testing process is used to verify the accuracy and effectiveness of the trained network for the classification of brain tumors. The proposed technique is tested more than 50 MRI brain images. This work implemented by using MATLAB 7.0 environment. The MRI brain images are collected from various hospitals in tamilnadu. The figure 1, shows the given input MRI brain images used for the MRI image classification steps. The input brain MRI scanning images are classified by back propagation neural network. These neural networks are trained using back propagation method. The result of Back Propagation Neural Network (BPNN) is calculated by unidentified testing images. The classification results of Back Propagation Neural Networks are shown in fig 2 and fig 3. The classification performance accuracy of testing data set range is 100% to 90%.



A. B.

Fig. 3 Pre-processing Result A. Input Image B. Blurred Image



C. D.

Fig. 4 Pre-processing Result C. Edge Detection D. Segmentation

R Figure 3 and 4 shows the result of pre-processed stage such as blurred image, edge detection and segmentation of images. The PCA method is to find the feature extraction of the image. The proposed Back propagation fuzzy neural network method achieved is 90% accuracy in brain tumor image classification. The overall accuracy percentage details are shown in figure 5.

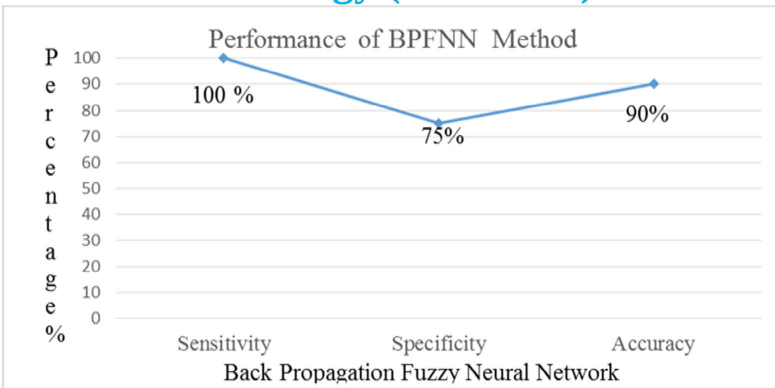


Fig. 5 Performance of Back Propagation Fuzzy Neural Network

D. Performance Analysis

The performance for brain functional image classification and brain structures are analyzed by using discrete where the features are extracted. By using segmentation and classification technique the number of deserted cells of benign stage is calculated as the tumor area is calculated as 12.2951mm. The proposed technique gives better accurate result in classification accuracy 90%, sensitivity accuracy 100% and the specificity accuracy 75% accuracy.

TABLE I
PERFORMANCE TABLE

S. No	Performance of Analysis						
	Algorithm	**Dataset**	**Correctly Classified Instances in %**	**Incorrectly Classified Instances in %**	**Processing Time**	**Sensitivity**	**Specificity**
1	BPFNN	Brain Tumor Images	90%	10%	Less than a Minute	100%	75%

V. CONCLUSION

Brain Tumor MRI image Classification with feature selection and extraction have been carried out in the past with limited success. In this research artificial neural network back propagation method is implemented to classify benign and malignant disease in brain tumor images. The pre-processing technique used to eliminate the unwanted noisy data from the images, in this work PCA method was used for the pre-processing stages. Back propagation algorithm neural network method was improved to train and testing the brain tumor images. In this work the Principal Component Analysis (PCA) is used for the pre-processing stage and the Principal Component (PCA) Method shows good result in a pre-processing level. Fuzzy clustering help in segmenting the digital images into multiple segments which make easy to get the information rapidly. The proposed Back Propagation Neural Network (BPNN) gives 90% classification accuracy in brain tumor image taxonomy. The classification process identifies the defected cells for benign stage is calculated as the tumor area is calculated as 12.2951mm. The proposed method achieves results as follows sensitivity 100% accuracy, specificity 75% accuracy and classification accuracy 90% and it is also minimizing the error rate as well as increase the classification accuracy. The processing time taken by the network is less than a minute. This the proposed technique performs better than the prevailing works. In future, this work may be implemented in large amount of datasets.

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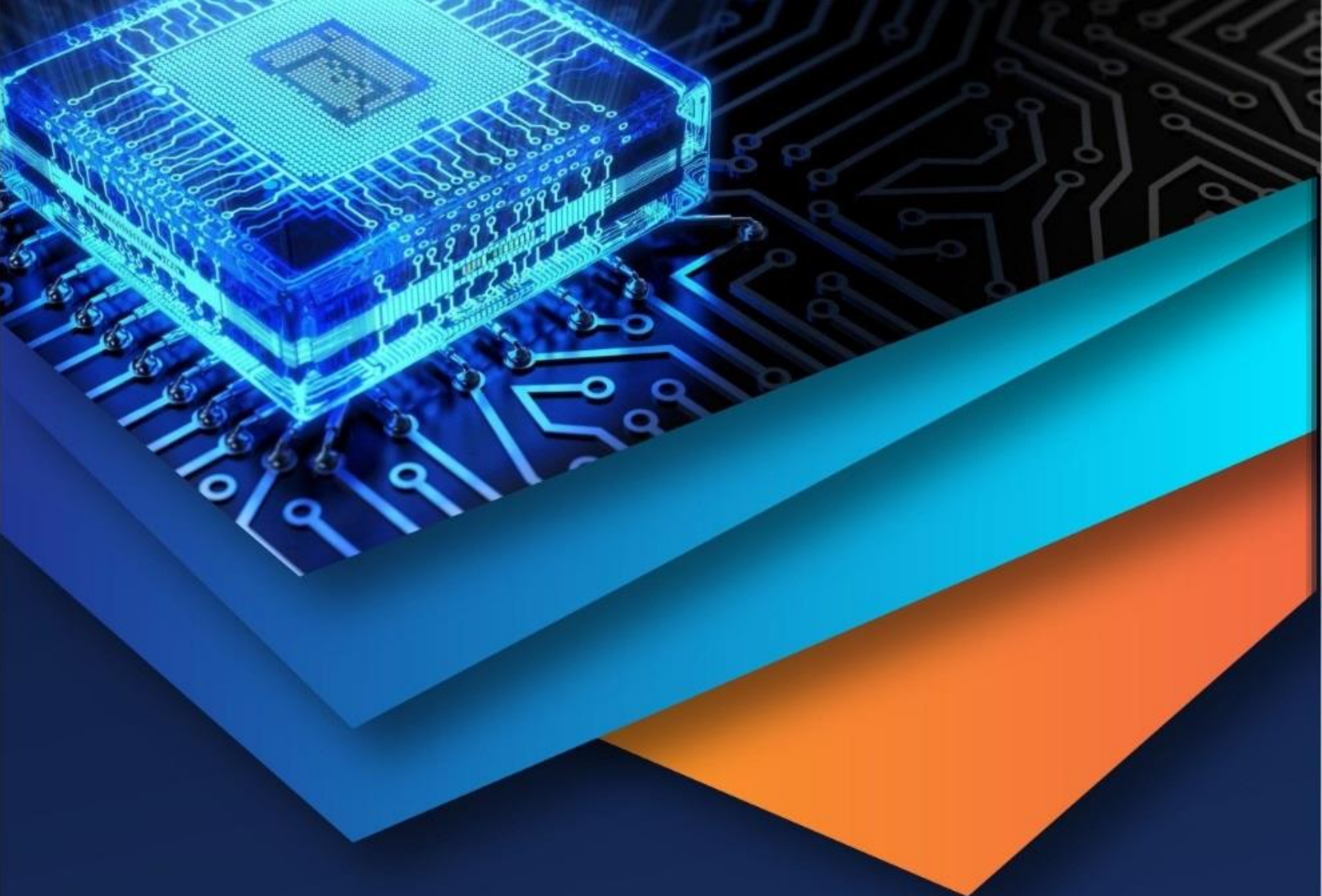

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