Brain Tumour classification, Detection and Segmentation Using Digital Image Processing and Probabilistic Neural Network Techniques

Dr. P.V. RAMARAJU
Department of Electronics and communication.
SRKR ENGINEERING COLLEGE
ANDHRA PRADESH, INDIA.
Email: pvrraju50@gmail.com

SHAIK BAJI
Department of Electronics and communication.
SRKR ENGINEERING COLLEGE
ANDHRA PRADESH, INDIA.
Email: baji .sk401@gmail.com

Abstract: **This paper proposes an automatic method for Brain tumor stage classification using Probabilistic neural network and Graphical user interface (GUI). The neural network will be used to classify the stage of Brain Tumor that is benign, *malignant* or normal. And also very small tumors from MRI images can also be identified very faster by this proposed algorithm. The detection of the Brain Tumor is a challenging problem in medical applications, due to the structure of the Tumor cells. This project presents a segmentation method, K-Means clustering algorithm, for segmenting Magnetic Resonance Images (MRI) to detect the Brain Tumor in its early stages. The segmentation results will be used as a base for a Computer Aided Diagnosis (CAD) system for early detection of Brain Tumor which will improve the chances of survival of the patient. Detection and extraction of tumour from MRI scan images of the brain is done by using software, developed in MATLAB.**

Keywords: **Probabilistic Neural Networks, Magnetic Resonance Images (MRI), GUI, Segmentation, Computer Aided Diagnosis (CAD), MATLAB.**

I. INTRODUCTION

Tumour is defined as the abnormal growth of the tissues. Brain tumour is an abnormal mass of tissue in which cells growand multiply uncontrollably and control normal cells. If the tumour does not invade nearby tissues and body parts, it is called a benign tumour, or non-cancerous growth. Benign tumours are rarely life threatening. Ametastatic brain tumour is a cancer that has spread fromelsewhere in the body to the brainEpilepsy is a brain disorder in which clusters of nerve cells,or neurons, in the brain sometimes signal abnormally.

An MRI (or magnetic resonance imaging) scan is a radiology technique that uses magnetism, radio waves, and a computer to produce images of body structures like brain.From these high-resolution images, we can derive detailed anatomical information to examine human brain development and discover abnormalities. Nowadays there are several methodology for classifying MR images, which are fuzzy methods, neural networks, atlas methods, knowledge based techniques, shape methods, variation segmentation. MRI consists of T1 weighted, T2 weighted and PD (proton density) weighted images and are processed by a system which integrates fuzzy based techniques.

Pre-processing of MRI images is the primary step in image analysis which perform image enhancement and noise reduction techniques which are used to enhance the image quality, then some morphological operations are applied to detect the tumor in the image. The MRI brain image is acquired from patient's database and then Image acquisition, pre-processing, image segmentation is performed for brain tumor detection.

II. METHODOLOGY

*GUI:*A graphical user interface (GUI) is a user interface built with graphical objects, such as buttons, text fields, sliders, and menus. In general, these objects already have meanings to most computer users. For example, when you move a slider, value changes; when you press an OK button, your settings are applied and the dialog box is dismissed. Of course, to leverage this built-in familiarity, you must be consistent in how you use the various GUI-building components.

Image Acquisition: - Maximum MRI Images of brain are collected form possible resources like Radiologists,Internet, and Hospitals etc.

Image compression and Image conversion: -Database of MRI images of brain is prepared. All images are converted into one standard size. If colour image is there, it is converted into gray image for simplicity. Similarly Images are converted into two dimensional or single dimensional according to the requirement.

Apply 4- level wavelet decomposition:

TWO DIMENSIONAL DWT: The two-dimensional DWT, is performed on images by applying the filters *L* and *H* to rows and columns. This operation produces a quadrant *c* containing the coefficients of the scaling functions and three quadrants of wavelet coefficients *d* usually labeled as horizontal, vertical, and diagonal (H, V, D). Wavelet coefficients of higher resolution are obtained by applying the below filtering steps to quadrants *c*.

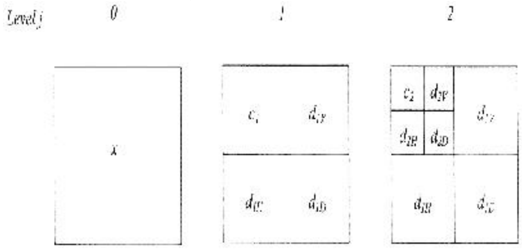


Fig 1: Filtering steps of 2D-DWT using MATLAB

Syntax:

[cA, cH, cV, cD] = dwt2(X,'*wname*')

[cA, cH, cV, cD] = dwt2(X,Lo_D,Hi_D)

Algorithm 2D DWT using MATLAB

Two-dimensional DWT leads to a decomposition of approximation coefficients at level *j* in four components: the approximation at level *j* + 1, and the details in three orientations (horizontal, vertical, and diagonal).

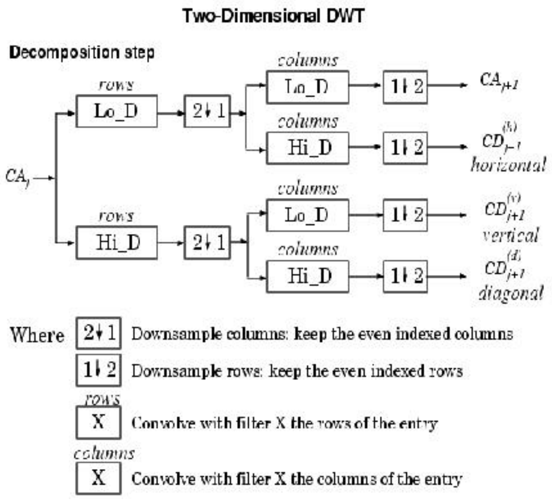


Fig 2: Decomposition Steps in 2-D DWT

Feature extraction (Training process): - Mathematical technique is used to extract feature vectors of all images in the database.

Feature extraction is a special form of dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant then the input data will be transformed into a reduced representation set of features, named features vector. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. By using feature extraction we can estimate theParameters of brain tumor like entropy, energy, contrast and correlation.

Testing Phase: - Feature vector of the test image will be computed in this phase. Euclidean Distance is also Calculated to decide in which class of 'brain tumor' the i/p image is to be fitted.

*Probabilistic Neural Network:*Probabilistic Neural Network with image and data processing techniques was employed to implement an automated Brain Tumor classification. Decision making was performed in two stages: feature extraction using GLCM and the classification using Probabilistic NeuralNetwork (PNN). The performance of the PNN classifier was evaluated in terms of training performance and classification accuracies. Probabilistic NeuralNetwork gives fast and accurate classification than other neural networks and it is a promising tool for classification of the Tumors.

Tumour Classification: - Feed Forward PNN will be used to classify MRI images.After applying probabilistic neural networks the cancer samples are classified According to the severity and they are named as benign (not harmful) and malignant (harmful).this classification is done with comparison of data base images.

*Segmentation:*Image segmentation is the process of partitioning a (sets of pixels, also known as super pixels)to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse.

*1.Clustering:*Clustering can be considered the most important *unsupervised learning* problem; so, it deals with finding a *structure* in a collection of unlabeled data. A*cluster* is therefore a collection of objects which are "similar" between them and are "dissimilar" to the objects belonging to other clusters.

2. K-means Clustering

Cluster analysis, an important technology in data mining, is an effective method of analysing and discovering useful information from numerous data. Cluster algorithm groups the data into classes or clusters so that objects within a cluster have highsimilarity in comparison to one another, but are very dissimilar to objects in other clusters. Dissimilarities are assessed based on the attribute values describing the objects. Often, distance measures are used. As a branch of statistics and an example of unsupervised learning, clustering provides us an exact and subtle analysis tool from the mathematic view K-means algorithm belongs to a popular partition method in cluster analysis.

The most widely used clustering error criterion is squared-error criterion, it can be defined as

$$J_c = \sum_{j=1}^{c}\sum_{k=1}^{n_j}\left\| x_k^{(j)} - m_j \right\|^2$$

Where*J,* is the sum of square-error for all objects in the database, x_k is the point in space representing **a** given object, and m_j is the mean of cluster C_j.

III. IMPLIMENTATION

MRI image is given as the input to this algorithm, and the colour image is converted to gray color image, and then a 4-level wavelet decomposition is performed to extact the features vectors. Then the training processed is performed on test image with reference to the data base image. This process is performed with the help of TRAINED PROBABILISTIC NEURAL NETWORKS. Then the classification of tumour is displayed on graphical user interface. This classification is done in comparision with the images in data base.

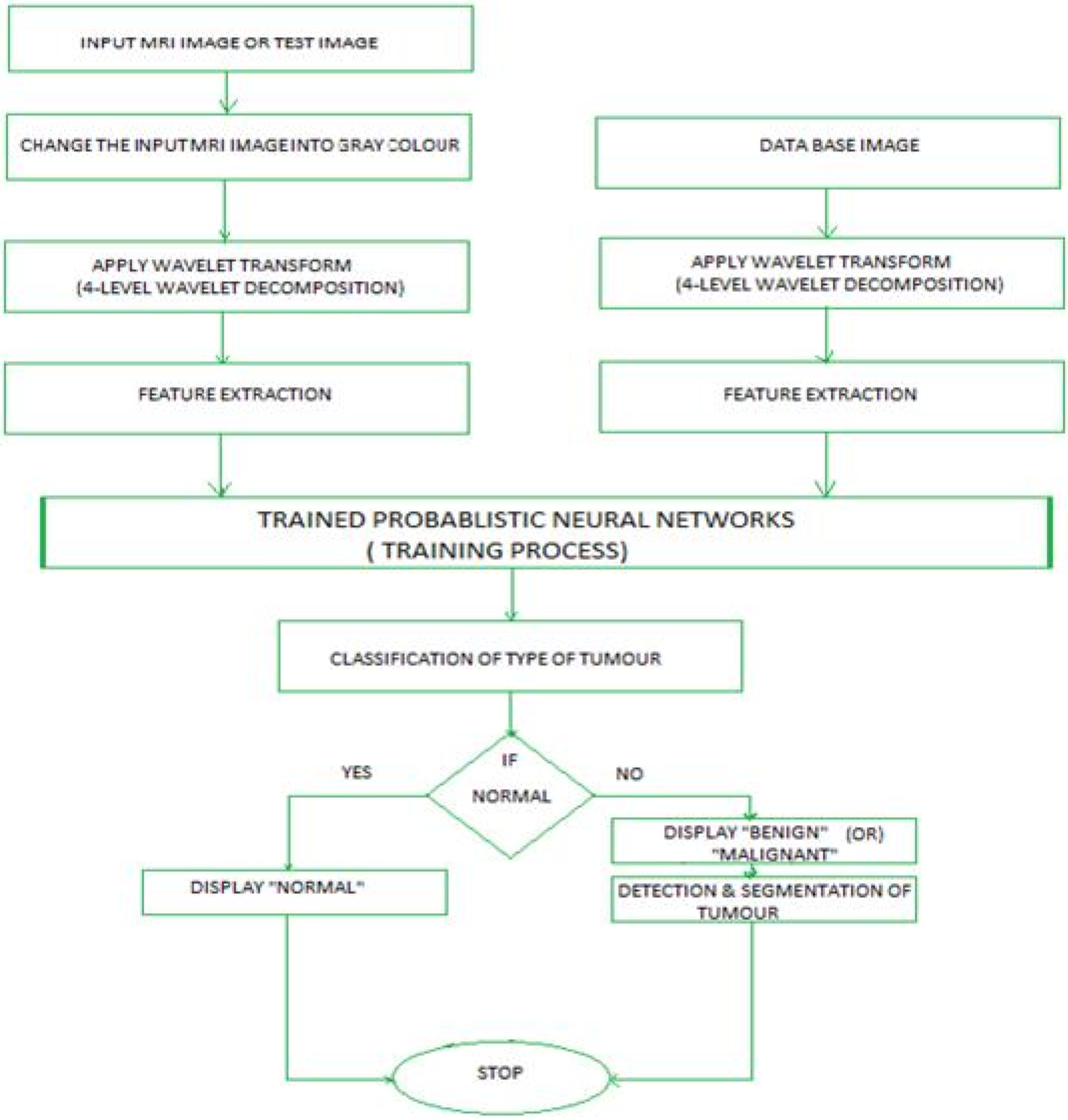


Fig3:Algorithm

Database:

Data base consist of pre processed MRI images. In this proposed method different images from different patients have been considered, analysed and classified.

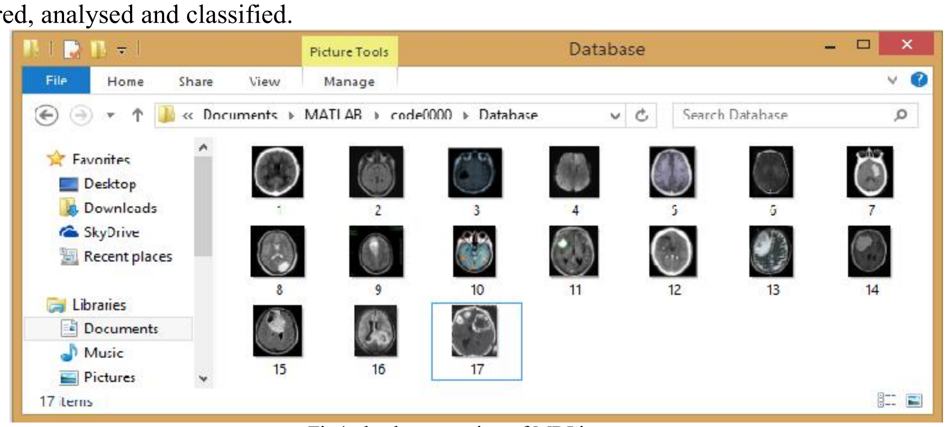


Fig4: database consists of MRI images

Classification:

After training process, input MRI image is compared with data base images and tumors are classified as 'normal', 'benign', and 'malignant'.

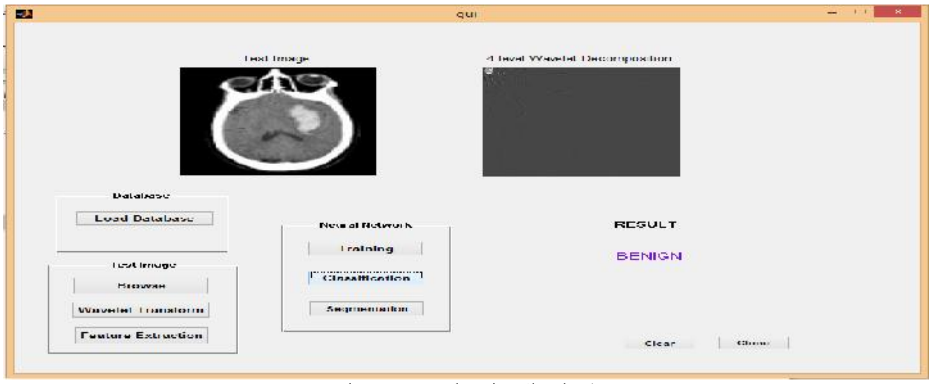


Fig5: output showing 'benign'

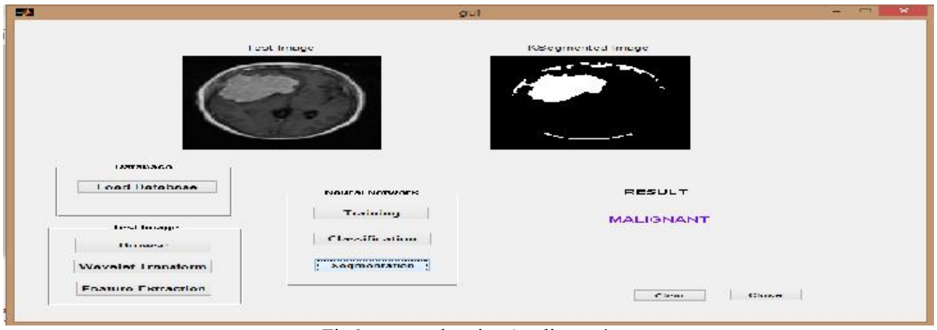


Fig6: output showing 'malignant'

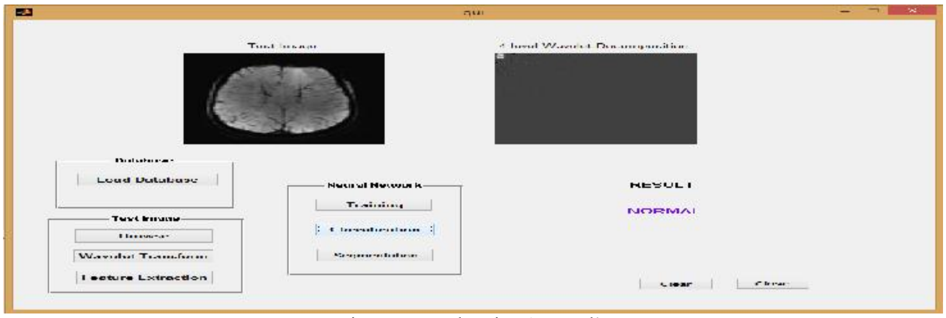


Fig7: output showing 'normal'

Segmentation and detected tumour region:

If the tumor is of type benign or malignant, then we perform segmentation operation to identify and extract the tumor affected region from MRI image. In this following figure the white area is the extracted tumour region.

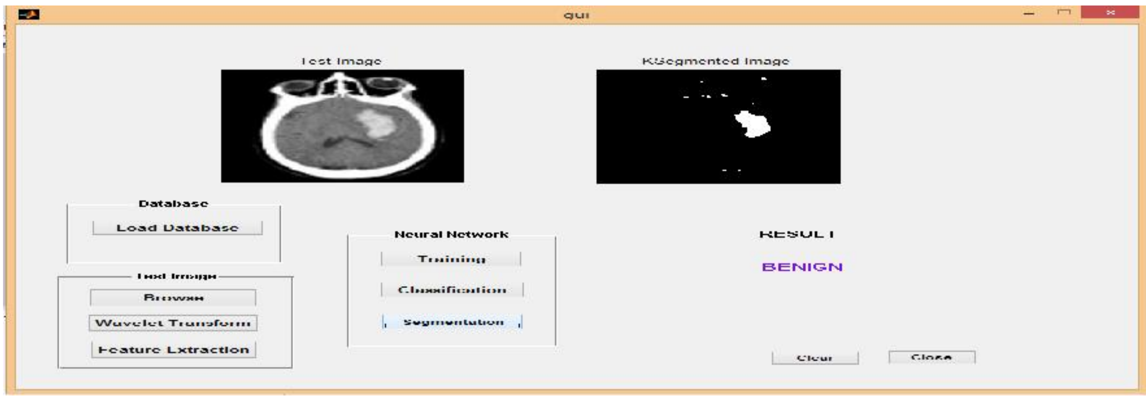


Fig8: output showing segmented tumour region

Parameters:

After the tumour is identified we can able to calculate the output parameters like area, mean, standard deviation and entropy.

Fig9: output parameters

IV. RESULTS

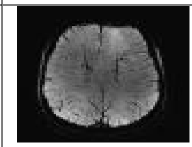
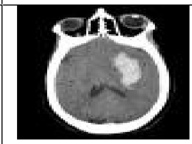
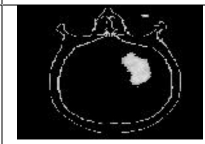
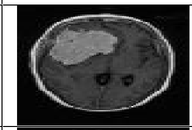
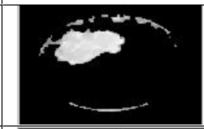
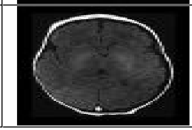
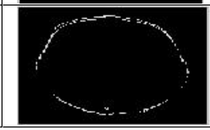
PATIENT S.NO	INPUT MRI IMAGE	SEGMENTED IMAGE	TYPE OF TUMOUR	TUMOUR AREA(mm.^2), MEAN, STANDARD DEVIATION AND ENTROPY
1		GIVEN INPUT IS NORMAL SO WE CAN NOT SEGMENT	**NORMAL**	0,0,0,0
2			**BENIGN**	10.1391, 0.0225, 0.1463, 0.1553
3			**MALIGNANT**	21.8084, 0.1041, 0.3054, 0.4819
4			**BENIGN**	4.9460, 0.0054, 0.0730, 0.0481

Fig10: results

V. CONCLUSION

By using this proposedmethod classification, detection and segmentation of brain tumor can be achieved fast. And also very small tumors from MRI images can be identified precisely and more rapidly. By performing feature extraction and classification using 'PNN', MRI images can be classified as benign, malignant or normal. And also we calculated parameters like area, mean, standard deviation and entropy.

VI. FUTURE SCOPE

If we analyse more no. of MRI images of a patient in a certain time period i.e. for several months, we can find the growth of the tumor cells. And we can also have a chance to predict in which direction the tumor cells affect the normal cells.

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Dr.P.V. Rama Raju is a Professor at the Department of Electronics and Communication Engineering, S.R.K.R. Engineering College, AP, India.

His research interests include Biomedical-Signal Processing, *S*ignal Processing, VLSI Design, Antennasand Microwave Anechoic Chambers Design. He is author of several research studies published in national and international journals and conference proceedings

Shaik Baji received B.Tech degree in electronics and communication engineering from Narasaraopeta Engineering College, narasaraopet, A.P, India in 2012.

Currently he is pursuing M.TECH specialization in Communication Systems, in S.R.K.R Engineering College, Bhimavaram, A.P, India.