Brain Cancer Detection Using Artificial Neural Network

Pooja R. Poornima, L. Poornima, Spanshini. R Dr. S. Padmashree
Department Of Electronics & Communication Engineering
GSSS Institute Of Engineering & Technology For Women

***Abstract*— Identifying Tumors in a MRI images is a useful process. For Tumor identification classification is done in this paper we use Nero Fuzzy classifier. The MRI images are fist preprocessed to remove noises from them. Histogram Equalization is done to equalize the contrast of the image. Then images are enhanced using sharpening filter. Then using gray scale thresholding the images are segmented.**

The text in the MRI images is minimized by applying some Morphological operations. Then GLCM features are extracted from the image. The extracted features are saved as training features. For query image the same process are done and the features are stored as test features. True label is set for all the images in the dataset. The test image features, train image features and True label are passed into the classifier. The Nero Fuzzy classifier finds if tumor is present or not.

I. INTRODUCTION

1.1 *Overview*

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows.

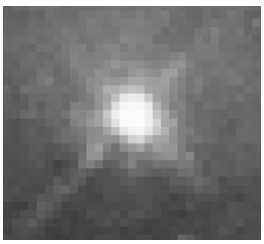


Figure 1: An image — an array or a matrix of pixels arranged in columns and rows.

In a (8-bit) grayscale image each picture element has an assigned intensity that ranges from 0 to 255. A grey scale image is what people normally call a black and white image, but the name emphasizes that such an image will also include many shades of grey.

Some grayscale images have more grayscale, for instance 16 bit = 65536 grayscales. In principle three grayscale images can be combined to form an image with 281,474,976,710,656 grayscales. There are two general groups of 'images': vector graphics (or line art) and bitmaps (pixel-based or 'images').

Pictures are the most common and convenient means of conveying or transmitting information. Pictures concisely convey information about positions, sizes and inter relationships between objects..Human beings are good at deriving information from such images, because of our innate visual and mental abilities.

About 75% of the information received by human is in pictorial form. An image is digitized to convert it to a form which can be stored in a computer's memory. The digitization procedure can be done by a scanner or video camera connected to computer. Once the image has been digitized, it can be operated upon by various image processing operations.

Brain cancer can be counted among the most deadly and intractable diseases. Tumors may be embedded in regions of the brain that are critical for the body's vital functions, while it invade other parts of the brain, forming more tumors too small to detect using conventional imaging techniques.

Brain cancer's location and ability to spread quickly makes treatment with surgery or radiation like fighting an enemy hiding out among minefields and caves. A brain cancer is a disease in which cells grow uncontrollably in the brain. Brain tumors are of two main types: 1) Benign tumors 2) Malignant tumors.

Benign tumors are incapable of spreading beyond the brain itself. Benign tumors in the brain usually do not need to be treated and their growth is self limited. Surgery or radiation can be helpful. Malignant tumors are typically called brain cancer. These tumors can spread outside of the brain.

Malignant tumors of the brain will always develop into a problem is left untreated and an aggressive approach is almost always warranted. Brain malignancies can be divided into two categories: Primary brain cancer originated in the brain. Secondary or metastatic brain cancer spreads to the brain from another site in the body.

Cancer occurs when cells in the body (in this case brain cells) divide without control or order. Normally, cells divide in a regulated manner. If cells keep dividing uncontrollably when new cells are not needed, a mass of tissue forms, called a growth or tumor. The term cancer usually refers to malignant tumors, which can invade nearby tissues and can spread to other parts of the body.

2.1 Objectives

The main objective is:

- Automated recognition system for the MRI image using neuro fuzzy logic.
- Better classification during the recognition process.
- Better accuracy level.

The main processes involved in processing are:

- Preprocessing
- Histogram Equalization
- Image Enhancement
- Feature Extraction
- Neuro fuzzy classifier

II LITERATURE SURVEY

- 'A Modified Fuzzy C-Means Algorithm for Bias Field Estimation and Segmentation of MRI Data'. Pierre-Louis Bazin. In this paper a novel algorithm for fuzzy segmentation of magnetic resonance imaging (MRI) data and estimation of intensity in homogeneities using fuzzy logic. The homomorphism filtering approach to remove the multiplicative effect of the in homogeneity has been commonly used due to its easy and efficient implementation.
- 'A neuro fuzzy color image segmentation method for wood surface defect detection'.). Zexuan Ji, Yong Xia, Quansen Sun In this study, neurofuzzy color image segmentation method forwood surface defect detection is proposed. The method is called fuzzy min-max neural network for image segmentation (FMMIS).
- 'Topology-Preserving Tissue Classification of Magnetic Resonance Brain Images'. Tamalika Chaira. This paper presents a new framework for multiple object segmentation in medical images that respects the topological properties and relationships of structures as given by a template.
- 'Fuzzy Local Gaussian Mixture Model for Brain MR Image Segmentation'. In this paper that the local image within the neighborhood of each voxel follows the GMM, and thus propose the FLGMM algorithm for brain MR image segmentation.

III METHODOLOGY

It is convenient to subdivide different image processing algorithms into broad subclasses. There are different algorithms for different tasks and problems, and often we would like to distinguish the nature of the task at hand.

- **Image enhancement**: This refers to processing an image so that the result is more suitable for a particular application.

Example includes:

- sharpening or de-blurring an out of focus image,
- highlighting edges,
- improving image contrast, or brightening an image,
- Removing noise.[2]

- **Image restoration**. This may be considered as reversing the damage done to an image by a known cause, for example:

- removing of blur caused by linear motion,
- removal of optical distortions,
- Removing periodic interference[2].

- **Image segmentation**. This involves subdividing an image into constituent parts, or isolating certain aspects of an image:

- Circles or particular shapes in an image.
- In an aerial photograph, identifying cars, trees, buildings, or roads.[2]

The image processing task can be accomplished by:

- **Acquiring the image**: First we need to produce a digital image from a paper envelope. This can be done using either a CCD camera, or a scanner.

- **Preprocessing:** This is the step taken before the major image processing task. The problem here is to perform some basic tasks in order to render the resulting image more suitable for the job to follow. In this case it may involve enhancing the contrast, removing noise, or identifying regions likely to contain the postcode.

- **Segmentation**: Here is where we actually get the postcode; in other words we extract from the image that part of it which contains just the postcode. The main purpose of segmentation is to partition the image into multiple segments which makes more meaningful and easy to analyze[1]. Each pixel assigning a label to the image so that Pixel having same label show similar characteristics and properties. For the anatomical detailed information of brain images, mapping and identification of tumor clustering algorithm has been very effective. Various methods for image segmentation:[1]

- Edge detection methods
- Region Growing methods
- Watershed segmentation
- Clustering segmentation

The best suited segmentation technique is clustering method for brain MRI Scanned images because in other methods the cancer cells near the surface of MRI image is very fat, thus appear dark which is very confusing for the isolation of the edge or periphery for the tumor part and non tumor part. So we use Fuzzy C-means clustering in which every point has a degree of belongingness to cluster for a given dataset [10].]

- **Representation and description** These terms refer to extracting the particular features which allow us to differentiate between objects. Here we will be looking for curves, holes and corners which allow us

to distinguish the different digits which constitute a postcode.[10]

- **Recognition and interpretation**: This means assigning labels to objects based on their descriptors (from the previous step), and assigning meanings to those labels. So we identify particular digits, and we interpret a string of four digits at the end of the address as the postcode**.**[10]

PROPOSED SYSTEM:

The MRI images are first preprocessed to remove noises from them. Histogram Equalization is done to equalize the contrast of the image. Then images are enhanced using sharpening filter. Then using gray scale thresholding the images are segmented. The text in the MRI images is minimized by applying some Morphological operations. Then GLCM features are extracted from the image.[3]

The extracted features are saved as training features**.** For query image the same process are done and the features are stored as test features. True label is set for all the images in the dataset. The test image features, train image features and True label are passed into the classifier. The Neuro Fuzzy classifier finds if tumor is present or not.[3]

Module Description:

1. Preprocessing:

In pre-processing we are applying Gaussian filtering to our input image. Gaussian filtering is often used to remove the noise from the image. **Gaussian filter** is windowed filter of linear class; by its nature is weighted mean.

The Gaussian Smoothing Operator performs a weighted average of surrounding pixels based on the Gaussian distribution. It is used to remove Gaussian noise and is a realistic model of defocused lens.. Noise can be added using the sliders.[4]

Gaussian filter algorithm:

1. Given window size $2N+1$ calculate support points $x_n=3n/N$, $n=-N, -N+1, \ldots, N$;
2. Calculate values G''_n;
3. Calculate scale factor $k'=\sum G''_n$;
4. Calculate window weights $G'_n=G''_n/k'$;
5. For every signal element:
    1. Place window over it;
    2. Pick up elements;
    3. Multiply elements by corresponding window weights;
    4. Sum up products — this sum is new filtered value.

2. Histogram Equalization*:*

Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. This method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values[6]

3. Image Enhancement:

Images are enhanced using the morphological operations. Morphology is a technique of image processing based on shapes. The value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. The first step is to create structure element. Morphological operations like top hat and bottom hat filters are used. Top-hat filtering is used to correct uneven illumination when the background is dark. Top hat operation contains peaks of object that fit the structuring element. Bottom hat operations are used to fill the gap between the objects.

Vessel Enhanced = Input image +top hat (Input image) - bottom hat (Input image) .[6]

4. Feature extraction:

GLCM (Gray level Co-occurrence matrix) Feature:

A GLCM is a matrix where the number of rows and columns is equal to the number of gray levels, G, in theimage. A statistical approach that can well describe second-order statistics of a texture image is a co-occurrence matrix. Gray level co-occurrence matrix (GLCM) was firstly introduced by Haralick.

A gray-level co-occurrence matrix (GLCM) is essentially a two-dimensional histogram. The GLCM method considers the spatial relationship between pixels of different gray levels [8]. The method calculates a GLCM by calculating how often a pixel with a certain intensity i occurs in relation with another pixel j at a certain distance d and orientation. A co-occurrence matrix is specified by the relative frequencies P (i, j, d).A co-occurrence matrix is therefore a function of distance d, angle □ and grayscales i and j. The calculation of the GLCM of an segmented image is as shown in fig.

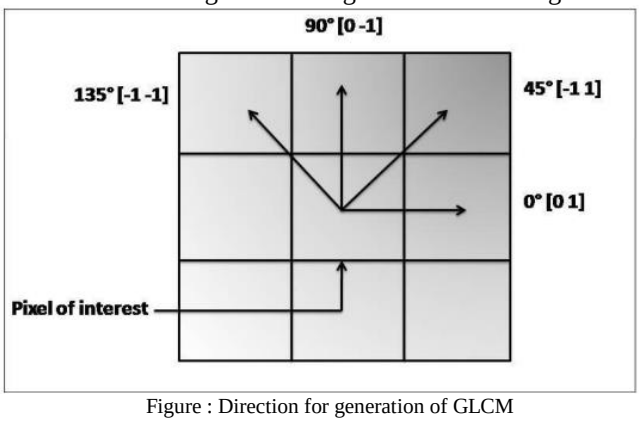


Figure : Direction for generation of GLCM

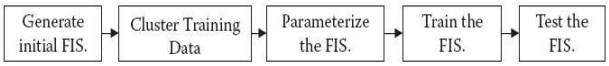
In our proposed system MRI image can be decomposed into patterns with regular textures. So we should be able to represent these regular texture regions by using co occurrence matrices. To do so, we utilize the co-occurrence matrices in angles of 0°, 45°, 90°, and 135°.

Neuro Fuzzy Classifier:

A Neuro-fuzzy classifier is used to detect candidate circumscribed tumor. Generally, the input layer consists of seven neurons corresponding to the seven features. The output layer consists of one neuron indicating whether the MRI is a candidate circumscribed tumor or not, and the hidden layer changes according to the number of rules that give best recognition rate for each group of features.[9]

Here we classify the result by the use of ANFIS (Adaptive Neuro Fuzzy Inference system).
It is the combination of neural network and fuzzy logic.
ANFIS largely removes the requirement for manual optimization of parameters of fuzzy system.The neuro-fuzzy system with the learning capabilities of neural network and with the advantages of the rule-base fuzzy system can improve the performance significantly and neuro-fuzzy system can also provide a mechanism to incorporate past observations into the classification process.In neural network the training essentially builds the system. However, using a neuro-fuzzy technique,the system is built by fuzzy logic definitions and and it is then refined with the help of neural network training algorithms.
General architecture of ANFIS.[9]

We develop a general problem-solving methodology for ANFIS.

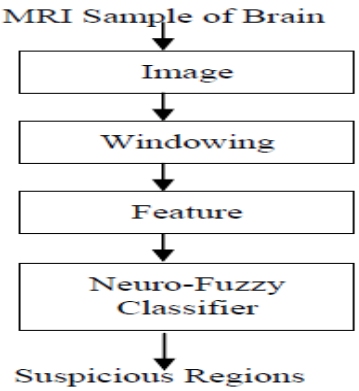


The problem-solving methodology in ANFIS.

The motivation of ANFIS is to train the FIS using neural network architecture. We start with an initial FIS for the purpose of training.

As stated above, we start by generating an initial FIS, which may be used for training by the system. If the initial FIS is not generated, we may use a randomly generated FIS with predefined inputs and a predefined number of MFs(Membership function) per input.[10]

System Architecture:



Activity diagram

The query image undergoes preprocessing in which noise are removed. GLCM features include test features and train features. The features are extracted in neuro fuzzy classifier. It gives classification of normal and tumor image. It also tells about the accuracy.
The features are labeled according to shape and size of tumor.

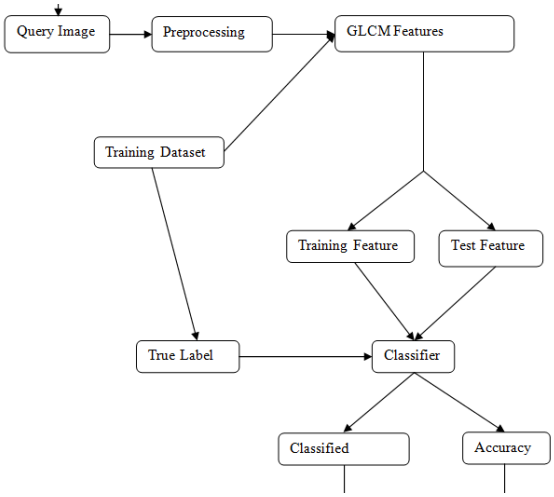


Fig: the classification of images in neuro fuzzy classifier.

APPLICATIONS

- Medicine: Inspection and interpretation of images obtained from X-rays, MRI or CAT scans.
- Agriculture: inspection of fruit and vegetables. Distinguishing good and fresh produce from old.
- Industry: Automatic inspection of items on a production line.
- Law enforcement: Fingerprint analysis.

ADVANTAGES

- The method is useful in images with background and foreground that are both bright or both dark.

- Images can be stored in computer memory and easily retrieved on the same computer screen.
- It allows electronic transmission of images.
- Facilitates quick and better access to data information.

HARDWARE SPECIFICATION:

The hardware requirements of the project are as follows.

- System : Pentium IV – 2.7 GHz
- RAM : 1GB DDR RAM
- Hard Disk :250Gb Hard Disk

SOFTWARE SPECIFICATION

The software requirements of the project are as follows.

- Operating System : Windows XP
- Tool : Matlab
- Version : 7.9

4. IMPLEMENTATION

This chapter gives information about the implementation of the proposed system.

4.1 SOFTWARE TOOL

MATLAB is the software tool used for the implementation of the proposed system

4.1.1 MATLAB

MATLAB® is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computation. Using MATLAB, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and FORTRAN.

Mat lab's standard data type is the matrix all data are considered to be matrices of some sort. Images, of course, are matrices whose elements are the grey values (or possibly the RGB values) of its pixels. Single values are considered by Mat lab to be matrices, while a string is merely a matrix of characters; being the string's length.

4.1.2 Steps for Programming

Following shows the snapshot of software implementation of proposed system which includes the steps involved in programming.

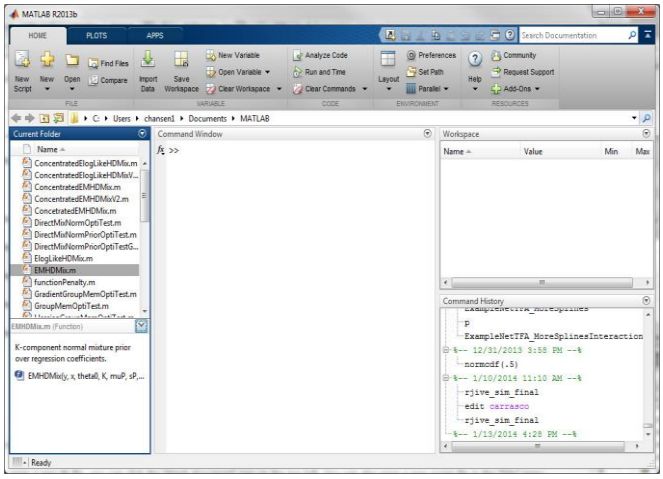


Figure 4.1: Snapshot of opening screen of MATLAB R 2013 software.

RESULTS AND DISCUSSIONS

This chapter gives the overall results and conclusion of the proposed system.

RESULTS

Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. We can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, spatial transformations, and image registration.

After completing the code, we load the image; do histogram equalization, followed by image segmentation and feature extraction.

The feature extraction has normal and tumor images. Neuro fuzzy classifier differentiates normal and tumor fault classification.

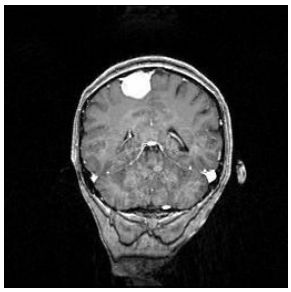


Fig1: database image

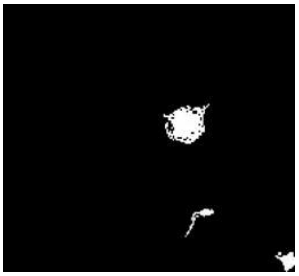


Fig2: tumor image

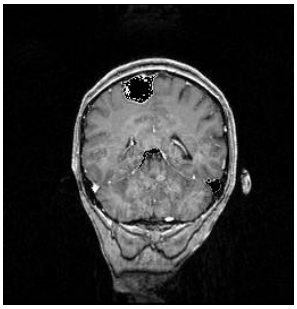


Fig3: normal image

Compared to other classifiers neuro fuzzy is effective because it gives better and faster results. If we use k-NN classifier it doesn't have abstraction. It takes high time to predicate the item. It takes large time to prepare data and design robust equation. The other is decision tree algorithm it splits dataset and homogeneous sets. Its disadvantage is it is not used for continuous variables and it takes large amount of time**.**

CONCLUSION

In our proposed method a automated recognition system for the MRI image using the neuro fuzzy logic. It is observed that the system result in better classification during the recognition process**.** CAD (Computer Aided Designing) system may be developed to automatically detect brain tumors through pattern recognition along with their respective shape, size, location and also to determine the stage and nature of the tumor. . The accuracy to detect cancer using neuro fuzzy classifier is 97%.
Well there are still many researches going on. It is not completely accomplished. If definitely used in future it will help to detect cancer and give useful results.

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