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Brain Tumor Detection using MRI Scan

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ABSTRACT
Magnetic resonance imaging (MRI) is a powerful image which can also be used to detect abnormalities in the tissues such a tumor whereas CT scan does not provide detailed information in an image. This paper explains the various stages applied on the MRI image to detect the presence of the tumor. Various stages include pre-processing, segmentation, morphological filtering, feature extraction and neural network. The aim of this project is to propose a method that will efficiently and accurately detects the tumor. This proposed algorithm will help the doctor to detect the tumor more efficiently.

Keywords
Brain Tumor, MRI Scan, Pre-Processing, Segmentation, Morphological Filtering, Feature Extraction

1. INTRODUCTION
Diagnosing the brain tumor can be done by using two different types of medical imaging techniques i.e. magnetic resonance imaging (MRI) and Computed Tomography (CT). CT scan sends X-Rays beams into the patient's body thereby taking many pictures of the desired soft tissue. Unlike CT scan, MRI uses powerful magnetic fields and radio frequency pulses to produce the image of the desired soft tissue. Magnetic resonance imaging (MRI) is able to distinguish clearly between abnormal and normal tissues. Due to the above medical knowledge, MRI images are used in the flow of the project. The following techniques are applied to the dataset such as preprocessing which helps in removal of noise, enhancing the image and improving the image quality, segmentation which segment the image so that the required region can be extracted easily, morphological filtering which helps in removal of imperfections in a gray scale image, finally tumor will be detected if present or not.

2. PROPOSED ALGORITHM
MRI image of the human brain is served as the input to the proposed algorithm. The image goes through the pre-processing stages which will transform the input image from the RGB color image to the grey scale image, which is followed by removal of the noise from the image (i.e. Salt and pepper noise) which is achieved by using the median filter which has resulted to be the most effective noise removal method. Removal of the noise is then followed by enhancement of the image. The pre-processing image is then fed as the input to the segmentation stage which uses the Otsu's method.

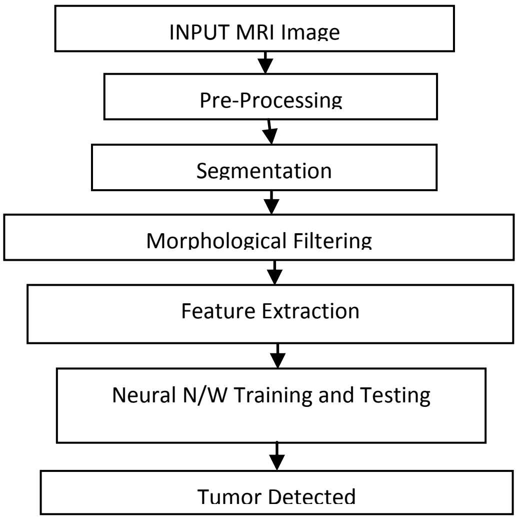


Fig 1: Block Diagram for proposed algorithm

3. PRE-PROCESSING
Image pre-processing is an improvement of the image that suppresses unwanted distortion or enhances some image features required for the further processing [2]. It helps in removal of the film artifacts (i.e. Marks or labels such as patient name, age, gender), converting the input image into a form which helps in performing the further stages more efficiently.

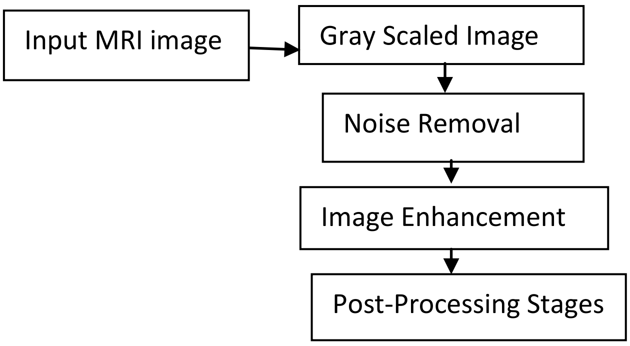


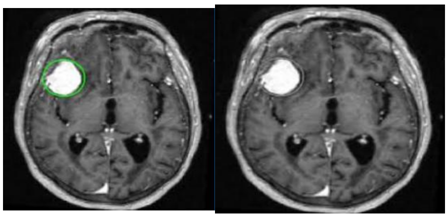
Fig 2- Stages in pre-processing

3.1 Gray Scale Image
The RGB image will be converted into the gray scaled image.

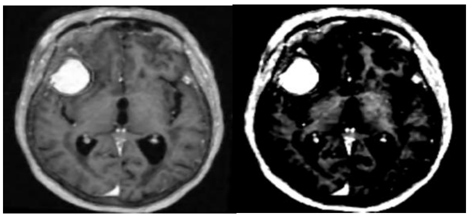
3.2 Removal of noise
Removal of noise is an essential stage in pre-processing as it helps in removing the disturbance from the image by removing the noise. This is achieved by using the median filter as it removes the noise without disturbing the images.

3.3 Image enhancement

Image enhancement provides a more prominent image by reducing the blurring effect from the input image.



(a) (b)



(c) (d)

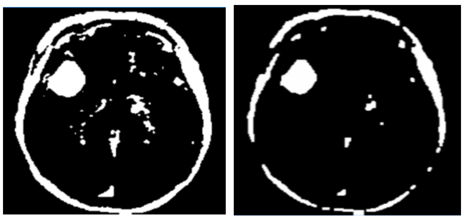
Fig 3: (a) Loaded MRI image, (b) Gray Scale conversion, (c) Filtering, (d) Image-enhancement

4. SEGMENTATION

The goal of image segmentation is to simplify and change the representation of the image into something which is more meaningful and easier to analyze [1]. This stage partitions the image into separate segments. Each segment will contain the pixels which share the same characteristics from the adjacent segment. Otsu's method is used to segment the image. It basically divides the image based on two different classes of regions namely foreground and background. The two different classes are selected using the weighted class variance.

5. MORPHOLOGICAL FILTERING

Morphological filtering is basically a collection of processes related to shape or morphology of features in the image [3]. To eliminate the unwanted pixels which are still present in the image after segmentation is removed in this stage. Different morphological filtering operations are erosion, dilation, opening, closing. Erosion shrinks an image while dilations expands an image. Application of dilation is bridging gaps and application of erosion is eliminating irrelevant detail.



(a) (b)

Fig 4: (a) After segmentation (b) After morphological filtering

6. FEATURE EXTRACTION

The input image contains several features which serve as the characteristics that capture properties of the image. When the input dataset to the algorithm is too large, it is then reduced to a state which makes it easier to be processed. This reduced dataset is easier to be used to perform the desired task. Texture feature is the most important, since it contains the structure information of the image. There are several ways for texture extraction but the most commonly used is the GLCM (Gray Level Co-occurrence Matrix).

6.1 Texture Extraction

The software uses GLCM which is most commonly used and the most efficient algorithm [7],[8]. Texture features are extracted here which makes the processing easier. Here the matrix is found with respect to four different degrees (i.e.0°,45°,90°,135°) which are then used to find the below listed feature:

1. Entropy

$$f1 = \sum_{i,j=0}^{N-1} P(i,j) * [-\ln (P(i,j))]$$

2. Contrast

$$f2 = \sum_{i,j=0}^{N-1} P(i,j) * (i-j)^2$$

3. Correlation

$$f3 = \sum_{i,j=0}^{N-1} \mathrm{Pij} \frac{(i-\mu)(j-\mu)}{\sigma^2}$$

4. Energy

$$f4 = \sum_{i,j=0}^{N-1} (\mathrm{Pij})^2$$

6.2 Shape

Shape is also an important feature in detecting the presence of tumor in an image. Here, use of blob counter is made, which is a detecting method and is aimed to detect regions in an image that differ in properties such as brightness or color compared to surrounding regions. A blob is a region of an image in which some properties are constant or approximately constant. Shapes can be described by shape parameters such as area, perimeter, major axis, minor axis, Euler number, solidity, circularity.

6.2.1 Area

Provides the area of the tumor which is the region of interest in detecting the tumor.

6.2.2 Perimeter

Perimeter gives the structural properties of the region which is defined by a list of coordinate and is the sum of the distances from each coordinate to the next.

6.2.3 Circularity

Circularity is calculated using area and perimeter. This provides the information of how circular the region of interest is.

7. ARTIFICIAL NEURAL NETWORK (ANN)

Artificial neural networks (ANN) are typically organized in layer fashion, where each layers are made up of interconnected nodes which consists of the activation function. There are three types of layers involved such as, input layer, hidden layer and the output layer. The input is fed via the input layer, which are connected to one or more hidden layers where the actual processing of the data takes place and the output is fed out via the output layer. Most of the neural networks contain some of the 'learning rule' which is used to find the weight that will be used in the testing phase to produce the output.

7.1 Learning phase

The data is processed through all the stages and the output is fed into the neural networks and based on some learning rule the weights are been determined which will be later used in the testing phase to determine the valid output.

7.2 Testing phase

Here the data is also processed through all the stages but the valid output is determined (i.e. in our algorithm it will determine whether tumor is present or not) by using the weights determined during the learning phase.

Fig (5) in training phase MRI image will be pre-processed, segmented, features will be extracted and the system will be trained. In testing phase MRI image will be pre-processed, segmented, features will be extracted and image will be tested and tumor presence will be detected.

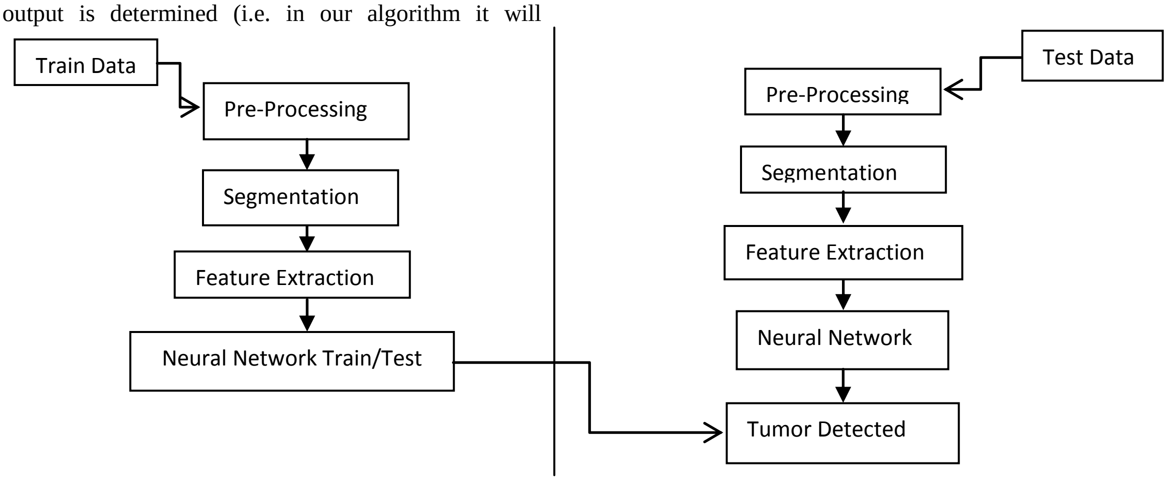


Fig 5:Proposed neural network

Here 7 different features Fig (6) i.e. contrast ,correlation, entropy, energy, area, perimeter and circularity is fed into the input layers. This calculates the weights and biases in the hidden layer during the training phase, which is used during the testing phase for detecting the presence of the tumor which will serve as the output.

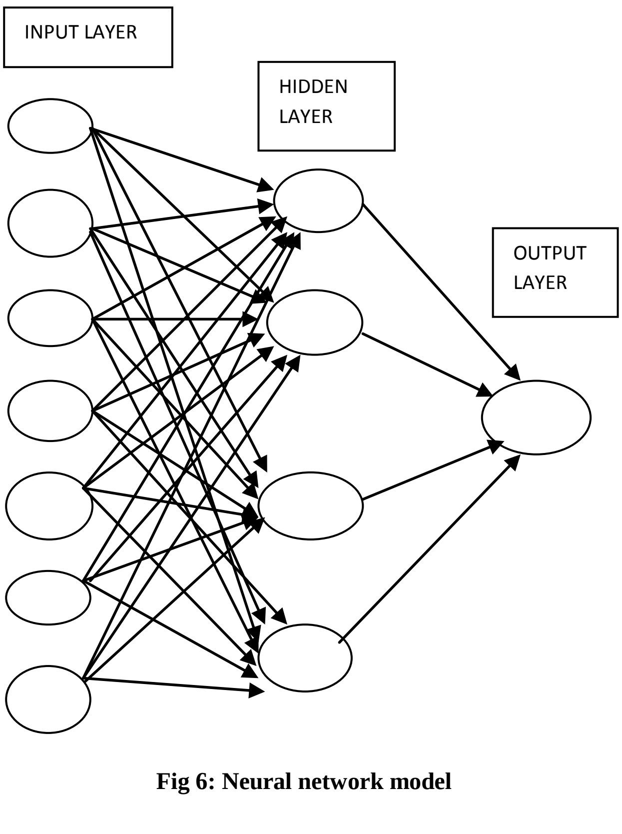


Fig 6: Neural network model

8. TUMOR DETECTED

By training the system, it is able to detect the presence of tumor, which leads to the last stage of our proposed research.

9. CONCLUSION

Brain tumor is one of the mainly life-threatening diseases and hence its detection should be fast and accurate. MRI images are very important for detecting the existence and outlines of tumors. It has a low error rate. Pre-processing is necessary to enhance the input MRI image followed by the later stages. All this is proposed using the Artificial Neural Network (ANN), this approach is computationally effective and yields good result. Neural Network is analyzed and valued in a more elaborate and in-depth manner. This automated analysis system could be further used for classification of images whether the tumor is present or absent. The system was trained using 150 MRI images and tested with 70 MRI images of tumor and non- tumor. The analysis is held out by detecting out the evaluation parameters including true positive, false positive, false positive, false negative, sensitivity, specificity and accuracy. The following is calculated by

Sensitivity = TP/ (TP + FN)
Specificity =TN/ (TN+FP)
Accuracy = (TN + TP)/ (TN + TP + FN + FP)

Sensitivity, Specificity and Accuracy values came about 0.60, 0.73, 0.65respectively.

Table 1. Tumor and Non Tumor Detection Result

Data Sets	Analysis Using Shape	Analysis Using Texture
Tumor Images	Total: 40 Detected: 20	Total: 40 Detected: 15
Non Tumor Images	Total: 30 Detected: 18	Total: 30 Detected: 16

70 MRI images were tested by considering only the texture feature, shape feature and by considering both the features and have observed that combining both the texture feature and the shape feature gives us better result rather than only considering only the texture feature or the shape feature separately.

10. FUTURE SCOPE

The future scope will be testing the system with larger number of datasets to increase the accuracy of the system, training the system with the brain tumor dataset that classifies the tumor as benign or malignant as this will enable the system to tell whether the tumor is benign or malignant and also to improve the classification accuracy by extracting more features.

Table 2. Comparison of shape and texture Based on Different Evaluation Parameters

Evaluation Parameters	Using shape	Using texture	Comparison of shape and texture
Sensitivity	50%	40%	60%
Specificity	60%	50%	73%
Accuracy	54%	44%	60%

11. DATA SET

We have referred to the data set from

1. Apollo Victor Hospital,Goa
2. Goa Scan Center.
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