

Diagnosis of Brain Tumor Using Artificial Neural Network

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Abstract

Accurate detection and diagnosis of brain tumor is one the crucial task of medical image analysis. Brain tumor classification system aids the physician to make accurate diagnosis and to provide effective treatment. Magnetic Resonance Imaging (MRI) is the gold standard imaging technique for brain tumor diagnosis. This paper proposes a method for brain tumor detection and classification using artificial neural network. The proposed method consists of four major processes such as preprocessing, region of interest segmentation, feature extraction and classification. Feed forward neural network is employed to classify the brain tumors. Classification performance of the proposed method is evaluated using 10-cross fold validation and compared with the previous methods. Empirical findings proved that the proposed method can efficiently classify the brain tumor with higher classification rate.

Keywords: Brain Tumors, Tumor Segmentation, Classification and Wavelet Neural Network.

Introduction

Automatic analysis of neuro imaging plays a significant role in detection and diagnosis of brain tumors. Brain tumors occur due to the rapid and abnormal growth of cells in the brain. Brain tumors can be categorized into cancerous or malignant and non-cancer or benign. Benign tumor can be treated while malignant tumor is the most dangerous form of cancer and can lead to death [1]. According to the Global cancer report, a total of 3,08,000 new cases of brain cancers was diagnosed that caused 2,51,000 brain tumor deaths in 2020[2]. Early detection is the best way for effective treatment of brain tumor.

With the advent of medical imaging modalities, neuro imaging techniques play a pivotal role in brain tumor analysis and can give physician with a clear picture of human brain. Neuro imaging modalities can give information on size, shape and structural changes, helping physician to make accurate decision about the disease. Magnetic Resonance Imaging (MRI) is the popular and widely employed screening method for brain tumor diagnosis [3]. It has the potential show difference between normal and abnormal tissues. Thus, MRI is more suitable for brain lesions detection.

Recently, Artificial Neural Network (ANN) and deep learning have gained more attention due to its successes in medical field. Brain tumor diagnosis using ANN has become an interesting research topic of medical image analysis. Over the past years, researchers have tried to develop a robust system for brain tumor diagnosis using ANN. Ge et al. [1] presented a deep learning framework for brain tumor classification. The proposed method uses semi-supervised learning based deep learning method for brain tumor classification. Mittal et al. [2] proposed an improved method for brain tumor detection which is based on deep learning neural network. Gu et al. [4] designed a convolutional neural network for brain tumor classification. Chen et al. [5] introduced a kernel sparse based method for brain tumor diagnosis. Badža et al. [6] developed a brain tumor classification system using convolutional neural network.

The main objective of this paper is to develop an efficient technique for brain tumor diagnosis. The proposed method consists of four major phases such as preprocessing, segmentation, feature extraction and classification. Primarily, all the images are preprocessed with median filter to suppress noise. Secondly, tumor region is extracted from its surrounding tissues using segmentation algorithm. Thirdly features are extracted from the lesion region and then classified using Feed Forward Neural Network (FFNN)

The remainder of the article is outlined as follows: Functioning of the proposed method is given in section “proposed methodology”. Numerical results are reported in section “empirical study”. Finally, conclusion is given in section “conclusion”.

Proposed Methodology

In this research work, a novel method for brain tumor diagnosis is proposed and implemented. Framework of the proposed method is evinced in Figure.1. The following processes are involved in the proposed system:

- Preprocessing
- Segmentation
- Feature extraction and
- Classification

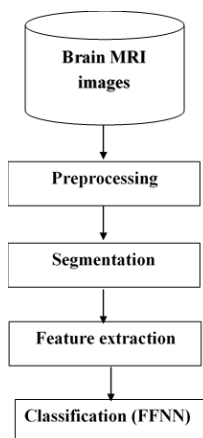


Figure 1: Proposed Methodology for Brain Tumor Diagnosis

1. Preprocessing

MRI images are preprocessed with median filter with a kernel size of 3 X 3 to remove noise. Median filter is used due to its capability of preserving edges and boundaries while denoising. Mathematically, median filtering can be defined as,

$$I'(u, v) = \text{median} \{I(u + i, v + j) | (i, j) \in R\} \quad (1)$$

Example image of median filtering is shown in Figure.2.

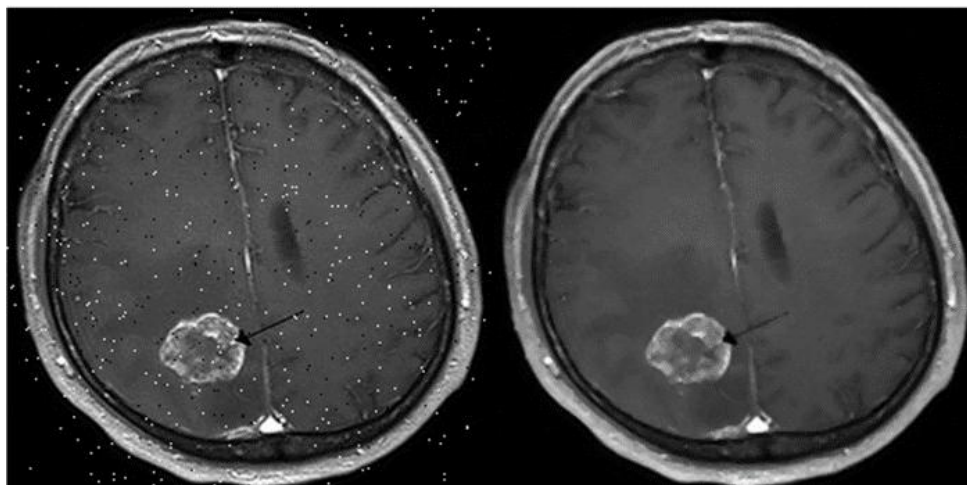


Figure 2: Preprocessed MRI Image

2. Segmentation

Segmentation is one of the essential steps of medical image analysis. In this research work, automatic segmentation algorithm is employed for separating tumor region from its background tissue. Sample images of segmentation algorithm is given in Figure.3.

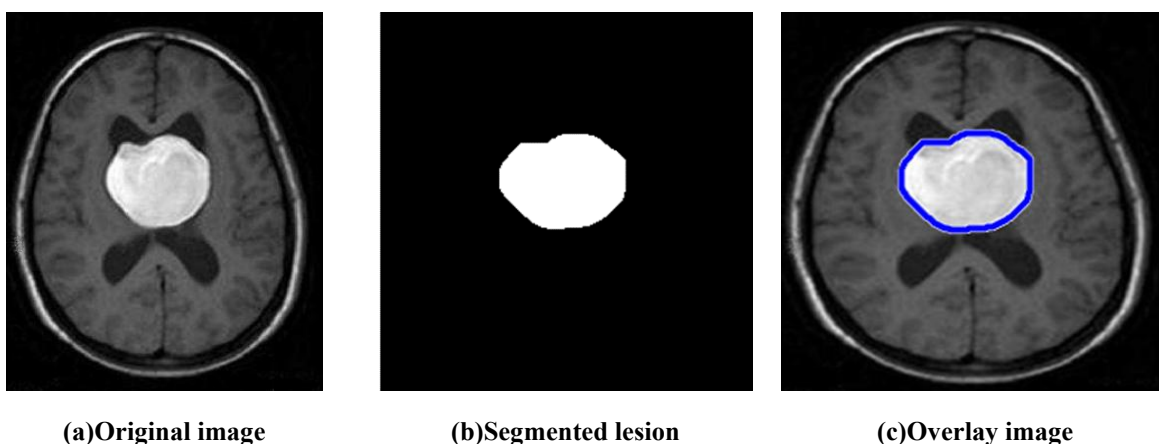


Figure 3: Segmented MRI Images

3. Feature Extraction

After segmentation, shape and texture [7] related features are selected from the segmented tumor region. The computed features are fed as input to the FFNN.

4. Classification

FFNN is employed for classifying the brain tumors based on the extracted features. FFNN is designed with an input layer, two hidden layers and an output layer. Sigmoidal and linear activation function is used at the hidden and output layer respectively. The network is trained with back propagation algorithm. Structure of FFNN is depicted in Figure.4.

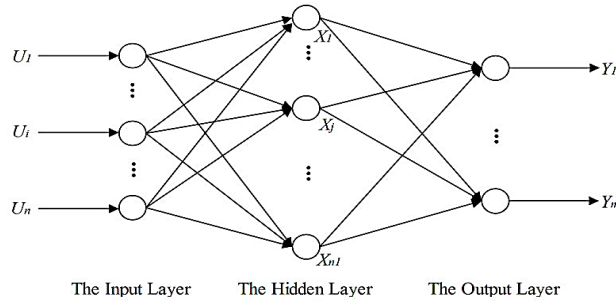


Figure 4: Structure of FFNN

Empirical Study

This section presents the simulation results of the proposed method in light of numerical terms.

1. Database

The proposed brain tumor diagnosis method is validated on Harvard data set. Harvard data set contained a total of 120 MRI images which includes 41 normal and 79 tumor images. Sample images of Harvard data is shown in Figure.5.

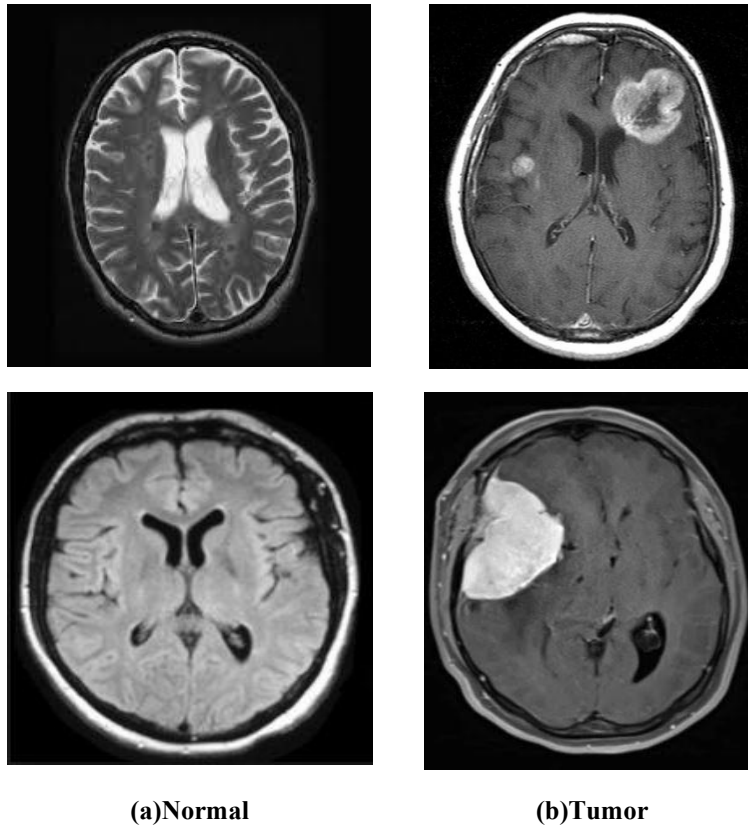


Figure 5: Sample Images of Harvard Dataset

FFNN is used for classification purpose. Classification performance of the proposed method is evaluated by computing classification accuracy, specificity, Matthews correlation coefficient (MCC) and sensitivity. 10-cross fold validated is used to assess the potential of the proposed method. Efficiency of the proposed system is tabulated in table.1.

Table 1: Efficiency of the Proposed Method

Dataset	Classifier	Specificity (%)	Sensitivity (%)	Accuracy (%)	MCC
Harvard	FFNN	93.3	96	95.5	0.89

Table.1 results proved that the proposed method can classify the MRI images with high classification rate. Classification performance of the proposed method is graphically shown in Figure.6.

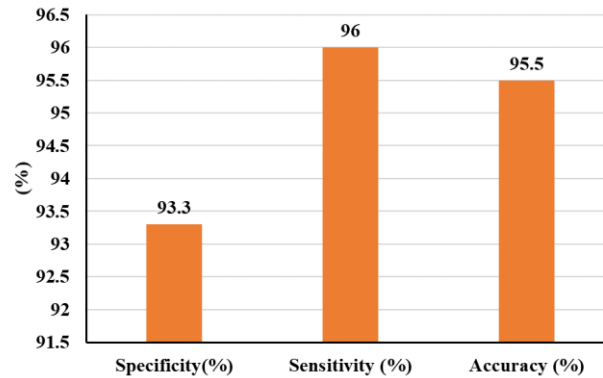


Figure 6: Classification Performance of the Proposed Method

Conclusion

This paper presented a new method for brain tumor diagnosis which is based on feed forward neural network. Input images are preprocessed using median filter and then segmented using automatic segmentation algorithm. After segmentation, shape and texture features are computed. Feed forward neural network performed the classification task. Experimental results showed that the proposed method achieves classification rate of 95.5% in classifying brain tumor images.

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