

Brain Tumor Detection Using Soft Computing Tools

Nilakshi Devi¹, Prasanta Kr. Baruah², Kaustubh Bhattacharyya³

¹M.Tech, School of Technology, Assam Don Bosco University

²Associate Professor, Gauhati Medical College & Hospital, Guwahati, Assam.

³Assistant Professor, Deptt.of Electronic and Telecommunication Engineering, Assam Don Bosco University

Abstract: Modern medical imaging research faces the challenge of detecting brain tumor through Magnetic Resonance Images (MRI). Normally, to produce images of soft tissue of human body, MRI images are used by experts. For brain tumor detection, image segmentation is required, which is a challenging task faced by today's medical neurologist. This is considered to be one of the most important step in detecting brain tumor as the further treatment and diagnosis depend on it. Hence, it is highly necessary that segmentation of the MRI images must be done accurately. Limitations in manual detection have made the researchers to turn their attention towards the using of soft computing tools in brain tumor detection. Over the years many researchers have proposed different methods of tumor detection using intelligent tools like ANN, Fuzzy Logic etc. obtaining better results. Here are discussed a few methods of brain tumor detection using different algorithms proposed by researchers.

Keywords: Brain Tumor, MRI, Artificial Neural Network, Fuzzy Logic, Genetic Algorithm, Brain Image Segmentation, Soft Computing Tools

1. Introduction

Brain Tumor as shown in Figure1, also medically known as, "intracranial neoplasm" is an abnormal mass of growth of cells within the brain without any specific direction. It is one of the most deadly diseases that medical science has ever seen. The cause of brain tumor is not known to medical science yet. Over the years there had been an increasing rise of brain tumor deaths in India[1]. According to World Health Organization (WHO) there are mainly two classes of tumor: Benign and Malignant[2]. Benign tumors are harmless and are less aggressive as compared to malignant tumors. Malignant tumors spread more quickly in the brain and are considered to be harmful as compared to malignant tumors.

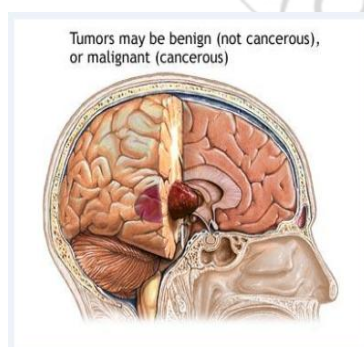


Figure1: Brain Tumor

In recent technology of medical imaging MRI (Magnetic Resonance Imaging) as shown in Figure2, is gaining importance over CT scan (Computed Tomography) because of its capability of producing 3-D views and high resolution images [3]. Unlike CT scan MRI does not uses ionizing radiation for which it is preferred more by the radiologist.

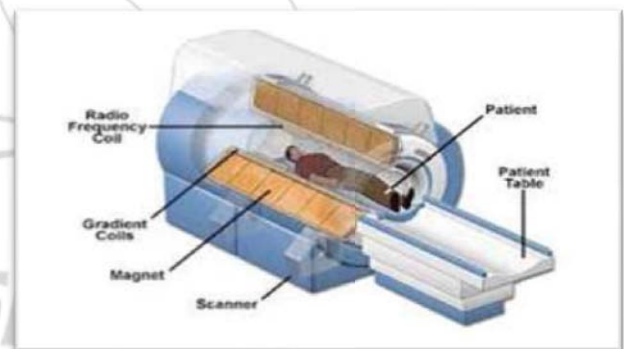


Figure 2: A MRI machine

Manual segmentation have been performed by the radiologists to detect the tumor area from the normal areas. But in today's imaging where many number of images are taken of a single patient, it becomes rather difficult and time consuming for the radiologist to detect the tumor of a single patient. So, the researchers are using soft computing tools like ANN (Artificial Neural Network), Fuzzy Logic, Genetic Algorithm (GA) etc. to detect tumor part from the normal areas. As far as human error and time is concerned the use of soft computing tool in brain tumor detection has emerged as an efficient method reducing time and increasing efficiency in detection.

2. Materials and Method

The materials used in the detection process are MRI images of brain tumor and different soft computing tools. These tools provides for automation of brain tumor detection. The materials have been described as follows:

a) MRI Images: MRI is a non-invasive technology used by the neurologist to detect the presence of any abnormality in the human brain. As compared to other imaging technologies like CT Scan, PET Scan etc. MRI Imaging has preferred in tumor detection because of its various

advantages. Brain MRI image as shown in Figure3, have been used here to analyze the presence of tumor.

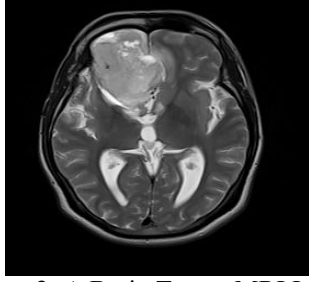


Figure 3: A Brain Tumor MRI Image

b) Soft Computing Tools: Soft computing are a group of methodologies that is meant to handle real life problems by using analytical and reasoning capacity. These tools are emerging as a promising help in different areas of science and technology like image processing, pattern recognition, in data clustering, in medical diagnosis etc. and many more. Soft Computing has the ability to handle uncertainty, imprecision, partial truth and provide better solution in comparable to a human mind. There are different soft computing tools like Neural Networks, Fuzzy Logic, Evolutionary Algorithm, Support Vector Machines etc.

2.1 Methodology

The process used in brain tumor detection begins with the step of lowest level of information extraction known as pre-processing followed by feature extraction and classification as shown in Figure4

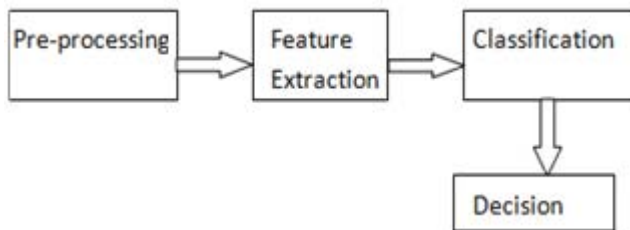


Figure 4: Methodology of Brain Tumor Detection

The input MRI image has to first undergo a series of pre-processing steps like conversion of the image to gray scale, histogram equalization, binarization, edge detection etc. to obtain minimum amount of information of the input image. Pre-processing is then followed by feature extraction, where meaningful features are extracted from the input data which contains valuable information about the input image. Gray Level Co-occurrence matrix has been used by many researchers for feature extraction [4] along with wavelet based pre-processing. Principal Component Analysis (PCA) [5] have also been used for feature extraction. Finally classification is performed which classifies the tumor brain and normal brain images. Many methods have been proposed for classification using neural network algorithms. The advantage of using ANN is the requirement of less time consumption in detection of large amount of MRI images. These soft computing tools indeed proves to be a efficient method of detection of brain tumor.

3. Brain Tumor detection using different Soft Computing Tools

1) **Fuzzy Logic:** The use of Fuzzy Logic is to handle imprecision and partial truth. Its used has been increased rapidly in image processing technique [6]. Fuzzy C-means is gaining importance as data clustering technique. Modified fuzzy c-means is also being used by many researchers in proper tumor segmentation. Fuzzy cognitive maps are also being used for low grade tumor classification [7].

2) **Artificial Neural Network (ANN):** ANN is a biologically inspired computing algorithm which is a model of the human central nervous system. ANN has two modes of operation: the training mode and the testing mode. The ANN is used in classification of brain tumor [8-14]. MLP is also proposed by many researchers for classification of normal and tumor brain images. A MPL is a feed forward neural network consisting of multiple layers of nodes as shown in Figure5.

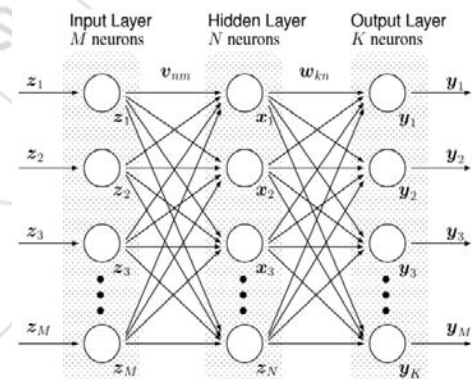


Figure5: Multilayer Perceptron(MLP)

In the above cited figure of MLP M, N and K represents input, hidden and output layers respectively. “z” denotes a set of signals which is input to the neurons in the input layers of the network. In the hidden layers each neuron takes the weighted sum of the output signals from the input layer. The (connection) weight from the n-th neuron in the input layer to the m-th neuron in the hidden layer is denoted by “vnm”. The output of the neuron in the hidden layer, denoted by xn, is determined by the equation

$$x_n = g \left(\sum_{m=1}^M v_{nm} z_m \right)$$

Where g is a quaternionic activation function introducing no n-linearity between the action potential and output in the neuron. And the output of the neuron in the output layer is given by the equation

$$y_k = h \left(\sum_{n=1}^N w_{kn} x_n \right)$$

Where w_{kn} is the connection weight between the neuron in the hidden layer and the neuron in the output layer.

3) **Genetic Algorithm:** Genetic algorithm is a bio-inspired search algorithm developed by the researchers for solving optimization problems and other search problems [15-20]. Genetic algorithm is also being preferred as a efficient tool for brain tumor detection. Researchers have

also used methods like watershed segmentation along with genetic algorithm for better accuracy of tumor detection.

4. Current Status of Research

Brain Image Segmentation is one of the most efficient techniques used now-a-days in detection of brain tumor. Various new methods have been proposed for detection of brain tumor. Segmentation techniques like Edge based segmentation, Histogram Thresholding methods, use of Morphological and Water Shed methods etc. have been used for tumor detection. But, it was found that manual segmentation of brain lacks in giving proper and the required information and is time devastating, for which now the attention is directed towards automation of brain image segmentation which is expected to give better results than earlier segmentation methods in less computation time. Also, in today's modern world where a large number of MRI datas are taken for a single patient, the use of non-intelligent methods are too much labour extensive, so the researchers are being compelled to find alternatives using soft computing tools. Tools like ANN, Fuzzy Logic, Genetic Algorithm are gaining importance in this aspects.

5. Conclusion

Proper detection of brain tumor is vital for the neurologist to carry out further diagnosis and treatment. Currently, information is obtained using intelligent methods that involves the use of soft computing tools. Brain Image Segmentation is one of the major challenging task in today's medical imaging. Limitations of manual segmentation compeled the researchers to direct their attention towards automation of brain tumor detection. Thus began the era of using soft computing tools in tumor detection. Soft computing tools using fuzzy c-means, neural network, genetic algorithm have gained importance in this discipline. The key contribution of these tools are that they are able to handle real life problems, analyze them and provide intelligent solutions as compared to human mind. The use of these tools also reduces the time consumption as well as it minimizes the human efforts required.

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