Computer Based Detection and Classification Technique for Brain Cancer

Snehalatha¹ and Dr. Narendra Mustare²

Abstract - A Brain Cancer Detection and Classification System has been designed and developed. The system uses computer based procedures to detect tumor blocks or lesions and classify the type of tumor using Artificial Neural Network in MRI images of different patients with Astrocytoma type of brain tumors. The image processing techniques such as histogram equalization, image segmentation, image enhancement, morphological operations and feature extraction have been developed for detection of the brain tumor in the MRI images of the cancer affected patients. The extraction of texture features in the detected tumor has been achieved by using Gray Level Co-occurrence Matrix (GLCM). These features are compared with the stored features in the Knowledge Base. Finally a Neuro Fuzzy Classifier has been developed to recognize different types of brain cancers. The whole system has been tested in two phases firstly Learning/Training Phase and secondly Recognition/Testing Phase.

Key words – Artificial Neural Network, MRI Image, Grey Level Co-occurrence Matrix.

I. INTRODUCTION

Curing cancer has been a major goal of medical researchers for decades, but development of new treatments takes time and money. Science may yet find the root causes of all cancers and develop safer methods for shutting them down brain tumors are benign and can be before they have a chance to grow or spread. Approximately 40 percent of all primary successfully treated with surgery and, in some cases, radiation. The number of malignant brain tumors appears to be increasing but for no clear reason.

Brain cancer is a complex disease, classified into 120 different types. So called non malignant (Benign) brain tumors can be just as life-threatening as malignant tumors, as they squeeze out normal brain tissue and disrupt function. The glioma family of tumors comprises 44.4 % of all brain tumors. Glioblastoma type of Astrocytoma is the most common glioma which comprises 51.9 %, followed by other types of astrocytoma at 21.6 % of all brain tumors. Brain tumors are the leading cause cancer death in children under the age of 20. They are the second leading cause of cancer death among 20-29 year old males. Metastatic brain tumors result from cancer that spreads from other parts of the body into the brain. About 10-15 % of people with cancer will eventually develop metastatic brain tumors. There are many types of Brain Cancers but among various types of Brain Cancers the most prevalent and common is Astrocytoma. Neural networks have over the last decade been successfully applied to many image processing task.

One particular application area where neural networks show some promise is the field of Magnetic Resonance (MR) image segmentation. Most previous studies of neural network based MR image segmentation have employed the back propagation (BP) algorithm. M. Ozkan and B. M. Dawant presented a BP neural network approach to the automatic characterization of brain tissues from multimodal MR images. In their papers, the ability of a three layer BP neural network to perform segmentation based on a set of images acquired from a pathological human subject were studied. The results were compared with those obtained using a traditional Maximum Likelihood Classifier (MLC). Neural networks-based segmented images appear less noisy than MLC segmented images. Brain Cancer Detection and Classification System are implemented using Artificial Neural Network. The design based on Image processing Techniques, Artificial Neural Network and Graphical User Interface was successfully completed and used in the system to Detect and Classify the Tumor. The designed Brain Cancer Detection and Classification System use conceptually simple Classification method using the Neuro– Fuzzy logic. Texture features are used in the Training of the Artificial Neural Network. Co-occurrence matrices at different directions are calculated and Grey Level Co-occurrence Matrix (GLCM) features are extracted from the matrices. The above procedure effectively classifies the tumor types in brain images taken under different clinical circumstances and technical conditions, which were able to show high deviations that clearly indicated as abnormalities in area with brain disease.

II. METHODOLOGY

The work carried out involves processing of MRI images that are affected by brain cancer for detection and Classification on different types of brain tumors. The image processing techniques like histogram equalization, image segmentation, image enhancement and then extracting the features using Gray Level Co-occurrence Matrix are used for Detection of tumor. Extracted feature are stored in the knowledge base. A suitable Neuro Fuzzy Classifier is developed to recognize the different types of brain cancers. Images used are MRI images. The system is designed to be user friendly by creating Graphical User Interface (GUI).

Snehalatha¹ and Dr.Narendra Mustare² are from PDA Engg., College Dept. of Instrumentation Technology, Gulbarga, Karnataka, India. ¹E-mail:veerl sneha@gmail.com; ²E-mail:namust@rediffmail.com
The designed and developed system works in two phases namely Learning/Training Phase and Recognition/Testing Phase. In Learning/Training Phase the ANN is trained for recognition of different Astrocytoma types of brain cancer. The known MRI images are first processed through various image processing steps such as Histogram Equalization, Thresholding, and Sharpening Filter etc. and then textural features are extracted using Gray Level Co-occurrence Matrix. The features extracted are used in the Knowledge Base which helps in successful classification of unknown Images. These features are normalized in the range -1 to 1 and given as an input to Artificial Neural Network Based Classifier. The unknown MRI images affected by cancer of type Astrocytoma are used for testing in Recognition/Testing Phase.

III. IMAGE CLASSIFICATION STAGES

A. Stage zero: Pathological Detection.

All the slices processed by the system have been automatically classified as abnormal. They are known to contain Astrocytoma tumor based on radiologist pathology report.

B. Stage one: Tumor Segmentation.

The first step in the system presented here is to isolate the tumor region from the rest of the image. Various image processing techniques are used to separate the tumor region. Image pre-processing consists mainly of Histogram Equalization. The main problem in the process of detection of edge of tumor is that the tumor appears very dark on the image which is very confusing. To overcome this problem, Histogram Equalization was performed. Segmentation subdivides an image into its constituent parts or objects. The level to which this subdivision is carried depends on the problem being solved, that is, the segmentation should stop when the edge of the tumor is able to be detected, and the main interest is to isolate the tumor from its background [3]. Thresholding has been used for segmentation as it is most suitable for the present application in order to obtain a binarized image with gray level 1 representing the tumor and gray level 0 representing the background. In simple implementations, the segmentation is determined by a single parameter known as the Intensity Threshold. In a single pass, each pixel in the image is compared with this threshold. If the pixel's intensity is higher than the Threshold, the pixel is set to white, in the output. If it is less than the Threshold, it is set to black. The process is described by following equation:

\[ T = \frac{\sum_{i=0}^{M-1} \sum_{j=0}^{N-1} e_{i,j} \cdot M_{i,j}}{\sum_{i=0}^{M-1} \sum_{j=0}^{N-1} M_{i,j}} \]

The fundamental enhancement needed is to increase the contrast between the whole brain and the tumor. Contrast between the brain and the tumor region may be present but below the threshold of human perception. Thus, to enhance the contrast between the normal brain and tumor region, a sharpening filter is applied to the digitized MRI resulting in noticeable enhancement in image contrast. The dilation operator is used for filling the broken gaps at the edges and to have continuities at the boundaries. Onto the dilated image a filling operator is applied to fill the close contours. After filling operation on an image, centroids are calculated to localize the regions. The final extracted region is then logically operated for extraction of Massive region in given MRI image.

The work involves extraction of the important features for image recognition. The features extracted give the property of the texture, and are stored in knowledge base Features of unknown samples. Unknown sample image for classification. Texture features or more precisely, Gray Level Co-occurrence Matrix (GLCM) features are used to distinguish between normal and abnormal brain tumors. Five co-occurrence matrices are constructed in four spatial orientations horizontal, right diagonal, vertical and left diagonal (0, 45, 90, and 135). A fifth matrix is constructed as the mean of the preceding four matrices.

D. Stage three: Knowledge Base

Knowledge is any chunk of information that effectively discriminates one class type from another. In this case, tumor will have certain properties that other brain tissues will not and vice-versa. In the domain of MRI volumes, there are two primary sources of knowledge available. The first is pixel intensity in feature space, which describes tissue characteristics within the imaging system. The second is image/anatomical space and includes expected shapes and placements of certain tissues within the image, such as the fact that CSF lies within the ventricle. The nature of tumors limits the use of anatomical knowledge, since they can have any shape and occupy any area within the brain. As a result, knowledge contained in feature space is extracted and utilized.

E. Stage four: Nero-Fuzzy Classifier.

A Neuro-Fuzzy Classifier is used to detect candidate circumscribed tumor. ANN’s are networks of inter connected computational units, usually called nodes. The input of a specific node is the weighted sum of the output of all the nodes to which it is connected. The output value of a node is, in general, a non-linear function (referred to as the activation function) of its input value. The multiplicative weighing factor
between the input of node $j$ and the output of node $i$ is called the weight $w_{ji}$. An Artificial Neural Network is an adaptive, most often nonlinear system that learns to perform a function (an input/output map) from data. Adaptive means that the system parameters are changed during operation, normally called the Learning/Training phase. After the training phase the Artificial Neural Network parameters are fixed and the system is deployed to solve the problem at hand (The Recognition/Testing phase). Back-propagation ANN’s used in this study consist of one input layer, one or two hidden layers, and one output layer. With back-propagation, the input data (Extracted Features) is repeatedly presented to the Artificial Neural Network, with each presentation the output of the neural network is compared to the desired output (Grade of Tumor) and an error is computed. This error is then fed back (back-propagated) to the Artificial Neural Network and used to adjust the weights such that the error decreases with each iteration and the neural model gets closer and closer to producing the desired output. This process is known as Training. The Training of these networks consists in finding a mapping between a set of input values and a set of output values. This mapping is accomplished by adjusting the value of the weights $w_{ji}$; using a learning algorithm, the most popular of which is the generalized delta rule. After the weights are adjusted on the training set, their value is fixed and the ANN’s are used to classify unknown input images.

The generalized delta rule involves minimizing an error term defined as

$$E_p = \frac{1}{2} \sum_j (t_{pj} - o_{pj})^2$$

In this equation, the index $p$ corresponds to one input vector, and the vectors $t_p$ and $o_p$ are the target and observed output vectors corresponding to the input vector $p$, respectively.

**IV. DATA FLOW DIAGRAMS**

Data-flow models are an intuitive way showing how data is processed by a system. At the analysis level, they should be used to model the way in which data is processed in the existing system. The notation used in these models represents functional processing, data stores and data movements between functions. Dataflow models are used to show how data flows through a sequence of processing steps.

**DATA FLOW DIAGRAM LEVEL 0**

Here input is image and using the artificial neural network in fuzzy logic provide image technique that is MRI technique gives the result output brain cancer detection.

**DATA FLOW DIAGRAM LEVEL 1**

The following process of curing the brain cancer is tumor segmentation, features extraction which provide knowledge bar information by using of neuron Fuzzy classifiers.

**DATA FLOW DIAGRAM LEVEL 2**

Here input MRI image is implement by grey level co-occurrence matrix which formulates image segmentation by fuzzification process gives affect MRI image for test the system.

**Context flow diagram**

This is the basic function and techniques which is used in the above context flow diagram and the main topic is for brain cancer.

**Sequence Diagram:**

Here input MRI image is implement by grey level co-occurrence matrix which formulates image segmentation by fuzzification process gives affect MRI image for test the system.

**Figure 2. Context Flow Diagram**

**Figure 3. Sequence Diagram**
This is sequence diagram which define between user input image and ANN topology by sequence it work and finally gives the output result.
This is process flow diagram which shows the basic origination last ending technique, which gives the result output.

Figure 4. Images of Brain Cancer

Figure 5. Select Test Image

Figure 6. Segmentation of Image

Figure 7. Enhancement of Image

Figure 8. Detection of Tumor region

Figure 9. Texture Extraction using Grey level Co-occurrence Matrix
Brain Cancer Detection and Classification System use conceptually simple Classification method using the Neuro Fuzzy logic. Texture features are used in the Training of the Artificial Neural Network. Co-occurrence matrices at different directions are calculated and Grey Level Co-occurrence Matrix (GLCM) features are extracted from the matrices. The above procedure effectively classifies the tumor types in brain images taken under different clinical circumstances and technical conditions, which were able to show high deviations that clearly indicated as abnormalities in area with brain disease. This system provides precision Detection and Classification of Astrocytoma type of cancer. The system has been tested only with the above sample Images. The system can be designed to classify other types of cancers as well with few modifications. The scope of the system can further be improved by using other types (e.g. PET, MRS, CTS) of Images. It is essential to use large number of patient’s data which will improve the accuracy of the system. More features that could be added to the system include metabolic and genetic data as well as anatomical attributes of the brain.

**BIBLIOGRAPHY**


