AUTOMATIC DETECTION AND SEVERITY ANALYSIS OF BRAIN TUMORS USING GUI IN MATLAB

M.Karuna[1], Ankita Joshi [2]

[1] M.E, [2] M.Tech, E.C.E, Vignan's institute of information technology, Vishakhapatnam, India
karunaleo98@yahoo.com.au, joshianki@yahoo.co.in

Abstract

Medical image processing is the most challenging and emerging field now a day's processing of MRI images is one of the parts of this field. The quantitative analysis of MRI brain tumor allows obtaining useful key indicators of disease progression. This is a computer aided diagnosis systems for detecting malignant texture in biological study. This paper presents an approach in computer-aided diagnosis for early prediction of brain cancer using Texture features and neuro classification logic.

This paper describes the proposed strategy for detection; extraction and classification of brain tumour from MRI scan images of brain; which incorporates segmentation and morphological functions which are the basic functions of image processing. Here we detect the tumour, segment the tumour and we calculate the area of the tumour. Severity of the disease can be known, through classes of brain tumour which is done through neuro fuzzy classifier and creating a user friendly environment using GUI in MATLAB. In this paper cases of 10 patients is taken and severity of disease is shown and different features of images are calculated.

Keywords: Brain cancer, Neuro Fuzzy classifier, MRI, GUI.

--***--

1. INTRODUCTION

The brain is the center of thoughts, emotions, memory and speech. Brain also control muscle movements and interpretation of sensory information (sight, sound, touch, taste, pain etc.) A brain tumor is a localized intracranial lesion which occupies space with the skull and tends to cause a rise in intracranial pressure. Tumors can affect any part of the brain and depending on what part(s) of the brain it affects can have a number of symptoms.

- Seizures
- Difficulty with language
- Mood changes
- Change of personality
- Changes in vision, hearing, and sensation.
- Difficulty with muscle movement
- Difficulty with coordination control

Brain cancer can be counted among the most deadly and intractable diseases. Tumors may be embedded in regions of the brain that are critical to manage the body's vital functions, while they shed cells to invade other parts of the brain, forming more tumors too small to detect using conventional imaging techniques. In recent years, the occurrence of brain tumors has been on the rise. Unfortunately, many of these tumors will be detected too late, after symptoms appear. It is much easier and safer to remove a small tumor than a large one. Computer-assisted surgical planning and advanced image-guided technology have become increasingly used in

Neuro surgery [1][2][3][4][5]. Tumor is defined as the abnormal growth of the tissues. Brain tumor is an abnormal mass of tissue in which cells grow and multiply uncontrollably, seemingly unchecked by the mechanisms that control normal cells.

Brain tumors are of two main types which are benign tumors and malignant tumors

1.1 Benign Tumors:

Benign brain tumors do not contain cancer cells, usually, benign tumors can be removed, and they seldom grow back. The border or edge of a benign brain tumor can be clearly seen. Cells from benign tumors do not invade tissues around them or spread to other parts of the body. However, benign tumors can press on sensitive areas of the brain and cause serious health problems. Unlike benign tumors in most other parts of the body, benign brain tumors are sometimes life threatening. Very rarely, a benign brain tumor may become malignant.

1.2 Malignant Tumors:

Malignant brain tumors are generally more serious and often is life threatening. It may be primary (the tumor originate from the brain tissue) or secondary (metastasis from others tumor elsewhere in the body).They are likely to grow rapidly and invade the surrounding healthy brain tissue. Very rarely,

cancer cells may break away from a malignant brain tumor and spread to other parts of the brain, to the spinal cord, or even to other parts of the body.

2. CLASSIFICATION OF TUMORS

Brain tumors are basically classified on bases of Tissue of origin, Location, Primary or secondary (metastatic), Grading. Basically tumors are classified into

- Gliomas
  - i. Astrocytoma (Grades I & II)
  - ii. Anaplastic Astrocytoma
  - iii. Glioblastoma Multiforme
- Oligodendroglioma
- Ependymomas
- Medulloblastoma
- CNS Lymphoma

In this paper the classification of Gliomas tumors is done which are subdivided into 3 types and class I, class II, and class III.

- i. **Class I: Astrocytoma** is slow growing, rarely spreads to other parts of the CNS, Borders not well defined.
- ii. **Class II: Anaplastic Astrocytoma** will grow faster.
- iii. **Class III: Glioblastoma multiforme (GBM)** most invasive type of tumor, commonly spreads to nearby tissue, grows rapidly.

3. EPIDEMIOLOGY

Annual incidence ~15–20 cases per 100,000 people. Annual incidence primary brain cancer in children is about 3 per 100,000. Leading cause of cancer-related death in patients younger than age 35 Primary brain tumors /secondary ~ 50/50 ~17,000 people in the United States are diagnosed with primary cancer each year. Secondary brain cancer occurs in 20–30% of patients with metastatic disease. Estimated 18,400 primary malignant brain tumors will be diagnosed in 2004 — 10,540 in men & 7,860 in women. Approximately 12,690 people have died from these tumors in 2004.Accounts for 1.4% of all cancers. Accounts for 2.4% of all cancer related deaths. In adults over 45 years of age 90% of all brain tumors are Gliomas.

4. HOW TO DIAGNOSE BRAIN TUMORS

- Computed Tomography(CT)scans
- Diffusion Tensor Imaging (DTI)
- Magnetic Resonance Imaging (MRI) scans
- Positron Emission Tomography (PET) scans
- Biopsy (tissue sample analysis)

The best preferred method for this project is MRI.

5. APPROACH

The work carried out involves processing of MRI images of brain cancer affected patients 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 for Detection of tumor. Extracted feature are stored in the knowledge base. A suitable Nero Fuzzy classifier is developed to recognize the different types of brain tumors. The system is designed to be user friendly by creating Graphical User Interface (GUI) using MATLAB.

Step 1: Consider MRI scan image of brain of patients.
Step 2: Test MRI scan with the knowledge base.
Step 3: Two cases will come forward.
  - i. Tumor detected
  - ii. Tumor not detected

Step 4: If tumor is detected the severity of tumor is known by classifying them into 3 classes.
Step 5: Appropriate treatment starts under medical supervision.
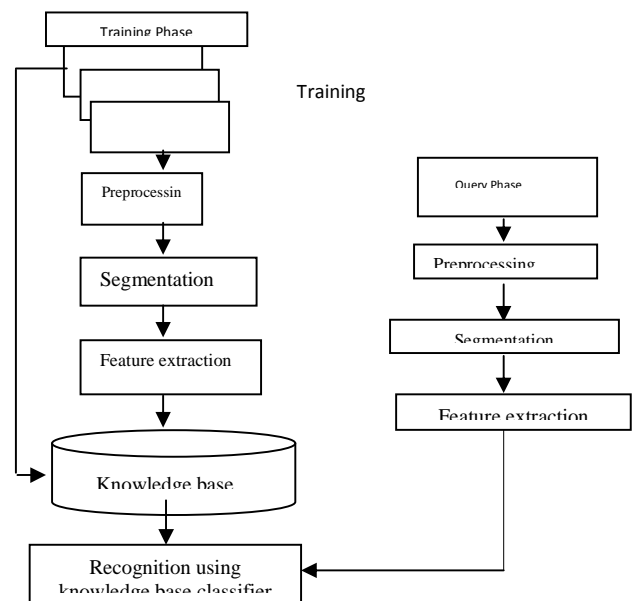
5.1 Proposed System

Fig- 1: Proposed methodology for classification of brain tumors

5.1.1 Image Segmentation

Image segmentation will partition the brain MRI scan image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.[14] Image segmentation is typically used to locate objects and boundaries (lines, curves,

etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture.

Segmentation subdivides an image into its constituent parts of 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 .i.e. the main interest is to isolate the tumor from its background. The main problem in the edge detection process is that the cancer cells near the surface of the MRI is very fat, thus appears very dark on the MRI, which is very confusing in the edge detection process. To overcome the problem, two steps were performed.
1. Histogram equalization has been applied to the image to enhance the gray level near the edge.
2. Thresholding the equalized image in order to obtain a binarized MRI with gray level 1 representing the cancer cells and gray level 0 representing the background.

A. Histogram Equalization

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. The method is useful in images with backgrounds and foregrounds that are both bright or both dark.

The histogram of an image represents the relative frequency of occurrences of the various gray levels in the image. Histogram modeling techniques (e.g. histogram equalization) provide a sophisticated method for modifying the dynamic range and contrast of an image by altering that image such that its intensity histogram has a desired shape.
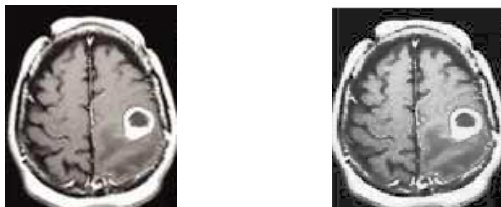
Fig- 2: a) The original MRI b) Histogram Equalized MRI

B. Thresholding

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images In many vision applications, it is useful to be able to be able to separate out the regions of the image corresponding to objects in which we are interested, from the regions of the image that correspond to background. Thresholding often provides an easy and convenient way to perform this segmentation on the basis of the different intensities or colors in the foreground and background regions of an image.

The input to a Thresholding operation is typically a greyscale or color image. In the simplest implementation the output is a binary image representing the segmentation. Black pixels correspond to background and white pixels correspond to foreground. 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. Segmentation is accomplished by scanning the whole image pixel by pixel and labeling each pixel as object or background according to its binarized gray level.
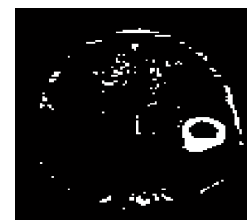
Fig- 3: Threshold binarized image

5.1.2 Image Enhancement

The fundamental enhancement needed in MRI is an increase in contrast. Contrast between the brain and the tumor region may be present on a MRI but below the threshold of human perception. Thus, to enhance contrast between the normal brain and tumor region, a sharpening filter is applied to the digitized MRI resulting in noticeable enhancement in image contrast.

A. Sharpening Filter or Windowing

Sharpening filters work by increasing contrast at edges to highlight fine detail or enhance detail that has been blurred. It seeks to emphasize changes.

The most common sharpening filter uses a neighborhood of 3*3 pixels. For each output pixel it computes the weighted sum of the corresponding input pixel and its eight surrounding

pixels. The weights are positive for the central pixel and negative for the surrounding pixels. By arranging the weights so that their sum is equal to one, the overall brightness of the image is unaffected. Weights can be adjusted as follows:

$$\begin{pmatrix} -1 & -1 & -1 \\ -1 & 0 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

5.1.3 Morphological Operation

- This is used as an image processing tools for sharpening the regions and filling the gaps for binarized image.
- The dilation operator is used for filling the broken gaps at the edges and to have continuities at the boundaries.
- A structuring element of 3x3 square matrix is used to perform dilation operation.
- The region filled operation is used to fill the gaps in the region of interest i.e. tumor.

Fig-4: a) Dialated binarized image b) Region filled image

5.1.4 Region extraction

- Onto the dilated image a filling operator is applied to fill the close contours.
- To filled image, centroids are calculated to localize the regions as shown beside.
- The final extracted region is then logically operated for extraction of Massive region in given MRI image.
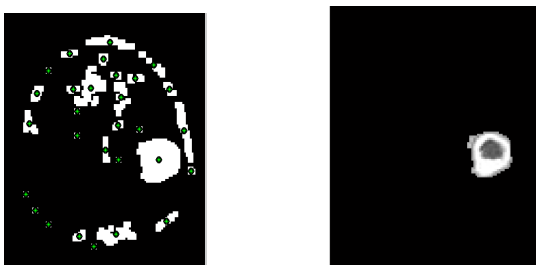
Fig- 5: a) Extracted region with centroids b) Extracted tumor

6. FEATURE EXTRACTION

From each co-occurrence matrix, a set of five-features are extracted in different orientations for the training of the neuro-fuzzy model.

Let P be the N*N co-occurrence matrix calculated for 4images, then the features as given by Byer are as follows:

1. **Contrast**

$$F1 = \sum_{i,j=0}^{N-1} Pi, j(i-j)2$$

2. **Inverse Difference Moment (Homogeneity)**

$$F2 = \sum_{i,j=0}^{N-1} \frac{Pi,j}{1+(i-j)^2}$$

3. **Angular Second Moment (ASM)**

$$F3 = \sum_{i,j=0}^{N-1} P^2_{i,j}$$

4. **Dissimilarity**

$$f4 = \sum_{i,j=0}^{N-1} P_{i,j} \left| i-j \right|$$

5. **Entropy**

$$f9 = \sum_{i,j=0}^{N-1} P_{i,j}(-\ln P_{i,j})$$

6. **Regionprops**

STATS = regionprops (BW, area, centroid)
STATS = regionprops (BW, properties) measures a set of properties for each connected component (object) in the binary image, BW. The image BW is a logical array; it can have any dimension.

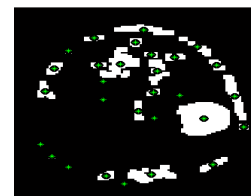The area of tumor is calculated using centroids of binary image.

Fig-6: Centroids located in binary image

7. KNOWLEDGE BASE

The data is already trained in the knowledge base. Almost 60 cases of patients are stored in the database; which will be helpful in comparing the MRI scan image and giving the severity of image

8. AREA CALCULATIONS

The area can be calculated by taking the extracted tumor by using the bwarea function in MATLAB, which gives area of objects in binary image.

Syntax: Total = bwarea (BW)

It estimates the area of the objects in binary image BW. total is a scalar whose value corresponds roughly to the total number of on pixels in the image, but might not be exactly the same because different patterns of pixels are weighted differently.BW can be numeric or logical. For numeric input, any nonzero pixels are considered to be on. The return value total is of class double.
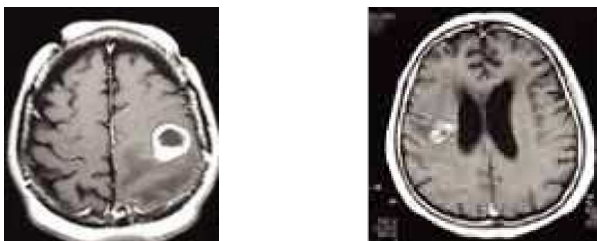
Fig- 7: MRI Test images

The obtained area for this image 1 is w2 =1.6620e+003.

And area obtained for image 2 is w2 =1.6360e+003.

9. 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. For the automated recognition of tumor cell in given MRI image a neuro fuzzy classifier is realized.

The classifier module implements a hybrid algorithm integrating neural network and fuzzy system. Fuzzy neural approach found to have more accurate decision making as compare to their counterparts. The obtained features are processed using fuzzy classification layer before passing it to neural network.
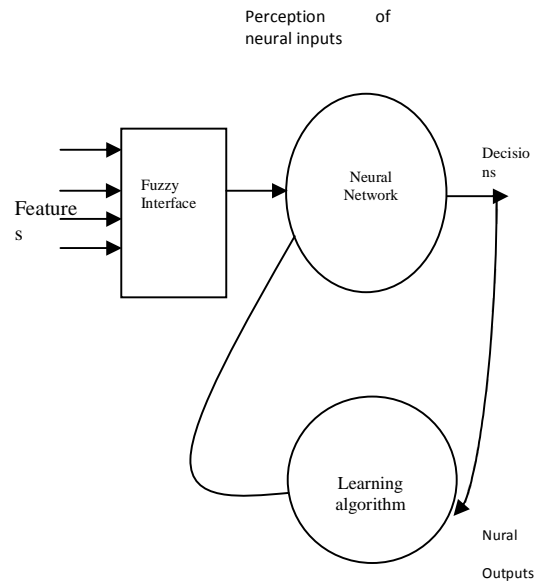
Fig-8: Neuro fuzzy logic classification

10. TRAINING AND TESTING PHASE

Neuro fuzzy classifier always works on Training Phase and Testing Phase. In Training Phase the fuzzy classifier is trained for recognition of different types of brain cancer. Neuro fuzzy classifier always works on Training Phase and Testing Phase. In Training Phase the fuzzy classifier is trained for recognition of different types of brain cancer. The known MRI images of cancer affected Subjects are first processed through various image processing steps and then textural features are extracted using Gray Level Co-occurrence Matrix. The features extracted are used in the Knowledge Base for algorithm which helps in successful classification of unknown Images. The extracted features are compared with the features of 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) [13].
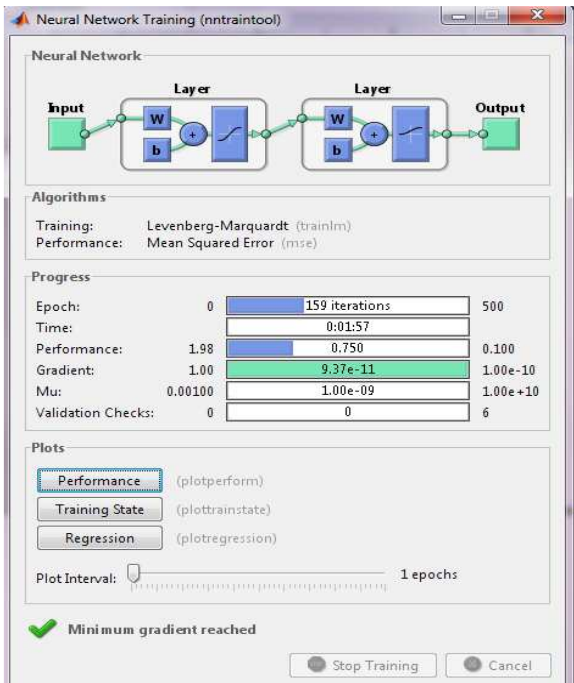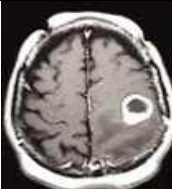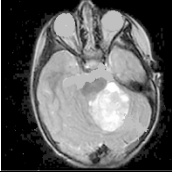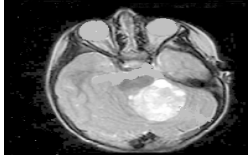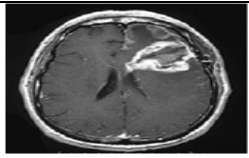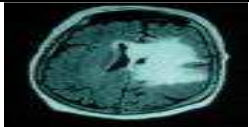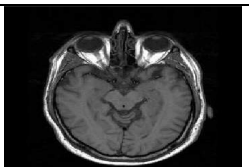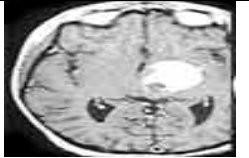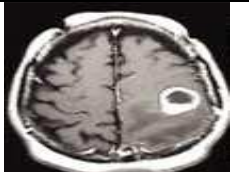
Fig-9: Training Phase

11. RESULTS
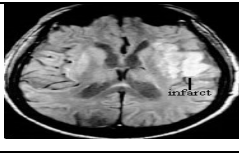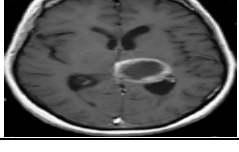
The severity of the tumor is known and the different features like entropy, Angular second moment (ASM), Contrast, Inverse Difference Moment (Homogeneity), Dissimilarity. The tumor region is extracted and the severity of the tumor is found out and area is calculated.

MRI images	Angular second moment(ASM)	Contrast	Inverse Difference Moment (Homogeneity)	Dissimilarity	Entropy
	5526	1254072	0.138847811665570	20960	-75.2267956408215
	6054	2045428	0.0170591123540511	26964	-150.867899634242
	13492	1153082	36.7389217370720	19866	-382.254867873060

	4578	2341894	3.07315762184331	29370	-76.9528880755323

S.No	Patients	MRI image of brain	Extracted tumor	Severity of disease	Area of tumor
1.	Patient 1			Class 2 Anaplastic Astrocytoma will grow faster	1.5060e+003
2.	Patient 2			Class 3 Glioblastoma multiforme (GBM) most invasive type of tumor, commonly spreads to nearby tissues grows rapidly.	1.72190e+003
3.	Patient 3			Class 2 Anaplastic Astrocytoma will grow faster	1.5190e+003
4.	Patient 4		No tumor	No tumor	0
5.	Patient 5			Class 3 Glioblastoma multiforme (GBM) most invasive type of tumor, commonly spreads to nearby tissue, grows rapidly.	1.6302e+003
6.	Patient 6			Class 1 Astrocytoma is slow growing, rarely spreads to other parts of the CNS, Borders not well defined.	1.1693e+003
7.	Patient 7			Class 3 Glioblastoma multiforme (GBM) most invasive type of tumor, commonly spreads to nearby tissue, grows rapidly.	1.6750e+003

8.	Patient 8			Class 1 Astrocytoma is slow growing, rarely spreads to other parts of the CNS, Borders not well defined.	1.0003e+003
9.	Patient 9			Class 2 Anaplastic Astrocytoma will grow faster	1.2380e+003
10.	Patient 10			Class 2 Anaplastic Astrocytoma will grow faster	1.4321e+003

CONCLUSIONS

- Finally for the proposed system the required effective image has to be chosen for opting better segmentation techniques.
- An effective data base with highly recognition has to be implemented.
- Early detection of the tumor will be useful to the patients for who are smaller tumors that is class 1 and class 2 tumors which can be cured easily if treated at early stages
- Detection and severity analysis with easy retrieval has to be developed.

REFERENCES

[1]. Cline HE, Lorensen E, Kikinis R, Jolesz F.Three-dimensional segmentation of MR images of the head using probability and connectivity. J Comput Assist Tomography 1990; 14:1037–1045

[2]. Vannier MW, Butterfield RL, Rickman DL, Jordan DM, Murphy WA, Biondetti PR. Multispectral magnetic resonance image analysis. Radiology 1985; 154:221–224

[3]. Just M, Thelen M. Tissue characterization with T1, T2, and proton-density values: results in 160 patients with brain tumors. Radiology 1988; 169:779–785

[4].Just M, Higer HP, Schwarz M, et al. Tissue characterization of benign tumors: use of NMR-tissue parameters. Magn Reson Imaging 1988; 6:463–472.

[5]. Gibbs P, Buckley DL, Blackband SJ, Horsman A. Tumor volume determination from MR images by morphological segmentation. Phys Med Biol 1996; 41:2437–2446

[6]. Velthuizen RP, Clarke LP, Phuphanich S, et al. Unsupervised measurement of brain tumor volume on MR images. J Magn Reson Imaging 1995; 5:594–605.

[7]. Vinitski S, Gonzalez C, Mohamed F, et al. Improved intracranial lesion characterization by tissue segmentation based on a 3D feature map. Magn Reson Med 1997; 37:457–469.

[8]. Collins DL, Peters TM, Dai W, Evans AC. Model based segmentation of individual brain structures from MRI data. SPIE VisBiomed Comput 1992; 1808:10–23.

[9]. Kamber M, Shinghal R, Collins DL, et al.Model-based 3-D segmentation of multiple sclerosis lesions in magnetic resonance brain images. IEEE Trans Med Imaging 1995; 14:442–453

[10]. Warfield SK, Dengler J, Zaers J, et al. Automatic identification of gray matter structures from MRI to improve the segmentation of white matter lesions. J Image Guid Surg 1995; 1:326–338

[11]. Warfield SK, Kaus MR, Jolesz FA, Kikinis R. Adaptive template moderated spatially varying statistical classification. In: Wells WH, Colchester A, Delp S, eds. Proceedings of the First International Conference on Medical Image Computing and Computer-Assisted Intervention. Boston, Mass: Springer-Verlag, 1998; 431–438.

[12]. Bonnie NJ, Fukui MB, Meltzer CC, et al.Brain tumor volume measurement: comparison of manual and semiautomated methods. Radiology 1999; 212:811–816

[13]. Aniket A. Kathalkar, R. S. Kawitkar, Amruta Chopade Artificial Neural Network based Brain Cancer Analysis and Classification. International Journal of Computer Applications (0975 – 8887).

[14] Linda G. Shapiro and George C. Stockman (2001): "Computer Vision", pp 279-325, New Jersey, Prentice-Hall, ISBN 0-13-030796-3

[15] Sudipta Roy, Samir K. Bandyopadhyay Detection and Quantification of Brain Tumor from MRI of Brain and it's Symmetric Analysis. International Journal of Information and Communication Technology Research

BIOGRAPHIES

Mrs. M. KARUNA obtained her B.Tech. Degree from Vignan's college, vadlamudi, Guntur from JNTU Hyderabad, India in the year 2002 She obtained her M.E. Degree from Andhra University, Visakhapatnam, India in the year 2005. Presently she is working as an Associate Professor in the department of Electronics and Communication Engineering, Vignan's Institute of Information Technology, Visakhapatnam. She has participated in various National and International conferences. She is interested in the fields of wireless communication, Biomedical Instrumentation.

Ms. ANKITA JOSHI has obtained B.Tech degree from Vignan's institute of information technology affiliated to JNTUK in the year 2011. Now she is pursuing M.Tech Degree in Department of Electronics & Communications, Vignan's institute of Information and Technology, Visakhapatnam. She is interested in the fields of Bio medical image processing.