A Review on Brain Tumor Detection and Classification System Based on Image Processing Techniques

B. Chitradevi[1] R. Saranya[2]
[1]Assistant Professor [2]Research Scholar (M. Phil)
[1,2]Department of Computer Science
[1,2]Thanthai Hans Roever College, Perambalur-621212, India

Abstract— Brain tumor is most commonly occurring malignancy among human beings, so study of brain tumor is important. Magnetic Resonance Image (MRI) is the greatest technology for diagnosing brain tumor in now a day. Brain tumor is identified at advanced stages with the aid of the MRI. Automatic detection of brain tumor through MRI can present the valuable outlook and accuracy of earlier brain tumor detection by using image processing techniques. This paper gives a tutorial review in different advances that have been made for the image processing techniques in MRI brain tumor images.

Key words: Magnetic Resonance Image, Brain tumor, Preprocessing, Segmentation, Feature extraction and Classification

I. INTRODUCTION

Brain tumor is naturally serious and life intimidating because of its character in the limited space of the intracranial cavity (space formed inside the skull). Most Research in developed countries proves that the numbers of people who have brain tumors were died due to the fact of inaccurate detection. Magnetic resonance images are a very useful tool to detect the tumor growth in brain. MRI is directed into intracranial cavity produces a complete image of brain. This image is visually examined by the physician for detection and diagnosis of brain tumor. However this method of detection resists the accurate determination of stage and size of tumor. To avoid that, the computer aided analysis for brain tumor detection is proposed. The image processing techniques allows the detection of tumor tissue with accuracy and reproducibility comparable to manual detection. In addition, it also reduces the time for analysis. At the end of the process the tumor is extracted from the MR image and its exact position and the shape also determined. The following figure embraces the fundamental steps in image processing system.

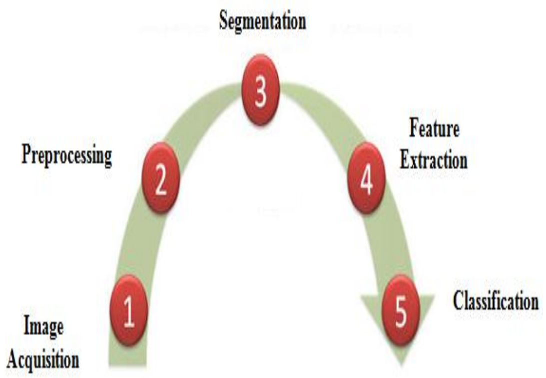

Fig. 1: Fundamentals steps in digital image processing

(1) Digital image acquisition is the creation of digital images, typically from a physical scene. The term is often assumed to imply or include the processing, compression, storage, printing, and display of such images. The most usual method is by digital photography with a digital camera but other methods are also employed.
(2) The aim of preprocessing is an improvement of image data that suppresses unwanted distortions or enhances some image features important for further processing.
(3) Image segmentation is the process of partitioning a digital image into multiple. The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. 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 characteristics.
(4) Feature extraction involves reducing the amount of resources required to describe a large set of data. When performing analysis of complex data one of the major problems stems from the number of variables involved. Analysis with a large number of variables generally requires a large amount of memory and computation power or a classification algorithm which over fits the training sample and generalizes poorly to new samples. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy. The best results are achieved when an expert constructs a set of application-dependent features.
(5) The objective of image classification procedures is to automatically categorize all pixels in an image into land cover classes or themes. A pixel is characterized by its spectral signature, which is determined by the relative reflectance in different wavelength bands. Multi-spectral classification is an information extraction process that analyses these spectral signatures and assigns the pixels to classes based on similar signatures.

II. MAGNETIC RESONANCE IMAGE

Magnetic resonance imaging permits a number of imaging techniques and protocols that can be used to capture the different features of the cardiac function and structure. The produced amount of data is huge and its classification and/or retrieval based on its visual content are necessary for educational and training purposes.

Protons and neutrons of the nucleus of an atom have an angular momentum which is known as a spin. These spins will cancel when the number of subatomic particles in a nucleus is even. Nuclei with odd number will have a resultant spin .This forms the basis of magnetic resonance imaging. A magnetic resonance imaging (MRI) scanner uses powerful magnets to polarize and excite hydrogen nuclei (single proton) in human tissue, which produces a signal that can be detected and it is encoded spatially, resulting in images of the body. The MRI machine emits radio frequency (RF) pulse that specifically binds only to hydrogen. The system sends the pulse to that specific area of the body that needs to be examined. Due to the RF pulse, protons in that area absorb the energy needed to make them spin in a different direction. This is meant by the resonance of MRI. The RF pulse makes the protons spin at the larmour frequency, in a specific direction. This frequency is found based on the particular tissue being imaged and the strength of the main magnetic field. MRI uses three electromagnetic fields: static field which is a very strong static magnetic field which polarizes the hydrogen nuclei; gradient field which is a weaker time-varying field used for spatial encoding; and a weak radio frequency field for manipulation of the hydrogen nuclei to produce measurable signals, which are collected through radio frequency antenna [1]. The following figure shows the operation of MRI system.

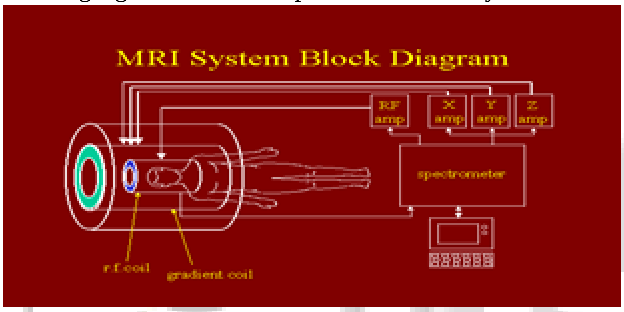

Fig. 2: Block Diagram for MRI System

III. BRAIN TUMOR

A brain tumor is an abnormal growth of tissue in the brain. Unlike other tumors, brain tumors spread by local extension and rarely metastasize (spread) outside the brain. A benign brain tumor is composed of non-cancerous cells and does not metastasize beyond the part of the brain where it originates. A brain tumor is considered malignant if it contains cancer cells, or if it is composed of harmless cells located in an area where it suppresses one or more vital functions. Each year, more than 17,000 brain tumors are diagnosed in the United States. About half of all primary brain tumors are benign, but in life-threatening locations. The rest are malignant and invasive [2].

A. *Benign Brain Tumors:*

Benign brain tumors, composed of harmless cells, have clearly defined borders, can usually be completely removed, and are unlikely to recur. Benign brain tumors do not infiltrate nearby tissues but can cause severe pain, permanent brain damage, and death. Benign brain tumors sometimes become malignant.

B. *Malignant Brain Tumors:*

Malignant brain tumors do not have distinct borders. They tend to grow rapidly, increasing pressure within the brain (IICP) and can spread in the brain or spinal cord beyond the point where they originate. It is highly unusual for malignant brain tumors to spread beyond the central nervous system (CNS).

C. *Primary Brain Tumors:*

Primary brain tumors originate in the brain. They represent about 1% of all cancers and 2.5% of all cancer deaths [2].

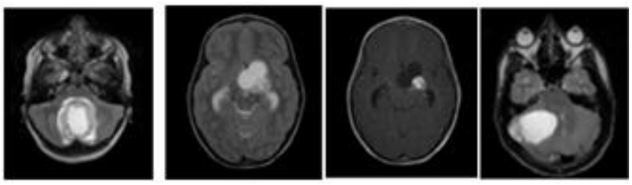

Fig. 3: MRI Brain Tumor images

The above figure shows the some samples of MRI Brain Tumor images.

IV. IMAGE PREPROCESSING

A method in which Histogram of an image is obtained and its contrast is adjusted is called as histogram equalization. Some images are having backgrounds and foregrounds with different intensities; in these cases this equalization technique can be applied. It is also known as spatial domain enhancement technique. This method was used by Ms Rungta at 2013 [3].

In Preprocessing and enhancement the proposed method has been used by N. Nandhagopal to remove the film artifacts using tracking algorithm. In the enhancement stage to remove high frequency components, the Median, Weighted Median and Adaptive Median Filter are used to enhance the image and the performance of the system [4].

In this paper the image enhancement is done by using a 3 – by – 3 ‘unsharp’ contrast enhancement filters. An ‘unsharp’ filter is generated by using the negative of the laplacian filter with parameter 'alpha', where the 'alpha' controls the shape of the laplacian and must be in the range 0.0 to 1.0. we had used the default value as 0.2. By the use of this filter the image is sharpened by subtracting a blurred version of the image from itself. A two dimensional array H is created as the filter. Each element of the output image is computed using double precision floating point. Since the input image pixel values are integer so output elements that exceed the range of the integer are truncated and fractional values are rounded [5].

Swe Zin Oo, Aung Soe Khaing used the average to smooth the image. The smoothed image is used to operate the next step of the system quickly. Average filter is low pass filter. Average filter is a simple and easy to implement method of smoothing images [6].

V. IMAGE SEGMENTATION

Correct segmentation of MR images is very important because most of the time MR images are not highly contrast thereby these segments can be easily overlapped with each other. So, to develop high contrast MR images, we propose two additional phases, namely, registration of adjacent layer MR images and fusing the registered images to produce a high quality image. This image is then used for segmentation by using advanced K - means algorithm with extended dual phase localization. This method is proposed by Samir Kumar Bandhyopadhyay, Tuhin Utsab Paul at 2013 [5].

Watershed segmentation is a gradient-based segmentation technique. It considers the gradient map of the image as a relief map. It segments the image as a dam. The segmented regions are called catchment basins. Watershed segmentation solves a variety of image segmentation problem. It is suitable for the images that have higher intensity value. Watershed segmentation is caused over segmentation. To control over segmentation, marker controlled watershed segmentation is used. Sobel operator is suitable for edge detection. In marker controlled watershed segmentation, sobel operator is used to distinct the edge of the object [7].

For Brain tumor segmentation, two types of segmentation techniques have been adopted by S.M. Ali, Loay Kadom Abood, and Rabab Saadoon Abdoon; i.e. region detection methods and boundary detection methods [8].

In region-based techniques, segmentation is applied by identifying all pixels that belong to the object based on the intensity of pixels. Their aim is the regions satisfying a given homogeneity criterion. They include region growing, watershed algorithm and thresholding [9]. This method was proposed by J.S.Weszka at 1978.

VI. FEATURE EXTRACTION

SivaSankari.S. Sindhu proposed an image processing technique to extract the optimal features of brain tumor in MRI by utilizing GLCM [13] (Gray Level Co-occurrence Matrix) and Gabor feature extraction algorithm with the help of k-means clustering segmentation. Some features are extracted using GLCM techniques and the Gabor features extractions are Contrast. Correlation. Homogeneity. Entropy. Energy. Shape. Color. Texture and Intensity. Thus the feature was extracted and compared with other metric and gives efficient result. [10]

Pratik P. Singhai, Siddharth A. Ladhake developed CCA (Connected Component Analysis) technique in Digital MRI images to extracts the region which are not supported by boundary after region boundaries have been detected. CCA is to detect the large sized connected foreground region or object. In image analysis, the object is extracted using the connected component labeling operation which consists of assigning a unique label to each maximally connected foreground region of pixel. Any set of pixels which is not separated by the boundary is called connected component. The set of connected components partition an image into segments and thus the area of detected tumor is calculated in pixels using connected component analysis. [11]

Neelam Marshkole, Bikesh Kumar Singh. A.S Thoke used feature extraction based on texture and shape features and it can be effectively used for classifying brain tumor with high level of accuracy. Shape is a basic property of an object present in the image itself. Set of features which used to describe a medical image is texture feature. Before Feature Extraction region of interest (ROI) consisting of tumor region was extracted for further analysis .Features are extracted and represented in a single array called as feature vector. Haralick‟s texture features were experimented for further classification. Feature vector is a row consisting of shape features such as Fourier Descriptor coefficients and seven moment invariants along with 13 texture features [12]. Texture and shape features can give satisfactory result in analysis and classification of brain tumors.

VII. CLASSIFICATION

Kailash D.Kharat & Pradyumna Kulkarni [13] proposed two approaches for Brain Tumor classification based on artificial neural networks. The networks were categorized into feed-forward neural networks and Back propagation neural Network. First classifier based on feed forward artificial neural network (FF-ANN) and second classifier based on Back propagation Neural Network (BP-ANN).FF-ANN classifier was created with 500 nodes in the first (input) layer. 1 to 50 nodes in the hidden layer and 1 node as the output layer and varied the nodes in order to determine the optimal number of hidden nodes. This was to avoid the fitting or under fitting the data. The most widely used neural-network learning method is the BP algorithm. Learning in a neural network involves modifying the weights and biases of the network in order to minimize a cost function. The classifiers have been used to classify subjects as normal or abnormal MRI brain images.

The MR images are classified by wrapper approach with Multi class Support Vector Machine classifier (MC-SVM) using color, texture and shape features. To reduce the large numbers of features to a smaller set of features wrapper algorithm with multi-class SVM is used. Performance of the MC-SVM classifier is compared with different kernel functions. From the analysis and performance measures like classification accuracy, it is inferred that the brain MRI classification is best done using MC- SVM with Gaussian RBF kernel function than linear and polynomial kernel Functions, the wrapper approach MC-SVM with Gaussian RBF kernel function enhance the classification of MR brain image with normal and benign or malignant classes This approach is efficient for classification of the human brain normal or abnormal (benign or malignant tumor) with high sensitivity, specificity and accuracy rates. This was developed by N. Rajalakshmi and Lakshmi Prabha. [14].

Neelam Marshkole, Bikesh Kumar Singh. A.S Thoke presents a hybrid approach to classify malignant and benign tumors using fusion of texture and shape futures. Both tumor and non-tumor regions appear with little distinction on an MR, image processing toolbox is used for feature extraction and ANN toolbox has been used for classification. Before feature extraction, region of interest (ROI) consisting of tumor region was extracted using MATLAB imtool function for further analysis. Textures features of both benign and malignant tumors are very close to each other and hence texture feature alone may not give desired classification efficiency. Linear vector quantization (LVQ) is finally used for classifying the pattern of malignant and benign tumors. LVQ is a supervised version of Kohonen learning rule. In LVQ each output unit represents a class. LVQ was used for classification of the tumor show that texture and shape features can give satisfactory result in analysis and classification of brain tumors [15].

VIII. CONCLUSION

This paper describes different image processing techniques for detecting brain tumor in MRI image. Four components were discussed in MRI images to improve the performance, classification and accuracy of detecting the brain tumor. They are Pre-processing, segmentation, feature extraction and classification. Various methods were discussed in the image processing for brain tumor in this survey. This presents the overview of image processing techniques among the existing systems.

REFERENCES

[1] Rohini Paul Joseph, C. Senthil Singh, M.Manikandan "Brain Tumor Mri Image Segmentation and Detection in Image Processing" Ijret, eISSN: 2319-1163 | pISSN: 2321-7308.
[2] http://medical-dictionary.thefreedictionary.com/Brain+Tumor
[3] Brain tumour detection using unsupervised learning neural network. Ms Rungta College of engg and technology Bhilai...2013 international conference on Communication system and network technologies.
[4] Dr. N. Nandhagopal, "Automatic Detection Of Brain Tumor Through Magnetic Resonance Image" Iijarcce, ISSN (Online): 2278-1021, Vol. 2, Issue 4, April 2013.
[5] Samir Kumar Bandhyopadhyay, Tuhin Utsab Paul" Automatic Segmentation of Brain Tumour from Multiple Images of Brain MRI" Volume 2, Issue 1, January 2013,ijaiem,ISSN 2319 - 4847.
[6] Swe Zin Oo, Aung Soe Khaing "Brain Tumor Detection and Segmentation using Watershed Segmentation And Morphological Operation" Ijret, eISSN: 2319-1163 | pISSN: 2321-7308, Volume: 03 Issue: 03 | Mar-2014.
[7] M. C Jobin Christ, R.M.S. Paravathi, "Segmentation of Medical Image using Clustering and Watershed Algorithms", American Journal of Applied Sciences 8(2): 1349-152, 2011 ISSN 1546-9239© 2011 Science Publication.
[8] S.M. Ali, Loay Kadom Abood, and Rabab Saadoon Abdoon "Brain Tumor Extraction in MRI images using Clustering and Morphological Operations Techniques", i-csrs,ISSN 2077-771X,2013.
[9] J.S.Weszka, "A Survey of threshold selection techniques", Computer Graphics and Image Proc., vol. 7, pp. 259-265, 1978.
[10] SivaSankari,S, Sindhu' Feature Extraction of Brain Tumor Using MRI' International Journal of Innovative Research in Science, Engineering and Technology, vol 3march 2014.
[11] Pratik P, Singhai, Siddharth A, Ladhake 'Brain Tumor Detection Using Marker Based Watershed Segmentation from Digital MR Images' (IJITEE) ISSN: 2278-3075, Volume-2, Issue-5, April 2013.
[12] Neelam Marshkole, Bikesh Kumar Singh 'Texture and Shape based Classification of BrainTumors using Linear Vector Quantization' International Journal of Computer Applications (0975 – 8887) Volume 30– No,11, September 2011.
[13] Kailash D,Kharat & Pradyumna Kulkarni 'Brain Tumor Classification Using Neural Network Based Methods' International Journal of Computer Science and Informatics ISSN (PRINT): 2231 – 5292, Vol-1, Iss-4, 2012.
[14] N,Rajalakshmi and Lakshmi Prabha,' Automated Classification of Brain Mri Using Colorconverted K-Means Clustering Segmentation and Application of Different Kernel Functions With Multi-Class Svm' 1st Annual International Interdisciplinary Conference, AIIC 2013, 24-26 April, Azores, Portugal – Proceedings.
[15] Neelam Marshkole, Bikesh Kumar Singh, A,S Thoke 'Texture and Shape based Classification of Brain Tumors using Linear Vector Quantization' International Journal of Computer Applications (0975 – 8887) Volume 30– o,11, September 2011.

