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A SURVEY ON AUTOMATIC BRAIN TUMOUR SEGMENTATION OF BRAIN MRI –A REVIEW

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ABSTRACT

Medical imageprocessing is the fast growing and challenging field now a days. Medical Image techniques are used for Medical diagnosis. Braintumor is a serious life threatening disease. The brain tumor detection is a very important application of medical images processing. In image processing for the detection of Brain Tumor involve four stages namely Pre –processing, ImageSegmentation, Feature Extraction and Classification. This paper has presented a review on various brain tumor segmentation techniques.Braintumor segmentation in magnetic resonance imaging (MRI) has become an important research area in the field of medical imaging system, as it helps in finding the exact size and location of tumor. The objective of this paper is to explore various image segmentation techniques in magnetic resonance imaging. This paper ends up with the suitable future directions.

Index Terms---*Classification, Feature Extraction, MRI Pre-processing, Segmentation*

I. INTRODUCTION

Brain tumor, which is one of the most common brain diseases, has affected and devastated many lives. According to International Agency for Research on Cancer (IARC) approximately, more than 126000 people are diagnosed for brain tumor per year around the world, with more than 97000 mortality rate [1]. To overcome this now days researchers are using multi-disciplinary approach involving knowledge in medicine, mathematics and computer science to better understand the disease and find more effective treatment methods. Magnetic resonance (MR) imaging and computer tomography (CT) scanning of the brain are most common tests undertaken to confirm the presence of brain tumor.With the help of this it is easy to identify tumor location .Currently,various options available for brain tumor these options include surgery, radiation therapy, and chemotherapy. The choice for the treatment options depends on the size, type,and grade of the tumor[2].For the accurate detection of brain tumor computer aided diagnosis (CAD) systems is used. With the help of CAD system a second opinion is provided as a computer output to assist radiologists' image interpretation[3].This paper represents the review of the methods and technique used during brain tumor detection through MRI images.

II. BRAIN TUMOR

A tumor is a mass of tissue that's formed by an accumulation of abnormal cells.A brain tumor is an abnormal growth of tissue in the brain or central spine that can disrupt proper brain function. Primary brain tumors

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emerge from the various cells that make up thebrain and central nervous system and are named for the kind of cell in which they first form. The most common types of adult brain tumors are gliomas and astrocytic tumors. These tumors form from astrocytes and other types of glial cells, which are cells that help keep nerves healthy. The second most common type of adult brain tumors are meningeal tumors. These form in the meninges, the thin layer of tissue that covers the brain and spinal cord.Braintumors identified in the children are primary tumors .The secondary tumor also called metastatic tumor are found in adults which means the cancer has spread to the brain from the breast, lung, or other parts of the body[4]. Nearly 1 in 4 people with cancer is affected by secondary brain tumor. Brain tumors are classified as benign or malignant. Benign tumors are noncancerous cells and malignant tumors are cancerous cells. Benign tumor do not invade brain or other tissues but they need to be treated because they might harm the neighbouring tissues or other vital organs. A malignant brain tumor invades normal tissue or contains cancerous cells either from the brain or other parts of the body. These types of tumors are dengerous, as they can spread throughout the brain or to the spinal cord. So patients with eitherbenign or malignant tumors, needs immediate recovery treatment after the diagnosis. Following are the areas where thebrain tumour can found:

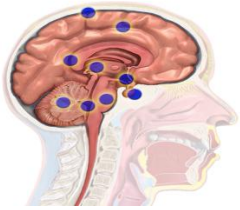

Figure A:Tumor view inside brain (Brain MRI)

Types of brain tumor:-

Benign: The least aggressive type of brain tumor is often called a benign brain tumor. They originate from cells within or surrounding the brain, do not contain cancer cells, grow slowly, and typically have clear borders that do not spread into other tissue.

- Malignant: Malignant brain tumors contain cancer cells and often do not have clear borders. They are considered to be life threatening because they grow rapidly and invade surrounding brain tissue.
- Primary: Tumors that start in cells of the brain are called primary brain tumors. Primary brain tumors may spread to other parts of the brain or to the spine, but rarely to other organs.
- Secondary: Metastatic or secondary brain tumors begin in another part of the body and then spread to the brain. These tumors are more common than primary brain tumors and are named by the location in which
- they begin[5].

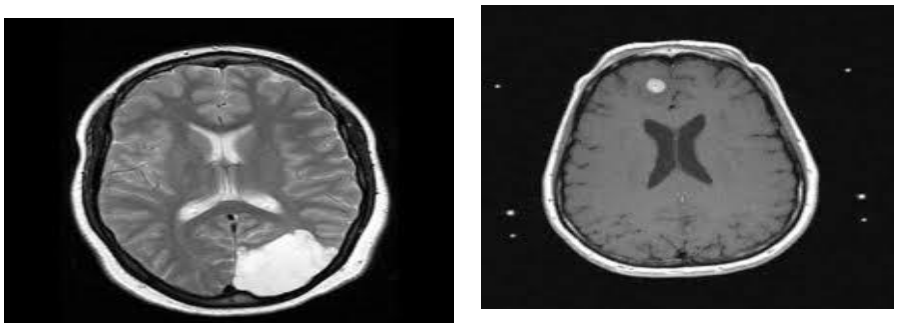

Figure B: Brain MRI containing tumor

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III. STEPS OF IMAGE PROCESSING SYSTEM

For the detection of brain tumorwith the help of MRI images some steps are there.These steps are Image Acquisition, Pre-processing , Segmentation , Feature Extraction ,Classification.Pre-processing of MRI images is the primary step in image Analysis which perform image enhancement and noisereduction techniques which are used to enhance the image quality. Image is enhanced in the way that finer details areimproved and noise is removed from the image.The following figure embraces the fundamental steps in image processing system [6].

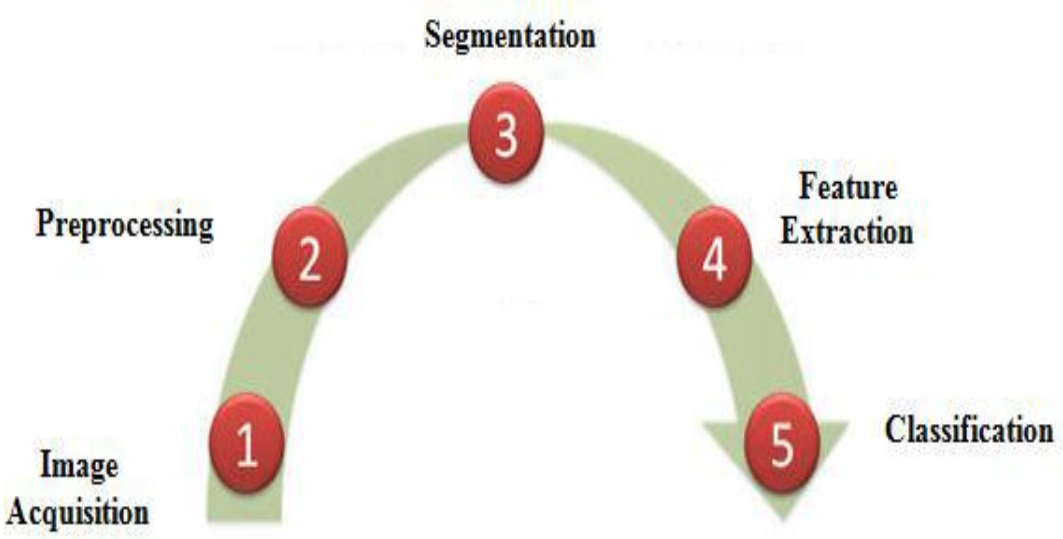

Figure C: Fundamentals steps in digital image processing

3.1) Image Acquisition: Digital image acquisition is the creation of digital image. The term is often assumed to 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 [7].

3.2) Pre-processing:.Preprocessing indicates that the same tissue type may have a different scale of signal intensities for different images. Preprocessing functions involve those operations that are normally required prior to the main data analysis and extraction of information, and are generally grouped as radiometric or geometric corrections. The Preprocessing Techniques such as Content Based model, Fiber tracking Method, Wavelets & Wavelet Packets, and Fourier transform technique [8]

Table 1: An overview of Preprocessing Methods

Methods	Remarks
Statistical Parametric Mapping, Pipe line Approach	Noise reduction, Intra-volume bias field correction, Linear&nonlinear alignment, Inter-slice intensity variation correction are handled by this method. .
Content Based model,Shape based, Texture based technique, Histogram and Profilling Method	It results detection of tumor with increase in image intensity with decrease in pixel count in binary images.
Pixel Histograms, Morphological Process	It is robust to noise and improve the integrity performance.

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Boundary Detection Algorithm, Generalized Fuzzyoperator(GFO), Contour Deformable Model, Region base technique	This Method gives good result in tumor detection. .
Standard Imaging Protocol	MRIs have been acquired in the standard follow-up.after surgical resection
Geometric prior,Bimodel	This method is used register the image.
Boundary Model ,Non linear matching scheme	This method gives idealized MR intensity profile .
Fourier transform technique	With the help of this method images were more clear in the transaxial plane.
Wavelets & Wavelet Packets, stein's . unbiased Risk Estimate(SURE)	With the help of this method we can vanishes the noise coefficients by thresholding the detail components.
Unseeded Region Growing(URG) Algorithm	With this algorithm MRI imageconverted into standard Formet.
Statistical Parametric Mapping Method	To confer robustness to areas of abnormality and it uses left-to-right symmetry.
Neural Networks, Genetic Programming	This method handles large volume data and processed it successfully.
PCA (Principal Component Analysis)	It is used to minimize the artifacts present in the PET data set.
Statistical Structure Analysis method	It provides 96.28% Accuracy
Histogram based(HB),Subsecond imaging technique	With this method we can separate brain image from head image removal of residual fragments .
Head Model, Finite Difference Time-Domain (FDTD)	Useful to analyse different Tissue types
Automatic Volume Registration method	It is used to remove artificats from MRI.
Independent Component Analysis(ICA)	Used to separate the components in MR images

3.3)ImageEnhancement:Enhancement and noise reduction techniques are implemented in brain tumor detection that can give best possible results. Enhancement will result in more prominent edges and a sharpened image like tumor is obtained noise will be reduced thus reducing the blurring effect from the image [9].Image de-noising is a standard pre-processing task for MRI. Many denoising methods for MRI image have been proposed, such as Anisotropic Diffusion Filtering (ADF)[10], wavelets[11], Non-Local Means (NLM)[12,13], and Independent Component Analysis (ICA)[14,15]. ADF is the current most popular method for the de-noising of brain tumor MRI images. Histogram equalization is the technique by which the dynamic range of the histogram of an image is increased. Histogram equalization assigns the intensity values of pixels in the input image such that the output image contains a uniform distribution of intensities[16].Skull stripping is an important pre-processing step for the analysis of MRI image. Skull stripping is the process of delineation and removal of non-cerebral tissue region such as skull, scalp, and meninges from the brain soft tissues. It has been considered as an essential step for brain tumor segmentation. The precision in this process has impacts in the efficiency in detecting tumor.

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Removal of the skull region reduces the chances of misclassifying diseased tissues. After the pre-processing of the image, segmentation techniques are applied toit[17].

Table 2: An overview of Enhancement Techniques

Methods	Description
Genetic Algorithm	Used for segment objective region from MRI and applied to enhance the detected Border.
Self organizing Map(SOM)	Used for segment the suspicious region
Triple Quantum Filtered (TQF) Sodium NMR	Found Non-Contrast Enhancing tissue and Minimizes the effects of extra cellular fluids
Anisotropic Diffusio	With this registered images are filtered clearly
Triple Quantum Filtered Sodium MRI (TQF) Technique	Used to develop blood brain barrier (BBB) breakdown.
Low pass Filter	To maintain local noisy fluctuations from MR images
Prewitt edge-finding filter	Used for extracts the image edges and moves the vertices towards the boundaries of the desired structure.
Median . filter	The mammogram images are enhanced using median filterand Low frequency image is generated and the border of the mammogram is detected from the binary image.
Radient – Based Method and Normalization Method	Removes the high frequency components and Shows the validity of detection of Memmographic lesions
Gadolinium-Diethylenetriaminepentaacetic acid (Gd DTPA)Enhancement	It improve the accuracy and provide additional independent information .
Population-Based Tissue Maps, K Nearest Neighbor Model.	Used to differentiate tissue types with high accuracy.
Level-Set Surface Model	Used to segment target regions from background tissue.
Support Vector machine	It is used to locate the boundary of an object quickly
Multi Layer Markov Random Field(MRF)	Create regions efficiently
Hybrid level Set (HLS) Model	It is used to segment edges and tumor.
Kohonen Self Organizing Map(SOM)	Used to segment the MR data in to regions which have similar characteristics

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Fuzzy C-means Clustering Method	It is used to produce suspicious regions from MRI database and to improve the validity of the partitioning by splitting and merging clusters.
Expectation Maximization(EM) Algorithm,	It is used to select the subsets of the expected
Gabor Filter Bank	It is used to remove the
Novel image Approach[10]	Earlier detection of non-contrast enhancing tissue
Prewitt edge-finding filter[4]	This filter enhances the tumor tissue greatly.
Morphological Filter	It is used to remove background

3.4) BRAIN TUMOR SEGMENTATION METHODS

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.

AUTHOR	YEAR	PAPER NAME	TECHNIQUE	RESULT
1) T.Logeswari and M.Karnan	2010	An Improved Implementation of Brain Tumor Detection Using Segmentation Based on Hierarchical Self Organizing Map	Hierarchical Self Organizing Map	Target area segmented and monitors the tumor, achieve computation speed Finding Rate:90%
2) 1Mehdi Jafari, 2Shohreh Kasaei	2011	Automatic Brain Tissue Detection in Mri Images Using Seeded Region Growing Segmentation and Neural Network Classification	Automatic Seeded Region Growing Segmentation (ASRGS):	Useful when similarities and discontinuities are detected in the image Finding Rate:96%
3) Abhishek Raj, Alankrita, Akansha Srivastava, and Vikrant Bhateja	2011	Computer Aided Detection of Brain Tumor in Magnetic Resonance Images	Morphological Segmentation	Provide more appropriate tumour image with sharp boundaries
4) Indah Soesanti1, Adhi Susanto1, Thomas Sri Widodo1, MaesadjiTjokronagoro	2011	OPTIMIZED FUZZY LOGIC APPLICATION FOR MRI BRAIN IMAGES SEGMENTATION	Fuzzy C means algorithm	Segmentation with spatial Information and yield more homogeneous region Finding Rate:95%
5) AnamMustaqeem, AliJaved, Tehseen Fatima	2012	An Efficient Brain Tumor Detection Algorithm Using Watershed &Thresholding Based Segmentation	Watershed segmentation	Developed algorithm can segment brain tumor accurately. Finding Rate:60%

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6)Pauline John	2012	Brain Tumor Classification Using Wavelet and Texture Based Neural Network	Daubechies wave late (db4)Discrete Wavelet Decomposition	the proposed method, with the help of the texture statistics obtained from LH and HL sub bands, is able to classify brain tumor into benign and malignant. Finding Rate:100%
7) 1Lavneet Singh, 2Girija Chetty	2012	A Comparative Study of MRI Data using Various Machine Learning and Pattern Recognition Algorithms to Detect Brain Abnormalities	K-Means clustering based Coarse Image Segmentation	In less computation time locates the tumor, noise effect is less Finding Rate:94%
8)Manoj K Kowar and Sourabh Yadav	2012	Brain TumorDetction and Segmentation Using Histogram Thresholding	Histogram Thresholding	The proposed algorithm can detect the physical dimension of the tumor
9) A Pethalakshmi, A Banumathi	2012	Optimized K –Means and Fuzzy C –Means For MRI Brain	UCAM, Fuzzy-UCAM algorithm	The proposed methods improve the scalability and reduce the clustering error
10) Dina Aboul Dahab1, Samy S. A. Ghoniemy2, Gamal M. Selim	2012	Automated Brain Tumor Detection and Identification Using Image Processing and Probabilistic Neural Network Techniques	Canny Edge Detection Algorithm	Proposed algorithm accurately detect and identify the contour of the tumor in less computational time Finding Rate:100%
11) Stefan Bauer et al.	2012	Multiscalemodeling for image analysis of brain tumor studies	Atlas-based Techniques	Provide more accurate result for the detection of brain tumor
12) Sudipta Roy, Samir K. Bandyopadhyay22	2012	“Detection and quantification of brain tumor from MRI of brain and its symmetric analysis	Image/Symmetry Analysis	Detection based on symmetry analysis of tumor
13) Vishal Paramane1, Lalita Admuthe2, Vinayak Sutar3	2013	BRAIN TUMOR DETECTION USING METHOD OF SEGMENTATION BASED ON SOFT COMPUTING	Localized Region Based Active Contour Segmentation	The presented CAD system provide the growth rate of tumor and gives 2nd opinion to doctors for accurate detection of tumor& its stages.
14) Ahmed Kharrat& Karim Gasmi	2013	A Hybrid Approach for Automatic Classification of Brain MRI Using Genetic Algorithm and Support Vector Machine	genetic algorithm	In proposed system optimal texture features are extracted from normal and tumor regions by using spatial gray level dependence method.
13) Kamal Kant Hiran1, Ruchi Doshi2 39	2013	An Artificial Neural Network Approach for Brain Tumor Detection Using Digital Image Segmentation	Threshold segmentation	Useful to provide more accurate and reliable result Finding Rate:92.3%

14) SONALI PATIL1 & V. R. UDUPI2	2013	A COMPUTER AIDED DIAGNOSTIC SYSTEM FOR CLASSIFICATION OF BRAIN TUMORS USING TEXTURE FEATURES AND PROBABILISTIC NEURAL NETWORK	Square Based Segmentation and Component Labeling	Proposed system provides precision Detection and Classification of Astrocytoma type of cancer. Finding Rate:94.87%
15) Mandhir Kaur, RinkeshMittal	2014	An Efficient Scheme for Brain Tumor Detection of MRI Brain Images Using Euclidean Distance With FVT	Euclidian distance classifier	Proposed system required less time for the detection of brain tumor
16)Hadia Bashir, *Fawad Hussain, and Muhammad Haroon Yousaf	2015	Smart Algorithm for 3D Reconstruction and Segmentation of Brain Tumor from MRIs using Slice Selection Mechanism	OTSU's segmentation	Proposed system utilizes slice matching to cut down on using a large number of slices. Finding Rate:96.6%
17) Jain R	2015	Machine Vision	Split and Merge Segmentation	Proposed system works on homogeneity criteria
18) Dou, W., Ruan, S., Chen, Y., Bloyet, D., &Constans, J.M	2015	A framework of fuzzy information fusion for the segmentation of brain tumor tissues on MR images. Image and vision Computing,	Fuzzy models Image Fusion	Algorithm is used to remove noise from multispectral images
19) El-Dahshan, El-Sayed Ahmed, Tamer Hosny, and Abdel-Badeeh M. Salem.	2015	Hybrid intelligent techniques for MRI brain images classification.	k nearest neighbor classifier (KNN)	to classify the human brain MRimages

In the early research of medical tumor detection, the algorithms have directly used the classic methods of image processing (Such as edge detection and region growing) based on gray intensities of images. In recent years, the classification of human brain in MRI images is possible via supervised techniques such as k-nearest neighbour, Artificial neural networks and support vector machine(SVM) and unsupervised classification techniques such as self organization map(SOM) and fuzzy C-means algorithm have also been used to classify the normal or pathological T2 weighted MRI images[18].

3.4) Feature Extraction

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.

GladisPushpaRathi V.P and Dr.Palani proposed Linear Discriminant Analysis which provide accuracy of 98.87as compared to PCA and SVM [19]. Daljit Singh, and Kamaljeet Kaur proposed Features Extracted by

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using GLCM and classified with RB-Kernel gives 100% classification accuracy better than PCA[20].Principal Component Analysis and kernel Support Vector Machine achieved the best accurate classification result with 99.38% as compared to HOPL and IPOL kernels proposed by Zhang Y and L. Wu [21].

3.5) Classification

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[22].EL-Sayed A.EL-Dahshan, Abdel-BadeehM.Salem and Tamer.H.Younis proposed a classifier Feed forward - Back propagation Neural Network with Wavelet Transformation and Principal Components Analysis provide the specificity rate 96%[23].

Lalit P. Bhaiya and Virendra Kumar Verma implement a classifier with Probabilistic Neural Network (PNN) and GLCM which produces 98.07% of accuracy in tumor detection[24].Modified Probabilistic Neural Network (PNN) model based on Learning Vector Quantization (LVQ) performance is measured with 100% accuracy[25].Kothavari. K proposed PNN Classifier with Image Encryption in which Classification accuracy is about 100-85%[26].

IV .CONCLUSION

In this survey paper various automatic detection methods of brain tumor through MRI has been studied .This is used to focus on the future of developments of medical image processing in medicine and healthcare. We have described several methods in medical image processing and to discussed requirements and properties of techniques in brain tumor detection .This paper is used to give more information about brain tumor detection and segmentation. It is a milestone for analyzing all technologies relevant to brain tumor from MRI in Medical image processing. In this paper, various steps in detection of automatic detection:

i) The Preprocessing and Enhancement Technique

ii) Segmentation Algorithm and their performance have been studied and compared.

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