EAI Endorsed Transactions
on Energy Web and Information Technologies Research Article EAI.EU

A Review On Automatic Detection of Brain Tumor Using Computer Aided Diagnosis System Through MRI

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Abstract

In diagnosing brain tumor using Magnetic Resonance Imaging (MRI) plays a major role in complicated stages. To extract the images, it uses a kind of nuclear magnetic resonance technique. To identify the exact region where the tumor is present is the most important task in the segmentation process. The most challenging and complicated medical image processing technique Brain image segmentation. The researchers are working towards to develop effective procedure for segmenting MRI images. In this research article Pre-processing, Enhancement and Segmentation process are deeply surveyed.

Keywords: MRI, Segmentation, CAD, Computer Tomography, Preprocessing, Enhancement.

Received on 06 July 2018, accepted on 25 August 2018, published on 12 September 2018

3rd International Conference on Green, Intelligent Computing and Communication Systems - ICGICCS 2018, 18.5 - 19.5.2018, Hindusthan College of Engineering and Technology, India

doi: 10.4108/eai.12-9-2018.155747

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1. Introduction

In our human body, Brain is one of the most attractive and less understandable organ. For centuries, most of the scientists and philosophers have wonder about the relationship of the human's behavior, emotion, memory, consciousness, thinking and Personality. In the late 19th century, the study of brain function progressed based on the work involving in the stimulation of applying electrical currents in the cortex of animal brains, at earlier stage it leads to the mapping of motor function in animals and later applied into the human body. However the result contains many inconsistencies.

To identify the structural abnormalities and responsible for the neurological disorder pathology a powerful technique called Magnetic Resonance Imaging is used for diagnosing the brain tumor . In a medical world only we analyze the pictures of several cross sections of a brain on a light board ,based on their result, neurologists can easily diagnosis or determine the course of a treatment based on these existing images. To support medical diagnosis there is an increase in the field of medical image processing, the semi-automatic and automatic tools had appeared. For an instance brain segmentation permits not only to visualize a volume of functional cortical structures yet in addition to measure it.

The various stages of Computer Aided Detection System (CAD) used for detecting the brain tumor by using Magnetic Resonance Image (MRI). They used in particular areas like preprocessing enhancement and segmentation process. The various process like Feature Extraction, Feature Selection and classification are also analyzed and compared. The image is transformed into standard format with specified process like: contrast manipulation, removal of noise in background, edge sharpening, filtering process and film artifacts removal in Preprocessing and Enhancement process. The next stage is Segmentation, which determines the process of segmenting an image into disjoint homogenous regions. By using feature extraction, resources are required to describe the large set of data is simplified and selected. Feature selection process is allocated for the classification of various stages.

2. Pre-processing And Enhancement

In medical image processing, one of the simple method is image preprocessing and enhancement, this method is used for increasing the quality and information content of an image and specified process like: contrast manipulation, removal of the noise in background, Edge sharpening and filtering process. Prior for the image generation, a few techniques can be employed in the image processing using coherent echo-signals. The enhancement method is classified into resolution enhancement and contrast enhancement. Both are used to suppressing the speckle and imaging of spectral parameters. The image is then transformed into standard image without noise film artifacts and labels after the enhancement process.

2.1 Pre-processing

Different scale of signal intensities will be there for similar types of tissue for various images which is said by preprocessing. Operation like data analysis and extraction of information are generally combined into radiometric correction or geometric corrections inpreprocessing function. For correcting the data of sensor irregularities, radiometric corrections are used, that remove the unwanted sensor or atmospheric noise and also convert the given data. Due to that corrections the Sensors measured the accurate representation of the reflected or emitted radiation.

The various Preprocessing Techniques are classified as: (i) Content Based Model, (ii) Fiber Tracking Method, (iii) Wavelets and Wavelet Packets and Fourier Transform Technique. As per the collection of research article, Olivier et al. implemented a brain tumor radiotherapy using a new Standard Imaging Protocol. [31]. Dana et al discussed about the implementation of statistical parametric mapping and pipeline approach for registration and various resampling levels. For reducing noise and inter-slice intensity variation correction the pipeline approach is used [9, 19]. Elizabeth et al defines the Pixel Histogram and Morphological process for obtaining brain tumor image from MRI and it becomes more strong [4, 5, 11, 25, 26, 29, 30]. Leung et al explained about various models such as Boundary Detection Algorithm, Generalized Fuzzy Operator, Contour Deformable Model, and Region Based technique used for 3D reconstruction by applying radiology [21].

To find the exact location of boundary points by intensity data with standardized data Patrick et al proposed the new Boundary Model and non-linear matching scheme [33]. Azadeh et al research work designed the method called Wavelets and Wavelet Packets, the main purpose of the work is to reduce noise and correcting the baseline. Paulo proposed a Fiber tracking method to process MR-DT1 datasets [3,4].

Lorenzen et al research based on prior Geometric image registration [33,34]. Xin et al. presents the Unseeded Region Growing (URG) Algorithm for the purpose of converting the MRI image into typical Format [43]. To separates the brain image from head image and to remove the residual fragments, Zu et al introduced a new mechanism called Sub-second imaging technique and the histogram based technique [35,45]. Xiao et al analyses the images from MRI using Statistical Structure Analysis also known as an automated method [42]. Principal Component for minimizing the artifacts that present in the PET data set is designed in Brian et al [6]. Shishir et al designed to improving the quality of MR brain image using histogram method [36].

Table 1.1 An Overview of Preprocessing Methods

Methods	Remarks
Standard Imaging Protocol	After surgical resection MRIs have been acquired in the standard follow-up.
Content Based model, Shape based, Texture based technique, Histogram and Profiling Method	It displays the detections of tumor with decreasing pixel count in binary images and also increases the intensity of the images.
Pixel Histograms, Morphological Process	It is high robustness and it may enhance the integrity execution.
Boundary Detection Algorithm, Generalized Fuzzy Operator, Contour Deformable Model, Region base technique.	These techniques gives a better solution for tumor consideration.
Boundary Model, Nonlinear matching scheme.	The idealized MR intensity profile is represented here.
Fiber tracking Method, Runge -Kutta method	The MR-DT1 datasets are processed here.
Wavelets and Wavelet Packets, Stein's Unbiased Risk Estimate(SURE)	By using thresholding the noise coefficients are vanished with detailed components.
Fourier Transform technique	Images were cleared in the trans axial plane.
Geometric prior, Bimodel	It is used to register the image
Unseeded Region Growing(URG) Algorithm	It converts the MRI image into typical Format.
Histogram based(HB), Sub-second imaging technique	To Separate brain image from head image for to removing residual fragments such as sinus, cerebrospinal/fluid, marrow are Separated from brain image to head image.
Principal Component Analysis(PCA)	In the PET data set the artifacts present are minimized.
Neural Networks, Genetic Programming	Successfully processed large volume of data.
Statistical Parametric Mapping Method	Properly images are aligned from left-to-right symmetry to deal robustness to areas of irregularity.

2.1.1 Enhancement

Image enhancement technique says an information about improving the digital display of different views like Magnetic Resonance Image (MRI), Computer Tomography (CT) and Positron Emission Tomography (PET). (i)Removing of film artifacts (ii) Labels and filtering of images are the activities of image enhancement. The various types of Conventional Enhancement techniques are Low Pass filter, Median filter, Gabor Filter, Gaussian Filter, and Prewitt edge-finding filter are employed. To eliminate the tagging lines and also to enhance the tag-patterned regions a method was proposed by Dimitris et al. which was called as Gabor Filter that is applied in the image [10]. A new CAD system used for image enhancement using median filter, which was implemented by Karnan et al. [27,39].

Tsai et al. analyzed about the low pass filter to eliminate the local noise fluctuations in the bone and soft tissue outlines [41]. The Triple Quantum Filter which was Boada et al introduced for decreasing the causes of Fluids which are extracellular often based on the measurement of concentrated intracellular sodium [6]. Marcel Prastawa discuss about Anisotropic Diffusion filter that filter the registered images [12,23,24,25,26]. Ladan et al. studied the various filters like Edge Finding filter used to reducing the noise and prewitt filter used to improve the quality of an image [20]. Aria et al. describes Gadolinium a research work which enhances tumor borders during the relation between contrast enhanced regions, tumor cell extent and is unclear from the MRI process [2].

Amini et al. discussed about the Prewitt Edge finding filter that enhances the image edges more robust [1,20]. Zhe et al. discussed a method called Morphological Operations which automatically detects the PET lesions this removes background brain images [44]. Xiao et al research based on Gabor Filter and its process is to filtering the noise from MRI brain tumor image and partition the space with equal angle of 30 degrees [42].Gaussian filter that is applied in the image to enhancing their boundaries level and create the image gradients more efficient under the research of Corina et al [8].To reduce the noise in MR brain images using nonlinear filter was designed by Shishir et al [36].

Table 1.2 An Overview of Image Enhancement Techniques

Methods	**Description**
Prewitt Edge-finding filter	Boundaries of images are extracted and vertices moved nearly to the desired structure boundaries.
Median filter	Median filter are used to enhance mammogram images with low frequency and pectoral muscle region will be deleted. From the left and right of binary image, mammogram border were detected.
Genetic Algorithm(GA)	Border detection is enhancing, if GA is applied. Detection ratio is high when compared with all other techniques.
Gradient-Based Method, Median Filter, Normalization Method	High frequency components were removed, mammographic lesions were detected and validity also shown.
Triple Quantum Filtered Sodium MRI (TQF) Technique	The Blood brain barrier and angiogenesis has been broken down and developed after detecting neoplastic changes.
Low pass Filter	It considers the local noise fluctuations from MRI images.
Triple Quantum Filtered (TQF) Sodium NMR	It reduce the cause of extra cellular fluids and Found Non-Contrast Enhancing tissue
Edge Finding filter, Morphological operation.	Compare to other methods it provides better performance.
Gadolinium-Diethyl enetriamine penta acetic acid (GdDTPA) Enhancement	It improves the accuracy and provides additional independent information.
Novel image Approach	Earlier identification of non-contrast enhanced image tissue.
Prewitt edge-finding filter	Better enhancement of tumor tissues.
Morphological Filter	Used to remove the background appearance.
Gabor Filter	Used to extract the Homogeneous texture descriptor (HTD).
Gaussian Filter	It improves the image Edges.
Median Filter	To enhance the mammogram image.
Gabor Filter Bank technique	The lines which is tagged and the tag-patterned region which is enhanced are removed.
V-filter	To Enhance the image by smoothing and to distribute the noise gray level while retaining the boundaries.
Non linear Filter	It aligns linear Non – Contrast enhancing Brain Volumes.
Region Growing Filter	By using a noise reduction filter to preprocess the image usually in a convenient manner.

K-nearest neighbour Algorithm	Generating the enhanced data volumes and highly correlated with defined standard manually.

2.1.2 SEGMENTATION

The segmentation process involves to segment the image and converted into similar attribute regions.The division procedure includes to portion the picture and changed over into comparative property parts. A definitive point of picture is preparing applications which is utilizing the division to remove imperative highlights from the given picture and gives the portrayal, elucidation of the scene. In attractive reverberation pictures the division of cerebrum tumor process is more imperative yet tedious is performed by restorative specialists. In short, the Regions of Interest (ROIs) of a picture is dictated by division which implies that the division does not decides the kind of the district, but rather essentially decides the picture pixels.

A few division strategies are created by the computerized picture handling network and a large portion of them are adhoc. What's more, the most widely recognized strategies are: (i) sufficient thresholding, it basically center in identifying the tumors edema and necrotic tissues. These sorts of strategies are utilized to isolates the pictures into a few classes (i) Pixel Based Technique (ii) Region or Texture Based Strategy and (iii) Structural Based Strategy.

Dimitris et al. clarified about programming division on Hybrid Deformable Model with Meta Morphs for incorporating the inside surface and state of the picture and its flow are resultant reasonably from both limit and locale informations [10] . Chunyan et al. characterized a deformable technique utilized for portioning the pictures semi naturally [7]. Tsai et al. presents a plan in light of Histogram and Morphological process for sectioning the various tissues from MRI data [41]. Ming et al investigate work in view of k-implies bunching for changing over the dark scale picture into shading scale MRI picture [88]. Marcel Prastawa presents a programmed tissue division process for MRI information utilizing k-closest neighbor strategy [12,23,24,25]. Ladan et al. learn about discrete shape display for dividing the cerebrum structures like thalamus from MRI [20]. Amini et al. plans a programmed division utilizing Dynamic shape show, great snakes for sectioning the particular cerebrum structures from MRI [1,20]. Zhe et al shows a portioning PET sore pictures in light of Content-based recovery method [44].

Corina et al. learn about sectioning the cerebrum MRI pictures utilizing Active Contour Model [8]. Mao et al.design a programmed division technique utilizing Fuzzy k-means, and Ant province improvement for processing the ideal marking of the picture pixels [22]. Dana et al. presents a strategy on 3D Variational Segmentation, because of the high assorted variety in appearance of tumor tissue from different patients [9, 19]. Jayaram et al. takes a shot at Fuzzy Connectedness and Fuzzy sets to build up the idea of fuzzy connectedness specifically connected in a picture for encouraging the picture division [14, 15]. Hideki et al. recommended a particular system for Partition the picture space into important areas [13].

Kabir et al. presents another technique called Markov arbitrary field demonstrationand used to portioning the stroke injuries utilizing different MRI arrangements [18].Leung et al. composed a Contour Deformable Model to section the particular locale from the MRI pictures [21]. Marcel Prastawa present a VALMET Segmentation approval device for identifying the force exceptions and scattering of the ordinary mind tissue power bunches [12,23,24,25]. Tang et al. presents a Multi-determination picture division to section the cerebrum tissue structure from the MRI picture [38].Pierre et al. composed an Atlas-based division used to propagate the named structures on to the MRI picture [31,35]. Jayaram et al describes a strategy called Evaluating Image Segmentation Algorithm that handled for portioning the items from the source picture [14,15]. Jaffrey et al planned a technique called self-loader division strategy which accommodating for volume following and to appraise the tumor volume with process [16,17].

Siyal et al portrays about Fuzzy C-implies for separation reason process. Aaron executes a level set surface model for division in view of GUI [37]. Stamp et al planned a Support Vector Machine (SVM) to portion the edema and tumor tissues [9,28]. Tolias et al depicts a calculation called Adaptive Spatial Deterministic Annealing Clustering calculation for gathering the homogeneous area (Xi) with focus little district (wk) and relies upon p(wk/xi) the participation work [40]. Azadeh et al explore work relies upon k-implies grouping calculation used to portion the cerebrum tissue and isolates the ordinary mind pixels from the internal cerebrum pixels [3, 4].

Table 1.3 An overview of Segmentation Algorithm

Methods	Remarks
Dynamic contour model	External and Internal powers are deforms here.
Fuzzy C means (FCM) unsupervised clustering	Picture edges are separated powerfully and vertices are move towards the limit of the predetermined structure.
Supervised k-nearest neighbor(kNN) rule, Semi Supervised Fuzzy C-Means (SFCM)	An example set of pixel vectors are favoured by the expert observer, and the vectors are added to tissue classes which are unlike.
Seed Growing Method	Independent seed propagation was done here.
Hybrid Deformable model, Meta Morphs model, Texture Integration, Graphical Model, Learning Methods	It connects both shape and the inside surface, its status are achieved coherency from region information and boundary in a routine alternative structure.
Fuzzy C-means Clustering Algorithm(FCM),Neural Network Model	Optimal labeling of the image pixels are processed.
Atlas Matching Technique, Finite Element Method(FEM)	Stimulation of invasion of the GBM in the brain parenchyma.
Morphological operations, Low level knowledge based segmentation rule, Adaptive Histogram Analysis.	To segment the heterogeneous tissues from double echo MR images. Soft tissue outlines, the bone elimination is occurred here.
Expectation Maximization scheme(EM)	Its performance is lower than Semi-Automated.
Automatic Two – dimensional Segmentation	To segment each and every PET plane.
Texture Features, Self-Organizing Map(SOM)	In brain MRI image, the tumor area is segmented.
Morphological Operations, Fuzzy model of Regions of Interest(ROI)	It represents the knowledge about the distance, shape and also interactions of various structures more appropriately.
Fuzzy C-means	Segmentation images are generated from raw MR image data which is used to display the clinically important neuro-anatomic tissue and contrast information about neuro-pathologic tissue.
Region Based Method, Region Growing Method, Multi Resolution Edge Detection Method, Modified Region Segmentation.	The Multi Resolution images are utilized for segmentation of brain tissue structure.
Graph-Based Method, G Weighted Aggregation Algorithm.	In difficult cases tumor segmentation process is done which also Indicates the benefits of incorporating model-aware affinities
Iterative Self-Organizing Data Analysis Techniques, Unsupervised Computer Segmentation Algorithm, Novel Model	Significant identification of Multi-parametric ISODATA volume
Multi-scale Method, Multi-scale linking Model, Supervised Segmentation Method	It shows an errors are in the order of, or smaller than reported article.
Semi-Supervised Fuzzy C-Means Clustering Method, K-nearest neighbor, Gray level Thresholding and Seed Growing, Manual Pixel Labeling	This method ensures the less operation time and good performance.
Hybrid level set (HLS)	Provides objective, Segmentations and Reproducible which are all close to the manual results.
Fuzzy Model	Correct detection are found from average probability.
Deformable Model, Med-Voltmeter	Under level set frame the target area is segmented.
3D Variational Segmentation Method	Accurately the tumor area was segmented.
K-nearest neighbor Algorithm	Preferred to train the patterns from the chosen regions
Automatic Neonatal (Atlas Driven)	From the MRI the brain tissue structure is segmented.
Fuzzy C-Means Clustering	It improves the coherence of the

Algorithm	segmentation performance
K-means Clustering method	Various types of tissues are incorporated all that when classifying voxels.
Fuzzy k-means, Ant colony optimization	For noise reduction thresholding is performed here.
Supervised technique-Mountain Method, Maximum Likelihood, K-nearest neighbour, Artificial neural network.	Excellent partitions are produced here for large amount of data sets.
Discrete Dynamic Contour model	In brain MRI thalamus and similar objects of interest are segmented.
Kd tree-based k-means(KMN), Maximum posteriori MRF method(MAP-MRF)	It estimates the average time activity curve (TAC) and also estimate the kinetic parameters are used to lead to in accuracies .
Expectation-Maximization (EM)	From t1 and t2 weighted image like WM, GM and CSF are separated.
Classic snakes, Deformable Contour model	With the help of low–contrast structures and discontinuous edges are segmented from the t1 weighted images of the brain.
Kohonen's competitive learning algorithm, Fuzzy KCL, Fuzzy-soft KCL	A Reduction of noise effects in the medical image.
Markov random field model	Single sequences are obtained from the segmentation of multiple sequences in the given image.
Generalized fuzzy operator(GFO), Contour Deformable model	Segmentation of tumor regions are processed.
Atlas-based segmentation	Labeled structures are propagated on to the MRI
Expectation-Maximization Technique, Robest Estimation, VALMET Segmentation validation tool	It Segments the tumor, edema and ventricles
Multilayer segmentation, Automatic region segmentation	Segments the original image into different spatial regions.
Content-based retrieval technique	Successful segmentation on images
Atlas-driven segmentation	Successfully tumor regions are segmented Automatically.
Fuzzy methods	A high accuracy results shown here relatively.
The graph-theoretic variational segmentation method, k-nearest neighbour	A results of high quality segmentation.
Active Contour Model	Processing the Segmentation in tumor regions using MRI scan.
Evaluating Image Segmentation Algorithm	Appear high accuracy during segmentation.
Fuzzy mean Algorithm(FCM), Silhovette Method(SM)	From the data of MRI it provides a simple way to identify the appropriate structure.
Contour Tracing Algorithm, Region Segmentation Method	Establishment of edge regions are segment the image into meaningful regions.
Synthetic Ground Truth Model, Biomechanical Model	Measurement of pathology is performed with reliable ground truth.
Soft-Margin Support Vector Machine(SVM)	It process millions of trainings and testing's level instantly and involved with relatively small feature set.
Adaptive Spatial Deterministic Annealing,Clustering Algorithm	Misclassification error is estimated here, which is affected by noise and also it generates accurate segmentation results.
k-means Clustering Algorithm	Accurate separation of background brain pixel.
k-means Clustering	It converts the gray-level MRI image into a color space image, also it separate the position of tumor from MRI image.
Statistical Model, Markov Random Field, Level Set Method, Non-Uniformity Correction Method	It removes the Non-brain structures and it estimates the tissue based on intensity variation.
Physics Based Deformable Organism	It has a capability to control physics based deformations and also to decreases the error rate.
Multi-Scale Watershed Segmentation	The subset of the expected regions to be selected automatically.
Deformable Region Model, Iterative Growing Method, Shrinking Method and Snake Method	To locate the boundaries of an object easily.
Hidden Markov Chain Model(HMC)	To provide better resolution in various spectral, spatial and temporal data's.
Seeded Region Growing Model, Active Contour Snakes Model	Based on extraction, the set of pixels are connected and whose pixel intensities are consistent with existing pixel statistics of a seed point.
Hybrid level Set (HLS) Model	Used for segmenting the edema and tumor in the brain image.
Kohonen Self Organizing Map	Used to convert the MRI data into sectors which have homogenous characteristics.
Expectation Maximization Algorithm, Multi-Layer Markov Random Field.	Preferred to identify the subsets of the anticipate regions dynamically.
Population-Based Tissue Maps, K Nearest Neighbor Model.	Provides high accuracy that specified to various tissue types.

3. Conclusion

This survey compares and discusses about the brain tumor and automatic detection methods by different sort of techniques which vast for two decades. Medical Image Processing plays an important role in the future of drug and medical sector. There are many strategies which described about the medical image processing using the preprocessing and the techniques which have a lot of enhancements in the future, beyond the properties and the requirements of the particular techniques. For investigating all the advancements which matches the brain tumor detection using MRI is one of the most important factor in the Medical Image Processing.

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