A COMPARATIVE STUDY (REVIEW) OF DISSIMILAR METHODS USED FOR BRAIN IMAGE SEGMENTATION

Author: Ashwini Jangde1, Navneet Sahu2
1Research Scholar, ECE Department, CSIT, Durg, India
2ASST.Professor, ECE Department, CSIT, Durg, India,

Email: ashwini.jangde12@gmail.com

Abstract: .
Medical Image Processing is one of the most challenging and emerging topics in today's research field. (MRI) is one of the parts in this field. Image segmentation plays an important role in image processing.\MRI is generally more useful for brain tumour detection because it provides more detailed information about its type, position and size. For this reason, MRI imaging is the choice of study for the diagnostic purpose and, thereafter, for surgery and monitoring treatment out comes. This paper presents a review of the various methods used in brain MRI image segmentation. The review covers imaging modalities, magnetic resonance imaging and methods for segmentation approaches. The paper concludes with a discussion on the upcoming trend of advanced researches in brain image segmentation. this research is focused towards highlighting the strengths and limitations of the earlier proposed segmentation techniques discussed in the contemporary literature. Besides summarizing the literature, the paper also provides a critical evaluation of the surveyed literature which reveals new facets of research. However, articulating a new technique is beyond the scope of this paper.

Keywords: *Brain tumor, Magnetic resonance Imaging (MRI), Image segmentation,*

Introduction

Brain has a very complex structure and is considered as a kernel part from the body. Nature has tightly safeguarded the brain Inside a skull that hinders the study of its function as well as makes the diagnosis of its diseases more intricate. But, brain is not prone to diseases and can be affected by the abnormal growth of the cells in that change its normal structure and behavior — a disease generally known as a brain tumor. Brain tumors either include tumors in the central spinal canal or inside the cranium. Automatic defects detection in MRI is quite useful in several diagnostic and therapeutic applications computed tomography and MRI are two imaging modalities that help researchers and medical practitioners to study the brain by looking at it non-invasively [1]. Most of the time, the tumor segmentation and classification become harder due to quantity of MR images and blurred boundaries. Since brain is safeguarded by the skull, therefore, an early detection of brain tumor is only possible when diagnostic tools are directed at intracranial cavity.

MRI is a medical imaging technique, and radiologists use it for visualization of the internal structure of the body. MRI can provide plentiful of information about human soft tissues anatomy as well as helps diagnosis of brain tumor. MR images are used to analyze and study behavior of the brain. A powerful magnetic field is used to align the nuclear magnetization of hydrogen atoms (or protons) of water in the body. In the presence of RF (radio frequency) electromagnetic fields, hydrogen nuclei produce a rotating magnetic field which is detectable by the scanner. Since protons can absorb energy at specific frequency and have the ability to reemit that energy; therefore, a transmitter coil is normally fitted around the human skull to measure the net magnetization. The transmitter coil functions in the following way: first, it produces electromagnetic waves and transmits these waves inside the brain, and then a receiver coil measures the intensity of the emitted electromagnetic waves. Moreover, an additional gradient coil is used for spatial localization of the signal. Lastly, the recorded signals (or electromagnetic waves) are reconstructed into an image by a specialized computer program. MRI being an advanced medical imaging technique provides valuable information about the human soft tissue anatomy. It can provide three dimensional (3D) data depicting a high contrast between the soft tissues. Nevertheless, the massive size of the accumulated data poses a biggest obstacle in the effective use of MRI as it makes manual analysis or interpretation nearly impossible. Therefore, it necessitates employing an automatic or semiautomatic technique that is capable to support computer-aided image analysis. Segmentation of MR images into different tissue classes such as white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF) is considered as an important task. Brain MR images possess a number of features. Particularly, they are statistically simple as they are theoretically piecewise constant having a small number of classes. In addition, these images have a relatively high contrast between different tissues.

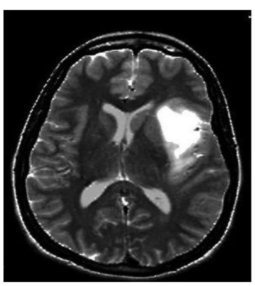

Figure 1: An MRI scan showing regions of activation in orange, including the primary visual cortex. Contrary to the other medical imaging modalities, the observable contrast within an MR image is inflexibly much dependent on the way it has been acquired. However, it is always feasible and doable to highlight different components in the image of the object by altering RF and gradient pulses as well as carefully choosing relaxation timings. This approach is quite promising and produces high-contrast images. The aforementioned features although facilitate segmentation, however, the ideal imaging conditions are hard to realize in practice. The piecewise-constant property of the image features is degraded considerably by the bias field (i.e., intensity inhomogeneities in the RF field), electronic noise, and the partial-volume effect (i.e., multiple tissue class occupation within a voxel). All of these factors cause classes to overlap in the image intensity histogram. Furthermore, MR images are not always available in high-contrast. A number of T2-weighted and proton density images exhibit low contrast between grey matter and white matter. Hence, it is imperative to exploit this exceptional efficacy of the available data as well as to overcome potential difficulties at the same time [2].

In MRI, the spatial intensity inhomogeneity induced by the RF coil poses a foremost problem to perform an automated analysis of MRI data. Such in homogeneities make the application of both traditional intensity-based classification of MR images and advanced techniques (like nonparametric and multichannel methods) extremely difficult. The most probable reason for this anomaly could be linked with the fact that the intensity in homogeneities that appear in MR images produce spatial changes in tissue statistics, such as mean and variance. Additionally, the image degradation hampers the clinical diagnoses because the physicians are left with no choice but to ignore the inhomogeneity artefact in the corrupted images in the first place. Removing spatial intensity inhomogeneity from MR images is also a difficult task as it invariably changes if different MRI acquisition parameters are used, and it varies from slice to slice and from a patient to a patient as well. Therefore, the necessary corrections in intensity inhomogeneities are ordinarily needed for each new image [3].

This study evaluates various techniques that play a vital role within the domain of segmentation of medical images. This paper is organized into four sections. After this introductory section, the next section highlights the major techniques that have been studied as part of the literature survey. Section III outlines critical evaluation of the techniques discussed in the related work section. Finally, we conclude in the last section.

Literature review:

In this section, we present review of the selected literature on image segmentation techniques and their usage. The key objective is to highlight key strengths and limitations to these techniques

Paul and Bandyopadhyay [4] emphasize that automation of the process to avoid any manual process is a challenging in tumor detection using MRI images. They present an automated two-step segmentation procedure which will stripped the skull by generating a skull mask and then after that by using an advanced K-means algorithm to provide two-level granularity for assessing the length and breadth of brain tumor. In a given algorithm, MRI image is read and image is enhanced using a 3 by 3 unsharpened filters. A clearer picture can be obtained by removing all the blurred area of the previous image. The two-dimensional array can be using to hold the output and values are rounded off in case if they are in the form of fraction. Mask can be generated for skull stripping and using a method automatically a histogram shape based image threshold is performed.

Meenakshi and Anandhakumar [2] emphasize that MRI are useful for analyzing brain images because of its high-accuracy rate. Detection of the brain tumor has become a challenging task. Most of the existing techniques used machine learning techniques to detect brain tumor, but still they are suffered by the wrong diagnosis. The proposed technique combines the clustering and classification algorithm to minimize the error rate. Segmentation task is performed using orthonormal operators and classification using BPN. Images having the tumor are processed using K-means clustering and significant accuracy rate of 75% is obtained.

Roy and Bandyopadhyay [5]
introduce the symmetric analysis to detect the brain tumor by making calculations on the area of tumor. Magnetic resonance imaging is used to perform quantitative analysis. MR images give better results as compare to other techniques used in the field of medical sciences like CT images and X-rays and ultrasound. Automatic segmentation of images helps facilitate medical specialists to make manual labeling since a healthy brain has a strong symmetry which does not remain stronger in case of a tumor.
An algorithm has been introduced to perform a calculation on MRI of brain image, which requires an image as an input which is read in the form of a color or grayscale image. If the image is colored, then it is converted into grayscale with all the details of RGB components. Then it is resized and filters the multidimensional array using the multidimensional filters and rounds off all the fraction values. Then it combines the grayscale image with the filtered image and generates an enlarged image. Afterwards, it uses binary image having values in the form of 0s and 1s to calculate the global threshold. In the next step, one can perform watershed segmentation. Finally, morphological operations can be computed and stored as a final image using two variables for rows and columns. The proposed segmentation method is quite helpful in detecting tumor using MRI. There is one limitation associated with the current methodology that it cannot properly capture the model in case of unforeseen pathologic tissue type.

Swati tiwari(6)

highlight that segmentation results will not be accurate if the tumor edges are not sharp, and this case occurs during the initial stage of tumor. Texture-based method is proposed in this paper. Along with brain tumor detection, segmentation is also done automatically using this method. The proposed texture analysis and seeded region method was implemented in MATLAB environment using 25 MRI images.

CRITICAL EVALUATION

In this study, we have studied different techniques for segmentation. The prominent intensity models studied in this paper include neural networks, Gaussian mixture models, wavelet based models, finite mixture models, fuzzy adaptive etc. Majority of the researchers preferred MR images, and CT scanned images are rarely used by the researchers. Some studies focused on trained data while other targeted untrained data; some studies used atlas, and some did not. A critical review of the studied literature is summarized in the compare and contrast table.1.

author	topic	Algorithm used	Proposed technique	benefits	Identified Problems
M.N. Ahmed, *IEEE transaction on Medical Images*, KY, USA, March 2002	A MODIFIED FUZZY C-MEANS ALGORITHM FOR BIAS FIELD ESTIMATION AND SEGMENTATION OF MRI DATA,‖	Modified Fuzzy C-Mean	Bias field Estimation	BCFCM algorithm is faster to converge to generate accurate classification.	Technique is limited to a single feature input. Incorporation of spatial constraints into the classification blurs some fine details.
Rosniza Roslan1, Nursuriati Jamil2 (2011)	SKULL STRIPPING MAGNETIC RESONANCE IMAGES BRAIN IMAGES: REGION GROWING VERSUS MATHEMATICAL MORPHOLOGY	Radial basis function on neural network	Receptive field	Training algorithm is relatively simple as compared to the back-propagation iterative algorithm used with MLP.	The proposed algorithm does not perform well on trained data.
Paul and Bandyopadhyay(june 2012)	"SEGMENTATION OF BRAIN TUMOR FROM BRAIN MRI IMAGES REINTRODUCING K–MEANS WITH ADVANCED DUAL LOCALIZATION METHOD	Symmetry analysis	advanced K-means algorithm	provide two-level granularity for assessing the length and breadth of brain tumor	MRI of three different angles are used
Roy (2012)	DETECTION AND QUANTIFICATION OF BRAIN TUMOR FROM MRI OF BRAIN AND IT'S SYMMETRIC ANALYSIS	Symmetry analysis	Modular approached to solve MRI segmentation	The proposed can identify the status of increase in the disease by employing quantitative analysis.	MRI segmentation is one of the essential tasks in medical area but is boring and time consuming. Visual study of MRI is generally more interesting and fast.
N.Gopinath(sept2012)	EXTRACTION OF CANCER CELLS FROM MRI PROSTATE IMAGE USING MATLAB	*basic concepts of Image Processing*	Watershed Segmentation & Threshold Segmentation	given MRI filtered Prostate Image.	The results of this study are quiet promising.
SWATI TIWARI1, ASHISH BANSAL2 Journal of Education , Volume 2, Issue 1, 2012,	IDENTIFICATION OF BRAIN TUMORS IN 2D MRI USING AUTOMATIC SEEDED REGION GROW-ING METHOD	tumor line detection and segmentation	SEEDED REGION GROW-ING	distinguish the involved area precisely.	The proposed method provides only one dimensional image feature.

Luis Garcia Ugarriza(IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 18, NO. 10, OCTOBER 2009)	AUTOMATIC IMAGE SEGMENTATION BY DYNAMIC REGION GROWTH AND MULTIRESOLUTION MERGING	color gradient detection technique	unsupervised color image segmentation algorithm	automatic segmentation of color images with varied complexities	Not used in 2d mri image
Rachana Rana (june 2013)	STUDY OF VARIOUS METHODS FOR BRAIN TUMOUR SEGMENTATION FROM MRI IMAGES	review of the various methods used in brain MRI image segmentation	Level set method,	Introducing new methods and combining different methods can be the future schema for making improvement in brain segmentation methods.	A review paper.
S.Muthamizhselvi1**,**	A NOVEL PREDICATE FOR ACTIVE REGION MERGING IN AUTOMATIC IMAGE SEGMENTATION	*automatic image segmentation in a region merging method*	proposed a novel predicate for merging the regions in automatic image segmentation.	Predicate P is used to determine the evidence of merging between the two neighboring regions. The Predicate is defined by using Sequential Probability Ratio Test (SPRT).	This technique is used in colour image segmentation not for brain tumor dedction
Sheenam Bansal1,(july-aug2013)	PERFORMANCE ANALYSIS OF COLOR BASED REGION SPLIT AND MERGE AND OTSU'S THRESHOLDING TECHNIQUES FOR BRAIN TUMOR EXTRACTION	region split and merge segmentation and Otsu's Thresholding	region of interest.	Otsu's thresholding segmentation was more productive as compared to CB region split and merge in terms of accuracy.	Virtual environment sometimes leads to inaccuracy.

CONCLUSION

Image segmentation is extensively used in numerous biomedical-imaging applications, e.g., the quantification of tissue volumes, study of anatomical structure, diagnosis, localization of pathology, treatment planning and computer-integrated surgery. As diagnosis tumor is a complicated and sensitive task; therefore, accuracy and reliability are always assigned much importance. Hence, an elaborated methodology that highlights new vistas for developing more robust image segmentation technique is much sought. Introducing new methods and combining different methods can be the future schema for making improvement in brain segmentation methods. Because of the today's research in biological world, increasing new knowledge about the relationship between different disorders with anatomical deviation is coming up. So, brain segmentation is gaining importance in using as the first stage in tools for detection and analyzing anatomical deviation

REFERENCES:

[1] M.N. Ahmed, S.M. Yamany, N. Mohamed and T. Moriarty, ―A modified fuzzy c-means algorithm for bias field estimation and segmentation of MRI data,‖ *Proceedings of the IEEE transaction on Medical Images*, KY, USA, March 2002.

[2] Rosniza Roslan1, Nursuriati Jamil2"kull Stripping Magnetic Resonance Images Brain Images: Region Growing versus Mathematical Morphology" *International Journal of Computer Information Systems and Industrial Management Applications ISSN 2150-7988 Volume 3 (2011*)

[3]R. Meenakshi and P. Anandhakumar, ―Brain Tumor Identification in MRI with BPN Classifier and Orthonormal Operators,‖ *European Journal of Scientific Research, September 2012.*

[4] T.U Paul and S.K. Bandyopadhyay, ―Segmentation of Brain Tumor from Brain MRI Images Reintroducing K – Means with advanced Dual Localization MethodTuhin,‖ International Journal of Engineering Research and Applications, June 2012.

[5] S. Roy and S. 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, Volume 2 No. 6, June 2012.

[6]Swati tiwari1, ashish bansal2 'identification of brain tumors in 2d mri using automatic seeded region grow-ing method" ***Journal of Education*** *ISSN: 2249-5517 & E-ISSN: 2249-5525, Volume 2, Issue 1, 2012*,

[7]Luis Garcia Ugarriza, Eli Saber, Sreenath Rao Vantaram, Vincent Amuso, Mark Shaw, and RanjitBhaskar,(2009)"Automatic image segmentation by dynamic region growth and multiresolution merging", IEEE Transactions on image processing, vol.18. no.10, pp.2275 –2288, Oct

[8]M. Kumar and K.K. Mehta, ―A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method,‖ International Journal of Computer Technology and Applications, August 2011.

[9] Sheenam Bansal, Dr. Raman Maini / " Performance Analysis of Color Based Region Split and Merge and Otsu's Thresholding Techniques for Brain Tumor Extraction "International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 3, Issue 4, Jul-Aug 2013,

[10]Rachana Rana1, H.S. Bhadauria " Study of Various Methods for Brain Tumour Segmentation from MRI Images*" International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 6, June 2013)*

[11] N.Gopinath "Extraction of Cancer Cells from MRI Prostate Image Using MATLAB" *ISSN: 2319-5967 International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 1, Issue 1, September 2012*

[12] S.Muthamizhselvi1, D.Jeyakumari2, "A NOVEL PREDICATE FOR ACTIVE REGION MERGING IN AUTOMATIC IMAGE SEGMENTATION*' ue 1, September 2012*

[13] M. U. Akram and A. Usman ―Computer aided system for braintumours detection and segmentation‖, IEEE transaction, 978-1-61284-941-6/11, 2011.

[14] R. C. Patil and A. S. Bhalchandra ―Brain Tumour Extraction fromMRI Images Using MATLAB‖, International Journal of Electronics, Communication & Soft Computing Science and Engineering Vol. 2, No. 1, pp. 2277-9477.

[15] A.Rajendran and R. Dhanasekaran―Fuzzy Clustering and Deformable Model for Tumour Segmentation on MRI Brain Image: A Combined Approach‖,Procedia Engineering,Vol. 30, pp. 327 – 333, 2012.

[16] L-H Juang and M-N Wu―MRI brain lesion image detection basedon color-converted K-means clustering segmentation‖.Measurement, Vol. 43, pp. 941–949, 2010.

[17] S. J. Hussain, T. S. Savithri and P.V. S. Devi ―Segmentation of Tissues in Brain MRI Images using Dynamic Neuro-Fuzzy Technique‖, International Journal of Soft Computing and Engineering (IJSCE), Vol. 1, No. 6, pp. 2231-2307, 2012.

[18] A. Kothari ―Detection and classification of brain cancer usingartificial neural network in MRI images‖, World Journal of Science and Technology, Vol. 2, No. 5, pp. 2231 – 2587, 2012.

19] T.U Paul and S.K. Bandyopadhyay, ―Segmentation of Brain Tumor from Brain MRI Images Reintroducing K – Means with advanced Dual Localization MethodTuhin,‖ International Journal of Engineering Research and Applications, June 2012.

[20] J. J. Corso, E. Sharon, S. Dube, S. El-Saden, U. Sinha and A. Yuille, "Efficient Multilevel Brain Tumor Segmentation With Integrated Bayesian Model Classification", IEEE Transactions on Medical Imaging, Volume: 27 , Issue: 5, pp. 629 - 640, May 2013.

