ISSN 2320 – 2602
Volume 4, No.3, March 2015
International Journal of Advances in Computer Science and Technology
Available Online at http://warse.org/pdfs/2015/ijacst01422015.pdf

AUTOMATED COMPUTER AIDED DIAGNOSIS SYSTEM FOR BRAIN ABNORMALITY DETECTION AND ANALYSIS FROM MRI OF BRAIN

Sudipta Roy[1], Prof. Samir Kumar Bandyopadhyay[2]

[1]Department of Computer Science & Engineering, University of Calcutta, India,sudiptaroy01@yahoo.com
[2]Department of Computer Science & Engineering, University of Calcutta, India, skb1@vsnl.com

ABSTRACT

Accurate measurement of clot thickness, hematoma area, and location on MRI scan have been successfully executed which is important because of need for accurate and rapid diagnosis and treatment, prompt transfer of the patient to a facility capable of MRI scanning and neurological intervention is necessary. Automated systems for analyzing and classifying medical images have gained a great level of attention by our proposed method. The results are encouraging and a higher accuracy for the 3-class classification problem can be attained by obtaining a better dataset with high resolution images taken directly from the MRI of brain. This will allow the future system to reach a level that will allow it to be a significant asset to any medical establishment dealing with brain hemorrhages.

Keywords: Brain Hemorrhage, Brain MRI Scans, CAD Systems, Image Processing, Image Segmentation, Position of Hemorrhage.

1. INTRODUCTION

Abnormality of brain is one of the most common brain diseases, which includes brain tumor, hemorrhage, acute stroke, alzheimer's disease, multiple sclerosis, cerebral calcinosis and many more, so its diagnosis and treatment have a vital importance. In recent years, developments in medical imaging techniques allow us to use them in several domains of medicine, for example, computer aided pathologies diagnosis, follow-up of these pathologies, surgical planning, surgical guidance, statistical and time series analysis [5-7]. Among all the medical image modalities, Magnetic Resonance Imaging (MRI) is the most frequently used imaging technique in neuroscience and neurosurgery for these applications. The brain abnormalitydetection and segmentation on MRI images is a very difficult and vital task which is used in surgical and medical planning and assessment. The difficulty in brain image analysis is mainly due to the requirement of detection techniques with high accuracy within quick convergence time. Automating this process is a challenging task because of the high diversity in the appearance of abnormal tissues among different patients and in many cases almost similar with the normal tissues. The detection process of any abnormalities in the brain images are a two-step process. Initially, the abnormal MR brain images are detected from different type of MRI images,finally, the abnormal portion is extracted (image segmentation) to perform volumetric analysis and classified for treatment planning varies for different types of abnormalities which verify the success rate of the treatment given to the patient.

Conventionally, the detection process is performed manually which is highly prone to error because of the intervention of human perception.In this research work, we have a plan to develop automated techniques with simultaneous merits of high accuracy and convergence rate for image classification and segmentation applications.

2. BRIEF TECHNICAL DETAILS

An autonomous image analysis from MRI of brain image will provide a definite and conclusive assessment for a particular patient suffering from the symptoms of different kind brain diseases like hemorrhage, vascular dementia, stroke, meningioma, sarcoma, glioma,Alzheimer's, multiple sclerosis and many more.An abnormal region occupies the positions of regular tissues and their intensity characteristics vary from the surrounding normal tissues. Using this information, we want to develop a method to found the regions engaged by abnormal portions with the help of suitable image processing algorithms and associated deliverables the medical practitioners (experts) and pathologists can easily determine the type, extent of infection and quantification of abnormality very accurately. The extent of the disease is dependent on the number of cells affected and their changes can be determined to provide significant information related to the presence and extent of abnormalities. The doctors can then correlate these features for providing effective therapy to ensure relief to the suffering patients. Our system will be able to generate large sets of simulation images with abnormality of varying size, shape and location, and will additionally generate infiltrated and deformed healthy tissue probabilities.

3. SCOPE OF THE WORK

This study is a consequence of a series of discussions with the medical practitioners and pathologists. Doctors and pathologists strongly put forward the need of autonomous software that can quickly identify and isolate abnormal infection in a simplified manner using contemporary computational methods.The abnormality of brain identification, segmentation, classification and analysis in MR brain images are the main objective of this research work. Normally, the abnormalities are identified by the human observer (radiologist). The probability of error for such identification is very high due to the presence of psycho-visual effect. Besides being inaccurate, the requirement of convergence time is also high which accounts for the practical difficulty of such abnormality detection systems.An extensive literature survey has revealed the availability of* semi-automated and fully automated techniques for this application. Most of them are computer based approaches and involves the concept of soft computing approaches such as ANN and fuzzy logic techniques. But, the major drawback is that if the techniques are accurate, the time requirement is high and vice-versa due to two key reasons: (1) there is a large number of abnormality (tumor) types which differ greatly in size, shape, location, tissue composition and tissue homogeneity[1-2]. In some cases, their border with normal tissues cannot be very well defined on images; therefore, they are even difficult for radiology experts to delineate. (2) The consequence of the phenomenon of partial volume effect, where 1 voxel may belong to multiple tissue types, in addition to noise of MRI automatic abnormality segmentation and analysis are still a difficult problem[3-4]. In other words, accuracy and low convergence time are not simultaneously available within the same technique. In this scenario the proposed Computer aided Design (CAD) system will be the solution of several existing problems and can be very useful and efficient.

4. METHODOLOGY

The broad idea is to analyze a series digital slide image obtained by moving the slide so that maximum slide image area can be covered so as to detect even minor infections if it is visible anywhere within the slide. The series of slide images will be pre-processed, post-processed and image analysis will be performed. Image binarization, artifacts removal, and edge detection are treated as a pre-processing whereas, detection, classification,contour determination and segmentation are treated as post processing. The specific abnormalities can be identified using intensity, features extraction,and classification of the disease will be done implementing pattern matching and other proposed algorithms. For this research work the focus will be concentrated on the detection of abnormality by identifying the characteristic changes with the normal tissue from MRI of brain.The overall framework of this research work has been shown in Figure 1., the complete system is made up of individual modules and each individual module is associated with its own techniques. The major modules of this work are image database, pre-processing, feature extraction, classification and image segmentation. Image classification and image segmentation includes techniques with power lawtransformation approaches with their performance evaluation. These techniques form the core part of our research work. A schematic block diagram of our proposed work has been shown in figure 1:

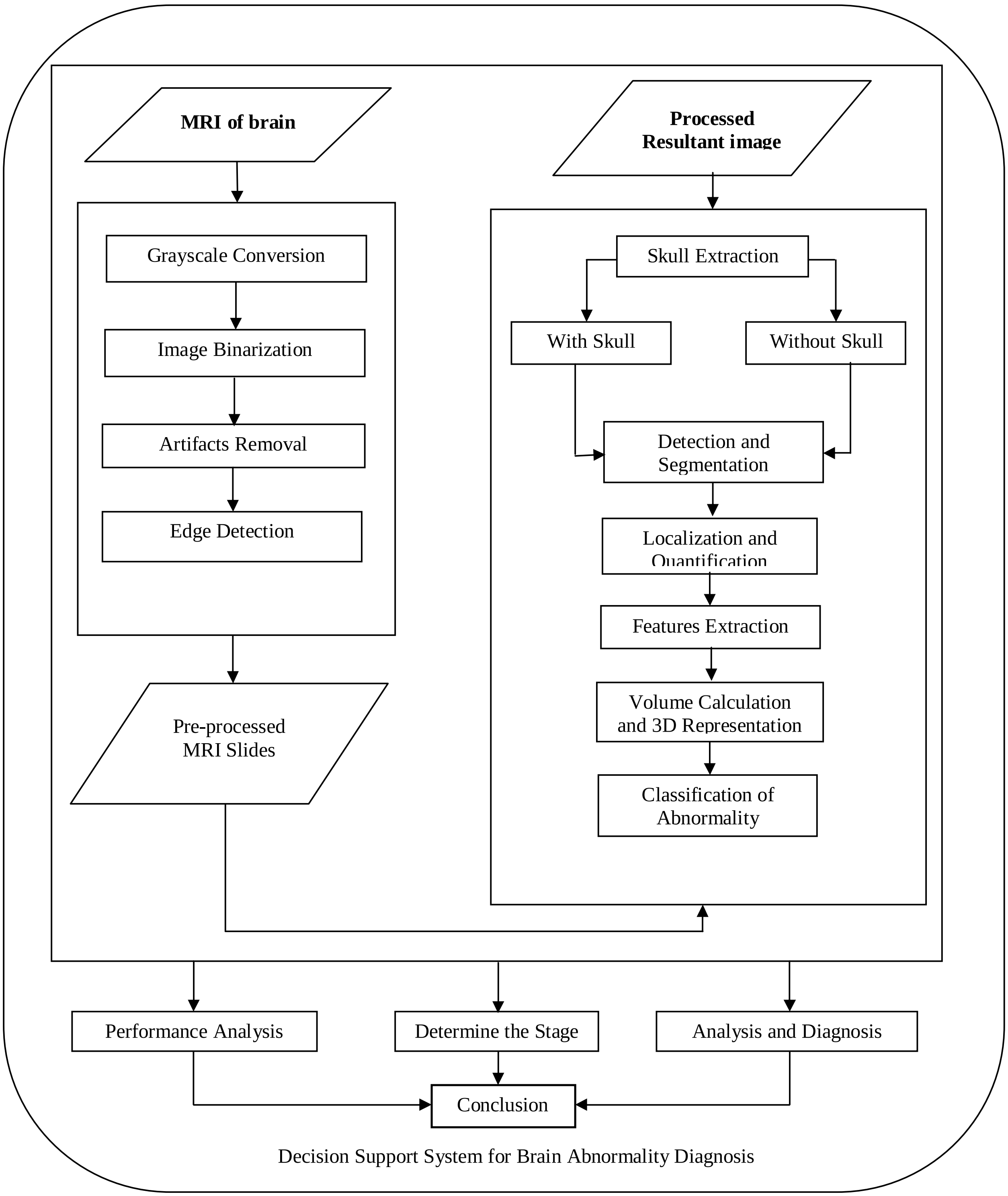

Figure 1: Automated brain abnormality detection system

4.1 For development of data set

The MRI slides can be gathered from several diagnostic centers and hospitals. For experimental analysis images available in the public domain are utilized that are utilized by several research organizations those are conducting similar research.We have also used a Harvard medical dataset (available from January 2014, with whole brain atlas and different type of brain diseases.

4.2 Image processing

We plan to propose a suitable image processing algorithms to developed and implemented on the obtained dataset to develop anautomated CAD System using above framework. The images will be pre-processed, abnormality detection, segmentation and classification performed subsequently. The obtained, processed images will then be analyzed for generating inferences.

4.2.1 Pre-processing

Many different artifacts can occur during magnetic resonance imaging (MRI), some affecting the diagnostic quality, while others may be confused with pathology. Thus to detect any abnormalities in brain artifact must be removed otherwise it will treated as an abnormality in automated system or may hamper the intelligence system.To remove those artefact as well as detection and segmentation MRI image binarization is essential task, a simple standard deviation approach results superior for MRI of brain images. The problem of binarization of gray MRI images due to the black background and large intensity variation has been overcome by our proposed method. Edge detection improves image readability and it is an important part of images pre-processing aimed to their segmentation and automatic recognition of their contents.

4.2.2 Skull Extraction:

Skull extraction is very important because many diseases are associated to skull and also many diseases are not related to skull. Thus we want to extract skull for the diseases like solitary osteolytic skull defect, multiple osteolytic skull defect, focal increased skull thickness, and diffuse increased skull thickness. The skull defect has a characteristics bevelled edge which could be seen in MRI. Langerhans cell granulomatosis arises from the dipolic space, most commonly in the parietal and temporal bones.this diseases of children and young adults, pre-dominantly in males.A lot of diseases are not related to skull like meningeal and sulcal diseases, extracrebral masses, intracerebral massesmass lesion in region of the ventricular system, parasellar masses etc. For those disease which need not have skull information we remove the skull to get higher accuracy.

4.2.3 Detection and Segmentation

We have a plan to detect the abnormal portion and other abnormality using intensity basedthreshold which can distinguish difference between normal and abnormal space and also useful for image with intensity inhomogeneity, and give good performance for images with weak object boundaries. After that to segment abnormal portion we have a plan to use power law transformation thus segmentation of medical images will lead towards improving the accuracy, exactness, and computational speed of segmentation approaches, as well as minimizing the amount of manual interaction. These can be improved by incorporating discrete and continuous based segmentation methods.

4.2.4 Localization and Quantification

We can calculate the centroideof the abnormal portion and findout theabnormal position from the center position as well as different side of the brain. Thiscentroid done by weighted mean of the abnormal pixels. Area can be calculated from each segmented MRI slides.From those localization and quantification we can aware the dangerousness of the abnormality. Identification and Localization of Affected Cells system will provide a detailed analysis of the infection and will locate the cells that are infected by the abnormality.

4.2.5 Features Extraction

Image features like texture and color characteristics are important towards determination of image features. Since the image contains white matter,gray matter, cerebral spinal flude, marrow, and skullare important to analyze these components for better extraction of features and detect alzimer disease and multiple sceleriosis.

4.2.6 Volume Calculation and 3D representation

The image features that are isolated in the above steps need to be extracted from the image to analyze and classify them into groups. This can be achieved by utilizing different techniques and approaches that involves intensity, feature and represent as 3D using stack. Volume can be calculatingsuccessive summation of each area with very low error rate.

4.2.7 Classification of Abnormality

Classification of different type of tumor and with grade, different type of haemorrhage lesson, different brain attack and degenerative diseaseare the vital module of the system that will be combine all features extracted as an input to the system. Classification involves grouping of features based on certain criteria imposed on the system. The classified information is used either by supervised on unsupervised system for decision making. Supervised systems can be developed by machine learning or training datasets for identification or Neural Network based systems. Unsupervised methods like FCM and morphological functions sometime provide a faster classification.

4.3 Development of an intelligent system

The ultimate objective of this research work is to develop and integrate all the image processing algorithms proposed on the obtained dataset of slide images to attain the deliverables. We plan to work with a greater number of brain structures and explore incorporating additional information to guide our proposal. We deal with two dimensional MR images in order to detect the brain tumors and features extraction for the applications such as treatment and follow-up, surgery, Individual modeling, etc. To segment the tumor we first discussed the various type of segmentation and detection procedure very carefully. Analyzing the performance of all steps gives us the correctness of the procedure and analyzing all steps we can say the type, stage, dangerousness of the abnormality.The following figures shows the actual results.

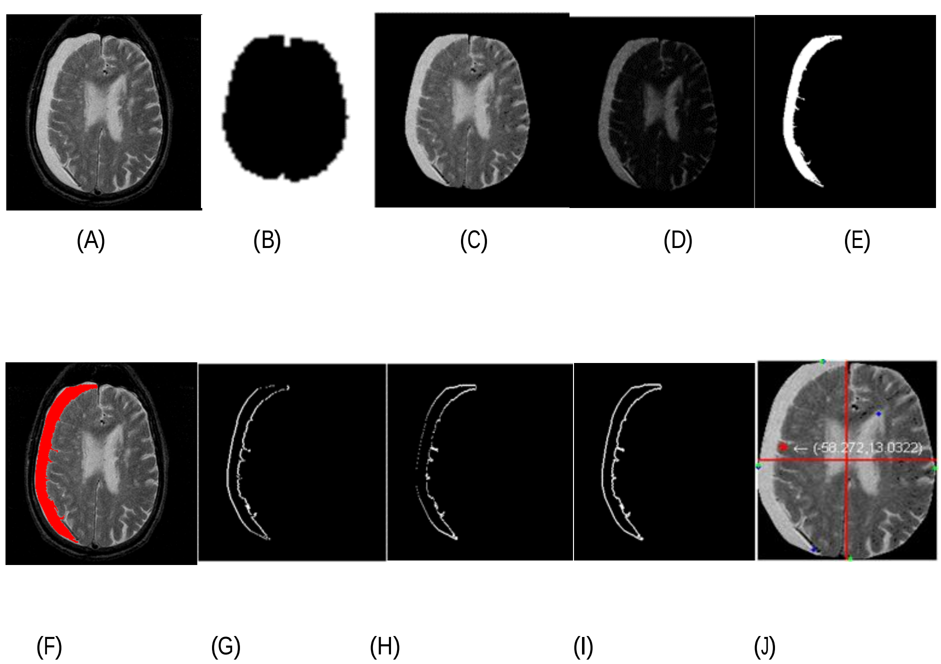

Figure 2 : A) input MRI of brain scan, B) complemented wavelet decomposed output, C) applying convex hull, D) after gamma transformation, E) segmented abnormal portion, F) abnormal portion by red marks, G) horizontal contour, H) vertical contour, I) contour of abnormal region, J) position of abnormal region.

5. CONCLUSION

Computer-aided diagnosis (CAD) systems have been the focus ofseveral research and it is based on the idea of processing and analysing images of different hemorrhage of the brain for a quick and accurate diagnosis.We use a gamma transformation approach with a pre-processing step to segmentand detect whether a brain hemorrhage exists or not in a MRI scans of the brainwith the type and position of the hemorrhage. The implemented system consistsof several stages that include artefact and skull elimination as an imagepre-processing, image segmentation, and location identification. We compare theresults of the conducted experiments with reference image which are verypromising visually as well as mathematically.

REFERENCES

1. Li, Y., Hu, Q., Wu, J., Chen, Z.: A hybrid approach to detection of brain hemorrhage candidates from clinical head ct scans. In: Proc. IEEE Sixth International Conference on Fuzzy Systems and Knowledge Discovery (FSKD), vol. 1, pp. 361–365 (2009)

2 (May 2014), http://nihseniorhealth.gov/stroke/prevention and diagnosis/01.html

3. Loncaric, S., Dhawan, A., Broderick, J., Brott, T.: 3-d image analysis of intra-cerebral Brain hemorrhage from digitized ct films. Computer Methods and Programs in Biomedicine 46(3), 207–216 (1995)

4. Loncaric, S., Majcenic, Z.: Multiresolution simulated annealing for brain image analysis. In: Medical Imaging. International Society for Optics and Photonics, pp. 1139–1146 (1999)

5. Cheng, D., Cheng, K.: Multiresolution based fuzzy c-means clustering for brain hemorrhage analysis. In: Proceedings of the 2nd International Conference on Bioelectromagnetism, pp. 35–36. IEEE (1998)

6. Cheng, K., Lin, J., Mao, C.: The application of competitive hopfield neural network to medical image segmentation. IEEE Transactions on Medical Imaging 15(4), 560–567 (1996)

7. Lin, J., Cheng, K., Mao, C.: A fuzzy Hopfield neural network for medical image segmentation. IEEE Transactions on Nuclear Science 43(4), 2389–2398 (1996)