INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH

IJCMPR

Available Online at http://www.journalcmpr.com

RESEARCH ARTICLE

CLASSIFICATION OF BRAIN DISORDER USING MEDICAL IMAGING

Samir Kumar Bandyopadhyay[1] and Goutam Roy Chowdhury[2]

[1]Research Director, Techno India University
[2]Chairman, Techno India Group Techno India University, EM-4, Sector-V, Salt Lake, Kolkata-700091, West Bengal, India

ARTICLE INFO

Article History:

Received 12th August, 2016
Received in revised form 28th September, 2016 Accepted 30th October, 2016 Published online 28th November, 2016

Key words:

Artifact Removal, Convex Hull, MRI of Brain, Skull Elimination, Segmentation and classification

ABSTRACT

Detection of brain abnormalities form magnetic resonance imaging (MRI) of brain image is very important task. Many different artefacts are present in MRI and due to this artefact degraded the image quality and also the diagnostic quality. Detection of abnormalities in brain like tumor and edema, skull elimination important otherwise it has been treated as an abnormality in automated system or may hamper the intelligence system. First a method is proposed to remove artefact and skull based statistical and computational geometric approach. Next method for segmentation and classification of brain tumour detection is given as a total process for detection of brain abnormalities from MRI image.

INTRODUCTION

Brain has a very complicated anatomical structure. It consists of central nervous system that is considered to be the kernel part of the body. The central nervous system consists of the brain and the spinal cord. The peripheral nervous system consists of the extensions of neural structures beyond the central nervous system and includes somatic and autonomic divisions. The brain is composed of 3 main structural divisions: the cerebrum, the brainstem, and the cerebellum. At the base of the brain is the brainstem, which extends from the upper cervical spinal cord to the diencephalon of the cerebrum. The brainstem is divided into the medulla, pons, and midbrain. Posterior to the brainstem lies the cerebellum. In recent years the anatomical study of human body and the treatment of different kinds of disease in distinct parts of the body show potential advancement depending on the medical imaging technology [25]. Brain tumor is one of the most common brain diseases. Brain tumor, occurs when abnormal cells form within the brain. Skull, is very rigid and it encloses the brain. So any growth inside such a restricted space increases pressure on the brain, as a result some brain tissues are shifted, pushed against the skull that cause of damage the nerves of the other healthy brain tissues [26].

Brain tumors can be cancerous (malignant) or non-cancerous (benign). Growth of benign or malignant tumors inside the skull cause of brain damage, and sometimes it can be life-threatening also. Therefore early detection of brain tumor is necessity for starting the treatment and saving life.

Rapid development of medical imaging technology and the introduction of various imaging modalities over the last few decades have transformed the medical image processing as one of the most emerging fields of this era. Medical imaging techniques play a crucial role for capturing the abnormalities of human body such as tumor, cancer, cyst, fibroid etc. Images are captured by different devices using different modalities such as X-ray, Computed Tomography (CT) Scan, Magnetic Resonance Imaging (MRI), Ultrasound, Positron Emission Tomography (PET), and Electrocardiogram (ECG). Among all the modalities MRI is the most efficient powerful tool to visualize the detailed and complete aspects of internal structures for accurate measurement of organ anatomy [27]. MRI medical imaging is non-invasive, provides high contrast between different soft tissues, high spatial resolution and also does not produce any harmful radiation. For these reasons MRI is widely used for detection, diagnosis and treatment of brain tumors. It is also able to provide the invaluable information regarding the tumor size, shape and localization without exposing the patient to a high ionization radiation [28]. It is also capable to produce images in axial, coronal and sagaittal planes [27].

The decision and communication center of body is the nervous system. The central nervous system (CNS) is the part of the nervous system consisting of the brain and spinal cord. Together they control every part of daily life, from breathing and blinking to helping in memorizes the facts. The brain is composed of three main parts forebrain, midbrain, and hindbrain. The forebrain consists of the cerebrum, thalamus, and hypothalamus (part of the limbic system). The midbrain consists of the tectum and tegmentum. The hindbrain is made of the cerebellum, pons and medulla. Often the midbrain, pons and medulla are together referred to as the brainstem. Cerebrum: The largest part of the human brain is cerebrum or cortex, which is associated with higher brain function such as thought and action. The cerebral cortex is divided into four sections, called "lobes" the frontal lobe, parietal lobe, occipital lobe, and temporal lobe. Cerebellum: Cerebellum is similar to the cerebrum, it has two hemispheres and has a highly folded surface or cortex. This structure is associated with regulation and coordination of movement, posture, and balance. Limbic System: The limbic system, often referred to as the "emotional brain", is found buried within the cerebrum. This system contains the thalamus, hypothalamus, amygdala, and hippocampus. Brain Stem: The "simplest" part of human brain is brain stem which underneath of the limbic system. This structure is responsible for basic vital life functions such as breathing, heartbeat, and blood pressure. The brain stem is made of the midbrain, pons, and medulla [28].

The brain is composed of two types of tissue, namely gray matter (GM) and white matter (WM). Gray matter is made of neuronal and glial cells, which is also known as neuroglia or glia that controls brain activity and the basal nuclei which are the gray matter nuclei located deep within the white matter. The basal nuclei is consists of caudate nucleus, putamen, pallidum and claustrum. Corpus Callosum which is a thick band of white matter fibers connects the left and the right hemispheres of the brain. Both, cerebellum and cerebrum contain thin outer cortex of gray matter, internal white matter is small but deeply situated masses of the gray matter. The brain also contains cerebrospinal fluid (CSF) which consists of glucose, salts, enzymes, and white blood cells. For protection of brain and spinal cord from injury CSF circulates through channels (ventricles). Meninges are the membrane covering the brain and spinal cord [29-34].

Medical imaging has been undergoing a revolution in the past decade with the advent of faster, more accurate and less invasive devices.Magnetic Resonance Imaging is considered very powerful diagnostic methods to detect any abnormalities. As in all imaging process, artefacts can occur, resulting in degraded quality of image which can compromise imaging evaluation. An artefact is a feature appearing in an image that is not present in the original object. Artefacts remain a problematic area in magnetic resonance imaging (MRI) and some affect the quality of the examination, while others may be confused with pathology. Depending on their origin, artefacts are typically classified as patient-related, signal processing dependent and hardware (machine)-related.
Pre-processing (artefact removal) techniques are used to improve the detection of the suspicious region from Magnetic Resonance Images (MRI). Thus a statistical method has been served to remove the artefact from MRI of brain image and the proposed method has been successfully implemented and produces very good results. This process helps to diagnosis any disease from MRI of brain. We no longer look to MR imaging toprovide only structural information, but also functional information of various kinds such that information about blood flow, cardiac function, biochemical processes, tumour kinetics, and blood oxygen levels (for mapping of brain function). Magnetic resonance (MR) imaging creates images of atoms' nuclei using the property of nuclear magnetic resonance. This allows MRI systems to extract more detailed information about the human body than is possible to get with X-rays. Artefacts occur in MR images in the presence of ferromagnetic metal

For decades, computed tomography (CT) images have been widely used to discover valuable anatomical information. Metallic implants such as dental fillings cause severe streaking artefacts which significantly degrade the quality of CT images. Metallic implants in CT images cause dark and bright streaking artefacts because of the high atomic number of metal. Low-energy X-ray photons passing through these objects are highly attenuated and this leads to loss of projection data.

There are different types of artefacts that may corrupt the x-ray image. Some artefacts are caused by the patient itself. For example, the motion artefact which occurs when the patient moves during the acquisition, and the metal artefact which results from having metallic dental fillings or implants. Another type of artefact results from an x-ray source that emits x-rays of multiple energies. This is called a beam hardening artefact.

The electroencephalogram (EEG) represents the electrical activity of the brain recorded by placing several electrodes on the scalp. While measuring the EEG, all of the signals are not contributed by the electrical activity of the brain. Many potential changes seen in the EEG may be from other sources. Artefacts are undesired signals that may introduce changes in the measurements and affect the signal of interest. Even if the ideal way of working with EEG signal is to avoid the occurrence of artefacts when recording the EEG signal is unfortunately often contaminated by various physiological factors other than cerebral activity, which are typically of non-interest. For instance, cardiac activity, ocular movements, eye blinks and muscular activity are among the most common types of artefacts.

Due to the sources of noise being very diverse and having different characteristics, most authors focus on removing single types of artefacts. The cancellation of noise and artefacts is an important issue in EEG signal processing and normally a prerequisite for the subsequent signal analysis to be more reliable. As a kind of physiological signals, the electroencephalogram (EEG) represents the electrical activity of the brain. Because of its higher time-varying sensitivity, EEG is susceptible to many artefacts, such as eye-movements, blinks, cardiac signals, muscle noise. These noises in recording EEG pose a major embarrassment for EEG interpretation and disposal. A number of methods have been proposed to overcome this problem, ranging from the rejection of various artefacts to the effect estimate of removing artefacts.

The medical image detection system consists of several phases. The first phase consists of capturing of the medical image by common capture devices like X-ray, MRI (Magnetic Resonance Imaging), CT (Computed Tomography), Mammographic Devices and Sonographer devices. In the next phase we need to convert the mode of medical image to gray scale image. Medical images from different devices show different intensities. We need to adjust the intensity to get a normalized intensity level. Some preprocessing steps are required to remove artefacts. Then we need to apply an edge-detection filter on the image. The next phase of the detection system is feature extraction. The objective of this process is to find the specification of the medical image and define the image morphology.

Process of identification of sharp discontinuities of an image is called edge of an image i.e., edges are significant local changes of intensity. Here discontinuities mean abrupt changes of pixel intensity of image in a scene. Thus intensity causes basically geometric events and non-geometric events; geometric events basically discontinuity in depth and/or colour and texture i.e., object boundary and discontinuity in surface and/or colour and texture i.e., surface boundary and non-geometric events basically direct reflection of light called specularity and inner reflection or shadows from other object or same object. In high level image vision, edge detection is used in the interpretation of 3D objects from 2D images obtained from an image occlusion in radiological imaging. The goal of edge detection is to produce a continuous line drawing of a scene from an image of that scene. Important features can be extracted from the edges of an image (e.g., corners, lines, curves) and these features are used by higher-level computer vision algorithms (e.g., recognition) for analysis.

Medical image analysis is critical in numerous biomedical applications such as detection of abnormalities, tissue measurement, surgical planning and simulation, and many more. In particular, image segmentation is an essential step, which partitions the medical image into different non-overlapping regions such that each region is nearly homogeneous and ideally corresponds to some anatomical structure or region of interest. It is the main tool in pattern recognition, object recognition, image restoration, image segmentation, and scene analysis. An edge detector is principally a high-pass filter that can be applied to extract the edge points in an image. Medical image are images of the human bodyor parts of the body intended for clinical purposes for revealing or diagnosis of disease in medical science.

There are different kinds of brain imaging techniques are available for investigating the disorders insider brain without invasive neuro- surgery. A snapshot of brain is obtained from those techniques which help the neuroscientists to locate the affected area of the brain with neurological disorder from the other parts.Most commonly used brain imaging techniques are discussed below [29-33].

Computed Tomography (CT): Computed Tomography or computerized axial tomography scan (CAT scan) which is also called CT scan uses x-ray for detecting variety of disease by producing the cross sections of the body. It produces multiple numbers of pictures of the body and cross sectional images have been reformatted in multiple planes, three dimensional images are also generated by it. More details can be obtained from CT images of internal organs, bones, soft tissue and blood vessels compared to traditional x-ray.

The advantages of CT images are (a) it is painless, noninvasive and accurate, (b) it is fast, simple; in emergency situation it helps to save life by detecting stroke area, internal injuries and bleeding, (c) exploratory surgery and surgical biopsy may be reduced due to the diagnosis which is determined by CT scanning. Delivery of high dose of radiation is the main drawback of CT scan.

Magnetic Resonance Imaging (MRI): Magnetic Resonance Imaging also known as Nuclear Magnetic Resonance (NMRI) or Magnetic Resonance Tomography (MRT) which is used in radiology for investigating the anatomy and physiology of the body in both health and disease. Magnetic fields, radio waves and field gradients are used in MRI scanner to form images of the body. It is highly versatile imaging technique which mostly used in diagnostic medicine and biomedical research due to of its better resolution than CT. In clinical practice MRI is used to distinguish the pathological tissue (brain tumor) from the normal tissue. The main advantage of MRI scan is that it is harmless to the patient as it does not use any ionizing radiation. Brain tumors, spinal infections, bone tumors, multiple sclerosis etc. can be diagnosis very well due to of its excellent contrast details. It is very expensive due to high cost of the equipment. In presence of foreign bodies and metallic implants like pacemaker, aneurysm clips etc MRI cannot be performed.

Functional Magnetic Resonance Imaging (fMRI): Functional Magnetic Resonance Imaging (fMRI) procedure using MRI technology and by measuring the brain activity changes in blood flow is detected by this technique. Blood flow occurs in response to neural activity. When the area of the brain is more active, blood flow to that region is increased. The primary form of fMRI uses the blood-oxygen- level-dependent (BOLD) contrast, it is used to produce the activation maps to show which parts of the brain are involved in a particular mental process. It is non-invasive and does not involve radiation. It is easy for experimental use and also has excellent spatial and temporal resolutions. The main disadvantage of this technique is it is very expensive.

Positron Emission Tomography (PET): Positron Emission Tomography (PET) is a nuclear medicine and functional imaging technique, metabolic process in the body has been observed by this technique. It is used in both medical and research field. It is mostly used in clinical oncology and for diagnosis of certain diffuse brain disease such as dementias. There are various advantages of PET which are: (a) PET is very powerful imaging technique for studying metabolic functions of patients and the study of these functions is able to establish PET imaging as an alternative of biopsy and other exploratory surgeries to determine how much a disease has spread, (b) it is more accurate and extremely useful medical tool which has the ability to distinguish between benign (non-cancerous) and malignant (cancerous) tumors.

Despite of various advantages of PET imaging, it contains some disadvantages that include: PET scan has risk caused by the radioactive component which has been used during this procedure and this kind of imaging is expensive also.

There are several types of imaging systems available for Brain analysis like Computed Tomography (CT) and Magnetic resonance imaging (MRI). MRI of the brain is a potent tool that has application both in research and in clinical diagnostic studies. CT scanners use harmful radiation on the subject to retrieve image whereas MRI does not use such harmful ionizing radiations, so they are the preferred choice of pathologists. The scanner hardware and MRI hardware are continuously improving and their advances have resulted in the detection of unexpected, asymptomatic brain abnormalities, such as brain tumors, aneurysms and subclinical vascular pathologic changes. MRI is used to detect brain tumors, strokes, multiple sclerosis, keep track of progression of disorders of head trauma, bleeding in the brain, tumors of the pituitary and can even identify masses that may be affecting the back of the eyes or ears. MRI images consisting of multiple slices each image containing image at a particular depth, provide detailed pictures of the brain and nerve tissues. A special type of MRI (called MRA, or magnetic resonance angiography) may be done to look at blood vessels within the brain.

Review Works

Magnetic resonance imaging (MRI), computed tomography (CT), digital mammography, and other imaging modalities provide an effective means for noninvasively mapping the anatomy of a subject. These technologies have greatly increased knowledge of normal and diseased anatomy for medical research and are a critical component in diagnosis and treatment planning. The properties of MR images have a strong influence on the usefulness of specific segmentation methods. Classical segmentation methods attempt to partition an image optimally into a number of regions that each satisfies some intensity uniformity constraint. In the ideal case, the resulting regions are meaningful and contain distinct sets of pixels. Medical CT image has been applied in clinical diagnosis widely. It can assist physicians to detect and locate pathological changes, and determine the property of them. But the diagnosis result is often subjective, different physicians may get different diagnosis result at different time [1]. Computer Aided Diagnosis (CAD) aims to provide a computer output as a second opinion in order to assist physicians in the detection of abnormalities, quantification of disease progress and differential diagnosis of lesions [2]. The typical architecture of a CAD system includes four main modules: image pre-processing, definition of region(s) of interest (ROI), extraction and se-lection of features and classification of the selected ROI [3]. Two fields closely related to segmentation that we discuss here are feature detection and motion estimation. The distinction we make between segmentation and feature detection is that feature detection is concerned with determining the presence of some image property while segmentation generally assumes that the property is already present and attempts to precisely localize areas that possess the property. For example, edge detection methods can find out the location of edges in an image but without further processing, do not necessarily extract any region of interest. Motion estimation methods often consist of applying segmentation algorithms to time sequences of images. Texture analysis is an important task in many computer applications of Computer image for classification, detection or segmentation of images based on local spatial patterns of intensity. Textures are replications, symmetries and combinations of various basic patterns, usually with some random variation. The major task in texture analysis is the texture segmentation of an image, that is, to partition the image space into a set of sub regions each of which is homogeneously textured. Automated MRI brain tumor segmentation provides useful information for medical diagnosis and surgical planning. However, it is a difficult task due to the large variance and complexity of tumor characteristics in images, such as sizes, shapes, locations and intensities. So in practice, segmentation of brain tumor continues to depend on manual tracing and delineating. Many image processing techniques have been proposed for MRI brain tumor segmentation. Feature extraction refers to various quantitative measurements of medical images typically used for decision making related to the pathology of a structure or tissue. When the features have been extracted, selection of a subset of the most robust features is essential, aiming at improving classification accuracy and reducing the overall complexity. Brain boundary detection as well as segmentation is a very important feature in image analysis. This process can improve clinical diagnosis of different types of brain diseases. The accurate segmentation of the brain region in MRI is an essential step in the computerized analysis of images. It allows the search for abnormalities to be limited to the region of the brain. It also facilitates enhancements for techniques such as comparative analysis, which includes the automated comparison of corresponding MRI. The brain boundary contains significant information relating to the symmetry and deformation between two halves of mage. Hence in this work, we have proposed step-by-step algorithms for segmentation, determine the edge of segmented region, extract the boundary and improve the boundary using boundary enhancement. One of the most difficulties in tumor excisions and tissue differentiation is the border and cells overlapping between normal and abnormal tissues in gray level of the medical images and that are the challenge of the surgeon orphysician to distinguish that. The difficulties are summarized by image gray level overlapping between two or more different parts in the same image. And that very clear when the image of MRI and CT scan were taken to a patient.MR imaging technique, because of good ability in showing difference between soft tissues, high resolution, good contrast and non-invasive technique forusing no ionization rays is very appropriate. Segmentation is the first step at quantitative analysis of medical images. Medical images analysis field [4, 5, 6], because of indirect and Sophisticate structures are very complicated but interesting. Segmentation methods are very successful on normal tissues [4, 7-12] but it has not been done good theoretical and practical segmentation on abnormal tissues yet [4]. Computer aided tumor detection is one of the hardest index infield of abnormal tissue segmentations.

There are two important problems. First, automatic tissue measurement is not very easy because of variations in the structures. Intensity distribution of normal tissues is very complicated and exist some overlaps between different types of tissues. Moreover it is probable to have some variations in the size, location and form of the brain tumor tissues and usually contains any dropsy. Other tissues that contain any dead, bloodshed or shrinkage, can be as abnormality and so abnormal tissues boundaries can be blurred. Second problem is the MR images have formed from high number of pixels (for example 256*256*128), so segmentation problem, has a high computational complexity and needs much memory. This problem can be solve by using 2Drepetitive methods or semi-automatic segmentation helping human knowledge, but will lose much information such as geometry and etc [4].MRI for patient with brain tumor; there is an overlapping between the boundaries of tumor in the cerebellum part and tissue surrounded; the surgeon must be very accurate and carful to remove that tumor without cause a damage for the surrounding tissue. If the surgeon has the accurate dimensions of the involved tissue he can do his job with more flexibility; there are a new medical instrument used to remove the tumor specially in the brain without opening a large area in the scalp depending on the image only, like Brain lab instrument (Navigator) [11], as well as Linear accelerator (LINAC) [12] these devices need well defined dimensions of abnormal tissue for extraction. There are many methods used inmany researches to differentiate biological tissue boundaries in the images like MateiMancas et al, they used a novel method called iterative watersheds is then used in order to segment the tumors for CT image of the neck [13] and then they used Fuzzy logic for tumor segmentation in another research [14]. Fuhui Long et al[15] they present a method based on 3Dwatershed algorithm of segmentation using both the intensity information of the image and the geometry information of the appropriately detected foreground mask of biological nuclei images. Regina Pohle etal [16] they developed a region growing algorithm that learns its homogeneity criterion automatically from characteristics of the region to be segmented for MRI and CT images. Rune PetterSørlie [17] used the water shed with snake method to study the speckle noise and edge detection of the liver tumor image. Kathleen Marty [18,37-38]used watershed algorithm for brain cortical surface meshes. The function used is curvature measures inherent in the geometry of the mesh with four different curvature measures are compared: mean, Gaussian, absolute, and root mean square.

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. Harvard medical dataset (available from January 2014) are also used. The data set of “Whole Brain Atlas” image data base [12] which consists of T1 weighted, T2weighted, proton density (PD) MRI image containing multiple image slice has been used. The RGB image has been converted to grayscale image using a weighted sum of the R, G, and B components

Proposed Process

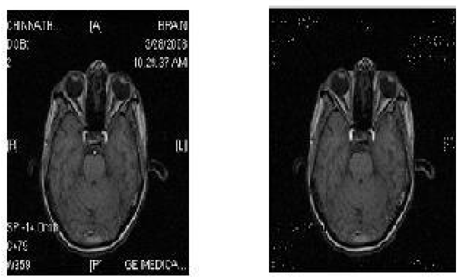
Abnormality of brain is one of the most common brain diseases, which includes brain tumor, hemorrhage, acute stroke, alzheimer's disease, multiple sclerosis, cerebral calcinosis and many more, so its diagnosis and treatment have a vital importance. In recent years, developments in medical imaging techniques 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 [8-10]. 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 abnormality detection 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.

Human brain is the most complex organ present in the human body. The functioning of the brain is complex and various research works are being carried out to completely interpret the functioning of the brain. The brain contains complex anatomical features and different abnormalities can arise at different regions involving specific tissue structures and organs. Brain tumor is serious brain illness that can originate in-situ or as a result of metastasis and can affect anybody at any phase in their lifetime. A tumor is defined as an abnormal growth of cells that forms a mass of tissue. A brain tumor is an intracranial solid neoplasm that is present within the brain or the central spinal canal. Its threat level depends on the combination of factors like the type of tumor, its location, its size and its state of development.

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 the following algorithm is used.

Artefact Removal

The MRI image consists of film artifact or labels on the MRI such as patient name, age and marks. Film artefact is removed using general pre-processing algorithm. Here, starting from the first row and the first column, the intensity value, greater than that of the threshold value is removed from MRI. The image is given to enhancement stage for the removing high intensity component and the above noise. This part is used to enhance the smoothness towards piecewise- homogeneous region and reduce the edge blurring effects. This proposed system describes the information of enhancement using weighted median filter for removing high frequency component. The following figure shows artefact removal from MRI image.



Before Preprocessing   After Preprocessing

Algorithm

Step1:- Converts input color images to grayscale which is done by eliminating the hue and saturation information while retaining the luminance and the image returns a grayscale color map.

Step2:- Filters the multidimensional array with the multidimensional filter. Each element of the output an integer or in array, then output elements that exceed the certain range of the integer type is shortened, and fractional values are rounded.

Step3:-Add step2 and step3 image get the resultant enhanced image.

Step4:- Computes a global threshold that can be used to convert an intensity image (step3) to a binary image with a normalized intensity value which lies in between range 0 and 1.

Step5:- Takes a grayscale or a binary image (from step3) as its input, and returns a binary image of the same size as binary image

Step6:- Removes from a binary image (step5) all connected components (objects) that have fewer than certain values pixels and producing another binary image. This are done by the determination of connected components, computation the area of each components, removal small objects then get the ultimate output image.

The advantage of smearing edge information is that it allows quick detection of features and their location within an image, thus enabling fast segmentation of the image. Image regions that lie nearby, but on opposite sides of a prominent edge are quickly distinguished. Grayscale conversion removes noise. It converts the true color pixels and producing another binary image. This are done by the determination of connected components, computation the area of each components, removal small objects then get the ultimate output image.

Edge Detection

Edge detection is a critical element in image processing, since edges contain a major function of image information. The function of edge detection is to identify the boundaries of homogeneous regions in an image based on properties such as intensity and texture. Many edge detection algorithms have been developed based on computation of the intensity gradient vector, which, in general, is sensitive to noise in the image. In order to suppress the noise, some spatial averaging may be combined with differentiation such as the Laplacian of Gaussian operator and the detection of zero crossing. Combining both spatial and intensity information in image MRI brain image segmentation approach based on multi-resolution edge detection, region selection, and intensity threshold methods were proposed. The automated edge detection technique is proposed to detect the edges of the regions of interest on the digital images automatically. The proposed technique consists of two algorithms, which are as follows:

In our experiment, 18 invasive brain tissues from different 18 patients and 8 noncancerous falsely detected breast tissues from 8 different normal patients are considered. Each of the 24-bit BMP Image size is 640 x 480 Pixels.

Algorithm

A.24-bit Color Image to 256-color Gray Image

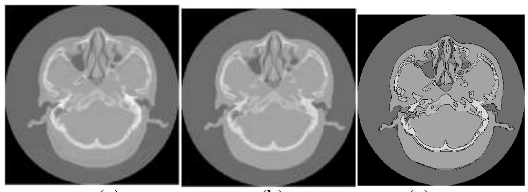
1. Take this 24-Bit BMP file as Input file and open the file in Binary Mode, (Size M x M).
2. Copy the ImageInfo (First 54 byte) of the Header from Input 24-Bit Bmp file to a newly created BMP file and edit this Header by changing file size, Bit Depth, Colors to confirm to 8-
   Bit BMP.
3. Copy the ColorTable from a sample gray scale Image to this newly created BMP at 54th Byte place on words.
4. Convert the RGB value to Gray Value using the following formula:
   - blueValue = (0.299*redValue + 0.587*greenValue + 0.114*blueValue);
   - greenValue = (0.299*redValue + 0.587*greenValue + 0.114*blueValue);
   - redValue = (0.299*redValue + 0.587*green Value + 0.114*blueValue);
   - grayValue = blue Value = green Value = redValue;
5. Write to new BMP file.

Now 24-bit BMP color image is taken as input. Then convert it to 256-color Gray Scale image by following this algorithm. This 256-color Gray Scale image is the output of the algorithm. In this algorithm, first read the red, blue and green value of each pixel and then after formulation, three different values are converted into gray value, stated in Step 4.256-color Gray Image to Bi-color (using Pixel Clustering on Threshold Value, T)

Algorithm for 24-bit BMP color image

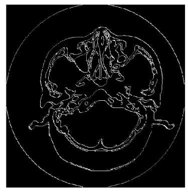
1. Open 256-color Image (Size M x M)
2. Read a Pixel value
3. 3If the Pixel Intensity value less than or equal to T (128) then make it 0 Else make it 255 and write into same Pixel Location
4. Go to Step 2 until end of file
5. Close file

This algorithm is actually used here to convert the Gray Image to Bi-color (Monochrome Image).This is the Edge Detection Algorithm set on a Threshold Value. Results are shown below.



(a) (b) (c)

(a) Original image of brain image
(b) Brain image (512x512) with noise
(c) Brain Image after Noise Removal



Brain Image after Edge Detection

Skull Removal

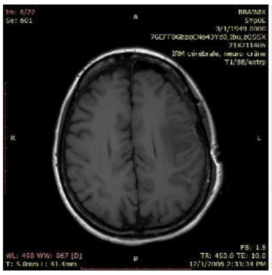
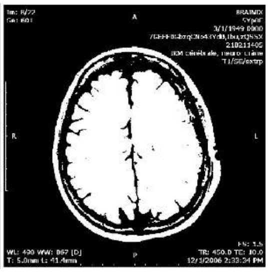
Skull extraction is very important because many diseases are associated to skull and also many diseases are not related to skull. Thus we want to extract skull for the diseases like solitary osteolytic skull defect, multiple osteolytic skull defect, focal increased skull thickness, and diffuse increased skull thickness. The skull defect has a characteristics beveled edge which could be seen in MRI. Langerhans cell granulomatosis arises from the dipole 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, extra-crebral masses, intracerebral massesmass lesion in region of the ventricular system, para-sellar masses etc. For those disease which need not have skull information we remove the skull to get higher accuracy.

Algorithm

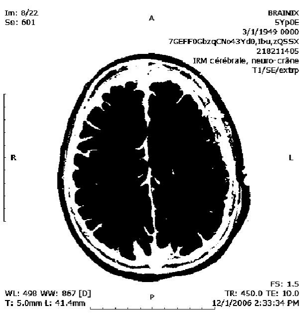
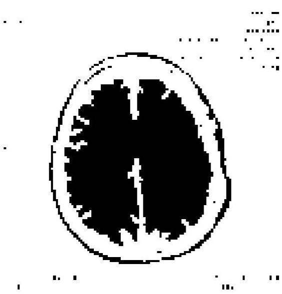
a. Binarize the image using the statistical standard deviation method.
b. The complement of binarized image is done.
c. Two dimensional wavelet decompositions is done using ‘db1’ wavelet up to level two.
d. Re-composition of the image is done using the approximate coefficient of previous step.
e. Interpolation method is used to resize the image of the previous step to the original size.
f. Re-complement of the image in the last step is done.

g. Labeling of the image is done using union find method.
h. The maximum area of all the connected components is found out which represents the brain.
i. All other components except the maximum component are removed from the image.
j. The image obtained contains only the brain as 1 pixel.
k. Convex hull is computed for these 1 pixel and the entire pixels inside the convex hull are set to 1 and outside it are set to zero.
l. The image of the previous step is multiplied to original image pixel wise and thus segmented brain is obtained.

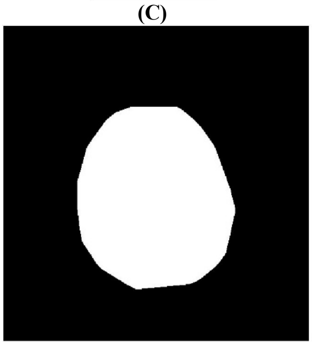
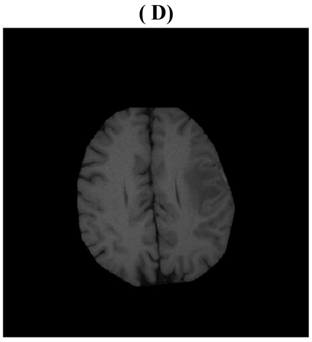
The following figures illustrates the result of the proposed algorithm.

(A) **(B)**

(C) **(D)**

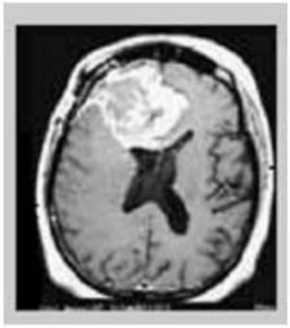



(E) **(F)**

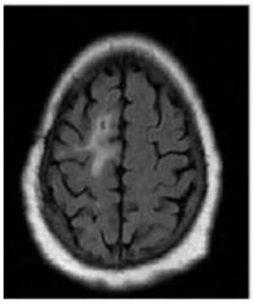
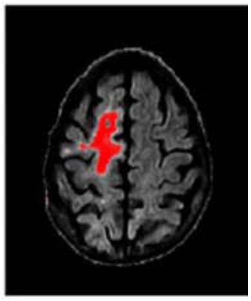
(A)is the original MRI image, (B)is the binarized image, (C) is the complemented binary image, (D) is the output after using wavelet decompositions , (E) is convex image and (F)is the final output image without any artefact and skull.

Segmentation

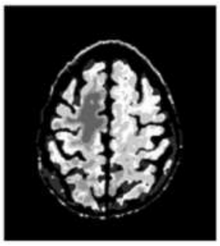
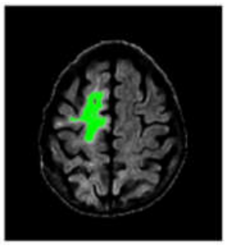
Segmentation divides image into its constituent regions or objects. Image segmentation techniques can be broadly classified as into five main classes threshold based, Cluster based, Edge based Region based, Water-shed based segmentation. Segmentation plays an important role in image analysis. The goal of segmentation is to isolate the regions of interest (ROI) depending on the problem and its characters. Many applications of image analysis need to obtain the regions of interest before the analysis can start. Therefore, the need of an efficient segmentation method has always been there. A gray level image consists of two main features, namely region and edge. Segmentation algorithms for gray images are generally based on two basic properties of image intensity values, discontinuity and similarity. In the first category, the approach is to partition an image based on abrupt changes in intensity, such as edges in an image. The principle approaches in the second category are based on partitioning image into regions that are similar according to a set of predefined criteria. Thresholding, region growing and region splitting and merging are examples of the methods in this category.



(a)

(b) **(c)**

(d) **(f)**

(g)

Figure 3(a) Input Image with Noise (b) Segmented Image (c)-(f) Isolated region of Interest
(g) Isolated Tumor

Algorithm

Input: MRI Gray Scale Image

Output: Isolation of Tumor

Step1:- Convert MRI scan image into grayscale image.
Step2:- Next the image passed through a high pass filter for removing noise and other spike in the image.

Step3:- Now filtered image is added to the grayscale image.
Step4:-Convert the enhanced image (image of step3) in to binary image with a threshold value
Step5:- Separate the tumor from segmented image by Watershed - Method
Step6:- Select only that part of the image from step4 which has the tumor with the part of the image having more intensity and more area.
Step7:-Obtained image from step6 are added to the original gray scale image from step1 and the resultant image is output.

In this process, the MRI image is treated as an array of pixel data. First step of the process is to determine the dimension of the image and determine the middle position of image array. We then take a maximum difference threshold (MDT) value, which is constant threshold determine by observation. We start checking this value with the image data by horizontally scanning from left of the array to the right. If result of any subtraction is greater than the MDT, the array will be divided into two equal subsets along middle position and the first and last positions of the two subsets will be pushed to stack. Otherwise, the mode value of subset will be propagated to all other position after modifying value using uniform colour quantization technique in colour space breaking in sixteen level scales. The process will be continued recursively, popping the start and end position subset array from the stack and repeat the aforesaid process. The process will be continued until the stack is empty. Outputs obtained from the process are shown in Figure 3 (a-g).

CONCLUSIONS

Our proposed intensity based segmentation method is being applied on MRI of brain data base and produce very good results visually as well as mathematically. It segments the abnormal regions with very low error rate (0.02602) and very high accuracy (almost 98 %) with proper segmentation and detection. Location of abnormal regions is detected very carefully with different distance calculation which very is very helpfully for diagnosis. For detecting brain abnormal regions segmentation we use several steps, binarization using standard produce very good results and removing of artefact with skull is very helpful for true segmentation i.e. it avoid false detection. Thus our overall segmentation procedure equally validated with reference image in order to detect and tracking the abnormal regions very efficiently and successfully.

References

1. Michael Barnathan, Jingjing Zhang, "ATexture-Based Methodology for Identifying Tissue Type in Magnetic Resonance Images", Proceedings of the IEEE International Symposium on Biomedical Imaging, pp(s) 464-467, 2008
2. Xiao Xuan, Qingmin Liao, "Statistical Structure Analysis in MRI Brain Tumor Segmentation", Proceedings Of fourth International Conference on Image and Graphics, pp (s)421-426, 2007
3. Devendram V, Hemalatha Thiagarajan, "Texture based Scene Categorization using Artificial Neural Networks and Support Vector Machines: A Comparative Study", ICGST-GVIP, ISSN 1687-398X, Volume(8), Issue (IV), December 2008
4. Bandyopadhyay G, Chattopadhyay S, "Single hidden layer Artificial Neural Network models versus multiple linear regression model in forecasting the timeseries of total ozone", *Intern. J. Environ.Sci. Technol*. 4(1): 141–149, 2007
5. Bilbro G, White M, Snyder W , "Image segmentation with neuro computers", In: R.Eckmiller and C.van der Malsburg (eds.),Neural Computers, NATO AS1 Series,(Springer-Verlag, Berlin, Germany) 41: 7l-79, 1987
6. Chattopadhyay G, Chattopadhyay S,"Autoregressive forecast of monthly totalozone concentration" A neurocomputing approach, Computers and Geosciences 35:1925–1932,2009
7. Chattopadhyay G, Chattopadhyay S, "Feed forward artificial neural network model to predict the average summer monsoon rainfall in India", Acta.Geophysica. 55(3): 369–438, 2007
8. Chunyan J, Xinhua Z, Wanjun H, Christoph M , "Segmentation and Quantification of Brain Tumor," IEEE International conference on Virtual Environment, Human-Computer interfaces and Measurement Systems", USA pp. 12-14, 2000
9. DeSieno D "Adding a conscience toc ompetitive learning", Proceeding of IEEE the Second International Conference on Neural networks (ICNN88) 1(20): 117-124.
10. Gendy, Kothapalli G, Bouzerdoum A, "A fast algorithm for image restoration using a recurrent neural network with bound-constrained quadratic optimization" in: Proceedings of the 7th Australian andNew Zealand Intelligent Systems Conference pp. 111–115,2001
11. HanShen, William S, Malcolm G,Annette S , "MRI Fuzzy Segmentation ofBrain Tissue Using Neighbourhood Attraction with Neural-Network Optimization" IEEE Transactions on Information Technology in Biomedicine9(3), 2005
12. www.brainlab.com
13. Fu KS, Mui JK , " A survey on image segmentation", Pattern ecognition 13: 3- 16, 1988
14. MateiMancas, Bernard Gosselin, "Towards an automatic tumor segmentation using iterative watersheds", Signal Processing & Circuit Theory Lab, Faculté Polytechnique de Mons BâtimentMultitel, ParcInitialis, avenue Copernic 1,7000, Mons, Belgium,2006
15. M. Mancas and B. Gosselin, "Fuzzy Tumor Segmentation based on Iterative Watersheds", Proc. STW Conf. of ProRISC, Veldhoven, Netherlands, 2003.
16. Fuhui Long, Hanchuan Peng, andEugene Myers "Automatic Segmentationof Nuclei in 3D Microscopy Images of C.Elegies", Janelia Farm Research Campus,Howard Hughes Medical Institute, Ashburn, Virginia, USA, 2007
17. ReginaPohle, Klaus D. Toennies,"Segmentation of medical images using adaptive region growing", Otto-von-Guericke University Magdeburg, Department of Simulation and Graphics, 2005
18. Rune PetterSørlie,"Automatic segmentation of liver tumors from MRIimages", Department of Physics Universityof Oslo, 31ST AUGUST 2005.
19. Kathleen Marty, "Segmentation of a Human Brain Cortical Surface Mesh Using Watersheds", CS766 Final Project,12/17/02, 2002

20. http://www.epa.gov/owow/watershed/whatis.html
21. Jos B.T.M. Roerdink and ArnoldMeijster.: "The watershed transform: Definitions, algorithms and parallelization strategies". Fundamental Informaticae 41,187–228, 2001
22. L. Najman et al, "Watershed algorithms and contrast preservation", Laboratories A2SI, Grouped ESIEE, Cit´eDescartes, BP99, 93162 Noisy-le-Grand Cedex France1999
23. Hua LI et al., "An improved image segmentation approach based on level set and mathematical morphology", GREYCISMRA,CNRS 6072, 6 BdMaréchalJuin,14050 Caen, France, 2002
24. Mahua Bhattacharya, Arpita Das," A Study on Seeded Region Based Improved Watershed Transformation for Brain Tumor segmentation ", Indian Institute of Information Technology & Management, Gwalior Morena Link Road, Gwalior-474010, 2005
25. M. P. Gupta and M. M. Shringirishi, "Implementation of brain tumor segmentation in brain mr images using k-means clustering and fuzzy c-means algorithm", *International Journal of Computers & Technology*, vol. 5, no. 1, 2013, pp. 54-59.
26. [26] Charles R. Noback, Norman L. Strominger, Robert J. Demarest and David A. Ruggiero, "The Human Nervous System: Structure and Function", 6th edition, 2005, Humana Press.
27. R. Damadian, "Tumor Detection by Nuclear Magnetic Resonance", Science, New Series, vol. 171, Mar.1971, pp.1151–1153.
28. V. Singh, "Textbook of Anatomy Head, Neck and Brain", vol.3, 2nd edition, 2014, Elsevier
29. D.Clark, N.Boutros and M. Mendez, "The Brain and Behavior An Introduction to Behavioral Neuroanatomy" 2nd edition, 2005, Cambridge University Press .
30. R.A. Novelline and L.F. Squire, "Squire's Fundamentals of Radiology", 2004 Harvard Univ Press, ISBN 0674012798
31. http://www.med.harvard.edu/AANLiB/cases/,(available at: July, 2013)
32. Cheng, D., Cheng, K.: "Multiresolution based fuzzy c-means clustering for brain hemorrhage analysis", Proceedings of the 2nd International Conference on Bio-electro magnetism, pp. 35–36. IEEE (1998)
33. 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)
34. 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)
35. Sudipta Roy and Prof. Samir K. Bandyopadhyay "Contour Detection of Human Knee", IJCSET, September 201, Vol 1, Issue 8, pp. 484-487.
36. T. Logeswari and M. Karnan, "An improved implementation of brain tumor detection using segmentation based on soft computing" Journal of Cancer Research and Experimental Oncology Vol. 2(1) pp. 006-014, March, 2010.
37. Prof. Samir K. Bandyopadhyay and Sudipta Roy "Detection of Sharp Contour of the element of the WBC and Segmentation of two leading elements like Nucleus and Cytoplasm", International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 1,Jan-Feb 2012, pp.545-551.
38. Varghese, T., R. S. Kumari. Discrimination between Alzheimer Disease, Mild Cognitive Impairment and Normal Aging Using ANN Based MR Brain Image Segmentation. Proceedings of the International Conference on Frontiers of Intelligent Computing: Theory and Applications (FICTA) 2014, Springer.