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A Method for Enhanced Brain New Abrasion Segmentation

[1]Veeresh Basavaraj Hatti
M.Tech Studeet, Department of Electronics and Communication Digital Systems and Computer Electronics, Chiranjeevi Reddy Institute of Technology Anantpur, Andhrapradesh, India
[2]Mr. B. Mohan Reddy
Assistant Professor, Department of Electronics and Communication Digital Systems and Computer Electronics, Chiranjeevi Reddy Institute of Technology Anantpur, Andhrapradesh, India

ABSTRACT

Brain tumor is these days increased major disease among children and adults. A tumor is a mass of tissue which rises out of control of the normal forced that controls growth. If there is more number of tumors in the human brain they are identified as abrasions. Brain Abrasion is a damaged part of Brain where damage may take place due to injury or disease. Though it occurs in rare cases, it is a life threatening disease. Here MRI image processing has been employed for identifying the brain abrasions automatically. Procedure of separating the doubtful part from the background MRI images is known as segmentation. The extremely complex is in pointing and detecting the abrasions. On finding the intensity point distinction between healthy tissue and tumor, abrasion part can be detected. The main plan of this effort is to design an automated tool for the detection of brain abrasions. We proceed based on the concept of identifying the brain part in which abrasion in present by fragmentation and then apply Ostu Thresholding segmentation technique to detect abrasion location automatically and finding its length and area. We print the range where brain abrasions are present and find the details of all such parts.

Keywords: Matlab; Image Segmentation; Thersholding

1 INTRODUCTION

The body is made up of several types of cells. Each type of cell has extraordinary functions. The cells in the body develop and then separate in the arranged way to figure new cells as they are required to maintain the body strong and working correctly. When cells mislay the ability to manage their escalation, they carve up too often and without any order. The additional cells which shape a mass of tissue is called a Tumor. Tumors can be nasty or gentle.
The brain is a yielding, fragile, non-replaceable and soft mass of tissue. Brain tumor is a cluster of irregular cells that grows within of the brain. Tumors can directly demolish all the fine brain cells. It can also indirectly harm strong cells by crowding other parts of the brain and causes swelling, brain inflammation and stress within the skull. Over the last 20 years, the overall incidence of cancer, including brain cancer, has amplified by more than 10%, as reported in the National Cancer Institute statistics (NCIS). Thus there is a very important need for the identification of brain tumor which is helpful in suitable medical treatment.
The major plan of this effort is to propose an automated tool for numerous brain abrasion discoveries using MRI image. Magnetic Resonance Imaging (MRI) is the state of the skill medical imaging technology which allows cross sectional view of the body with unparalleled tissue contrast. MRI plays an vital role in assessing pathological situation like ankle, foot and brain. It has quickly evolved into an usual modality for medical imaging of infection processes in the musculoskeletal structure, especially the foot and brain due to the use of non-ionizing energy.
MRI provides digital illustration of tissue feature that can be obtained in any tissue plane. The images formed by an MRI scanner are described as slices through the brain. MRI has the added benefit of being able to generate

images which slice through the brain in both horizontal and vertical planes. The whole method when accomplished visualizing the inside of the human body, it makes surgeons capable to carry out operations within the brain without using open surgery. Especially the aim for this effort is to segment a tumor in a brain. This will make the surgeon capable to observe the tumor and then ease the treatment. The instruments required for this could be ultrasound, Computer Tomography (CT Scan) and Magnetic Resonance Imaging (MRI). In this project, the method used is Magnetic Resonance Imaging (MRI). The segmentation of brain tumors in MRI images is a challenging and tricky task because of the variety of their feasible shapes, position, image intensities.The outcome of image segmentation is a set of segments that together cover the complete image, or a set of contours extracted from the image. Every pixel in an area is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Neighboring regions are appreciably dissimilar with respect to the similar characteristic(s). As applied to a stack of images, typical in medical imaging, the resultant contours following image segmentation can be used to generate 3D reconstructions with the aid of interpolation algorithms like marching cubes.

1.1: Medical Image processing

In computer vision, **image segmentation** is the method of partitioning a digital image into many segments (sets of pixels, also identified as super pixels). The aim of segmentation is to simplify and/or alter the representation of an image into something that is added meaningful with easier to examine. Image segmentation is in general used to place objects and boundaries (lines, curves, etc.) in images. More accurately, image segmentation is the method of conveying a label to every pixel in an image such that pixels with the similar label share certain visual characteristics.

The outcome of image segmentation is a set of segments that together cover the whole image, or a set of contours extracted from the image. Each of the pixels in an area is similar with respect to some feature or computed property, such as color, intensity, or texture. Adjacent regions are considerably different with respect to the similar characteristic(s). As applied to a stack of images, typical in medical imaging, the resultant contours after image segmentation is used to produce 3D reconstructions with the help of interpolation algorithms like marching cubes.

In medical image processing brain tumor recognition is one of the challenging tasks, because brain images are complex and tumors can be analyzed only by skilled physicians. Hence In this document brain tumor is detected at different methods. Segmentation is made by means of histogram clustering, Global thresholding and watershed segmentation. In this process, the histogram can be calculated and the threshold value is obtained and set. This effort is carried by means of MRI image.

1.2 BRAIN TUMOUR

Brain cancer can be counted between the most deadly and intractable diseases. Tumors can be embedded in area of the brain that are dangerous to orchestrating the body's critical functions, whereas they shed cells to attack other parts of the brain, forming additional tumors too small to identify using conventional imaging techniques. Brain cancer's position and capacity to spread quickly makes treatment with surgery or radiation such as fighting an opponent hiding out among minefields and caves. A brain cancer is a syndrome in which cells raise uncontrollably within the brain. Brain tumors are of two main types

(i) Benign tumors
(ii) Malignant tumors

Benign tumors are unable to broaden beyond the brain itself. Benign tumors in the brain typically do not require to be treated and its development is self-limited. Sometimes they cause problems since their location and surgery or radiation may be helpful. Malignant tumors are usually called brain cancer. These tumors can broaden outside of the brain. Malignant tumors of the brain are most dangerous that may

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stay untreated and a forceful approach is nearly always warranted. Detection of Brain tumor is a severe matter in medical science. Brain tumor is one of the major causes for the raise in mortality amid children and adults.

The dataset comes from a study of 5 human brain tumor types and contains 90 samples. Every sample has 5920 genes:

a. **Medulloblastoma:** Medulloblastoma is a extremely malignant principal brain tumor which originates within the cerebellum or posterior fossa.
   Before, medulloblastomas were through to represent a subset of primitive neuroectodermal tumor (PNET) of the posterior fossa. On the other hand, gene expression profiling conveys that medulloblastomas have different molecular profile and is different from other PNET tumors.

b. **Malignant glioma:** A glioma is a kind of malignant brain tumor. A malignant tumor is a mass of irregular cells that is cancerous.
   i. **Astrocytoma's** are named for the cells where they start off, the astrocytes. These tumors can explain clear borders between normal brain tissue and the tumor (called focal) or no clear border (called diffuse). Focal astrocytomas are mainly common in children and are not frequently found in adults.
   ii. **Ependymomas** begin in cells called ependymal cells that are found lining certain areas of the brain and spinal cord. These cells assist repair damaged nerve tissue. They typically occur in children and young adults.
   iii. **Oligodendrogliomas** shape in oligodendrocyte cells, which make a fatty substance called myelin that protects the nerve. In addition common in adults, these tumors may move to other parts of the brain and spinal cord.

c. **AT/RT (atypical teratoid/rhabdoidtumours):**
   Atypical teratoidrhabdoid tumor (AT/RT) is a uncommon tumor generally diagnosed in babyhood. Though typically a brain tumor, AT/RT can happen wherever in the central nervous system (CNS) as well as the spinal cord. About 60% is in the posterior ranial fossa (mainly the cerebellum). One appraisal estimated 52% posterior fossa, 39% sPNET (supratentorial primitive neuroectodermal tumors), 5% pineal, 2% spinal, and 2% multi-focal.[1]

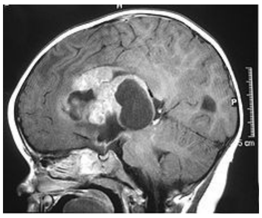
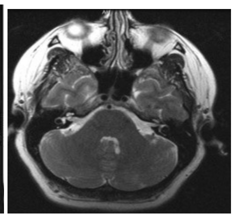

Figure 1: MRI of AT/RT Figure 2: The cerebellum with surrounding skull and spinal fluid occupies the bottom 1/3 of this axis MRI image

a. PNET (primitive neuroectodermaltumors)

PNET (pronounced pee-net) stands for a collection of tumors identified as Primitive Neuro Ectodermal Tumors. PNETS build up from cells which are left over from the initial stages of a body's growth in the womb. Usually these cells are safe. But infrequently they turn into a cancer. These cancers are further common in children than adults.

Doctors utilize the word PNET to categorize the tumor. They are classified into two major groups:

a. PNETs of the brain and central nervous system

b. Peripheral PNET (outside the brain and nervous system)

PNETs of the brain or spinal cord

Primitive neuroectodermal tumors that arise in the brain and spinal cord (the central nervous system or CNS) comprise

• Medulloblastoma (develops in the

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back part of the brain – the hindbrain)
- Pineoblastoma (develops in the pineal region of the brain)
- Non pineal supratententorial

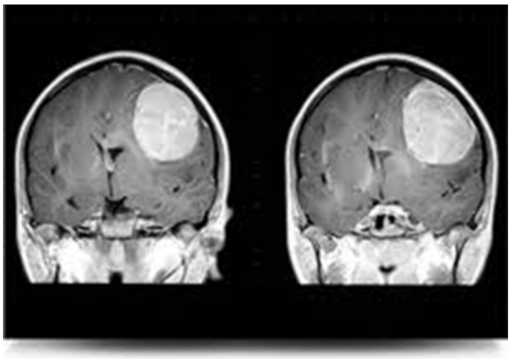
What are Brain Tumors?

Tumors are clumps of cells which rise abnormally from usual tissue. Some tumors in the brain are noncancerous, or kind. Others may be cancerous. They may initiate in the brain, or they may widen from somewhere else in the body (metastatic). They may raise quickly or they may remain steady.

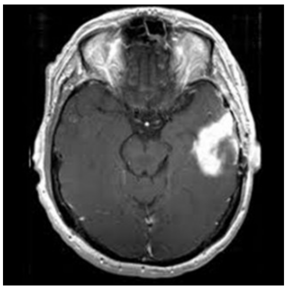
PRIMARY BRAIN TUMORS

Primary tumors begin in the brain, whereas secondary tumors widen to the brain from another site such as the breast or lung. (In this description, the term "brain tumor" will refer mainly to primary malignant tumors, unless otherwise specified.)

Benign Brain Tumors: Benign tumors stand for half of all primary brain tumors. Their cells appear comparatively usual, rise gradually, and do not spread (metastasize) to other sites in the body or attack brain tissue. Benign tumors can still be severe and even life-threatening if they are in critical areas in the brain where they put forth pressure on sensitive nerve tissue or if they boost pressure within the brain. While some benign brain tumors pretense a health risk, plus risk of disability and death, the majority are typically successfully treated with techniques such as surgery.



Malignant Brain Tumors: A primary malignant brain tumor is one that originates in the brain itself. Though primary brain tumors frequently get rid of cancerous cells to other sites in the middle nervous system (the brain or spine), they hardly ever spread to further parts of the body.



Brain tumors are usually named and classified according to each of the following:

- The type of brain cells from which they start off
- The location where the cancer develops

SECONDARY (METASTATIC) MALIGNANT BRAIN TUMORS:

A secondary (metastatic) brain tumor originates when cancer cells spread to the brain from a primary cancer in a different part of the body. Secondary tumors are concerning three times more general than primary tumors of the brain. Usually, multiple tumors grow. Solitary metastasized brain cancers may arise but are less common. Most frequently, cancers which spread to the brain to cause secondary brain tumors initiate in the lung, breast, kidney, or from melanomas in the skin.

All metastatic brain tumors are malignant.

Diagnosis

A neurological test is typically the first experiment given when a patient complains of symptoms which imply a brain tumor. The exam comprises inspecting eye movements, hearing, feeling, muscle movement, sense of odor, and steadiness and coordination. The doctors also test mental state and memory.

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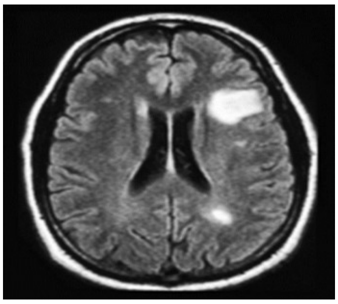
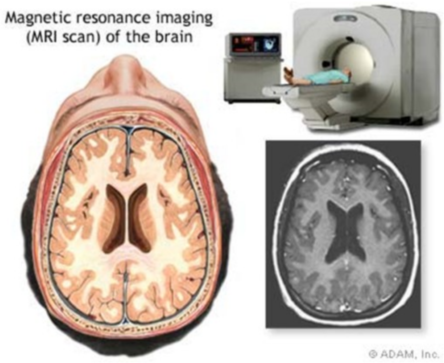


1.4 IMAGING TECHNIQUES

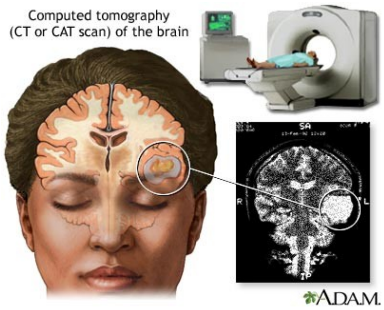
Highly developed imaging methods have significantly enhanced the diagnosis of brain tumors.

An MRI (magnetic resonance imaging) of the brain creates a thorough image of the compound structures in the brain. An MRI creates a three-dimensional picture of the brain, which permits doctors to more accurately place problems such as tumors or aneurysms

Magnetic Resonance Imaging. Magnetic resonance imaging (MRI) is the standard key step for diagnosing a brain tumor. It offers pictures from a variety of angles which can aid doctors to build a three-dimensional image of the tumor. It yields a clear image of tumors near bones, smaller tumors, brain stem tumors, and low-grade tumors. MRI is as well helpful in surgery to prove tumor bulk, for precisely mapping the brain, and for identifying response to therapy.



***Computed Tomography**. Computed tomography (CT) employs a complicated X-ray device and a computer to generate a detailed photo of the body's tissues and structures. It is not as responsive as an MRI in identifying small tumors, brain stem tumors, and low-grade tumors.



Design

The idea behind the current work is based primarily on three points: (i) the balanced arrangement of the brain, (ii) pixel intensity of image and (ii) binary image conversion. It is a well recognized reality that human brain is symmetrical about its central axis and throughout this work it is assumed that the tumor is either on the left or on the right side of the brain. MRI image of the human brain is separated into sub section such that white matter, gray matter, blood cells and cerebrospinal fluid are easily detected. Tumor is known as the group of blood cells at several exact points. The image of a brain in MRI is denoted through pixel intensity. In gray scale images the intensity lies between 0-255 with 0 representing for black and 255 is implied for the white color. The blood cells (RED color in RGB) are denoted by white color and 255 pixel intensity. All the gray matter has pixel intensity less than 255. The proposed work is classified into three parts

(i) First part of the current work addresses the difficulty of detecting the location of the tumor, i.e., whether the tumor is situated on the left or right side of the brain. This is accomplished with the information based on which part of the brain includes maximum number of the pixels having it.

(ii) Second part is to take out the tumor through intensity about 255. Segmentation by means of histogram thresholding.

Based on the above idea, an algorithm is developed that has been implemented by making use of MATLAB.

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IMAGE SEGMENTATION

Image segmentation is the procedure of dividing a digital image into multiple segments (sets of pixels, also identified as super pixels). The objective of segmentation is to make simpler and/or change the representation of an image into something which is added significant and easier to examine. Image segmentation is in general used to situate objects and boundaries (lines, curves, etc.) in images. More accurately, image segmentation is the method of conveying a label to each pixel in an image so that pixels with the same label distribute certain visual characteristics.

The outcome of image segmentation is a set of segments that together cover the entire image, or a group of contours extracted from the image (see edge detection). Every pixel in an area is same with respect to several characteristic or computed property, such as color, intensity, or texture. Neighboring regions are considerably dissimilar with respect to the similar characteristic(s). As applied to a stack of images, usual in medical imaging, the resultant contours after image segmentation is used to produce 3D reconstructions with the aid of interpolation algorithms

TYPES OF SEGMENTATION

Thresholding

The simplest way of image segmentation is known as the Thresholding method. This technique is based on a threshold value to turn a gray-scale image into a binary image. The key of this method is to choose the threshold value (or values as multiple-levels are selected). Some popular techniques are used in industry comprising the utmost entropy technique, Otsu's technique (maximum variance), and k-means clustering.

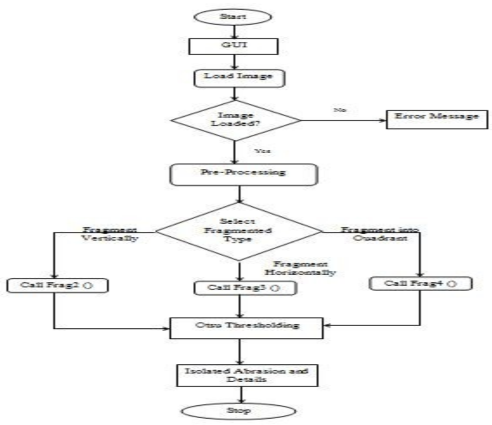
Recently, methods have been invented for thresholding Computed Tomography (CT) images.

Histogram-based techniques

Histogram-based techniques are extremely proficient as compared to other image segmentation techniques since they normally need only one pass through the pixels. In this method, a histogram is calculated from all of the pixels in the image, and the peaks and valleys in the histogram can be used to place the clusters in the image. Color or intensity can be used as the measure.

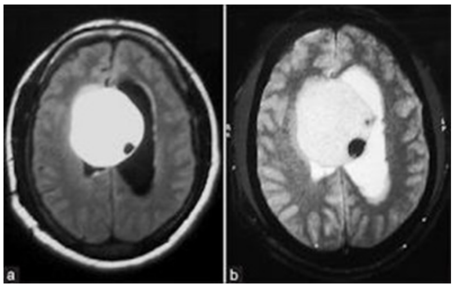
A refinement of this method is to recursively apply the histogram-seeking method to clusters in the image in order to separate them into smaller clusters. This is recurred with smaller and smaller clusters till no more clusters are produced.

One limitation of the histogram-seeking scheme is that it may be hard to recognize important peaks and valleys in the image.



CURRENT SYSTEM

With Single Tumor In A Human Brain Current system utilizes a classifier method to identify brain tumor in an MRI image. This method recognizes only a single brain tumor. It finds the area of the tumor and displays its intensity.



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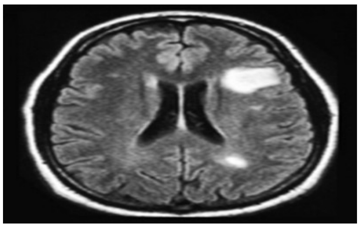
PROPOSED SYSTEM

We propose a new system that efficiently recognizes multiple brain abrasions in a single image.

It improves the functionality of the earlier system that lacked this property.

We make use of a segmentation idea to achieve this.

The system provides the count of abrasions and area of every abrasion.



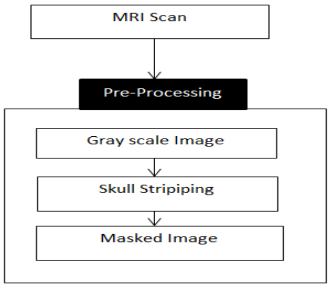
DETAILED DESIGN

The key factor of the functional specification is nothing but a detailed design. For the detailed design, user uses real world technology constraints for the conceptual model which include implementation and performance considerations. The detailed design should contain interfaces for the existing systems and provisions to achieve projected further needs.

Input Module:

The primary and the essential module is Input module. The MRI scan of the brain can be loaded into the software as the input. MRI scanner is suitable for imaging soft tissue. An MRI is non-invasive, doesn't make use of radiation and gives excellent visualization of the spinal ligaments, a herniated disk, bone infection of the spine or disc, a tumor, and spinal cord compression or damage. MRI provides much better distinction among the different soft tissues of the body than computed tomography (CT) does, making it particularly useful in neurological (Brain), Musculo-skeletal, Cardio-Vascular and Oncological (cancer) imaging. Unlike CT, MRI makes use of no ionizing radiation. Rather, it makes use of a powerful magnetic field to line up the nuclear magnetization of (typically) hydrogen atoms in water in the body. Radio frequency (RF) fields can be used to methodically change the alignment of this magnetization. This causes the nuclei to generate a rotating magnetic field noticeable by the scanner. This signal is manipulated through additional magnetic fields for building up sufficient information to build an image of the body.

Preprocessing Module:



Block diagram of pre-processing module

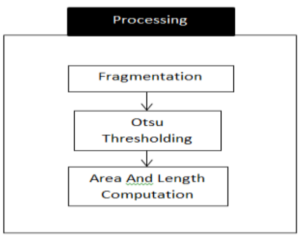
This consists of three major steps:

- Creating a gray scale image.
- Strip the skull region
- Mask the image.

The first step is to convert an MRI input image to a gray scale image which is essential as it eliminates some color information in the image to make it easier to recognize the objects. The RGB2GRAY converts the color picture into gray scale image and stores it into the matrix.

In second step, we use the freehand tool for highlighting the brain section in the MRI. Masking can be done to split the skull region from the gray matter of the brain. The user has to do it by hand since the brain size and sizes differs from one subject to another.

PROCESSING MODULE



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The preprocessed module is then passed to this module to carry out the processing of the image. This module includes fragmentation of image and the Otsu Thresholding of the image through the help of morphological operators. The image segmentation plays a significant role in image analysis and computer vision system.

OTSU THRESHOLDING:

In computer vision and image processing, **Otsu's method** is utilized to automatically carry out clustering-based image thresholding, [16] or, the reduction of a gray level image to a binary image. The algorithm imagines that the image to be threshold includes two classes of pixels or bi-modal histogram (e.g. Foreground and background) then computes the optimum threshold separating those two classes hence their joint spread (intra-class variance) is minimal. [17] The extension of the original technique to multi-level thresholding is called as the Multi Otsu method. [18] Otsu's technique is named after Nobuyuki Otsu

METHOD

In Otsu's method we thoroughly look for the threshold which decreases the intra-class variance (the variance within the class), called as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = \omega_1(t)\sigma_1^2(t) + \omega_2(t)\sigma_2^2(t)$$

Weights ω_i are the probabilities of the two classes separated by a threshold t and σ_i^2 variances of these classes.

Otsu represents that minimizing the intra-class variance is the same as maximizing inter-class variance:[2]

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = \omega_1(t)\omega_2(t)\left[\mu_1(t) - \mu_2(t)\right]^2$$

This is expressed in terms of class probabilities ω_i and class means μ_i.

The class probability $\omega_1(t)$ is calculated from the histogram as t:

$$\omega_1(t) = \Sigma_0^t p(i)$$

While the class mean $\mu_1(t)$ is:

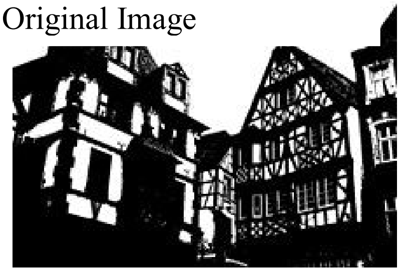
$$\mu_1(t) = \left[\Sigma_0^t p(i)\, x(i)\right] / \omega_1$$

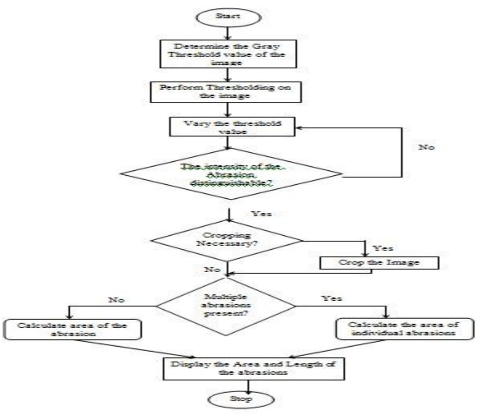
Here $x(i)$ is the value at the center of the i^{th} histogram bin. Likewise, you can calculate $\omega_2(t)$ and μ_t on the right-hand side of the histogram for bins greater than t.

The class probabilities and class means are computed iteratively. This thought gives an efficient algorithm.

The following figures illustrates the working of the Otsu Thresholding

Original Image





TESTING

Test techniques contain the process of executing a program or application with the intension of finding software bugs. It can also be defined as the process of validating and verifying that a software program, application/product meets the business and technical requirements which guided its design and development, so that it works as estimated and can be implemented with identical characteristics.

Software testing depending on the testing technique employed, can be implemented at any time in the development process. However the most test attempt is employed after the requirements.

Software Testing Procedure

Software testing is a serious element of software quality assurance and represents the ultimate process to make sure the accuracy of the product. The quality product constantly boosts the customer confidence in using the product thereby enhances the business economics. In other words, good quality product means zero defects which are derived from superior quality process in testing.

“Testing is an action in which a system or component is executed against the precise requirements, the results are observed and recorded and an evaluation is made of similar aspect of the system or component”.

Unit Testing

Unit testing is nothing but the smallest unit of the software design, the software component or module. This consists of testing all individual components to guarantee that they function properly. Unit testing is necessary for verification of the code procedural during the coding phase and hence the objective is to test the internal logic of the modules.

Unit testing of “**Brain Abrasion Detection**” that was carried out is listed below

The first module is the input through which the MRI image of brain was taken from the user.

The second module is Pre-processing where the skull part of the brain was removed and the enhanced image was obtained.

The third module involves fragmenting the MRI image into quadrants and applying Otsu thresh holding to get the threshold value and the area of each of the abrasion present in the brain.

Integration Testing

Integration testing is a methodical technique to build a program structure while conducting tests to uncover errors associated with interfacing. The purpose is to acquire unit tested modules and construct a program structure which has been designed. Here many tested modules are united into sub-systems which are then tested. The aim is to observe if module can be integrated appropriately, the emphasis being on testing interfaces between modules. There are two approaches for testing.

Black-box or Functional Testing

Black box testing alludes to test that are carried out at the software interface. Even though they are designed to uncover errors, Black box tests are utilized to show that software functions are operational, that input is appropriately accepted and output is properly produced. A black box test inspects several basic aspect of a system with little regard for the internal logical structure of the software.

The set of possible test cases for input, preprocessing and processing modules is illustrated here.

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Test Cases	Expected Results	Actual Results	Result
Input Image	Loaded image visible to user	Image loaded successfully	Pass
Image Not Loaded	Image not visible	Error message appears	Pass
Image in .gif format	Image not visible	Error message appears	Pass
Pre-Processed image	Processed image on screen	Pre-Processed image appears on the screen	Pass
Fragmented image	Fragmented regions of image appear on the screen	Image fragmented as quadrants according to user choice	Pass
Segmenting Image	Segmented image on screen	Displays segmented image on the screen	Pass
Size of Abrasion	Area and length of each abrasion	Area and length of abrasion found	Pass

White-box or structural testing

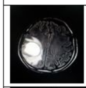
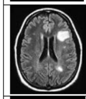
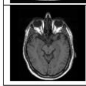
White box testing of software is expected on close inspection of the code. Logical paths through the software are tested by offering test cases which consists of particular sets of condition.

The "Status of the Program" can be observed at a variety of points to find out if the estimated or asserted status corresponds to the actual status. Here test cases are determined completely on the business logic of the program/module under testing. The external specifications are not considered.

The different test cases designed so as to check the structure of framework is presented below

Test Cases	Expected results	Actual results	Result
Pre-processing	Skull stripping	Skull stripped successfully	Pass
Passing .jpeg image	Image displayed for preprocessing	Error in command line	Fail
Passing the preprocessed image for fragmentation	Image fragmented into quadrants	Image fragmented as quadrants successful	Pass
Passing the image for Otsu method of segmentation	Image segmented	Image segmented successfully identifying the abrasion	Pass
Passing large matrix for preprocessing	Optimized in 2-3 minutes	Optimized in 2-3 minutes	Pass

Statistical Analysis

MRI Image	Fragmentation Style	Threshold value	Abrasions	Areas (cm^2)	Actual Areas (cm^2)	Difference (cm^2)
	Vertical Fragmentation	0.984	1	(i)22.3	(i)22.5	0.2
	Quadrants Fragmentation	0.795	2	(i)0.0566 (ii)0.0085	(i)0.071 (ii)0.0082	(i)0.02 (ii)0.0003
	Horizontal Fragmentation	No abrasions	0	-	-	-

System Testing

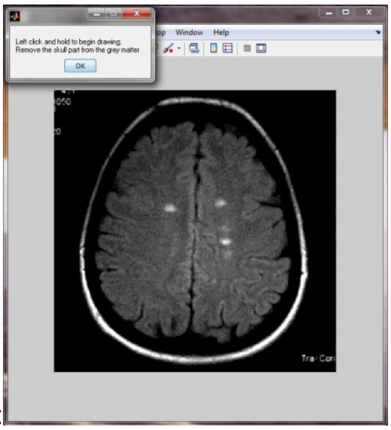
The subsystems are incorporated to make up the complete system. The testing procedure is in fact a series of a series of different test cases whose primary purpose is to completely exercise the computer-based system and the estimated output is given. It is concerned with validating which the system meets its functional and non-functional requirements.

The different test cases along with their output as achieved when Brain Abrasion detection was tested in out computer

Module Name: Input

Test Case: Input image

Output:

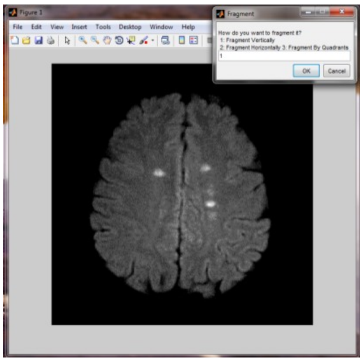


:

Module name: Pre-processing

Test Case: Skull stripping

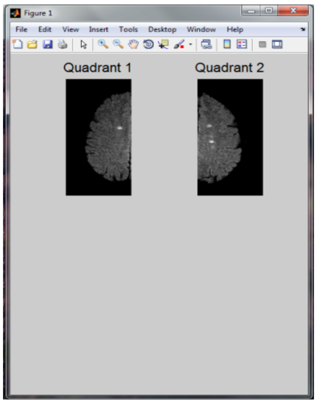
Output:



Module name: Fragmentation

Test Case: The stripped image is passed for fragmenting into quadrants.

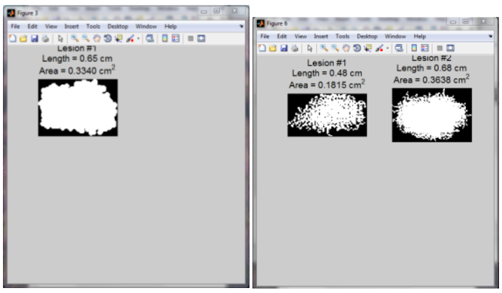
Output:



Module Name: Segmentation

Test Case: The abrasion is isolated and area and length of the abrasion is obtained.

Output:



Acceptance Testing:

To verify that, the software is ready and the end-users can carry out those functions and tasks for which the software was constructed can be used.

The results of these tests offer assurance to the End-user as to how the system will perform.

CONCLUSION AND FUTURE ENHANCEMENTS

The segmentation of MR images is an essential trouble in medical imaging. Even though much effort has been put on finding a good solution to the MRI segmentation problem, this project provides an implementation of a computational method to solve the trouble. This project explains and validates a semi-automatic procedure for brain abrasions identification and extraction based on the idea of distinguishing intensity levels.

In this project a latest approach for segmentation of the brain tissues in MR images is presented. The results illustrate that this technique can successively segment a brain abrasion provided the user provides the parameters for fragmentation and Thresholding correctly. The visualization and detective valuations of the outcome of segmentation demonstrate the victory of the approaches. In this study, the abrasions identification and the investigation are done for the potential use of MRI data for improving the abrasion extraction and analyzing the abrasion shape and 2D visualization of the surgical planning.

Future Enhancements

Future research in MRI segmentation should attempt toward improving the correctness, accuracy, and calculation speed of the segmentation algorithms, while reducing the amount of manual interactions required. This is mainly significant as MR imaging is becoming a routine diagnostic process in clinical practice.

Future work will focus on using different approaches that more powerfully extracts the tumor from the MR images.

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