Software Requirement Specification Document

Omar khaled
Sherouk Amr
Ahmed Abdelsalam

Supervisor: Dr.Ashraf
Eng.Targgie Mohie

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1 Introduction

Brain tumor is collected of abnormal cells. Normally tumors are identified by CT and MRI. So conversion of 2D images to 3D images are taken place which has many issues like sharpen edges, color ambiguity, large displacement and zoom in zoom out which results in less accuracy of the image. Nowadays, 3D images gives effective results for identifying brain tumors, for this purpose we need to reconstruct 3D images from 2D images, which is a tedious process.

3D modeling have been involved in many applications such as:

(1) According to IEEE, 3D technology had been involved in modeling design graphics of environment art design teaching.

Yanan Zahang "The Application of Smart 3D Modeling for Design Graphics of Environment Art Design Teaching" in Measuring Technology and Mechatronics Automation (ICMTMA), IEEE, 2016,pp 1-6.

(2) Accuracy verification and enhancement 3d model.

G. Guidi "Accuracy verification and enhancement in 3D modeling: application to Donatello's Maddalena" in 3-D Digital Imaging and Modeling, IEEE, October 2003, pp 1-9

(3) According to IEEE, 3D technology had been used in modeling the brain of human body.

Ernesto Ponce "Modeling Neck and Brain Injuries in Infants", in IEEE Computer Graphics and Applications, 20 October 2011, pp 90-96.

1.1 Purpose of this document

According to CancerIndex.org, People newly diagnosed with brain cancer are 108,600 and those who died in the last year from brain cancer were 72,300.Moreover, one of the biggest problem that faces doctors is the calculation of the tumor volume through those 2D images. It's medically essential for the doctors to know the volume of the tumor, Knowing the accurate volume and the position of the tumor are key information doctors need to know which part of the patient body will be affected, Moreover will be able to plan treatment and they may predict the stage of the tumor.

1.2 Scope of this document

The system is targeting the adult male and female brain tumor patients. Our research scope is MRI images and Detect brain tumor only. We will be working on detecting the volume of the tumor.Our system will be integrated with many hospitals.

1.3 Overview

The System will have a number of input images which will be passed over several image processing techniques to clarify the images as much as possible.The second step will organize the output images in a stack by pushing the images on the top of each other considering the distinct separation between every 2 image slices, then create a 3D mesh box where each element in the matrix gives us the coordinate of each pixel in the box.Then 3D model is constructed, Finally, there will be intuitive control-er with the doctor to manage the 3D model in the screen.

1.3 Business Context

Many Countries are moving too far from ordinary traditional techniques and methods.As result of our aim is to enhance the expe-

rience of doctors with through treating with MRI scans of brain tumor.Though the traditional method is holding up, a lot of complaints are received due to lack of efficiency. The introduced system would avoid a lot catastrophic disadvantages of the old techniques and method, such as the wrong diagnosis and wasting time. As matter of fact, the proposed system will ensure full satisfaction for doctors and patients.

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2 General Description

2.1 Product Functions

Our project depends on MRI slices which will be the input to our system we will calculate the volume of the tumor and reconstruct a 3D model for the whole brain and for the tumor using 2D input slices then the doctor will be able to interact with the visual 3D brain model using a dummy head. There will be a set of buttons in the dummy head that represents an important places in the brain if the button that refers to a specific part is pressed the system will highlight it this part in the brain 3D model and view set of outputs such as how far this area is affected by the tumor and what this area is responsible of in the human body. The system is divided in to 3 modules. (1)Image processing module (2) 3D Construction (3) Tangible user interface

2.2 Similar System Information

1- Sudipta Roy, Shayak Sadhu, Samir kumar "Useful approach towards 3D representation of brain abnormality from its 2D MRI slides" in Control and Information technology (C3IT). IEEE, 7-8-2015, pp 1-6.

-They make this research to find the volume of the tumor inside the brain.

- Calculate the volume of the tumor inside the brain

-They used to kinds of methodology: 3D construction of brain, volume calculation from 3D constructed figure.

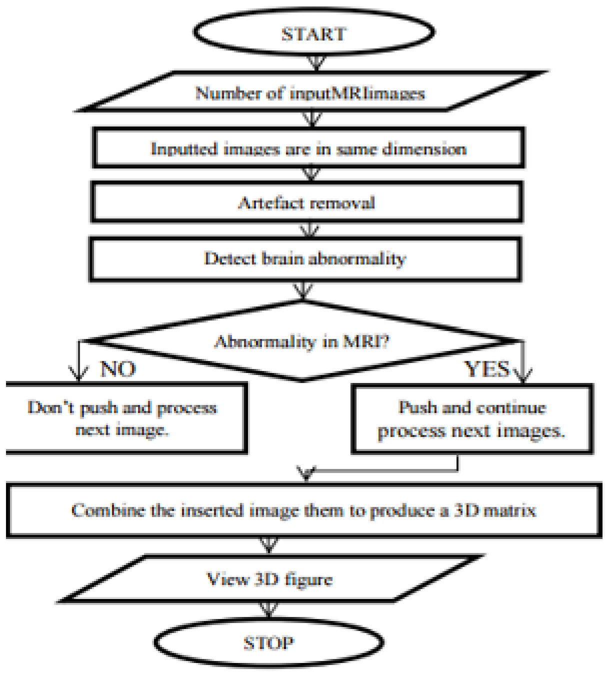


Figure 1: Overall steps of 3D visualization of brain abnormality.

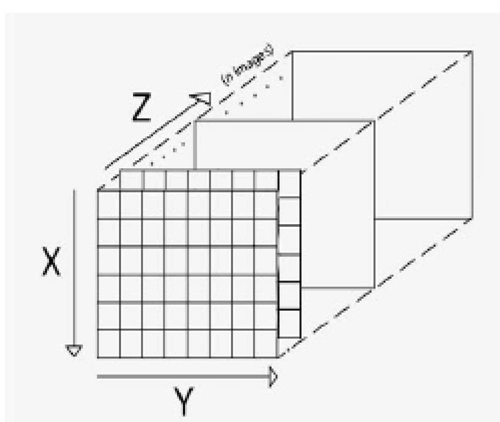


Figure 2: 2D matrices pushed into one another to form a stack

They used the concept of stack and it's data structure. Here They consider each 2D matrix as stack and is pushed on top of each other to create a 3D matrix. A distinct separation is maintained between two image slides which denote the real-time separation when the slides were taken.The above explained method can be described by the figure They used mathematical equations to calculate the volume

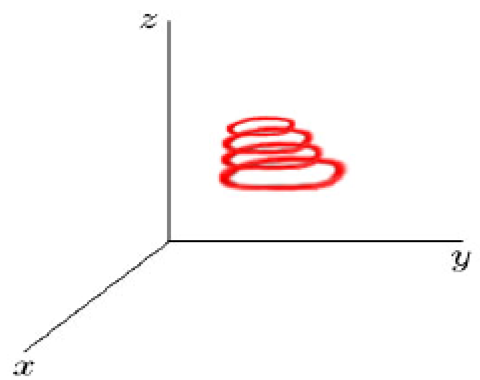


Figure 3: Graphical view the edges of each slide

After obtaining the above 3D matrix we 3D construct the above obtained matrix. In this process we consider the matrix as a 3D mesh box where each element in the matrix gives them the coordinate of each pixel in the box.Here they take the coordinates with 0's as the transparent part and the 1's as the solid part.

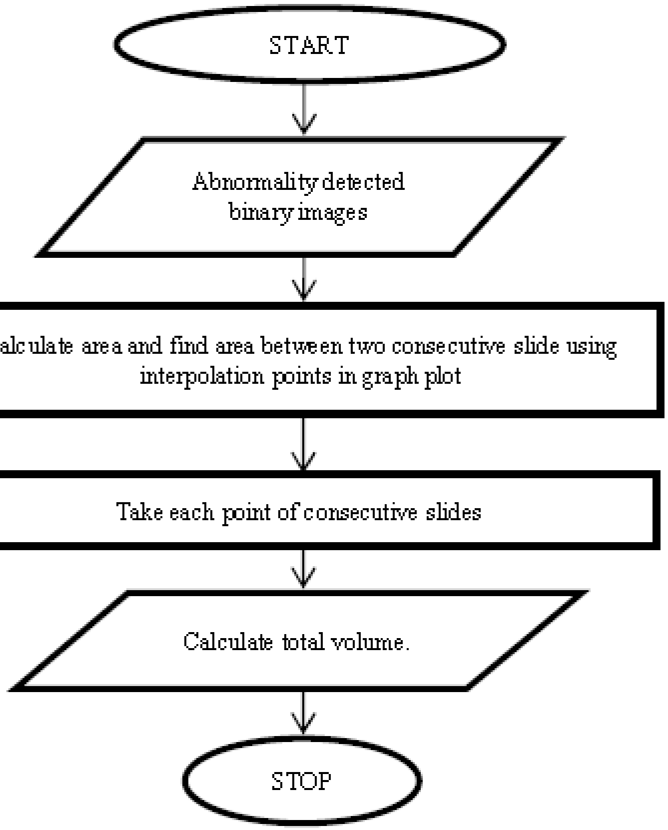


Figure 4: Steps of volume calculation

In this second part they calculate the volume of the tumour by taking binary images from tumour detection part from the previous stated algorithm as input. From the previous algorithm they get the binary image as the output of the tumour detection algorithm and using it as matrix they calculate the total volume of the whole tumour in pixels using the binary images and distance between two consecutive slides or slice thickness which must be taken from the user as it affects our calculation in estimation of volume. This image which can also be considered as a matrix is processed by the following algorithm to get our expected result. The flow diagram of this algorithm is given below in figure 3.

2.3 User Characteristics

The users of the system will be doctors, they should have a background on how to use computers.The System should support friendly interface to give the doctors the ability to interact with the system

easily

2.4 User Problem Statement

Doctors have a big problem which is, they must pass over all MRI images one by one to track the slices which contain tumor.They want an algorithm to make this process automatically by giving an abnormal density inside the brain to determine the tumor instead of wasting time in checking every slice.

2.5 User Objectives
Flexibility in treating with the 3D model and algorithm to track the tumors in all slices of the MRI images

3 Functional Requirements

3.3.1 User Login

Requirement: The system will able the doctor to log in
Rationale: The system needs to identify registered users to allow specific functionalists

Input: User name/Email, Password

Priority: High

Priority reason: Essential requirement that must be included in the system because every doctor will have the flexibility to access the patients he have

Status: Committed

3.3.2 Input Images

Requirement: The doctor will import the images of MRI scans in the system

Input: MRI scans for patients

Priority: High

Priority reason: These input images will be passed by several image processing techniques

3.3.3 Preprocessing

Requirement: initial process which uses 2d images as input. The system converts 2d images to gray scale. The system uses high pass filtering for sharping the edges, then contrast enhancement that attempts to improve the contrast in images and finally, Threshold methods for separation of light and dark regions

Priority: High

3.3.4 Segmentation

Requirement: In dividing an image into multiple segments which is achieved based on similar attribute. The goal of segmentation is to simplify or change the representation of an image

Priority: High

3.3.5 Feature extraction and selection

Requirement:It extraction involves reducing the amount of resources needed to describe a huge set of data and process of selecting features which has been extracted. it helps to reduce features by improving the prediction accuracy and reduce computation time.

Priority: High

3.3.6 Classification

Requirement: grouping the individual items based on similarity and description of those items

Priority: High

3.3.7 Tumor Detection Slices

Requirement: collects all slices that contain tumor.

Priority: High

3.3.8 Tumor Volume Calculation

Requriement: calculate the volume of the tumor by taking binary images from tumor detection process as an input

Input: Binary images from tumor detection process

Priority: High

3.3.9 Organize Images

Requirement: Put the output images into a stack to form a 3D matrix

Priority: High

3.4 Create Mesh Box

Requirement: Send each co-ordinate in the 3D matrix to the mesh box

Input: 3D matrix

Priority: High

—3.4.1 Plot the matrix

Requirement: plot the 3D matrix to construct 3D model of the brain

Priority: High

3.4.2 3D model orientation

Requirement: orient the 3D model exactly as dummy head current position in the real time

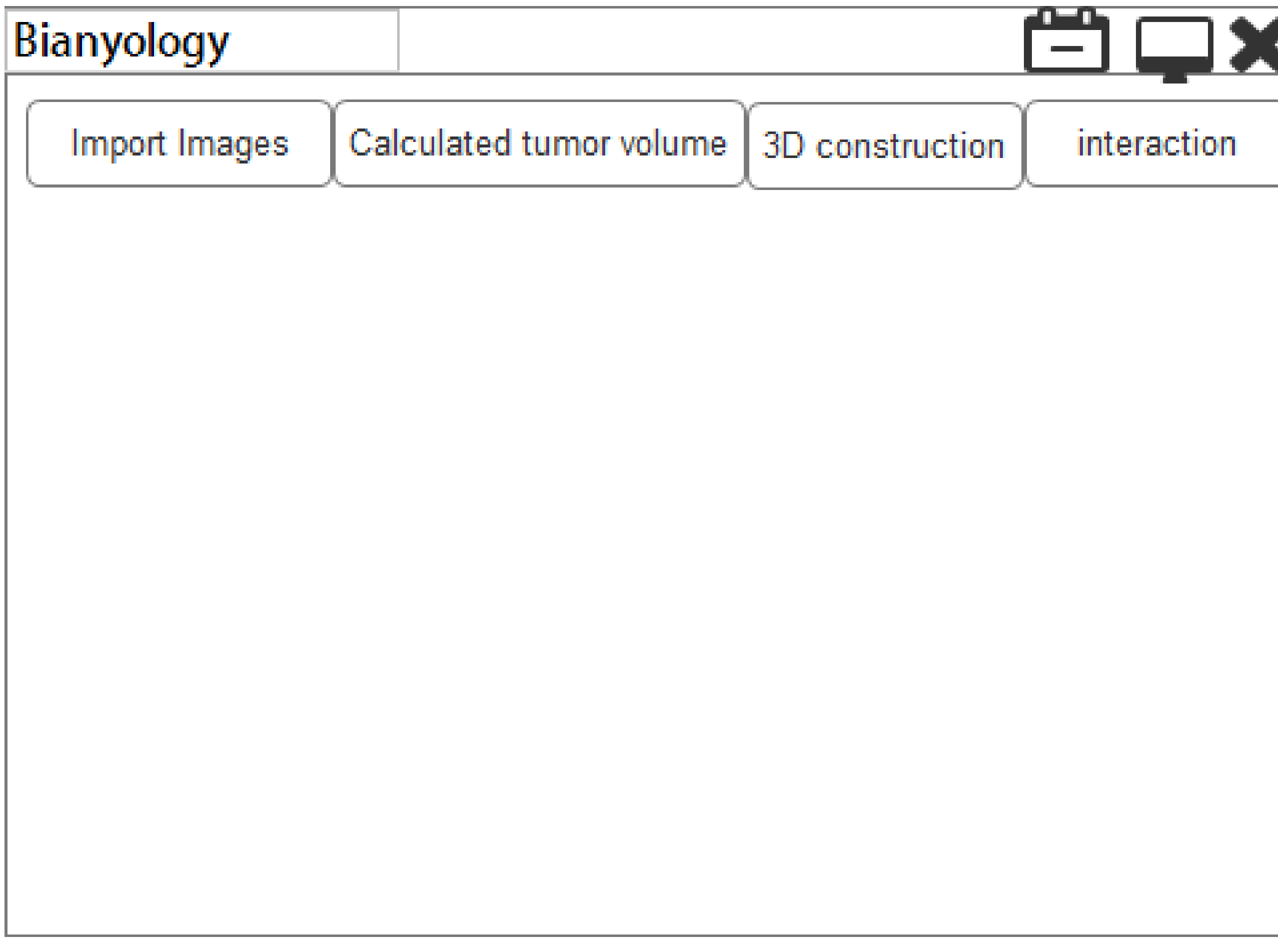
Priority: High

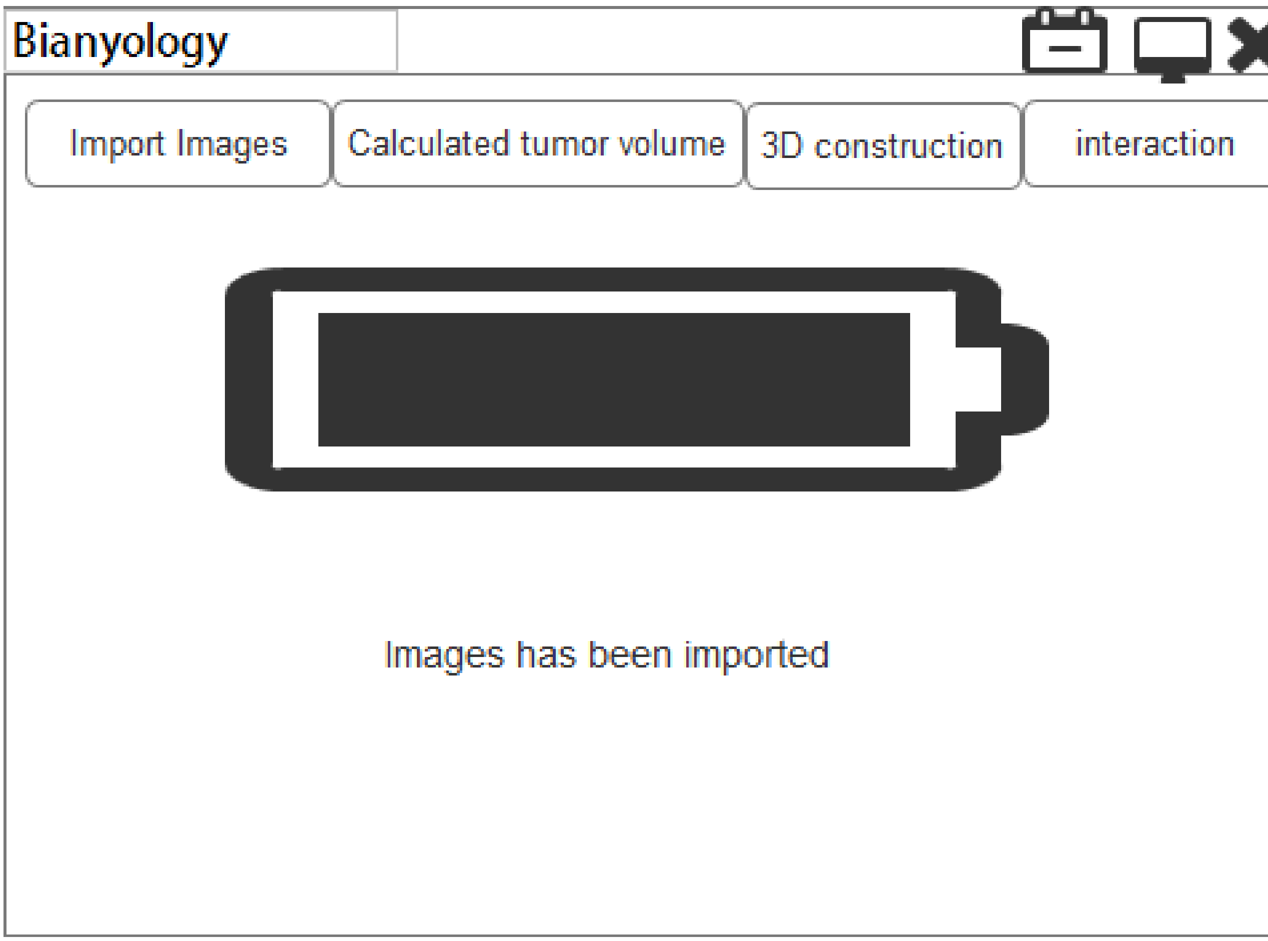
3.4.3 Brain Anatomy Segmentation

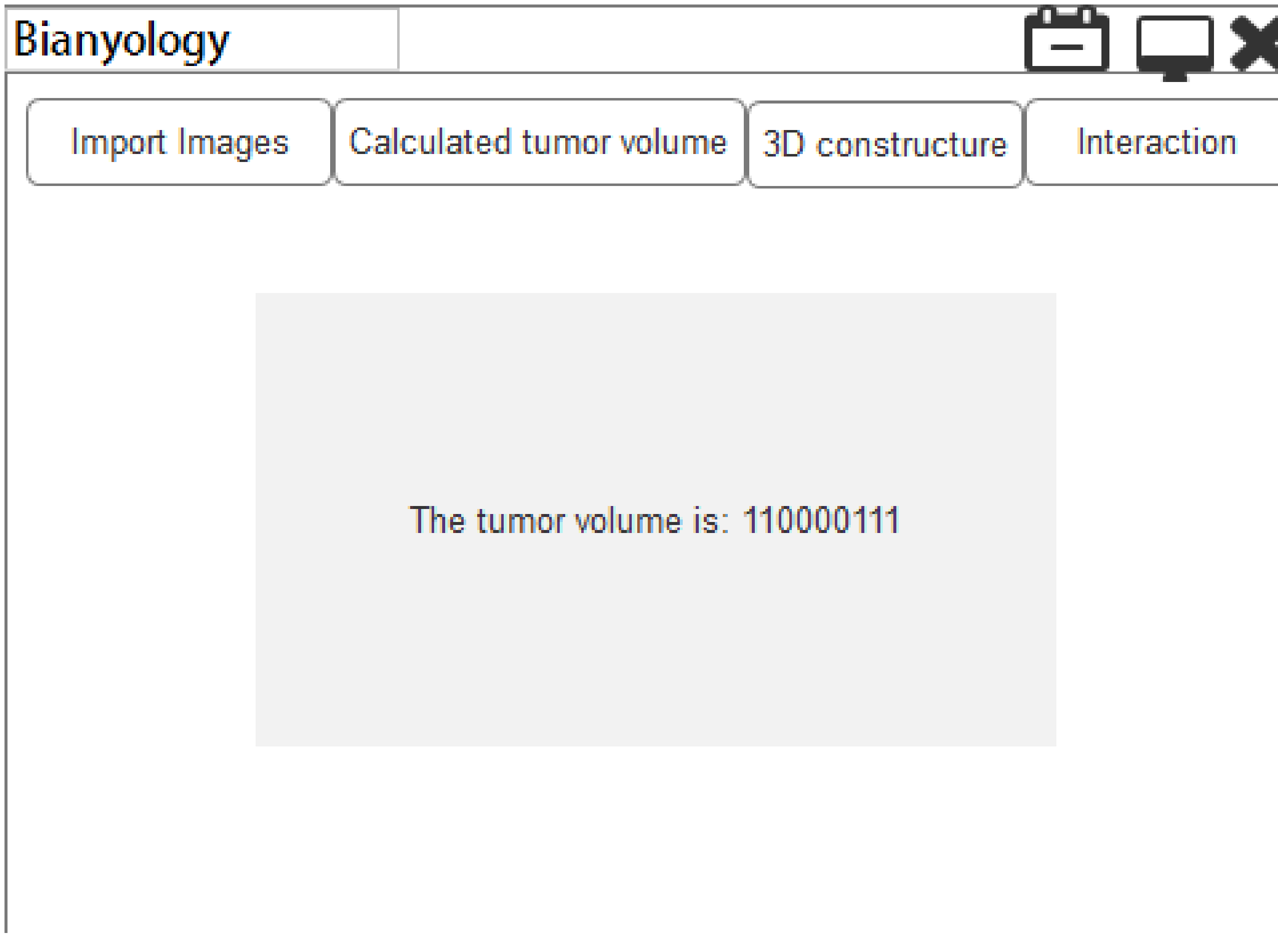
Reuriement: Divide each part in the brain to be controlled by intutive controller

Priority: High

4 GUI




Bianyology
Import Images
Calculated tumor volume
3D construction
interaction
Images has been imported



5 Hardware Interface

The Hardware Interfaces of the system are handled by x-imu sensor , arduino mega , 13 buttons , bluetooth module and a dummy head . The code is written by arduino and c.

6 Communication Interface

Doctor will use the GUI to input the MRI images and interact with the output 3D model using TUI Dummy Head

7 Software interface

Matlab: Matlab is a high-performance language for technical As for image processing in Matlab there is an image processing toolbox which provides a comprehensive set of reference-standard algorithms and functions, for image processing, analysis, visualization, and algorithm development. We are performing image analysis, image segmentation, image enhancement, noise reduction, geometric transformations, and image registration. As for 3D reconstruction after applying the image processing technics we will take those images and put it in a 2D matrix. We will consider each 2D matrix as a stack to create a 3D matrix, and then finally we will represent those 3D matrixes in to a 3D mesh box.

Java: will integrate the Matlab with java to be able to create an interface for the system

Ardino: Using Hserials library to send and receive data from and to arduino

C Sharp: using opengl, in the hand library and AHRS algorithm.

8 Performance Requirements

The System need a high speed processor to overcome the processes of image processing techniques and generating 3D model. The system need a high performance of memory to be able to store the amount of data sets for different patients

9 Design Constraints

The intention of the system is to segment the anatomy of the brain and segment the brain tumor then create a 3d model for the brain and calculate the volume of the tumor then finally allow the user to interact with the 3d model by a TUI , therefore the internal structure

of the system should be designed in such a way that the system shall be using the least possible complexity to reduce the time of rendering for the 3d construction and the system should be in a real time in the TUI part. Every single process of segmentation will be based on data set gathered from specialists and doctors especially for the brain anatomy segmentation. This product is initially being developed for a non-profit with a limited budget, and therefore is constrained to low-cost methods of implementing the system. The team has selected matlab language to implement the segmentation and 3d construction Behind the arduino and visual studio c to implement the TUI.

10 Non-Functional Requirement

7.1 Availability: The system must be available for the doctor when he need it during the diagnoses of a patient

7.2 Reliability:Data, as entered, must be imported to the system In addition, each feature must work correctly 99 percent of the time. The probability of a system failure should be minimized as much as possible. In other words the system should be failure safe

7.3 Usability: The system will be used by individuals of varying skill level and technical competence. The system shall be intuitive to use and have extensive help documentation to walk doctors through the operations they are trying to perform.

7.4 Maintainability: The system may likely be developed or improved by a different team. The code and design need to be documented well enough and designed such that a senior project team with the same amount of academic and co-op experience can ramp up on the project within 3 weeks

7.5 Performance: The loading time of the system must be small. And the response time for the user should be acceptable. Also any operation must be done in less time in order to increase speed and ease to use.

11 Operational Scenario

First the doctor will import the images in to the system, the system will be expecting a specific number of images whether form 297 images to 501 images, if the images imported in less than 279 or greater than 501 the images will not be imported to the system. All the images must be of the same format and dimensions, if they are neither the same format nor dimensions the images will not be imported to the system. After the images being imported to the system the images will faces some image processing techniques which is the first part of the system. The initial process is pre processing, in this process the system will use high pass filtering for sharping the edges, then contrast enhancement that attempts to improve the contrast in images and finally, Threshold methods for separation of light and dark regions.If the images are not of gray scale then they will not proceed to the next process. Segmentation is second process in this process the system will divide the images in to multiple segments which is achieved based on similar attribute. We have four popular techniques of segmentation which are Unseeded Region growing, OTSU'S thresholding, and Morphological Erosion and Connected component. We applied the OTSU'S thresholding and Connected component and the results of OTSU'S thresholding were better than connected component. After the segmentation process is over the images will pass through the feature extraction and selection process. This process involves reducing the amount of resources needed to describe a huge set of data. We use WV$_G LCMmechanismforthefeatureextractionprocess.ThisincludescombinedprocessofbothGLCMandWa$