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Master Thesis

Title
Surgery Support System Based on Touchless Control of Anatomic 3d Model **Система поддержки хирургии, основанная на бесконтактном управлении анатомической 3д-моделью**

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Major Information	1. Motivation 2. Introduction 3. Project Goal 4. Medical imaging Software 5. Virtual Reality In Medical environment 6. Analysis and design

Content	1. Introduction and literature review 2. Overview of 3D slicer 3. Overview of Unity3D 4. Medical Visualization 5. Results 6. Final Management and Resource Efficiency 7. Social Responsibilities
Assigned Date	

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Chapter 1

1. Motivation

The strategies used for the motive of surgical operation planning are mind imaging and electroencephalography (eeg). There are following techniques of neuroimaging: computed tomography (ct), magnetic resonance imaging (mri), purposeful magnetic resonance imaging (fmri), positron emission tomography (puppy) and unmarried-photon emission computed tomography (spect). Eeg is a monitoring technique that detects electrical activity of brain the usage of electrodes located on a scalp. The invasive eeg (eeg) is a variation of eeg with surgically implanted electrodes. These kinds of techniques are used for spotting and specific localization of seizure onset quarter. Clinical medical doctors traditionally use multi planar reconstruction (slices view) of volumetric records sets that are an output from neuroimaging methods. Any other alternative is a 3-d reconstruction - volume rendering - that improves spatial navigation interior of extent version. The subsequent step in three-d graphic visualization for this purpose may be virtual reality (vr) which is now applicable thanks to high performance image hardware. A aim of this thesis is to explore and try to use advantages of virtual reality for medical extent rendering. Treatment of epilepsy is a complex manner that consists of a broad spectrum of techniques and strategies. Visualization in vr brings a new piece into this puzzle with goal intention to enhance diagnosis, surgical operation making plans and additionally communication among player clinical doctors and researchers motive of this work is a layout of utility a good way to guide analysis and surgical operation planning in surgical treatment.

Abstract

In the operating room a touchless interface is an ideal solution since it does not demand any physical contact and still can provide the necessary control features in a cleansed and sterilized environment. While surgical practices are increasingly reliant on a range of digital imaging technologies, the ability for clinicians to interact and manipulate these digital representations in the operating theatre using a traditional touch based interaction devices is constrained by the need to maintain sterility. While there have been important technical strides in the area, there has been little in the way of understanding the use of these touchless systems in practice. We present findings from a study of the system in use focusing on how, with touchless interaction, the visual resources were embedded and made meaningful in the collaborative practices of surgery. We discuss the broader implications of these findings for how we think about the design, evaluation and use of these systems.

Introduction

Computer interfaces based on gestures have been intensively researched but limitations like high cost, bad accuracy, and setup complexity have contributed to keep this technology impractical for real-world applications. This situation changed drastically recently with the release of an accurate, low-cost, and easy-to-setup device by Microsoft, called Kinect.

Gesture user interfaces have applications in many areas, and the present work is primarily focused on one particular application that is the visualization of 3D medical images during a urological surgical procedure. This scenario is particularly important because the operating room (OR) is a cleansed and sterilized environment to adhere to the principles of asepsis, and the contact of the surgeon with traditional computer interfaces (like mouse and keyboard) could lead to contamination, increasing the risk of patient infection.

Integrating recently developed virtual reality technologies into the OR to facilitate performance of nephron-sparing surgery could be applied to traditional open and laparoscopic surgery. Such systems are usually controlled using mouse and keyboard, requiring an undesired physical contact during the surgery

We present a touchless gesture user interface that allows the surgeon to control medical imaging software just by performing hand gestures in midair. The system is also open-source, low-cost, and simple to deploy which allows a widely adopted solution.

Method

The imaging software used in our system is the Unity 3d, open-source software for visualization of 3D medical images at developed Unity technologies founded by David Helgason. It offers visualization in 2D slices (multi-planar reconstruction) and in 3D using a high-quality volume and surface rendering technology. The engine targets the following graphics apis: Direct3D on Windows and Xbox One, opengl on Linux, macos, and Windows, opengl ES on Android and ios; webgl on the web,and proprietary apis on the video game consoles. Additionally, Unity supports the low-level apis Metal on ios and macos and Vulkan on Android, Linux, and Windows, as well as Direct3D 12 on Windows and Xbox One.Also, measurement tools (linear, angular and volumetric) are provided. It is freely available for Windows, Mac OS and Linux platforms in seven languages and is compatible with the most common file formats such as DICOM, Analyze and STL. Two prototypes of gesture interface were developed using two different technologies to communicate with Kinect. The first one uses a simpler but completely open-source library called Libfreenect and is based on depth threshold and post-processing filtering to detect the hand. The second prototype uses a non-open-source solution (NITE/openni) to detect the position of the hand. In both prototypes, the hand of the user is tracked and the corresponding position is used to move the mouse pointer and button clicks events are also virtually generated. The next sections describe in details the Kinect device and the two prototypes.

2. Literature Reviews

2.1

The main goal of in this paper is using 3D models the patient's body shows up as a need in the medical procedure. This paper has two distinct frameworks as virtualized interface and a minimal effort of the touch screen. The framework can grow the client's developments and is utilized for careful arranging and the making of 3D models from CT pictures. The specialist can watch informations all things considered, as the CT pictures information and the 3D model of the organs from these images.The develope is the main model which maintains a strategic distance from an any reached with the computer.So that the specialist can imagining models to collaborating by moving the fingers in the free spaces. The multi touching screen gives a customing UI produced for specialist's that enable client's to connect for pre-agent purposes both with the 3D model of restorative pictures and with the picture dataset. This work deals with the designing and an evaluation of a gesture manage device for manipulation of the CT images the usage of a Kinect device. several abstractions have been applied to enhance the performance, making it simple at a low price. specific gestures can trade the settings of three-D fashions. similarly, a detailed usability testings with customers had been accomplished to determine overall performance measures and analysis. The results confirmed that the participants were capable of perform the duties speedy and appropriately, which indicated the usefulness of the gadget as a effective and opportunity solution, to the traditional techniques.(Reference Number 28).

2.2

In this paper explaining use of gesture user interface as a touchless images navigate system in dental surgery. At some stage in the surgical operation of while simultaneous dental implant placement and guided bone regeneration (GBR) approaches were done, the brand new NUI machine changed into used considerably and become very beneficial due to the fact the anatomy of the neighbor tooth and the maxillary sinus made the usage of images vital for proper implant placement even as fending off harm to anatomical systems. The functions of this study have been to broaden a workstation computer that allowed intra-operative Touchless manage of diagnostic and surgical photos by means of a general practitioner, and to record the initial revel in with using the device in a sequence of cases in which dental surgical treatment become achieved. A custom computer with a new movement sensing input tool (leap motion) changed into installation if you want to use a natural consumer interface (NUI) to control the imaging software through hand gestures. The system allowed intraoperative Touchless manipulate of the surgical pix. Graphical user interfaces (GUIs) have advanced over greater than three a long time to end up the standard in human-pc interaction. The multitouch display interfaces of cellular devices inclusive of telephones and capsules constitute an evolution of the GUI and are very famous nowadays; however, they require physical touch to function. herbal user interfaces (NUIs) are computer interfaces designed to use natural human behaviors for interacting without delay with the laptop. The purposes of this study had been to develop a workstation computer that allows intraoperative a touchless manipulate of diagnostic and surgical pics by using a health practitioner, and to test the usability of this machine in a case collection of dental surgical operation tactics. So that the doctor can make a pre planning for surgery. (Reference Number 30)

3. Project Goal

The main purpose is to design and put into effect an application primarily targeted on quantity rendering with adaptation into virtual truth. Key requirements are multi-volume guide, visualization of vertex EEG information (information from invasive electroencephalography) with projection to quantity information and widespread planar presentation of volumes. Picture consumer interface ought to be intuitive and appropriate for utilization in medical praxis.

Chapter-2

BACKGROUND

Medical image visualization principal

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues (physiology). Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are usually considered part of pathology instead of medical imaging**.**

COMPUTED TOMOGRAPHY IMAGING

Computed tomography imaging, commonly known as CT imaging, is a non-invasive imaging procedure that generates 2D cross-sectional images of the body. In CT imaging a narrow beam of X-rays is used to scan internal regions of the body. Tomography is a method used to record the differences in effects on the passage of electromagnetic waves impinging on the 3D structure represent in the body. CT imaging is also known as Computerized Tomography. The tomographic images/slices provide 3D information of the patient's anatomy, as opposed to the conventional X-ray. This includes information about bones, soft tissues, blood vessels and internal organs. Examples of sagittal, coronal and axial views generated using CT imaging are shown in Figure.

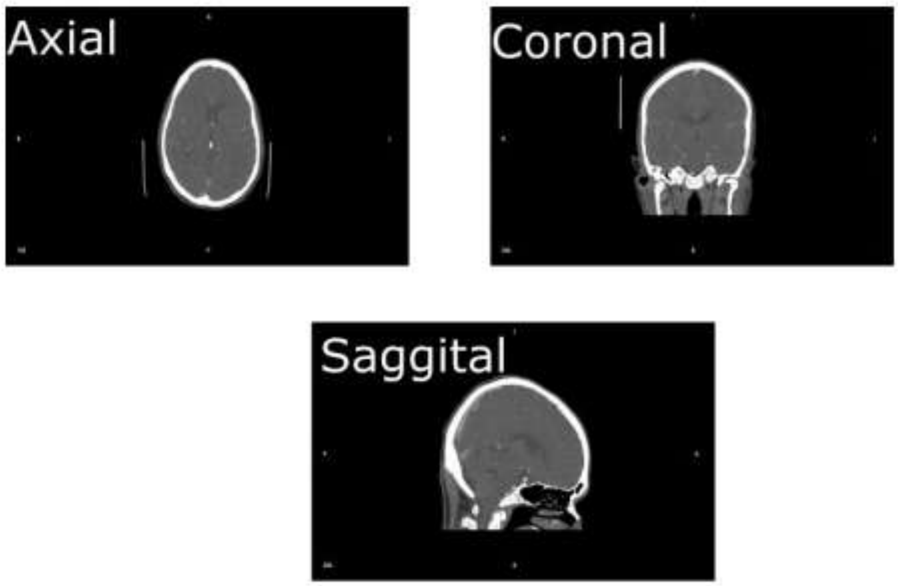


Figure-1. CT scan of human Head

CT scanners consist of two key components - an emitter and a receiver. The patient lies inside tunnel-like equipment which is equipped with the scanner. The emitter is 180° across from the receiver. The patient is maintained in a stationary position while the scanner rotates around the patient along the circumference of the tunnel, known as the gantry. X-rays are beamed and receivedat different points along this trajectory. Each time the bed moves to introduce a different anatomical structure, the scanner rotates to capture new information. A computer analyzes the information provided by the X-rays and constructs cross-sectional images of the body by transformation through mathematical reconstruction algorithms. Since different parts of the body absorb the radiation in varying degrees due to their radio-density, the image consists of differing shades of gray, to depict the level of absorption. This is crucial in identifying tumors and lesion certainly. The bones appear as bright regions as opposed to soft tissues, which are represented inshades of gray. Air appears black in a reconstructed image. Biological Material Hounsfield Unit.

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body in both health and disease. MRI scanners use strong magnetic fields, electric field gradients, and radio waves to generate images of the organs in the body. MRI does not involve X-rays or the use of ionizing radiation, which distinguishes it from CT or CAT scans. Magnetic resonance imaging (MRI) is a noninvasive medical test that physicians use to diagnose medical conditions. MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures

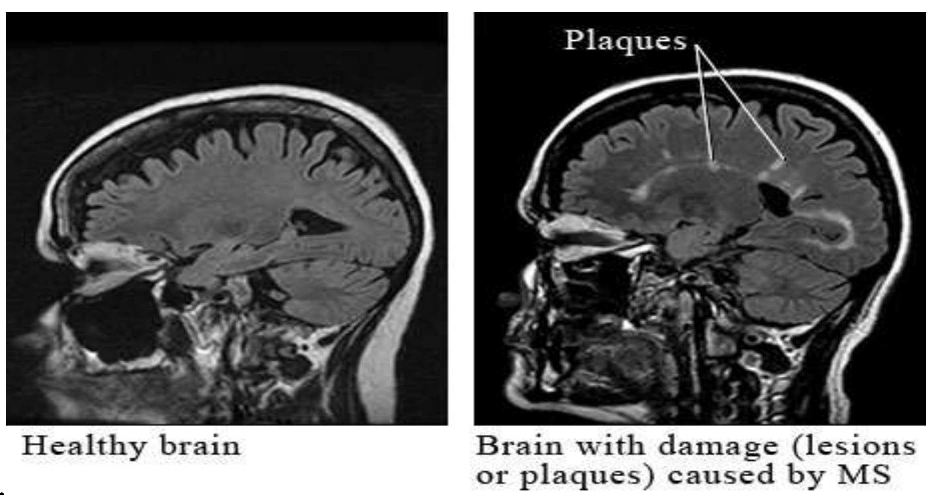


Figure-2 Magnetic Resonance of Human skull

X-Ray Imaging

An x-ray (radiograph) is a noninvasive medical test that helps physicians diagnose and treat medical conditions. Imaging with x-ray uses a very small dose of ionizing radiation to produce pictures of any bone in the body. It is commonly used to diagnose fractured bones or joint dislocation. Bone x-rays are the fastest and easiest way for your doctor to view and assess bone fractures, injuries and joint abnormalities.

Figure-3 X-Ray Image of the Human foot

DIGITAL IMAGING AND COMMUNICATIONS IN MEDICINE

The Digital Imaging and Communications in Medicine (DICOM) normal has been established and wide accepted as a protocol for handling medical imaging and image-related info. It absolutely was developed by National Electrical Manufacturers Association (NEMA) and American College of Radiology (ACR) in

1993. DICOM provides compatibility between imaging modalities to dependably store info concerning patients, procedures, equipment, and to the medical pictures. DICOM has been central to all or any medical imaging technologies for process and transfer medical info dependably. This includes X-ray machines, Computed Tomography (CT) imaging, Magnetic Resonance Imaging (MRI) and Ultrasound amongst others. It hierarchically structured and encompasses a Client-Server design. This consists of information interchange protocol, image file or data formatting and network protocol design. These protocols will be wont to retrieve info concerning the patient's imaging knowledge throughout the surgery. Since it supports up to sixty five, 536 reminder grey for monochrome image show, it offers inflated image quality than alternative ways. Currently, the DICOM normal is split into twenty elements. These function a model for procedures and interface specification to alter property between medical imaging technology and alternative systems. This permits knowledge from totally different devices to be processed in associate practical approach. The quality is often changed to include new technologies. The information storage processes imaging data by linking it with the data of the patient. This can be done by generating associate examination range once image transfer is synced Picture Archiving and Communications System (PACS). These area unit typically selected by the Radiology Information Systems (RIS) or Hospital info System (HIS) additionally to patient knowledge, every DICOM knowledge object contains one attribute for component knowledge. This sometimes relates to one image for imaging systems, though every attribute might enable storage of multi-frame knowledge. The DICOM committee outlined a search table for systematically generating grayscale show pictures across devices. The devices used for viewing pictures will either use DICOM grayscale standard display function (GSDF) or will be tag to the curve. Every of the grayscale pictures captured exploitation imaging systems will be expressed as a nonstop operate $(\boldsymbol{x})$.

Here, $\boldsymbol{x}$ is that the special coordinate vector and f(x) is its intensity worth during this project, the ($\boldsymbol{x}$) info is digitized to be processed by a laptop.

2. Image Processing

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be an image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them.

It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps.

Importing the image with optical scanner or by digital photography.

Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs.

Output is the last stage in which result can be altered image or report that is based on image analysis.

Purpose of Image processing

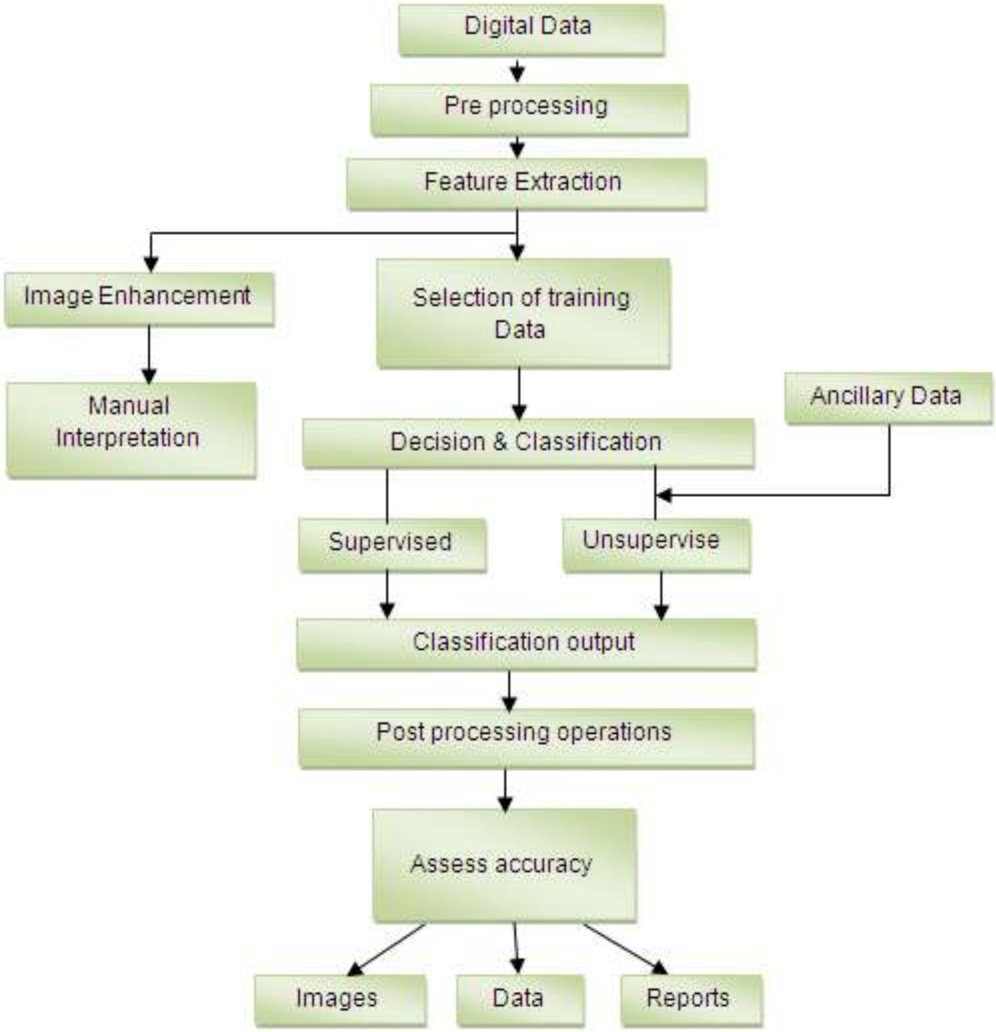
The purpose of image processing is divided into 5 groups. They are:

1. Visualization - Observe the objects that are not visible.
2. Image sharpening and restoration - To create a better image.
3. Image retrieval - Seek for the image of interest.
4. Measurement of pattern – Measures various objects in an image.
5. Image Recognition – Distinguish the objects in an image.

Types

The two types of methods used for Image Processing are Analog and Digital Image Processing. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to the area that has to be studied, but on knowledge of analyst. The association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing.

Digital Processing techniques help in the manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction.



Chapter-3

Medical visualization

This section will at first present short overview of software used in clinical praxes and related research; then a brief description of application 3d slicer and unity3d will follow and in the last part will discuss the possibilities of virtual reality application in a medical environment.

Medical Imaging Software

For this purpose, there the software solutions will be divided into two groups:commercial and open source applications. Commercial solutions usually cover whole sets of features needed for particular tasks or provide complex workstations. Examples of these products are: AW Volume Share (GE Healthcare), syngo. Via(Siemens), PMOD (PMOD Technologies Ltd), Definiens (Definiens Inc.) And mimvista (MIM Software Inc.). Main advantages of this type of software are coverage of wide spectrumof tasks, professional customer support provided by their vendors and for some of them approval by the FDA (Food and Drug Administration) for certain clinical tasks. On the other hand, this software type is not always affordable for academic research and usually there are no options for end users to extend these solutions with custom features. The opposite side occupies a wide spectrum of open source software. These tools are usually built on top of libraries such as ITK (Insight Segmentation and Registration Toolkit) and VTK (Visualization Toolkit) which provide tools for image processing and visualizations. Examples of free software are: 3D Slicer, Clear Canvas, ostrix, Bio Image Suit, volview, mevis Lab and SCI Run. They typically provide API for developing additional extensions and plugins that enables utilization for a specific function.

3D Slicer

One of the foremost used open software package is 3D Slicer. It's a multi-platform, free and open supply software package, that provides tools for medical image computing and mental image. This application integrated antecedently separate comes targeted on image visualization, surgical navigation and graphical interface.

The tool with the at first specific purpose for operation and analysis has been reworked during years of development into Associate in Nursing integrated platform employed in varied fields. The Slicer contains many modules sure tasks from registration, segmentation and expansion to volume rendering. Further options could be developed with 3 differing types of command line interface (CLI), loadable module or scripted module. For the extensions together with significant computations, a loadable module sort that is written in C++ is offered. On the opposite hand, for prototyping and custom progress development there is convenient Python scripted module. 3D Slicer with all its options and extensibility potentialities became a helpful tool for clinical analysis. A stability and future development is ensured by companies Isomics INC., Kitware INC., and GE international analysis and additionally still growing broad Slicer community.

To begin including CT picture information the 3D slicer, open a loaded data and include information through the order which determined record source contained DICOM arrangement or drag the information from source organizer specifically to the product stage.

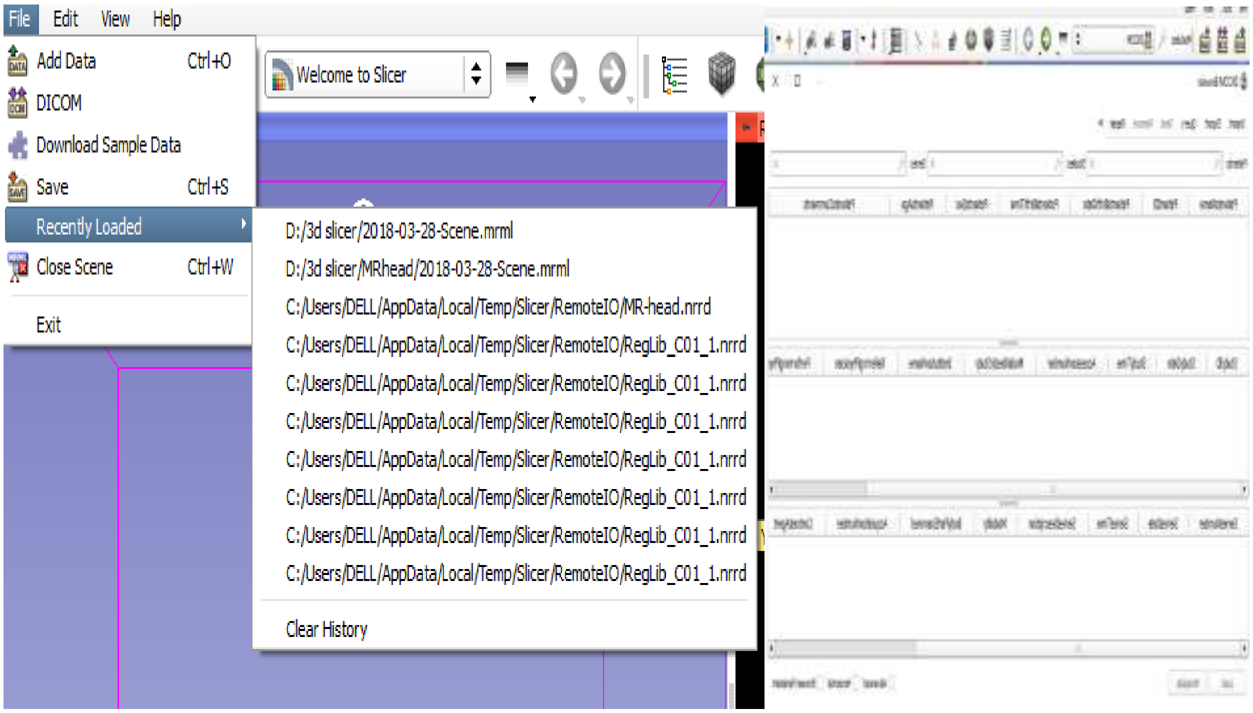


Figure-1. Adding file or directory form the source folder

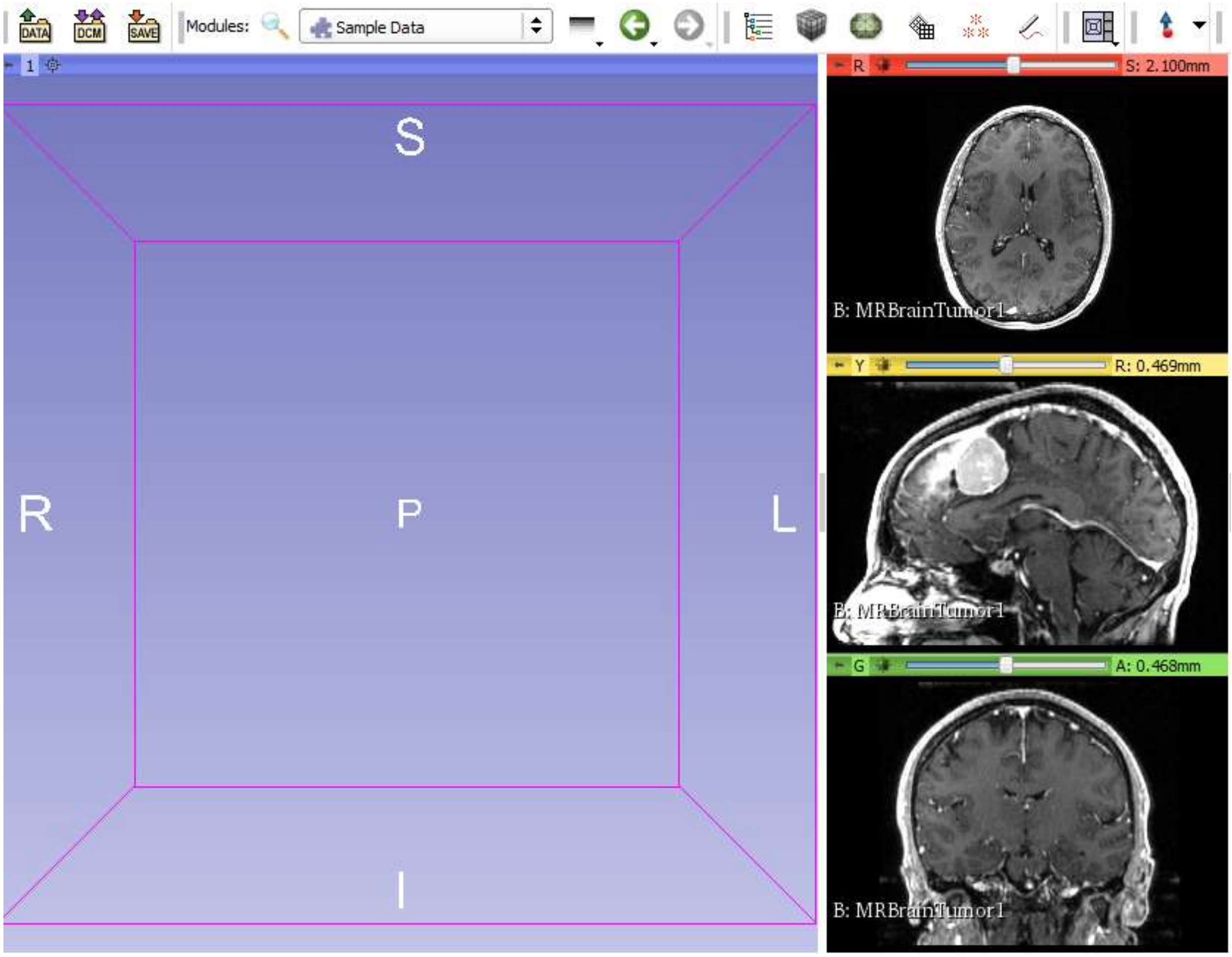
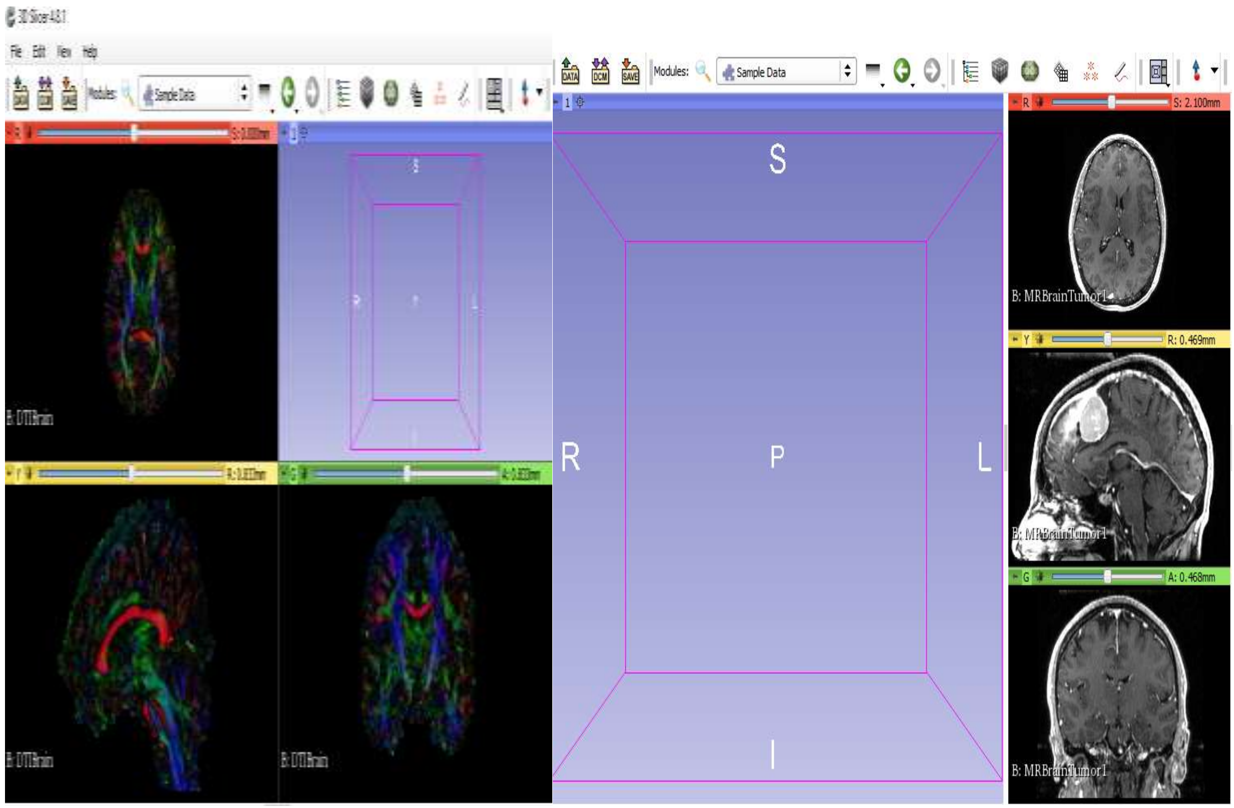


Figure-2 Loading the scene from the navigated folder

When the startup window indicates three unique views of DICOM information document in conjunction with the 3D image panel windows where the DICOM facts transformed into 3-D model view. Which its inserted document may be seeing into multiple home windows as in keeping with requirement due to the fact the software bundle permits to analyzing the data and may be seen the perspectives in one of a kind positions and rotation via the unique tool as shown in . Then pick four view layouts to view and adjusting the edge limit on those home windows pallet. The determine of window format.



(a) (b)

Figure-3. (a) & (b) scan views on 3D Slicer software tool

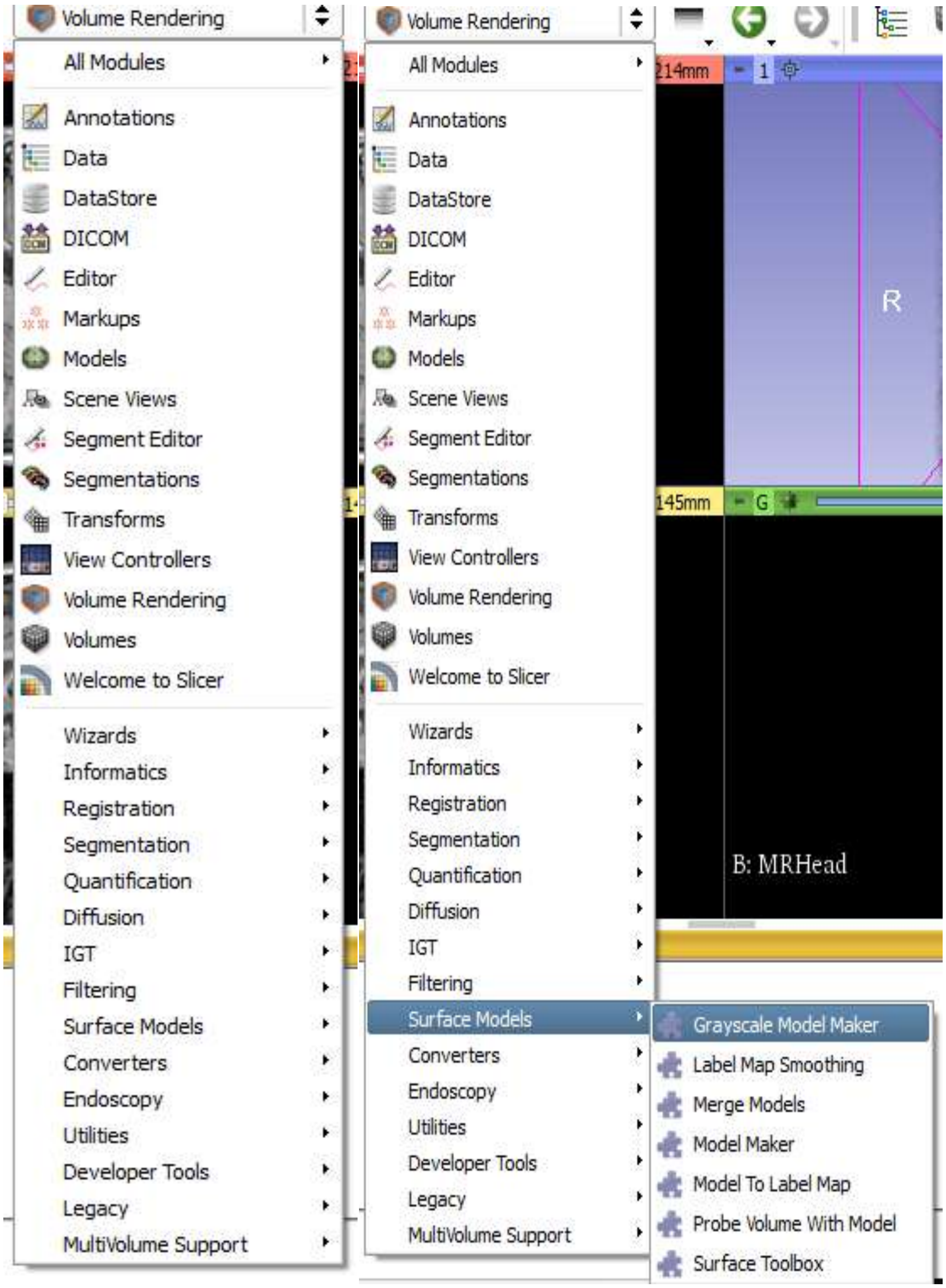


Figure- 4. scan views selection on a 3DSlicer software tools

The fundamental conversion of scan statistics into the 3-D model, we're going to use the command on the menu bar of the slicer that is extent rendering. On deciding on of this command there is the icon like an eyeball on the left side of the command window that has been became on, the 3D volumetric model has been generated routinely. It's been viewing by rotation with the aid of the proper click of laptop mouse.

The second step is which model want we can choose the preset command for this particular version with a purpose to convert information into model. The slider is at the beneath aspect to elevate it for the best bone version till looks as if a real version as in step with requirement. We are able to use the middle button of the mouse to zoom in and left button to rotate the data on home windows for appears precisely.

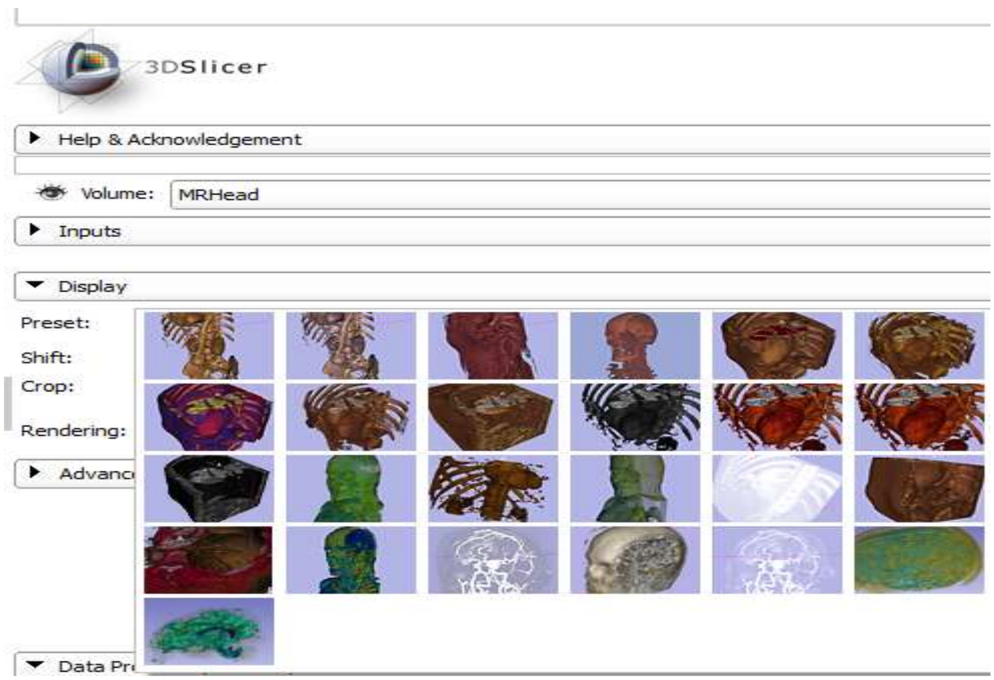


Figure-5 Scan rendered volume bone model on 3DSlicer software

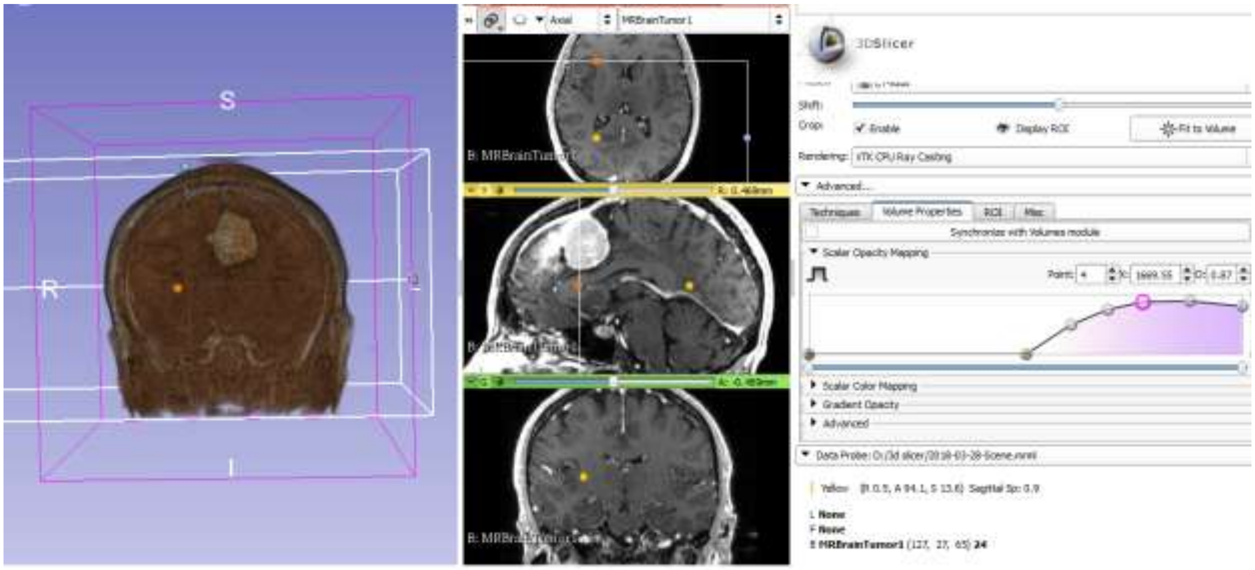


Figure-6. MRBrain Tumor

On clicking on the apply button we created a label map which basically shows a model.

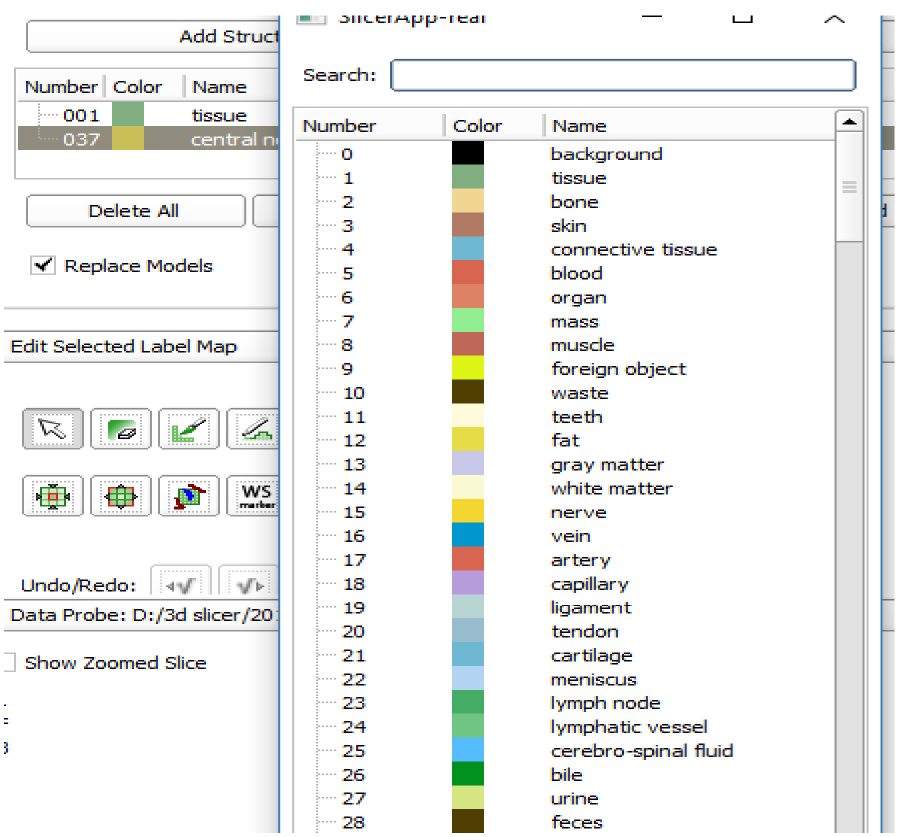


Figure-7 Selection the type of model according to its characteristic

Purpose of make model effect command we may also specify the color of the targeted version and select the type.changing the residences of the brain tumor in phrases of color and threshold set the limits according to the perfectness of that focused version.

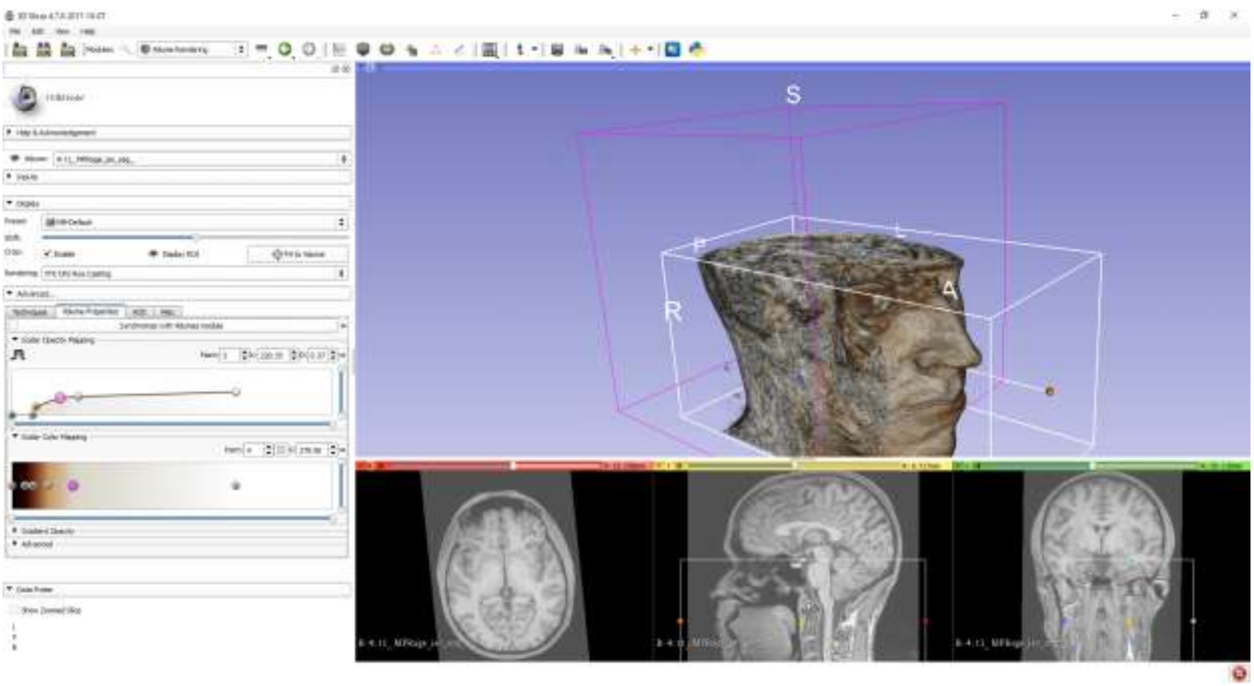


Figure-9. Selection and making threshold limit

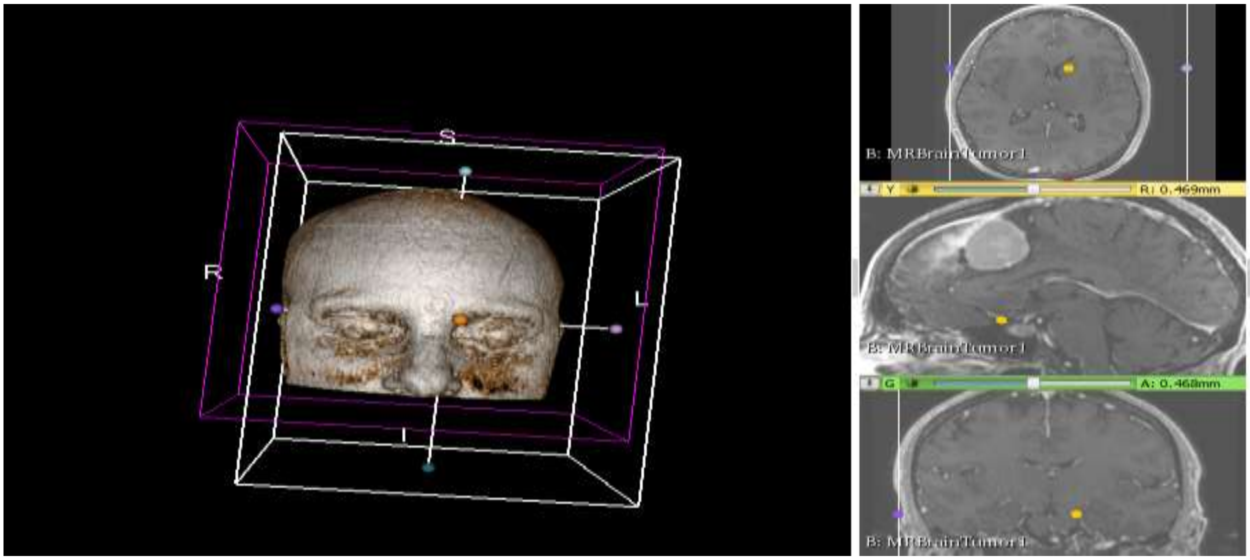


Figure-10. The material of targeted project

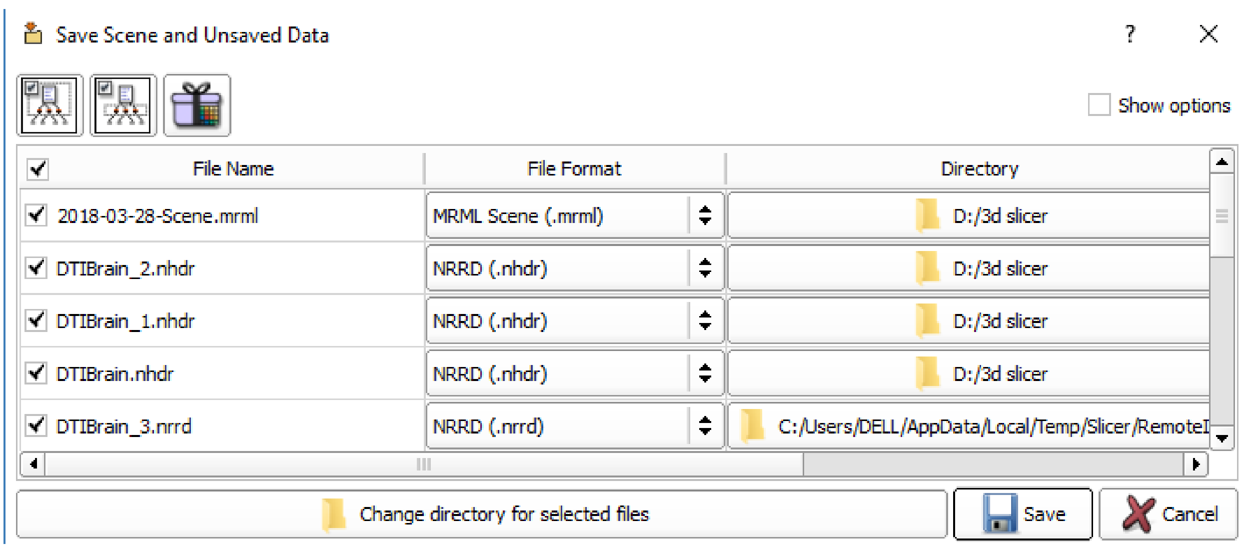


Figure11- Saving a Image data

Finaaly, we save this file format into.stl or .obj file and click to check on the .vtk option and select the directory into.stl file extension on our specified storage destination.

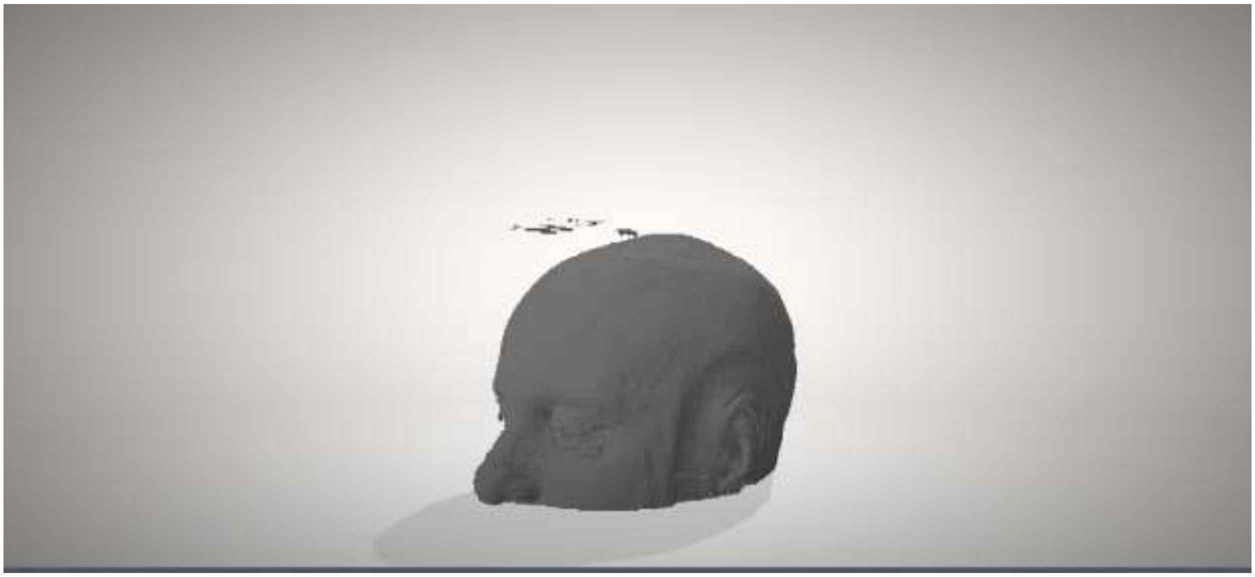


Figure -12. Final object

II. MR Head:Model 2

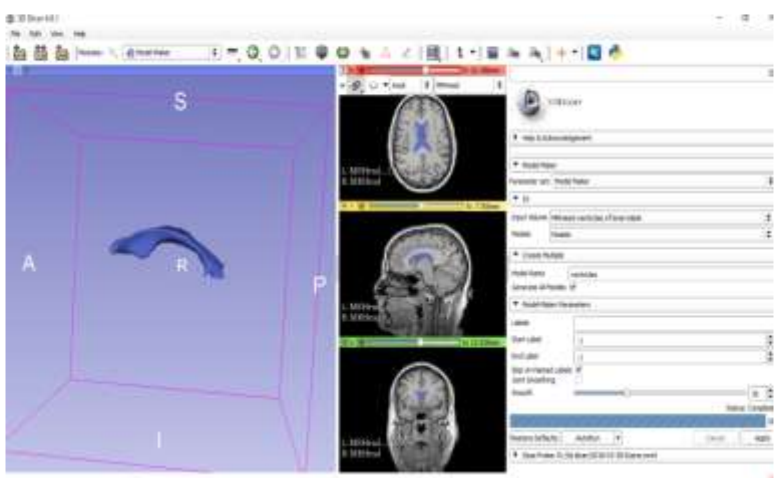


Figure-13. Create MRbrainHead

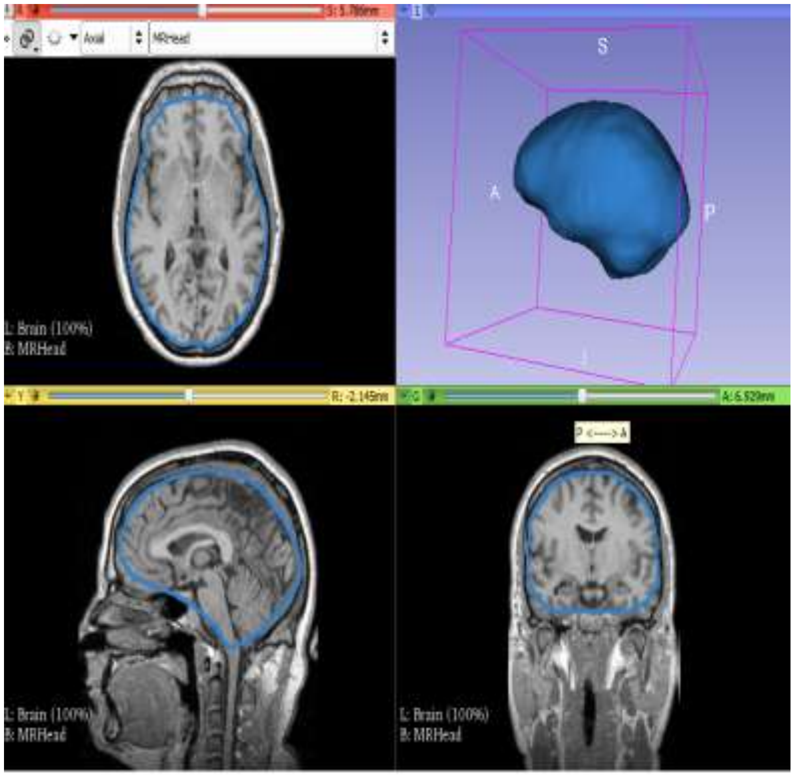


Figure 14. The material of targeted project

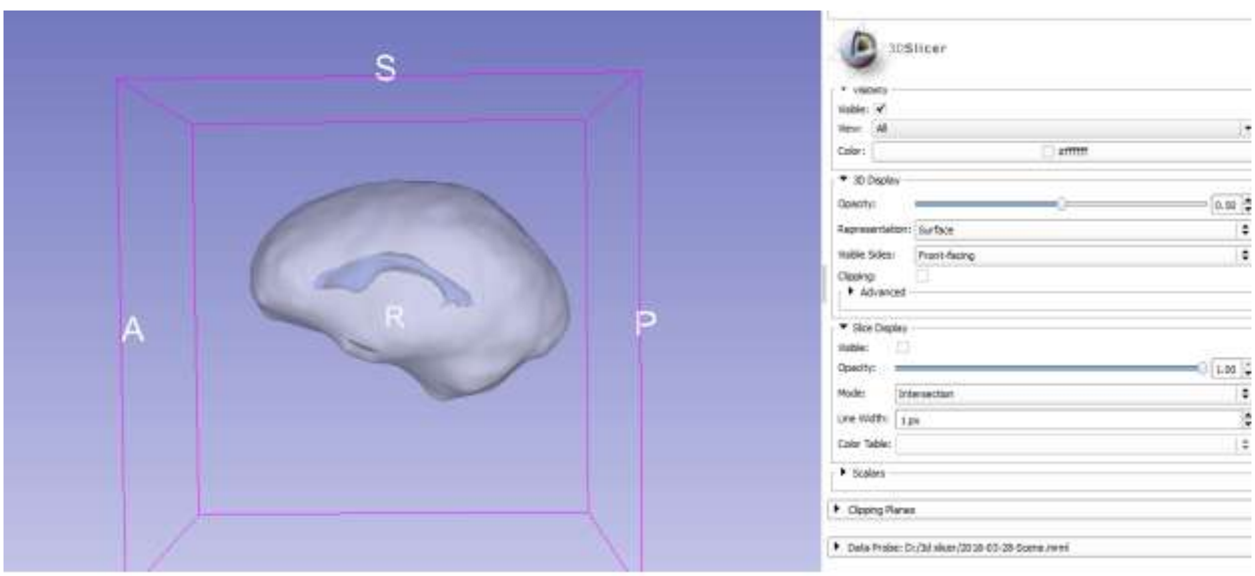


Figure-15. Final object

Analysis and design

1.1 Requirements

Functional requirements

• Single modality visualization

• Multi modalities visualization into one 3D workspace

• Vertex iEEG data projection into volume modalities

• Standard planar presentation of volume modalities

• Rendering output customization using linear transfer function

• 3D model manipulations Non-functional requirements

• Implementation in framework Unity3D

• NIFTI raw data file format support

• Support of VR interface

• Intuitive GUI for medical doctor.

Single modality visualization

Modalities MRI and CT are provided in the form of volumetric data set. Volume data consist of numerical floating point scalar values.

Multi modalities visualization into one 3D workspace

The key requirement is to increase information value of output image by combining different modalities together and displaying them into a common 3D workspace. Different modalities, which belong to one patient, are registered to the same coordinates system and have the same spacing and rotation.

Vertex iEEG data projection into volume modalities

Data from the invasive electroencephalography (iEEG) are produced by 120 or more electrodes. Data sets contain coordinates and array of values for each electrode. The coordinates are registered with volume data coordinates.

Standard planar presentation of volume modalities

Medical volume data are typically presented as three planar slices, called multiplanar reconstruction (MPR). Coronal, axial and transversal planes are mutually orthogonal slices.

Rendering output customization using linear transfer function

Volume rendering must be customizable with the linear transfer function which sets brightness and contrast of data.

3D model manipulations

Volume rendering must support basic manipulating functions – rotation, zoom and volume crop.

Implementation in framework Unity3D

Application must be implemented in framework Unity3D

NIFTI raw data file format support

Volume data are saved in unified NIFTI-1 format. Each volume is stored with metadata in a single file.

Support of VR interface

The application should support virtual reality GUI for displaying volume data as well as multi planar reconstruction.Single modality visualization

Modalities MRI and CT are provided in the form of volumetric data set. Volume data consists of numerical floating point scalar values

Intuitive GUI for medical doctors

Target users of the application are technical researchers and medical doctors. The graphic user interface must satisfy a following requirements: intuitive user controls, corresponds with a classical arrangement of MPR and flexible layout.

1.2 **Domain model**

This section is identified the main domain entities related to the topic of this thesis.

Volume data

Volume data represent neurological examinations such as CT, MRI, etc. Raw data are provided as array of scalars. Voxel is represented as a single floating point number. Multi-volumes data from one patient are re-sampled and share the same slice spacing, spatial dimensions and rotation.

Vertex data

For this purpose, there are iEEG data provided in form of 3D coordinates and 1D array of values. The array represents the time progress of the value measured by a single electrode.

Scene

The scene consists of several objects representing modalities. The first one is a 3D model of single or multi volume data.

Planar views

Planar view is a single slice of volume data. Medical software standardly work with three orthogonal planes - coronal, axial and transversal

Virtual reality in medical environment

Virtual reality (vr) is speedily growing field that's principally accelerated by progress in graphics hardware performance throughout last years. Though VR devices and computer code development square measure principally battery-powered by the show business, there square measure several opportunities for adapting vr for serious tasks for various fields. A lot of info concerning video game are going to be bestowed within the next section. In a medical atmosphere, there square measure many fields wherever vr has already been used for years. The subsequent list provides an outline of such usages: exposure therapy, treatment for post-traumatic stress disorder (PTSD). Brain harms assessment and rehabilitation, social knowledge coachin for patients with syndrome and customarily surgery. In a very surgery there ar three main approaches, it's surgical coaching, identification and surgical coming up with. All higher than mentioned examples offer positives results and that they contribute to enhancement of the standard of care. In surgical process, ancient multi-planar views of modalities are usually used besides the 3d model that doesn't increase data price plenty. This state of the art could amendment with computer game wherever the user is directly within of scene. Code for this specific application is for instance developed by surgical theater, an organization that that integrates vr with the 3d surgery navigation device referred to as snap. Consistent with university of golden state losangeles, that uses their code in surgical process for identification of brain tumor, it considerably hurries up neoplasm localization and overall identification method applications like one from surgical theater bring new potentialities into the medical atmosphere and on the opposite hand, it additionally opens new challenges on the technological facet. The positive results of existing solutions show its utility which ought to be inflated with a future development.

Virtual Reality

Virtual Reality is associate alternate world stuffed with computer-generated pictures that reply to human movements. These simulated environments square measure typically visited with the help of a fashionable knowledge suit that options two-channel video eyeglasses and fiber-optic knowledge gloves. (Coates, 1992).

VR is that the next step in overwhelming of 3D graphic. It places the user in the middle of a virtual surroundings and with specialized controllers provides believable simulation. The VR device consists of a head-mounted display (HMD) that provides stereoscopic read of the virtual scene. It’s one show split in or 2 separate displays. The right pure mathematics of scene is calculated for each eye so as to produce 3D illusion. The device traces the position of the user's head and comes the top rotations (and generally also special position in reality) into the virtual scene. The movement's square measure tracked by constitutional gyro or by external motion pursuit cameras. Interaction with the virtual scene is controlled by classical gamepads, specialized controllers or as an example by the Leap Motion. Specialized controllers similarly to HMD embody rotation and position trackers and a few of them conjointly offer somatosensory feedback. Leap Motion could be a contactless controller, which traces space up to at least one meter, usually user's hands, and acknowledges hands and fingers inputs. VR devices are going to be bestowed in 2 teams for this purpose. The first one covers skilled HMD devices and therefore the second includes Google Cardboard and Cardboard-like merchandise.

Libfreenect

Kinect was designed only to be connected to Xbox, and there was no official support for any other platform. Libfreenect was the first successful attempt to communicate with Kinect from a personal computer. Basically, this library offers basic functions to fetch the RGB (red, green, and blue light) and depth images, as well as to read the other sensors.

Kinect

Released in November 2010, Kinect is a relatively low-cost (about $149) device developed by Microsoft that provides joystick-free gaming just using body gestures recognition. The device provides a color camera, microphones, accelerometers, and a motorized tilt; however, the most important and novel component is a depth camera.

The depth sensing is provided by an infrared (IR) projector that projects a fixed structured light (consisting of a pattern with millions of small dots), and an infrared camera captures the reflections of this pattern and provides an 11-bit single-band image (i.e., from 0 to 2,048). The microprocessor inside Kinect performs stereo triangulation between the image captured by the infrared camera and the original pattern, obtaining the depth information for each point on the field of view.

All the cognitive features like players and gesture recognition are not really performed by Kinect. The device itself just provides the cameras, leaving the recognition itself to be executed by software that implements state-of-art computer vision methods The output of this triangulation is the depth image, which is a gray-scale image, where the intensity of each pixel is proportional to the depth, which is the distance from the device to the object on the scene in the corresponding pixel position.based on depth images

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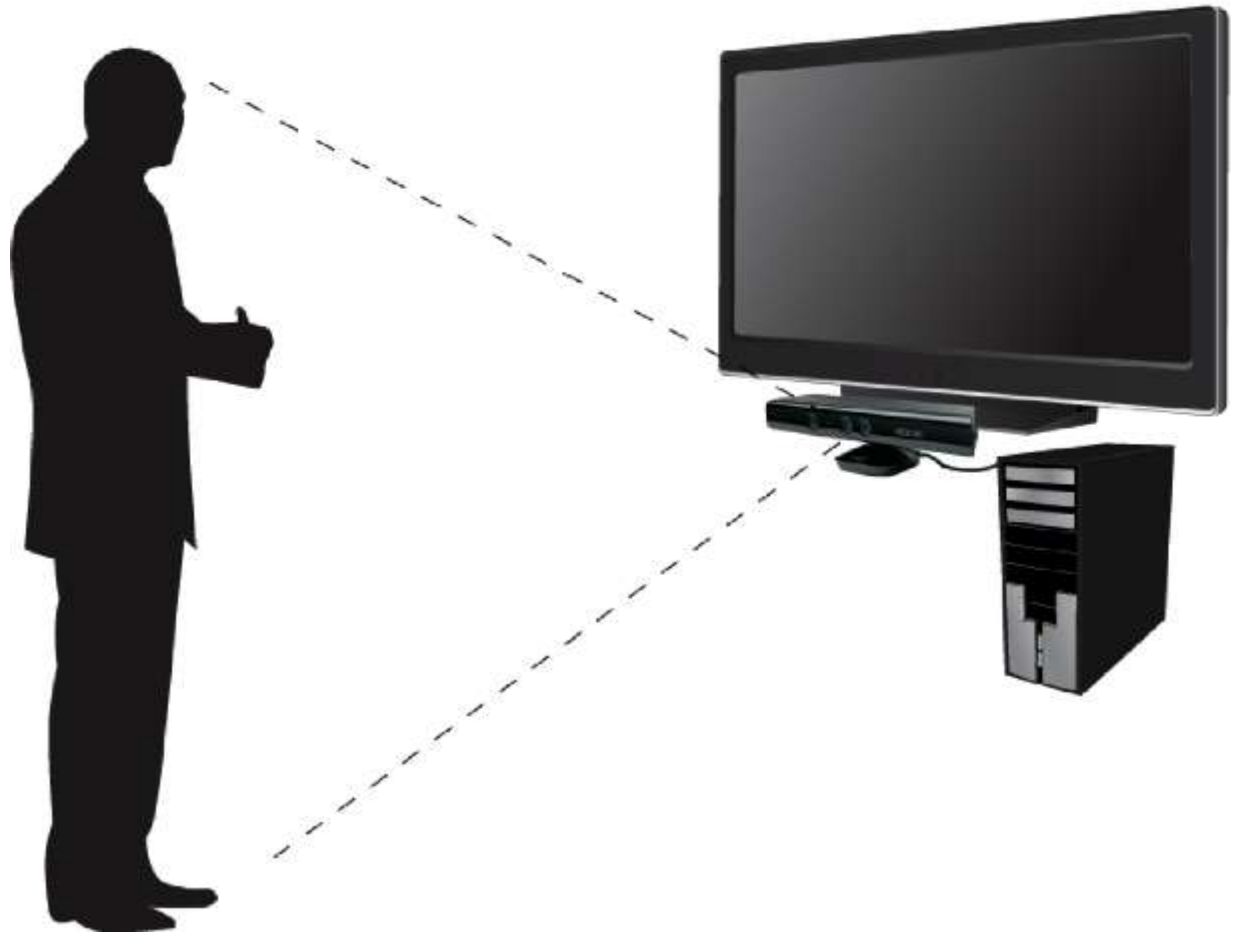
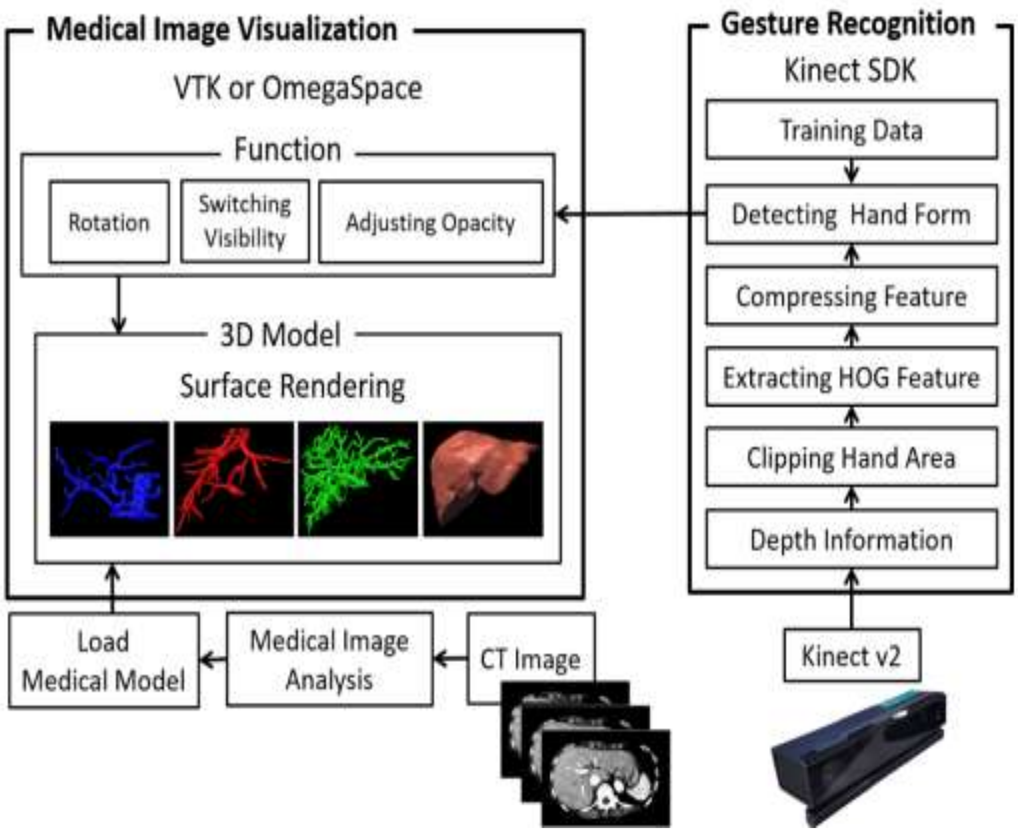




Virtual Reality

VR to be good for treating post-traumatic stress disorder. And stroke doctors, pain specialists, surgeons, and other medical practitioners have found their own uses for VR. In some cases, medical VR involves the familiar headsets; in others, 3D glasses and special video screens give a VR-like experience. he use of VR and 3D visualization technology in medicine isn't brand-new. Medical researchers have been exploring ways to create 3D models of patients' internal organs using VR since the 1990s. But advances in computing power have made simulated images much more realistic — and much faster to create.

X-rays, CT scans, and MRI scans can now be turned into high-resolution 3D images in under a minute, said Sergio Agirre, chief technology officer of

EchoPixel, a Mountain View, California firm whose visualization software is being used in hospitals across the U.S. “Twenty years ago, it would probably take them a week to be able to do that.”

PLANNING COMPLEX OPERATIONS:

These days, common surgical procedures like appendectomies or cesarean sections are often pretty routine — one case is similar to the next. But some especially complicated procedures — including the separation of conjoined twins — present unique challenges that can be met only with meticulous planning. For these, 3D visualization is proving to be a game-changer.

Recently, VR played a vital role in the successful separation of conjoined twins at Masonic Children’s Hospital in Minneapolis. The three-month-old twins were joined far more extensively than some other conjoined twins, with intricate connections between their hearts and livers. That meant the surgery to separate the twins would be unusually complicated — and potentially very dangerous for the twins.

Before surgery, the surgical team took CT, ultrasound, and MRI scans and created a super-detailed virtual model of the twins’ bodies — and then ventured “inside” their organs to identify potential pitfalls and plan how these would be avoided during surgery.

“You look through the 3D glasses, and you can basically walk through the structure, peeling apart parts so you can look at exactly what you want to,” said Dr. Anthony Azakie, one of the surgeons who separated the twins. He said the high-resolution visualization “helped minimize the number of surprises that we were potentially dealing with.”

HMD

Head-mounted displays (HMDs) have been discussed since the 1960s but actually deployed in only a few domains like military applications. A renewed interest in HMDs with augmented reality (AR) modalities is fostered by commercially available and cheaper products and the needs for using computers in mobile contexts, among others in the healthcare domain.

As a starting point for a user-centered design process and in order to derive relevant scenarios, we reviewed current literature and conducted interviews with more than 20 physicians, nursing sta and members of emergency medical services. Two HMDs (Google Glass, Epson Moverio BT-200) have been evaluated for use in the medical domain. Google Glass (see Figure 1) can be controlled by either using a touch pad at the right sidepiece or a xed and small set of voice commands. Its display is show on the right side of the user's visual eld and equals a 64 cm (~25") high denition screen seen from a distance of 250 cm (~8 ft.). The device should be positioned slightly above and not directly in front of the eye

Another device, the Epson Moverio BT-200 (see Figure2), features a binocular display which allows viewing contents centered like watching a 200 cm display (~80") seen from a distance of 500 cm (~16 ft.). A trackpad can be used for manually controlling applications and built in motion trackers and a camera can be used for hands free interactions. Location-based services can be realized through an integrated GPS-sensor. Our research indicates great interest in HMDs with AR capabilities by medical professionals all along the rescue and medical chain, independent from specific device models. Use cases mentioned spin around two aspects retuning an interactive system hands-free and second having medical information ubiquitously available. However, there is still uncertainty among the medical experts about special features, limitations and reliability of HMDs.

Unity 3D

Unity3D is a game engine developed by Unity Technologies for developing cross-platform games in 2D and 3D. These could be deployed on Personal Computers (PC), consoles, mobile devices, Head Mounted Display devices and over the web. The personal edition of Unity is freely available for users to develop interactive content. It offers intuitive user interface tools and is customizable to fit any developer's needs. The Unity Editor provides highly optimized physically-based shading and enables the user to generate high-resolution graphics. It is not game-genre specific and is a feature rich game engine. It offers a great asset pipeline (the workflow for generating assets used in game development) and has a deep feature set. For developing on Unity, the users can either use C# or JavaScript programming language. It natively offers Visual Studio and Mono Develop integration. Unity supports iterative development as opposed to using DirectX or OpenGL and offers a relatively efficient engine in comparison to other game engines available. Unity3D is the most commonly used for developing games for Virtual Reality and Augmented Reality devices. Unity has been used for Universal Windows Platform (UWP) apps even before HoloLens was available publicly. UWP applications appear as 2D projections when deployed to the HoloLens. Unity3D is the recommended platform for developing applications on the HoloLens. The user can start developing on the device after setting up the Windows SDK with Unity. The developer will need to switch between the Unity Editor and Visual Studio for completely prototyping an application package for the HoloLens. Once the Virtual Reality support is enabled on Unity, the Unity camera component handles the head tracking and stereoscopic rendering for HoloLens. The HoloToolkit made available on GitHub provide commonly used prefabs for the HoloLens that can be imported into the Unity editor. These are helpful in rapidly developing applications for the device. Unity3D has an active ecosystem of assets and plugin creators and offers cross-platform integration for over 25 platforms. The Asset Store offers a wide variety of objects that can be used in projects for free or a minimal fee.

Introduction

Three dimensional (3D) productions are becoming a vital unit not only in the game industry but also in many other industries such as architecture, physics, science, and health in particular. Currently, 3D engines have accumulated different tools and methods to deal with the rapid changes in the upcoming and progressive technologies. Continuous increase in computing performance makes it possible to create new graphic contents. In the health sector, diseases, such as leukemia cancer, are still under investigation. Every year, an increased number of studies are attempting to find effective ways to combat this illness and answer domain experts' questions on the data analysis of leukemia patients. The underlying complexities of the disease are not always clearly reflected by the clinical presentation or pathological results. For example, genomic variation, typified by single-nucleotide polymorphisms (SNPs), have considerable influence on how humans develop diseases and respond to pathogens, chemicals, drugs, vaccines, and other agents. Unity3D makes graphical user interface (GUI) code easy to write, enabling rapid prototyping, and the workflow for incorporating assets from other tools. Moreover, Unity3D can use Direct3D on Windows machines, which allows users to employ off-the-shelf drivers to see 3D charts such as scatter plot and even a heat map in stereo on suitable equipments. Using OpenGL, we would have to code the view from each eye explicitly to produce the stereo.

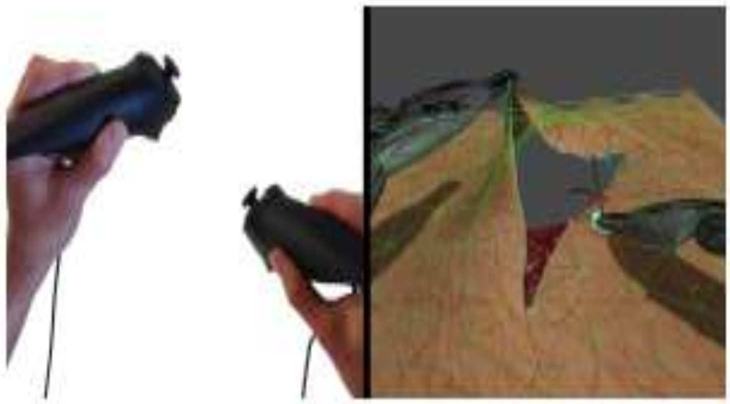
The application allows users to move and rotate the reconstructed model facilitating zoom in and out simply pressing buttons.

2. The application should play model rotation animations for easy viewing from different points of view.

3. Layers will have to show different human tissues separately.

4. Surgical preparation with virtual reality may represent a more cost-effective and efficient alternative. Virtual reality training improves operating performance. The use of VR surgical simulation to train skills and reduce error risk

5. The last iteration, we added support for the Razer Hydra – a pair of controllers from which an accurate three dimensional position and rotation can be



The Razer Hydra used in the Surgical Skin Simulator prototype

Unity3D application

1. Architecture model:

Unity application is split into three logical modules. Each module is mainly

Controlled by its manager class which is View Manager for the presentation module, Model Manager for the logic module and Data Manager for the data module**.**

3D formats

Unity supports importing Meshes from two different types of files:

1. **Exported 3D file formats**, such as .Fbx or. obj. You can export files from 3D modeling software in generic formats that can be imported and edited by a wide variety of different software.

2. **Proprietary 3D or DCC (Digital Content Creation) application files**, such as .max and .blend file formats from 3D Studio Max or Blender, for example. You can only edit proprietary files in the software that created them. Proprietary files are generally not directly editable by other software without first being converted and imported. An exception to this is SketchUp .skp files, which both by SketchUp and Unity can read.

Advantages:

3. Instead of importing the whole model into Unity, you can import only the parts of the model you need.
4. Exported generic files are often smaller than the proprietary equivalent.
5. Using exported generic files encourages a modular approach (for example, using different components for collision types or interactivity).
6. You can import these files from software that Unity does not directly support. Exported 3D files (.fbx, .obj) can be reimported into 3D modeling software after exporting, to ensure that all of the information has been exported correctly.

Unity Application automatic tests

Automatic testing of Unity Application was made with N Unity, which is a unity in testing framework. Unity3D enables running these tests inside of the Unity

Editor, so all features from Unity are available. For each class in application was created a test class with appropriate tests.

Presentation module

The presentation module covers everything connected with GUI. The structure of the module is captured ViewManager class is implemented as a singleton. It holds the current layout structure and because Unity uses a single rendering thread, there is no need of more instances per application. Individual elements are arranged in hierarchical structure implemented by using inheritance. To each class of graphic component belongs another class named "class name + TargetScript" which inherits from Unity class MonoBehaviour. This allows the script to execute per frame updates.

Working on Unity3D

To start adding 3d model on unity3D, open a software platform and add data through the command which specified file source contained .Obj or drag the data from source folder directly to the software platform.

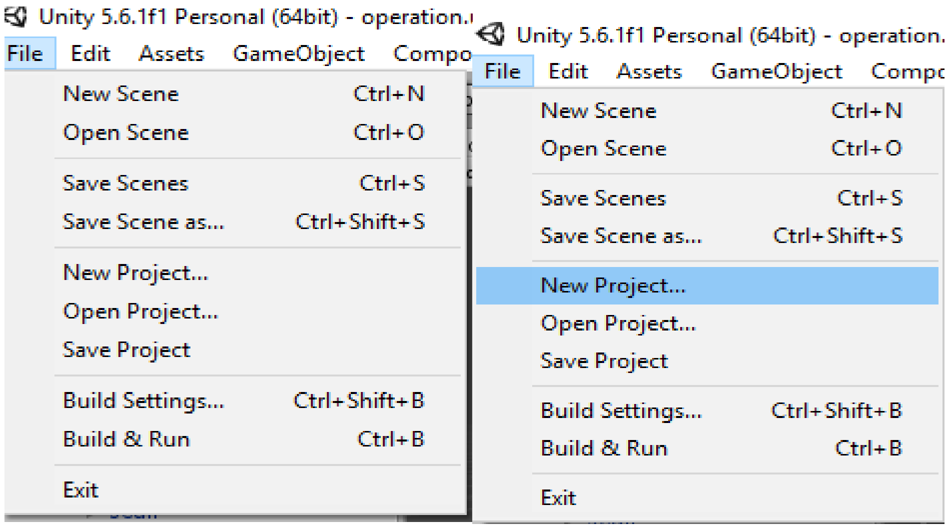


Figure -16 Open a new project

The source directories in the navigated folder choose it and drag to the software then we can import our object in asset models.

Figure-17. Import to the object on asset model

Next step we should insert main camera because of we can see the object view clearly.

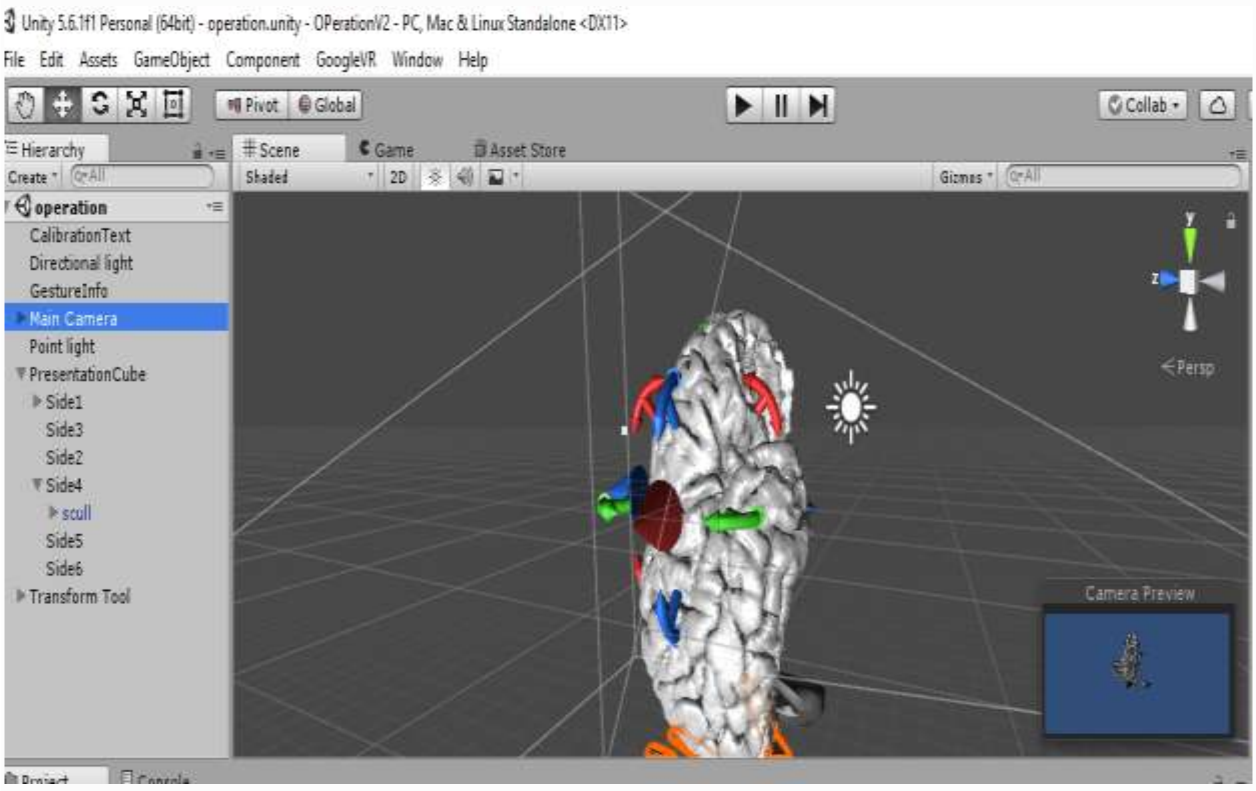


Figure-18 Insert to the maincamera

Import Leap Motion:

The manipulation of these display systems is usually done by manual input devices such as a mouse, a keyboard or a touch screen, putting at risk the sterile conditions of the room and therefore the success of the intervention.

There are some human-computer interfaces controlled by hand gestures, facial expressions and body gestures that allow surgeons to browse and manipulate medical image keeping sterile conditions. It uses intuitive gestures and can be useful in the operative room increasing the patient safety.

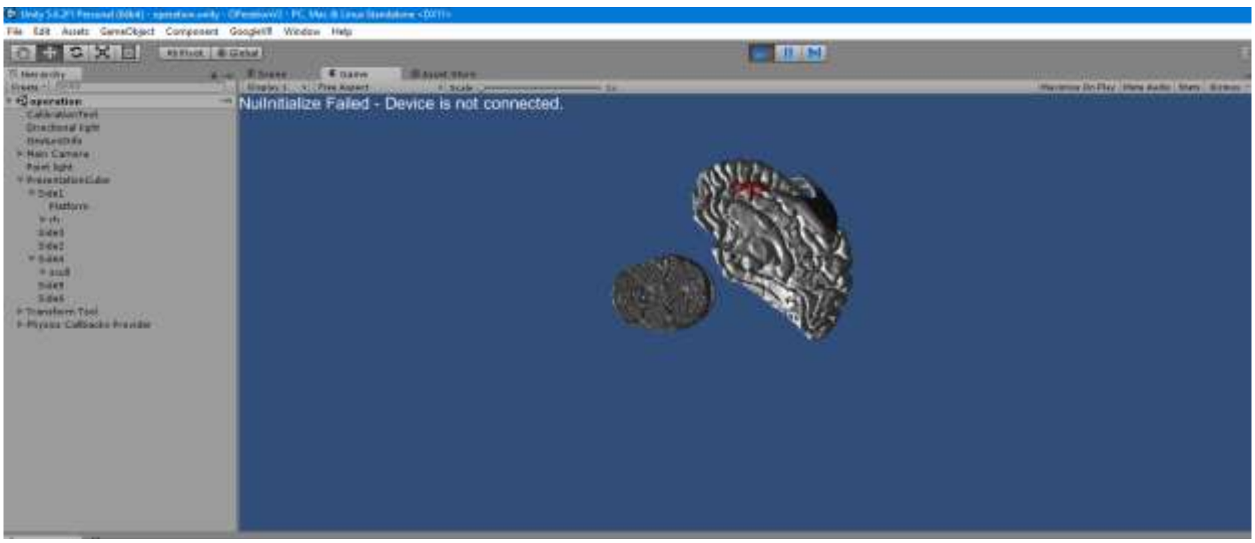


Figure-19. Import Brain 3d object

The proposed system requires a computer with Unity 3D- software previously installed and the LM connected. The first requirement to use the developed module is that a diagnostic image should be loaded in the Unity 3D environment.

The model used for the transmission of information between the LM device and the Unity 3D software is a client-server and the communication protocol is TCP-IP, where the software module receives the information transmitted by the LM and generates a series of events under the established conditions for the handling of medical images in the Unity 3D.

Additional to the gestures, the LM captures the position of each finger. That information is also sent to the visualization software. That something that corresponds to manipulate the view point of the uploaded images scene. The motion of the axial, the sagittal and the coronal planes are also possible as well as the zoom in and zoom out on specific areas. The Zoom function is set by default in the visualization module. This function allows the user to Zoom in or Zoom out on axial, sagittal or coronal planes of the images

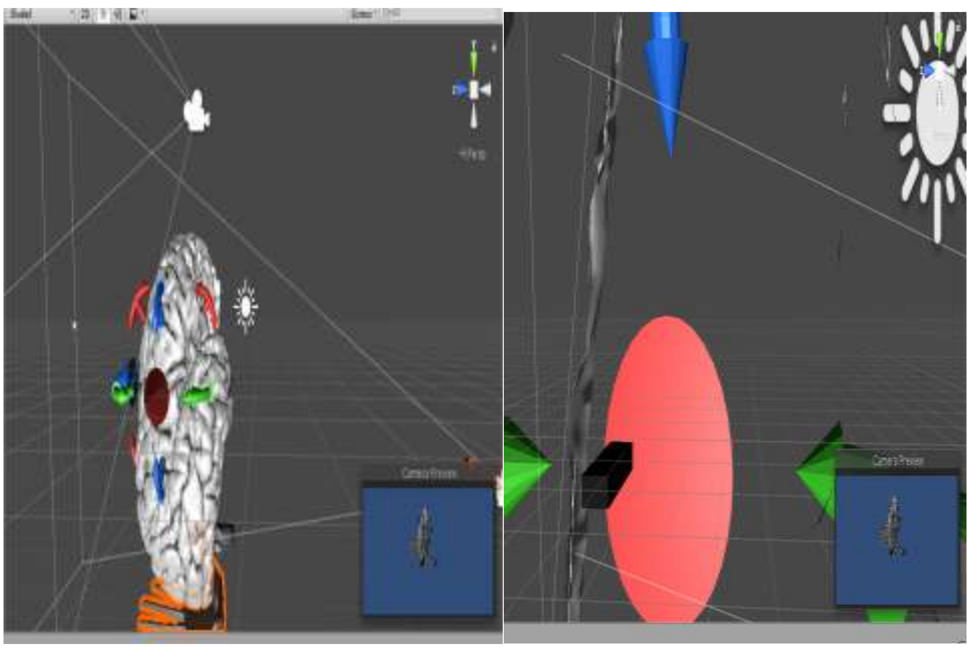


Figure-20. Zoom in and Zoom out

Moving the hand up and down, right to left or toward and away from the monitor, the planes respectively move keeping correspondence between the plans and movements of the hand.

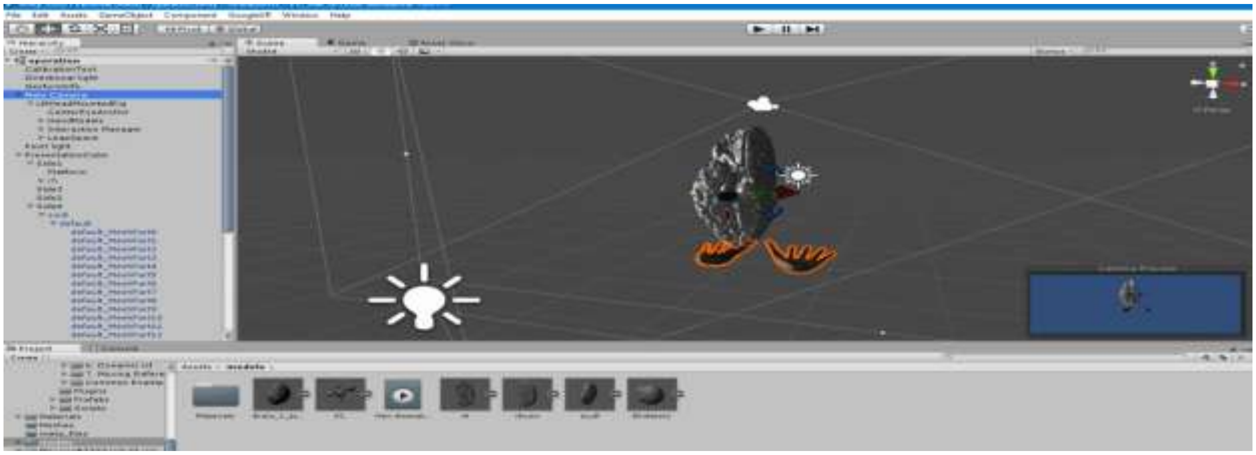


Figure-21. Supporting gesture control

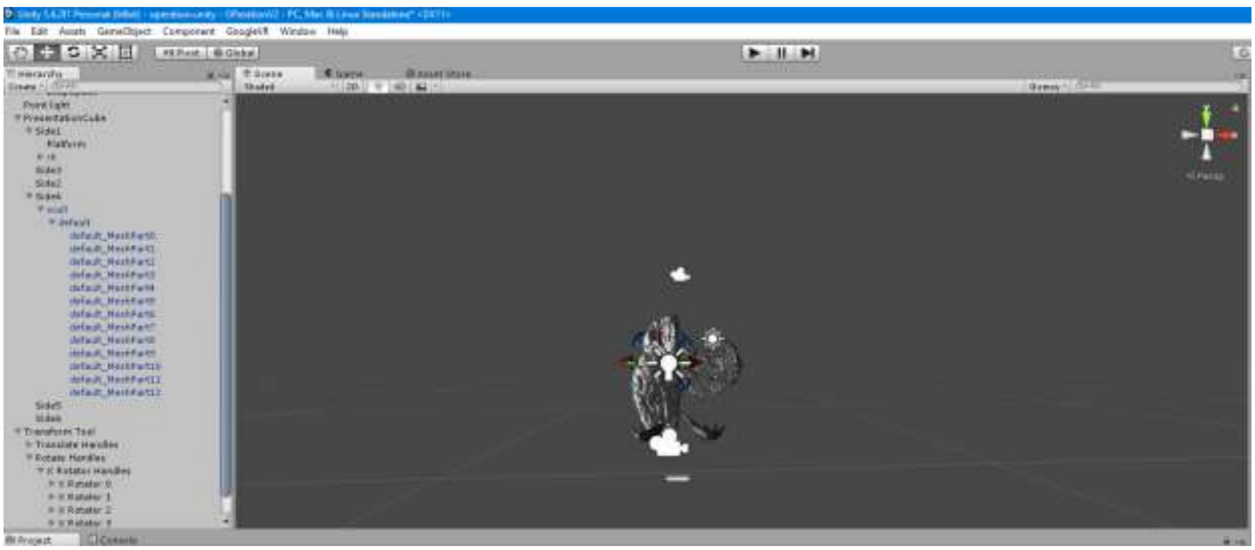
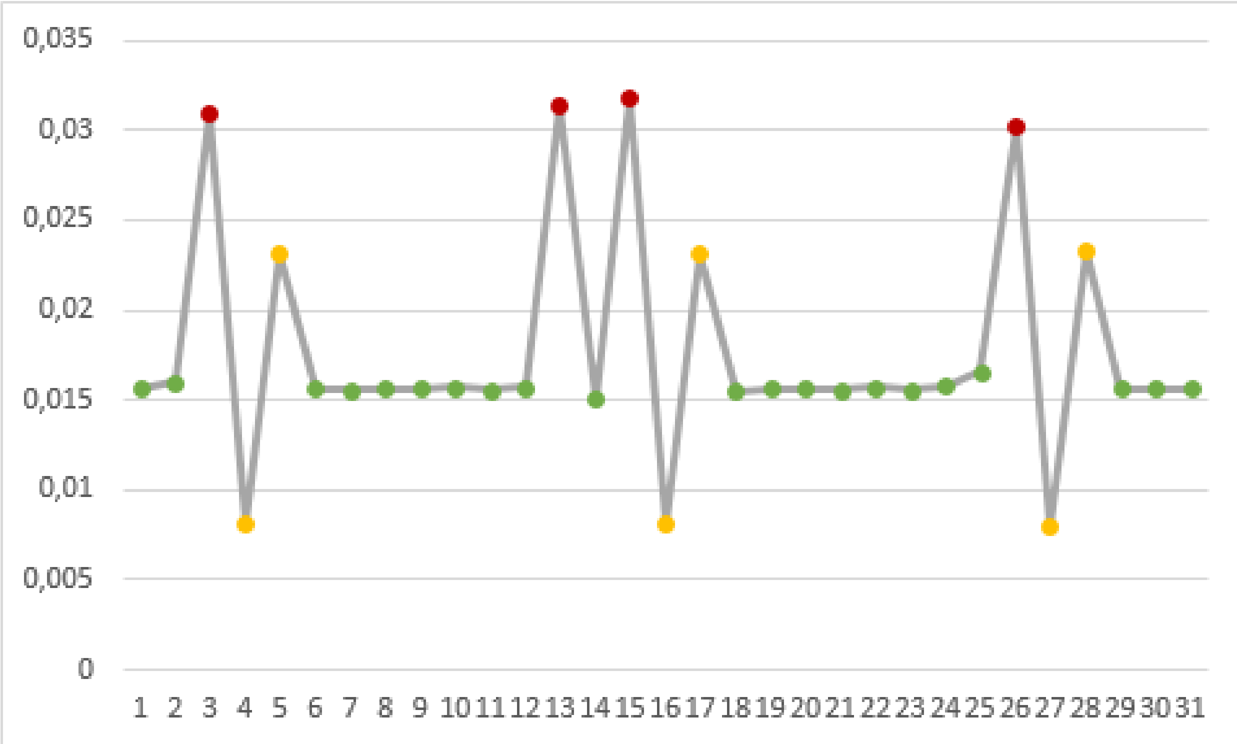


Figure-22. Supporting gesture to rotate the object

Next step we will operate the model as a separate model, its very useful for the doctor can easily identify the issue of the patients.

The second part of the unity 3d for the targeted project is to make a separate the model. We are going to apply on it. On the result, we are going to save this model and import into.Obj file in navigation folder.

Leading to stutters in the camera moment.



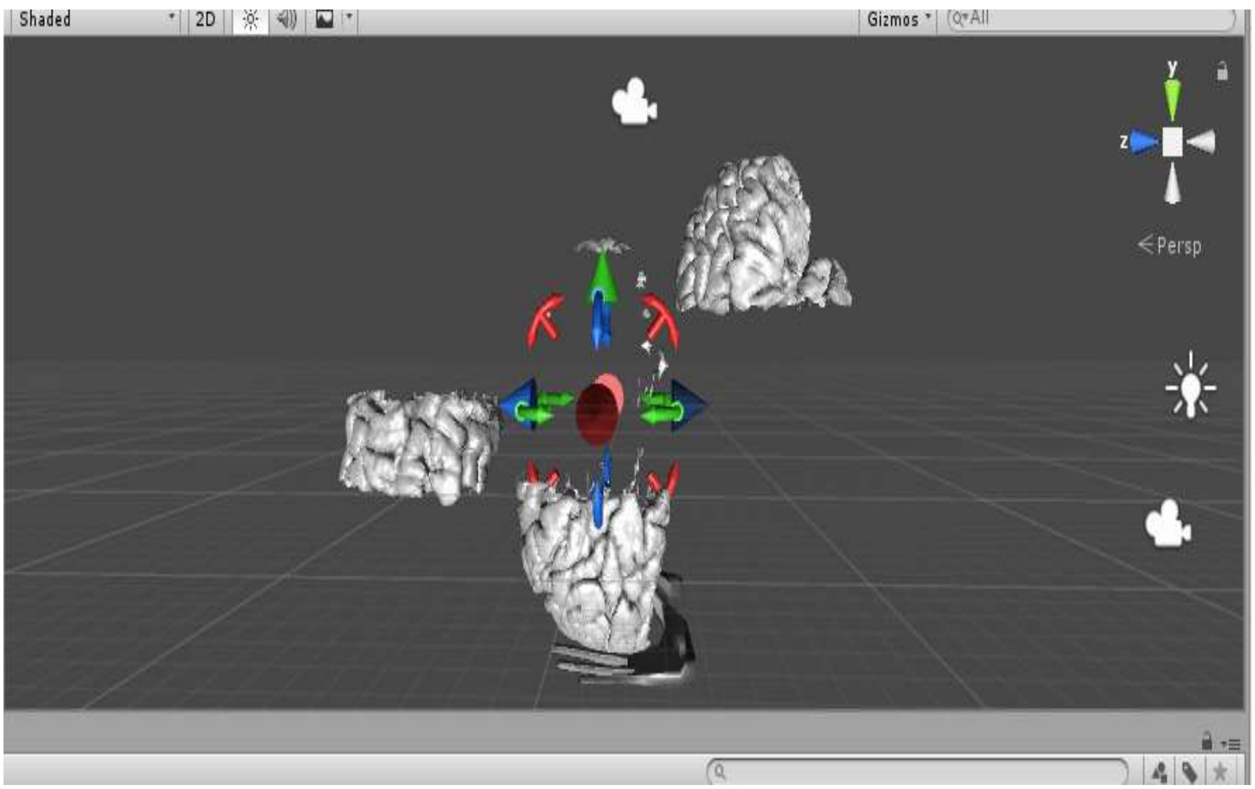


Figure-23. Selection to making three separate model

Chapter-4

Conclusion

The main purpose of this thesis was to design a 3d anatomical viewer for virtual reality and it was successfully fulfilled. Purpose In the operating room a touchless interface is an ideal solution since it does not demand any physical contact and still can provide the necessary control features in a cleansed and sterilized environment. A touchless user interface solution applying the Kinect and leap motion device showed to be very efficient and enabled a low-cost and accurate control of the software intraoperative, just using hand gestures. It can be used with any mouse-controlled software, opening an avenue for potential applications in many other areas, such as data visualization, augmented reality, accessibility, and robotics. The further validation and advancement of this technology are underway.

Beside the main application designed in Unity3D framework, an extension for Slicer 3D application was developed. The main goal of the application is a future adaptation for any virtual reality platform such deployment to clinical research environment. The main improvement requirement is a redesign of the current graphic user interface.

TASK FOR MASTER'S THESIS SECTION

"FINANCIAL MANAGEMENT, RESOURCE EFFICIENCY AND RESOURCE CONSERVATION"

List of graphic material	
1. *Segmentation of the market* 2. *Estimation of competitiveness of technical solutions* 3. *SWOT Matrix* 4. *Schedule and budget of the project* 5. *Assessment resource, financial and economic efficiency of the project*	

Date of issue of assignment	

Assignment given by consultant:

Position	Name	Degree	Signature	Date
Associate Professor	**Dankov Artem Georgievich**	**PhD Economics**		

Assignment received by student for implementation:

Group	Name	Signature	Date
1DM6I	Ramesh Janarthanan		

Abstract:

While surgical practices are increasingly reliant on a range of digital imaging technologies, the ability for clinicians to interact and manipulate these digital representations in the operating theatre using traditional touch based interaction devices is constrained by the need to maintain sterility. To overcome these concerns with sterility, a number of researchers are have been developing ways of enabling interaction in the operating theatre using touchless interaction techniques such as gesture and voice to allow clinicians control of the systems. While there have been important technical strides in the area, there has been little in the way of understanding the use of these touchless systems in practice. With this in mind we present a touchless system developed for use during surgery. We deployed the system in suite of a large hospital for use in the context of real procedures. We present findings from a study of the system in use focusing on how, with touchless interaction, the visual resources were embedded and made meaningful in the collaborative practices of surgery. In particular we discuss the importance of direct and dynamic control of the images by the clinicians in the context of talk and in the context of other artefact use as well as the work performed by members of the clinical team to make themselves sensable by the system. We discuss the broader implications of these findings for how we think about the design, evaluation and use of these systems

Introduction:

Registration of preoperative images to the interventional setting is one of the key technical components of image-guided navigation systems.The most commonly utilized registration approaches rely on the use of fiducials or anatomical landmarks and surfaces. These structures are localized in the preoperative image either manually or automatically. Intraoperatively, they are digitized using a tracked pointer tool or, possibly, a laser range scanner. The preoperative 3D data are then registered to the 3D data acquired intraoperatively using various 3D/3D point-based rigid registration algorithms.

An alternative approach is to perform 2D/3D anatomy-based rigid registration, aligning the preoperative volume, MR, or CT to the intraoperative setting using a few x-ray images. This subject has been studied extensively, resulting in a large number of published algorithms. A broad overview of the various approaches to solving this challenge is given in a recent survey. While the differences are many, all of these algorithms have one thing in common, they are iterative and require initialization.

- In practice, the majority of these algorithms have not been able to transition from bench to bedside. The only domain where 2D/3D registration has become part of standard clinical care is radiation therapy. The distinguishing characteristic of this domain is that a good initial estimate of the transformation is obtained by accurate patient positioning using other means. 1.Manual initialization — interactively manipulate the pose of the 3D image using the keyboard and mouse. In combination with the known x-ray camera parameters, a 2D image is generated from the volumetric image. The user actively manipulates the transformation parameters such that the computer generated image and the x-ray image become visually similar.It should be noted that there are clinical procedures where such an approach can serve as the final registration result. Two recent examples include x-ray/MR registration for congenital heart disease catheterization and x-ray/CT registration for radiation therapy treatment of head and neck cancer.

• 2.Coarse paired point registration — using an analytic, paired-point registration algorithm with coarsely localized points in the intraoperative setting. These can be either skin adhesive fiducials or anatomical landmarks. Points can be localized intraoperatively either by using a tracked pointer tool or by using several x-ray images and estimating point locations as the intersection of back-projected rays. A recent example describing automatic identification of a sparse set of corresponding anatomical landmarks, vessel bifurcations, and spine centerline to perform initialization was described inWhen using fiducials, it is sometimes possible to accurately localize them both in the x-ray and the 3D imaging modality, and thus obtain the final registration result. An example illustrating this approach for x-ray/MR registration is described in , and describes this approach in the context of x-ray/CT registration.

• 3.Clinical setup — using the known geometry of the intraoperative imaging system to bound the transformation parameters. A rough initialization can be obtained by using the intersection point of all principle rays to position the preoperative image. Procedure specific knowledge can also be incorporated to estimate orientation. That is, assuming a specific patient setup (e.g., supine), and associating x-ray images with specific camera orientations (e.g., anterior-posterior).

Additional initialization approaches include:

• 1.Brute force — using an estimate of the transformation parameter values based on clinical setup, sample the parameter space in that region using a coarse grid. For all parameter values generate corresponding digitally reconstructed radiographs and compute the similarity measure's value. The parameters corresponding to the best similarity value are used as the initial estimate.

- 2.3D/3D intensity based registration — obtain an initial registration by registering intraoperative Cone Beam CT (CBCT) to the preoperative CT. This approach is also readily applicable to initialization of x-ray/MR registration, via CBCT/MR registration.

- 3.Fourier slice theorem — specifically address the task of initialization in the context of x-ray/CT registration. In this work, the Fourier slice theorem facilitates estimation of the orientation, and phase correlation is used to estimate translation. This method was able to improve the registration success rate of an intensity based registration algorithm from 28.8% to 68.6%.

- 4.Virtual fiducial marker — using a bootstrap form of approach to initialize x-ray/CT registration, equally applicable to x-ray MR. This method is based on the use of a virtual fiducial marker. That is, an easily identifiable set of fiducials, graduations of radiopaque ruler, are placed next to the patient intraoperatively. In an initial setup step, two wide field of view x-rays are acquired and x-ray/CT registration is performed using the paired-point approach with corresponding anatomical landmarks localized in the two x-rays and the CT. The ruler coordinates are then mapped to the CT coordinate system, creating a virtual fiducial. From here on, re-initialization is obtained in part using knowledge about the clinical setup, orientation, and one component of translation, and use of a single virtual fiducial point and triangulation to resolve the two additional translational components. The method was successfully evaluated using data from 31 aortic aneurysm repair interventions.

EXPENSES OF THE RESOURCES:

Leap Motion Sensor : 4,500- 7000 rubbles

Kinect: 3000 – 5000 Rubbles

VR HoloLens: 3000 USD

Epson 300: 60,000 Rubbles

Computer: 40,000 Rubbles

The basic salary

The initial regulations wages of these categories of workers is salary, which determines the level of monthly salary, depending on the volume of work and responsibility. The structure of the basic salary includes premiums paid monthly from the salary fund in the amount of 20 to 30% of the rate or salary.

It is believed:

The salary of the head: 1 thousand rubles / day;

Wage of Students: 0.4 thousand rubles / day;

Payroll of Consultant: 1 thousand rubles / day;

<u>SWOT Analysis:</u>

Strengths:

- Enhanced Ecological Validity
- Stimulus Control and Consistency
- Real-Time Performance Feedback
- Cuing Stimuli to Support “Error-Free Learning”

- Self-Guided Exploration and Independent Practice
- Low-Cost Environments That Can be Duplicated and Distributed

The main purpose of this thesis was to design a medical imaging viewer for virtual reality and it was successfully fulfilled. The current implementation of the application is a rough development preview but it has met all the main requirements which were set in the beginning. Despite broad spectrum of topics which are related with this thesis it was successfully brought to the objectives. The application is implemented in an environment of the Unity3D framework with usage of Google Cardboard SDK.

The Actuality Systems creates a volumetric image with the pixels arranged using cylindrical coordinates, that is, the volume is sliced by a set of radial planes. A rotating, semi transparent screen under a glass enclosure displays these radial slices according to the screen position, and the eye of the observer then synthesizes a true, volumetric image. The image can be observed from all sides, except from below.

We found that the greatest strength of this kind of display is that the viewer can study a fixed 3D image from different directions, simply by walking around it.

A strength can be viewed as a resource, a unique approach, or capacity that allows an entity to achieve its defined goals (e.g. VR can allow for precise control of stimulus delivery within a realistic training or rehabilitation simulation).

The software has regular updates, hence it is possible to make use of the latest updates for higher performances.

Weaknesses:

- The Interface Challenge 1: Interaction Methods
- The Interface Challenge 2: Wires and Displays
- Back-End Data Extraction, Management, Analysis,
- Visualization

A weakness is a limitation, fault, or defect in the entity that impedes progress toward defined goals (e.g., the limited field of view and resolution in a head-mounted display can limit usability and perceptual realism).

The project is dependent on fast computers to perform the data processing and imaging.

Programming in the software is a difficult task, each simulations has to be programmed separately and precisely.

The Challenges faces are that this Research is now subjected only for Scientific Trials and not undergone any Clinical trials. And also, when undergoing Clinical trials it should be approved by the Ministry of Health and Science, Russia and also should pass all the Ethical clearance tests.

Threats

● Too Few Cost/Benefit Proofs Could Impact VR Rehabilitation Adoption

● Aftereffects Lawsuit Potential

● Ethical Challenges

● Limited Awareness/Unrealistic Expectations

Opportunities

● Emerging Tech 1: Processing Power and Graphics Video Integration

● Emerging Tech 2: Devices and Wires

● Emerging Tech 3: Real-Time Data Analysis and Intelligence

● Gaming-Industry Drivers

● VR Rehabilitation with Widespread Intuitive Appeal to the Public

● Academic and Professional Acceptance

● Close-Knit VR Rehabilitation Scientific and clinical Community

● Integration of VR with Physiological Monitoring and Brain Imaging

● Telerehabilitation

An opportunity pertains to internal or external forces in the entity’s operating environment, such as a trend that increases demand for what the entity can provide or allows the entity to provide it more effectively (e.g., tremendous growth in the interactive digital gaming area has driven development of the high-quality, yet low-cost graphics cards needed to make VR deliverable on a basic PC).

REFERENCE TO THE SECTION

"SOCIAL RESPONSIBILITY"

Student:

Group	Full name
1DM6I (1ДМ6И)	RAMESH JANARTHANAN

School	Research School of Chemistry & Applied Biomedical Sciences		
Education Level	Master	Direction / specialty	Biotechnical system and technologies

The initial data to the "social responsibility":	
1. Characteristics of the research object (a substance material, the device, the algorithm technique, the working zone) and its use	Surgery support system based on Touchless control of anatomic 3d model
List of subjects for the study, design and development:	
1. Operational safety	Analysis revealed harmful factors in the design and operation of the projected solutions Analysis of identified hazards in the design and operation of the designed solutions
2. Environmental Security:	– analysis of the impact object in the atmosphere (emission); – analysis of the impact object in the hydrosphere (discharges); – analysis of the impact of the object on the

	lithosphere (wastes); - develop solutions to ensure environmental safety, with reference to the reference document for environmental protection.
3. Safety in emergencies: –	– a list of possible emergencies in the development and operation of the designed solutions; – selection of the most typical emergencies; – the development of preventive measures for the prevention of emergency situations; - development of action arising as a result of - emergency situations and elimination of consequences of its actions.
4. Legal and organizational issues of security: –	– special (typical of the operation of the object of research, designed work area) the legal norms of the labor legislation; - arrangements at the work area layout.

Date of issue job to the linear section of the schedule	

Specifying issued consultant:

Position	**Full name**	**Academic degree**	**Signature**	**date**
Associate Professor	Yulia V. Anishchenko	PhD		

Task execution took the student:

Group	**Full name**	**Signature**	**date**
1DM6I	RAMESH JANARTHANAN		

Abstract:

While surgical practices are increasingly reliant on a range of digital imaging technologies, the ability for clinicians to interact and manipulate these digital representations in the operating theatre using traditional touch based interaction devices is constrained by the need to maintain sterility. To overcome these concerns with sterility, a number of researchers are have been developing ways of enabling interaction in the operating theatre using touchless interaction techniques such as gesture and voice to allow clinicians control of the systems. While there have been important technical strides in the area, there has been little in the way of understanding the use of these touchless systems in practice. With this in mind, we present a touchless system developed for use during vascular surgery. We deployed the system in the suite of a large hospital for use in the context of real procedures. We present findings from a study of the system in use focusing on how, with touchless interaction, the visual resources were embedded and made meaningful in the collaborative practices of surgery. In particular we discuss the importance of direct and dynamic control of the images by the clinicians in the context of talk and in the context of other artefact use as well as the work performed by members of the clinical team to make themselves sensable by the system. We discuss the broader implications of these findings for how we think about the design, evaluation and use of these systems

1.Occupational safety:

The main occupational safety concerned with the project is electrical shock from the working equipment.

1.1. Identification and analysis of workplace hazards, which the research object can create for people.

The main workplace hazard which arises from this project for people using the system is the electrical shock hazards that may occur due to poor wiring and insulation. Therefore all the connections have to be thoroughly inspected and checked before the operation of the system. The mainly we need power backup. With thoughtful system design that targets clinical and research applications that are well matched to current technology assets and limitations, it is predicted that VR rehabilitation will continue to gradually grow and gain acceptance as a mainstream tool.

1.2. Identification and analysis of workplace hazards, which may influence a researcher during the research process.

Most of the time spent during the research process by the researcher is coding and working on a computer, for experimental results working with the ultrasound transducer and a medium is necessary. Care has to be taken while working and safe equipment had to be always worn by the researcher for safety precautions. Also the data which is used for research is important, it has to be safely stored in a secured database.

1.3. Protection methods to mitigate the potential damage.

Safety checks has to be done periodically to avoid any potential damage from the shock and other electrical factors associated with the system.

2. Environmental safety

The main purpose of this thesis was to design a medical imaging viewer for virtual reality and it was successfully fulfilled. The current implementation of the application is a rough development preview but it has met all the main requirements which were set in the beginning. We found that the greatest **s**trength of this kind of display is that the viewer can study a fixed 3D image from different directions, simply by walking around it. So this project does not have any kind hazardous emissions or components that affect the environment. Care has to be taken during the disposal of the waste products which includes wiring and other electrical components used during the experimental trails.

2.1. Impact analysis of research object on environment.

A weakness is a limitation, fault, or defect in the entity that impedes progress toward defined goals (e.g., the limited field of view and resolution in a head-mounted display can limit usability and perceptual realism). Electrical wastes are the only problem associated with the project on environment, hence the waste products that arise during the project trails has to be safely disposed.

2.2. Impact analysis of research process on environment.

There is not much impact by the research process on the environment as it mostly done by a software on a computer. 3D printed models can be used in clinical practice for anatomical education and pre-operative training, improving patient safety.

2.3. Protection methods to mitigate the potential damage.

The project is dependent on fast computers to perform the data processing and imaging .The electrical wastes had to be disposed accordingly to prevent its potential damage on the environment.

3. Safety in emergency

Laboratory is excluded to any sort of danger, as it maintained with all necessary precautions of electrical safety, it is a dry room with less evaporation. Additionally, the floor is covered with insulating material. A safe working environment where users can effectively rehearse tasks with electrical hazards and ultimately promote their abilities for electrical hazard cognition and intervention. Its visualization and simulation can also remove the training barriers caused by electricity's features of invisibility and dangerousness

3.1. Identification and analysis of emergency situations, which the research object can create.

The main emergency situation that arises is fire due to short circuits and electrical shock by physical contact. Proper isolation of the power supply unit and insulation of the wires can prevent these emergency situations.

3.2. Identification and analysis of emergency situations, which may occur during the research process.

Programming in the software is a difficult task, each simulations has to be programmed separately and precisely.

3.3. Protection methods to mitigate the potential damage.

Proper backups and antivirus and antimalware software’s has to be installed to protect the data during the research process.

4. Workplace design:

Do not use electrical equipment or appliances near water or wet surfaces. Never use electrical equipment when your hands or the equipment is wet. The workplace should be neat and dry, as a moist working place can cause problems to the electrical components of the project. Use extension cords temporarily. If you need the extra length more often, speak to a certified electrician to install additional electrical outlets.

Reference:

1.Informatics in Radiology: Developing a Touchless User Interface for Intraoperative Image Control during Interventional Radiology Procedures, https://doi.org/10.1148/rg.332125101

2.Augmented Reality Guidance with Multimodality Imaging Data and Depth-Perceived Interaction for Robot-Assisted Surgery, Department of Mechanical Engineering, National University of Singapore, Singapore 117575, Singapore

3.Simultaneous categorical and spatio-temporal 3D gestures using Kinect, Ali Bigdelou, Comput. Aided Med. Procedures (CAMP), Tech. Univ. Munchen, Munich, Germany

4.Method and system for cropping a 3-dimensional medical dataset, Erik N. Steen

5.Hand shape classification using depth data for unconstrained 3D interaction, Luigi. Institute for High Performance Computing and Networking, National Research Council of Italy (ICAR-CNR), Via Pietro Castellino 111, 80131, Naples, Italy

6.Hand gesture control system, William T. Freeman,Mitsubishi Electric Information Technology Center America, Inc.

7.Touchless advanced image processing and visualization, Tiecheng,ZhaoKeiji, ItoRyan Moffitt

8.Development and clinical evaluation of a touchless operating interface on the 3D image guided navigation for intravascular neurosurgery, Yoshita Nagano Japan.

9.Evaluation of contactless human–machine interface for robotic surgical training, Nabil ZemitiGermain ForestierAlonso SánchezPierre JanninPhilippe Poigne

10.A Survey on Applications of Kinect in Health Care, Yasser Khan and Alaz Gulec, School of Information Technology and Engineering.Canada.

11.Gesture recognition system for tv control, Kuang-Man HuangMing-Chang LiuLiangyin Yu

12.System and method for sensorized user interface, Jason McIntoshMartin RocheMarc BoillotCarlos Gil

13.Design and Development of a Da Vinci Surgical System Simulator, Loi-Wah Sun, Department of Surgery, Chinese University of Hong Kong, HKSAR, China.

14. Comparative Evaluation of Gesture and Touch Input for Medical Software, Patrick Saalfeld, André Mewes, Maria Luz, Bernhard Preim1, Christian Hansen,Germany

15.Initial Experiments with the Leap Motion as a User Interface in Robotic Endonasal Surgery, T.A. Travaglini, P. J. Swaney, Kyle D. Weaver, and R.J. Webster

16.Real-Time Range Imaging in Health Care: A Survey, Friedrich-Alexander-Universitat Erlangen-Nurnberg,Erlangen, Germany

17. Kido T, Kurata A, Higashino H, Sugawara Y, Okayama H, Higaki J, Anno H, Katada K, Mori S, Tanada S, Endo M, Mochizuki T (2007) Cardiac imaging using 256-detector row four-dimensional CT: preliminary clinical report. Radiat Med 25: 38–44

18. Kirchgeorg M, Prokop M (1998) Increasing spiral CT benefits with post processing applications Eur J Radiol 28: 39–54

19. 3D printing based on imaging data: review of medical applications//F. RengierA. MehndirattaH. Von Tengg-KobligkC. M. ZechmannR. UnterhinninghofenH.-U. KauczorF. L. Giesel

20. The use of CT scan based planning for oral rehabilitation by means of implants and its transfer to the surgical field: a critical review on accuracy. J Oral Rehabil. 2008, 35: 454-474. 10.1111/j.1365-2842.2007.01816.x. // Vercruyssen M, Jacobs R, Van Assche N, van Steenberghe D

21. Tardieu PB, Vrielinck L, Escolano E: Computer-assisted implant placement. A case report: treatment of the mandible. Int J Oral Maxillofac Implants. 2003, 18: 599-604.

22. Clinical application of stereolithographic surgical guides for implant placement: preliminary results. J Periodontol. 2005, 76: 503-507. 10.1902/jop.2005.76.4.503.// . Di Giacomo GA, Cury PR, de Araujo NS, Sendyk WR, Sendyk CL:

23. The slow Wallerian degeneration gene, WldS, inhibits axonal spheroid pathology in gracile axonal dystrophy mice. Brain. 2005, 128: 405-416. 10.1093/brain/awh368. // Mi W, Beirowski B, Gillingwater TH, Adalbert R, Wagner D, Grumme D, Osaka H, Conforti L, Arnhold S, Addicks K, et al

24. Image guided oral implantology and its application in the placement of zygoma implants Comput. Methods Programs Biomed., 93 (2009), pp. 162-173 // X.J. Chen, M. Ye, Y.P. Lin, Y.Q. Wu, C.T. Wang

25. Basic research and 12 years of clinical experience in computer-assisted navigation technology: a review Int. J. Oral Maxillofac. Surg., 34 (2005), pp. 1-8 // R. Ewers, K. Schicho, G. Undt, F. Wanschitz, M. Truppe, R. Seemann, et al.

26. Placement of endosteal implants in the zygoma after maxillectomy: a cadaver study using surgical navigation. Plast. Reconstr. Surg., 107 (2001), pp. 659-667 // .F. Watzinger, W. Birkfellner, F. Wanschitz, F. Ziya, A. Wagner, J. Kremser, et al.

27. “Touchless gesture users interface for interactive image visualization in urological surgery”, Jorge Vicente Lopes da Silva. Springer-Verlag, 2012

28.“Advanced Visualization and Interaction Systems for Surgical Pre-operative Planning”, Giovanni Aloisio,Department of Innovation Engineering, University of Salento, Lecce, Italy2010. (**2.1** Literature review)

29.“Design and Evaluation of a Gesture-Controlled System for Interactive Manipulation of Medical Images and 3D Models”, Edimo Sousa Silva,SBC Journal on Interactive Systems, volume 5, number 3, 2014.

30.“Use of a gesture user interface as a Touchless image navigation system in dental surgery”, Guillermo M. Rosa, María L. Elizondo, Department of Pediatric Dentistry, School of Dentistry, National University of the Northeast, Corrientes, Argentina (Literature Review 2.2)

31.“Vision Based Hand Gesture Recognition”, Pragati Garg,Naveen Aggarwal and Sanjeev,Sofat International Journal of Computer and Information Engineering Vol:3, No:1, 2009

32.“Finger based Gestural Interaction for Exploration of 3D HeartVisualization”, Institut Technology Sepuluh November,Surabaya, Indonesia

33.“Performance of remote target pointing hand movements in a 3D environment”,Yung-HuiLeeShu-KaiWuYan-PinLiu, https://doi.org/10.1016/j.humov.2012.02.001

34.“Current progress in 3D printing for cardiovascular tissue engineering”,Bobak Mosadegh, Guanglei Xiong, Simon Dunham and James K Min

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35.“On the utility of 3D hand cursors to explore medical volume datasets with a touchless interface”, Daniel SimõesLopes,Pedro Duarte de FigueiredoParreira, 2017.07.09

36.A Usability Study of a Gesture Recognition System Applied During the Surgical Procedures, Carlo Maria Medaglia

37.Touchless Measurement of Medical Image Data for Interventional Support,

Patrick Saalfeld1 , Dominique Kasper2 , Bernhard Preim1 , Christian Hansen2

38.Kinect-Based Gesture Recognition for Touchless Visualization of Medical Images, 2Department of Computer Science, Hiroshima Institute of Technology, Hiroshima Japan.

39.Interactional Order and Constructed Ways of Seeing with Touchless Imaging Systems in Surgery, Graeme Penney,Abigail Sellen

40.Exploration of 3D Medical Image Data for Interventional

Radiology using Myoelectric Gesture Control, Computer-Assisted Surgery Group, Faculty of Computer Science, University of Magdeburg, Germany

41.SURGICAL WORKFLOW MODELLING AND MONITORING,

Chiba University, Center for Frontier Medical Engineering, Chiba, Japan