PERFORM COMPLEX SURGERIES ON VIRTUAL REALITY USING GOOGLE CARDBOARD AND GESTURE CONTROLS

A PROJECT REPORT

Submitted by

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in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

PSNA COLLEGE OF ENGINEERING AND TECHNOLOGY,

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APRIL 2016

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BONAFIDE CERTIFICATE

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ACKNOWLEDGEMENT

I thank the Almighty for his grace and blessings which drove me to the successful completion of the project. I would like to express my gratitude towards my parents for their kind co-operation and encouragement which help me in completion of this project

I take this opportunity to express my sincere thanks to the respected Chairperson **Tmt. K. DHANALAKSHMI AMMAL,** who is the guiding light for all the activities in our college. I would like to express my deep gratitude to our Pro-Chairman**Rtn.Thiru. R.S.K. RAGURAAM D.A.E, M.Com,** and Vice-ChairmanThiru. **R.S.K. SUKUMARAN B.A** for their continuous support towards the development of the Students.

I would like to thank our Principal ,**Dr. V. SOUNDARARAJANB.E., M.E., Ph.D.,** for being a beacon in guiding every one of us and infusing us the strength and enthusiasm to work over successfully.

I express my sincere thanks and heartfelt gratitude to **Dr.D.SHANTHI M.E., Ph.D.,** Professor and Head of the Department of Computer Science and Engineering for her valuable suggestions and continuous encouragement in the completion of the project work.

This project would not have been possible without the motivation and guidance of our Project Coordinatorand my Project guide, **Dr.T.HEMALATHA.,M.E.,Ph.D,**Associate Professor& UG Head of the Department of Computer Science and Engineering.

Finally, I express our deep appreciation to our parents and our friends for their support and encouragement throughout the project.

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ABSTRACT

Arising moral and ethical issues on over usage and abuse of cadavers in the medical field has made every practicing (learning) surgeon's task tedious, when they perform on living people for the first time. The evolution of computing and communication technologies can overcome this barrier, by proposing a Novel design called "Virtual Surgery". This project combines the Virtual Reality technique and Google Cardboard to perform Virtual Surgery.

By using Google Cardboard, a virtual environment (operation theater) can be simulated and the objects inside it needs to be controlled using a Hand gesture recognition control system which will coincide with the virtual hands in the virtual environment and help surgeons practice (learn) in real time complex surgeries without the need for cadavers.

LIST OF FIGURES

LIST OF ABBREVIATIONS

GND Pin	Ground Pin
HMD	Head Mounted Display
ICT	In-circuit Testing
IDE	Integrated Development Environment
OS	Operating System
PC	Personal Computer
SDK	Software Development Kit
VR	Virtual Reality

CHAPTER 1

INTRODUCTION

1.1OVERVIEW OF THE SYSTEM

Strides are being made in the realm of education, although much needs to be done. The possibilities of VR and education are endless and bring many advantages to pupils of all ages.Few are creating content that may be used for educational purposes, with most advances being made in the entertainment industry, but many understand and realize the future and the importance of education and VR.The usage of VR in a training perspective is to allow professionals to conduct training in a virtual environment where they can improve upon their skills without the consequence of failing the operation.VR plays an important role in combat training for the military. It allows the recruits to train under a controlled environment where they are to respond to different types of combat situations. A fully immersive virtual reality that uses head-mounted display (HMD), data suits, data glove, and VR weapon are used to train for combat. This setup allows the training's reset time to be cut down, and allows more repetition in a shorter amount of time. The fully immersive training environment allows the soldiers to train through a wide variety of terrains, situations and scenarios.VR is also used in flight simulation for the Air Force where people are trained to be pilots. The simulator would sit on top of a hydraulic lift system that reacts to the user inputs and events. When the pilot steer the aircraft, the module would turn and tilt accordingly to provide haptic feedback. The flight simulator can range from a fully enclosed module to a series of computer monitors providing the pilot's point of view. The most important reasons on using simulators over learning with a real aircraft are the reduction of transference time between land training and real flight, the safety, economy and absence of pollution. By the same token, virtual driving simulations are used to train tank drivers on the basics before allowing them to operate the real vehicle. Finally, the same goes for truck driving simulators, in which Belgian firemen are for example trained to drive in a way that prevents as much damage as possible. As these drivers often have less experience than other truck drivers, virtual reality training allows them to compensate this. In the near future, similar projects are expected for all drivers of priority vehicles, including the police.Medical personnel are able to train through VR to deal with a wider variety of injuries. An experiment was performed by sixteen surgical residents where eight of them went through laparoscopic cholecystectomy through VR training. They then came out 29% faster at gall bladder dissection than the controlled group.VR application was used to train road crossing skills in children. It proved to be rather successful. However some students with autistic spectrum disorders after such training might be unable to distinguish virtual from real. As a result, they may attempt quite dangerous road crossings.

1.1.1Evolution of the system

Reports of adverse outcomes caused by technical errors during surgery and better understanding of the components of surgical competency have highlighted the importance of teaching surgical technical skills in a safe and pedagogically efficient environment. This need has been further emphasized by the rapid development of new approaches, such as minimally invasive surgery and endoluminal therapies, both of which require proficiency with sophisticated technical skills. The old approach of 'see one do one, teach one' is no longer acceptable to either the surgical profession or to the well-informed and demanding public. New tools have been developed for teaching and assessing technical skills outside the operating room using virtual reality simulation, which has been applied for many years with great success in many industries including aviation and the military.

Traditionally, surgical virtual reality simulators facilitated training in basic skills relevant for laparoscopic surgery by enabling users to perform maneuvers using abstract graphics (low-fidelity simulation). With software development, the simulators now enable users to perform complete procedures with the added simulation of rare anatomical variations and various pathological conditions. The interface of these high-fidelity systems enables the surgeon to 'feel' the tissue (haptic feedback). The realism, however, of these simulated procedures is still suboptimal, and the high cost of virtual reality simulators limits their widespread distribution. Furthermore, the advantages of the high-fidelity, high-cost systems have not yet been demonstrated and future studies are needed to establish the potential advantages of procedure-specific simulation.

Laparoscopy poses significant psychomotor challenges to the surgeon because of the loss of three-dimensional depth perception and the fulcrum effect of the body wall on instrument handling. Virtual reality simulators facilitate repeated practice of standardized tasks to help surgical trainees become familiar with specific psychomotor skills before performing procedures in the operating room, which is a stressful and high-cost environment. Furthermore, the simulator software often incorporates extensive teaching guidance, eliminating the need for an instructor and, therefore, offering a flexible training schedule to fit the busy day of a surgical trainee. The simulators also offer the unique possibility to quantify surgical performance on the basis of objective measures, which provides an unbiased assessment of surgical performance.

Despite these obvious advantages, there are still areas that require improvement. Most of the available high-fidelity systems have undergone substantial developments in both graphics and haptics; however, their level of realism requires refinement. The objective measures used in these systems to assess performance are excellent; however, they are difficult to interpret by the trainee and this limits their value as a source for constructive feedback. A major disadvantage is the high cost of simulator systems, which poses a significant challenge for many institutions. Finally, most simulator systems provide training in psychomotor skills only and do not address the other components of surgical competence (i.e. knowledge, decision making and communication).

Validation of virtual reality simulation as a surgical training tool requires evidence of the transferability of skills acquired in the virtual reality environment to the operating room. Two studies have compared virtual reality training versus conventional training and have shown that surgical trainees who undergo simulator training outperform their colleagues without simulator experience. In a randomized, controlled trial of 16 surgical trainees, those who had received virtual reality training for a laparoscopic procedure were faster, made fewer errors and showed greater economy of motion compared with those who had not received such training. Virtual reality training, therefore, contributes to the development of skills relevant for real procedures and might shorten the learning curve for new procedures. Most educators agree that virtual reality simulators are efficient training tools in laparoscopic surgery and should be widely implemented in the surgical training curricula.

If applied to a residency curriculum, virtual reality assessment can be used for continuous monitoring of a trainee's performance as well as for early intervention when the speed of a trainee's skill acquisition is suboptimal. Studies have demonstrated that constructive feedback based on objective criteria contributes to improved learning and has the potential to shorten the learning curve of a procedure in the operating room.

There is a considerable amount of evidence confirming that virtual reality simulators provide an instantaneous, unbiased, reliable and valid assessment of technical skills for laparoscopic surgery. Face and construct validity (the degree of resemblance between the system and the procedure it intends to simulate and the ability of the system to discriminate between individuals from different experience levels) have been demonstrated for most of the commercially available virtual reality systems. The most powerful evidence of validity-predictive validity (the extent to which the scores on a test are predictive of actual performance in the operating room)-has so far been shown in two observational studies. This substantial evidence on the validity of virtual reality simulation has been summarized in a consensus document by the European Association of Endoscopic Surgery who indicated level 2 recommendations for the assessed simulator systems. As evidence continues to evolve, clinicians will observe validation of curricula for resident training as well as certification and recertification of practicing surgeons on the basis of objective assessment. Virtual reality simulation will without doubt play a major role in these processes.

Most of the commercially available simulation systems are offered with a broad range of settings with no predefined proficiency criteria and no information on the intensity or duration of training needed to achieve technical competency. In order to standardize the process of virtual reality training, there four questions that must be addressed. Firstly, what should the difficulty setting be set at for each task? Secondly, has the validity for each difficulty setting been established? Thirdly, has the learning curve for each setting and task been assessed? Finally, have performance proficiency criteria been established for procedures on the basis of expert assessment? An evidence-based proficiency curriculum can be designed only after each of these questions has been answered.

Previous studies have investigated and validated curricula for simulator training in basic laparoscopy. It should be highlighted, however, that virtual reality simulators are mainly technical skills trainers and a comprehensive residency curriculum should include additional tools such as box trainers, animal models, cadavers and human patient simulators.

Virtual reality simulation will continue to have an important role in the training of basic and procedure-specific skills in various surgical specialties, and endoscopy and endoluminal therapies. Future efforts should investigate the impact of this type of training on the quality and speed of skills acquisition of trainee surgeons to facilitate the production of excellent surgeons in a safe and pedagogically supportive environment.

1.2AIM

Arising moral and ethical issues on over usage and abuse of cadavers in the medical field has made every practicing (learning) surgeon's task tedious, when they perform on living people for the first time. The evolution of computing and communication technologies can overcome this barrier, by proposing a Novel design called "Virtual Surgery". The Virtual Reality technique and Google Cardboard can be combined to perform Virtual Surgery. By using Google Cardboard, a virtual environment (operation theater) can be simulated and the objects inside it needs to be controlled using a Hand gesture recognition control system which will coincide with the virtual hands in the virtual environment and help surgeons practice (learn) in real time complex surgeries without the need for cadavers.

1.3 OBJECTIVES

The main objective of this project is to reduce the moral issues arising over the usage of cadavers and to induce new and convenient learning technique using Virtual Reality.

Budding surgeons can benefit by practicing more virtual and cultivate more real time experimental experience over each and every other surgery which can take up several practices before being able to be performed for the first time in a living human being.

1.4 PROBLEM DESCRIPTION

Virtual reality is used in medical schools and other similar settings as a means of education and instruction. It enables medical students to acquire knowledge and understanding about the human body by means of interaction within a virtual environment.

Medical students can perform 'hands on' procedures but in a safe and controlled setting. They are able to make mistakes – and learn from them but in an environment where there is no risk to the patient. They interact with a virtual patient and as a result of this, learn skills which they can then apply in the real world.

Also the increase in the usage of cadavers has risen to moral and ethical issues over few parties. To reduce the over usage of cadavers VR in medical training has become essential.

A new training model, leading up for the surgeons to gear up and prepare for the unexpected by repeated practice and operating time to account for which will indirectly benefit to patient care.

CHAPTER 2

SYSTEM ANALYSIS

Systems analysis is a problem solving technique that decomposes a system into its component pieces for the purpose of the studying how well those component parts work and interact to accomplish their purpose". According to the Merriam-Webster dictionary, systems analysis is "the process of studying a procedure or business in order to identify its goals and purposes and create systems and procedures that will achieve them in an efficient way". Analysis and synthesis, as scientific methods, always go hand in hand; they complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results.

This field is closely related to requirements analysis or operations research. It is also "an explicit formal inquiry carried out to help a decision maker identify a better course of action and make a better decision than she might otherwise have made."

2.1 ANALYSIS OF EXISTING SYSTEM

2.1.1. Virtual Reality Medical Training

Let's start with virtual reality as a means of training healthcare professionals. It is used in medical schools and other similar settings as a means of education and instruction. It enables medical students to acquire knowledge and understanding about the human body by means of interaction within a virtual environment.

Medical students can perform 'hands on' procedures but in a safe and controlled setting. They are able to make mistakes – and learn from them but in an environment where there is no risk to the patient. They interact with a virtual patient and as a result of this, learn skills which they can then apply in the real world.

2.1.2. Virtual Reality dentistry

But virtual reality isn't only confined to medical schools. Dentistry is another area in which it plays a part. For example, there is a system known as 'HapTEL' which is based upon haptics (Greek for touch) in order to train new dentists. This virtual dental chair includes a training scenario in which the student is shown a 3D set of teeth that they work on.

They perform a range of procedures, e.g. a filling using a virtual drill which replicates the movement and pressure of a real drill by means of force feedback. This feedback takes the form of subtle changes of pressure which enables the student to adjust their technique accordingly.

2.1.3. Virtual Reality preventative medicine

Virtual reality is used to educate patients about positive lifestyle choices, such as stopping smoking, moderate alcohol intake, healthy eating and exercise. There is an emphasis on educating people to make positive changes about their health which will reduce the risk of illnesses, many of which are preventative.

Both desktop and fully immersive CAVE systems can be used to demonstrate the effects of negative lifestyle choices, e.g. smoking on health with the aim of changing people's behavior.

2.1.4Disadvantages of Existing System

There are various applications already facilitating the usage of Virtual Reality in domains such as Gaming, Combat Training, flight Simulation etc. The application of VR in places of medical training is minimal as of now and no thorough reference to be compared with is present. But still the ones that are present only concentrate on certain and not all types of surgeries.

2.2 Proposed System

The Proposed System consists of Google Cardboard to facilitate Virtual Environment where the inputs are taken out from an external hardware system using Arduino Micro Controller to which inputs are sent in using UltraSonic Sensors. The inputs from the Controller is then sent to an android application which will make possible for the Virtual Reality to be observed using Google Cardboard.

2.2.1 Characteristics and Features

The system consists of four main units which are as follows

Palm Unit - This is where the Ultrasonic Sensors are present and the hand gesture inputs are collected.

Arm Unit – The Part where the inputs from the Ultrasonic Sensors are collected and processed and further sent to the third unit.

Environment Simulator – Inputs from the Arm Unit is processed and relevant functions are carried out and the output is displayed.

Cardboard – This part is just to display or view the output from the Unity3d/ Environment Simulator.

2.3 REQUIREMENTS OF PROPOSED SYSTEM

2.3.1 Requirements Analysis

To be used efficiently, all computer software needs certain hardware components or other software resources to be present on a computer. These prerequisites are known as (computer) **system requirements** and are often used as a guideline as opposed to an absolute rule. Most software defines two sets of system requirements: minimum and recommended. With increasing demand for higher processing power and resources in newer versions of software, system requirements tend to increase over time.

The following are the Hardware and Software required for the proposed system.

2.3.1.1 Hardware requirements

- Ultrasonic Sensor

Ultrasonic transducers are transducers that convert ultrasound waves to electrical signals or vice versa. The distance between both hands and the fingers between the bases of the palm are calculated using the reflected signals from the echo pin of the sensor and computed accordingly. Each distance or range marks to a corresponding input signal that is to be sent out of the serial port.

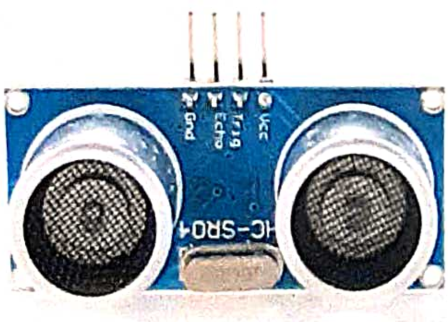

Figure No. 2.3.1.1a Ultrasonic Sensor

- Arduino Uno Micro controller

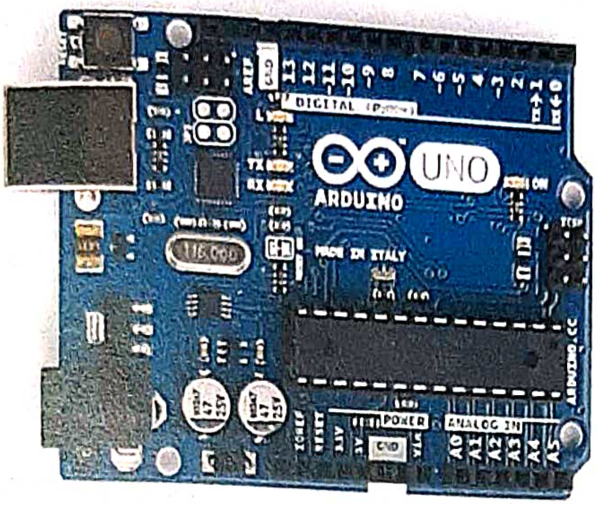

Figure No. 2.3.1.1b Arduino Uno Micro controller

- Google Cardboard

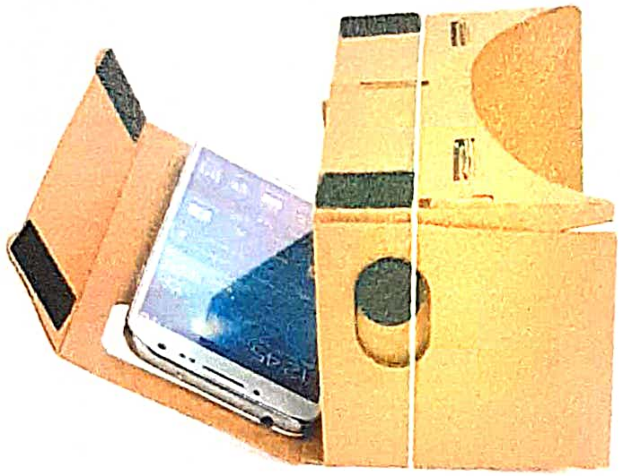

Figure No. 2.3.1.1c Google Cardboard

Google Cardboard headsets are built out of simple, low-cost components. The headset specifications were designed by Google, who made the list of parts, schematics, and assembly instructions freely available on their website, allowing people to assemble Cardboard themselves from readily available parts. Pre-manufactured viewers were only available from third-party vendors until February 2016, when Google began selling their own through the Google Store.

By using this VR solution the scene from the Unity3d environment is transmitted to the Android application interface of the android device placed inside the cardboard and the scenes are observed.

2.3.1.2 Software requirements

- Unity3d Game Development Engine

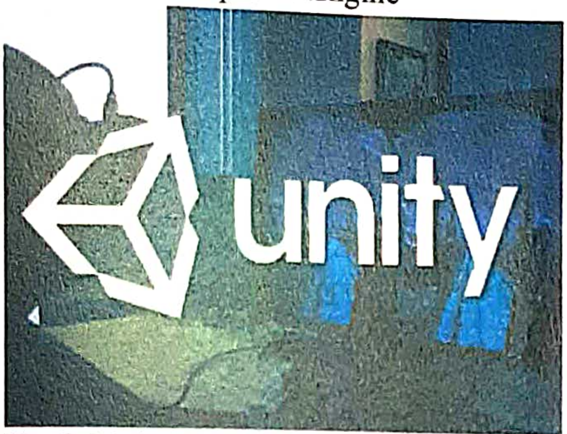

Figure No. 2.3.1.2a Unity3D Game development Engine

- Arduino IDE

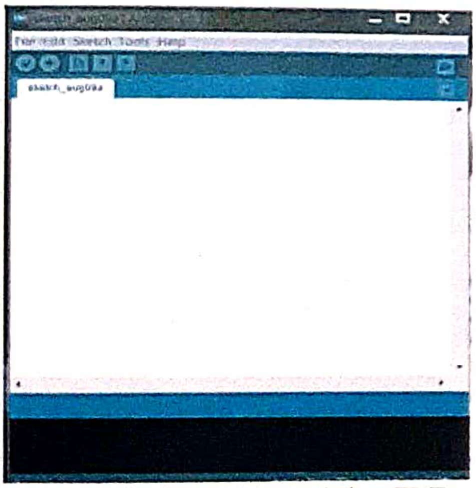

Figure No. 2.3.1.2b Arduino IDE

2.3.1 Study of requirements of proposed system

2.3.1.1 Arduino UNO

The Uno is a microcontroller board based on the ATmega328P. Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Figure No. 2.3.1.1a Arduino Uno

Specifications of Arduino Uno

- Microcontroller – ATmega328;
- Operating Voltage – 5V;
- Input Voltage (recommended) – 7-12V;
- Input Voltage (limits) – 6-20V;
- Digital I/O Pins – 14 (of which 6 provide PWM output);
- Analog Input Pins – 6;
- DC Current per I/O Pin – 40 mA
- DC Current for 3.3V Pin – 50 mA;

- Flash Memory – 32 KB (ATmega328) of which 0.5 KB used by bootloader;
- SRAM – 2 KB (ATmega328);
- EEPROM – 1 KB (ATmega328);
- Clock Speed – 16 MHz;

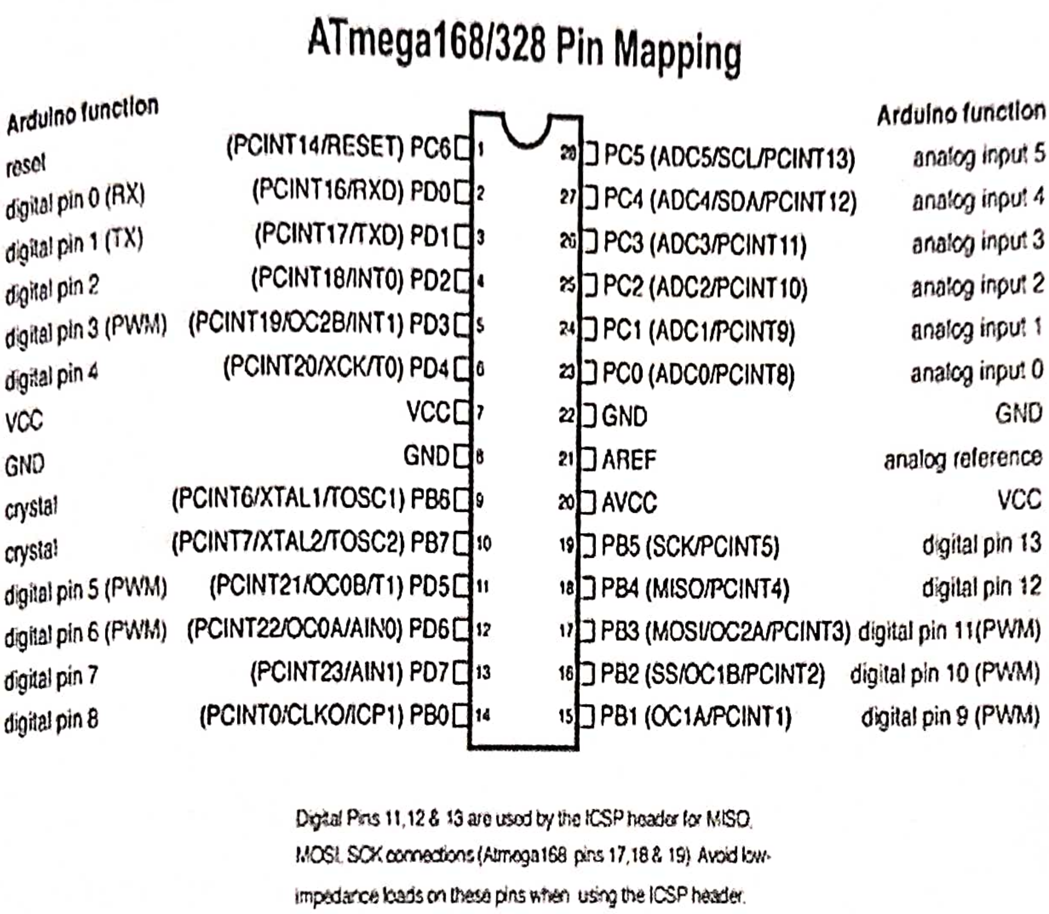

Figure No. 2.3.1.1b Pin diagram of Arduino Uno

2.3.1.2 Programming Languages

C/ C++

The Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler (avr-g++). All standard C and C++ constructs supported by avr-g++ should work in Arduino.

C#

Unity3d supports programming with C#, UnityScript or Java Script and Boo. Since C# is most compatible language when considering that our system needs a networking layer at the back.

2.4 FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

- Economic Feasibility
- Technical Feasibility
- Social Feasibility

2.4.1 ECONOMIC FEASIBILITY

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

2.4.2 TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

2.4.3 SOCIAL FEASIBILITY

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

CHAPTER 3

SYSTEM DESIGN

3.1 Design of the system

The Palm unit consisting of the Ultrasonic sensor provides input to the micro controller (Arduino Uno) at the Arm unit which in turn provides signals to the Unity3d Virtual Environment. The signals from the Unity3d are then sent to the Android app facilitating VR to be viewed and experienced on Google Cardboard.

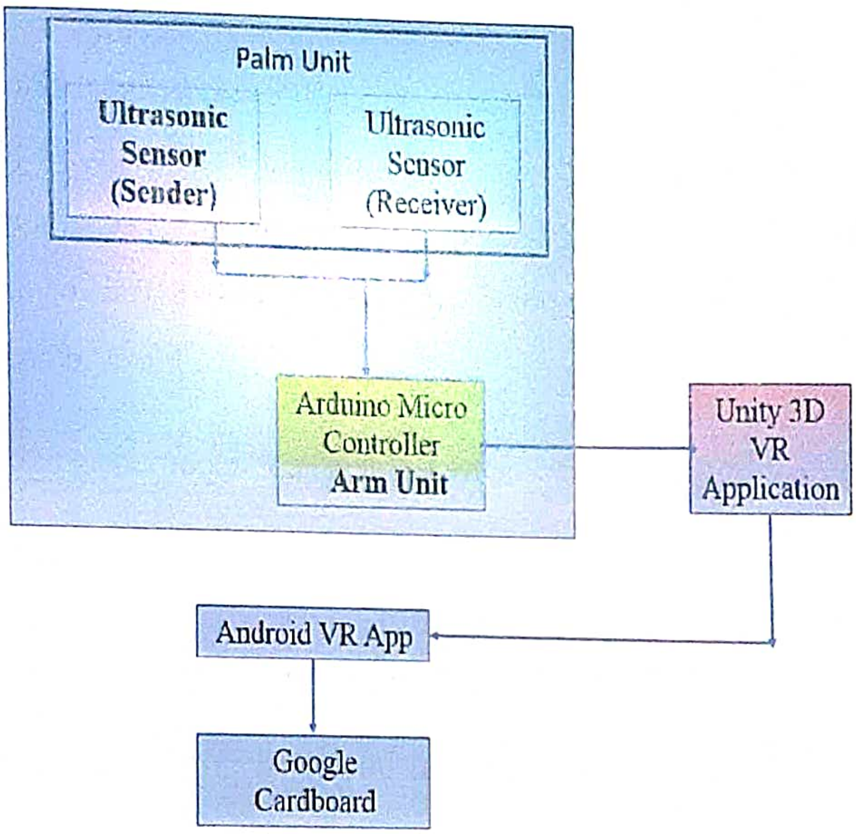

Figure No. 3.1 Design of the system

3.2 UML DIAGRAMS

3.2.1 Use case diagram

A **use case diagram** at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can identify the different types of users of a system and the different use cases and will often be accompanied by other types of diagrams as well. To model a system the most important aspect is to capture the dynamic behaviour. Dynamic Behaviour means the behaviour of the system when it is running /operating.

So only static behaviour is not sufficient to model a system rather dynamic behaviour is more important than static behaviour. The purpose of use case diagram is to capture the dynamic aspect of a system. But this definition is too generic to describe the purpose. So in brief, the purposes of use case diagrams can be as follows:

- Used to gather requirements of a system.
- Used to get an outside view of a system.
- Identify external and internal factors influencing the system.
- Show the interacting among the requirements are actors.

Use case diagram should have the following items identified.

- Functionalities to be represented as an use case
- Actors
- Relationships among the use cases and actors.

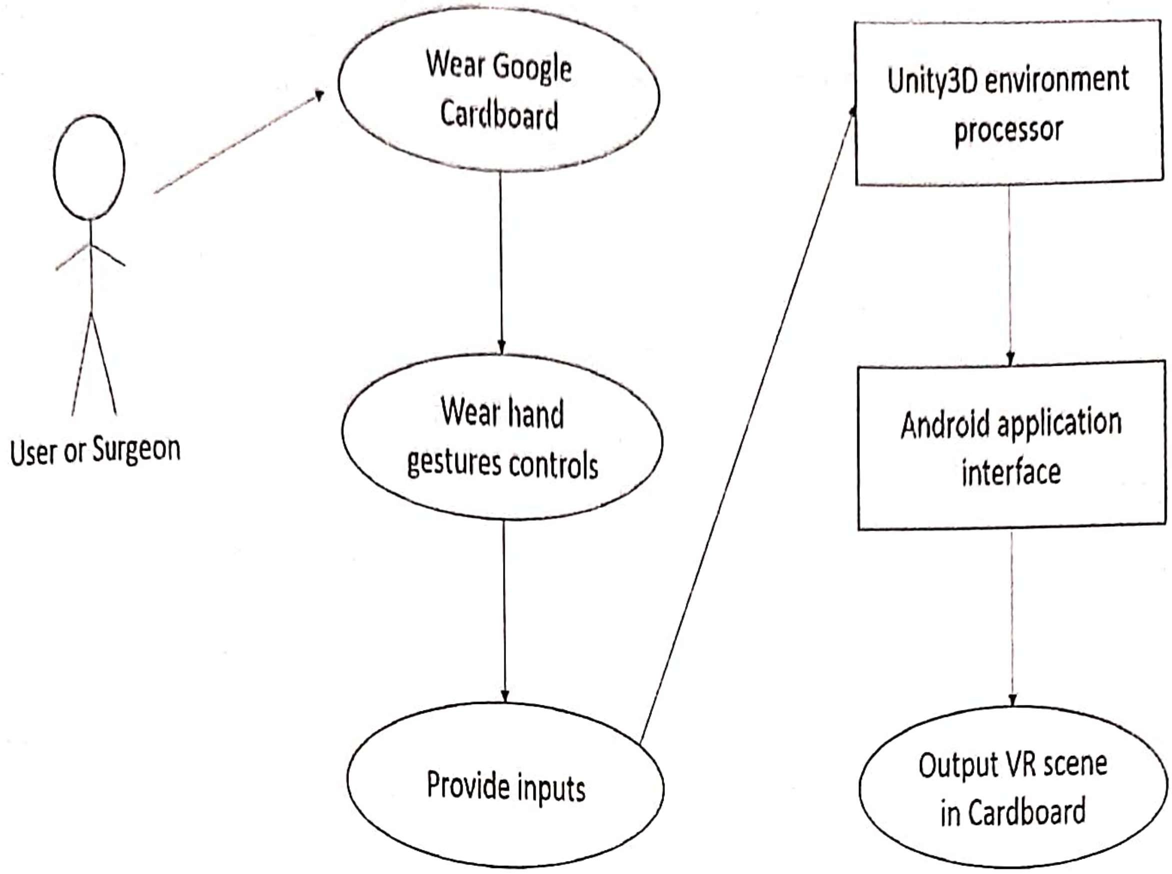

Figure No. 3.2.1 Use Case Diagram

3.2.2 Sequence diagram

A Sequence diagram is an interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios.

A sequence diagram shows, as parallel vertical lines (*lifelines*), different processes or objects that live simultaneously, and, as horizontal arrows, the messages exchanged between them, in the order in which they occur. This allows the specification of simple runtime scenarios in a graphical manner.

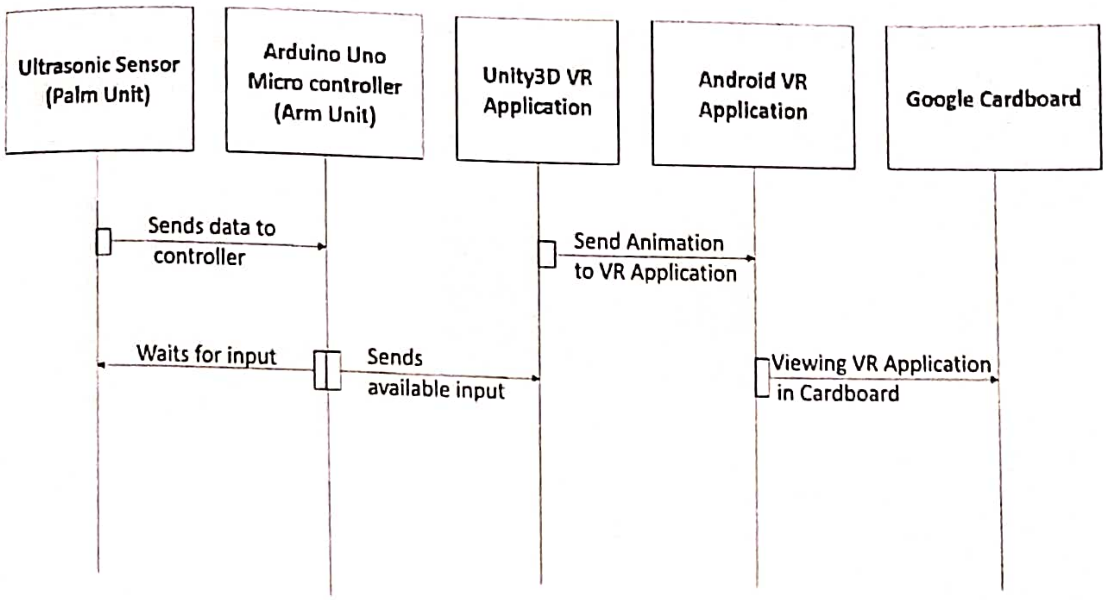

Figure No. 3.2.2 Sequence Diagram

CHAPTER 4

INTEGRATION AND TESTING

4.1 Module Description

4.1.1 Palm Unit

An Ultrasonic sensor enclosed within a glove is the available Palm Unit in the system.

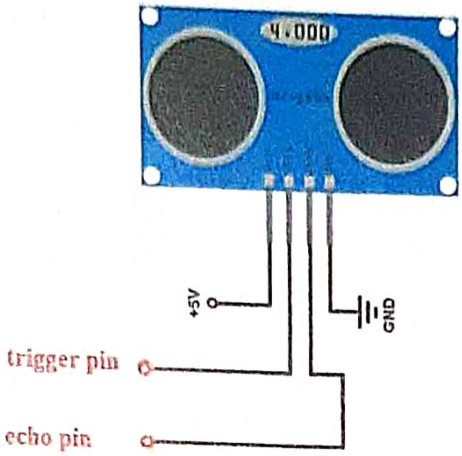

Figure No. 4.1.1 Palm Unit

There are four major pins in the sensor. The echo pin, acts as a sender and sends ultrasonic signals out of the palm unit and the trigger pin, receives the reflected ultrasonic signal and sends it further and gets it processed. This also has a +5V pin for power supply and GND pin.

4.1.2 Arm Unit

The Arm unit is a black box which contains an Arduino Uno Microcontroller. The Arm Unit is connected to the Palm Unit. The input from the trigger pin from the palm unit is sent in here and the pulse input is converted into measurable or computable format. It is then sent to the Virtual Environment in the Unity3d Engine.

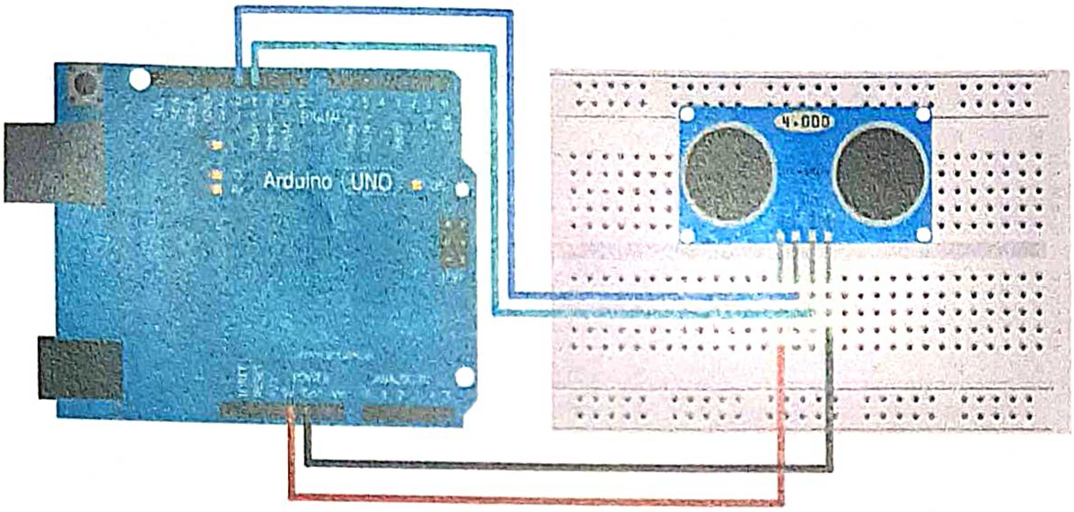

Figure No. 4.1.2a Arm Unit

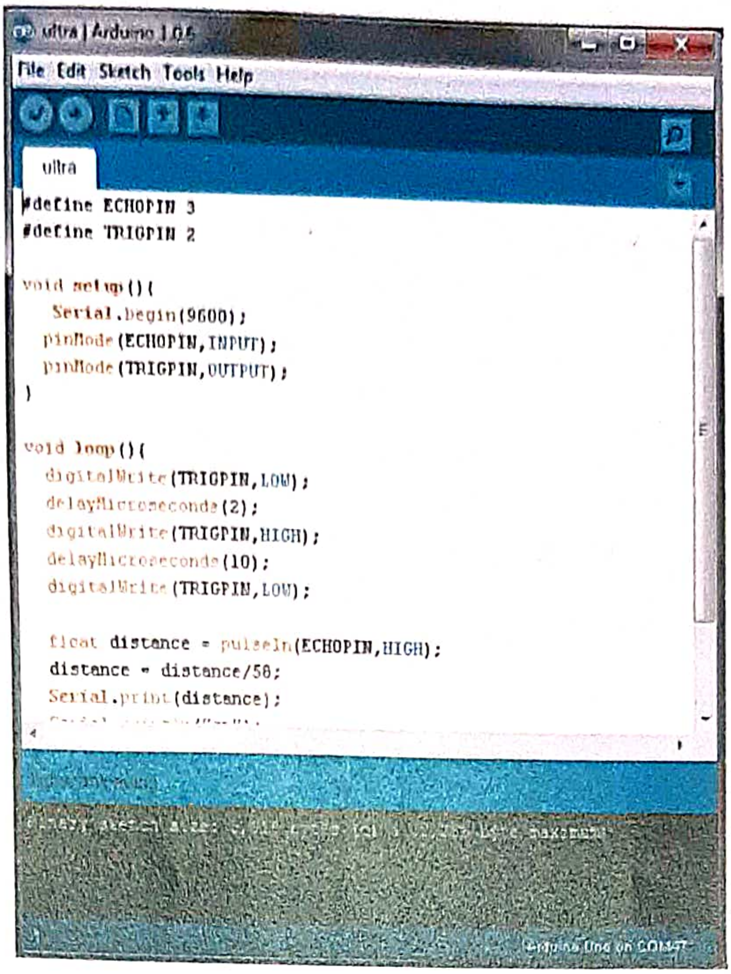

Figure No. 4.1.2b Arm Unit code

4.1.3 UNITY3D

Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites. First announced only for OS X, at Apple's Worldwide Developers Conference in 2005, it has since been extended to target more than fifteen platforms. It is the default software development kit (SDK) for the Wii U.

Five major versions of Unity have been released. At the 2006 WWDC trade show, Apple Inc. named Unity as the runner up for its Best Use of Mac OS X Graphics category.

The Virtual Environment present in this consists of,

- 3D Models, Designed with 3DS Max
- Animation scenes for Object, Designed with 3DS Max
- Cardboard Package for Unity3d from Google – This is to make sure we can observe the VR in Google Cardboard

4.1.4 Google Cardboard

Based on the inputs received by the Unity3d from the arm unit, corresponding animation is played in the Android Device placed inside the Cardboard. User wears the cardboard on their head and can observe the actuations happening inside the Virtual Environment

4.2 TESTING

Since the error in the software can be injured at any stage. so, we have carry out the testing process at different levels during the development. The basic levels of testing are

- Modular Testing
- Integration Testing
- Validation Testing

4.2.1Modular Testing

4.2.1.1 White Box Testing

White-box testing (also known as clear box testing, glass box testing, transparent box testing, and structural testing) is a method of testing software that tests internal structures or workings of an application, as opposed to its functionality (i.e. black-box testing). In white-box testing an internal perspective of the system, as well as programming skills, are used to design test cases.

The tester chooses inputs to exercise paths through the code and determine the appropriate outputs. This is analogous to testing nodes in a circuit, e.g. in-circuit testing (ICT). White-box testing can be applied at the unit, integration and system levels of the software testing process. Although traditional testers tended to think of white-box testing as being done at the unit level, it is used for integration and system testing more frequently today. It can test paths within a unit, paths between units during integration, and between subsystems during a system–level test. Though this method of test design can uncover many errors or problems, it has the potential to miss unimplemented parts of the specification or missing requirements.

There are four major test cases in this system, which are as follows,

- **Test Case 1 – Palm Unit**

  The echo pin in the ultrasonic sensor is made HIGH and is checked if it can reflect back inputs from the trigger pin and into the system to get it processed. There are further four type of inputs obtained from the sensor which corresponds to the four discrete events happening in the animation part at the Unity3d Environment and Cardboard. It is explained later.

- **Test Case 2 - Arm Unit**

  It is tested for inputs from the sensor and the pulse input is considered as distance it took to travel to reflecting point at the sensor and transmit it back to the arm unit for scene simulation at the Virtual Environment.

- **Test Case 3 – Unity3d**

  Based on the inputs collected from the Arm Unit, either one of the four discrete animation scenes are played. It is also made sure that this unit listens to the same port for input as to which the arm unit is transmitting and the baud rate between the units remains the same.

- **Test Case 4 – Cardboard**

By using the android application interface present inside the Android device in the Cardboard we observe the corresponding animation played. The screen is made sure that is spilt left and right for better VR experience.

4.2.1.2 Black-box Testing

Black-box testing is a method of software testing that examines the functionality of an application without peering into its internal structures or workings. This method of test can be applied to virtually every level of software testing: unit, integration, system andacceptance. It typically comprises most if not all higher level testing, but can also dominate unit testing as well.

4.2.2 Integration Testing

In this system, the considered surgery is caesarean section. The events of the surgery are divided into four phases or scenes.

The inputs from the arm unit are integrated to the unity3d environment.

Pseudocode 1

Step 1: Begin Serial Communication

Step 2: Set baud rate and com port.

Step 2: Send out input to Echo Pin.

Step 3: Receive input from Trigger Pin.

Step 4: If the inputs are between particular ranges send corresponding outputs.

Step 4: Print signals received to serial port.

Step 5: Close Serial Port.

The above code makes sure that the Palm and Arm Unit works fine and the obtained input is sent to the defined Communication port.

Now, the transmitted input are tried to catch from the Unity3d Environment all the while listening to the predefined port.

Step 1: Begin Serial Communication
Step 2: Set baud rate and com port.
Step 3: Read input from the defined Serial Port.
Step 4: Play animations based from the inputs received.
Step 5: Close Serial Port.

The system receives the input from the port and if the input received is corresponding to one of the action or range specified from the Arm Unit, then the respective animation is played in the Unity3d Environment which is then observed in the Android application interface using Google Cardboard.

4.3 SNAPSHOTS OF THE WORKING PROJECT

Figure No. 4.3.1 Google Cardboard

Figure No. 4.3.2 (Palm Unit) Ultrasonic Sensor

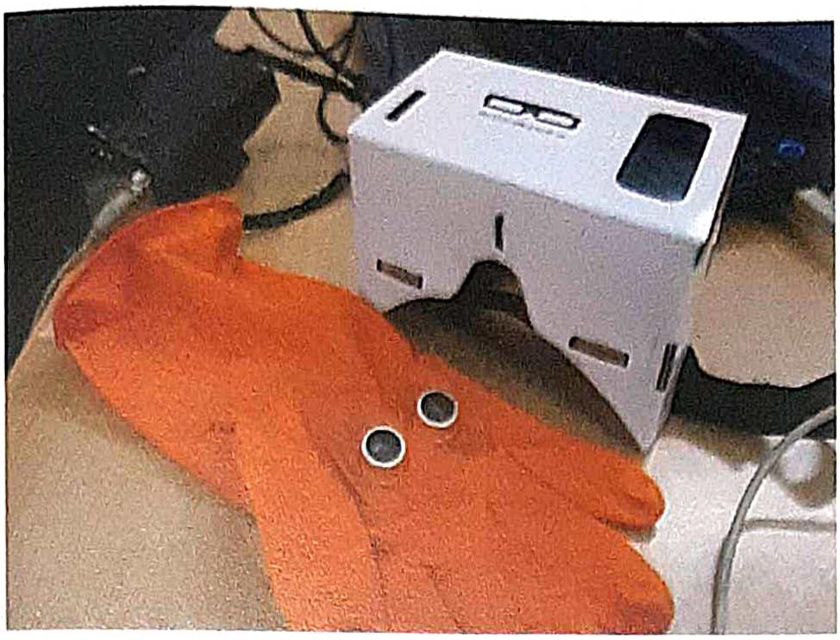

Figure No. 4.3.3 Ultrasonic Sensor connected to Arduino Uno Microcontroller

Figure No. 4.3.4 Virtual environment to perform surgery

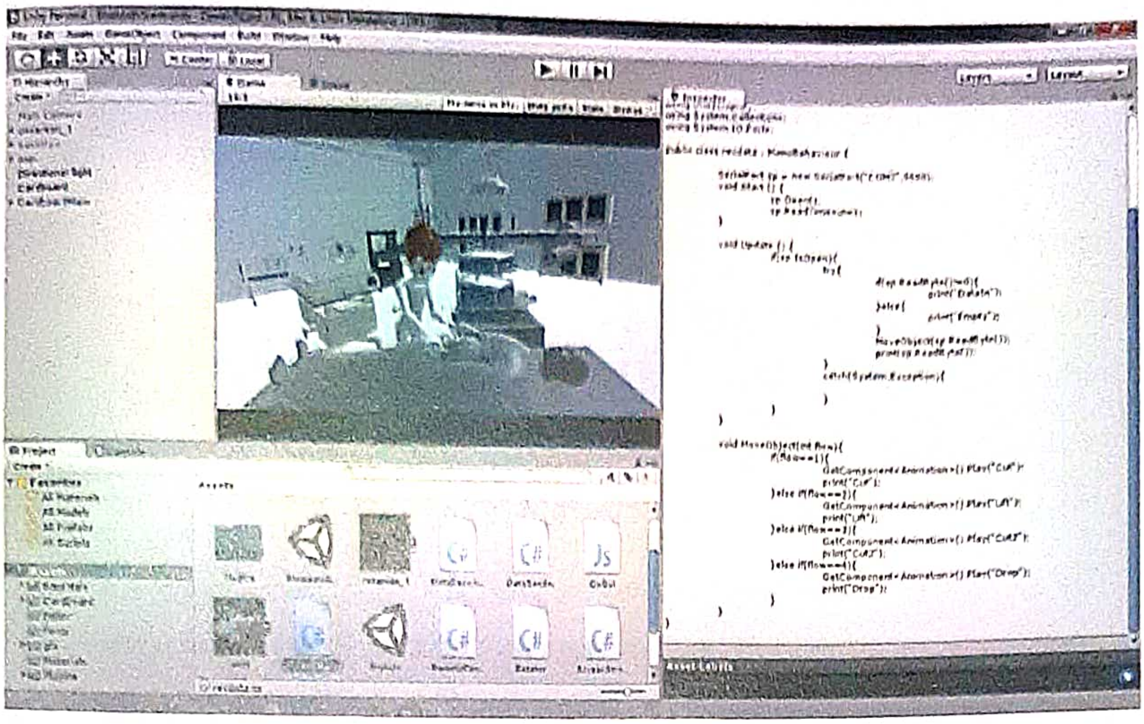

Figure No. 4. 3.5 Unity3D Game developing Engine

Figure No. 4.3.6 Gesture control while in Virtual Environment

CHAPTER 5

CONCLUSION

Due to the evolution of ICT Infrastructures, there is a big thrust in applying ICT Infrastructure is almost all the verticals of varied fields. Biomedical Engineering is gaining a very high momentum. Hence the objective of this work is to propose an experimental prototype to establish a Virtual Environment which is a Hospital Operation Theater where objects in it are actuated using the inputs obtained from the Gesture Controls from the external Hardware Unit. The external hardware units are precisely chosen and integrated together which works with accuracy to certain level. Further it can be enhanced with more objects to accommodate various types of surgery with tight synchronization to attain high accuracy.