Virtual Telepresence Robot

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Session 2018-22

A Report is submitted to the Department of Electrical Engineering,
Bahria University, Islamabad.
In partial fulfillment of requirement for the degree of BS(EE).

Certificate

We accept the work contained in this report as a confirmation to the required standard for the partial fulfillment of the degree of BS(EE).

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Dedication

We dedicate our dissertation work to our family, teachers and friends whose words of encouragement and push to tenacity kept us working. We thank our supervisor Dr. Imran Fareed who was more than generous with his expertise and precious time. This work would not have been possible without his support. Thank you all for being supportive.

Acknowledgments

ALLAH is the creator of the universe and has the complete knowledge of past, present and the future, without his will and guidance, the project completion was not possible. A special thanks to our supervisor Dr. Imran Fareed for his support and dedication towards our work throughout the process.

We would like to thank the department of Electrical Engineering, Bahria University Islamabad in providing us facilities to make this project. We would like to thank all the people who helped without any personal interest including the teacher, parents and friends.

Abstract

This Virtual Telepresence Robot with a camera is placed in a remote location to capture the environment in visual form using Arduino UNO microcontroller. The captured visuals are displayed on the user's virtual reality (VR) headset. An added feature allows the camera to move in the direction of the user's head movements. This gives the user a real-time experience as if he is present where the virtual telepresence robot is located. The virtual telepresence robot can also be moved in any direction through an app installed in the user's smartphone.

Virtual telepresence robot is a revolution in the robotics and IOT domain. The enhanced Virtual reality is the main objective of this project. IOTs, clouds and controller are the key constituents of the virtual telepresence robot. The data from the software is saved and transmitted by cloud storage platform known as IOT cloud.

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Chapter 1

Introduction

1.1 Introduction

A Telepresence Robot is a videoconferencing bot that revolutionizes the way you feel. It enables people to be at more than one place at a single time. It helps one feel more connected by allowing a person to be present virtually where one can't be in person physically. Driving your own virtual presence robot means you can see around the office, attend meetings, visit work sites, attend class and do much more from anywhere at any time. A tele-presence robot enables to place "you" in an isolated place quickly, giving you a real presence, or "telepresence." [1] People from all sorts of places use telepresence robots for surveillance operations. For example, schools, offices, hospitals, medical clinics, business centers, etc., seek the potential benefits of using sensible advances in the field of virtual telepresence. Thus, the telepresence robots themselves are evolving and emerging since their power continue to be tested, developed, and utilized. Robot owners prefer cost reduction, time and energy saving, and the better connectivity and availability that smart robots can bring to any location. [2]
Telemedicine features have been used in hospitals for years and now telepresence robots are more advanced and providing more robust technology to help surgeons successfully advise their peers and nurses during surgery, doctors to make their duty easier or monitor newly discharged patients, and specialists, eradicating travel times in urgency such as stroke, in which every minute saved results in conservation of millions of brain cells. These robots are commonly termed as "health tele presence robots" or "hospital tele presence robots," in the medical field.

1.2 Background

Telepresence is such a technology that enables a person to feel like they exist in such an environment, to give the appearance of being present, or to influence, with tele robotics, somewhere other than the real world.

Telepresence demands that users' senses be provided with objectives that facilitates them a sense of reality. Additionally, users can be given the ability to feel a remote location virtually. In this case, user location, movement, actions, voice, etc. can be heard, transmitted and remotely to achieve this feeling or sensation. So, the information may have to propagate in both directions between the user and a distant place.

The most popular app is available for telepresence videoconferencing or video broadcasting, which is the highest level of video telephony. Video Telepresence uses more sophistication and improved precision for both visual and audio than in conventional video conferencing. Technological advancement in mobile technology has not only expanded but also influenced the power of videoconferencing outside the boardroom to be utilized with hand-held mobile devices, allowing for offline communication. Telepresence robots can also be considered to communicate with humans during a pandemic such as COVID-19.

Teleport, which was the first famous company using telepresence was founded by David Allen and Harold Williams in 1993. Before Teleport, they ran a resort business from which they got the idea of telepresence because they often observed businessmen would leave urgently to attend important conferences.

1.3 Problem Statement

During COVID-19, patients who are infected have to stay isolated for number of days to recover. In that case, they are totally cut off from the environment for number of days. On the other hand, even to monitor the condition of the patient, the nurse have to wear a special suit so that he/she does not get infected.
In an ICU, relatives of the patient are not allowed to visit the patient until and unless the patient is recovered.
In order to overcome these difficulties, we need a medium, that can not only be beneficial for the patient but also for the hospital staff and for the relatives of the patient.

1.4 Project Objectives

We aim to make a prototype of a virtual telepresence robot. The main objective is to create a virtual reality robot which enables the user a real sensation of the environment and allow him to be present virtually where the robot is located. This robot which is placed in a distant area is capable to record the environment surroundings in virtual form using Arduino microcontroller. The visuals are viewed on an app and can be viewed in VR headset. The robot present in the remote location can be maneuvered by the user using their smartphone.
The robot allows the camera to move in the same position of the user's head gestures which gives 3-Dimensional immersive view to the user through VR Headset. This way, this robot can be used in Covid-19 wards by the hospital staff who needs to monitor the condition of the patient without putting

himself/herself in risk. This robot will be beneficial to the relatives and to the patient as well.

1.5 Applications

This telepresence robot can be used for the purpose of surveillance. This robot can also be used in situations where the house owner would like to know and observe his servant at home for example. Further uses include:

- In a war scenario, we don't have to send an army personnel to a surveillance site, a robot can be dispatched. Hence, even if a surprise attack occurs, no human being will be harmed; only the robot will be damaged.
- In a medical scenario, the robot can be utilized to check on the patient's condition.
- This robot can be made fire resistant, and it can be used for fire-fighting and rescue operations.
- The robot's range can be increased so that the robot can be used in space research.

1.5.1 Other Applications

- **Connecting Communities**

Virtual Telepresence Robots are used in areas that are not only inaccessible but also dangerous to human workers. Over time, remote-controlled robots increase their range and use of space. In short, telepresence robots are utilized to join people together using video conferences to connect with the public. In this regard, mobility, dual direct communication, and efficiency are required. By using a display screen, HD web camera, wheels, etc. such functionality is achieved. These robots can also be utilized in the office environment, in hospital building, in the nursing home, and in the school environment to help the people.

- **In Medical and For Remote surgery**

Telepresence robot is a new technological instrument in health care field. The Telepresence Robots provides a platform for the user to remotely communicate through the use of components such as web cameras, sound system, microphones, and different motion sensors. The biggest advantage is that they can be controlled using smartphones. With the help of these useful features, people can view, hear, and interact with each other.

Telepresence robots are getting popularity in the healthcare industry and the medical industry around the world. Many factors are increasing the growth of the telepresence robot's market and making it popular, these factors include advancement and precision in artificial intelligence, more usage of smart mobiles, and an increasing trend of bringing automation in business operations. However, the cost of manufacturing the robot, as well as installing and maintaining them are high and is expected to hinder the market acceptance of robots in the upcoming years.

- **Education**

Research conducted by Oregon State University suggests that Telepresence robots can be useful for university student's study distance to feel part of the classroom.

The research results are even more crucial when viewed internationally in online teaching which resulted due to recent by COVID-19 pandemic, compelling many future students to pursue their education from long distance using online tools such as Microsoft Teams or Zoom which was before done in classrooms and labs.

- **Security or Defence**

A portable small sized robot is being developed for use in fire monitoring and testing. The system allows accurate detection and identification of data collection without placing the user in a potentially dangerous remote location. Since controlling such a robot is a daunting task, the telepresence interface is designed to allow users to hear the robot as their own extension.

1.6 System Limitations

- This robot is unable to manage doors, stairs, lifts, etc.
- Robot has short battery life
- Little costly
- Needs a good security encrypted system
- Controlling the robot is challenging and office and hospital conditions are not always ideal for it, since buildings include obstacles, sloping floors, uneven WIFI signal, etc. [3]

1.6.1 Other Limitations and Solutions

To view a live video, a fast and non-interrupting Wi-Fi signals are required. High speed internet connectivity with low latency ping can overcome this difficulty.
Sensor data is transmitted as the VR headset is moved. In a situation where the head is moving rapidly, the data transfer rate is also high. This also requires the Arduino microcontroller to process data rapidly as well.

The current design of the robot allows it to travel over a smooth surface. The body of a powerful robot allows it to run in extremely dangerous environments. [4]

1.7 Work for Future Scope

The project can be expanded based on applications, such as fire extinguishing control, bomb demolition, industrial robot, medical robot, visual tool for education etc. In the present case, the project can be extended to visual gestures and other movements.

Currently, the robot's base motion is being managed using a mobile application. Using additional sensors, the robot can be made to directly mimic the movement of the user.

We can also make a robotic arm to which the camera may be attached. To minimize space while boosting accuracy and efficiency, more efficient design and execution is required. Specific design that is as per demands to the user can help save money and increase productivity. This method can also be used in conjunction with a drone to reach regions that are not easily reachable by land. We can work on the overall design to maximize efficiency.

Chapter 2

Literature Review

2.1 Methodology

Virtual Telepresence Robot is a device consisting of a camera and allowing a user to appear to be in place other than the real world. It is possible with combination of virtual reality and IOT using Raspberry pi or Arduino. Three major components of this project are Wi-Fi module with mobile application for driving the robot, mobile for VR headset and head movement tracking and the actual robot which has camera. [5]

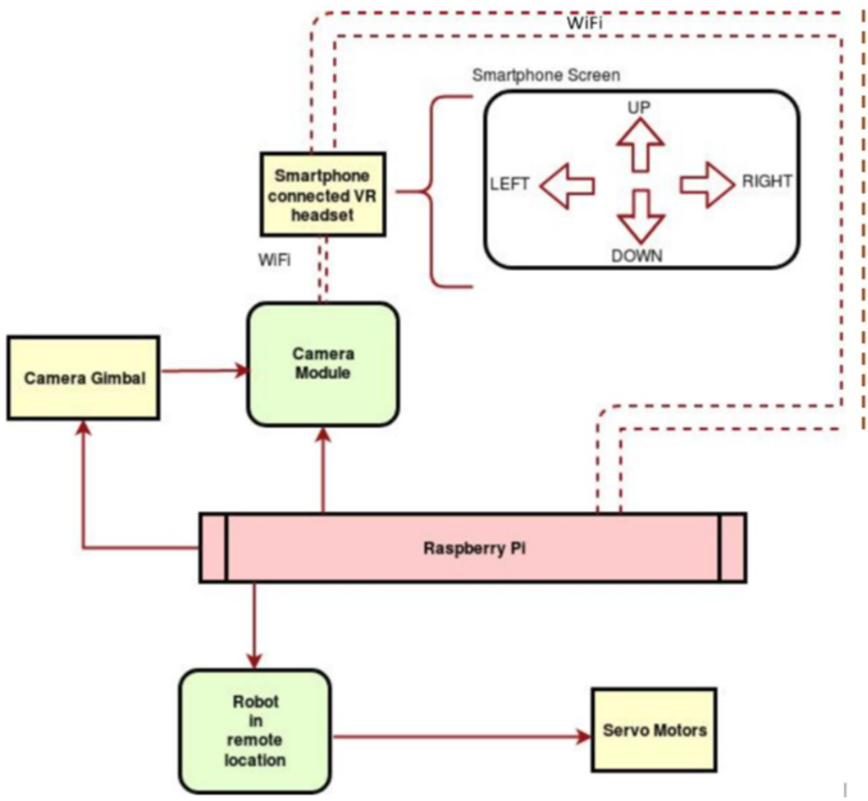

Figure 2.1: Project Methodology [6]

Figure 2.1: Project Methodology

- Raspberry pi 3B or 3B+ is the central component that interfaces user and the virtual telepresence robot through Wi-Fi. It is used for controlling robot movements, video capture and 3600 camera rotation.

- The live video feed being recorded by camera can be viewed on a smartphone through camera application, placed inside the VR headset. This robot allows the person to sense virtual reality through VR headset. For this reason, dual screen mode is enabled in the smart mobile to view the live video feed in immersive view.
- The Arduino gathers the accelerometer sensor data of the direction in which the user moves his head. This sensor data is then transmitted over Wi-Fi module and to the Arduino board through Bluetooth module, which, acts as inputs to the DC motors.
- To mimic the head gestures, two DC motors are used to move the camera for both the vertical and horizontal gestures. So, when you turn your head to the right side, the camera will also turn to the right direction to mimic the exact input gesture as required.
- H bridge IC that allows the tires to move in any position.
- Arduino IOT mobile application is used to control the movement of the robot. Commands are sent to Arduino over Wi-Fi from the mobile application.
- The accelerometer sensor data make the DC motors to move in any position. [6]

2.2 Components

2.2.1 Raspberry Pi

Alternatively, we could choose Raspberry Pi, since fast video transmission is possible using Raspberry pi over Wi-Fi network. The Raspberry pi is the main component of the robot because it will control all the operations of the robot. Raspberry Pi is a small sized single board computer, powerful enough to be used for many applications:

- The Raspberry pi requires very less power. It requires only 5V supply which can be supplied by attaching it to a 5V battery.
- This microcontroller is relatively expensive as compared to other microcontrollers.
- Raspbian OS is the Operating System that runs the Raspberry pi.
- It consists of GPIO up to 40pin to enable user to connect more input and outputs. [7]

2.2.2 DC Motors

There are different types of motor which can be used in robotics but using DC Motors in robotics give us some advantages. The biggest advantage is that they allow the robot to be battery powered. The speed of the motors can be varied by applying different supply voltages. They can also provide constant torque at a given speed. [8]

2.2.3 H- Bridge

Drivers serve as a visual link between motors and circuits. Motor requires a high current value while the control region operates at low input current

Figure 2.2: Raspberry Pi

Figure 2.2: Raspberry Pi

signals. The motor works by taking the low current as input and then amplify it to a high current that can drive the engine or circuit. H-Bridge or LM293D driver module is used in this project.

Figure 2.3: H-Bridge

2.2.4 Camera

To record images in ultra high resolution, we need a camera resolution that is as good as 16 megapixels, that will depend on the model of the camera. To get higher camera resolution, the more details and depth each video incorporate. We will be using Wi-fi camera in this project that has its separate Application to view the live video feed.

2.2.5 VR Headset

The device is almost compatible with most Android smartphones and iPhones as long as it fits in a VR headset. The average screen size provided by the manufacturer is 4 to 6 inches. [9]. A VR headset is wearable on your head and over your eyes, and visually distant you from whatever space you're physically carrying. Images or video can be seen by your eyes from two small lenses that are fitted inside the VR headset. Through VR you can virtually hike the Margalla Hills, visit any museum, watch a movie as if you are really part of it, and even indulge yourself in a video game without leaving your comfortable bed. In this project, a mobile phone will be placed inside the VR Headset and the user can move his head in any direction and the camera mounted on the robot will mimic the exact same movements and will provide the live video so that you can watch it from the VR Headset and feel like you are virtually present there.

2.3 Mobile Application

We used Arduino IOT cloud mobile application to control robot movement. From this app the data sent to the Arduino IOT cloud and then Arduino will take data from cloud as an input and then controller will decide what to do then based on the received commands.

Figure 2.4: VR Headset

Figure 2.4: VR Headset

2.4 Wireless IMU Application

To mimic the real time response of the user's head movement to the video captured by the camera, we can use another alternative approach, i.e. of the inertial measurement unit which is in-built in smartphones nowadays. This helps us is in avoiding an additional use of an Accelerometer sensor IC and helps us in the direct transfer of data between the sender and receiver. Inertial Measurement Unit(IMU) is made of these three sensors.

- Gyroscope
- Accelerometer
- Magnetometer

The data from these sensors can be used to map the users head position and can be used to send signals to the motors connected to the camera to rotate it.

2.4.1 Working

To mirror the rotation of the head of the user wearing the VR-headset, the data from the IMU App must be used. This app sends the sensor readings to the target IP address and port via UDP as Comma Separated Values (CSV). The UDP packet looks like:

Timestamp[sec], [Sensor ID(3)], x, y, z,[Sensor ID(4)], x, y, z,[Sensor ID(5)], x, y, z

where Sensor ID represents:

3 = Accelerometer

4 = Gyroscope

5 = Magnetometer

This application can be run in the background to capture the data while one can watch the live screening.

We configure the application on the phone to run in the background connecting to the IP address and specific port. There is a test run done to capture the data sent by this application by using the socket function in python. The user interface of the application looks like this:

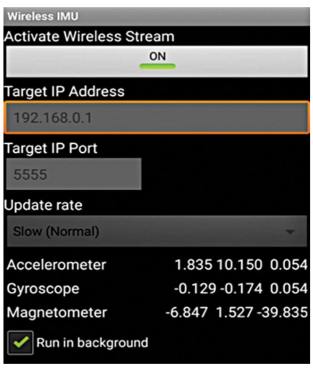

Figure 2.5: Wireless IMU App

Figure 2.5: Wireless IMU App

2.4.2 Algorithm

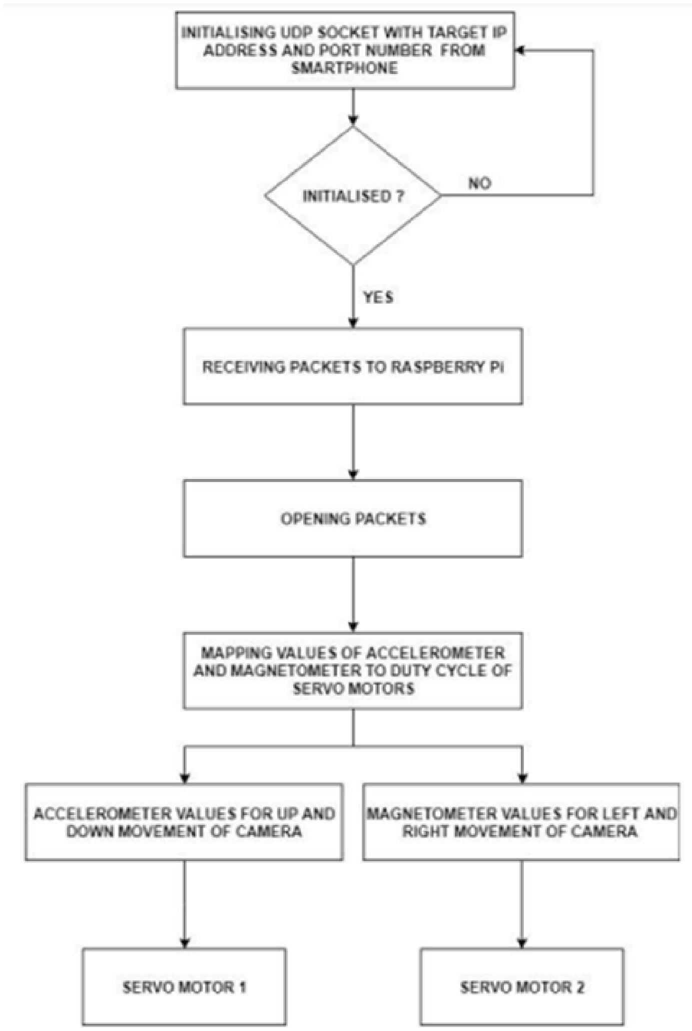

Figure 2.6: Algorithm learned from Literature review

2.5 Design and Development

The project is divided into various phases. We followed an incremental approach towards designing our telepresence robot. In this section, we'll be describing the design and testing approach. In the emerging stages of the project, we have a clear picture of what our plan should look like which was further developed as we experience further reductions and depth in this work. The existing remote robot must be able to navigate the remote control controlled by commands sent to the smartphone via Wi-Fi. Similarly, it should record a video using the camera module that will be sent to the smartphone using Wi-Fi. An additional feature is that the camera has to move left, right, up and down based on the user's head motion based on signals ranging from a smartphone with a magnetometer, accelerometer and gyroscope to servo motors to control the camera.

Chapter 3

Requirement Specifications

3.1 Existing System

There is very little work done on the project which are similar to Virtual Telepresence Robot.

Existing virtual telepresence robots have a little delay in their operation. The working and components are almost similar but their integration is different, hence there is a little delay in them.

3.2 Proposed System

In this proposed system, we have minimized the delay of the robot. The robot starts working as soon as the command is received from the application.

There are two parts of project , one is hardware and the other one is software. The hardware and mechanical part consist of:

- ESP8266 Wi-Fi controller
- DC gear motors
- 24V DC gear motor
- 12V Battery
- Relays
- 2N2222 transistor
- 10k resistors

- Robot Mechanical Structure
- DC to DC buck converter

3.2.1 ESP8266 Wi-Fi Controller

We have used esp8266 module for controlling of robot base and camera. As the camera of robot require 360-degree movement so the we can control the rotation of camera. The esp8266 controller has built in Wi-Fi for cloud server.

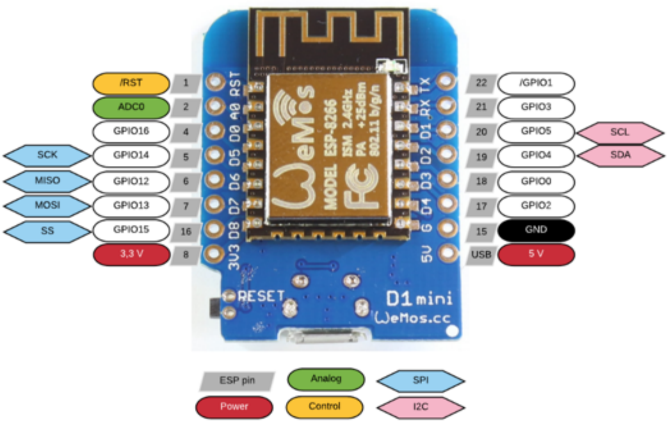

Figure 3.1: ESP8266 Wifi Module

This module has 8 digital pins and one analog pin. This module working voltage is 3.3V.

3.2.2 Node MCU

The NodeMCU is same like the WEMOS module, that module is compact and smart. This module is of large size, the chip and pins are same as

WEMOS D1 module.

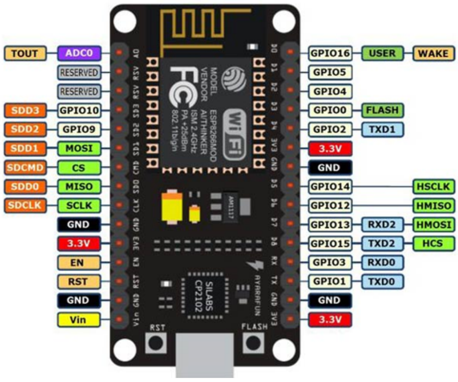

Figure 3.2: Node MCU

Figure 3.3 shows the detail structure of NodeMCU having pins outs.

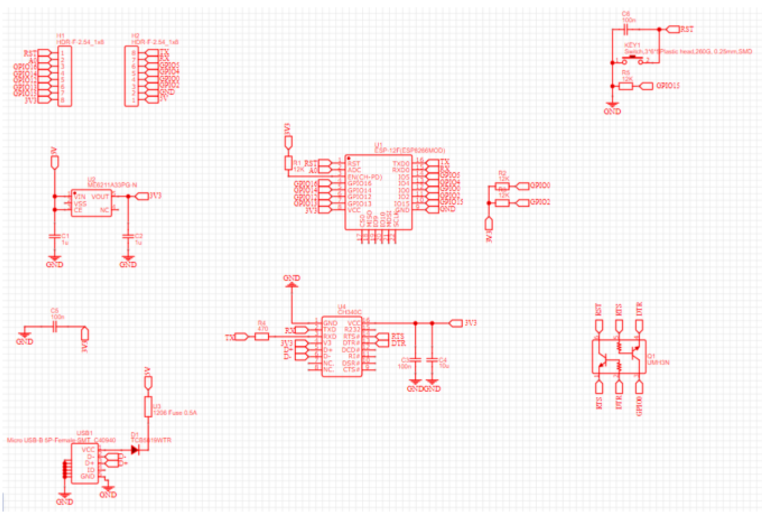

Figure 3.3: Pin Configuration of NodeMCU

3.2.3 DC to DC buck converter

The esp8266 work on 5V and we have all adapters of 12V , we cannot use many types of adapter or batteries, to make the system efficient we used DC to DC muck converter, we have selected LM2596 DC to DC buck converter which can provide sufficient amount of current and its beauty is its output is variable , we can adjust output as per our own requirements.

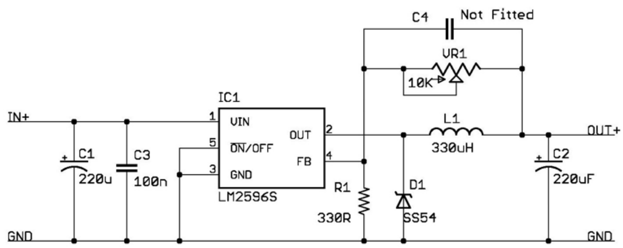

Figure 3.4: DC to DC Buck Converter

The schematic shows that the buck converter has capacitors at the input and out, the LM2596 has one inductor which us used to stabilize the voltage. The diode is used for reverse polarity protection. When the device turns off the inductor acts as source.

3.2.4 12V battery

We have used three 4V batteries via connecting in series to make 12V. and the current rating is 1.2A. These batteries are light in weight and their discharge rate is very low.

Figure 3.5: Battery

We have connected three batteries in series to make 12V DC. This battery is of low weight and nominal capacity.

3.2.5 DC Gear Motor

The conveyor belt movement require DC gear motor, as the motor speed decreases torque increases.This DC gear motor can operate on 24V DC with a very less amount of current. The gear box used in this motor is worm gear which are very powerful.

Figure 3.6: DC Gear Motor

3.2.6 Robot Mechanical structure

The robot mechanical structure is based on acrylic material having base dimensions are 11 inch and length is 18 inches. The height of box if 4 inches. We have placed camera mount over the height of 2 feet to see the objects clearly.

3.2.7 IN4007 Diode

We have used general purpose diode which maximum voltage is 1000V and the maximum bearable current is 1A.

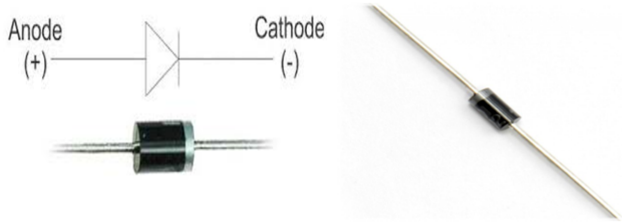

Figure 3.7: IN4007 Diode

3.2.8 IN4148 Diode

It is a high frequency switching diode having voltage range is 40V and the current rating 500mA. But this diode is of high speed diode and is also called fast recovery diode.

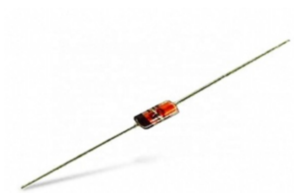

Figure 3.8: IN4148 Diode

3.2.9 2N2222A

It is a general purpose NPN transistor having nominal current and voltage rating. This transistor is used as a relay driver.

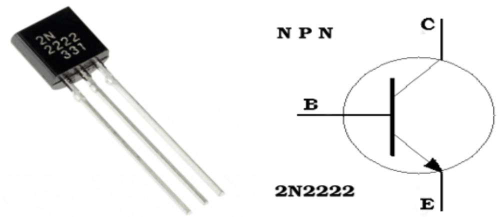

Figure 3.9: 2N2222A NPN Transistor

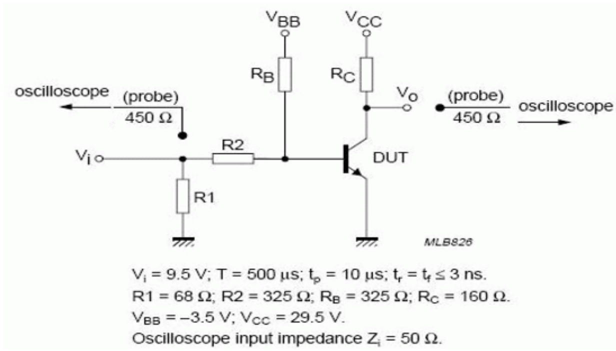

Figure 3.10: Detailed Configuration of 2N2222A Transistor

This transistor is of 3 pin packages having three terminals

Pin Number	Pin Name
1	Emitter
2	Base
3	Collector

Table 3.1: Pin Configuration

3.2.10 Relays

For automatic switching, relays are used. Relay is an electromechanical device which is used to turn on and off the appliances.

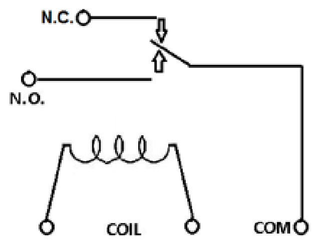

Figure 3.11: Internal Relay Configuration

Figure 3.11 shows the internal structure of relay having 3 terminals and one coil.
The relay physical structure is shown below:

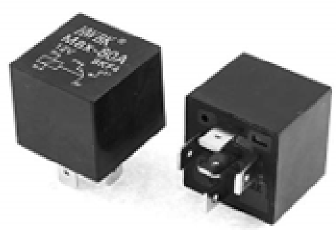

Figure 3.12: Relay

Chapter 4

System Design

4.1 System Architecture

We have used ESP8266 wifi module and relays to control the robot movement using Mobile Application. The raspberry pi controller will be used to stream live video to an IP address which can be viewed by the user on the VR Headset. An input signal will be given from the mobile application which acts as an input to the wifi module. The wifi module will then switch the relays to perform the desired task.

4.2 Design Methodology

The system design has three main parts:

- Software simulation design
- Hardware design
- Cloud base Application

4.2.1 Hardware Design

The hardware of project is based on relays, WEMOS D1 Wi-Fi module , battery , Wifi Camera ad Arduino UNO microcontroller. Another approach is to use Raspberry pi and Pi camera in this project. Consider this approach for a second.

4.2.2 Pi Camera interfacing with Raspberry Pi

Raspberry Pi has a default camera port where we can directly connect the camera, this camera is available in two specifications, one is 5MP and the second one is 8MP. We have used 5 mega pixel camera in our project.

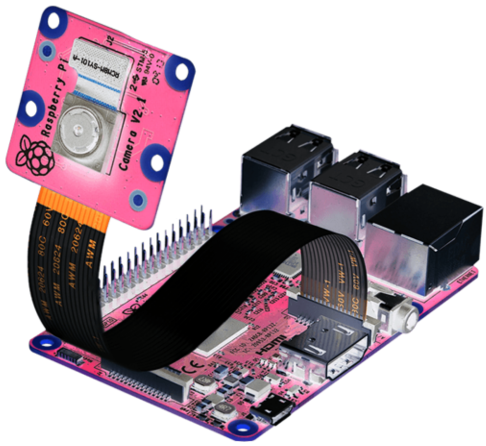

Figure 4.1: Alternative Approach using Pi Camera with Raspberry Pi

RP interface needs to be interfaced based on our need as we know that raspberry pi interfaces are disabled by default. It is done by using the following command.

sudo raspi-config

By using above command, we can see the following window as shown in Figure 4.2 to enable the raspberry pi camera.

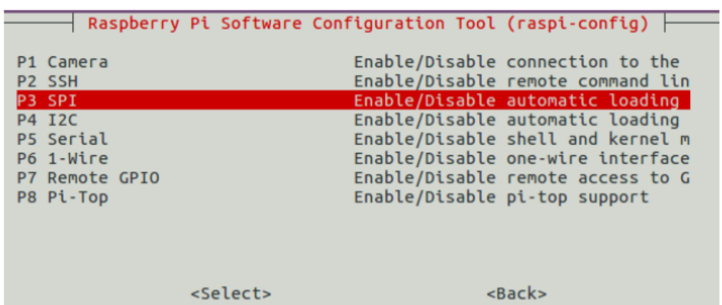

Figure 4.2: Enabling Raspberry Pi Interface

Figure 4.2 shows the interface enable and disable window when ever we enable any interfaces the raspberry pi would reboot to get the libraries of respective interface.

For pi camera interfacing we preferably use python language which is easy to use and have very simple commands:

import picamera

In the above code we use word import to include the library, here we include the library of pi camera.

from time import sleep

We use time library and in time library we use sleep function for delay purpose in seconds.

camera=picamera.Picamera()

We make the object camera of our own choice that we can use in programming code further. In capturing image, we use the command of camera.capture.

4.2.3 DC Gear Motors

The robot has an option of small movement so for this purpose we have used DC gear motors which will be able to move the robot. The DC gear motors which we have used are having 120RPM and the operating voltage of this motor is 6V.

Figure 4.3: DC Gear Motor

As raspberry pi pins gives 3.3V at the output pins with a very less amount of current. DC gear motor requires least amount of current for proper operation and 6V input supply, for this reason, we use motor driver circuit for DC gear motor.

Our project's aspects in dealing with the human can be increased by advancing the capabilities of robot.

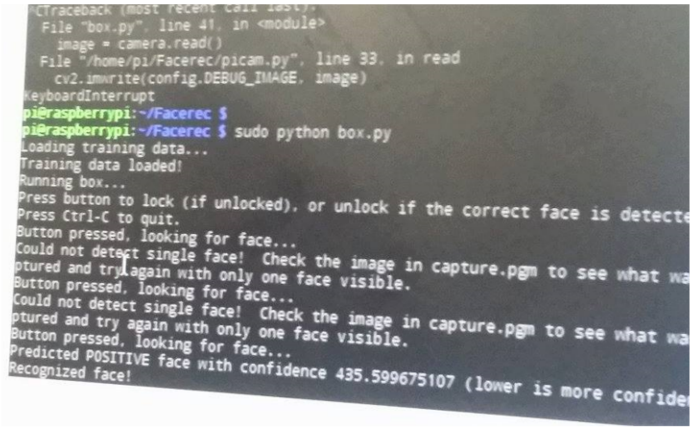

Figure 4.4: Testing Pi Camera

The interface of raspberry pi is shown below:

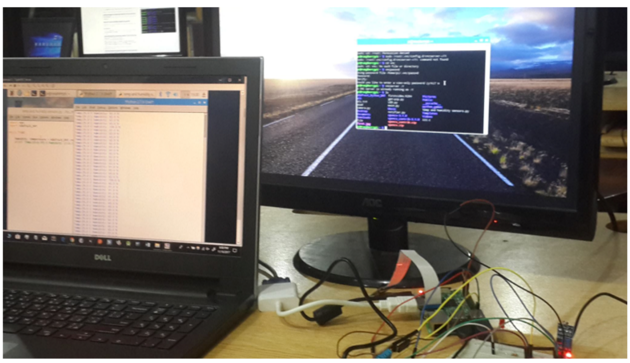

Figure 4.5: Raspberry Pi Interface

Figure 4.6 shows the hardware setup of raspberry pi

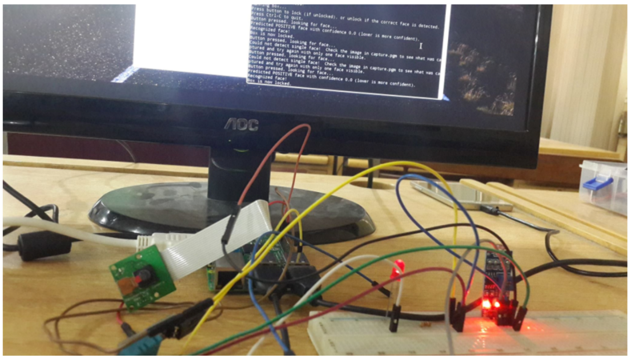

Figure 4.6: Hardware Setup of Raspberry Pi

Figure 4.7 shows the Raspberry camera testing, using raspberry pi hardware.

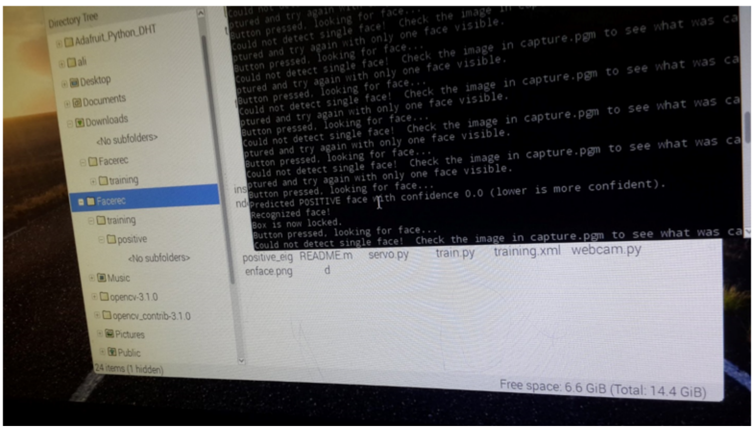

Figure 4.7: Raspberry Pi Camera Testing

Figure 4.7 shows the hardware interfacing of Raspberry pi. We have seen that raspberry pi has terminal for command-based operation.

4.2.4 Arduino IOT Cloud Platform

We have used arduino MQTT IOT platform and also used the Arduino cloud server. This server provides a free of charge cloud parameters display and its control system. We can select the widgets from the app which we want to use it.

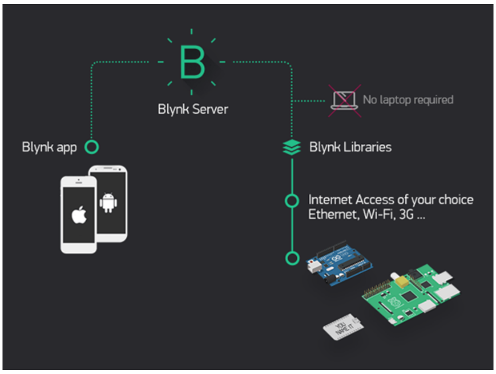

Figure 4.8: Blynk Cloud Server

By using blynk server we can connect to any hardware like arduino, raspberry pi , node MCU and esp32. We can use any board to connect. We just need internet SSID and password. In this application we must login first and then used to design project

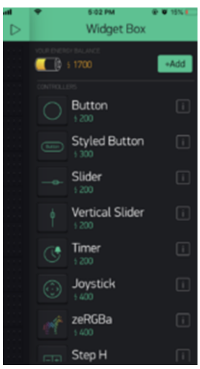

Figure 4.9: Blynk Application

From this widgets box we would select the buttons and value display boxes. These widgets would connect to the cloud using virtual pins like V0, V1 etc.

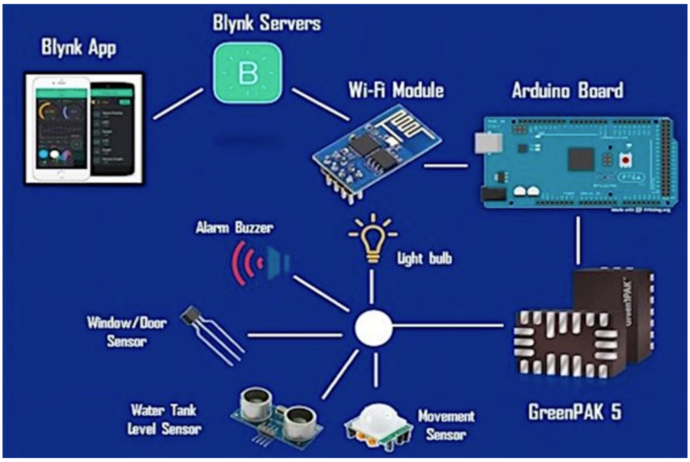

Figure 4.10: Blynk Cloud Functionality

Blynk provides the complete and compact IOT platform in which we can connect sensors, boards and modules with wi-fi and display its values on blynk application.
Blynk has its own server and library, we can use blynk application for IOT display. This application would provide the cloud service.

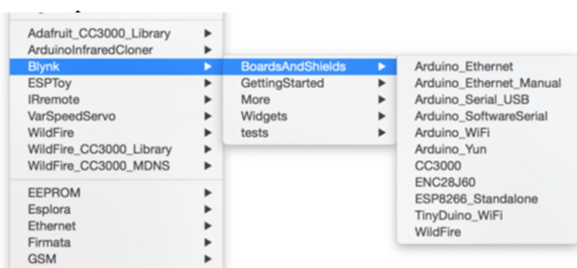

Figure 4.11: Blynk Arduino Library

By using arduino software we can add the blynk library and run the programming codes on arduino software. This software provides the complete platform using blynk cloud.

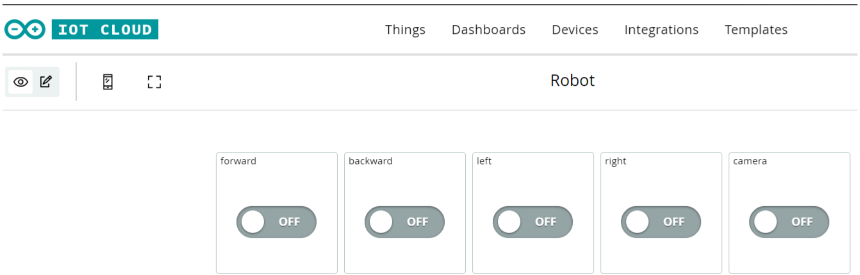

Figure 4.12: Arduino IOT Cloud Dashboard

4.2.5 Cloud Information

We have studied many web based cloud systems and we have seen pros and cons in all systems , free cloud service with many extra features we have short listed the MQTT based cloud server which provides us extra functionality and totally free.

Sr.No	Cloud Server	Service provider company	Advantages	Disadvantages
1	Amazon Cloud Services	Amazon	A good optimized cloud platform	Its free version does not meet our requirements. And paid version is relatively expensive
2	Azure Cloud Services	Azure	A good optimized cloud platform	Its free version does not meet our requirements. And paid version is relatively expensive
3	Thingspeak	Thingspeak	A Free cloud platform for basic users	We can monitor easily but controlling is unstable
4	MQTT	MQTT	A free Cloud server for small applications	We cannot optimize big data set application on it. But it can be good for our application that is required in this project
5	Google cloud Services	Google	A good optimized cloud platform	Its free version does not meet our requirements. And paid version is relatively expensive.
6	Arduino cloud Server	Arduino	A good platform for students	Free of cost but it has limited features for free users

Figure 4.13: Cloud Services Comparison

We have short listed MQTT based cloud server in which we have used arduino based services because it is totally free and have many extra features.

4.3 Software Implementation

The project is basically having two parts, software and hardware. The software part is the core part of project which is called the brain of project.

The softwares that we have shortlisted for our project are

- Proteus
- Arduino IDE

4.3.1 Proteus

Proteus software has two functionalities, one is real time simulation and the other PCB designing. The ISIS is used for real time simulation and the ARES is used for PCB designing.

4.3.2 Arduino IDE

We have used Arduino IDE software for the programming main controller. The main controller board has ATMEGA328 microcontroller which is based on Arduino UNO , we just need to burn the code on the microcontroller.

Chapter 5

System Implementation

The implementation of system is based on software simulation, programing and hardware integration. The project have two main parts, one is software and the other one is hardware.

5.1 System Architecture

The project architecture is based on following block diagram

The architecture of the system is mainly based three parts, the first part is used for VR head set, the second part is used for robot and the third one is used for camera movement. The main components that we have used in this project are

5.1.1 ESP8266 Wi-Fi Module

We have used esp8266 module for IOT and the cloud server that we have used is Arduino IOT Cloud.

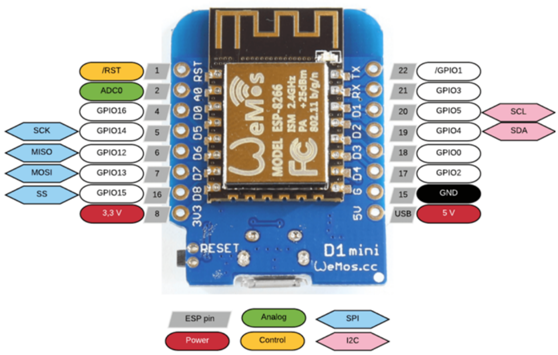

Figure 5.1: ESP8266 module

This Wi-Fi module has 8 digital pins, and one analog pin. These digital pins are used for the control of motors and its Wi-Fi chip is used for IOT applications.

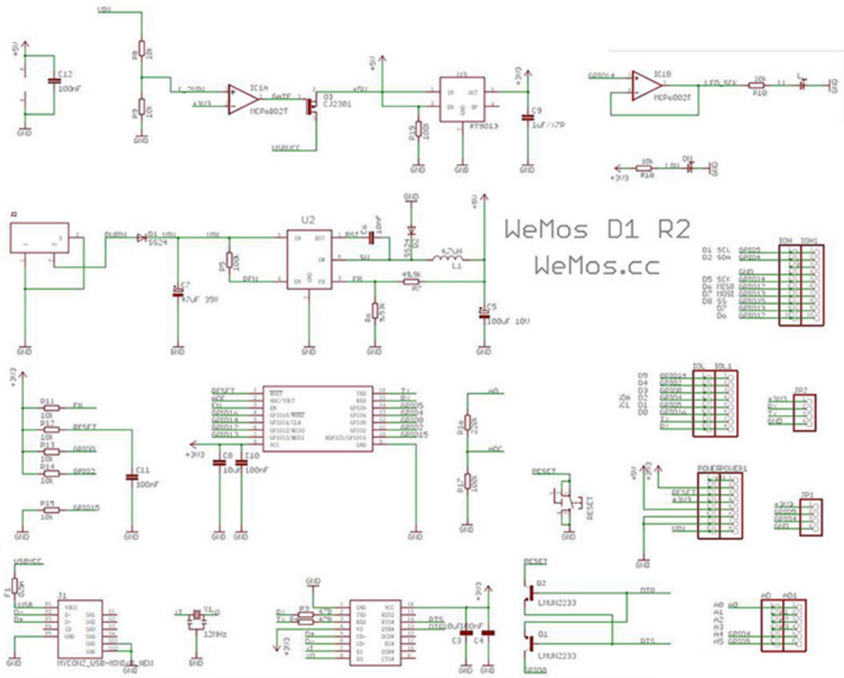

Figure 5.2: Schematic of WEMOS D1, R2 and mini

5.1.2 Accelerometer Module

Accelerometer Sensor is used in this project and is attached on top of the VR Headset to get the head movement position and transfer it to the Arduino Microcontroller for further processing. The accelerometer is used for controlling camera movement using head gesture. The schematic of Accelerometer Sensor is shown in Figure 5.4.

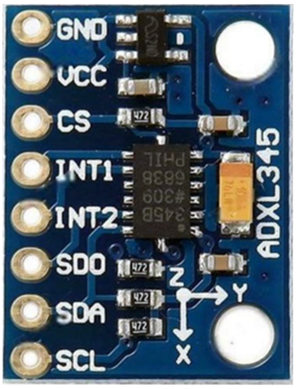

Figure 5.3: Accelerometer Sensor

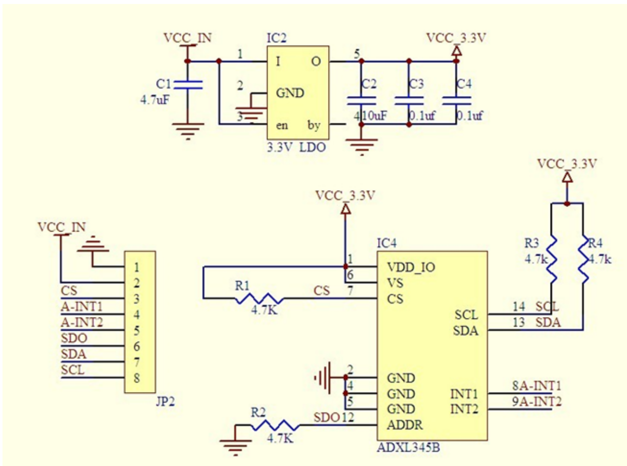

Figure 5.4: Schematic Diagram of Accelerometer Sensor

Figure 5.5: Accelerometer Sensor, ESP8266 and Bluetooth Module attached to VR Headset

5.1.3 DC Gear Motor

The dc gear motors are used to drive the camera module as well as robot. The movement is mainly based motor driver and driver module.

The DC gear motor working voltage is 24V with a RPM of 60. These gear motors torque would be increased using gear box.

5.1.4 HC-05 Module

The HC05 module is used for wireless communication, this module is based on 2.4GHz and the working voltage of this module is 5V.

5.2 Tools and Technology Used

5.2.1 Arduino Software

Arduino IDE is a software development environment, which can be used for programming, this software is used to code or write a specific program.

5.2.2 Proteus

The Proteus Design Suite is a designing software to create microcontroller electric circuits. It has nearly all of the microcontrollers which make the software tested and the simulations convenient for users. Proteus is mostly used by electronic engineers for the production of electronic prints and PCB schemes. 2D product drawings can also be produced. The programme ISIS is used mostly to create schematics in real time.

Figure 5.6: ISIS Programme

ARES's major benefit for the design is that it gives a 3D perspective of the design and components of the printed circuit.
To design and simulate the layout of a PCB, schematic capture is the fundamental component.

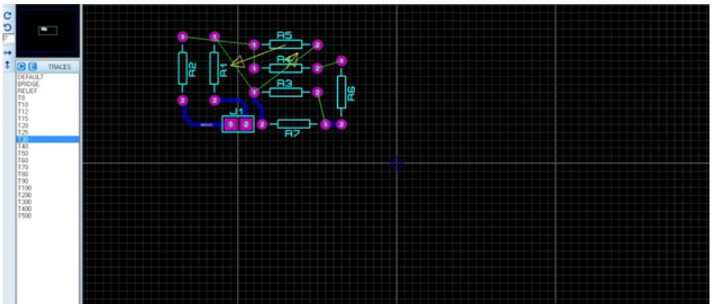

Figure 5.7: ARES Programme

5.3 Development Environment/Languages Used

We have used Arduino language for programming and the IDE is the development environment of this software is used for the development of programming code.
The language which we have used is C language.

5.4 Processing Logic/Algorithms

The algorithm that we have used in this project is based on flow diagram given below:

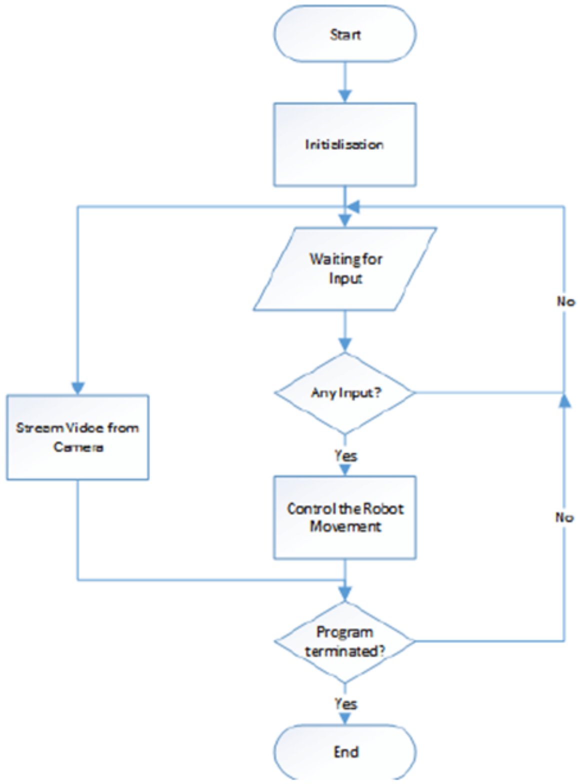

Figure 5.8: Algorithm utilized to control the robot's base motion

The above algorithm is utilized to control the robot's base motion, The program get the input and move accordingly.

Chapter 6

System Testing and Evaluation

6.1 System Testing and Evaluation

The system testing is based on hardware and software testing. The hardware testing is using physical connection of components.

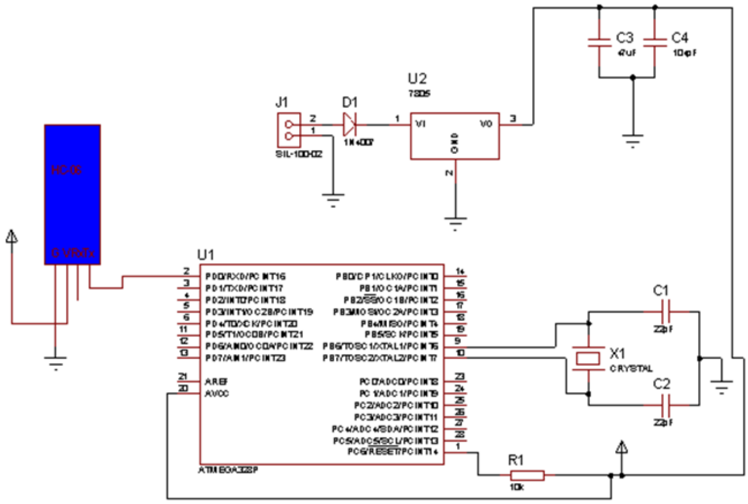

Figure 6.1: Bluetooth interface with microcontroller

Figure 6.1 shows the Bluetooth interface with microcontroller in which we connect the Tx pin of Bluetooth with the Rx pin of microcontroller and the Rx pin of Bluetooth with the Tx pin of microcontroller (Arduino board).

Figure 6.2 shows the schematic diagram of relay based circuit in which the optocouplers are used as a relay driver. The relay coils required nominal current. The WEMOS D1 is used as a Wi-Fi controller in which its pins are also used for controlling the robot.

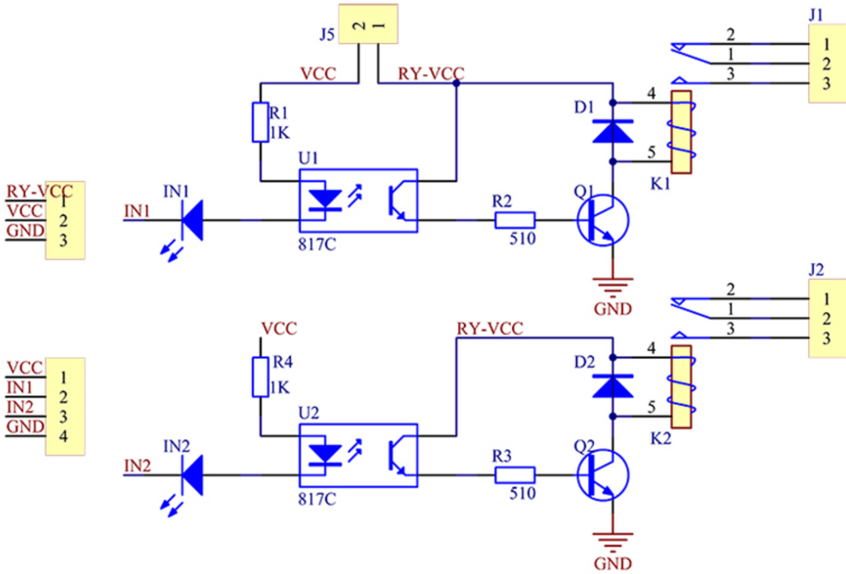

Figure 6.2: Schematic diagram of relay based circuit

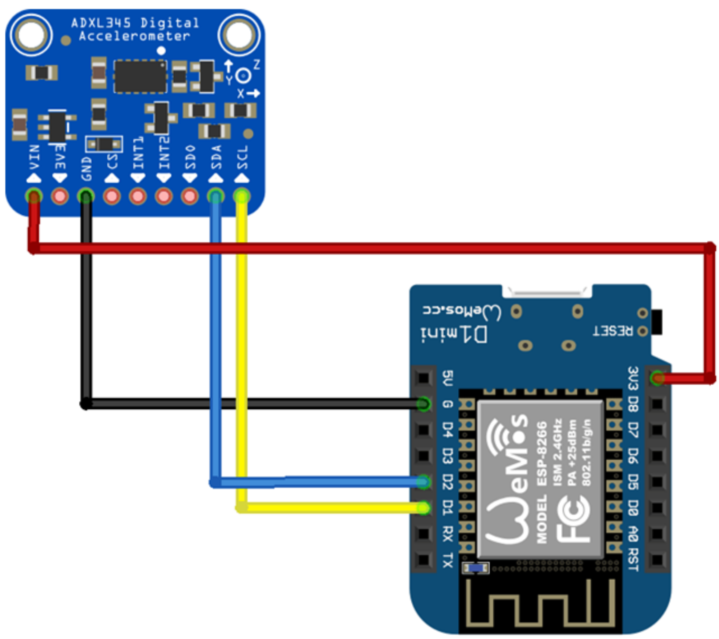

Figure 6.3: ADXL345 interfaced with WEMOS D1 mini

The accelerometer is used for gesture based caera movement control. The ADXL345 is interfaced with WEMOS D1 mini using I2C interface. The I2C interface has 2 pins, one is SDA and the other one is SCL. The SDA pin is connected to the SDA pin of WEMOS D1 mini and the SCL pin is connected to the SCL pin of WEMOS D1 mini.

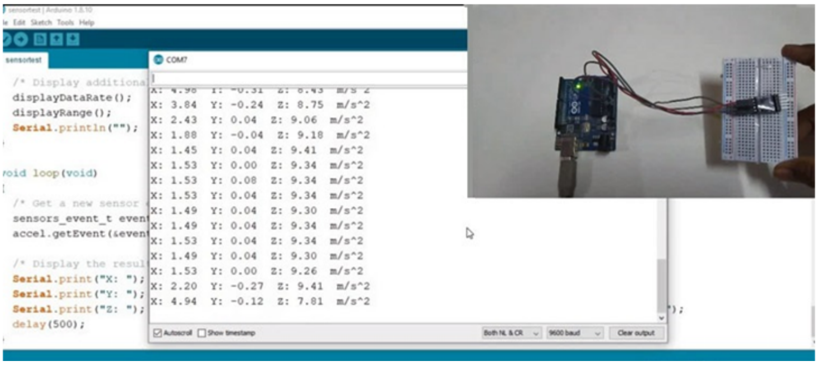

Figure 6.4: Accelerometer 3 axis results in Serial Monitor

Figure 6.4 shows the accelerometer 3 axis results. In which the calibrated values of all three axis are shown in serial monitor.

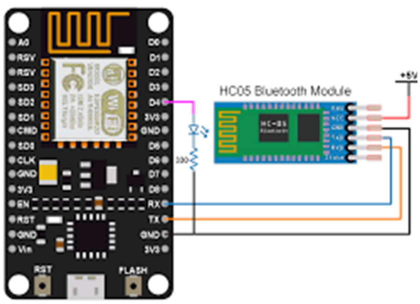

Figure 6.5: HC-05 interface with ESP8266 module

Figure 6.5 shows the HC-05 interface of ESP8266 that we have used for communication of VR headset and also robot camera movement. The VR head set send the signal wirelessly using Bluetooth module, the signal has been generated through ADXL345 and the esp process that accelerometer signal.

Figure 6.6: Complete connection of VR Headset with different modules

Chapter 7

Conclusion

The project main focus is the gesture controlled security surveillance robot with VR head set. The camera which we have used is wireless camera having cloud based connectivity. The camera give the video streaming to VR headset based mobile phone. The mobile phone display the video of camera, and the person visualize the video. The Movement of camera is based on head movement of person. The accelerometer is used generate the head gesture signal. The communication link that we have used is a Bluetooth. The Bluetooth take the signal from VR head set and send that signal to robot for the movement of camera.

We have faced many issues in wireless communication. Many modules have been tried and many communication links have been tested, the problem is that some of them like ZigBee are very much expensive and some of them have a latency issue.

The module which is based on NRF24L01 has a data latency issue which communication create a delay between transmitter and receiver signals The NRF long range module also compromise the transmission distance. The camera which we have tried are of 1MP and 2MP. The results of 2MP camera is very good and the one main feature that we have seen in this camera is that it work on Wi-Fi direct, without internet connection. Some places we got handicapped and having no internet connection. So we prefer the Wi-Fi direct option. The robot is based on 2 motors and 4 tires. The robot successfully finalized with proper functionality. The VR headset control the movement of camera and the two DC gear motors are installed for the camera rotation separately. These motors are of low RPM and high torque.

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