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DESIGN AND IMPLEMENTATION OF A TELEPRESENCE ROBOT FOR COVID-19 PANDEMIC

by

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MOON DHAR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

Department of Electrical and Electronic Engineering
INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

APRIL 2022

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A project
submitted as partial fulfillment of the requirement for the degree of

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

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CERTIFICATE OF APPROVAL

The project entitled as "**Design and Implementation of a Telepresence Robot for Covid-19 Pandemic**" submitted by **Md. Sirajul Islam**, bearing Matric ID: **ET 163009** and **Moon Dhar**, bearing Matric ID: **ET 153077** of session **Autumn 2020**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **16th April, 2022.**

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this project has been submitted elsewhere for the award of any degree or diploma.

_____

Md. Sirajul Islam

_____

Moon Dhar

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Authors

ABSTRACT

The word "Tele" means distant, and the word "Presence" refers to the state of being present in a place. It is almost like being teleported to another place. Telepresence is a medium in which transducers, such as video cameras and microphones, replace the participants' corresponding senses and enable real-time two-way collaboration between people who are not in the same location. They can communicate as if they are in the same room and easily share data. Nowadays telepresence robots are used in different sectors. This kind of robot uses virtual reality implementations with human-system interfaces, communication technologies, and robotics and is used for tour guides, night watchmen, factory inspectors, Mining, bomb disposal, military operations, the rescue of victims from fire, toxic atmospheres, deep-sea exploration, or even hostage situations. It is also used for social interactions during pandemic crises such as COVID-19. Covid is an infectious disease. It can spread from one person to another person. That is why people should maintain social distance and protect themselves from being infected. Our prototype can help people maintain social distance and it can also be for medical purposes during the lockdown and covid treatment. Our prototype contains a raspberry pi, a motor driver, a Pi camera module, and other components. The primary work of this prototype is to perform visual communication through video conferencing and share information with others. Here we send a command from the computer to the prototype and we can remotely control its movement. The raspberry pi works as the prototype's heart. It tracks all the movement of the prototype. Besides medical use, it can use for personal use. In this lockdown situation, people are not only being sick physically but also mentally. Being in lockdown people fells lonely and this loneliness causes different physiological sicknesses or disorders. Our prototype can reduce this loneliness by creating social interaction by video conference, this way people can share their emotions with others. This way they can reduce their loneliness. So this robot can use both medical purposes and personal use. This robot will be able to help a lot of people in many situations. This robot will be light, cheap, small, and easy to operate so anyone can operate this robot easily without any extra knowledge.

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LIST OF ABBREVIATIONS

ROCS	Remote Open Campus SYSTEM
LINUX	Lovable Intellect Not Using XP
IOT	The Internet of Thing
CPU	Central Processing Unit
RAM	Random Access Memory
GPU	Graphics Procesing Unit
GPIO	General Purpose Input and Output
UART	Universal Asynchronous Receiver and Transmitter
HDMI	Horable Discharge Minor Under

CHAPTER 1

INTRODUCTION

1.1 Introduction

Telepresence is a technology that allows a person to feel as if they were present at a location other than their true location via tele robotics.

Telepresence works in such a way that it gives the users such a sensation that they think they are in another location. Users may also be allowed to interact with the remote location. To achieve this effect, the user's position, movements, activities, voice and so on may be sensed, relayed and reproduced in a remote place. As a result, data between the user and the remote location may move in both directions.

According to Sheridan, "Telepresence is a human-machine system in which the human operator receives visual, kinesthetic, tactile, or other sensory feedback about the teleoperator and the work environment, portrayed in a sufficiently natural manner, that the operator feels physically present at the remote site" [1] [2].

In other places, Akin et al say "The manipulators have dexterity on the worksite to enable the operator to carry out normal human tasks functions. The operator works at the control station where he receives an adequate quantity and quality of sensory feedback to provide a sense of real presence on the worksite" [3].

Nowadays telepresence robots are used in different sectors. This kind of robot use virtual reality implementations with human–system interfaces, communication technologies and robotics and used for tour guides, night watchmen, factory inspectors, Mining, bomb disposal, military operations, the rescue of victims from fire, toxic atmospheres, deep-sea exploration or even hostage situations. It is also used for social interactions during pandemic crises such as COVID-19.

Covid is an infectious disease. It can easily spread from one person to another person. That's why we need social distancing. In many countries locked down occurs to prevent further the virus from spreading. Social distancing is the standard practice to reduce the influence of infection spread, especially for vulnerable groups because the spread is strongest while social contact occurs [4]. But right now people not only suffering from this disease but also mental sickness. Fear and incomplete information are the main cause of this mental sickness. Fear is understandable, this is a new virus that appears to be highly contagious and lethal, and we have no immunity to it. With that lack of information, people become very afraid. Any false information or lack of communication with other people became afraid and lonely.

During quarantine of infected people is a type of social distancing that is useful for many infectious diseases, social distancing on a larger community level aims to achieve minimal interaction between people in the population and is, therefore, more ethically challenging [5]. In many situations social distancing can be easily misunderstood as "distancing"; it is not meant to imply a reduction in social or emotional support [6]. Long-term social distancing can be causes loss of motivation, loss of meaning, loss of self-worth, and subsequent mental health problems [7]. From recent pandemics (SARS, H1N1, Ebola, MERS) there is some scientific evidence that highlights the impact of being "quarantined" on psychosocial factors [8]. The negative outcomes from the scientific evidence are depression, stress, irritability, sleep disorders, anger, etc. The psychosocial impact of quarantine during this covid pandemic implied extensive negative consequences for mental health [9]. In this pandemic mortality increased; lack of social support, loneliness and limited social contact are the main reasons for these [10], as well as an increased risk of cardiovascular disease [11] and dementia [12]. Furthermore cancer patients had a better chance of survival, those who had more social support [13]. This, which is thought to be a stress-relieving effect [14], is most likely caused by physiologic pathways related to neuroendocrine or immunologic function [15]. Social support improves the immune system's ability to deal with inflammatory processes [16,17]. In further, studies show that neurons in socially isolated animals are less responsive to stimulation [18], highlighting the importance of social contact in neurodegenerative processes. The health-promoting effects of social contacts contrast with older people's vulnerability to loneliness [19].During lockdown older people has to stay home. Unable to contact with others older people fell loneliness. Loneliness and isolation are especially harmful to one's psychological and physical health.They can result in the development of a variety of disorders, including depression [20], high blood pressure, poor sleep quality, cognitive decline [21], chronic alcohol consumption [22], and an increased risk of mortality when compared to non-isolated people [23,24]. A clinical review of COVID-19 testing, treatment, and prognosis in the elderly supports the link between age and the presence of comorbidities and increased severity and mortality [25]. In this complicated situation, we need to maintain social distance and also reduce our loneliness in the lockdown period, especially for elderly people. Here comes our telepresence robot to solve both problems. Our telepresence robot is a machine so we can use this robot to interact with others in this lockdown situation. We can also use this robot in health care to deliver medicine or other things to the patient and through the robot's monitor doctor can check his patient without one on one contact. This way it can lower the risk of infection for healthcare staff [26]. It can also use for entertainment, social networks, sharing things with others without one on one contact and by video conferencing people can

communicate with others and they can see each other through the robot's monitor [27]. Our prototype will be on wheels. It will have a screen and a camera. It can be operated by computer remotely. people can see video or information on the screen. They can see each other and communicate with each other by video conferencing remotely [28].

1.2 Motivation

Mobile robots are now capable of interacting with humans in a variety of situations. Specifically, the evolution of friendly robots, as well as the simplicity of controllers, allows robots to supplement humans in a variety of tasks. These robots are capable of carrying out a given task on behalf of a human being in remote working environments and emergency conditions. Telepresence robots are similarly available for entertainment, audio-video interaction, and remote monitoring. In this pandemic situation, this telepresence robot is the new way for social interaction. In this pandemic situation when everywhere are under lockdown and everyone maintains social distancing and one on one contact is not allowed but still healthcare staff, doctors give treatment to the patients, and this way they are at a higher risk of infection [29]. To overcome this problem we need a machine or robot which can help doctors do their job without being affected by the virus. Here we can use our telepresence robot which will prevent one on one contact between doctor and patient. This robot is not only can useable for medical purposes but also for personal use. In this lockdown situation, people suffer from psychosocial problems because of long-term social distancing. Loneliness is a major factor for different psychosocial problems. Specially elderly people suffering from this. This loneliness is responsible for different types of disorders, such as depression, high blood pressure, poor quality of sleep, cognitive decline, chronic alcohol consumption, etc. Here also our telepresence robot can perform nicely. The telepresence robot will be on the wheel and it can be controlled by a computer remotely it will have a camera and a monitor for social conversation. It will be light, cheap, and easy to use. It can be used for entertainment, social networks, sharing things with others without one on one contact. This way by using this robot we can reduce one on one contact which will reduce the number of patients and we can also cure loneliness by sharing one's emotions with others by video conferencing remotely.

1.3 Objectives

The objectives of the project are given below:

- To develop a robotic system that can be controlled wirelessly.
- To make a video interface for remote viewing.
- To carry an important object and send them to the expected location through the robot.

1.4 Report Outline

This project's design and construction have been covered in six chapters. The chapters and their contents are as follows:

- **Chapter 1** (Introduction): This chapter will provide the background, motivation and purpose of the project.
- **Chapter 2** (Literature Review): This chapter will provide an exploration result of previous work or studies related to this project.
- **Chapter 3** (Components): This chapter will provide detailed information on the components which are used in this project.
- **Chapter 4** (System Design): This chapter will provide the experimental setup of this project.
- **Chapter 5** (Implementation and Result): This chapter will provide the execution and the performance of the project.
- **Chapter 6** (Conclusion): This chapter will provide an overview of the project and we will discuss the advantages and disadvantages of this project, the result, the benefit of this project, and the possible future work or development of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A telepresence robot is a moveable remote-controlled gadget with wireless internet access. A tablet is typically used by the robot to give video and audio capabilities. Telepresence is a technology that allows a person to experience something from a far distance. This technology uses different sensory feedback like visual, kinesthetic, tactile and duplicates the targeted area and sends the effect to the user, this way user fell like he is in a different location.

2.2 Review of previous works

In this current period of time, there is much research is going on the telepresence and telepresence robots including a variety of up-to-date ways for new telepresence robots and new technologies to upgrade our system on a daily basis. In this field, there are still many things to study and different people's ideas work in different ways. That's why every day we see different ideas, different telepresence robots with different functions to fulfill the different needs of people. The below sections will discuss a depth review of the work involved.

2.2.1 A Remote Navigation System for a simple Teleepresence Robot with virtual reality

A remote navigation system for a small telepresencerobot is proposed in this work. In general, telepresence robot functions are limited, and the visual angle of the camera on robots is narrow, making them unsuitable for use with navigation services. The suggested solution addresses the challenge by employing a system architecture in which robots are controlled remotely via an Internet server, by employing well-designed virtual reality techniques for robot control, and by including practically all robot navigation capabilities into the server. We also developed Remote Open Campus System (ROCS) as a prototype system in this study, and by doing so, we validated the efficacy and utility of the suggested system [30].

2.2.2 Monitoring and controlling of VIA internet through Raspberry pi board

This study describes how to manage terrorist attacks all across the world by monitoring and commanding mobile robots over the internet using the Raspberry Pi board. Monitoring and controlling robotic motions through a wireless network using a web browser and a website. To improve sight of the items, a camera is put to the robot. The robot's programming language is based on the LINUX platform and will be interfaced with the Raspberry Pi board. The PIR sensor identifies a person or item entering a monitoring area, while the

smoke sensor detects fires by sensing a rise in smoke levels in the environment. The output of the sensors can be conveyed to the user via an alert. Using the internet of things, this mobile robot can be controlled from anywhere in the globe (IoT)[31].

2.2.3 Remote controlling of robots

In terms of research on remote control of robots via computer networks, several remote operation methods based on multi-view displays and multiple sensing data are presented (i.e. tele-operation). Kajima Corp. in Japan, for example, has created a "Unmanned Construction System" that can remotely control 10 construction machines at the same time [32]. Each construction machine has 5 or 6 cameras attached on it, and the high-definition images collected by them are relayed at the same time through optical fibers. Remote human operators control the equipment while verifying the photos and the operating sound. There are also several studies on telexistence that offer operators with experiences of a portion of the five senses, such as sight and hearing (a distant presence feeling) [33].These studies emphasize seamless functioning with presence by attaching several sensors to robots and surroundings. We can't employ these technologies directly since the suggested system is Designed to use a basic robot.

CHAPTER 3

COMPONENTS

3.1 Introduction

Components are the most essential part of a project, without suitable components, one cannot design an appreciable project. Selecting the suitable components is another important and difficult task. In this section, we will discuss the components that are used in the design of our project. In this section, we will try to discuss hardware descriptions elaborately and also their functions, block diagrams,etc.

3.2 List of Components

The components that are used in this project are given below:

1. Raspberry pi
2. Webcam
3. USB Microphone
4. Speaker
5. LCD I2C
6. LiPo Battery
7. L298 motor driver module
8. Gear motor
9. Servo motor
10. Sonar sensor

3.3 Raspberry Pi

The Raspberry Pi is a single-board computer. It is a cheap, small computer that can be connected to a computer monitor or television. It can do everything a computer can, from browsing the internet and watching high-definition videos to creating spreadsheets, and playing games. In the beginning, the original Raspberry Pi had a single-core 700MHz CPU and only 256MB RAM, whereas the latest model has a quad-core CPU that clocks in at more than 1.5GHz and 4GB RAM[9].

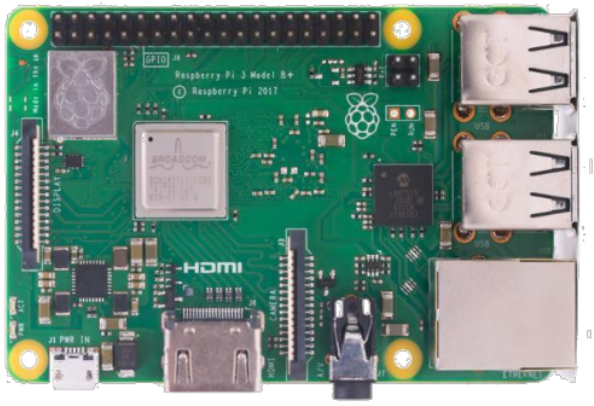

Fig 3.1: Raspberry Pi [34]

3.3.1 Working Procedure of Raspberry Pi

The working procedure of a Raspberry PI can easily be understood from below block diagram:

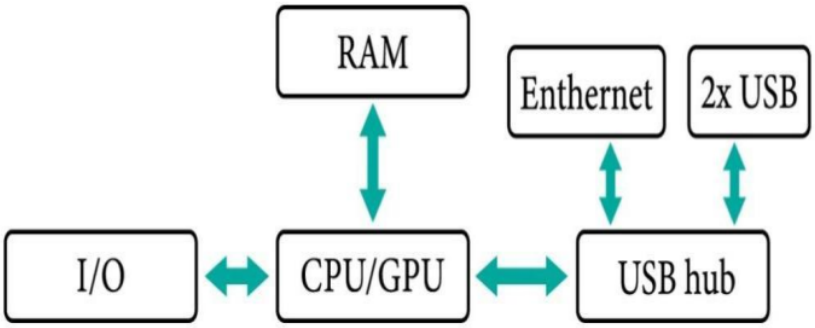

Fig 3.2: Working procedure of a Raspberry Pi [35]

3.3.2 Features of Raspberry PI

Raspberry PI is a complex device. It has a lot of features. The Features of Raspberry PI are given below:

- 512 MB SDRAM memory
- Broadcom BCM2835 SoC full high definition multimedia processor
- Dual Core Video Core IV Multimedia coprocessor
- Single 2.0 USB connector
- HDMI (rev 1.3 and 1.4) Composite RCA (PAL & NTSC) Video Out
- 3.5 MM Jack, HDMI Audio Out

- MMC, SD, SDIO Card slot on board storage
- Linux Operating system
- Dimensions are 8.6cm*5.4cm*1.7cm
- On board 10/100 Ethernet RJ45 jack

3.3.3 Components of Raspberry PI

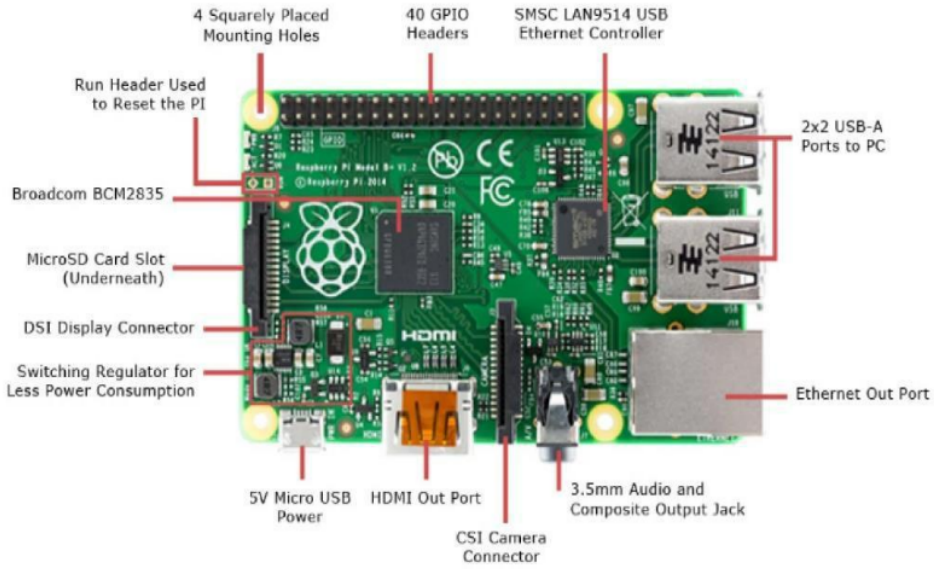

Fig 3.3: Components of Raspberry Pi [36]

3.3.3.1 Memory

The raspberry pi has 512 MB SDRAM memory. Raspberry Pi is a small version of a desktop PC, it is like a small PC. RAM memory in standard PCs is measured in gigabytes. However, the RAM memory on the Raspberry Pi board is larger than 256MB or 512MB.

3.3.3.2 CPU (Central Processing Unit)

The central processing unit is in charge of carrying out the computer's instructions through logical and mathematical operations, it's like the brain of this mini-computer. The Raspberry Pi is powered by an ARM11 series processor, it is often used for making a smartphone.

3.3.3.3 GPU (Graphics Processing Unit)

In the raspberry pi board, there is a specialized chip which is known as GPU. Its work is accelerate image calculation operations. This board is equipped with a Broadcom video-core IV and supports OpenGL.

3.3.3.4 Ethernet Port

This Ethernet port helps us to connect with the outside world. The Raspberry Pi's Ethernet port serves as the primary gateway for communicating with other devices. The raspberry pi Ethernet port is used to connect to the internet. The connection will be between our home router and the raspberry pi Ethernet port.

3.3.3.5 GPIO Pins

In the raspberry pi, there are a lot of pins some general-purpose input and output pins are used to connect to other electronic boards. Based on raspberry pi programming, these pins can accept input and output commands. Digital GPIO pins are available on the Raspberry Pi. Other electronic components are connected to these pins. we can connect a sensor and we can get digital data from the sensor.

There is a total of 40 GPIO pins in Raspberry Pi. They all have different properties and they are all used for different specific connections. All 40 pins and their name is given below,

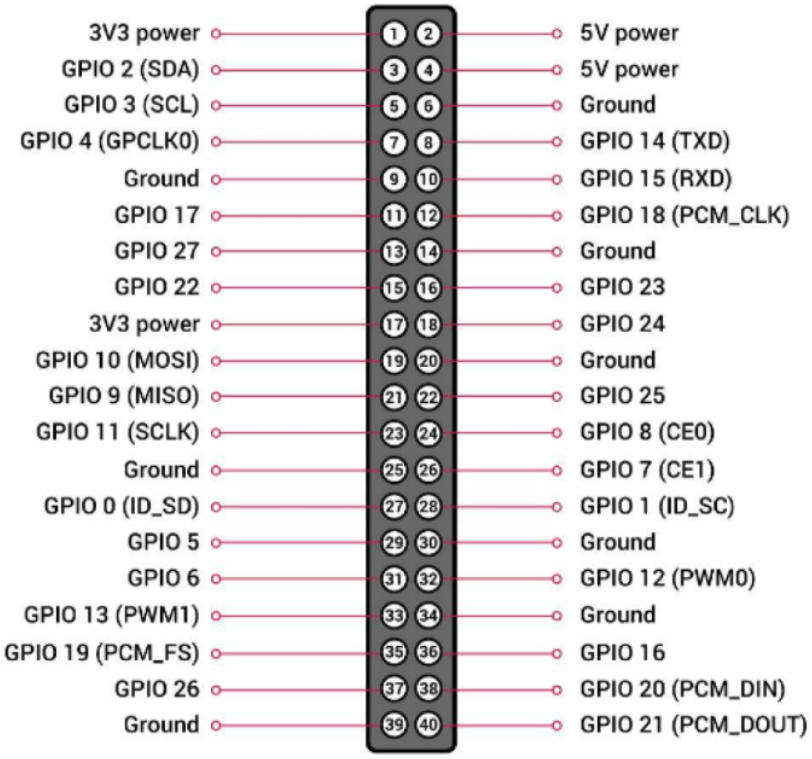

Fig 3.4:GPIO Pinout Diagram [37]

3.3.3.6 XBee Socket

There is a lot of wireless communication system. For this wireless communication purpose in the Raspberry Pi board, the XBee socket is used.

3.3.3.7 Power Source Connector

Every device has a power source. The connector or pin that connects the device with the power source is the power source connector. The power source cable is a small switch located on the shield's side. Its primary function is to enable an external power source.

3.3.3.8 UART

The UART or Universal Asynchronous Receiver/ Transmitter provides a serial input & output port. If we want to transfer the serial data we can transfer this in the text form and we can also convert debugging code by this. It is very useful for this kind of work.

3.3.3.9 Display

The Raspberry Pi board has two types of connection options: HDMI and Composite. Using an HDMI male cable and a low-cost adaptor, many LCD and HD TV monitors can be connected. The HDMI version 1.4 cable is recommended for this kind of connection and HDMI versions 1.3 and 1.4 also support these connections. The Raspberry Pi outputs audio and video via HDMI, but it does not support HDMI I/p. Composite video can be used to connect older televisions. Audio is available from the 3.5mm jack socket when using a composite video connection and can be sent to the TV. A cable that adjusts from 3.5mm to double RCA connectors is required to send audio to the TV.

3.4 Webcam

A webcam is a tiny digital video camera that is linked to a computer or a computer network, either directly or indirectly. Webcams come with software that must be installed on the computer in order for users to capture video or stream it from the Internet. Webcams can take images as well as high-definition movies, albeit the video quality is often poorer than that of other camera models. Webcams are frequently referred to as Web cameras.

Fig 3.5: Webcam [38]

A webcam is a digital image capture device that is used as an input device. These are sent to the computer, which then sends them to a server. They can then be transferred to the hosting

page. A webcam is commonly seen on laptops and desktop computers. Webcams are far less expensive than other types of cameras, especially when it comes to videotelephony. A webcam's maximum resolution is poor when compared to most handheld cameras. The qualities of a camera are heavily influenced by the computer's software operating system as well as the computer processor. Webcams can include capabilities such as motion detection, image archiving, automation, and even bespoke coding. Webcams are generally used for videoconferencing and security monitoring. Video broadcasting, social video recording, and computer vision are some of the other applications.

3.4.1 Webcam Features

- Resolution: 1280 x 720 pixels/720p (HD Ready).
- Frame Rate: Almost all modern webcams are capable of at least 30 fps, which is still considered high quality and is suitable for any occasion, with some being as high as 120 fps.
- Field of View (FOV): The field of view range from 60 to 90 degrees horizontally, vertically and diagonally.
- Built-In Microphone: Almost all webcam have built in microphone, some webcam have two microphone.
- Autofocus: Webcams with this feature automatically focus on the person or subject in frame, whether stationary or in motion..
- Low-Light Correction: This feature can brighten and adjust images in dark rooms.
- Green Screening: By this feature we can edit or change photo or video background.

3.4.2 Webcam working principle

A webcam is a small digital camera that is connected to a computer or a project and broadcasts video pictures in real-time. It collects light through a small lens at the front, just like a digital camera, utilizing a tiny grid of minuscule light detectors embedded into an image-sensing microchip. Previously we used a charge-coupled device (CCD) and now more often these days, a CMOS image sensor is used. The image sensor and its electronics turn the image in front of the camera into a digital format a string of zeros and ones that a computer can understand.A webcam, unlike a digital camera, does not have a built-in memory chip or flash memory card: it does not need to "remember" photographs because it is meant to record and send them instantly to a computer. That's why USB wires protrude from the rear of cameras. The USB cable connects the camera to the computer and transports the digital information taken by the webcam's image sensor back to the computer, where it is transmitted to the Internet. Some cameras operate wirelessly and do not require a computer to function: they commonly utilize Wi-Fi to transfer their images to an Internet router, which may then make them available to other PCs on other networks or, via the Internet, to anybody, anywhere in the world. This way we can see a distant person in real-time.

3.5 USB Microphone

A USB microphone in its most basic form is a microphone with a USB output. The USB Microphone is a high-quality microphone with an "in-built" interface that allows us to plug it straight into a USB port. A USB microphone has the analog-to-digital converter built-in, so all you need to do is plug the microphone into your computer and fire up your recording or communication software. The second thing you need to know is that your USB microphone works with a device driver on your computer. It has the necessary amplification to ensure that the signal is at the appropriate level.

Fig 3.6: USB Microphone [39]

If we want to talk about it briefly, First and foremost, it is a microphone. Transducers that transform sound waves into analog audio signals are known as microphones. They do this by the use of a transducer element (also known as a capsule, cartridge, or motor) with a movable diaphragm. Second, the gadget has a USB output, indicating that it is digital.
In particular, the output is a digital audio stream.

3.5.1 Features of USB Microphone

The features of the USB Microphone are given below:

- The MIC can be adjusted thanks to the flexible neck.
- Realistic sound reproduction using a high-performance microphone.
- High sensitivity, effective distance of 2 meters or more.
- Distance limitation 0.5M-1M.
- -47dB + 4dB Sensitivity.

- Sensitivity is reduced by -3dB 1.5V.
- The voltage is 4.5V.
- 100~16 kHz frequency response.
- There is no need to install a driver because it is plug and play.
- Can be used with any computer that has a USB port (even Apple), Windows XP system above the free driver, and is plug and play.
- pleasant, safe, and environmentally friendly.

3.5.2 USB Microphone working principle

USB microphones are similar to other microphones in most ways, with the main distinction being that they have built-in audio interfaces. To understand how USB microphones operate, we must first understand how 'normal' microphones function. The microphone is essential in audio production. Microphones are used for a variety of audio-related reasons, such as musical performance, recording, and presenting presentations or speeches in front of an audience.A microphone is an electronic device that transforms acoustic energy into electrical energy.USB microphones have a converter that converts an analog signal to a digital signal, allowing us to connect it straight to our computer's USB port. They are quite simple to set up and do not necessitate the use of any additional equipment.

3.6 Speaker

A speaker is a sound reproduction equipment that converts electrical energy into acoustical signal energy, which is then transmitted into a room or into the open air.A speaker is a type of transducer.These are electronic gadgets that transform electrical energy into sound waves.Speakers are an often-overlooked component of an otherwise superb system.

Fig 3.7: Speaker [40]

3.6.1 Speaker inside components

Most classic speakers are made up of the following components. They collaborate to create sound:

- Permanent magnet: This magnet creates a magnetic field surrounding the voice coil, allowing it to move.
- Bobbin and voice coil: The bobbin is a circular tube connected to the bottom of the cone.
- The voice coil is an extremely long, tightly wound wire coil that generates a magnetic field when electricity passes over it.
- This is caused by the musical signal generated by an amplifier.
- Spider: The spider, also known as suspension, is a thin, wavy-shaped material that keeps the voice coil assembly together and pushes the cone back into position as the cone moves.
- Cone (diaphragm), dust cap: This is a cone-shaped, stiff substance that generates sound by being pushed together by the magnet and voice coil.
- The dust cap is a tiny piece of cloth that covers the central aperture.
- It guards against dirt and dust.
- Speaker basket: The basket is a metal or stamped steel frame that holds the speaker pieces together and maintains them aligned.
- The basket can also be utilized to support the speaker assembly when it is mounted on a box.
- Braided wire and speaker terminals: Speaker terminals are metal connections that join the speaker wire to the speaker itself.
- These are linked to the voice coil via a flexible braided wire that travels together with the cone.
- Surround: This flexible, durable, circular material (usually rubber or some other type of foam) connects the cone's top edge to the basket.

3.6.2 Speaker working principle

Speakers work on the premise of converting electric energy into mechanical energy (motion).Mechanical energy compresses the air and converts it to sound energy, or a high degree of air pressure (SPL).When an electric current flows through a wire voice coil, a magnetic field is formed.An electric field is created when a current travels through speakers.This vector field interacts with the magnet of the speaker.Charges that are similar repel one another, whereas charges that are dissimilar attract one another.As a sound signal is sent through this wire, the magnet attracts and repels the voice coil.The voice coil is linked to a cone

that rotates back and forth.This causes pressure electromagnetic radiation to be produced inside the air, which we perceive as sound quality.

3.7 LiPo Battery

A LiPo battery or lithium-ion polymer battery is a rechargeable battery that uses lithium-ion technology using a polymer electrolyte. The electrolyte is made of solid polymer, and one of the electrodes is made of lithium. Commercially available LiPo batteries are hybrids. These hybrid batteries are as gel polymer or liquid electrolyte in a pouch format, more accurately known as a lithium-ion polymer battery.

Fig 3.8: LiPo Battery [41]

3.7.1 Features of LiPo Battery

The features of the LiPo Battery are given below:

- Greater weight-energy rate, greater volume-energy rate.
- High voltage supply.
- For a low self-discharging rate It keeps for a long time.
- Lipo batteries do not have a memory effect, that's why there is no need to discharge them before charging them.
- It has a long lifespan.
- These batteries charge quickly.
- These batteries can be used in parallel.

3.7.2 LiPo Battery Pin Diagram

In LiPo batteries, there are few cells in series and the battery poles are terminated separately through a connector. It is recommended that the individual batteries be charged separately by correctly locating the poles from the connector.

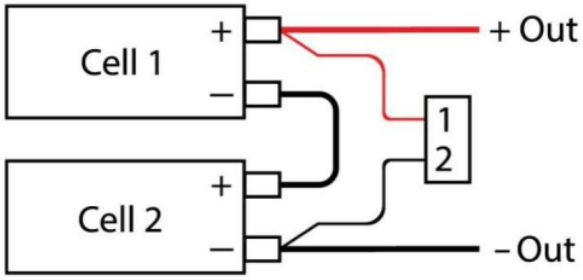

Fig 3.9: LiPo Battery pin diagram

3.7.3 Working Principle of LiPo Battery

LiPos, like other lithium-ion cells, operate on the principle of lithium I intercalation and de-intercalation from a positive electrode material and a negative electrode material, with the liquid electrolyte acting as a conductive medium. A microporous separator is placed between the electrodes to prevent them from directly touching. This allows only the ions, not the electrode particles, to migrate from one side to the other.

3.8 L298 Motor Driver Module

This L298N Motor Driver Module is a high-power motor driver module. It can power both DC and stepper motors. The L298 Dual H-Bridge Motor Driver IC serves as the foundation for this dual bidirectional motor driver. This module will allow you to control two motors of up to 2A each in both directions easily and independently. It is ideal for robotic applications and can be connected to a microcontroller with only a couple of control lines per motor.

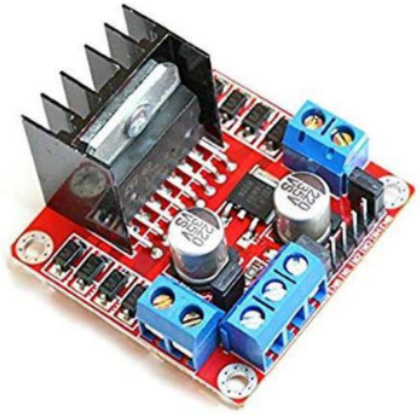

Fig 3.10: L298 motor driver module [42]

3.8.1 Features of L298 Motor Driver Module

The features of the L298 motor driver module are given below:

- The driver here used is L298.
- Here power supply +5V~+46V.
- Logic power output Vss needed +5~+7V (internal supply +5V).
- Its Logic current is 0~36mA.
- For Controlling needed Low -0.3V~1.5V, high: 2.3V~Vss.
- Dimension of the module 2.7 * 4.5 * 4.5 cm
- The weight of the driver 48g.

3.8.2 Pin Diagram of L298 Motor Driver Module

Fig 3.11 represents the pin diagram of an L298 motor driver module and pin description shown in **table 3.1**.

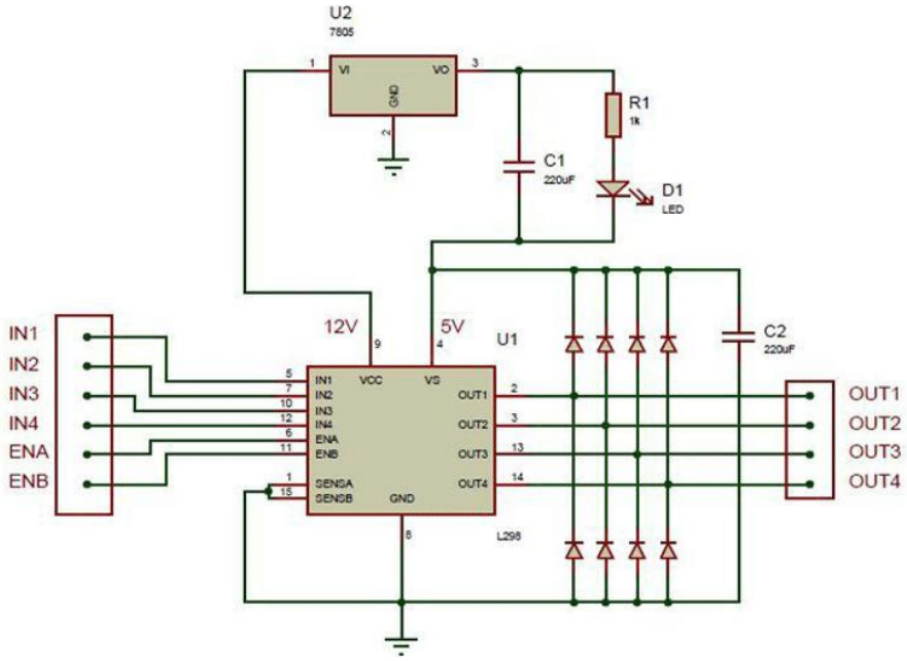

Fig 3.11: L298 motor driver module pin diagram [43]

Table 3.1: Pin description of L298 motor driver module.

Pin Name	Pin Description
IN1 & IN2	Motor A input pins. Used to control Motor A
IN3 & IN4	Motor B input pins. Used to control Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins for Motor A
OUT3 & OUT4	Output pins for Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

3.8.3 Working Principle of L298 Motor Driver Module

Engine drivers serve as a conduit between engines and control circuits. The engine requires a high voltage, whereas the controller circuit works with low-current signals. Engine drivers are responsible for converting a low-current control signal into a higher-current signal capable of driving an engine.

3.8.3.1 DC Motor Controlling

If we want to completely control the DC motor, we must adjust its speed and rotation direction. These two approaches can be combined to achieve the desired result.

- PWM – This will be for speedregulation
- H-Bridge – This will be for rotation path monitoring

3.8.3.2 PWM (speed regulation)

By varying the input voltage of a DC engine, we can control its speed. PWM (Pulse Width Modulation) can be used as a standard tool. PWM is a technique that sends a sequence of pulses to change the average input voltage value. The average voltage is proportional to the width of the pulses, which is referred to as the Duty Cycle. The higher the average dc voltage, the longer the working time, and the lower the average dc voltage, the shorter the duty cycle.

3.8.3.3 H-Bridge (rotation path monitoring)

DC motor rotation direction can be controlled by changing the polarity of its input voltage. An H-Bridge is a popular method for accomplishing this. At the heart of the engine, there are four H-Bridge circuits in an H-like configuration. By closing two specific switches at the same time, the polarity of the voltage applied to an engine is reversed. This causes the engine to turn in a different direction.

3.9 Gear Motor

A gear motor combines a motor and a gearbox into one unit. A Gearmotor is a small electric motor with an integrated gear reducer. The end shield on the motor's drive end is designed to serve two purposes. The armature/rotor bearing support and a sealing provision through which the integral rotor or armature shaft pinion passes are located on the side facing the motor. On the other side of the motor end shield, there are multiple bearing supports for the gearing as well as sealing and fastening provision for the gear housing.

Fig 3.12: Gear motor [44]

3.9.1 Features of Gear Motor

The features of the Gear motor are given below:

- These motors are available in both brush type and brushless type modules.
- During motor sizing, these motors are very popularly used.
- As the motor power-to-torque ratio these motors are like the figure of merit.
- These motors contain sealed bearings with high-temperature grease.
- These motors have high temperature molded field insulator.
- Heavy-duty commutator construction.
- High efficiency.
- High-flow die-cast aluminum fan used in these motors.

3.9.2 Internal view of Gear Motor

Fig 3.13 represents the internal view of a Gear motor

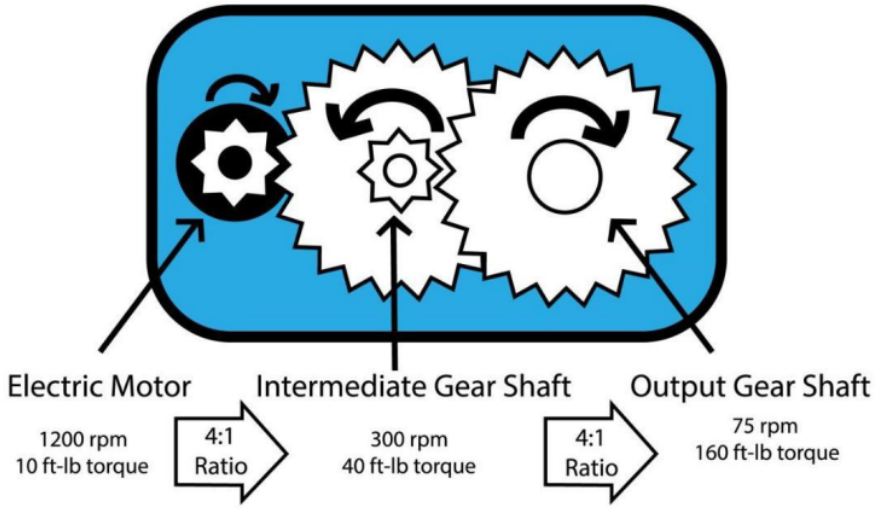

Fig 3.13: Internal view of Gear motor

In this internal view of the gear motor, there are three gears. One is an electric motor other is an intermediate gear shaft and another one is an output gear shaft. The gear ratio will be 4:1.

3.9.3 Working Principle of Gear Motor

1200 to 3600 revolutions per minute is the output speed range of most synchronous alternating current electric motors. They also have torque specifications for both normal and stall speeds. Gear motor reduction gear trains are designed to reduce output speed while increasing torque. The increase in torque is proportional to the decrease in speed.

Reduction gearing enables small electric motors to move largely driven loads, albeit at a slower rate than larger electric motors. Reduction gears are made up of a small gear that drives a larger gear. A reduction gearbox may contain several sets of these reduction gear sets.

3.10 Servo Motor

A servo motor is a simple electric motor that is controlled by servomechanism. If the motor, as a controlled device, is associated with servomechanism, it is commonly referred to as a DC Servo Motor. The controlled motor is known as an AC Servo Motor if it is powered by AC. A servomotor is a linear or rotary actuator that enables precise control of linear or angular position, acceleration, and velocity. It is made up of a motor and a sensor for position feedback. It also necessitates a fairly sophisticated controller, which is frequently a

dedicated module designed specifically for use with32servomotors.

Fig 3.14: Servo motor [45]

3.10.1 Features of Servo Motor

The features of the Servo motor are given below:

- It is designed for rapid response.
- It has high-precision positioning.
- Capable of controlling rotation angle and speed precisely.
- It can be used in different situations.

3.10.2 Internal view of Servo Motor

Fig 3.15 represents the internal view of a Gear motor

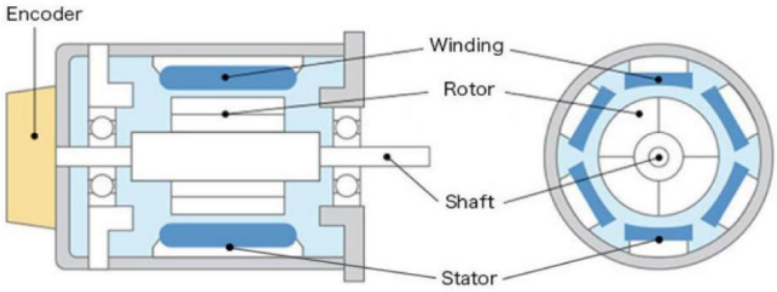

Fig 3.15: Internal view of Servo motor [46]

There is a lot of part in this motor and each part has its own function. The parts of the motor and their functions are given below.

Stator - A stator generates torque by generating a rotating magnetic field.

Winding - When current flows through a winding, it creates a rotating magnetic field.

Shaft - The shaft is responsible for transmitting the motor's output power.

This load is propelled by the transfer mechanism.

Rotor - A rotor is a permanent magnet that is located outside of the shaft.

Encoder - An optical encoder constantly observes and calculates the number of rotations completed while also monitoring the position of the shaft.

3.10.3 Working Principle of Servo Motor

A servo is made up of a motor either DC or AC, a potentiometer, a gear assembly, and a control circuit. First and foremost, we use gear assembly to reduce RPM and increase motor torque. Assume that at the initial position of the servo motor shaft, the position of the potentiometer knob is such that no electrical signal is generated at the potentiometer's output port. An electrical signal is now applied to the error detector amplifier's other input terminal. The difference between these two signals, one from the potentiometer and one from other sources, will now be processed in a feedback mechanism and output will be provided in the form of an error signal. This error signal serves as the motor's input, and the motor begins to rotate. The motor shaft is now connected to the potentiometer, and as the motor rotates, so does the potentiometer, generating a signal.As a result, as the potentiometer's angular position changes, so does its output feedback signal. After a while, the position of the potentiometer reaches a point where the output of the potentiometer is the same as the external signal provided. There will be no output signal from the amplifier to the motor input because there is no difference between the external applied signal and the signal generated at the potentiometer in this condition, and the motor will stop rotating.

3.11 Sonar Sensor

An ultrasonic sensor is a type of electronic device that emits ultrasonic sound waves and converts the reflected sound into an electrical signal to determine the distance of a target object. Ultrasonic waves travel at a faster rate than audible sound. The transmitter and receiver are the two main components of ultrasonic sensors. Here we will use HC-SR04 Ultrasonic Sensor as our sonar sensor.

Fig 3.16: HC-SR04 Ultrasonic Sensor [47]

3.11.1 Features of HC-SR04 Ultrasonic Sensor

The features of the Servo motor are given below:

- Functioning voltage: +5V.
- Measuring Distance (theoretical): 2cm to 450cm.
- Measuring Distance (Practical): 2cm to 80cm.
- Accuracy of the sensor: 3mm.
- Measuring angle covered: <15°.
- For operating Current: <15mA.
- For operating Frequency needed: 40Hz.

3.11.2 Pin Diagram ofHC-SR04 Ultrasonic Sensor

Fig 3.17 represents the pin diagram of an L298 motor driver module and pin description shown in **table 3.2**.

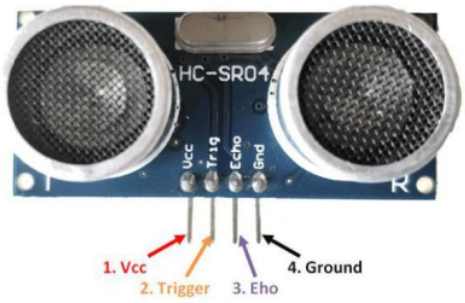

Fig 3.17: Pin Diagram of HC-SR04 Ultrasonic Sensor [47]

Table 3.2: Pin description of HC-SR04 Ultrasonic Sensor.

Pin Number	Pin Name	Pin Description
1	Vcc	The sensor is powered by the Vcc pin, which is typically powered by +5V.
2	Trigger	Trigger pin is an Input pin.This pin must be held high for 10us in order to initiate measurement by sending a US wave.
3	Echo	The Echo pin is a type of output pin. This pin goes high for a period of time equal to the time it takes the US wave to return to the sensor.
4	Ground	This pin is connected to the system's Ground.

3.11.3 Working Principle of HC-SR04 Ultrasonic Sensor

The HC-SR04 Ultrasonic sensor is a four-pin module with the pin names Vcc, Trigger, Echo, and Ground. This sensor is widely used in many applications that require measuring distance or sense objects. The front of the module has two eye-like projects that form the Ultrasonic transmitter and receiver. The sensor operates based on a simple high school formula.

Distance = Time + Speed

The Ultrasonic transmitter sends out an ultrasonic wave, which travels through the air and is reflected toward the sensor when it collides with any material. The Ultrasonic receiver module detects this reflected wave. We need to know the speed and time to calculate the distance using the above formulae. We know the universal speed of the US wave at room conditions because we use it, which is 330m/s. The circuitry built into the module calculates the time it takes for the US wave to return and sets the echo pin high for that same amount of time, allowing us to know the time. Simply use a microcontroller or microprocessor to calculate the distance.

CHAPTER 4

DESIGN METHODOLOGY

4.1 Introduction

This is the most important chapter of any project report. In this chapter, we will discuss about the design methodology of the project, which includes block diagram, flow chart, and circuit diagram with their operations briefly. The step by step discussion of this project is given below:

4.2 Block Diagram

We have developed a block diagram for this project. We have used Raspberry Pi which is the core of this project. Raspberry Pi is a mini computer. In the circuit it controls everything. Block diagram of this project is shown in **Fig 4.1.**

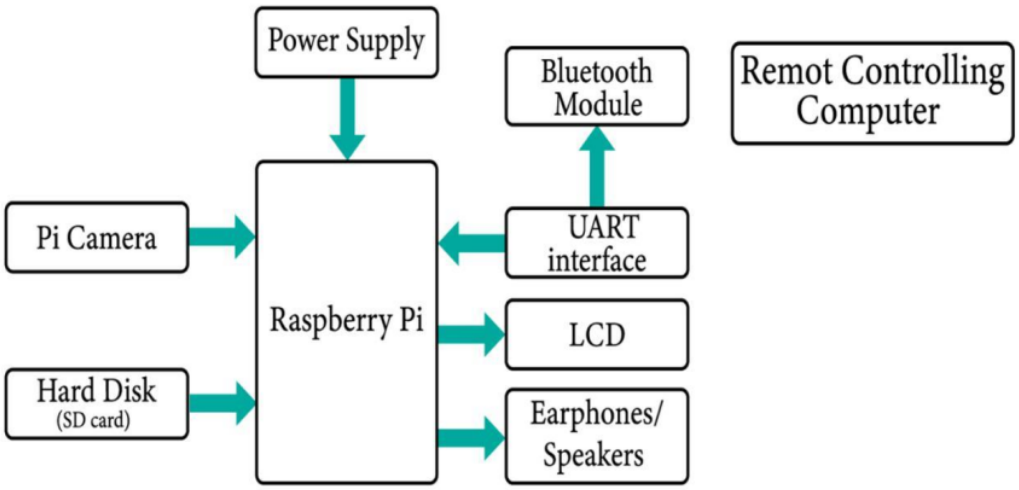

Fig 4.1: Block Diagram of This Project

Here Everything is connected with the raspberry pi. It is kind of a mini computer. As a mini-computer, it has all the quality of a computer. It has a single-core 700MHz CPU and 256MB RAM. By this, it can control almost everything. It works as the core and Everything is implemented around it. It connected to a power supply which supply power. It has its own memory card and the memory card can externally connectable. It has it's own bluethooth module, we can also connect it with LCD monitor. External headphone or microphone can be added. By using IoT we can connect raspberry pi with other external computer. We can give command externally to the reaspberry pi from thea computer easily.

4.3 Flow Chart

Before developing a system, we must need to develop its workflow. And workflow is well understood from the flow chart. Accordingly, we have also developed a flow chart for our system. The developed flow chart of this project is shown in **Fig 4.2.**

Fig 4.2: Flow chart of this project

As it is a normal telepresence robot, its flow chart is not that big or complicated. The operation of the flow chart is discussed below:

We have initiated our system by specifying the targeted location. Then we set the coordinates as json object. Using that targeted coordinate we finds its place id from google map api. After that Using that place id the system determines if its reachable or not. If no the system will reverify the location. If yes the system will proceed to next step. After that if the system finds no route to that location it will restart the process. Else the system will loop through the suggested routes for that location.After choosing a specific route the system will lock for it and moving operation executed. After reaching to the destination our system will end its process

4.4 Circuit Diagram

For this project, two circuit diagrams were drawn in the EasyEDA Software. All the circuit diagrams and their operations are given below:

4.4.1 Circuit Operation

The circuit diagram which is shown in **Fig 4.3** is the full circuit of this project.

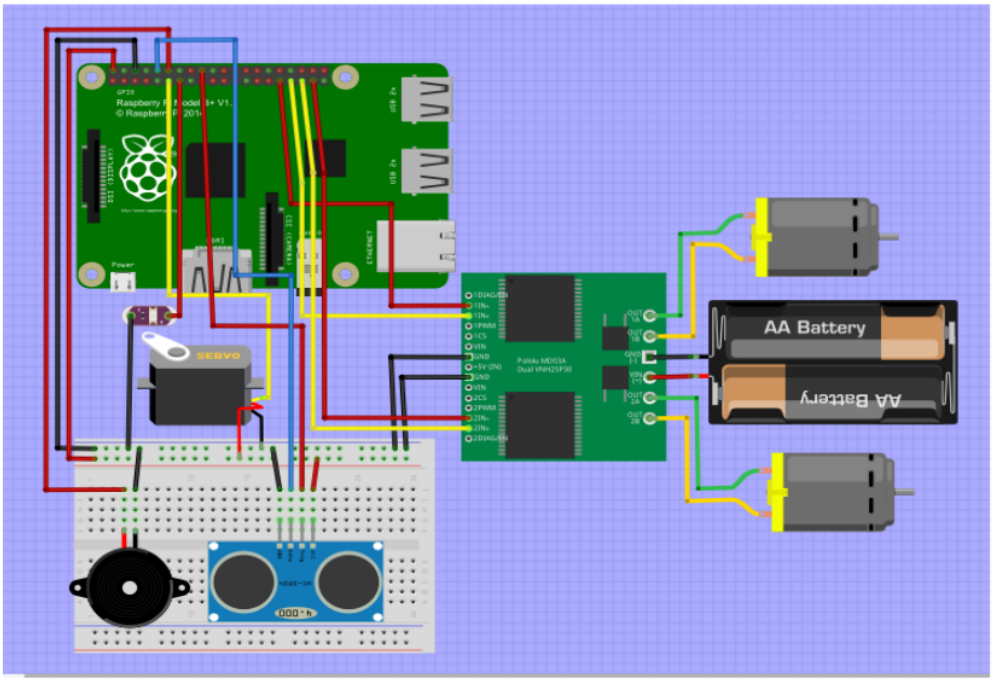

Fig 4.3: Circuit diagram telepresence robot.

We have developed our circuit from easy eda online web editor. Its a free circuit making and pcb simulating software. Our system node voltage counted in circuit Diagram into two segment. One is 7 volt 2400mAh powered motor power and another is 5 volt 2 Amp power bank supply for raspberry pi. We have used 5 gpio pins for controlling the device. Our gpio pins are based on BCM mode. Pin 17 is servo angle pin. Using that pin we changed its dutycycle based on camera angle. Pin 21,19,9,13 are motor one clock wise, motor one anti clock wise, motor two clock wise, motor two anti clock wise pin respectively. We took raspberry pi grpund pin as common ground with motor driver and 7 volt Lithium ion battery. We have connected the webcam to usb port that why we did not show any connection with camera and raspberry pi.

4.4.2 Circuit Operation and Circuit Diagram

Here in **Fig 4.4**. we all the conection between all the hardware components. If we observe this we can easily understand the whole circuit and their connection and how they work.

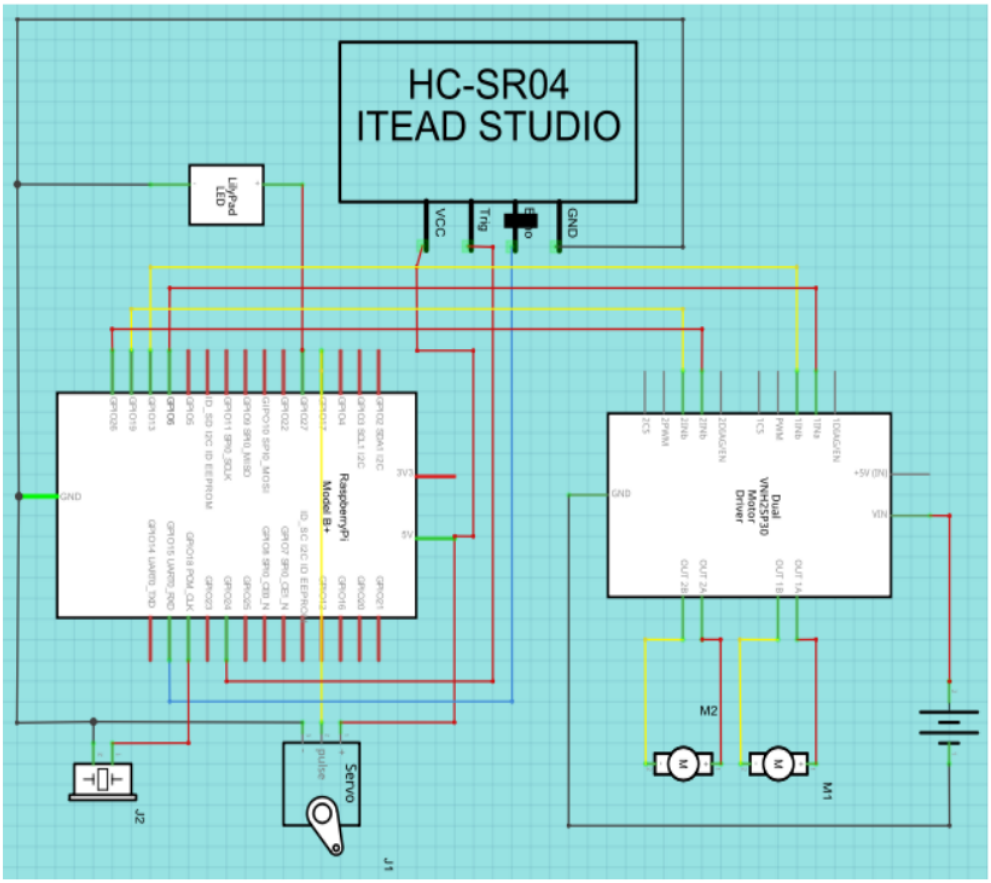

Fig 4.4: Circuit diagram for circuit operation.

Here from power supply raspberry pi get the supply then we used 5 gpio pins for controlling the device. Our gpio pins are based on BCM mode. Pin 17 is servo angle pin. Using that pin we changed its dutycycle based on camera angle. Pin 21,19,9,13 are motor one clock wise, motor one anti clock wise, motor two clock wise, motor two anti clock wise pin respectively. Here gear moto used for the robots movement and the servo motor will be used for changing the camera angle. We also used ultrasonic sensor for avoiding unnecessary contact. We also connected a camera. The camera help two persons can contact each other by this robot.

CHAPTER 5

IMPLEMENTATION AND RESULT

5.1 Introduction

In this project we first design our circuit is Easy EDA Software. Then we find suitable base to start our project. Every project need a lot of hardware components and software components and connecting wire to connect them. After finishing the circuit design and collecting all components we start implementing our project. In this project we are using some plastic sheet for our base and structure the wewill arrange our components, connect them with wires and finish our project.

5.2 Implementation

This project is developed to get ideas about basic raspberry pie. It works as a mini-computer. In this chapter, system implementation and result is discussed. As a mini-computer, it has all the quality of a computer. It has a single-core 700MHz CPU and 256MB RAM. By this, it can control almost everything. It works as the core and Everything is implemented around it.

We have designed a telepresence robot in our project. We have used sensors, raspberry pi, servo motor, gear motor, motor driver module, and so many connecting wires in this project. **Fig 5.1** indicates the complete overview of the system.

We used a big rectangular size plastic plate. It is the base of the project. Then we maked a rectangular plastic tower by using 4 same-sized long plastic sheets and later we attached it in the middle of the base plate. we used chloroform as a glue substance for attaching purposes. Then use make some holes on the base plate by using a drill machine. These holes will be used to attach 2 gear motors. Each motor stays on 2 sides of the base plate. And to make the connection sturdy we used a glue gun. We attached another wheel on the front side. Then we set up our all components on the base plate and glued them. we attached the servo motor on top of the tower and place the camera on top of it. we glued them both with the glue gun. We have implemented our hardware this way.

Fig 5.1: Total overview of the system

Fig 5.1 represents the overall outlook of this system. We have attached two box with our system. The box from the top side contains medicine and the box from the bottom side contains foods. Our system initiates from the former output. From a terminal we can move and rotate the camera. So that our admin user can view everything.

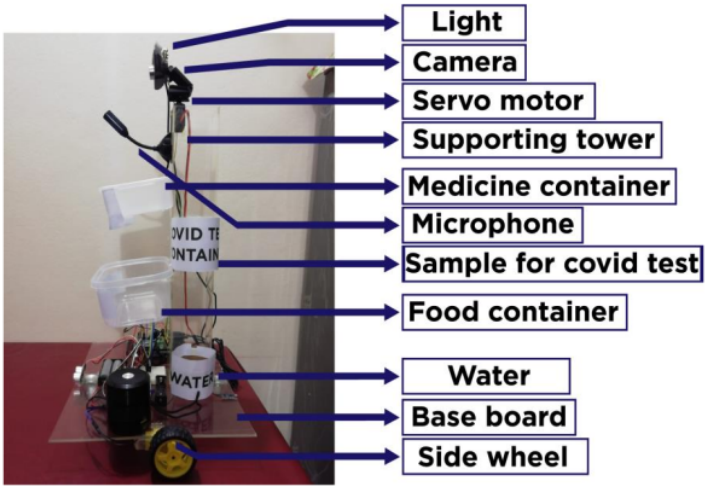

Fig 5.2: Total overview of the system (side view)

Fig 5.2 represents the side view of overall outlook of this system. Here we indicate the outside structure or component of our project. Here we see the main base and main pillar of the project which is the main support of our project. Here we also see our wheel, medicine box and some componenets on top like servo motor, camera, microphone, and light.

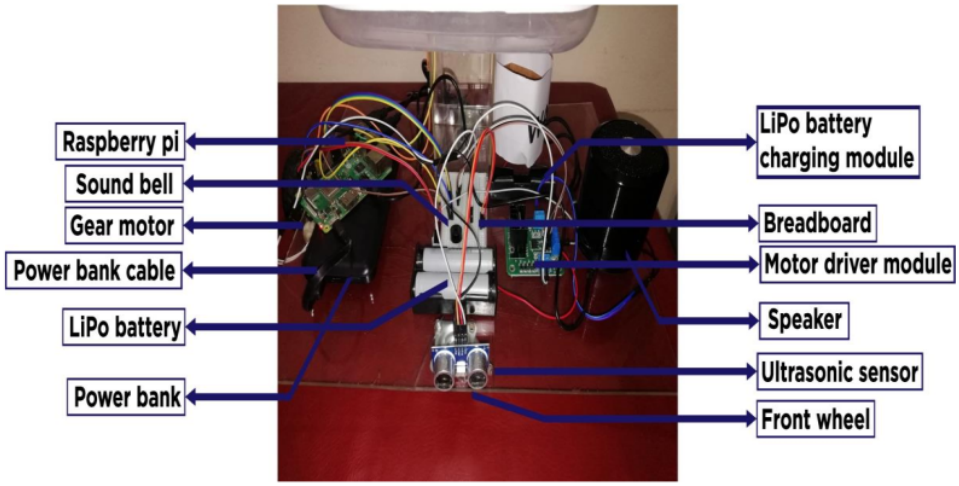

Fig 5.3: Total overview of the system (equipment)

Fig 5.3 represents closeup view of overall connection of our project. Here we marked all of the components in our project. Here we see raspberry pi, sound bell, gear motor, power bank, LiPo battery, motordriver, speaker, ultrasonic sensor etc and their connection.

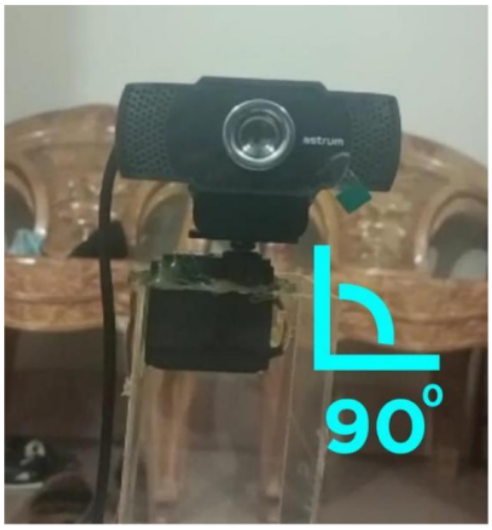

Fig 5.4: Desktop RDP view.

Fig.5.4 represents the camera position using servo motor. Whenever we set the duty cycle to 5 on raspberry pi the servo motor rotes 90 degree and set the camera as front view. By rotating this camera we can view the front side of the robot.

Fig 5.5 Camera rotates to left.

Fig.5.5 represents the camera position using servo motor. Whenever we set the duty cycle to 2 on raspberry pi the servo motor rotes 60 degree and set the camera as left view. By rotating this camera we can view the left side of the robot.

Fig 5.6 Camera rotates to right.

Fig.5.6 represents the camera position using servo motor. Whenever we set the duty cycle to 7 on raspberry pi the servo motor rotes 120 degree and set the camera as right view. By rotating this camera we can view the right side of the robot.

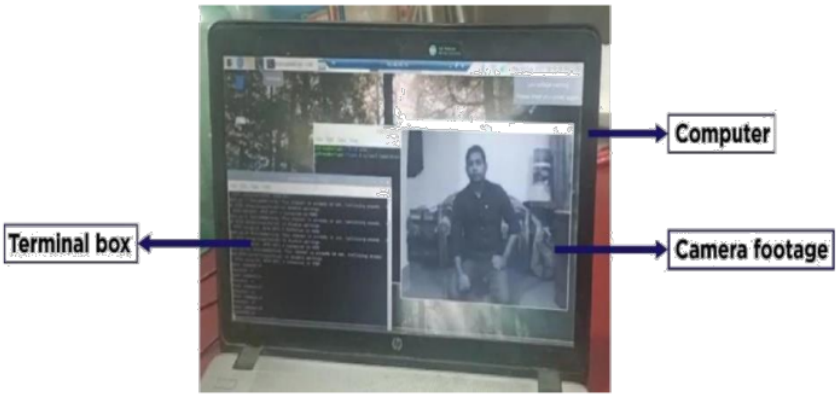

Fig 5.7 camera view

Fig.5.7 represents the remote desktop screen of our system. What we see from the picture is the robotic camera view of this system. We also have a terminal opened in this picture.

5.3 Total cost of the Project

Our project is very costly as it is normally used for the industrial purpose. This project cost more than 10,000 taka, If we want to reduce the cost, then we need to reduce or replace some equipment. But it will bring down the performance of the project. Since this is the basic idea of using PLC for industrial purposes, it is important to use good and long lasting equipment. Total cost of this project is shown in **Table 5.1**.

Table 5.1: Total cost of the project.

Component Name	Qantity	Price (BDT)
Respberry pi	1	6000/-
Camera	1	1200/-
Wheel	2	100/-
Motor driver	1	250/-
Acrylic	1	500/-
Lipo battery	2	180/-
Charging circuit	1	60/-
Ultrasonic sensor	1	200/-
Servo motor	1	500/-
Speaker	1	500/-
Motor	2	120/-
USB Microphone	1	1000/-
	Total	**10,610/-**

5.4 Cost Comparison

The given samples are not well sufficient methods for our telepresence robotic system. Firstly the system developed by Yang, G.Z et al in paper [28] which was medical based telepresence robot is mostly used by IoT technology. But we know internet are not that much efficient on remote area. What if the system disconnects after reaching the remote area. According to our calculation it's overrated.Secondly the system that have been shown on the relevant with Laura Aymerich paper [29] on similar technology but they are supplying different content for medication. But their technology implementation is alsmot same. And thirdly this robot is almost our kind based on controlling. But they did not use asynchronous controlling. As a result it takes a huge time for implementation. Our system is mostly cost effective and efficient controlling. Our RDP based robotic controlling has made this system smooth and efficient.

CHAPTER 6

CONCLUSION

6.1 Introduction

This is the final chapter of this project report. In this chapter, we will discuss about the conclusion of the project. We will also discuss about the limitations, future improvements, applications and advantages of this project.

6.2 Conclusion

The telepresence robot is not a unique invention. But our IoT-based android-controlled telepresence robot can take a huge difference from others. Our telepresence robot is cheap, easy to use. This one robot can use in a different situation like we can use this robot in the medical field where it will help people in a pandemic situation, we can also supply food or medicine to the patients maintaining social distance, we can also use their robot to communicate with others which will reduce loneliness in this lockdown situation, even if we make some small changes in this robot we can use this robot in military purpose also. For a two-way communication system, users can communicate with anyone. And finally, we can say that we make this robot in a more user-friendly way than any other previous telepresence robot.

6.3 Applications

Our project has real life applications which are given below:

- To develop a robotic system that can be controlled wirelessly.
- To make a video interface for remote viewing.
- To carry an important object and send them to the expected location through the robot.
- Ensure social distancing in pandemic situations.
- Easy trafficcontrolling.

6.4 Advantages

Our project has some advantages which are given below:

- We can control it remotely with the power of IoT.
- User can communicate at both end.
- System has a huge controlled controlling system. As a result, it can operate smoothly.

- There are two box. User can provide both secured contents through the box.
- Cost effective.

6.5 Limitations

Anything in this world has some limitations. In that sense, this project also has some limitations which are given below:

- Camera response is 1.4 sec of lagging.
- Motor deriver response delays for one second.
- Power management system is over rated.

6.6 Future Improvement

Some improvements can be made to this project in the future for the further research work that are discussed below:

- In future we shall add auto controlling based on AI.
- Motor speed will be increased based on required manual.
- Server delay and camera delay will be decreased.
- We will control the system using human voice.

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