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# Telepresence Robot Using Raspberry Pi

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**ABSTRACT**
Robots are machines or automated task doers, that help the man with simple tasks to multiple tasks that can be done automatedly with or without the presence of the humans by adding specific program functionalities to the robots. There are different type of robots that helps humans from life-risk-based threats such as firefighting robots, patient monitoring robots, etc. These robots work on the main principle of telepresence, made possible using Virtual Reality and some networking protocols, etc. Telepresence as the word means the human can monitor the robot's surroundings even without being present at that place. In this project, we have built a robot that helps humans to monitor the surroundings of the robot. This project is built using a VR headset, two smartphones, some specific applications (play store), a four-wheeled robotic vehicle, and Raspberry Pi as its main components. A remote controller is used to control the movement of the robot. The magnetometer and accelerometer data which are processed by Arduino and Raspberry pi are used to control the functionality of the robot. The IP address for the video monitoring through the smartphone is received through Raspberry Pi. We can also control the movement of the robot using the head movement i.e., left or right with the help of a VR headset. Dual-screen mode is enabled using the dual-split browser app in the smartphone. Using this the operator can experience virtual reality using the VR headset.

**Keywords**: **Telepresence, Virtual Reality, Robot, VR headset, Raspberry Pi**.

## 1. Introduction

The main goal of this work is to create a Raspberry Pi-based robot for virtual telepresence. The smartphone reads the accelerometer and magnetometer data of the user's head-turning direction such as right or left. This information is circulated to the modem over Wi-Fi and then to the Raspberry Pi board, which then gives these values as inputs to the servo motors. The Raspberry Pi is a , low-cost computer which is of the size of a playing card that can be used in electronics projects. It's a accomplished small device that permits persons of all ages to learn virtually computers and programming languages like Scrape and Python. The Raspberry Pi is used to complete the projects goal. This Raspberry Pi equipped robot is deployed in a faraway location to capture the environment in visual form. The user's virtual reality(VR) headset displays the collected visuals. An app on the user's smartphone can also move the robot in any direction (in which the user turns his head, for example, right or left).The camera is moved by two servo motors, one for vertical movement and the other for horizontal movement. As a result, if you turn your head to the right while wearing a VR headset, the Raspberry Pi camera will also turn to the right. The Arduino Mega (Board2) receives input from the smartphone for the purpose of navigation or movement of the robot. At the end of the navigation circuit, the motor driver IC and geared motors are connected. The commands to track the robot can be sent via Bluetooth from the smartphone.

## 2. Objectives

The major goals of the project are:

1. To build a Robot for virtual telepresence.
2. To complete the task using a Raspberry Pi and Arduino.
3. To deliver data to the modem using Wi-Fi

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4. To receive input from the smartphone via Wi-Fi and sends a control pulse to the servo motors to travel the Raspberry Pi camera.

## 3. Motivation for Work

Krishna, G.S.V et al (2021)**,** Application of Virtual Telepresence Robot Using Two Methodologies Raspberry Pi and MyRIO, telepresence is the skill, [1] which assistances a operator to feel that they were in a harmful state without being present at the actual location. Harikrishnan, Nandagopal, et al [2] The innovation of their robot is that no conservative supervisors are used for the motion regulator rather the user's movement in the physical space itself is mapped to the robot. The robot design is based on an Arduino Mega coupled with motors for driving the wheels. D. Jadhav, P. Shah and H. Shah, (2018) [3] how virtual certainty with telepresence robots can be used to make virtually complete classrooms that deliver improved educational occasions for homebound pupils with frailties. J. Edwards,(2011) the impression behind telepresence, an emergent teleconferencing equipment that's designed to not only connect people together but to make them feel like they're all collaborating together inside the same room [4].

## 4. Methods

In this model, the Raspberry Pi camera module is used along with the four-wheeled robot to capture the remote environment location. An IP address can be obtained through the Raspberry Pi to view/ capture the environment virtually. The movement/working of the robot is based on the data received from the Arduino and the Raspberry pi. We can also capture the head movements i.e., right, left, top, and bottom of the user through a smartphone one placed in the virtual reality headset. We can also control the working of the robot using the Bluetooth-based application called “Bluetooth Terminal HC-05”. This application provides a user-friendly environment for the operating of the robot such as forward, backward, left, right, and stop commands.

The Raspberry Pi camera has a 360-degree movement which is possible with the use of two servo motors, one for the vertical movement and another for the horizontal movement. The camera module moves right or left or top or bottom with the head movements of the VR headset or using the Bluetooth terminal commands. The commands of the Bluetooth application are sent using the Bluetooth of the device used as well as the Wi-Fi hotspot is connected via Raspberry Pi to the smartphone for the real-time video streaming of the device.

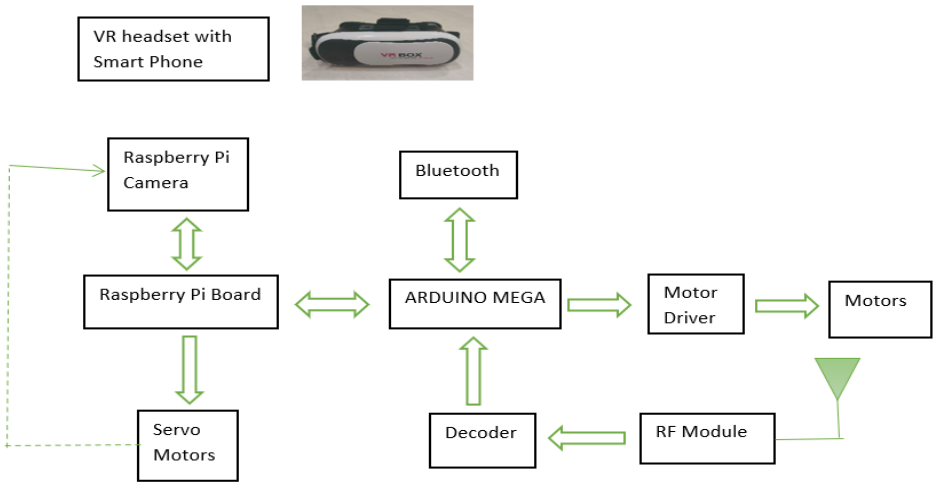


Figure 1 Block diagram

A. Working

The model has to be fully charged before for the proper functionality of the device, shown in figure 1 block diagram. Here, we have used two batteries one is used for powering up the raspberry pi board, this has to be charged 3-4 hours maximum. The second battery type is used for controlling the servo motors and geared motors for the physical movement of the robot and this battery has to be charged for a maximum of 12 hours. Here, the power supply used for charging both the batteries is an AC power supply and the cable of type-B is used. Check

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whether the required software and the applications are installed or not. The data from the Arduino board is used for the operation of the servo motors for controlling the camera movement and the geared motors for the movement of the robot. Next, the Raspberry pi board configurations are made, and the Wi-Fi is connected. An IP address is programmed and used to capture the video streaming in the robot environment. The smartphone is used to experience Virtual Reality through the VR box. The pi camera movement is controlled using two servo motors i.e., one for the vertical movement of the camera and another for the horizontal movement of the camera. Thus, making it possible to view a 360-degree view of the surroundings

B. Hardware Used:

1. Raspberry pi - 3 model B

Raspberry pi almost acts as the brain of the system. The raspberry pi is a mini or credit card-sized computer that performs the tasks with higher efficiency and performance. It is used for video transmission over the network with a Wi-Fi connection. Here, the third generation raspberry pi of model B is used. It has a 64-bit architecture and belongs to the silicon core family BCM2xxx. It consists of an SD card socket, HDMI, and ethernet along with USB ports. It also has 40 GPIO pins. This can also be used for different types of applications.

2. L239D Motor Driver Integrated Circuit
    - It is a medium-powered motor driver circuit for driving DC and stepper motors.
    - It drives the motors with a total of 600mA up to 12V.
    - It can drive once four DC-powered motors.
    - To double the maximum current in parallel the two channels are to be connected in parallel.
    - These are used for line-follow robots, simple arm-controlled robots, etc.

3. Cable

The power supply to the circuit figure 2 is given using the AC cable to the two rechargeable batteries. From these batteries, the DC power is supplied to the Raspberry Pi board and servo controllers

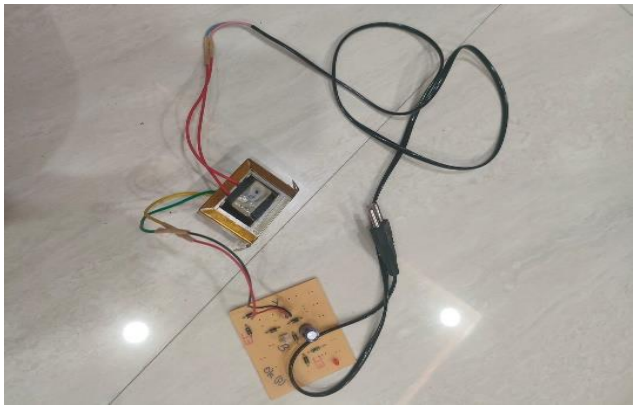

Figure 2: Power supply to the circuit

Figure 3: Raspberry Pi Camera V2.1

4. Raspberry pi camera

The raspberry pi camera figure 3 is used to take pictures or used for video streaming. This camera is placed in the camera module port of the raspberry pi board. There are different versions available in the camera module here we have used camera V2.1. The camera module has two versions:

- Standard/Default version: Designed to take pictures daylight.
- NoIR (No Infrared Filter) version: IR source is used to take pictures in dark places.

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Thonny Python IDE consists of the pi camera library that allows the user to control the camera module.

## 5 Arduino UNO Board

An Arduino board is a microcontroller board, used for a specific purpose application. It has high computational power and is programmed with Arduino IDE software in C/C++ software. This Arduino board acts as the directional processor for the movement of the robot. It belongs to the ATmega328P family and has 14 digital input or output pins. In these 14 pins, 6 pins can be used as pulse-width modulation outputs.

## 6 VR Box

For the virtual reality experience for the user, we are using this VR headset box shown in figure 4. In this box, we have given the option to place the smartphone in which the Ip address from the raspberry pi board is copied into the dual browser that is used by the user for viewing the visuals through both of his eyes.


Figure 4: Virtual Reality Headset Box

## 7 Case for Robot

The robot structure is built using the metallic casing with four wheels attached to it for its movement and a pole for allowing the 360-degree rotation of the camera as in figure 5, other connections such as power supply, raspberry pi board, Arduino, batteries, servo motors, etc are attached to the body of the robot.

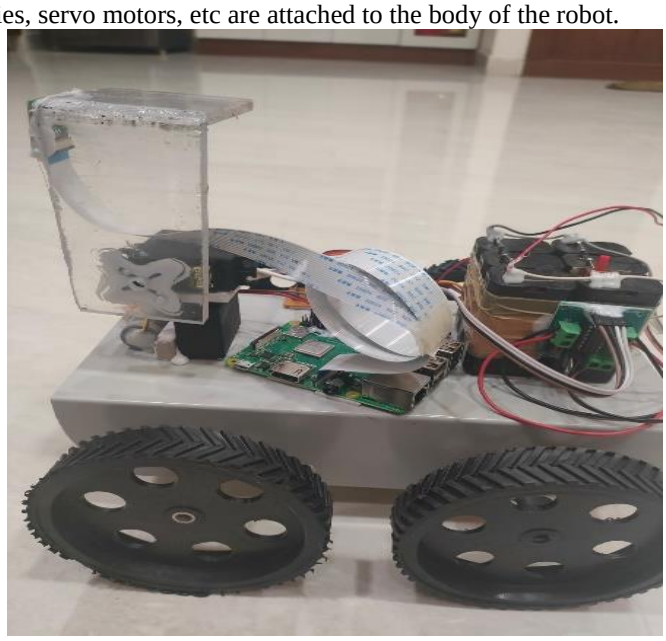

Figure 5: Robot

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C. SOFTWARE USED:

- Python programming – Raspbian OS
  The Raspbian operating system is free open-source software that can be downloaded from raspberrypi.com for windows, mac, Linux, etc., and then needs to be dumped into the raspberry pi board that is connected to the monitor or desktop for its use. The Raspbian software is mostly programmed using the python programming language.

- ARDUINO IDE - microcontroller data
  The Arduino software is used for controlling the programming data given to the Arduino board and the programming language used here is C/C++.

D. APPS USED

In building and working of the device we need two smart phones for installation and useage of the following applications:

1. **Dual Browser, Split Browser, Multi-Browser**
   - Used to split the browser into the dual or multi-modal split as shown in figure 6 with the help of this application.
   -It helps in viewing the remote location using the Virtual Reality headset.

2. **Wireless IMU**

This application is used to get the gyroscope data from the smartphone as in figure 7.

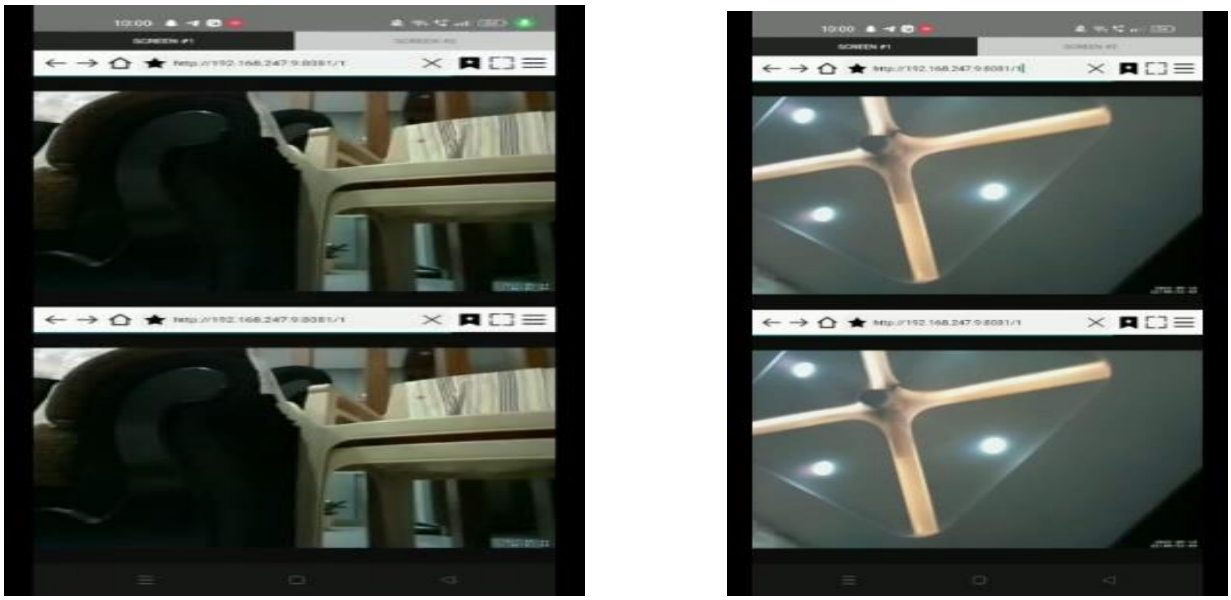

Figure 6 Splitting of the browser into two using Dual Browser

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Figure 7:Wireless IMU application

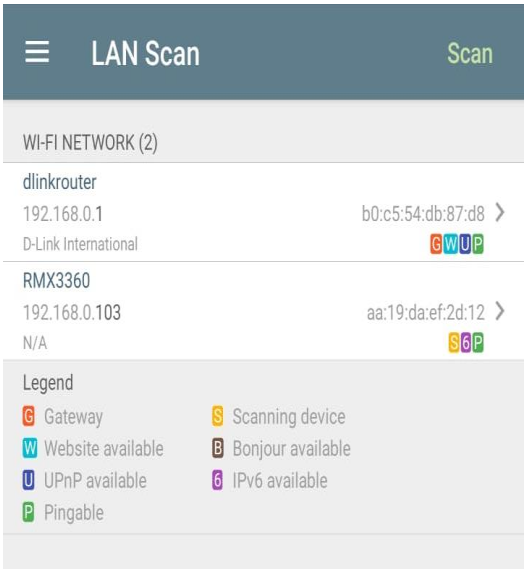


Figure 8 : Network Analyzer application

**3. Network Analyzer**

- LAN scan is done using this application shown in figure 8.
- We get the IP address of the Raspberry Pi for the video streaming.

**4. Bluetooth Terminal HC-05**

- Here, the Bluetooth module used is HC-05, figure 9 has a range of use up to <100m, and is used for many wireless applications like a headset, mouse, and many more.
- It is used in a master or slave type of configuration.
- Pairing of HC-05 with the smartphone.
- Turn on Bluetooth connection on smartphone and check for new devices
- Find the device named HC-05 name and try connecting with the default password 1234 or 0000.
- We can also change the baud rate, command modes, and passwords with the help of AT commands.

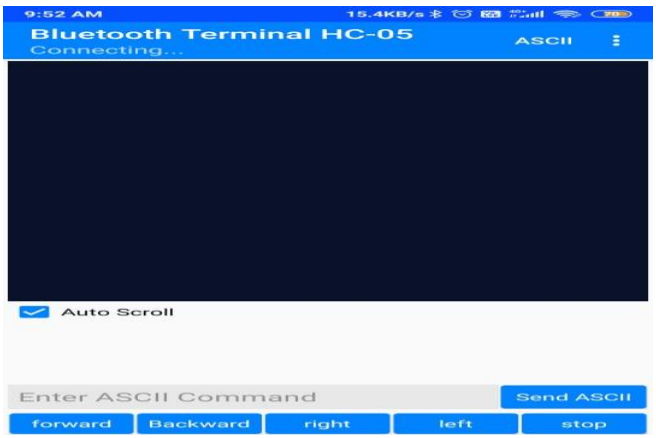


Figure 9: Bluetooth Terminal HC-05 application

E. ADVANTAGES:

1. Highly green and user-pleasant design.
2. Fingerprints is primarily based totally authentication system.
3. Easy to operate.
4. Low energy consumption.

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5. Wi-Fi primarily based totally verbal exchange and sending indicators through mail.

F. DISADVANTAGES:

1. Interfacing fingerprint scanner to ARM-eleven processor is exceptionally sensitive.
2. Attaching mail with the assist of Raspberry Pi is difficult.

G. APPLICATIONS:

1. Examination centers.
2. Home security.
3. Industrial security

5. **Results**:

The project "Virtual Telepresence mechanism victimization Raspberry Pi" the aim of the project is achieved by using Raspberry pi. This robot with a Pi camera is placed in an exceedingly remote location to capture the surroundings in visual type using Raspberry Pi. The captured visuals are displayed on the user's video game (VR) headset. The robot may be enraptured in any direction as in figure 10 (in that the user turns his head, say, right or left) through an app put in within the user's smartphone. Integration options of all the hardware parts used are developed in it. Presence of every module has been reasoned out and placed carefully, so causative to the most effective operating of the unit. Secondly, victimization extremely advanced IC's with the assistance of growing technology, the project has been with success implemented. So the project has been successfully designed and tested.

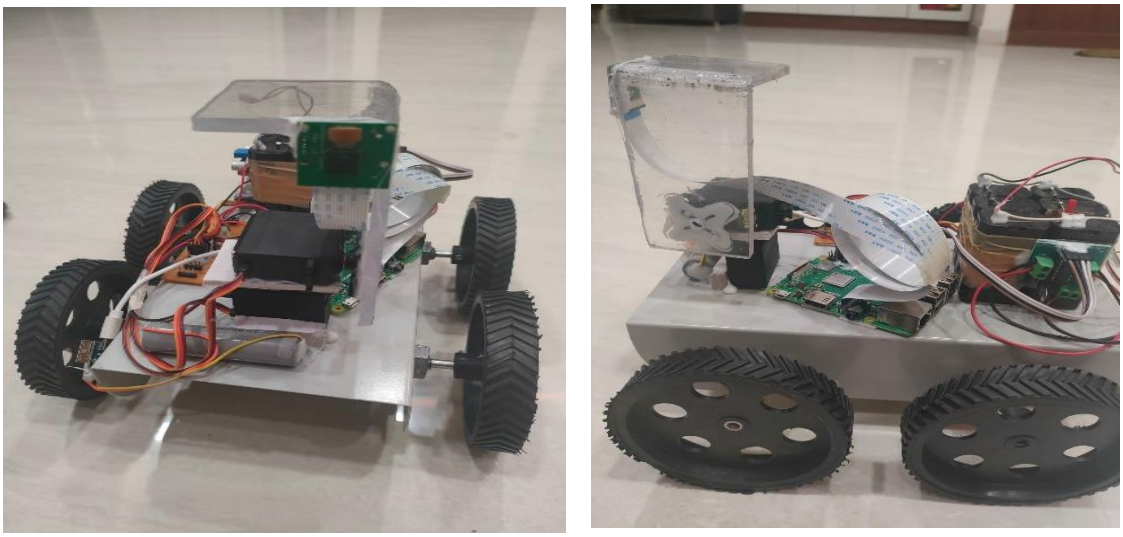

Figure 10: Working model of Telepresence Robot

**6 Future Scope**

Our "Virtual Phone Robot Using Raspberry Pi" project is mainly intended to provide orientation for robots using VR headsets.

The control device of the whole system is the Raspberry Pi processor. Arduino, Pi Camera, Servo Motor, Bluetooth Module interfaced with ARM CORTEX A5 1.2Ghz Raspberry Pi processor. The data received by the fingerprint reader will be transmitted to the ARM CORTEX A5 1.2 GHz processor. The processor operates accordingly and opens or does not open the door. When performing the task, the controller is loaded with a program written in the embedded Linux programming language.

This project can be extended using a high-performance. GSM module with which we can notify users of unauthorized access. The GSM module provides SMS-authenticated SMS messages

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