

Robotic Virtual Telepresence with Raspberry pi

Safa K. Jalal¹, Nice Menachery²

¹ PG Student, Industrial Automation and Robotics, Jyothi Engineering College Thrissur, Kerala, India.

² Assistant Professor, Mechanical Engineering, Jyothi Engineering College Thrissur, Kerala, India.

Abstract - Robots are machines or automated task doers that assist humans with a variety of jobs, from simple to complex, that can be completed automatically with or without the presence of humans. Robots that protect people from threats that put their lives in danger include patient monitoring robots, firefighting robots, and others. These robots operate primarily on the telepresence principle, which was made possible by virtual reality, certain networking protocols, etc. The term "telepresence" refers to the ability of a human to observe a robot's surroundings while not physically present there. In this project, we created a robot that enables people to keep an eye on the robot's surroundings. A VR headset, two smartphones, a few particular apps (from the Google Play store), a four-wheeled robotic car, and a Raspberry Pi serve as the project's primary building blocks. The robot's movements are managed via a remote controller. The operation of the robot is controlled by the magnetometer and accelerometer data that are analyzed by Arduino and Raspberry Pi. Raspberry Pi receives the IP address needed to monitor video on a smartphone. With the aid of a VR headset, we can also move the robot's head left or right to control its movement. The dual-split browser app on the smartphone is used to activate dual-screen mode. With this, the user of the VR headset can experience virtual reality.

Keywords - Smartphone, Telepresence, Magnetometer, Accelerometer, VR headset, Arduino Uno, Raspberry Pi.

1. INTRODUCTION

A group of technologies known as tele-presence allow a person to appear to be present, to feel as though they were present, or to make an impact via tele-robotics at a site other than their actual location. In order for telepresence to work, users' senses must be exposed to stimuli that will make them feel as though they are in another place. Users could also be given the option to influence the remote location. This effect can be achieved by sensing, transmitting, and duplicating the user's position, movements, actions, voice, etc. to the remote site. As a result, communication between the user and the remote location may occur in both directions. The most advanced kind of video telephony, telepresence video conferencing, has a lot of uses. Compared to regular videoconferencing, telepresence via video uses more advanced technical infrastructure and increases the fidelity of both sight and sound. With the help of handheld mobile devices, technological improvements in mobile collaboration have also expanded the potential of videoconferencing

outside the boardroom, enabling collaboration regardless of location. A telepresence robot is a wheeled, remote-controlled gadget with a display for video conferencing and other use that allow participants to view and communicate with distant locations as if they were physically present.

They also make interactive video conferences much more possible than before. A telepresence robot, for instance, may roam around a classroom and engage in face-to-face interactions with specific pupils, exactly like an instructor who is physically present. In addition to many other possibilities, telepresence robots can provide remote office assistants, home visitors, night watchmen, and manufacturing inspectors. Telepresence solutions use a combination of technological components like high quality audio, HD video, telemetry system, and remote control to provide the same-room illusion. The demand for communication tools that enable these activities while efficiently addressing the rising expenses of domestic and international travel is continuously expanding as firms continue to become more global in their business practices.

1.1 Objectives

The project deals with design, simulation and hardware setup of a manipulator working in image sensing.

The main objectives of this project are:

- To design a mobile robot for visual capturing.
- To use OpenCV to detect the video.
- To use Raspberry Pi as the prime microcontroller.
- To use Arduino UNO as the motor driving microcontroller.
- To implement a manipulator prototype setup.

2. LITERATURE REVIEW

Harikrishnan et al., 2021 [1] The virtual interactive reality telepresence robot is an integration of two main technologies, the virtual reality and telepresence. Both the robot and the user are in different environments. The VR headset worn by the user is fed with the live video footage of the robot environment using the Pi camera.

The present available telepresence systems lack the natural ways of interaction and exploration of environments that are remote. Our telepresence robotic system excels among the

existing systems. It enhances the user-friendly aspect by mapping the user motion to the robot. Hence, the use of any conventional controllers which is a drawback of the currently existing telepresence robots can be avoided. Our telepresence robot can be extended in different aspects.

Alexandra Q et al.,2020 [2] This paper has introduced the notion of virtual reality for robots (VRR), by drawing parallels between VR for humans (and other organisms) and spoofing a robot's sensors. This has led to a mathematical framework that contains general and formalized notions of displays, rendering, and VWG. Our definitions are directly interleaved with standard notions from robotics, including state spaces, actions, sensor mappings, state transitions, and information states. Using this framework, we identify several interesting open problems for further research, and guiding principles for systematic testing and experimentation. The engineering challenges involved are worth pursuing because of the enormous potential for applications in reliability testing, reverse engineering, security, and machine learning.

Hossain et al.,2017 [3] This paper provides an inexpensive solution for mobile surveillance in any necessary environment. Rover can be indeed controlled fully to move in all directions. By using the camera module video footage in real-time can be accessed even while the rover is on the move. Rover is fully controlled through internet connection, whether it is through local network, Wi-Fi, 3G or a cloud server, which makes our rover best option for integrating IoT application into issue of security and surveillance services. The use of the smartphone instead of the computer and laptop makes the system more reliable and easy to use. Most of the existing surveillance system are costly and common people cannot afford it. This system is designed with an aim that it can be used by all kind of people since security of every one home should not be left behind.

2.1 Conclusion Based on Literature Review

Based on the above articles, I tried to design and developed a robot which could bring us the experience and satisfaction of being in a desired location without actually being present there. The following information has led me to conclude that adding automation to the current model is necessary for improved performance. I've seen a few problems that need to be resolved for a better system. The robot is controlled by hand gestures and it has range of 15m to 20m, it works under Bluetooth module. In order to enhance the distance coverage, we will have to establish the communication of the transmitter and the receiver for the movement of the robot over cloud, since this is only a prototype we considered to go with Wi-Fi. Camera is controlled by the head movements with the wireless imu app and is placed in VR box to experience virtual reality. This is beneficial in various streams as in surveillance, hospitals, defense, education and work.

3. DESIGN OF MODEL

3.1 Selection of Mobile Robot

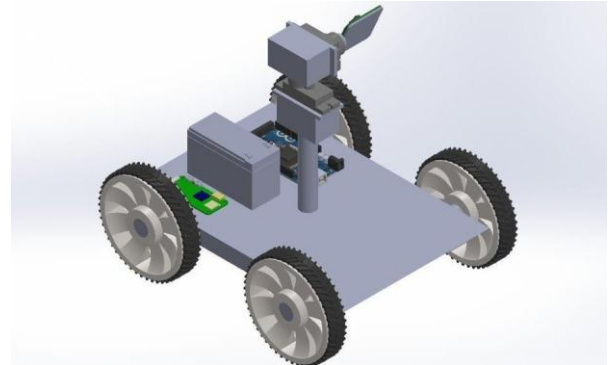


Fig 1: Design Model

Robotic vehicles with wheels are those whose movement is caused by the interaction of the wheels with both the ground. The slip phenomenon is a significant issue related to how wheels interact with the ground. In contrast to automotive wheels, the geometry and qualities of wheels on wheeled robots are often different. Robotic wheels frequently use pneumatically inert tyres, necessitating the execution of specialized investigations. To the first category belong robots with steering or caster wheels. Typically, they are intended for usage inside of buildings (indoor robots). The well-known Pioneer 2-DX robot is one illustration of such a design. A mobile robot with four wheels is created in this project. The robot's two wheels are propelled by geared motors.

A mobile robot's core capabilities include the capacity to move around and investigate, transport payloads or goods that generate income, and carry out sophisticated tasks utilizing an onboard system, such as robotic arms. Mobile robots are widely used in industry, particularly in warehouses and distribution centers, but they can also be used in other fields such as security, medical, and surgery. One of the most widespread applications for mobile robots is the exploration and navigation of the oceans and space. Mobile robots can correctly identify their surroundings in real time because of the sophisticated array of sensors they use. This is helpful in particular for industrial environments that are dynamic and ever-changing. Another benefit is provided by the AI and onboard intelligence system employed by AMRs. The autonomy offered by mobile robots allows for swift adaptation to novel situations and supports the ongoing quest of industrial productivity. Mobile robots can learn their surroundings either through an uploaded design or by driving about and generating a map.

3.2 Selection of motor

3.2.1 DC Geared Motor

A geared motor is a part whose mechanism regulates the motor's speed, causing them to run at a specific speed. As the gearhead acts as a torque multiplier and enables small motors to reach higher speeds, geared motors have the capacity to deliver significant torque at low speeds.

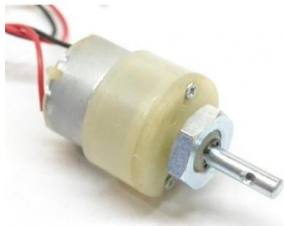


Fig 2: Gear Motor

Since a geared motor simply combines a speed reducer with a motor that generally functions as a gearbox to reduce speed and increase available torque, it may also be thought of as a gear reducer. Based on the motor they are paired with, geared motors can be categorized as bevel, helical, hypoid, spur, or worm gears.

3.2.2 Servo Motor

A type of motor with incredibly accurate rotational capabilities is a servo motor. A control circuit that provides feedback on the motor shaft's current location is often present in this sort of motor. The servo motors can rotate quite precisely thanks to this feedback. An object can be rotated at predetermined angles or lengths using a servo motor. It is made up of a simple motor that powers a servo mechanism. When a motor is driven by an AC power supply, it is referred to as an AC servo motor rather than a DC servo motor. In this session, we will only discuss how the DC servo motor works.



Fig 3: MG90S Servomotor

3.2.3 L293D Motor Driver

L293D Motor Driver Module is a medium power motor driver perfect for driving DC Motors and Stepper Motors. It uses the popular L293 motor driver IC. It can drive 4 DC

motors on and off, or drive 2 DC motors with directional and speed control. The driver greatly simplifies and increases the ease with which you may control motors, relays, etc. from micro-controllers. It can drive motors up to 12V with a total DC current of up to 600mA.



Fig 4: L293D Motor Driver

3.3 Selection of Camera

A USB external webcam gives you greater versatility and other enhancements that will make you appear and sound your finest on television. In this buying guide for webcams, we'll go over the crucial hardware requirements, unique capabilities, and advantages of webcams. The quality of the video that a webcam records is its most crucial component. This is understood in terms of resolution and frame rate for digital video.



Fig 5: Web Camera

3.4 Selection of Micro controller

3.4.1 Raspberry Pi

An effective and potent minicomputer called the Raspberry Pi is about the size of a credit or debit card. The United Kingdom Raspberry Pi foundation created it in an effort to educate and empower the next generation of learners to be more inventive and effective. Numerous open-source communities have made contributions since the launch of the Raspberry Pi to open-source operating systems (OS), applications, and numerous other types of computers. Additionally, a number of embedded system academics and researchers from all over the world are consistently working to create cutting-edge projects that use this module, which is known to have immediate applications.

3.4.2 Arduino Uno

A microcontroller board called Arduino Uno is based on the ATmega328P. It has a 16 MHz quartz crystal, 6 analogue inputs, 14 digital input and output pins (of that which 6 could be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; to get started, just use a USB cable to connect it to a computer, or an AC-to-DC adapter or battery to power it.

3.4.3 Arduino Nano



Fig 6: Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor. The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a Type-B mini-USB cable or from a 9V battery.

3.5 Selection of Battery

The lithium-ion battery within a lithium-polymer (LiPo, LIP, or Li-Poly) battery sits in a soft exterior "pouch" thanks to the soft polymer used to create the battery's case. It might also refer to a lithium-ion battery with an electrolyte made of a gelled polymer. However, the phrase frequently designates a kind of pouch-style lithium-ion battery. par Lithium-ion polymer battery is a more appropriate moniker for this kind of battery.

3.6 HC-05 Bluetooth module

A Bluetooth module called HC-05 is created for wireless communication. This module could be set up as either a master or a slave. used for a variety of consumer applications, including wireless headsets, game controllers, wireless mice, and wireless keyboards. The red LED on the HC-05 shows the connection state, whether Bluetooth is active or not. This red LED continually and irregularly blinks before being connected to the HC-05 module. It blinks for two seconds when it is in Bluetooth range of any other device.



Fig 7: HC-05 Bluetooth module

3.7 RF Transmitter and Receiver



Fig 8: RF Transmitter and Receiver Module

This hybrid RF Transceiver Module provides a complete RF transmitter and receiver module solution which can be used to transmit data at up to 3KHz from any standard CMOS/TTL source. The transmitter module is very simple to operate and offers low current consumption (typical. 11mA). Data can be supplied directly from a microprocessor or encoding device, thus keeping the component count down and ensuring a low hardware cost. The RX - ASK is an ASK Hybrid receiver module.

3.8 Power Bank

Keep our devices well-charged at all time with this Mi power bank. While its dual USB input helps you charge two devices together, its smart power management lets you switch it to 2-hour low charging mode to charge low-power devices with ease. In this project power bank is used to power up the whole devices and it's easy to carry out through the system. It consists of 10000mAh battery.

3.9 VR Headset

Virtual reality VR Box headset is a head-mounted gadget that you wear over your eyes like a couple of goggles. This VR gadget gives computer generated reality to the wearer. The objective of the VR headset is too give vivid computer generated simulation experience. The VR BOX is a smartphone VR headset made by VR BOX. This mobile VR headset is a very popular product, but users don't like the design. Indeed, users comment that the device can hurt their nose and that prolonged use may irritate the forehead. Also, the smartphone VR headset doesn't come with a controller, which limits the gaming experience.



Fig 9: VR Box Headset

4. SIMULATION OF MODEL

4.1 Computer vision

The project also used Python Open CV programming to find the environment's video. Artificial intelligence of computer vision enables machines and systems to extract useful information from digital photos, videos, and other visual inputs and to conduct actions or offer recommendations in response to that information. If AI gives computers the ability to think, computer vision gives them the ability to see, observe, and comprehend. Since human eyesight has been around longer than computer vision, it has an edge over the latter. Human vision has the advantage of learning how to differentiate between items, gauge their distance from the viewer, assess whether they are moving, and assess whether an image is accurate throughout the course of a lifetime. Instead of using retinas, optic nerves, and a visual brain, computers can now learn to perform identical tasks considerably faster thanks to computer vision, which uses cameras, data, and algorithms.

4.2 Mobile Connection

In order to watch the visuals and move the camera using smartphone, two mobile applications must be installed.

4.3 Wireless IMU



Fig 10: Wireless IMU App

The wireless IMU app is linked to the Raspberry via an IP address, after which it will function in accordance with the smartphone's sensors to determine the camera's movement. Figure 5.2 depicts the IMU app's main panel, where we had to include the target IP port as well as the target IP address. This software uses UDP to transfer CSV (Comma-Separated Values) data from your phone's inertial sensors to a computer on your network. Your phone becomes a mobile inertial measurement unit as a result (IMU). The app is

compatible with the following sensors: accelerometer, gyroscope, and magnetometer.

4.4 Dual Quad Browser



Fig 11: Dual Quad Browser

The Private Browser programme teaches you how to multitask or use two browsers simultaneously. You can conduct two things on the same browser while using a dual browser for private surfing without opening and closing additional tabs. Fastest browser that allows you to use numerous windows at once to watch movies, listen to music, read articles, or use social media. a browser that protects your privacy by not tracking you and keeping no history. Download the user-friendly simple-to-use Dual Browser multitasking browser. This is a split-screen, quick surfing programme for mobile devices that enables quick internet browsing.

5. WORKING

5.1 Block Diagram

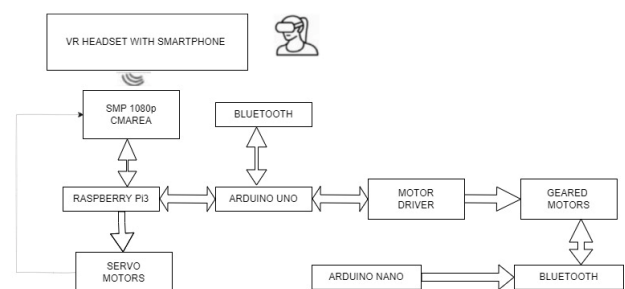


Fig 12: Block Diagram

A smartphone inserted into a Virtual Reality headset can be used to see the video that the camera shot. Through a VR headset, the initiative enables users to experience virtual reality. The smartphone has dual-screen mode turned on for this. The smartphone receives the magnetometer and accelerometer data of the user's head movement, such as a right or left turn. This information is transmitted via Wi-Fi to the modem and the RPi board, which then use these numbers as inputs to the servo. The camera is moved by two servo motors, one for vertical motion and the other for horizontal movement. Therefore, the RPi cam will also turn right when users turn your head to the right when wearing a

VR headset. Webcams are used in a variety of settings and can transmit real-time images to computers using USB, Ethernet, and Wi-Fi. Webcams are used for video chatting and private broadcasting even though they cannot produce images in high quality like broadcasting cameras do. Instead, they operate similarly to inexpensive camcorders and can send images over large distances over the internet. Additionally, webcams are employed as monitoring tools for security systems and child safety.

5.2 Circuit Diagram

The circuit's 12V charger, which is used to charge rechargeable batteries, is the first stage. To provide an 8V power source, four lead-acid rechargeable battery packs, each with a 4V and 1Ah capacity, are placed in series and parallel. The ultimate voltage increases and the current stays the same if the batteries are placed in parallel. The voltage stays the same while the current increases if the cells are connected in parallel. By connecting two of each in series, followed by two sets in parallel, you may obtain an 8V, 2Ah power source. The Arduino, a motor driver IC, and other modules are powered by an 8V power source. The Raspberry Pi is powered by a 5V power bank.

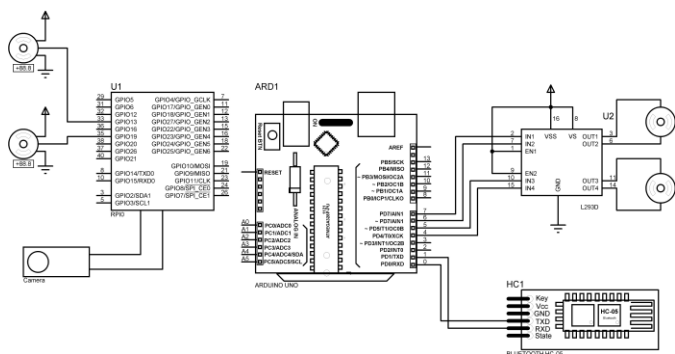


Fig 13: Circuit of Mobile Robot

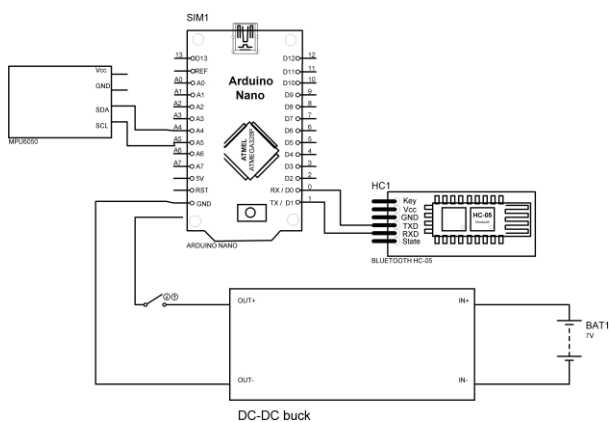


Fig 14: Circuit of Glove

The robot's mobility is managed by the navigation circuit. The L293D motor driver, HC-05 Bluetooth module, Arduino, with couple of DC gear motors make up the system. The HC-

05 Bluetooth module transmits directional information or commands from the smartphone to the navigation circuit. The geared motor is driven in the desired direction by the motor driver IC after being processed by the Arduino. The Wireless IMU app that is installed on the smartphone receives commands. The robot is moved by moving the glove in a way that the wireless transmitter transmits signals to the gadget. The arduino Nano that is attached to the glove controls everything.

6. RESULT AND DISCUSSION

6.1 Prototype



Fig 15: Mobile Robot

On a smartphone inserted into a virtual reality headset, users may watch the video that the Raspberry Pi camera recorded. Through a VR headset, the initiative enables users to experience virtual reality. The smartphone has dual-screen mode turned on for this. The device reads the magnetometer and accelerometer data of the user's head movement, such as a right or left turn. This information is transmitted via Wi-Fi to the modem and the Raspberry pi board, which then use these values for input to the servos. The camera is moved by two servo motors, one for vertical motion and the other for horizontal movement. As a result, the Raspberry pi board camera will turn to the right when you move your head to the right when wearing a VR headset.

6.2 Result

In the Virtual interactive reality telepresence robotic system, there are two parts, the robotic part and the user part both of which are at different locations. The robotic part consists of a basic robot with four wheels. The camera module is placed on the top of the robot.

The user part consists of the user who will be wearing a VR headset and A glove that performs hand gesture to control the robotic vehicle.

1. Display Live Footage in VR Headset: The live footage of the surroundings where the robot is placed is captured by the Pi camera and is fed to the smartphone in the VR headset worn by the user. The video footage is streamed in the dual screen facility of the smartphone in order to have a feeling of a virtual environment.

2. Map The User's Motion: The robot is able to move in all directions according to the movement of the user. Robotic vehicle is controlled by the glove with hand gestures.

3. Map the User's Head Movement: The camera mount on the robot moves exactly according to the movement of the VR headset which is worn by the user. The data from the wireless IMU app is used for this purpose.

7. CONCLUSION

In this project, a prototype of a four-wheeled mobile robot with a Raspberry Pi and camera to capture images from dangerous locations and transmit them to the analyzer through virtual reality is built. The Raspberry Pi serves as a server, and the smartphone connects to that localhost to access the graphics. Flask framework and Python are used to help create and host videos. The recommended model is capable of moving via gas wells and other inaccessible locations for humans. Future research should develop methods for autonomously navigating mobile robots by gathering environmental data directly from the environment.

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