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TELEPRESENCE SURVEILLANCE ROBOT USING RASPBERRY PI

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Abstract

A telepresence surveillance robot is a remote-controlled, wheeled device with a display to enable video streaming which enable the participants to view remote locations. This virtual surveillance robot allows the user to capture the real-time video even when the robot is in a remote location and displays it on the user's virtual reality (VR) headset. This robot is a wheeled, Bluetooth remote-controlled device with a camera to capture real-time video using Raspberry Pi (RPi) in visual form. The Bluetooth remote controller controls the movement and the direction of the Robot via Arduino. The Live-streamed video can be received on any smartphone device using the specified IP address by Raspberry Pi.

Keywords: Arduino UNO, Bluetooth module, Remote-controlled, Raspberry Pi, Video streaming, VR headset.

1. INTRODUCTION

In today's world, the development of science and technology has introduced the concept of virtual reality and robotics. The term virtual reality means 'near-reality'. This concept enables people to be at more than one place at a single time. This robot enables to observe the people and their surrounding without being physically present. It helps one person feel more connected by giving a virtual presence where one can't give in physical. Robots have increased widely in today's world. In almost all industries, the concept of robotics is used as they are user friendly. The Robot used in this project uses a rechargeable battery. Telepresence uses virtual reality technology. The telepresence robot gives a virtual reality experience that can be felt by the user even when the robot is in any remote location.

This paper explains the working of the robot and capturing of the visuals by RPi camera, how to configure Wi-Fi and interfacing servomotors with Raspberry Pi and geared motors with Arduino. It explains how the data is received, as signals, from an android application and sent to Raspberry Pi and Arduino. The mini rover camera is stationary. As the rover moves, the camera moves along. In the proposed system, we have the facility to rotate the camera according to our head movement. The mini rover gives a normal display. Whereas in the proposed system, we get a virtual reality effect.

The idea behind this project is taken from [1] and [2] explains the working of the robot and the capturing of the visuals. [3] talks about Raspberry Pi and its architecture including both hardware and software. [3] gives us a highlight of connecting and controlling motors to the Raspberry Pi. [4] talks about the robotic arm controlled by Raspberry Pi and android application software using Wi-Fi protocol. It also talks about how to configure Wi-Fi and interfacing servo motors with Raspberry Pi. It explains how to send data from an android application to Raspberry Pi. [6] gives us the idea of how to live stream a video using the RPi camera.

2. PROPOSED SYSTEM OVERVIEW

The block diagram of the telepresence surveillance robot system is shown in Fig1. Raspberry Pi is the brain of this project. RPi receives input data from an android phone via WIFI which is further sent as controlling pulse to the servo motors attached with the camera which rotates the camera in 2 axis planes.

The android smartphone also sends the input directional data to the Arduino UNO board from a Bluetooth electronics app for the movement of the telepresence surveillance robot. The geared motors are interfaced with the Arduino UNO board via motor driver IC (L293D) at the end of the navigation system.

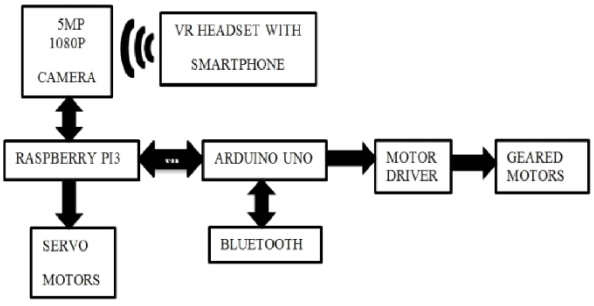

Figure 1 System blocks- Telepresence surveillance robot

Navigation

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The navigation system influences the direction and movement of the robot. This circuit consists of Arduino

UNO, HC-05 Bluetooth module, motor driver IC and 4 geared motors. The directional input data is received by the HC-05 via a smartphone. It is then computed by Arduino and then send to the motor driver IC which drives the motors in the direction needed. These signals are transmitted by the Bluetooth Electronics app installed on an android smartphone.

First, launch the app and pair it with the Bluetooth module. After pairing necessary buttons can be added and edited in the app and configured with the keywords stated in the Arduino code (for forward, backward, right, left and stop). Data is transmitted as soon as the key is pressed.

After HC-05 receives the command it sends it on the TX and RX pins of Arduino. The Arduino then computes this command by comparing it with the Arduino program.

Capturing live video

Two servo motors are interfaced to the GPIO pins of Raspberry pi configured as PWM. The two servo motors and RPi camera are attached in such a way that when motor1 takes turns in X-Axis the camera will follow the same direction and when motor2 takes turns in Y-Axis the camera will follow. The X and Y Axis's direction is controlled by wireless IMU app installed on an android smartphone. The app fetches the real-time data of accelerometer, gyroscope, and magnetometer of the phone, and can run in the background. UDP protocol is used to transmit the data over WIFI. The magnetometer and accelerometer readings make the servo motor to move left/right and up/down respectively. Hence the camera can record videos from different angles.

All of the hardware that is used in this system is affordable and can be easily purchased from the local market or an online store. Below is the list along with a short description of the major hardware used in this project.

Raspberry Pi model B

The Raspberry pi is selected as the brain of this project as it allows easy, fast and real-time video streaming over WIFI.

Features of raspberry pi

1 GB SDRAM

4 USB 2.0 ports

HDMI and composite video

MicroSD slot

CSI and DSI

ARM Cortex-A53 1200 MHz processor

Figure 2 Raspberry Pi model B

Arduino UNO

Arduino UNO is Microchip ATmega328P microcontroller-based microcontroller board. It comes with the sets of digital and analog I/O pins that can be used to interface with various sensors and expansion boards. The microcontroller on the board has pre-programmed by the manufacturer with a bootloader which allows uploading new codes without using an external hardware programmer.

1. Geared motors

   Geared motors are used because it produces a high torque while maintaining a low-speed motor output.

2. Servo motor

   Servo motor acts as a rotatory actuator allowing the precision in the control of angular or linear position, velocity and acceleration.

3. Bluetooth module (HC-05)

   HC-05 is based on the serial port protocol (SPP) which is designed for wireless serial transmission of data up to a certain range. It has a 3Mbps modulator with 2.4GHz radio baseband.

4. L293D Motor Driver IC

   It has 4 control signals which accept +5V signals and two motor outputs. This motor driver IC works on +12V powered by a lead-acid battery.

5. VR headset

6. A VR headset allows the user to experience virtual reality through visuals.

7. RPi camera module

8. RPi camera module lens integrated image sensor which comes with a detachable connection ribbon. The RPi camera used here is 5MP HD camera with a fixed focus which can support VGA90, 720p and 1080p as well as image capture.

9. Power supply

   The movable robot is powered by a 12V, 1.3AH rechargeable lead-acid battery and the Raspberry pi is powered by a 10000mah power bank

Figure 3 VR headset

Figure 4 RPi camera module

Software

The main software and programming languages used are listed below.

Raspbian OS

The Debian based OS Raspbian in flashed on to a 16GB MicroSD card. MicroSD card is then mounted into the SD card slot on the Raspberry pi board. After powering Raspberry pi using a power bank turns it on and connects to the WIFI network. The RPi desktop can be accessed by entering an IP address into VNC software.

1. VNC viewer

   This software is used to access the RPi desktop wirelessly as the RPi is mounted on a movable robot.
2. Python

   Python is very suitable to use as it is open source and easy to learn and this allows Raspberry Pi to interact with the user.
3. Arduino IDE

   The C/C++ language is used to configure commands for robot in Arduino.
4. Wireless IMU app

   Wireless IMU app reads the real-time readings of accelerometer, magnetometer, and gyroscope which helps to differentiate the movement of the head in either possible direction.
5. Bluetooth Electronics app
6. This app sends the directional command over Bluetooth.
7. Dual screen app

   As the operator has to watch the visuals through the VR headset, it should be in the form of a split-screen so that the virtual reality can be experienced.

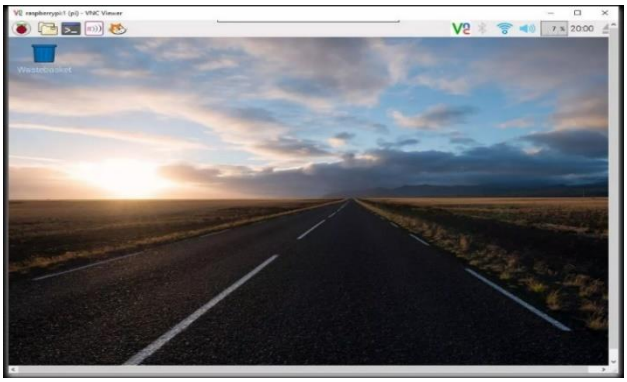

Figure 5 The Raspberry Pi desktop

Figure 6 Pairing with Bluetooth module

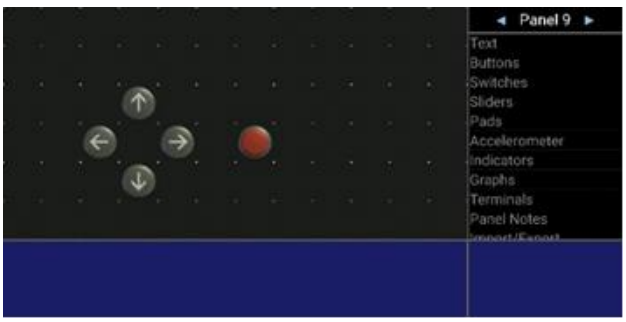

Figure 7 Configuring the buttons

3. RESULTS

After the proper assembly of hardware and installing followed by running the required software we demonstrated that the telepresence surveillance robot can provide HD coloured live video in a region and direction as per our requirement.

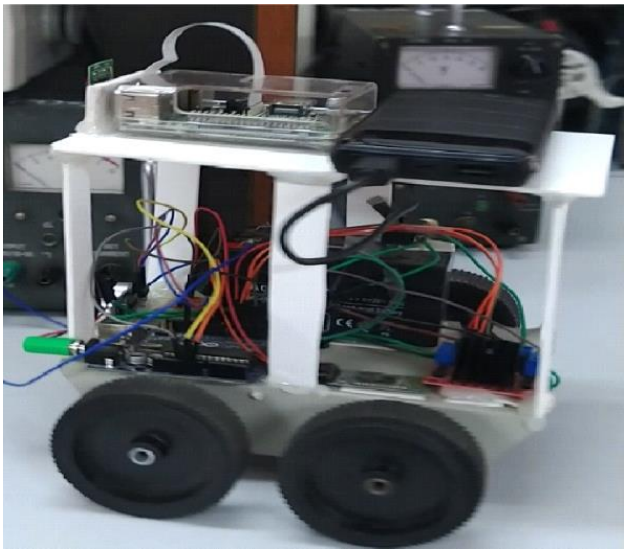

Figure 8 Telepresence surveillance robot

Figure 9 A person watching visuals from camera

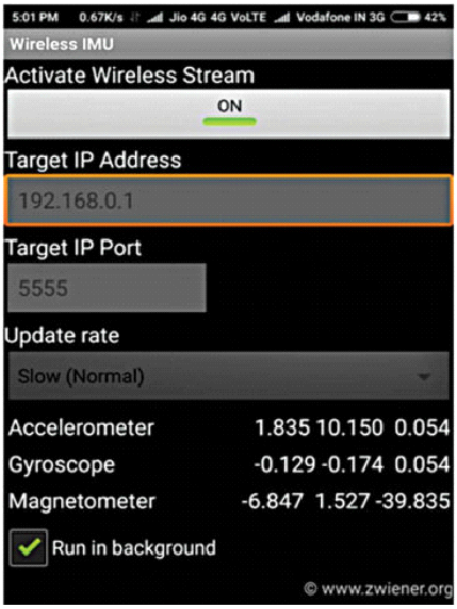

Figure 10 screenshot of wireless IMU app

Figure 11 Screenshot of dual screen app

4. CONCLUSION AND FUTURE SCOPE

Limitations

The directional data are transferred as the head moves. In the case when the head moves very fast the data, the transfer rate is high. This, in turn, requires the Raspberry Pi to process the data very quickly. The app should be programmed in such a way that the Raspberry Pi board gets enough time to process the data and prove it as input to the servos.

The currently designed robot is suitable to run over only smooth surfaces. The stronger body of the robot will allow it to run over rougher terrains.

Application

1. In the military, this robot can be sent for monitoring instead of a soldier. In this way, only the robot gets damaged and no life is lost even if there is an unexpected attack.
2. The robot can be used for surveillance in the house where the owner wants to keep an eye on his home.
3. In Medical, when the doctor is not available to go on rounds, the robot can be used to check the state of the patient.
4. They can even provide home care assistance to the elderly.
5. The robot can be used in fire and rescue operations if it is made fireproof.

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