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Virtual telepresence robot

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ABSTRACT

This paper proposes a method for a Virtual Telepresence Robot. That is a user can control a wireless robot remotely from any part of the world along with the live video transmission from the robot's location. The 3 components of this project are the wheeled-robot, the camera with pan-tilt head mechanism and a web server (Flask Web Server). Raspberry Pi is the central component that interfaces user and the virtual telepresence robot over internet. The web interface is built on a flask Micro-web server application, which used to control the robot in localhost, further Ngrok is used for tunnelling local host web server to internet, through which the user can control the robot over the internet. The web server sends a wireless command which is received by Raspberry pi thus actuating robot and camera directions. The MJPEG streamer application is used for streaming video that gets mjpeg data and sends it through a HTTP session. The Raspberry pi is programmed in python language.

***Keywords**— Raspberry Pi, web-server, pan-tilt, mjpeg, flask, Ngrok, tunneling.*

1. INTRODUCTION

Surveillance is a major thing when we are going to secure anything as it is a tedious job for people which involve risk in observing things so we are going to make a robot which continuously monitors everything. This robot continuously watches and sends a live streaming of it to the authorized person. Because of the monitoring the work will be somewhat easy and it will be accurate because of the use of technology.

In recent times, surveillance technology has proved to be of much need. Due to the influence of various events, over the years, the need for security and surveillance systems has changed significantly. Different kinds of sophisticated electronic devices including surveillance alarm, Closed Circuit Television (CCTV) surveillance etc. is flooding the market at a greater pace. With the advancement in technology, locations can be monitored from remote places at anytime from anywhere in the world. These advancements have greatly improved the scope of security and surveillance devices in various credible applications like monitoring factory premises, government buildings, manufacturing units, airports etc. A Virtual Telepresence Robot is a web-controlled wheeled device can be controlled from any remote location and is capable of capturing the environment in virtual form using Raspberry Pi. The captured visuals are displayed on a webpage. A web server is built using flask framework in python, and the webpage displayed on this web server will contain the buttons to control the robot and the camera movements, along with which the live video transmitted will be displayed on the web page screen. As a security measure, there is a unique login credentials that is required to be entered by the user before he can have the access to robot control and video display.

Major 3 components of this project are the robot, the camera with pan-tilt head mechanism and a web server. Raspberry Pi is the central component that interfaces user and the virtual telepresence robot over the internet. It's used for controlling robot movements, video capture and 180-degree camera. Servo motor is used for precise control of angular or linear position of the pi camera. Two servo motors are used to move the camera in both directions (180 degree) one for the vertical movement and the other for the horizontal movement. A motor driver IC is used to control the DC motors to drive in either direction. Raspberry Pi Wi-Fi enabled controller is used to control the movement of the robot through the Internet. The controller is connected to the Internet and commands are sent to Raspberry Pi through Wi-Fi.

2. RELATED WORK

[1] This paper proposes a method where an android application is built to control a wireless surveillance robot. A web page will be opened by the Android application, which will consist of

buttons for controlling the robot and the camera and the video display screen. The Raspberry pi and the Android phone is connected to the same Wi-Fi. The smartphone sends a wireless command to the Raspberry pi, and the corresponding robot function is executed to make the robot move. The MJPG streamer program is used for the video streaming. The MJPEG data is collected and is sent through a HTTP session. The programming language used is python. The experimental analysis result is that the video stream rate is up to 15 frames per second.

[2] The System simulation has been done using proteus software along with the developed GUI for both client and server. The control circuit is connected to the server software through a virtual serial port represented by the compin component. The microcontroller atmega16 is connected with the virtual terminal along with motors driver circuit L293D and LCD. The system standalone simulation and that mean all of the data transitions is done on one machine including the client, server and control circuit. The software that controls the data conditioning in the microcontroller has been done using Bascom - A VR programming language, based on a predefined condition the microcontroller is then acts as desired. The hardware design of the system consists of ATmega16L microcontroller connected to the PC through the serial communication, L239D drive circuit IC used to regulate current flowing through a circuit, Max232 IC used to convert from RS232 level to TTL level or vice versa and the two DC motors, the software implementation include both of the Client and Server GUIs on the same machine connected through the loop back mechanism.

[3] In this paper, a Raspberry Pi remotely controlled surveillance robot has been developed. Its major use is in the military departments as a spy robot where it can replace the humans, thus saving human lives in risky operations, and reducing the manual error. This spy robot uses the Raspberry Pi as the microprocessor, the pi camera and various sensors. The PIR sensor would detect living objects in the robot location and the pi camera is used to capture moving objects there, this data is sent to the user in the remote location over the web server. A webpage is created for viewing the live video stream, and the webpage consists of buttons to control the wheeled-robot. Python programming language is used to control the robot. Obstacle detection sensors are also used to avoid collision of the robot, which makes it automated control to some extent. This robot can be used in various fields such as industries, shopping malls and banks.

3. PROPOSED SYSTEM

The proposed concept is based on a virtual telepresence robot, also known as remote-controlled surveillance, which is a fixed wheeled device with a camera to enable live video streaming and is operated by a user from afar. With the use of telepresence, this proposed robot provides us the impression that they are present at a location different than the true location where the robot is positioned. This can be accomplished by employing a Raspberry Pi with a pi cam attached to it, which records visuals and displays them on a webpage designed to manage the robot according to the user's requirements for movement direction and disengagement. Live streaming has become increasingly popular in recent years because it allows people and robots to connect without needing to travel to a certain location to be observed. Live Streaming is particularly useful in military sectors as a spy robot that can execute specific activities in place of humans.

4. METHODOLOGY

4.1 Components Description

4.1.1 Raspberry Pi 3 Model B+: The microprocessor used in the project is the Raspberry Pi 3 Model B+. There have been many significant upgrades made in the latest version of the Raspberry Pi board in comparison to the Raspberry Pi 2, which make it more suitable for this project. The SOC in the Raspberry Pi 3 Model B+ is Broadcomm BCM2837B0, which is almost 50% faster than the Raspberry Pi 2. The CPU is also faster, at 2.4GHz, in comparison to the 900MHz Quad Cortex A7 in Pi 2.The Graphical Processing Unit is clocked at 400MHz compared to the 250 MHz VideoCore IV in Pi 2. Above all, the Raspberry Pi 3 Model B features an on-board Wi-Fi and Bluetooth, which makes it easier to use in IoT applications. Apart from all these, there are many other improvisations made in the Raspberry Pi 3B+, but hardware wise, there has not been any major changes when compared to the Raspberry Pi 2. All the peripherals required in this project are connected to the Raspberry Pi 3B+ and it also contains the programs required for controlling the movements of the robot. It is the brain of the complete project. The Raspberry Pi features 4 USB 2.0 ports, which are used to connect the different components. The Raspberry Pi is powered using 5V DC supply to the micro–USB Power input. It has been upgraded to handle up to 2.5 amperes of current. The MicroSD card slot is inserted with a memory card which contains the OS running on the Raspberry Pi.

Fig. 1: Raspbberry Pi 3 Model B+

4.1.2 Pi Cam: The pi cam module acts like a portable light-weight camera which can keep up with the raspberry pi it communicates with pi using mi-pi camera having serial interface protocol. It’s basically operated in digital image processing machine learning and surveillance project it is also utilized in surveillance drones because the payload of camera is very less apart from these modules pi cam can also be used as normal USB webcams that are used along with computer.

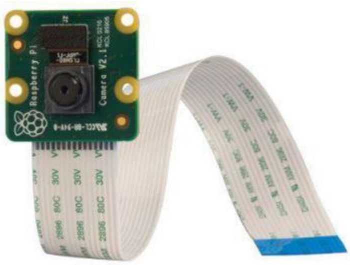

Fig. 2: Pi Cam

4.1.3 Pan Tilt: To provide a wider vision of the area being inspected a pan tilt mechanism for the camera is used, which gives it a broader vision and fulfills the need of better surveillance. The mechanism is such that it comprises of two brackets where two servo motors are fitted in a way that it serves the purpose of pan and tilt motion of the camera and a frame that holds the camera, in this way this whole setup implements the much-required video streaming.

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Fig. 3: Pan Tilt

4.1.4. Motor Driver: Motor drivers acts as an interface between the motors and the control circuits. Motor requires high amount of current whereas the controller circuit works on low current signals. It is basically used to run the motors. A motor driver is undoubtedly something that makes the motor move as per the given instructions or the inputs (high and low). It listens to the low voltage from the controller/processor and control an actual motor which needs high input voltage. In simple words, a motor driver IC controls the direction of the motor based on the commands or instructions it receives from the controller. Many motor drivers follow different topology.

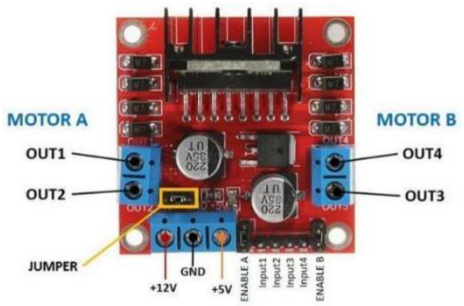

Fig. 4: Motor Driver

4.2 Working Principle

When the virtual telepresence robot is set up in an unapproachable environment can be competent enough for taking visuals of the place ins indirect practical form using the pi. The raspberry pi is programmed using the flask framework that acts as a local server the visuals that are captured are exhibited in a webpage. The robot set up in an unreachable place can be skilfully handled using the user's computer or mobile. The main intension in the project is to create a indirect practical reality robot which can give the user a real time involvement as if the person is in the environment. The system can allow the camera to be moved in any direction as per the user's instructions given from the web page which has the control keys. The camera module will send the video live streamed on the control page as per the user's instructions with the help of buttons on the web page. The robot can be moved in right, left, back and forward directions when user presses the buttons on the control page. Thus, the visuals of an unreachable place can be seen on the webpage.

4.3 Hardware

The hardware of the virtual telepresence robot is basically designed in such a way so that there are two compartments made to accommodate all the hardware components. The heart of the project is the raspberry pi in which all the functions are programmed. The other hardware components that have essential importance is pi cam, servo motors, motor drivers and the dc motors. For movement of the robot we have used DC motors which are driven by a motor driver. To power up the motor driver lipo batteries are used. The camera module used for surveillance is Raspberry's camera v 1.2,5 mega pixels. A pan tilt mechanism is attached with the camera module consisting of two servo motors for wider coverage in video streaming. To power up the Raspberry pi we have used a power bank. The Pi cam captures the visuals and sends it to the web page.

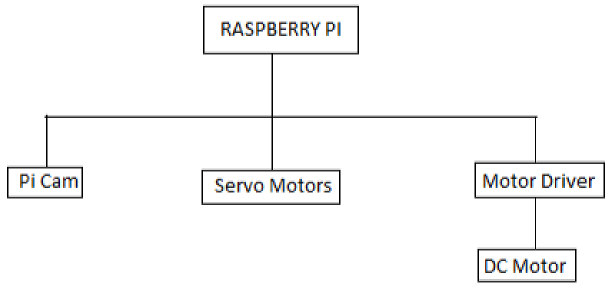

Fig. 5: Hardware

4.4.Software

A web-controlled page is set up in the frontend which is done using html, CSS and JavaScript. Html gives structure to the web page and the CSS is used for styling. To make the web page interactive JavaScript is used. Flask is downloaded in raspberry pi which is a mini computer. You can go to your browser and enter the raspberry IP address *http://YOUR_RPI_IP* to access the web page. Here through human intervention(client) takes the data and performs the necessary action. Raspberry Pi is the central component that interfaces the user that is the web page and the virtual telepresence robot over internet. The webpage is used for controlling robot movements, video capture and 180-degree camera. A web server is set up using the python's flask framework on the raspberry pi which acts as the controller with a webpage for controlling keys which includes the servo blaster library for controlling servos and the video streamer for live transmission of the video captured by the robot. The video captured by camera can be viewed on the webpage. There is a login page set up where the user is required to put correct username and password to successfully login. After successful login the user is directed to the control page where they can control the robot. It is then brought to public network from localhost using Ngrok.

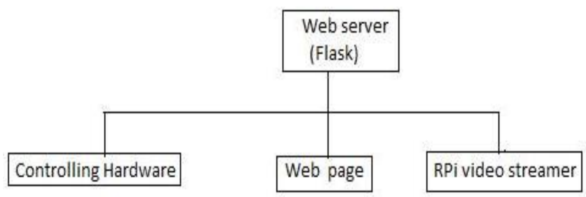

Fig. 6: Software

5. RESULTS AND DISCUSSIONS

The Virtual Telepresence Robot has been tested for navigating in a specific location of the robot. The user controls the robot from a remote place. The system runs well and the robot gives a delay of 3 seconds to transmit the MJPEG image from robot to the controller device through internet. This delay is caused due to MJPEG consumes high bandwidth. It is also seen that the latency for controlling the robot is 1 second. The delay is caused due to the speed of internet.

The web application based on Google Chromium bowser is used for the controlling the robot. Web application is interfaced with the Flask Microweb Server. In the telepresence mode the user is able to control the robot, by logging into the webpage using correct credentials, as show in the figure below.

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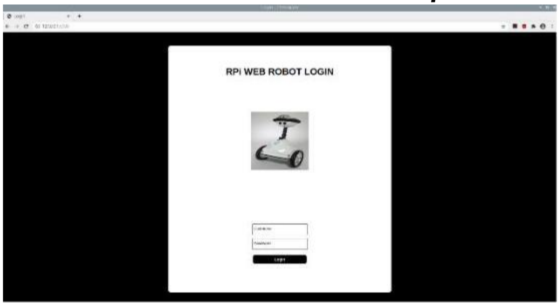

Fig. 7: Login Page for Robot control

If the login credentials are incorrect then we get a pop-up message as Invalid Username or Invalid Password as show in the fig below.

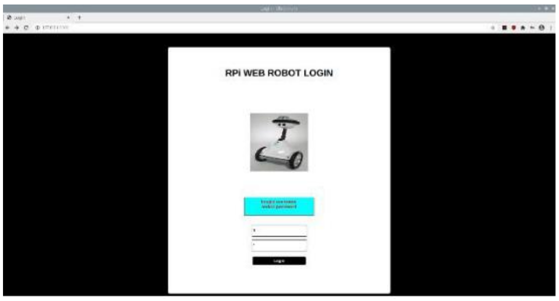

Fig. 8: Login page with invalid credentials.

After successfully logging into the webpage. The live video is available on the screen with the control buttons, as shown in the fig below.

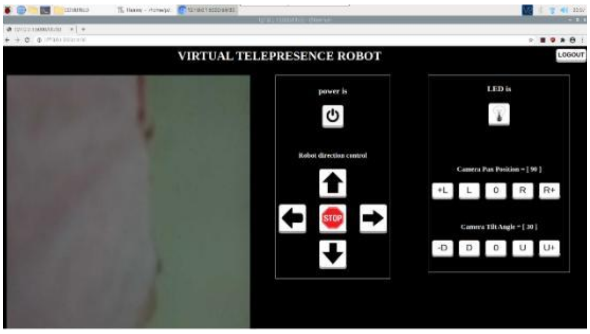

Fig. 9: Robot control page.

The virtual telepresence prototype model is built and controlled using the control page. The picture of the prototype is as show below.

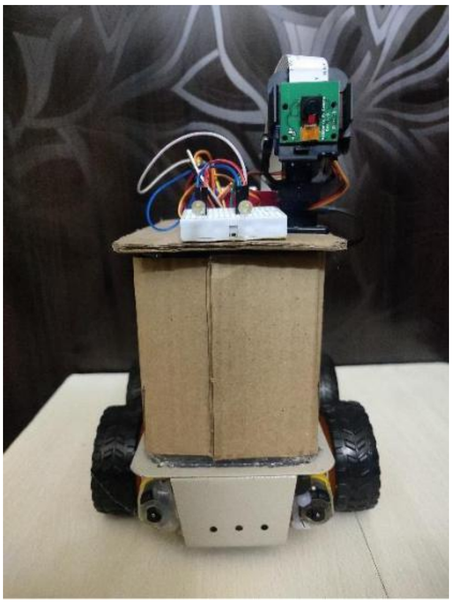

Fig. 10: Virtual Telepresence Robot Front view

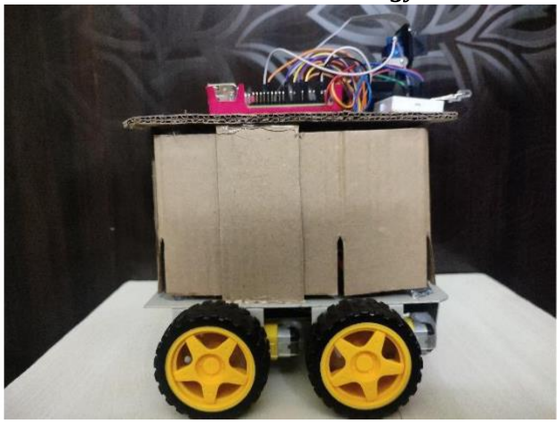

Fig. 11: Virtual Telepresence Robot Side view

Experiments were carried out to find the graph of time taken by the robot to travel for a distance of 100m with change in the load. The graph is as shown below:

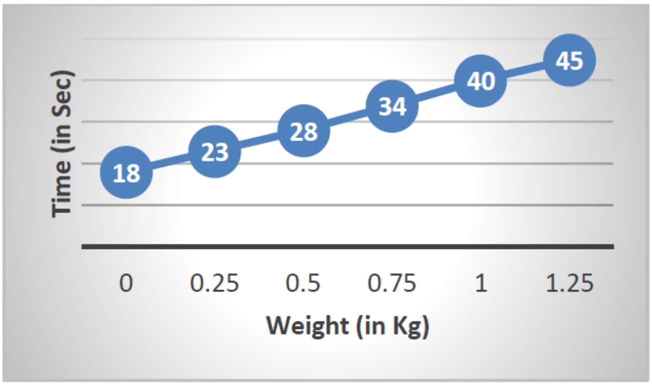

Fig. 12: Weight vs Time taken graph

From the above graph we get to known that as the weight increases the time taken to cover 100m by the robot increases.

6. CONCLUSION

After successful integration of software and hardware components of virtual telepresence robot we realized that this robot allows users to communicate and interact observe people and their surrounding environment without the need of any physical presence human operator has visible telepresence that may direct the fixed four wheeled robot from a distance using unilateral control method these robots have the abilities of changing the dynamics of a wide range of domains as these robots can help elderly people in their homes and even by allowing physically disabled students to attend classes virtually these virtual telepresence robots have the ability to reduce the requirements of business travellers to travel to meetings from their respective places as a results this intelligent robot offers a straight forward cost effective and effective solution to a variety of real world issues and problems faced by people.

7. ACKNOWLEDGEMENT

Every project that is started and completed in a systematic manner is a success. This work, like any other, necessitates the collaboration of many people. This project was tough for a variety of reasons, some of which were beyond our control, such as error correction. We felt like a rudderless boat at times, unsure of what to do next. The timely direction of that has seen us through all of these challenges. They have been a source of inspiration, support, and advice for us throughout the project.

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