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Virtual Telepresence Surveillance Vehicle

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Abstract:
Telepresence systems are playing an important role in various fields which impacts our day to day task and working. It finds applications in the fields of education, health sector, business, meetings and conferences. The major advantage of telepresence system is that it eliminates the time dependent factor distance for the real world so that interaction with each other is possible instantly. With the transition in innovation in the field of technology due to growth of AI, ML and fast growth in the field of robotics, enough opportunities are available to explore the field of Robotics. These technologies are enhancing the capabilities of humans as well as robots. As the components involved are complex and needs to deal with complicated physics it is important to understand the phenomena within the actions that a robot makes. The paper discusses classification of telepresence robots developed. Information from some prominent literature regarding various robots based on different technologies is summarized. This paper also describes how to design a virtual telepresence surveillance vehicle using Raspberry Pi and the incorporation of sensors in the vehicle.

Keywords: *Telepresence, Raspberry Pi, Artificial Intelligence (AI), Machine learning (ML)*

I. INTRODUCTION

Surveillance vehicles are vehicles which allows us to have a close watch of any place or objects of interest remotely and also in difficult situations such as adverse weather and difficult physical conditions [1]. Telepresence system is a combination of audio, video aids along with network conferencing technologies and services to have real time experience of communication [2]. It is a tool for teleconsultation[3]. A virtual telepresence surveillance vehicle places the user to another location of interest in a matter of few seconds. Mobile robotic telepresence offers rich capabilities for human-human interaction [4].Telepresence system provides immersive visual experience [5].It can be a mobile device controlled vehicle allowing users to have real time communication from two different locations.

Various applications of a virtual telepresence surveillance vehicle include monitoring of its surroundings, monitoring of classrooms as well as offices. It can access remote locations and identify any threats if present. It acts as a guard dog which captures all the images and relays it through the website. It also displays temperature and humidity thus helping us to determine the weather outside or the atmosphere of the place at which it is present.

Lot of work has been carried out in order to design various types of telepresence robot using different

components and technologies. A detail study of latest work was carried out and is summarized in the next section.

II. Classification Of Telepresence Devices

The Telepresence Devices are classified based on (a) Technology used (b) Power source used (c) Microcontroller used (d) Application (e) Telepresence (f) Hardware. The detail classification of various telepresence devices has been shown in Figure 1. and further the working principle, merits and demerits of prominent types of telepresence devices are discussed.

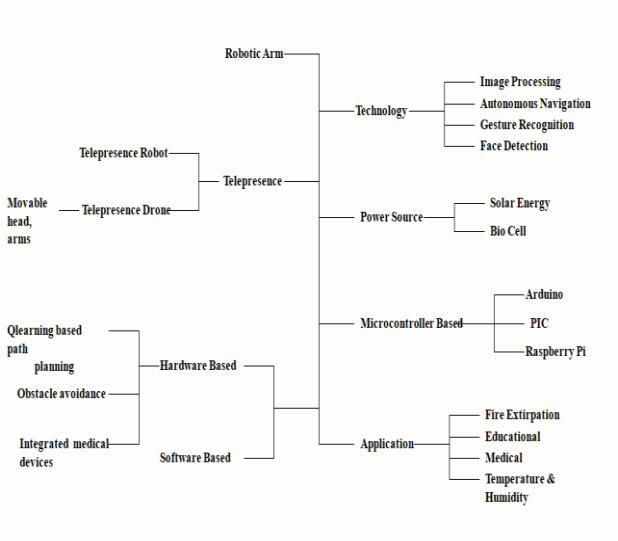

Figure 1: Classification Chart of various Telepresence devices

III. Literature Review

All the work carried out for developing the telepresence system can be classified into three groups:

(a) Studies related to modification in design of Telepresence Robots
(b) Studies related to autonomous motion of Telepresence Robots
(c) Studies related to Robotic Arm

Berri et al. (2014) [6] interfaced and designed using a Kinect sensor as the main perception/interface device a Telepresence Mobile Robot. The main feature of this Robot was its ability to interact with the humans more effectively and efficiently by detecting the human face and their exact position using camera and image processing.

Rezecke et al. (2013) [7] for telepresence developed a prototype of a robotic system, consisting of a robotic avatar, providing virtual presence of the user and a program to control the robotic system.

.Ching et al. (2016) [8] created "Expression Display & Gesturing Avatar Robot" (EDGAR) an anthropomorphic telepresence humanoid. It was developed for telepresence application having 28 degrees of freedom mimicking the movement of the user.

Budiharto and Suhartono (2015) made a prototype of intelligent service robot in indoor environment with voice recognition and telepresence capabilities [9].

Carranza et al. (2018) [10] developed a telepresence system which included a telepresence robot called Akibot with integrated medical devices such as otoscope, stethoscope, and ultrasound probe.

Janard and Marurngsith (2015) [11] designed a telepresence robot that can effectively perform face detection in real-time which is an essential procedure for achieving autonomous motion in telepresence robots.

Popa et al. (2008) [12] designed solutions related to the problems related to the navigation of the mobile robots requires which are, to determine the current position, action planning and to avoid obstacles. It was designed for the mobile robot to navigate indoors.

Shojio et al.(2016) [13] demonstrated a self-powered environmental monitoring robot with a biofuel cell (BFC) and a micro wireless sensor module on insect. Szabó and Sfirat (2016) [14] designed a robotic arm control, with color

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recognition which was implemented on a Raspberry Pi.

Bae (2016) [15] designed a prototype of drone technology for the representation of a person as a drone pilot.

A similar attempt is made by us to design a Virtual Telepresence Surveillance Vehicle which will have telepresence feature along with sensors to capture physical parameters of any remote location where the surveillance vehicle is present. A detailed explanation of all the various aspects involved in the designing of our prototype is discussed in the next section.

OBJECTIVES

The main task of our prototype is to have virtual Telepresence Surveillance Vehicle that is able to provide live feed of the remote location in form of video i.e. have telepresence feature along with ability to capture images of the place where the vehicle is situated and provide $180^{o}$of view. It determines the temperature and humidity of the location, along with presence of any smoke via temperature and smoke sensor respectively. These sensors data can be accessed via end user devices such as mobiles, tablets, PC's and laptops connected on the same network.

One of the objectives is to detect the objects and identify human beings and animals with the use of Image Processing. It should be able to perform simple task of pressing a switch, our shifting light weight objects via robotic arm. In next section the hardware and software description of the designed prototype is presented.

IV. SURVEILLANCE VEHICLE

The designed virtual telepresence surveillance vehicle is based on Raspberry pi as is main controller which acts as the brain of the vehicle. The vehicle is controlled via Wi-Fi network with the help of ESP8266 IC, which is wireless enabling technology at low price but packed with a bunch of hardware capabilities [16]. The vehicle has a 5MPcamera to capture the images and video of the remote location. The camera is attached to a servo motor which allows 180^{o} rotation ability to the camera. It also has Digital Temperature and Humidity sensor along with smoke sensor to record the physical parameters.

The block diagram of the prototype is give below:

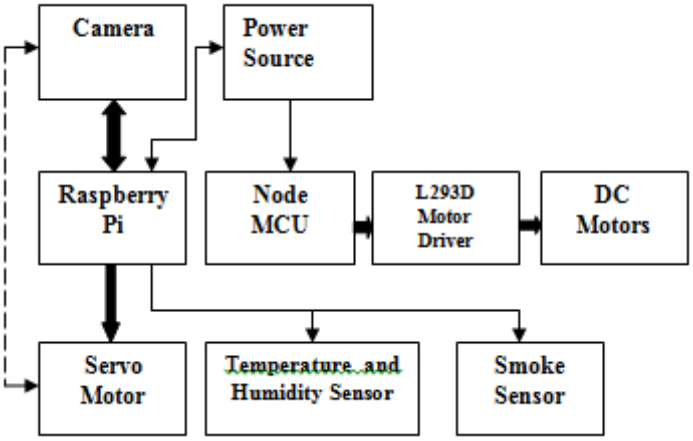

Figure2: Block Diagram of the prototype

A. EQUIPMENT USED

Raspberry Pi: It is implemented on a single board featuring BCM2835 chip. It has 700 MHz processor. Model B is used having 512MB RAM. A Video Core IV GPU is used. GPIO pins of Rpi, enable the user to get the data from outside world as inputs and processes these inputs to give the output back to the user [17].

Digital Temperature and Humidity sensor: The DHT22 sensor calculates the temperature and humidity of a location. It is low cost and versatile sensor. It has a range of 20m. It has an analog to digital converter in it, making it easier to interface with Rpi. The DHT11 has sampling rate of once per second whereas DHT22 has a sampling rate of once per 2 second.

Smoke Sensor: The MQ-x series of smoke detectors work well with Raspberry Pi. MQ-7 smoke sensor is capable of providing analog and digital output. The digital output pin indicates

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the presence of CO. The CO level is measured via analog output by performing analog to digital conversion with the help of an ADC.

Servo Motor: It belongs to the family of DC motor which can rotate from 0-180 degrees when a signal of particular frequency is applied to it.

WORKING

This telepresence surveillance vehicle consists of 4 wheels which ensure that the device moves in the required direction. The movement of the vehicle is controlled through mobile which sends the instruction to Node MCU which is operating on the same network as that of the vehicle. The Node MCU is connected to L293D which is a motor driver which ensures that the vehicle moves in the desired direction.

The vehicle also has a camera attached to its head which gives us real time data. The image from the camera is displayed on a web page which can be accessed from cell phones, PC's as well as laptops. The head of the vehicle is attached to a servo motor which enables us to view a 180 degree view of the place at which the vehicle is present. The servo is controlled using the Raspberry Pi installed in the vehicle whose interface is controlled using a desktop/laptop and can be enabled as and when the user wants it.

The vehicle also has a temperature and humidity sensor which is interfaced with the Raspberry Pi and displays the data on the user interface. The vehicle has a smoke detector which is again interfaced with Raspberry Pi and displays 'Action is detected' whenever it detects any smoke.

B. SOFTWARE IMPLEMENTATION

The interfacing of sensors as well as programming of Raspberry Pi is done using Python. The operating system of Raspberry pi used is Raspian Os which is based Linux. The live camera feed was transmitted to the webpage using RPI Cam Web Interface V.6.

V. RESULT

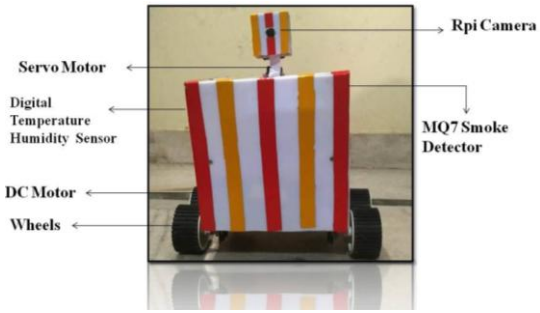

Figure 3 Prototype of Virtual Telepresence Surveillance Vehicle

The Figure 3 is the actual designed prototype of the Virtual Telepresence Surveillance Vehicle.

The Vehicle was tested with a local network, where the vehicle was controlled via Wi-Fi with the help of mobile app and the output of camera and the sensor were obtained on the web page of the browser and the terminals on the laptop respectively

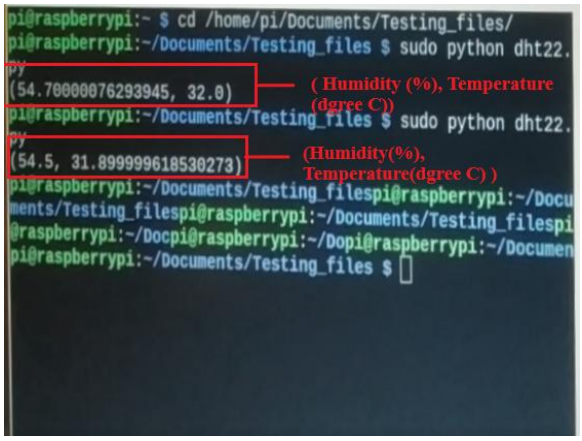

Figure 4: Output terminal of sensors displaying Humidity and Temperature.

VI. CONCLUSION

The prototype of Virtual Telepresence surveillance vehicle was designed with incorporating features of telepresence robots along with the interfacing of the sensor. The results

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obtained are satisfactory but with the incorporation of the more features as mentioned in the future scope the vehicle is guaranteed to be more efficient and beneficial for the surveillance purpose.

VII.FUTURE SCOPE

This vehicle can further be updated by using image processing which will help in identifying objects, places, persons, etc. Machine learning (ML) which allows computer to simulate the behavior of human being can be used to make the vehicle autonomous [18]. It can also be developed to work on different networks so that it will send the data to a server from where we can access it. It can also be attached with solar panels which will ensure that it is self-charged and not depend on human interference for charging its power supply.It can also be enhanced by interfacing with Google Assistant, Alexa, Siri. It can also have a microphone and speaker making it a virtual assistant and a human companion which can also deliver messages. A screen can also be added to display recorded videos, data, also conduct video conferences. An arm can also be incorporated which can hold objects or perform certain operations.

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