SMART ROBOT USING RASPBERRY PI AND NODEMCU

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ABSTRACT

This research paper is based on a smart robot which is made to monitor and check the situation of your home live from remote place through the internet. The main purpose of this research paper is to mention the sources or technology used to make this robot. This robot contains one Raspberry Pi and NodeMCU as the central unit. The camera is connected to Raspberry Pi which will stream live videos to the internet. All the motors and sensors are connected to the NodeMCU microcontroller. We have developed one android based mobile application to monitor live video and simultaneously control the motor of the robot. The main aim of our project is to check the safety of home with Artificial intelligence (AI) features like Google assistant which can be used when we are at home. The user is also notified through app notification or email when battery of robot is low or any suspicious gas is detected.

Keyword: *Smart Robot, Surveillance Robot, Raspberry Pi, NodeMCU, Raspberry Pi camera, Gas sensor, IoT, AI*

1. Introduction

Nowadays security of home or office is a major concern. The current CCTV system has many limitations e.g. it can monitor only a particular area and is very costly for personal use. Also, there are no extra security features so we made the smart robot which is Internet of Things (IoT) and Artificial intelligence (AI) based technology. Smart Robot is made for frequent travelers who want to monitor and check the situation of particular place remotely through the internet. The robot has a camera for live video streaming to the mobile application and user can control the movement of the robot like forward, reverse, left or right from the same application [9-11]. Apart from this we have also embedded variety of sensors for security and data analysis [2]. The sensor data can be viewed on a separate tab of the application. There is a cool offline feature which updates the user through email or SMS when any suspicious gas is detected or voltage of the robot battery decreases below threshold level [12]. The smart robot has AI features like Google assistant which can be used when the user is at home or office [8]. Raspberry Pi and other components of the project are protected from heat by using a fan which automatically turns on when the temperature rises. This robot is having two layers of hardware used and is very compact in size [1].

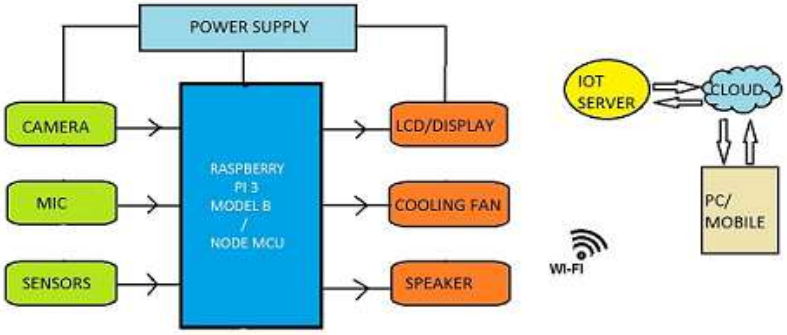

Fig -1: Functional block diagram of the system

2. System Components.

2.1 Raspberry Pi 3 model B

Raspberry Pi 3 model B has quad-core 1.2GHz Broadcom processor with 1GB RAM. It has 40 pin extended GPIO pins [3]. It has inbuilt wifi and Bluetooth which will give wireless internet connectivity to our project. It has four USB ports and stereo output for audio. We have used these for Google assistant. It has camera serial interface (CSI) port for connecting Raspberry Pi camera. It has a micro SD card for loading an operating system and storing data.

2.2 NodeMCU microcontroller

NodeMCU is open source IoT platform [4]. It has inbuilt ESP8266 wifi module which will give internet connectivity to control the GPIO pins. It has nine digital GPIO pins and only one analog pin. We have used NodeMCU for controlling motors and reading sensor data. It also sends PWM signals to control the servo motors. NodeMCU can be connected to the server by writing relevant authentication code and server hostname in the program.

2.3 Shift Register IC (SN74HC595)

As there are limited GPIO pins available in NodeMCU, we have used shift register IC. Using this IC we can control number of devices with three pins of NodeMCU [5]. Here in our project, we are controlling seven output pins which include two servo motor, two DC motors of the robot and a torch.

2.4 Raspberry Pi camera

We are using 5MP Raspberry Pi camera module. It is capable to shoot 1080p videos at 30 frames per second [6]. The frame rate and resolution can be set according to the internet speed. For better clarity frame rate should be high but it is at cost of the higher data rate.

Fig -2: Raspberry Pi camera

2.5 Mic and speaker

For Google assistant, we need a USB mic and speaker. The mic will take our audio signal as input. On the basis of questions asked to Google assistant we get answers from same via speaker of the robot. The audio output coming from Raspberry Pi is very weak so we need to amplify it. We have used TDA 2030 audio amplifier for amplifying the signal before sending it to the speaker.

2.6 L298N Motor Driver

L298N is a high voltage, high current dual H-Bridge motor driver [7], it can drive the motors which can be controlled in both direction, clockwise and counterclockwise. L298N motor driver has four inputs and outputs pin so that it can drive two DC motors. The DC motors of robot run on 12V supply so we need a motor driver L298N which accepts TTL logic from NodeMCU and drive motors.

3. Hardware Description

3.1 Circuit diagram

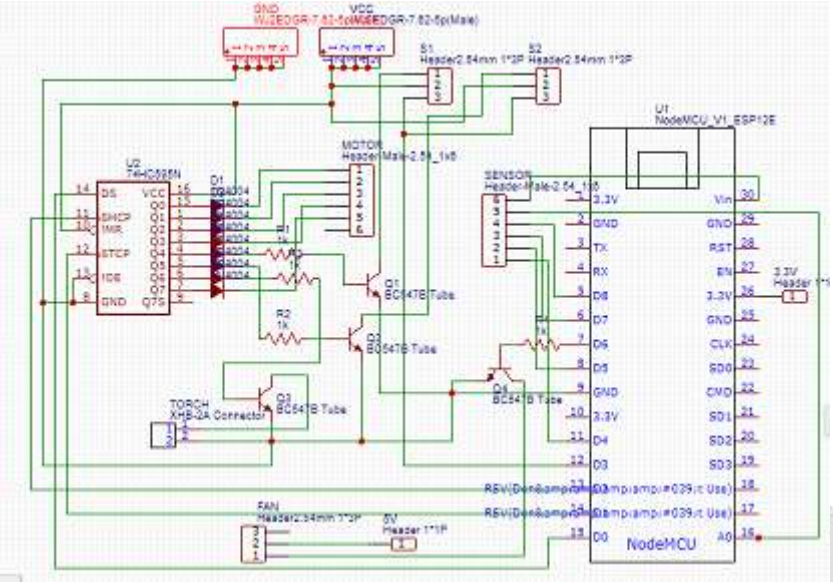

Fig -3: Schematic diagram of PCB

The above circuit diagram is to control the motors and read sensor data from NodeMCU. All the DC motors are controlled through a shift register IC and switching of the servo motors are done by a 2N2222 transistor. Power can be saved as servos get supply only when we click pan/tilt ON button in the mobile application. The control signals of servos are given directly to the NodeMCU. Male connectors are given to connect sensors to the NodeMCU and to give 5V power supply to the board. There are also input ports to connect torch and fan in the circuit.

3.2 Smart Robot

From the side view of robot as shown in figure 4, you can see the camera is mounted on Pan-tilt servo motor so it can monitor a wide area via Pan-tilt control in the mobile application. The robot also has mic and speaker mounted on the second layer. The mic is connected directly to Raspberry Pi while the speaker is connected to audio amplifier board, which gets input from Raspberry Pi. The two metal terminals are for charging the battery of the robot. There is also torch above the camera for night view.

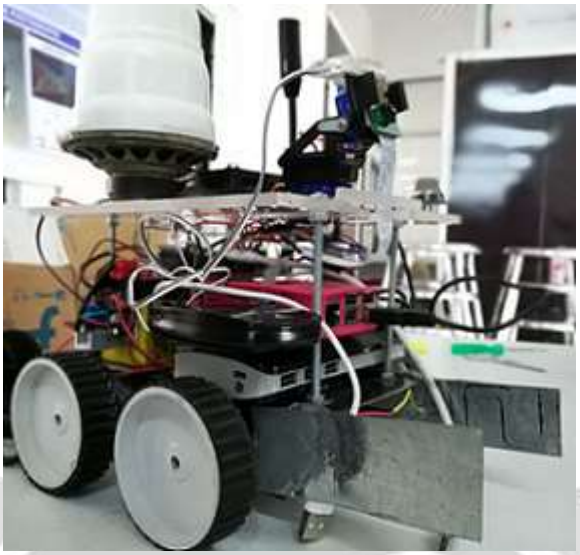

Fig -4: Side view of Smart Robot

3.3 Charging station

It is obvious that when we are outside home/office we cannot charge the battery of the robot. For its charging, we have made charging station, two metallic terminals of the charging station are connected to the 12V DC adaptor which is connected to the main ac supply. So when battery level decreases below a threshold level, user will receive email or notification. After that, by watching live video and controlling robot we can park our robot to the charging station.

Fig -5: Front view of charging station

4. Software Description

4.1 Arduino IDE

Arduino software is an open-source prototyping platform. It can be used to program NodeMCU and other ESP8266 boards. The programming language of Arduino is very simple to understand. There are a lot of libraries available online for various sensors and open source IoT platforms. Serial monitor is another terminal window used for debugging purpose and to send or receive serial data.

4.2 Android application

To control the movement of the robot and to watch the live streaming video we have developed one android application. In first tab of the application, one can control the motion of DC motors and servo motors mounted for Pan-tilt camera. The switching of both servo motors can be handled along with the torch. By varying the slider position, we can change the position of the servo motor. After scrolling down, there is a button for 'offline mode' and another button to move to the second tab of application. On the second tab of application, you can monitor real-time sensor data values like temperature, humidity, gas levels and voltage of the robot battery.

Fig -6: Screenshot of application

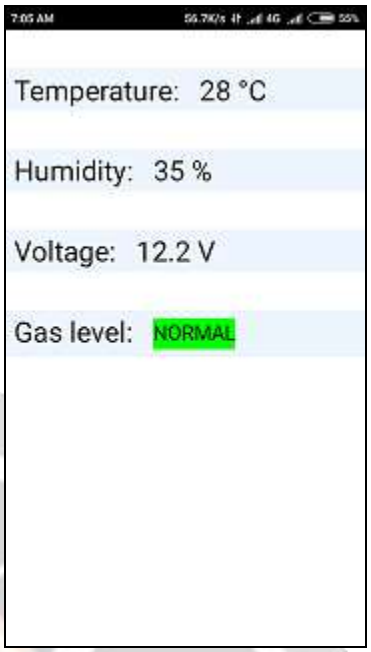

Fig -7: Screenshot of second tab

5. WORKING OF THE SYSTEM

First, when user gives command from the application that command goes to the server. Our NodeMCU and Raspberry Pi are connected to their respective server. As soon as when a command is received at the server, NodeMCU will take this as input and execute the task accordingly. So everything is connected to the internet. There is a fan on top of the robot; it is for cooling the Raspberry Pi and other components. The fan automatically turns ON when the temperature goes beyond set value. The temperature and humidity values are obtained from DHT11 sensor, whereas gas concentration in air is measured from MQ2 Gas sensor. Voltage reading is obtained from voltage sensor. When "offline mode" button is pressed user gets updates via e-mail or SMS if any sensor value increases or decreases beyond the set threshold value.

6. RESULT AND ANALYSIS

After trying different methods like installing Lighttpd and Blynk servers we got better result using Dataplicity service. We also tested YouTube live video streaming from Raspberry Pi and then converting that link to downloadable form using youtube-dl command. Then pasting that converted link in video streaming widget of Blynk application. But we found 10-20 second delay in the live video stream. Now using Dataplicity we are getting approximately 1 second delay for the same in our application. Controlling the robot initially through our application gave approx 500 millisecond delay. After including different sensors, servos, and torch, we got 1-2 second delay due to the increase in the amount of these data. Practically we found Google firebase faster than others IoT platforms.

7. CONCLUSION

The smart robot is designed in such a way that it can fulfill the needs of frequent travelers and security personnel. This robot has multiple features which will give more security to any place. The real-time video streaming with a robot is made possible through an android application. There are varieties of sensors for analyzing the current situation, a lot more can also be added according to the need. Everything can be controlled and monitored using single mobile application from any part of the world. Moreover, the user can taste the latest artificial intelligence technology at home. This 'Smart Robot' is definitely going to make life a lot more secure and comfortable than before.

8. FURTHER EXTENTION

1. In this project, we have used two controllers, one is Raspberry Pi which itself is a single board computer and other is NodeMCU. Use of these two controllers can be reduced to one i.e. Raspberry Pi only.
2. Here we have used two power supplies for our project. One is a 12V lead acid battery for DC motors, amplifier and other one is power bank for NodeMCU and Raspberry Pi which can be reduced to a single high capacity 12V battery.
3. More smartness can be added like auto human/object detection and identification using Image processing etc.

9. ACKNOWLEDGEMENT

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10. REFERENCES

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