ROBOTIC SURVEILLANCE ROVER

Kumar Kunal, Dept of CSE, National Institute of Engineering, Mysuru, Karnataka, India

Mohamed Suheab, Dept of CSE, National Institute of Engineering, Mysuru, Karnataka, India

Keval S Borkar, Dept of CSE, National Institute of Engineering, Mysuru, Karnataka, India

Kiran HS, Dept of CSE, National Institute of Engineering, Mysuru, Karnataka, India

Abstract

In this paper, we are aimed at developing a cost effective, surveillance robot, which will provide live video streaming and move around in the area which we want to observe [1]. It has an obstacle detection ultrasonic sensor attached to it. It will be monitored and controlled remotely having a simple architecture. The Android application will have a video screen for surveillance and buttons to control robot and camera. Android device and Raspberry pi board will connected with the help of Wi-Fi. We are using Motion package which will provide live video streaming. Python programming language is used for coding purpose. The biggest advantage of the system is that user can access the robot from anywhere in the world and can respond according to situations [2].

Keywords : *Android Application, Mini Rover, Python, Raspberry PI 3 Model B+, Ultrasonic Sensor, Video Surveillance, Motion, Flask*

1. Introduction

In our modern day to day life, security and surveillance plays a very pivotal role. An effective security and surveillance system can provide crucial early warnings in case of any kind of emergency. The application has wide range of purposes like traffic monitoring, understanding human activity. However, if the surveillance system is capable of roaming inside the area of surveillance, more area of interest can be observed with optimum number of surveillance equipment under constrained budget. Surveillance camera helps the user to get a remote view of his home and the sensor networks add extra security features depending on the type of sensors [3]. These types of robots are more flexible than the fixed cameras.

The wheel based robots are more suitable for flat platform. With the development in wireless communication and internet, the videos captured by wheel robot can be seen remotely on computer, laptop or a mobile phone. With the development in wireless communication and internet, security systems are rapidly improving. This paper describes a method for controlling a robot using a Smartphone. The main unit of robot is Raspberry Pi. Using motor driver IC two stepper motors are connected to the GPIO of Pi. Servomotor is used for the tilt motion of a camera. An application is built for Smartphone. The application from Smartphone will have a screen for video streaming and buttons for the movement of robot and camera. In this paper we present a robotic rover with simple architecture by assembling open source hardware and advanced sensors. An android app running on a remote device is used to access the sensor's data mounted on the rover.

2. COMPONENTS USED

2.1 Raspberry PI 3 Model B+

The Raspberry Pi is a low cost, credit-card sized computer. It is a capable little device that enables people to learn how to program in languages like Scratch and Python. It consist of an in-built Wi-Fi, 1 GB RAM, 1.2 GHz processor, 4 USB ports & GPIO pins.

2.2 Ultrasonic Sensor

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. We will use this sensor to detect and avoid obstacles while our rover is moving autonomously. This calculation can be formulated as follows

Distance = (speed of sound * time taken) / 2

Fig 2.2 Ultrasonic Sensor

2.3 L298N Motor Driver IC

The L298 is an integrated monolithic circuit. This allows you to control the speed and direction of two stepper motors. The L298N H-bridge module can be used with motors that have a voltage of between 5 and 35V DC. These L298 H-bridge dual motor controller modules are inexpensive.

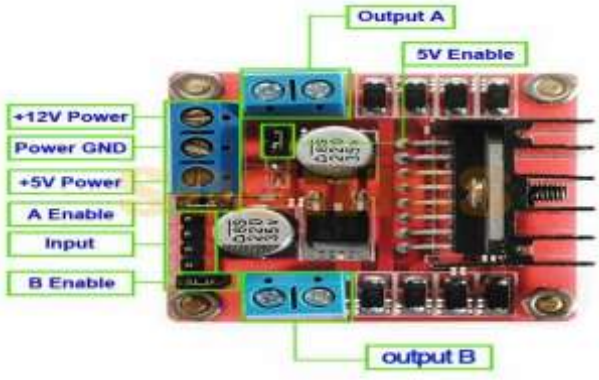

Fig 2.3 L298N Motor Driver IC

2.4 Stepper Motor

A Stepper motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. They have the advantage that they can be positioned accurately, moved forward or backwards one 'step' at a time, but they can also rotate continuously. It is low cost for control achieved, has high torque at startup and low speeds and can be used in robotics in a wide scale.

Fig 2.4 Stepper Motor

2.5 Lead Acid Battery (12V)

We will use a 12V lead acid battery to power up the L298N motor driver ICs.

2.6 Raspberry Pi NoIR camera V2

The Raspberry Pi NoIR Camera Module is a custom designed add-on for Raspberry Pi. It has a native resolution of 8 megapixel. The camera is capable of 2592 x 1944 pixel static images and also supports 1080p30, 720p60 and 640x480p video.

Fig 2.5 Raspberry PI NoIR Camera V2

2.7 Tower Pro Servomotor SG90

It is tiny and lightweight with high output power. Servo can rotate approximately 180 degrees, (90 in each direction), and works just like the standard kinds but smaller.

Fig 2.6 Servomotor

3. SOFTWARE AND LANGUAGES USED

3.1 Raspbian OS

There are several different operating systems for the Raspberry Pi [5]. Among these, Raspbian stands out to be the most popular Debian Linux based operating system for the Raspberry Pi.

3.2 Python

In the context of our project, Python is the best programming language that can be used to allow the Raspberry Pi to interact with user or client.

3.3 Android Studio

Android Studio is the official IDE for developing android applications. It provides the fastest tools for building apps on every type of Android device.

3.4 Flask

A web server is created using Flask, which provides a way to send the commands from webpage to raspberry pi to control the robot over the network. Flask allows us to run our python scripts through a webpage and we can send & receive data from raspberry pi to web browser and vice versa. Flask is a micro framework for Python. This tool is Unicode based having built-in development server and debugger, integrated unit testing support, support for secure cookies and easy to use. These things make it useful for hobbyist.

3.5 Motion

Motion (Surveillance Software), which is the heart of this project. Motion is free, open source motion detector CCTV software, developed for Linux. It detects the motion and start recording video of it. With Motion installed in raspberry pi we can magically turn your raspberry pi into a security camera and can get the following functionalities :

1. We can watch live Video feed on web browser by entering IP address of PI along with the port.
2. It will record and save the video whenever it detects motion or any disturbance in the view area. It will keep recording the video until there is some motion, then it stops and save the file, which can be watched later.

4. SYSTEM ARCHITECTURE

Alongside the major hardware mentioned previously, we used the following miscellaneous items to implement our project :

1. A robust encasing for protecting the raspberry pi.
2. Jumper cables.
3. Acrylic sheet and caster wheels for stability of the robot.
4. Wooden encasing.

After obtaining all the necessary hardware and accessories, we began to setup and connect the hardware together for the rover. After enclosing the RPI3 inside a protective plastic casing, we established required connections between RPI3 GPIO pins and L298N input pins as shown

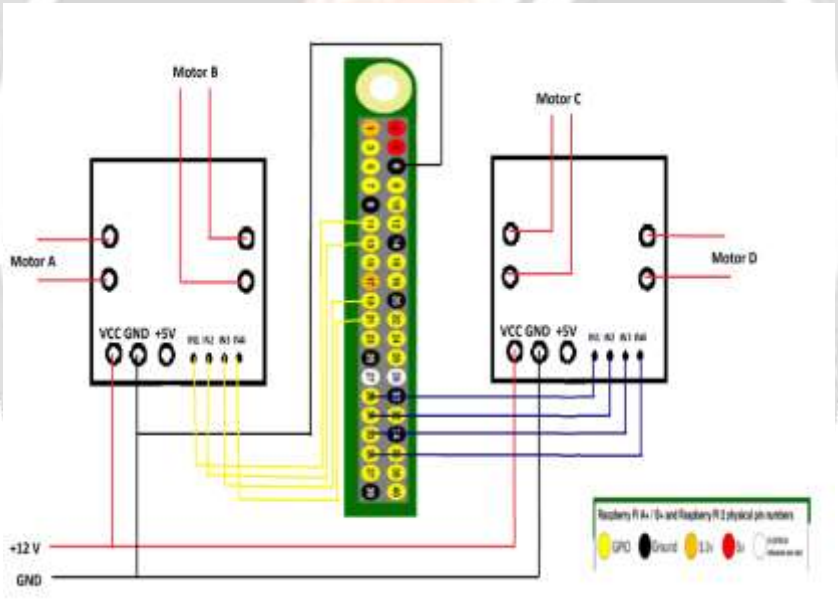

Fig 4.1 Connections between RPI3 GPIO pins and L298N

After connecting the 2 stepper motor attached to chassis with the motor controller, we then motor controller with raspberry pi 3's GPIO pins we then attached all the connected hardware so for on the RC car as shown in Fig . Power bank is connected with Raspberry PI at the last stage of hardware assembly to supply power. After powering the Raspberry PI, we tested the code for stepper motor to run for each direction, which was initially controlled by the user from laptop (testing purpose).

After we achieved movement control remotely, ultrasonic sensors and camera module (includes night vision) were tested for adaptability issues. At the front end of robotic car an ultrasonic range detector modules is attached which detects the obstacle at a distance of 5 cm during motion in forward direction. We also have developed an android application which runs on the android device, used for video feed, directional motion control of the car and to access sensor mounted on it.

Fig 4.2 Video Feed from application

Then, we connected the rover and application over same Wi-Fi network to access the video feed and rover's movement control panel [4]. Later, the same setup was designed and built to access the video feed and rover movements over different networks which is the main agenda of this project [6]. In our project this is achieved by port forwarding. Port forwarding is an application of network address translation (NAT) that redirects a communication request from one address and port number combination to another while the packets are traversing a network gateway, such as a router or firewall. When configuring port forwarding, the network administrator sets aside one port number on gateway for exclusive use of communication with a service in private network, located on specific host. [8] External hosts must know this port number and address of the gateway to communicate with network internal service. Often the port numbers of well-known internet services such as port number 80 for web services (HTTP), are used in port forwarding, so that common internet services may be implemented on hosts within private network. The below diagram illustrates a scenario where port forwarding is used.

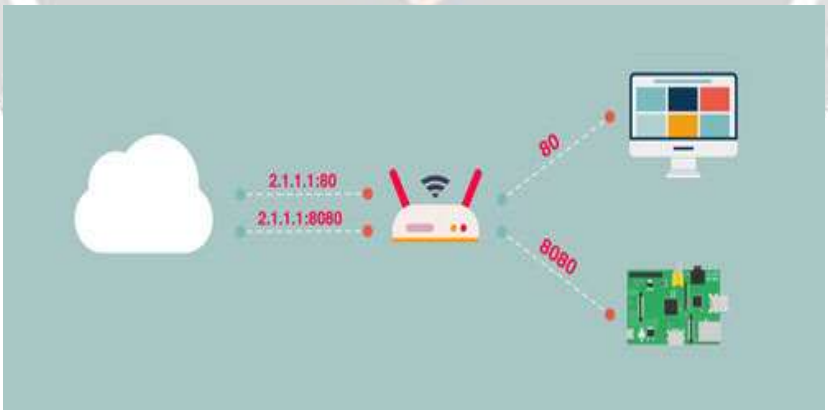

Fig 4.3 Port Forwarding

Below figure depicts the workflow of system. As soon as the Raspberry Pi gets power it starts initializing the IP address allocated to application and establishes connection with the Wi-Fi [7]. Once it gets connected successfully, it remains idle until the user sends any command to it. After receiving command the Raspberry Pi decodes the command and starts capturing the video with required robotic motion.

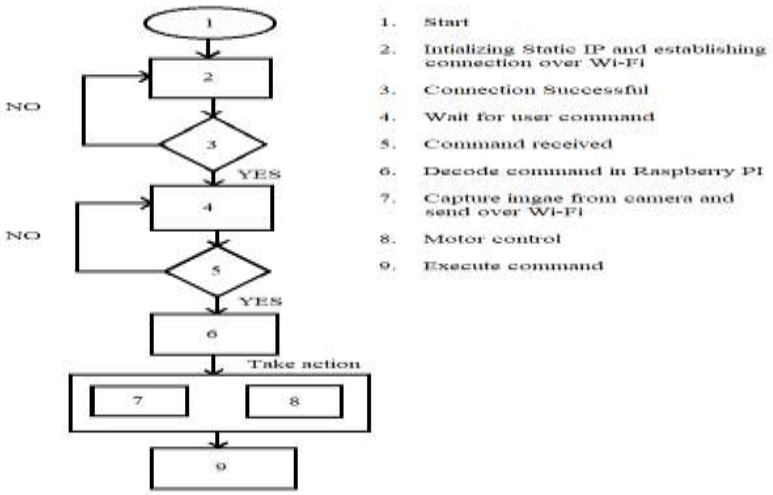

Fig 4.4 Workflow Diagram

Below Snapshot and block diagram shows robotic car with various sensors [9], including mobile phone and configured camera module of the raspberry pi

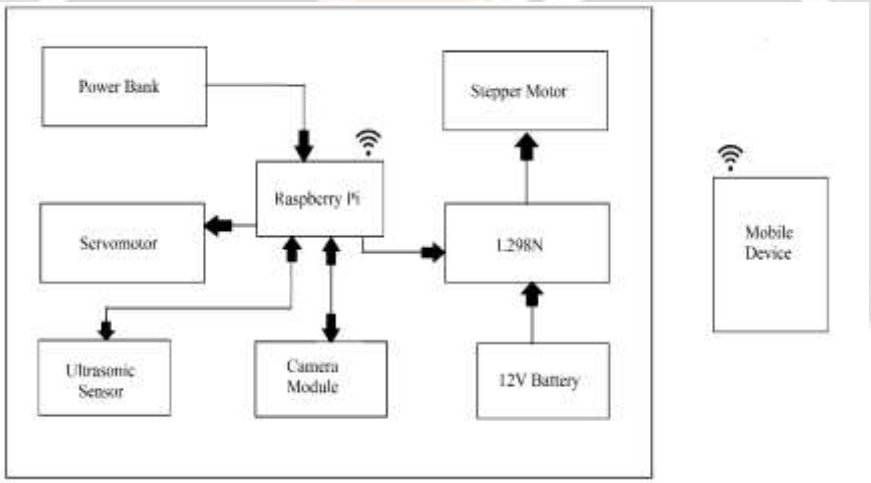

Fig 4.5 Block Diagram

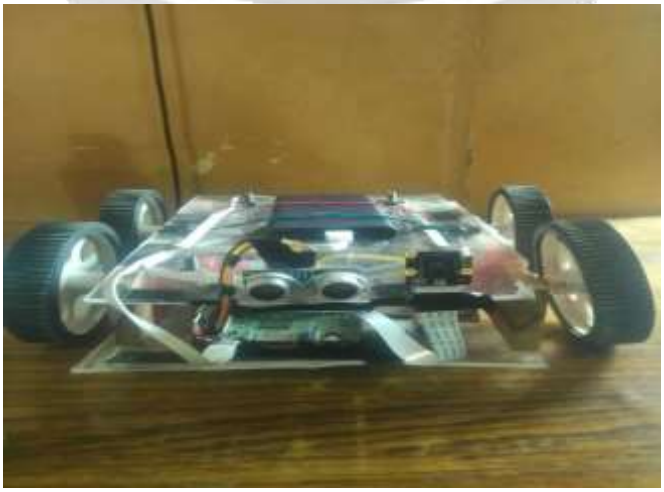

Fig 4.6 Snapshot of Rover

5. CONCLUSION

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's home should not be left behind.

6. REFERENCES

[1] 'The Internet of Things' Thing by Kevin Ashton' – Retrieved from http://www.rfidjournal.com/articles/view?4986.

[2] Fahim Slauddin and Tarif Riyad Rahman. "A Fuzzy based low-cost monitoring module built with raspberry pi – python – java architecture". International Conference on Smart Sensors and Application (ICSSA), 2015.

[3] Valeria Loscri, Nathalie Mitton, and Emilio Compagnone. "OpenCV WebCam applications in an arduino-based rover". International Workshop on Wireless Sensor, Actuator and Robot Networks (WiSARN), Jun 2014, Benidorm, Spain. 2014.

[4] Dadi Anil Kumar and Mrs.Dr.M.Sangeetha. "Controlling raspberry pi rover through any smart device using web browser via WLAN/ internet". International Journal of Science, Engineering and Technology Research (IJSETR), Vol. 4, Issue 4, April 2015.

[5] Harrington, N. 'Learning Raspbian'. Packt Publishing – ebooks Account.2015.

[6] Christian Hernandez, RacielPoot, Lizzie Narvaez, Erika Llanes and Victor Chi, "Design and Implementation of a System for Wireless Control of a Robot," International Journal of Computer Science, 7(5), 163-169.

[7] A Real-time Surveillance Mini-rover Based on OpenCV-Python-JAVA Using Raspberry Pi 2 Nazmul Hossain, Mohammad Tanzir Kabir, Tarif Riyad Rahman, Mohamed Sajjad Hossen, Fahim Salauddin, 2015 IEEE International Conference on Control System, Computing and Engineering, 27-29 November 2015, Penang, Malaysia.

[8] Video Surveillance Robot Control using Smartphone and Raspberry Pi, Ashish U. Bokade and V. R. Ratnaparkhe, 978-1-5090-0396-9/16/$31.00 ©2015 IEEE.

[9] Android application based monitoring and controlling of movement of remotely controlled robotic car mounted with various sensors, Debarun Chakraborty, Kangku Sharma, Ram Kishore Roy, Hidam Kumarjit Singh and Tulsi Bezboruah, 978-1-5090-2889-4/16/$31.00 ©2016 IEEE.

[10] Wi-Fi Enabled Home Security Surveillance System using Raspberry Pi and IoT Module, Sruthy S, Sudhish N George, Member, IEEE, 978-1-5386-3864-4/17/$31.00 © 2017 IEEE.