

Video Surveillance Robot Control using Smartphone and Raspberry Pi

Ashish U. Bokade and V. R. Ratnaparkhe

Abstract—This paper proposes a method for controlling a wireless robot for surveillance using an application built on Android platform. The Android application will open a web-page which has video screen for surveillance and buttons to control robot and camera. Android Smartphone and Raspberry pi board is connected to Wi-Fi. An Android Smartphone sends a wireless command which is received by Raspberry pi board and accordingly robot moves. The Video Streaming is done using MJPG streamer program that gets mjpeg data and sends it through a HTTP session. The Raspberry pi programming is done in python language. The experimental result shows that the video streamed up to 15 frames per second.

Index Terms—Android Application, Robot, Raspberry pi, Surveillance.

I. INTRODUCTION

THE video surveillance has played supreme role in the research of last few decades. The application has wide range of purposes like traffic monitoring, understanding human activity. In [1] author has stated that, different kind of cameras is used for surveillance like fixed cameras, and pan and tilt cameras. These kinds of cameras are generally used for indoor security. In indoor security system multiple cameras are mounted on wall with different angels to track object. These types of systems need a computer or a laptop for monitoring.

Nowadays, most of the system uses a mobile robot with a camera for surveillance. The camera mounted on the robot can move to different locations. These types of robots are more flexible than the fixed cameras. In [2] it is given that mostly used surveillance robots are wheel robot. 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 or laptop.

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The above two types of systems need computer or laptop which makes the whole system bulky. In [3] the systems uses Bluetooth module for controlling robot using phones. But the range of Bluetooth is limited.

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. Fig. 1 shows the basic block diagram of the system. The main unit of robot is Raspberry Pi. Using motor driver IC two dc motors are connected to the GPIO of Pi. Servomotor is used for the tilt motion of a camera. A web server is built in Raspberry Pi using MJPG streamer program. An application is built for Smartphone. The application from Smartphone will open the web-page which has a screen for video streaming and buttons for the movement of robot and camera.

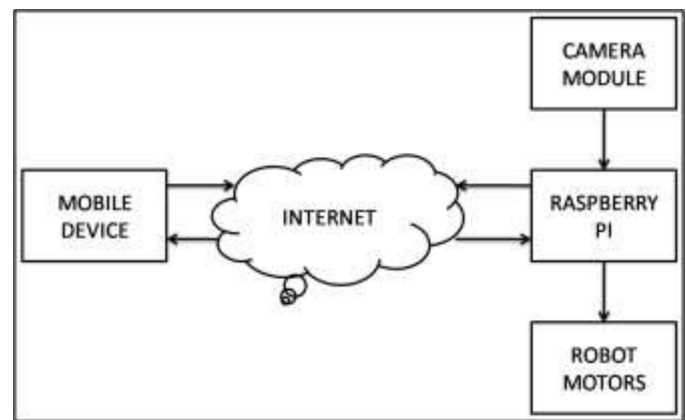


Fig. 1. Block Diagram

The rest of the paper is structured as follows. Section II consists of the overall hardware required and the robot design. Section III consists of overview of the software's used and the communication flow diagram. The overall system development is described in Section IV. Finally concluding comments are given in Section V.

II. HARDWARE

A. Raspberry Pi

Raspberry pi 2 Model B is used which delivers 6 times the processing capacity than its previous version. In [4-7] it is stated that this Pi board has an upgraded Broadcom BCM2836

ARMCortex-A7 900MHz processor. This board also has an increased memory of 1Gbyte LPDDR2 RAM. The Pi Board boots from Micro SD card which runs a version of Linux operating system. The Raspberry Pi board takes power from Micro USB socket of 5 Volts, 2 Amperes. The Board itself has a 10/100 BaseT Ethernet socket and 4 numbers USB 2.0 connector. The board has 40-pin 2x20 strip expansion header of which each pin spaced 2.54mm. This 40-pin provides 27 GPIO for connecting input output devices as well as +3.3, +5 Volts and GND supply lines. The board also has 15-pin MIPI Camera Serial Interface for interfacing Raspberry Pi camera module.

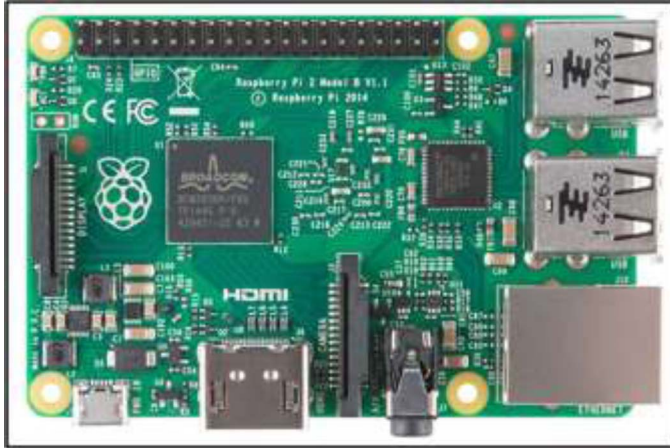


Fig. 2. Raspberry Pi

B. Robot

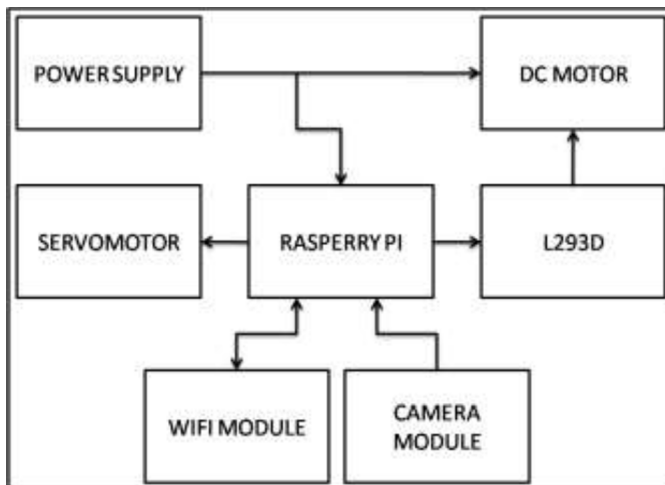


Fig. 3. Robot Hardware

Fig. 3 shows the architecture of robot hardware. The robot is built using mechanical and electrical components. The main controlling unit of the system is Raspberry Pi. Power supply circuit is designed to provide power to Pi board and motor driver IC (L293D). Two dc motors are used to control the forward, backward, left and right movement of robot. Camera module is used to take picture frames for video. Tilt motion of

camera is controlled using servomotors to provide the wide capturing area. Wi-Fi dongle is used to connect Raspberry Pi to the Wi-Fi Router.

Fig. 4 shows the experimental set up of robot. The camera is mounted at the center of the chassis on a robotic arm. The movement of the arm is controlled by servomotor. The motor driver IC and other signal conditioning circuitry including power supply is designed on a PCB. To reduce the complex connections a 2 x 20 header cable is used to provide all the GPIO connections from Pi to PCB. A 12 volts battery is there inside the chassis to provide required power supply to the system.

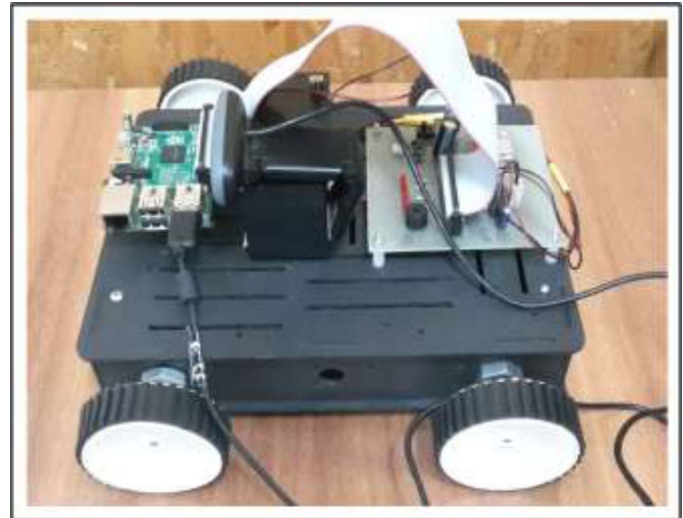


Fig. 4. Robot

C. Motor Driver Circuit

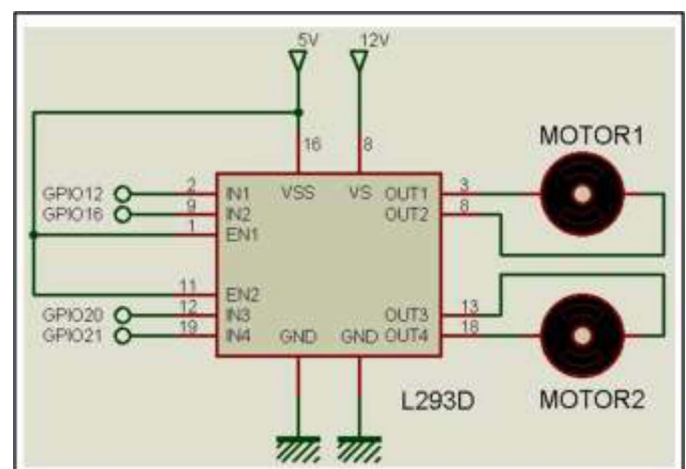


Fig. 5. Motor Driver Circuit

Motor driver IC allows DC motor to run in either clockwise or anticlockwise direction. L293D works on H-Bridge principle. There are two H-Bridges in IC. In Fig. 5 there are two Enable pins which are connected to logic 1. There are two supply

pins; VSS which is connected to +5 volts and VS which is connected to +12 volts. The higher voltage +12 volt provides current to DC motor. There are four input pins, each of two pins control a single DC motor. By changing the logic level on two pins like “0 and 1” or “1 and 0” the motor rotation direction has been controlled.

III SOFTWARE

A. For Android App Development

Nowadays, Android phone are used by most of the people in almost every part of world. Developing an android application is a complex task and need knowledge of software. For developing an application the system needs JAVA and Android Studio. Besides this there are many web-based tools available for developing android application like MIT AppInventor. In [8] we got that AppInventor is jointly developed by MIT and Google and it has gained popularity as a learning tool and a way by which students can practice creative innovations. AppInventor is a visual, block based development environment which does not require any prior programming knowledge.

B. For Embedding Code in Raspberry Pi

From [9] the coding of Raspberry Pi Python language is used. Python language is easy-to-learn since it has a small set of keywords and clearly defined syntax. The diverse set of libraries for Python is portable and compatible with almost all operating systems like Windows, UNIX, and Macintosh. Its programming is 4 times shorter than languages like JAVA. There is no need to declare any type of arguments or variables. It uses simple functions and variables without defining classes.

C. For streaming video on web

MJPEG-streamer application is used for video streaming over HTTP[10-12]. It is a command line application for Linux used to stream JPEG picture file over an IP based network taken from webcam. It streams up to 960 x 720 pixel images at a high frame rate (≥ 15 frames per second). Along with this *libv4l* library is needed which is installed by using following command “*sudo apt-get install libjpeg8-dev imagemagick libv4l-dev*”.

IV. SYSTEM DESCRIPTION

Today most of the Smart phones are based on the Android platform. It has almost all the features that are available in computer or laptop. So the controlling of robot using smart phone makes the system efficient and reliable. A Wi-Fi dongle is used for connecting Raspberry Pi to Wi-Fi router. The Wi-Fi router is connected to local area network (LAN) for providing internet connectivity to the Pi.

Fig. 6 depicts the workflow of system. As soon as the Raspberry Pi gets power it starts initializing the IP address allocated to the web server and establishes connection with the LAN. 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.

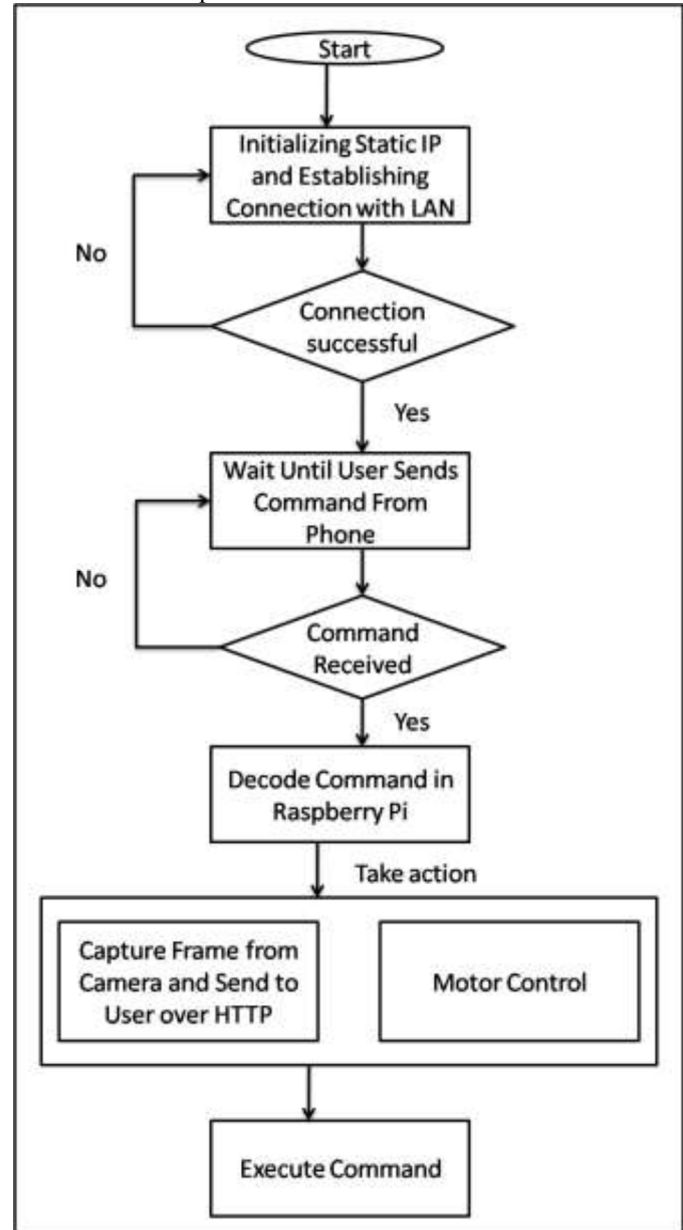


Fig. 6. System Workflow

V. CONCLUSION

The Raspberry Pi is used to control robot using Smartphone from remote location. The time required for processing the commands from the smart phone and responding accordingly is negligible. The experimental result has proved that the fetching of a good quality video is quick and clear which is up to 15 frames per second. The use of Smartphone instead of Computer and Laptop make the system more reliable and easy to use.

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