Live video monitoring robot controlled by web over internet

M Lokanath and Guruju Akhil Sai
School of Electronics Engineering, VIT University, Vellore,Tamil Nadu 632014, India

E-mail: lokanath.m@vit.ac.in

Abstract: Future is all about robots, robot can perform tasks where humans cannot, Robots have huge applications in military and industrial area for lifting heavy weights, for accurate placements, for repeating the same task number of times, where human are not efficient. Generally robot is a mix of electronic, electrical and mechanical engineering and can do the tasks automatically on its own or under the supervision of humans. The camera is the eye for robot, call as robovision helps in monitoring security system and also can reach into the places where the human eye cannot reach. This paper presents about developing a live video streaming robot controlled from the website. We designed the web, controlling for the robot to move left, right, front and back while streaming video. As we move to the smart environment or IoT (Internet of Things) by smart devices the system we developed here connects over the internet and can be operated with smart mobile phone using a web browser. The Raspberry Pi model B chip acts as heart for this system robot, the sufficient motors, surveillance camera R pi 2 are connected to Raspberry pi.

1. Introduction

During war time, terrorist attacks, mass protesting movements its very important to have surveillance near and surrounding areas. In military scenarios adversary location and territory are important security concerns. Sensitive location areas can be covered with human soldiers so that they can continuously monitor and observe the changes. But humans have restrictions and organizing shifts in adversary areas can give a chance to enemy to get advanced [1]. A huge loss can happen in adversary areas because of human errors. The solution is to get use of advanced technology developed over the years, robot with help of robovision algorithms can observe the location of interest and make proper intimations or actions in time. A huge advantage comes in saving our soldiers or workforce from disaster. Robots with high resolution cameras can monitor over long distance and larger areas. Robot loaded with different sensors can even detect subtle chemical objects hidden that cannot be done by humans. Sensors [1] can also help in localizing the area, communicating with the satellite remotely. Satellite communication can continuously contact robots in non human areas like deserts, hill stations, high altitude areas, snow covered areas, and can recover audio visual feedbacks. So surveillance with robots is a very interesting topic in recent time with great research interest.

Recent attacks like a USA twin tower blast with aeroplane, Bombay hotel Taj attack, terrorists entering army posts in Punjab are so different and influences to get more advanced in tackling the situations. As the year passes the technology gets advanced in security and surveillance systems. A more sophisticated electronic devices like closed circuit television (CCTV), security alarms, etc. are

entering into market with great pace. A closed circuit TV's with advance technology can be monitored remotely from any place in the world with the help of an Internet connection. Recently Internet of Things (IoT) applications has gotten more popular. These advancements gives great scope in security and surveillance systems. Even commercial areas have huge applications with surveillance like observing company premises, factory outlet, government offices, international hotel, airports, railway stations, bus stations, etc. The commercial applications have a surveillance system covered to only one particular direction in most of the cases. But in this project we give commands to robot in which direction we want to observe. Even the live streamed data can be recorded on hard disk with the help of digital video recording (DVR).

2. Prevailing system.

Keeping in mind related to military, army services we designed this robot system for Ruf and Tuf, faces the hardships with ease at certain locations. We preferred wireless technology than wired for accessing the robot in remote areas. In the design[1-2], the wireless adapter is placed to support WiFi technology. In Raspberry pi, Pi stands for python hence the whole code is written in python. Raspberry pi plays the main key role in the robot decision. The communication between the web page and raspberry pi is done with shell scripts from computer system and gpio pins in the raspberry pi. In raspberry pi, gpio pins are integrated with the circuit board and are mainly used for input and output data. For robot to act like surveillance a camera is placed on the robot and integrated with raspberry pi. A camera is used for capturing the video data, the data gets transmitted by WiFi module and live video can be monitored on the screen where the web page is displayed.

An open source software named putty is used to do all the operations which is freely available in internet [3]. The operating system used is Linux which is installed in raspberry pi and communication with robot is done by python language. Hypertext markup language (HTML) is used for creating web pages. The markup symbol and codes tell the web browser for displaying images, texts, tabs and so on. The robot frame is designed with four motors which has 6v dp I/P power, 9v batteries are placed to supply power to the motors. The Arduino UNO board [4] is used as a connection source between robot frame and raspberry pie. Arduino UNO output pin gives 5v which is connected to L293 board and h bridge L293D for driving and controlling the motors with frame. The C language is used in Arduino UNO. The raspberry pi [1] gives commands to the Arduino UNO board to control the motor speed and directions.
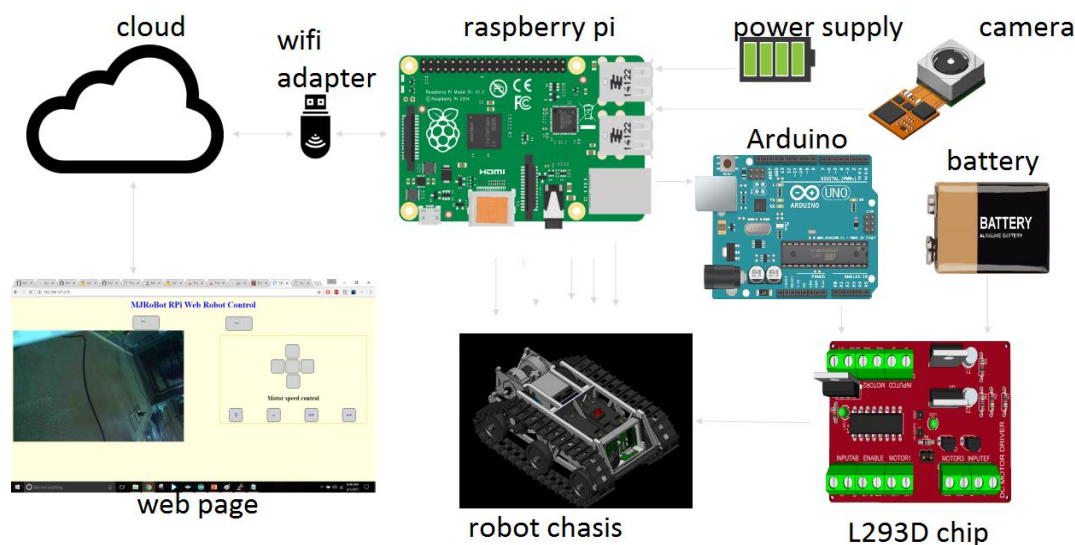
The main aim of the robot is to observe the live stream in the website. The real time live streaming faces multi environmental conditions in a local network. The live video is transmitted in MJPG format and Java programming is used for building the client server model. Internet protocol (IP) based address is provided to access from anywhere. IP based models are superior than analogue systems because of great picture quality and more flexible and scalable (resize). The IP based system requires more information on networking and re too costly than the analogue ones. The web server model can work on some operating systems such as linux, mac(unix) and windows. For the entire setup we are using local network for web server as well as robot control.

3. Proposed system

The proposed robot system for live video monitoring robot using Raspberry Pi installed with WiFi connection is shown in the block diagram fig. 3.1. The computer or smart phone can be used to give commands to Raspberry pi for monitoring the real time video streaming recorded by Pi camera. The communication between the web page to raspberry pi can be done with Wi-Fi or LAN wire also. The sequence of image frames or video gets recorded by Pi Camera with good quality. The input, output pin of Raspberry Pi named as GPIO (General Purpose Input Output). The GPIO connects between the arudino and Raspberry Pi. The Arduino output pins are connected to the input motor shield. The Motors ouptu shield pins are connected to the H bridge motor. A DC battery of 9v, 2Amp is connected to the motor and 5v,2 Amp is connected to Raspberry Pi. Once the connections are made

properly, we can start Raspberry Pi for booting. For controlling the motors a python program is written as .cgi.py file. Motors connected through arudino and arudino connected to raspberry pi pins GPIO gets controlling values. On the [5] website controlling buttons with directions mentioned is created using HTML code and webpage (URL) universal resource locator Internet protocol address.
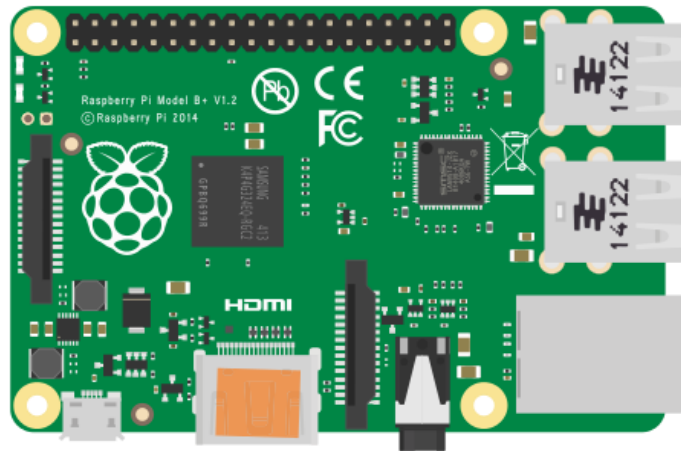
Once the setup is ready communication between the webpage and raspberry pi 3 happens through WiFi. The pi camera installed on Robot to Raspberry pi enable its settings to start the live video stream. Motion joint picture expert group (MPJEG) format [6] stream is done as a standard format. Once the pi camera start and data is transmitted by pi can be viewed in the app as well as in the web page. The webpage has designed to allow more number of users to get experience on the live monitoring wherever they are present because of cloud server (Internet). The administrator has full rights to issue or allow users to monitor live video streaming.

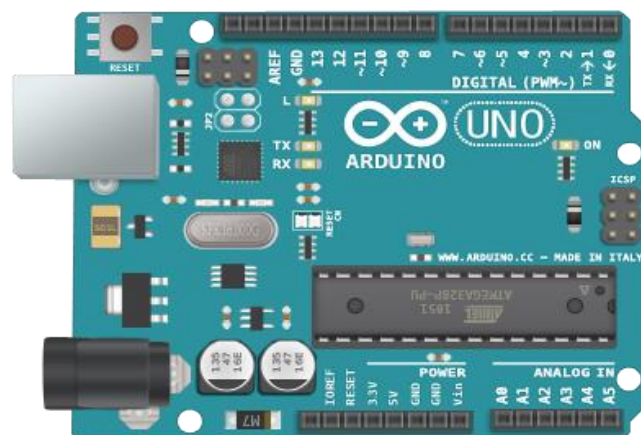**Figure 3.1** Block Diagram of the proposed system

3.1 Raspberry pi
The major operations on the robot is center controlled by the Raspberry Pi 3 model. Raspberry pi installed operating system is Linux and communicated through python language. The images captured by the pi camera are sent to raspberry pie. The raspberry Pi sends the video data and receives through the WiFi router in our proposed system. Once the data receive from web site regarding the direction of the robot, these information is Passed to aurdino board with general Purpose Input Output pins (GPIOs) of raspberry pie [7]. The raspberry pi sends control signals to Arduino to control the motor direction and speed. The specification of the Raspberry Pi 3 model is, ARM8-quad core processor, 1200 MHz Broadcom BCM2837, HDMI support, 1GB Ram with the support of 4 USB devices, and also micro SD card slot. The memory can be further increased to a capacity of about 1 GB. The 40 General Input output pins can be used to connect different types of sensors, multiple connector with expansion boards also can be added. The fully backward compatibility is given to the first 26 identical pins of Model B boards

Figure 3.2 Raspberry pi 2 Model B+ Board

3.2 Arduino uno

The raspberry pi gives input to the Arduino UNO to operate the h bridge DC motor driver. The Arduino acts in between the motor for mechanical movement and raspberry pi's software decision. Although raspberry pi can handle the whole situation, then why we need Arduino? Because Arduino gives a high DC voltage of 5V which sufficiently drives the motor. The motor requires high DC voltages to start. Once the code is applied and started execution 5v power supply is required for Arduino to drive motors [7]. The ATmega328P micro controller is present on Arduino board. 16 Mega Hertz quartz crystal, power jacket, 14 digital input or output pins, 6 analog inputs, a USB connection, and ICSP header with reset button are present on Arduino board.
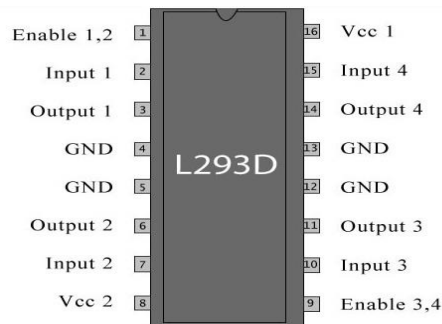

Figure 3.3 Arduino Uno

3.3 DC motor driver

To control the DC motors in our proposed system we need L293D dual H-bridge motor driver. These H-bridge motor drives takes low current as input and delivers high current as output hence acting as current amplifier. The high current signals drives the motor. Two inbuilt H – bridge driver circuits in L293D will drive the motors. Simultaneous actions like front and back directions can be driven by DC motors in its common mode operation. L293D has input logic controlled pins at 2 , 7 , 10 and 15.

These input logic pins, controls the DC motors. The Associated driver gets enabled when the enable inputs are high. The DC motors start operating themselves when enable pins are high.
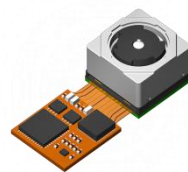

Figure 3.4 L293D H bridge Motor driver IC

3.4 Motors
Motors are needed for the movement of Robot it gives motion and mobility for the robot to move forward, backward and even side turns can be done. We cannot connect the motor directly to the raspberry pi as it gives the less amount of current to drive the motor. So motors are connected through Arduino board and raspberry pi. The motor requires high amount of current for starting a movement. The motors we used are complete motive force systems which are easily mounted and configured. The reduction gear and set of electrical motors helps in easy installation and programming of the robot. This saves cost and reduces the complexities in designing the robotic system for movement.

3.5 Raspberry pi camera module
As the raspberry pi board gets popular the company increased its accessories like wifi module, camera module and so on. We used official product form the company called R pi camera [5]. This V1 pi camera has a resolution of about 5 Mega pixels which is sufficient for high resolution frames in the Video. The R Pi camera is placed in the appropriate slot on raspberry pi board which will get integrated on the board itself. Small command in python code helps starting the live streaming which can be seen by a command run on the computer screen.

Figure 3.5 Raspberry pi camera module

3.6 SD card
The secure digital card is used as a memory for our proposed live streaming robot. The SD card is placed properly on Raspberry pie, which is behind the board and has all the memory related to raspberry pi. The operating system on the board named as Raspibian it occupies around 6 GB. Further we want to install another OS or store any video it requires more memory. So at least 8 GB of memory is required for our purpose.

3.7 WIFI router
The communication between raspberry Pi and webpage happens with WiFi connection. The WiFi adapter placed on the board helps to do WiFi services. Generally more power is needed for Wi Fi device to transmit large data or there is a large distance between Wi-Fi adapter and Wi-Fi access point. So therefore a power supply to the USB hub in pi has to be connected for uninteruptions.
Key features
> * compatible IEEE 802.11b/g/Draft-N standard
> * To increase wireless network scope an Efficient antenna is needed.
> * WiFi router Supports the popular encryption methods like WPA, WPA2, and WEP encryption.
> * easy installation of USB 2.0 interface.
> * for security reasons and to prevent unauthorized users-Wireless access control is used.

4. Implementation
4.1 Installation of Raspberry pi camera
To make camera ready for live streaming we have to do a proper installation. Once the camera module is properly placed on Raspberry Pi board it has to be installed using the proper commands. First, libjpeg62-turbo-dev is installed and then cmake is installed. By using Putty an open source software the MJPG steamer [7] is installed into Pi by user interface display in LINUX command prompt. MJPG streamer software also has to be installed properly with required commands. After complete installation, just adds library path in the command window. And verify whether IP address, port appears or not. We can also add sudo command so that it can run automatically when Pi is rebooted.

4.2 Installing input output wiringPi library
The General Input output pins on Raspberry pi operates when the WiringPi library is added. These GPIO pins are used to read and write the commands, or data to other devices connected to Raspberry pi. Through Shell Scripts we can control GPIO pins. The Wiring Pi library is required to set the input or output pins.

4.3 Controlling motors with raspberry pi and wiringPi
The GPIO pins has to be included in sudo nano/et/rc.local to give output commands and following below commands sets the raspberry pi output even when it gets rebooted.

```
gpio -g mode 5 out
gpio -g mode 6 out
gpio -g mode 13 out
gpio -g mode 19 out
```

New folder cgi-bin is made to include .cgi library files later to be used by Hyper text message language to access the general input output pins . The cgi-bin is created with proper command window. Make directory/variable/world wide web/cgibin. Once the folder is formed we hav create .cgi library files accordingly. The command for creating is sudo forward [8-9]. Cgi and later logic has to inserted in logic file for access the input and output options from raspberry pi such as follows.

```
#!/bin/bash
gpio -g write 5 1
gpio -g write 6 0
gpio -g write 13 1
gpio -g write 19 0
```

The script is executed once the permission is given and the command is sudo chmod 755 forward.cgi . Similarly for reverse, left, right, stop and so on the following commands are used and to be extuced. LIGTHPPDD WEBSERVER has to be installed once .cgi filea are created and executed. The Commands are

```
sudo apt-get -y install lighttpd
sudo lighttpd-enable-mod cgi
sudo lighttpd-enable-mod fastcgi
```

We can further edit or update the ligthppdd server using sudo commands. As part of webserver we can have cloud server for fast access. The default server is Ligthppdd [10] we can see in index. Html web page. For changes we use below commands.

```
Change:
     server.document-root ="/var/www/html"
To:  server.document-root ="/var/www"
To allow these changes to take the effect
sudo /etc/init.d/lighttpd stop
sudo /etc/init.d/lighttpd start
```

By using commands index.html is created in /var/www. Throught this live stream link is provided and other webpages .cgi files are further accessed. The below picture shows the browser how it looks along with the Pi Internet Protocol address.

Figure 4.1 Result of the web page designed

4.4 Installing the arduino uno
Arudino is micro controller used for driving motors because of high output currents. The code is written c language and raspberry pi [5] gives the output to arudino which drives the H bridge Motor driver IC with high current to generate torque in motors. The output given by raspberry pi the same outputs can be seen in adjacent pins in arudino and connected to L623

5. Pros and cons
The proposed system has many advantages as well as disadvantages as discussed below.
5.1 Pros
* The main advantage of the system is to do surveillance at low cost and more real time streaming.
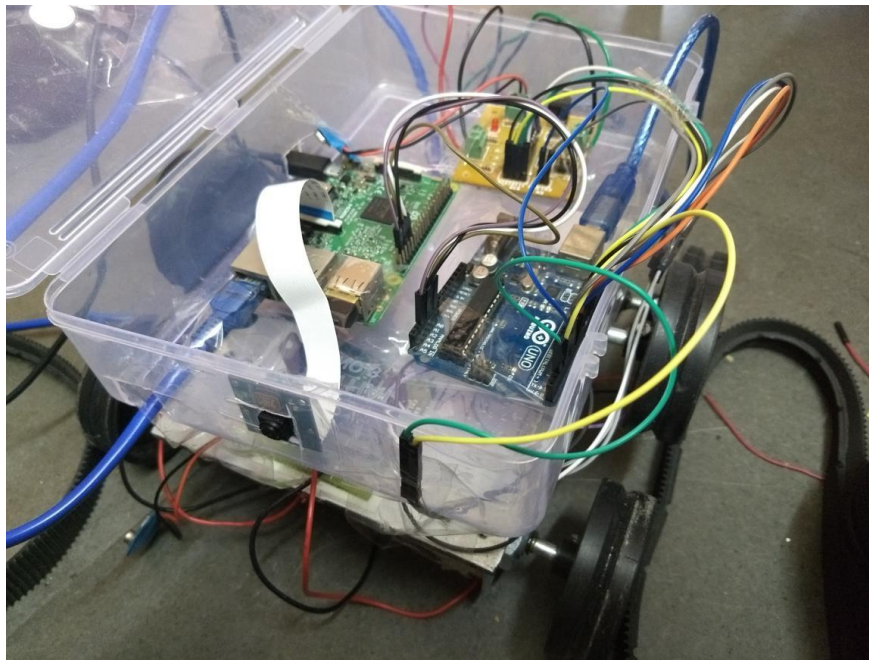* By high resolution cameras and wide angel camers we can also stream video of wide areas, crowded areas.

* All the equipments can be checked and updated with advanced technology so than no error occours while streaming.
5.2 Cons
* A separate WiFi router and WiFi adapter is installed.
* raspberry pi for storing video requires additional memory
* processing of images/videos in raspberry pi is slow.

6. Results
The proposed robot for live video streaming looks like this.

Figure 6.1 The real time live video streaming robot implementation

The designed web page with live streaming window, control button with the implementation looks like below.

Figure 6.2 Screenshot of the proposed website designed

7. Conclusions and future work
The proposed robot for live video streaming has lot of scope in the areas where human cannot reach. The system can be accessed anywhere as we connect through the internet. Further more sensors, including temperature, pressure, environment monitoring and many more features can be included. But image processing/video processing in the raspberry pi is very slow and can be advanced through technology**.** Robotics has good feature scope with artificial intelligenc and recently advancing deep learning techniques.

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