IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

INTELLIGENT ALL GROUND SURVEILLANCE

Kale Manoj, Kulkarni Chaitanya, Patil Ramesh, Ruikar Sachin
Department of Electronics Engineering, Walchand College of Engg., Sangli, India

DOI: 10.5281/zenodo.573656

ABSTRACT

The paper is aimed at designing and building a manually controlled surveillance robot which runs on multiple surfaces. The main purpose of the robot is to roam around in each environment while transmitting back real time data (video) to the ground station. This real-time data can then be used by the controller (human) to move the robot around. The System is divided in two parts, base station and robot vehicle. The base station is a web-page used for controlling the robot vehicle. It consists of a graphical user interface for controlling the motion of robot-vehicle and for displaying the video. The robot vehicle is a compact set of chassis, motors, raspberry pi 3b, pi-camera, motor driver unit and batteries. The controlling signals send from the base-station are received by the raspberry pi 3b controller. These signals are used for the motion of the robot vehicle. The pi-camera is used for the taking the video signals which are transmitted back to the base station. The Controlling person should take an appropriate decision for the further motion of the robot vehicle. The system designed is a wireless manually controlled system, which can be used for the surveillance of various places.

KEYWORDS: Raspberry Pi, DC Motor, Pi camera, etc.

INTRODUCTION

Surveillance is the process of monitoring a situation, an area or a person. This generally occurs in a military scenario where surveillance of borderlines and enemy territory is essential to a country's safety. Human surveillance is achieved by deploying personnel near sensitive areas to constantly monitor for changes. But humans do have their limitations, and deployment in inaccessible places is not always possible. There are also added risks of losing personnel in the event of getting caught by the enemy. With advances in technology over the years, however, it is possible to remotely monitor areas of importance by using robots in place of humans. Apart from the obvious advantage of not having to risk any personnel, terrestrial and aerial robots can also pick up details that are not obvious to humans. By equipping them with high resolution cameras and various sensors, it is possible to obtain information about the specific area remotely. Satellite communication makes it possible to communicate seamlessly with the robots and obtain real-time audiovisual feedback. In recent times, surveillance technology has become an area of great research interest. For such purpose, basic requirement is small size and mobility through different areas. The size of the robot should be small enough, so that it will not be easily noticed. Now with the advancement in the field of Embedded systems, it is possible to build small but efficient systems. The System consists of many sophisticated-designed sections such as navigation, obstacle detection sensor, and network devices for communication. For remote surveillance, a robot is designed on which a pi camera is fitted in front of the robot. There is a base station to give control signals for the motion of robot. Controller raspberry pi 3B is used to control the robot and send video signals to the base station. As per the video signals, the proper decision is taken and the robot will be given further instructions. A graphical user interface is there at base station, to control the robot and to see the video. A proper system is designed, such that the robot will not crash in its path.

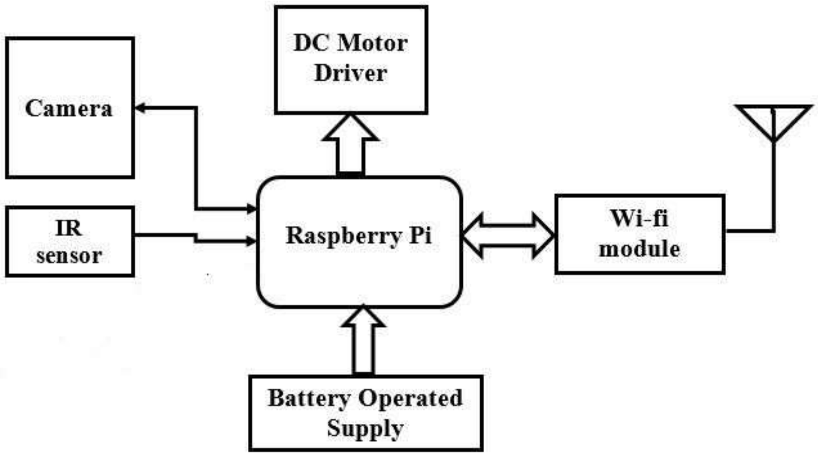
ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

MATERIALS AND METHODS

I. BLOCK DIAGRAM:

The System is divided into two parts, one is robot itself and second is base station. Base station is used to control the robot motion.

Figure:



Block diagram of Robot Side

- ***Pi Camera:*** The pi camera is interfaced with raspberry pi board by using CSI (camera serial interface). It is 5 Megapixel camera, giving maximum resolution of 1920 × 1080 pixels. The camera is fitted on the front side of the robot. The camera is connected to the BCM2837 processor on the pi via CSI bus, a higher bandwidth link which carries pixel data from the camera back to processor. This bus travels along the ribbon cable that attaches the camera board to pi.
- ***Raspberry pi 3B board:*** It is a main controller on the robot, which has 40 GPIO pins. Different modules such as HDMI slot to connect LCD display, CSI camera port to connect pi camera, DSI display port to connect external display, Wi-fi facility, Ethernet cable support and four USB ports are present on the raspberry pi 3B board. Out of 40 GPIO pins, 26 pins support input-output programming.
- ***Power Bank***: To power raspberry pi board, a separate power bank is used. It provides 5V DC and 1A current. The capacity of battery is 4000mAh.
- ***Wi-fi Module***: The 3B version of raspberry pi has inbuilt wi-fi module. It works on 802.11n IEEE Standard. It works on 2.4GHz frequency. This module is used to transmit signals wirelessly over the network.
- ***L298n Motor driver module:*** L298n Motor driver module is used to control the motion of robot depending upon input given from raspberry pi.

Table:

Table 1. Comparison table for motoring mode

Motion	Left Motor Control		Right Motor Control	
	26	24	31	32
Forward	VCC	GND	VCC	GND
Backward	GND	VCC	GND	VCC
Left	VCC	GND	GND	VCC
Right	GND	VCC	VCC	GND
Stop	GND	GND	GND	GND

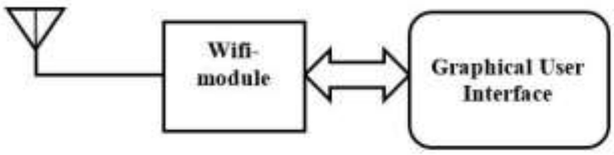
2 DC motors are controlled bidirectionally by one motor driver module. L298n Module has 4 control input pins and 4 output pins to control 2 motors. From raspberry pi, gpio pins 24, 26, 31, 32 are

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

connected to four control inputs of motor driver IC. External battery pack of 12 V is given as power supply to the motor driver. Here the ground of external battery and raspberry pi should be shorted for proper operation of motors. There are 4 output pins of motor driver for connecting 2 DC motors. The below table shows control signals status for required motion of robot.

- ***NiMH (Nickel-metal hydride) rechargeable battery***: L298n is powered by using NiMH rechargeable battery. It provides 9.6V as output and minimum capacity of 2100mAh.

Figure:



Block diagram of Base Station

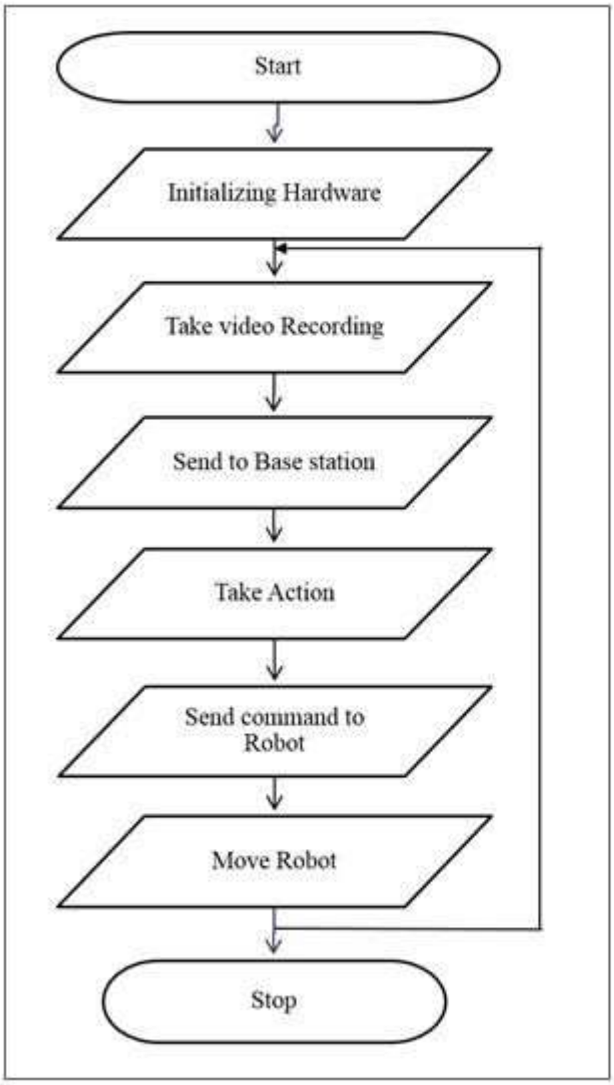
A network is created using wireless router. Raspberry pi and controlling device are connected to same network. The range of the network is about 150 m.

A GUI (graphical user interface) is created using html and php. It consists of control keys and a section for live video. The web page is accessed using browser. When the IP address of raspberry pi (for e. g. 192.168.43.80) is entered in the browser, login page is displayed. After login with proper credentials, it redirects to control panel.

PROCESS FLOW DIAGRAM

The Process flow diagram of the system is as follows:

1. Power up the Raspberry Pi board and Motor Driver by using Batteries.
2. When Raspberry Pi gets Booted, Web server gets started.
3. Connect the System to a Network, created using a wireless router. Connect the controlling device to the same network.
4. At Control Station (a Laptop or Mobile), open a browser. Enter IP address of Raspberry Pi.
5. Login Page gets opened. Enter the Login Credentials. When Proper Login Credentials are entered, it redirects to Control Panel.
6. Live streaming can be seen on the screen. As the Camera is Fixed on front side of Robot, the surveillance area is seen. The Video is continuously sent on the Webserver by Pi.
7. Maneuver the bot using Control keys present on Control Panel. When a control Key is pressed, the command is sent to a Robot to run the motor in a particular direction. GPIO pin related to that motor gets activated which drives the motor to direction.
8. Steps 6 and 7 gets continuously executed till the surveillance operation is ended



Process Flow Diagram

SOFTWARE PROCESS

a. How Web Page works using PHP

A step-by-step explanation of each step is as follows:

- The user enters http://xyz.com into their browser and taps/hits 'enter'.
- After the user has tapped/hit 'enter', the browser sends the page request over the Internet to the web server.
- The web server gets the request and analyzes the request information. Apache realizes that a file is not specified, so it looks for a directory index and finds index.php.
- Since Apache knows to send files that end with the .php file extension to the PHP interpreter, it asks PHP to execute the file.
- In this step, PHP is executing the code contained in the index.php file from the request. During this step, PHP may interact with databases, the file system or make external API calls, amongst other things.
- After PHP has finished executing the index.php file, it sends the output back to Apache.
- Apache receives the output from PHP and sends it back over the Internet to a user's web browser. This is called the web response.
- The user's web browser receives the response from the server, and renders the web page on a computer or device.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

b. Controlling GPIO using php

The easiest way to use PHP with Raspberry Pi is through the shell exec() function. This function executes shell commands, so it can act as a sort of bridge between PHP and the Raspberry Pi. Shell_exec() can call Python scripts that perform certain tasks and control GPIO pins.

When a button in Webpage is pressed, its value is passed as a part of the URL. The values are read by php and are executed by shell_exec() function.

c. Motion JPEG

Motion JPEG (MJPEG or M-JPEG) is a video compression format in which each video frame or interlaced field of a digital video sequence (including video and metadata such as subtitles and closed captioning) is compressed separately as a JPEG image. Originally developed for multimedia PC applications, MJPEG is now used by video-capture devices such as digital cameras, IP cameras, webcams, and by nonlinear video editing systems.

MJPEG is an intra-frame-only compression scheme. Because frames are compressed independently of one another, MJPEG imposes lower processing and memory requirements on hardware devices. As such, the image quality of MJPEG is directly a function of each video frame's spatial complexity. Frames with large smooth-transitions or monotone surfaces compress well and are more likely to hold their original detail with few visible compression artifacts. Frames exhibiting complex textures, fine curves and lines are prone to exhibit DCT artifacts such a ringing, smudging and macro-blocking. This gives MJPEG an advantage over interframe compression schemes, which do not accommodate rapid motion between frames and require more hardware to meet the memory demands of interframe compression.

d. ***Python for controlling GPIO***

Using Python on the Raspberry Pi opens the opportunity to connect to the real world through the Pi's GPIO pins. This can be done with the RPi GPIO library. In Python script (or in the REPL), GPIO module is imported, board mode is set to BCIM or Board, the pins are set to use and turn them on.

RESULTS AND DISCUSSION

I. SETUP

The pi camera is fitted at the front side of robot as shown in figure. The raspberry pi board, L298n motor driver module and power bank are fixed inside the enclosure. The two left sided motors are shorted together and two right sided motors are shorted together, for the connection of belt over the tyres. The rechargeable NiMH battery is fixed at the bottom side of chassis. The chassis provide support for fixing of motors, battery and the remaining system over it. When the key is pressed on the GUI, respective pins change their voltage level of respective pins of raspberry pi for required motion.

Figure:

Front view of Robot

Side view of Robot

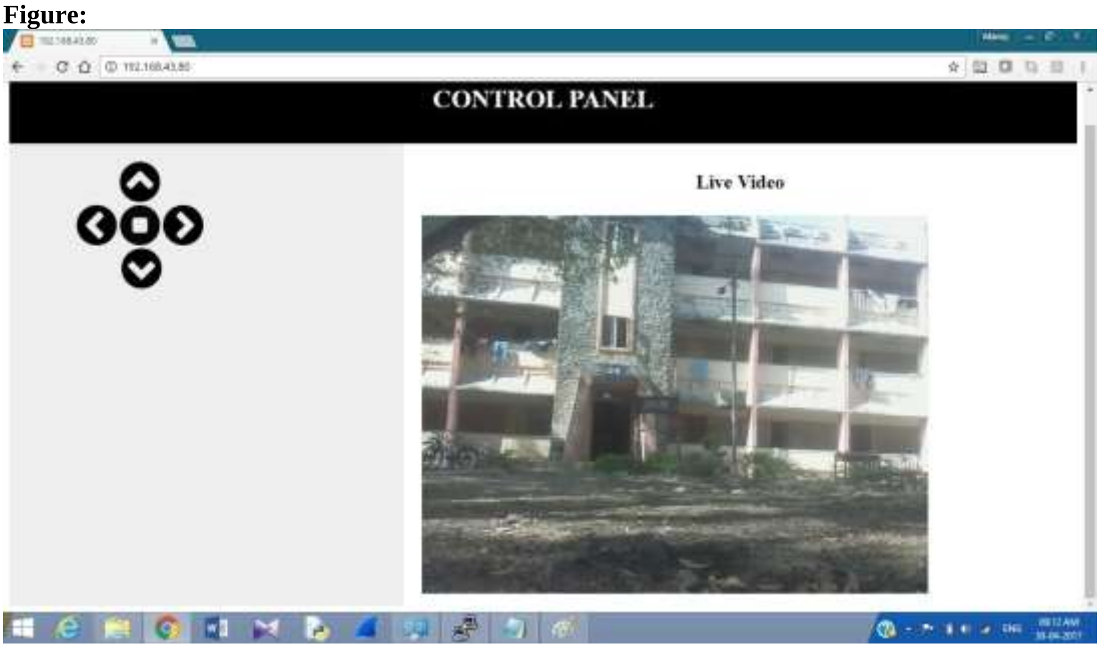
Figure:

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Login Page

login page for secured connection to GUI of base station. The login page redirect to GUI page, after entering correct username and password given to user.

Figure:



Graphical User Interface

In Figure, the GUI present at the base station to control the robot. When the IP address of raspberry pi is entered in the browser, the GUI is visible to the user. There are total 5 keys to perform further actions of robot:

- The up key is used for forward motion of robot.
- The left key is used for motion of robot in left direction.
- The bottom key is used for backward(reverse) motion of robot.
- The right key is used for motion of robot in right direction.
- The middle key is used for stopping the robot.
- There is a rectangular window present at the right section of GUI for displaying video sent by the robot.

OBSERVATIONS

The robot runs on plane ground as well as on rough surface. The speed test of robot on all ground describe in Table.

Table:

Table 2. Speed test with various ground

Place	Distance(cm)	Time(s)	Speed(cm/s)
On smooth floor	210	3.92	53.57
On Tar Road	300	5.61	53.47
On Grass	300	6.09	49.26

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Figure:

On rough surface

On Paved road

On floor

On slope

The observed range of wi-fi router is nearly 150m in open space. The video signals (640 * 480 p at 15 fps) send by robot to base station can be clearly seen. Video signal from robot has a delay of about 0.5 to 1 s. The controlling action of robot from base station is fast. The robot moves in proper direction, when the user click on direction control key, present on GUI at base station. The power bank supply power to the raspberry pi board for about 2 hour and 30 minutes. The size of robot is small. The dimensions of robot are 20cm×20cm× 9cm. Robot is controlled over the internet using PORT FORWARDING. Using Global IP address, robot is maneuvered from a distant place. The latency obtained is of 3 to 4 seconds.

CONCLUSION

The Robot can move on multiple surfaces with ease at a reasonable speed. The controlling action of robot is eased by using Web control. The live streaming with minimum latency is obtained. The quality of video signal obtained from robot is high with very little delay. This robot works for four hours with all functioning in real time. In web browser, all actions can be seen with high resolution video. The Robot is controlled over internet using Global IP address.

REFERENCES

[1] Jun Pyo Lee, “Future Unmanned System Design for Reliable Military Operations”, International Journal of Control and Automation Vol. 5, No. 3, September, 2012.

[2] Khursid J., Bing-rong H., “Military robot-a glimpse from today and tomorrow”, 8th International Conference on Control, Automation, Robotics and Vision, Kunming, China, 2004.

[3] William Brown, “Improving the Electromechanical Reliability of Unmanned Ground Vehicles”, GRRC Technical Report 2009-2, University of Michigen.

[4] V. Meenakshi, Ch. Lakshmi Saketh, K. KalyanKumar, “Secured Spy IP Control Robot Using Raspberry Pi”, International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 2, February 2015).

[5] Daniel Jackson, Research and Component Systems of Unmanned Ground Vehicles: A Survey, University of Northern Iowa.

[6] Jennifer Carlson, “Analysis of How Mobile Robots Fail in the Field”, Master thesis,Department of Computer Science and Engineering, University of South Florida, 2004.

[7] S. Singh and P. Ranjan, “Towards a new low cost, simple implementation using embedded system wireless networking for UAVs”, Proceedings of the IEEE 5th International Conference on Advanced Networks and Telecommunication Systems, (2011).

[8] Chinmay Kulkarni, Suhas Grama, Pramod Gubbi Suresh, Chaitanya Krishna, Joseph Antony, “Surveillance Robot Using Arduino Microcontroller, Android APIs and the Internet”, First International Conference on Systems Informatics, Modelling and Simulation, IEEE 2014.

[9] R.Raran Kumar, Raju.n, PIBOT: Surveillance & Live Streaming System using Raspberry Pi, International Journal of Science, Engineering and Technology Research (IJSETR) Volume 5, Issue 8, August 2016.

[10] D. Vidya Sagar, G. Vyshnavi Vihitha, WebIOPi- Remote Controlled Robot Cam Using Rest Framework, International Journal of Emerging Research in Management & Technology ISSN 2278-9359 (Volume-4, Issue-8), August 2015

[11] Atharva Kaluskar, Kshitij Avalaskar, Het Gandhi, Web-Controlled Surveillance Robot with A Robotic Arm, IJRCCE, Vol. 3, Issue 9, September 2015

[12] Angela Antony, Prof. G. R. Gidveer, Live Streaming Motion Detection Camera Security System with Email Notification using Raspberry Pi, IOSR Journal of Electronics and Communication Engineering (IOSRJECE) e-ISSN 2278-2834, p- ISSN 2278-8735, September 2015

[13] Ron Oommen Thomas, K. Rajasekaran, Remote Monitoring and Control of Robotic Arm with Visual Feedback using Raspberry Pi, International Journal of Computer Applications (0975 – 8887) Volume 92 – No.9, April 2014

[14] Aaruni Jha, Apoorva Singh, Ravinder Turna, Sakshi Chauhan, War Field Spying Robot With Night Vision Camera, Journal of Network Communications and Emerging Technologies (JNCET) Volume 2, Issue 1, May (2015).

[15] raspbian OS, https //www.raspberrypi.org/downloads/raspbian

[16] MJPEG Streamer, https //miguelmota.com/blog/raspberry-pi-cameraboard-video-streaming/

[17] Python Package for GPIO, https //pypi.python.org/pypi/RPi.GPIO

[18] apache web server, https //www.raspberrypi.org/documentation/remoteaccess/web-server/apache.md

CITE AN ARTICLE:

Manoj, K., Chaitanya, K., Ramesh, P., & Sachin, R. (2017). INTELLIGENT ALL GROUND SURVEILLANCE .*INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 6*(5), 240-247. doi:10.5281/zenodo.573656