

Implementation of Spy Robot for A Surveillance System using Internet Protocol of Raspberry Pi

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Abstract—At present the surveillance of International border areas is a difficult task. The border guarding forces are patrolling the border seriously, but it is not possible to watch the border at each and every moment. An essential requirement of this situation is a robot which automatically detects trespasser in the border and report nearby board security control unit. Many of the military departments now utilize the robots to carry out risky jobs that cannot be done by the soldiers. In this present work, a Raspbian operating system based spy robot platform with remote monitoring and control algorithm through Internet of Things (IoT) has been developed which will save human live, reduces manual error and protect the country from enemies. The spy robot system comprises the Raspberry Pi (small single-board computer), night vision pi camera and sensors. The information regarding the detection of living objects by PIR sensor is sent to the users through the web server and pi camera capture the moving object which is posted inside the webpage simultaneously. The user in control room able to access the robot with wheel drive control buttons on the webpage. The movement of a robot is also controlled automatically through obstacle detecting sensors to avoiding the collision. This surveillance system using spy robot can be customized for various fields like industries, banks and shopping malls.

Keywords—Border security, Raspbian OS, IoT, Spy Robot, Raspberry Pi, PIR sensor, Obstacle Detecting Sensor.

I. INTRODUCTION

In today's world the robotics field is growing exponentially and some of the popular robotic products are used largely by the industries, defense, academic and research communities. The design and implementation cost of a robot is very less than hiring a human caregiver. The robots can be reprogrammed faster and more efficient. The robot has sufficient intelligence to cover the largest area to provide a secured space. The intelligent robots can perform preferred tasks in unstructured environments with or without human direction [1]. The real time object detection is required because safety and security are essential in the remote monitoring and control systems such as intelligent home environments, consumer surveillance system, etc [2, 3]. The real-time human body detection is essential for various fields like home security systems, surveillance systems, communication systems and more [4]. Basically the surveillance systems are building up with multiple cameras which are placed in different angles of view to track human objects [5]. Particularly the tracking task is needed on cameras for dynamic objects which increases the number of cameras used in the system. An intelligent surveillance system with multiple cameras is complicated and

costly. In proposed system a single camera is installed on a robot and the robot can move all directions to take photos in different angles. This system is very flexible to monitor any living object with the help of the PIR sensor [6] and it is more suitable for surveillance systems. A robot can be controlled in two methods by hardwired control or wireless control. The wireless control provides additional benefits including increased flexibility and reduced installation cost. In latest the internet technology is used for movement control and all other purposes like image or video capture by the robot and shared via internet [7].

II. SYSTEM OVERVIEW

Basically, two gear motors are sufficient to produce the movement of spy robot and the motor driver module is used to supply enough current to drive two gear motors which protects the Raspberry-pi module from the damage. The major advantage of using the minimum number of gear motor is minimizing the power consumption. Robot has two infrared sensors which are used to sense the obstacles coming on both sides of robot path. It will move in a particular direction and when the obstacle coming in its path, it will turn to the opposite direction. Besides, the PIR sensor is used to detect the presence of living object in the robotic environment, which in turn triggers the visual sensor (pi camera) then capture the image or video and store it in the web server. An autonomous platform for the spy robot is a machine that can

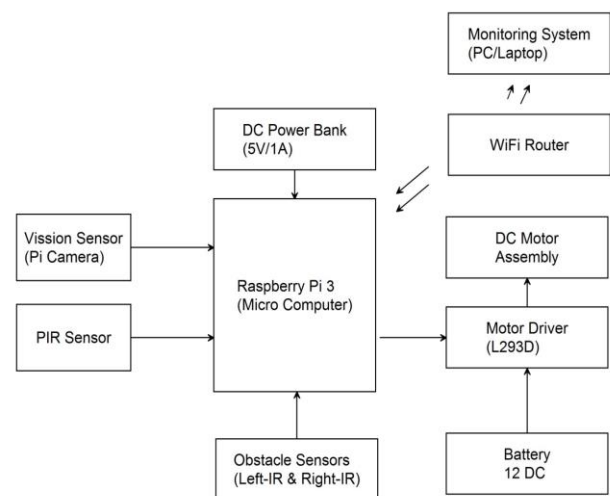


Figure 1. The block diagram of the spy robot for a surveillance system

be operated from human-made environment by using control buttons available on client web page. Now-a-days the Raspberry-pi has been widely used to make projects in various fields like medical, defense, agriculture and industries [8].

The spy robot is designed with Raspberry-pi 3 module which having an inbuilt wireless controller, Bluetooth controller and pi camera support. It continuously monitors the surrounding areas for the presence of unauthorized people and to detect the presence of enemies at the border. The user will be observing this image data on the web page at the control room. User unit communicates with spy robotic unit with the help of Internet. This IoT application is developed by python, HTML and Javascript [9]. The proposed system has limitation which is more suitable for almost flat surface on which the robot can operate. This design would not be suitable for rough terrain environments like rocky or hilly terrain due to their wheeled mechanisms. Figure 1 shows the block diagram of the spy robot for a surveillance system.

III. HARDWARE DESIGN AND IMPLEMENTATION

The entire proposed system consists of a Raspberry pi Model 3 board, PIR and IRs sensors, L298N motor driver, and robot chassis. The Raspberry pi is a credit card size single board small, inexpensive computer developed in the United Kingdom by the educational charity Raspberry pi Foundation. Raspberry pi has included software such as Python, Java, Scratch, Mathematica, Sonic Pi and more which enables users to teach programming and design animation, game, interesting video, etc [10]. In addition, programmers can also develop scripts or program using the Python language and it is the main core language in the Raspbian operating system. Python language has been used in this project to write the script for client/server communication. The Raspberry pi 3 Model-B is the 3rd generation Raspberry pi minicomputer with a 64-bit 1.2GHz quad-core processor, 1GB RAM, WiFi and Bluetooth 4.1 controllers. It also has 4 x USB 2.0 ports, 10/100 Ethernet, 40 GPIO pins, Full-size HDMI 1.3a port, Camera interface (CSI), Combined 3.5mm analog audio and composite video jack, a Display interface (DSI), MicroSD slot and VideoCore IV multimedia/3D graphics core @ 400MHz/300MHz. The GPIO18 (Physical pin 12) of Raspberry Pi is connected to the PIR motion sensor. The GPIO23 (Physical pin 16) and the GPIO24 (Physical pin 18) are connected to the Left IR sensor, and Right IR sensor respectively. The GPIO27 (Physical pin 13) and the GPIO22 (Physical pin 15) are connected to IN1 and IN2 of L298N module respectively, to drive the left motor. The GPIO20 (Physical pin 38) and the GPIO21 (Physical pin 40) are connected to IN3 and IN4 of L298N module respectively, to drive the right motor.

The Raspberry pi Camera V1 is 5MP static sensitive type camera. It is a small PCB on which an Omnivision OV5647 camera module [11]. The pi camera module is connected to CSI port of Raspberry pi. When pi starts and logged in to desktop then type `raspistill -o image.jpg` command in prompt and press enter. The image will storing as *image.jpg* and able to view in GUI which will confirm the running of pi camera. Python script is used to control the pi camera and capture the image.

A Passive Infra Red (PIR) sensor is a pyroelectric device which detects level of IR radiation from the living objects. The

PIR device does not emit an IR signal, rather passively detects the infrared radiations coming from the human body in the surrounding area. The PIR sensor has a bunch of supporting circuitry. The detected infrared pulses are passed to FET amplifier circuit which will reset or set the sensor output. The PIR sensor will set the output (logic '1') when the living body within the range approximately less than 10 meters and otherwise it reset the output. The PIR sensor module has three terminals: Pin1 is connected to the drain terminal, Pin2 corresponds to the output terminal of sensor, and Pin3 is connected to the ground. It is used in many systems because low-power, inexpensive and easy to interface with all type of microcontrollers.

The motors assembly includes the Robot chassis and two DC geared motors. The L293D IC is a dual H-bridge motor controller, which is typically used to control the motor speed and direction. This driver module is supplies a high current and high voltage to connected DC motors [12]. It can drive up to two DC motors 1A each. The Raspberry pi 3 comes with inbuilt WiFi and Bluetooth controller features. An inbuilt WI-Fi controller is used for connecting Raspberry Pi to WI-Fi router and the router is connected to the local area network (LAN) for providing internet connectivity to the Raspberry pi. Once the IP assigned to Raspberry pi and it establishes the internet connection with LAN through a router.

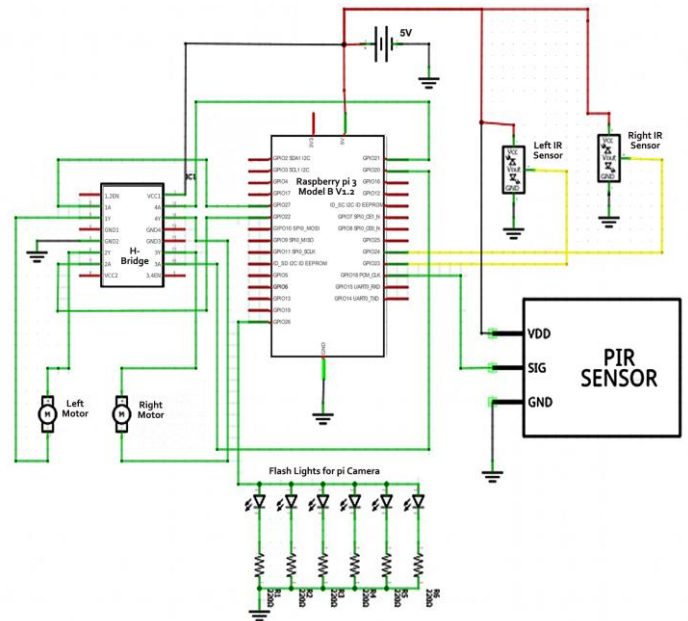


Figure 2. The schematic diagram of the proposed system

The schematic diagram of the spy robot for a surveillance system is shown in Figure 2. The major intention of this system is to capture images when the human-being is present in the Robot's ambient and transmit it as soon as possible to the storage which can be accessed through a webpage. The Robot is developed by using DC geared motors, which is controlled through the GPIO pins of the Raspberry Pi. The Python programming language is used to operate the robot. Furthermore, the webpage is used to monitor the status of the sensors and the action of spy robot is controller through IoT. The Raspberry pi camera continuously captures the image and it is saved on the SD card of the Raspberry pi module. This

image is displayed on the webpage using HTML and PHP scripts [13]. Buttons for every function have been created. When a button is clicked upon, the corresponding macro is called from the python script resulting in the corresponding GPIOs being made LOW or HIGH. Then the IR sensors determine the obstacles and show the status of each IR, and according to the state of the obstacle the robot moves the opposite direction. In addition, the LDR sensor is used to provide a flashlight for camera at night.

IV. SOFTWARE DESIGN AND IMPLEMENTATION

A. Python Source Code for Raspberry Pi

The entire system is based on a Raspbian operating system like Linux platform. The Raspbian OS is based on Debian that optimizes the Raspberry Pi hardware. The programming language which is utilized for coding is Python. Python referred to as a widely used high-level programming language for general-purpose programming. Python language is created by Guido van Rossum and was released in 1991. Besides Python is interpreted language which has a design philosophy that emphasizes code readability. It uses white space indentation to delimit code blocks rather than keywords or curly braces. A syntax which permits users to express concepts in lesser lines of code than possible in languages such as Java or C++. Python programming language has a compiler that runs automatically when the Python source code (.py file) is executed in the terminal, and the .pic file is generated [14]. The Figure 3 illustrates the software design flow of spy robot for a surveillance system. Basically, the functionality of system clarifies the cyclic phase rotation for robot movement. From the flowchart, the invoking sequence and the relationship between various functions are visualized.

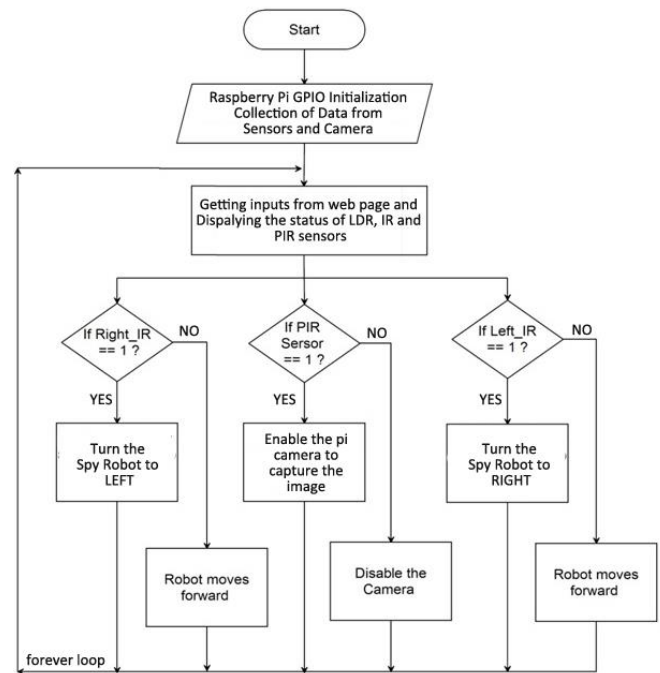
B. HTML JavaScript

HTML provides the basic structure of sites, which is improved and customized by other technologies like CSS and JavaScript. CSS is used to control presentation, layout and formatting. JavaScript is used to control the performance of different elements. Bootstrap is the most popular HTML, CSS, and JavaScript front end framework for developing web pages, mobile web sites and more. Bootstrap is completely free to use. The Internet of Things (IoT) can be considered as a global network which enables the communication between human to human, humantothings and thingstothings [15]. It is anything in the world by providing unique identity to each and every object. The commands can be sent through the web page with the help of internet. The user control command can be sent from anywhere in the world through web page. The robot is controlled from remote place which isolates the human being from dangerous environments.

As the main code is being executed, first, the robot will move forward, checks for human-being in the field, and IR sensors checking for obstacles might come before the robot, the robot will do these processes simultaneously. When the user giving inputs from the webpage, it is stored in server as a text file. At robot end the Raspberry pi running the python script which will read the text file and execute the command according the user inputs. The Raspberry pi is connected the H-bridge IC L293D which will control the direction of motors

based on command received from user. From the website the user clicks on the forward button, the robot moves forward and similar movements are achieved for reverse, left and right. Once spy robot gets turned on, user can see the photograph of moving living objects in web page which are taken by pi camera.

Figure 4 shows the web page of secured spy robot for a surveillance system. The webpage can be used to monitor and control the spy robot by displaying all sensor status, and



according to specific sensor condition the button can be used

Figure 3. The software design flow of Spy Robot for a surveillance system

To decide the direction of the robot to go. Figure 5 shows the photograph of front view of the spy robot for a surveillance system.

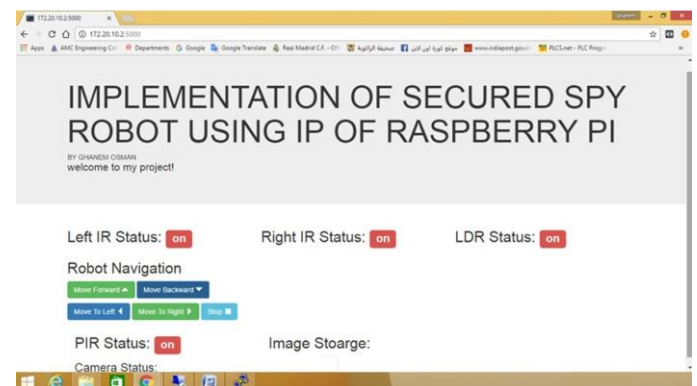


Figure 4. shows the web page of secured spy robot for a surveillance system

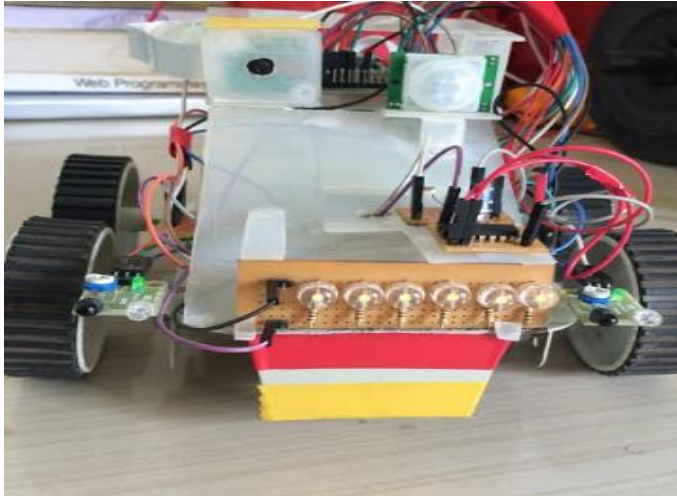


Figure 5. The front view of the Spy Robot for a surveillance system

This spy robot can be used for various applications in military like navigator in forest, bomb finder with metal detection sensor, etc. It is used to minimize human casualties in terrorist attack. The future work of this system is quadcopter spy robot which can be used in war field, hilly terrain, terrorism and sensitive areas.

V. CONCLUSION

The Spy Robot used for this secure purpose can operate effectively in order to collect various types of information that required by users. For instance, the presence or absence of the unwanted folks in war areas whose are not allowed in such areas can be determined by the PIR sensor which sends a signal to the Raspberry Pi when a human - being is in the ambient of the Robot. In turn, the Pi triggers the camera module immediately to capture an image and send it to the web page. The PIR sensor and proximity sensors are activated depend on external stimuli via IoT. The control room collects this information for later reference.

The brain of the spy robot is the Raspberry Pi minicomputer. The Robot is operated by three modes. Firstly, only run the code and leave the Robot to navigate freely based on the sensor status. Secondly, control the moving to a specific direction by the Laptop Keyboard. Thirdly, monitor the information available on the web page, and control accordingly with various buttons.

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