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Research Article

Home Automation using Raspberry Pi 2

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Abstract

Home Automation System is a mobile web based application that allows the user to monitor and control their home using their mobile device. This system requires a micro SD card with an OS for the Raspberry Pi. In this project we have selected the OS Raspbian which is mostly preferred for beginners and projects, before copying the OS on the micro SD card we need to copy a file named NOOBS which helps to download the latest OS's for the Raspberry PI as well as works as an interface like BIOS in windows. After booting the OS we installed Python 2.7, 3.0, Scratch etc. for programming. There is a messaging API which sends text messages to the user about the changes in the house, with the help of a text to speech plugin we have recorded messages which the user can play when he is not home, and using a FTP server he can access the Raspberry pi. The system can also be used for various other purposes in offices where the security guard can have the access in his smart phone and when he is on his rounds if a person comes then he can allow him to enter. This system includes the remote control and monitoring of home appliances and security which can be done as the Raspberry Pi can be customized which can provide security and energy management.

Keywords: *Home Automation System, Remote control via mobile, PIR sensor, SMS messaging, IR sensors, Intruder Detection, LED array.*

1. Introduction

The Home Automation project is based on an Raspberry Pi 2 processor, which is supported by 1GB RAM and running at 900 MHz CPU which is over clocked at 1 GHz without damaging the board, In this project an image of the person will be clicked and sent to the user via FTP network , A CMOS camera is placed on the front door of the house which will take the photo, if the stranger tries to enter forcefully an alert message will be sent to the user, and the user is given an option to open the door or lock it right from his smart phone. This project can be customized a lot as it has multiple GPIO ports that can be programmed and they can give the user control over various things from his smart phone like security, surveillance, lighting, energy management, access control, entertainment etc. These interfaces are all possible by the help of the GPIO ports in the Raspberry Pi 2 board. In present times there is an increasing need for Home security due to thefts and threats. And the benefits of automation are obvious. It is like a home where the lights came on after dusk, doors open for the home owner etc. There is also a need for surveillance in today's world, as well as energy management. Nowadays the increase in various computing devices such as laptop, computers, mobiles etc. shows that users prefer things which are more comfortable to use i.e. rather than physically going to the place and controlling it doing the same thing remotely saves time. For example, if the Admin receives a message saying that there was a break in his house, he/she can connect to the internet and watch the video from the camera which is in the house to know what is happening. By receiving alerts on your device the user are informed of all possible issues occurring in the house and it gives them various possibilities to deal with the problems. This is how an automated system proves useful to people in providing them security, comfort and easily accessible.

2. Concept Review

2.1 Proposed System

In this system there is a PIR sensor which is connected to the door this sensor has a 180° range up to 1 to 2 meter approximately. This sensor is very much useful than the normal IR sensor which have a range in a straight line so this sensor is able to detect people even if they come from the side.

When a person comes in range of the sensor it sends a trigger pulse which activates an LED array and the camera, the led provide a good light environment

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for the camera to take a good photo and so there is no problem of a bad photo in which the persons face is not seen which can cause problems.

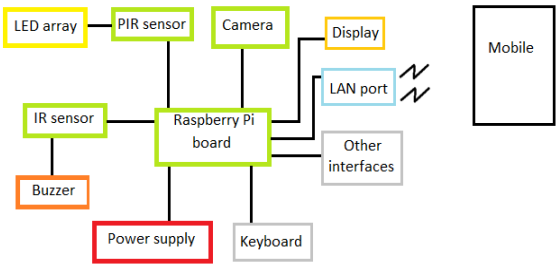

Fig.1 Block Diagram of the Proposed System

After the camera is activated it takes the photo of the person present in front of the door and sends a message to the user, also it sends the image to the users phone via FTP server which he downloads to check the person. There are also IR sensors connected in the house for safety i.e. if some person tries to break in the house through the window or the back door then the sensor will detect that and send a trigger pulse to the buzzer and activate it also a message is sent to the users phone so that he can take action, this precaution is also taken care of in this project. Once the person is recognized by the user then he will allow him to enter the house. This is how the project flows.

2.2. Hardware description

In this system there are various hardware devices used which are given below:

2.2.1. Raspberry Pi Board

Fig.2 Raspberry pi 2 Board-Model B

The Raspberry pi 2 board model B has a processor of 900 MHz CPU and 1GB RAM which almost acts like a mini computer. We installed NOOBS in the memory card used for the board and then with the help of NOOBS we can boot the raspberry pi with various operating systems. We have booted it with a LINUX based operating system called Raspbian which is mostly recommended (Amit Narote, Abhishek Dsilva, Selma Misquitta and Palak Khandelwal, 2015). There are also40 GPIO pins which can be used as both digital input, digital output and to control and interface with various other devices in the real world, 4 USB ports, 1 HDMI port, 1 Ethernet port, 1 3.5mm Audio jack, micro USB power supply. This board also has connections for connecting a camera and a display to it which really makes it a multipurpose and multiuse board.

2.2.2. Raspberry pi camera

Fig.3 Raspberry Pi camera

The Raspberry Pi camera module is used in this system to capture photos of the people. It is a 5 Megapixels fixed-focus CMOS camera which can be used to take High-definition videos and images. A 15cm ribbon cable comes with the camera which is used to connect the camera with the Raspberry Pi board (Pierre Raufast, 2013).

2.2.3. Motor driver

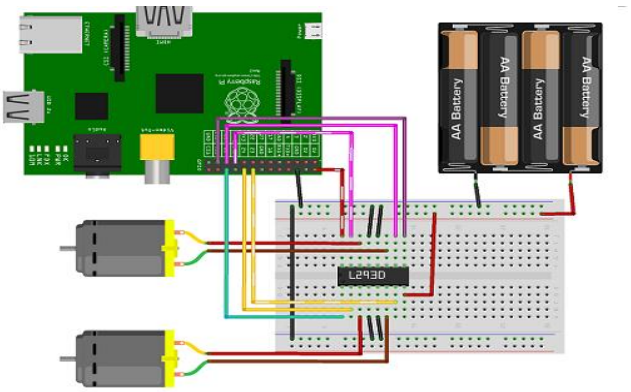

Fig.4 Motor Driver Circuit

The L293D is a typical Motor driver IC which allows the DC motor to be driven in either direction's according to the way it is coded. It is a 16 pin IC which can control two DC motors simultaneously in any directions with the help of the code. The IC uses an

input of 5 volt at pin 8 and16 as well as pin 1and 9 which is enable, the other pins 4,5,12 and 13 are grounded (Jason Barnett, 2014).

Working: The motors are controlled with the help of the inputs given from the Raspberry Pi to the IC. The inputs to the IC's pin no 2 and 7 are for the first motor connected at pin 3 and 6. The inputs to pin 10 and 15 are for the second motor which is connected at pin no 11 and 14 as shown in the figure 4. The inputs are logic 0 or logic 1 given from the Raspberry Pi (Rakesh Ron, 2013).

2.2.4. PIR sensor

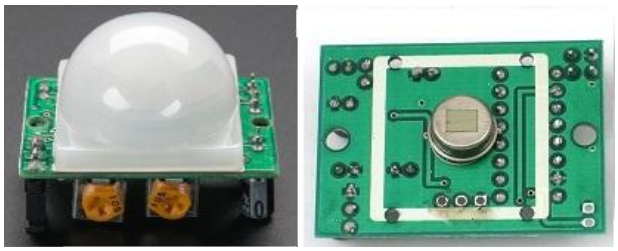

Fig.5 PIR Sensor

The PIR sensor is used to sense motion, they are used to detect if a person or object has moved in or out of the sensors range accordingly they send a trigger pulse. They are often referred to as PIR, Passive Infrared, Pyro electric, or IR motion sensors. PIRs are basically made of a Pyro electric sensor (which is shown in the figure 5 the round metal can with a rectangular crystal in the centre), it can detect infrared radiation from people. Everything emits some low level radiation, and the hotter something is, the more radiation is emitted (lady ada, 2014).

Input: It can be given a 3 to 9 volt input, but 5 volt is ideal

Output: It has a 3 volt pulse as an output when it detects motion pulse lengths are determined by resistors and capacitors on the PCB and they differ from sensor to sensor.

Sensitivity: It can range up to 10 to 12 feet (3 meters) and about 110° x 70° detecting range.

2.2.5. IR Sensor

Fig.6 Infrared Proximity Sensor

An Infrared proximity photoelectric sensor has a set of transmitter and receiver i.e. an IR led and a photo diode. It has a detection range is about 3-80cm depending on the components used in the sensor the range may vary (P.Vigneswari, V.Indhu, R.R.Narmatha, A.Sathinisha and J.M.Subashini, 2015). The IR sensor operates at an input power of 5V. When the sensor detects an object it sends a trigger pulse, the trigger pulse remains active till the object is in its range.

3. Product Description

3.1 PIR Sensor Module

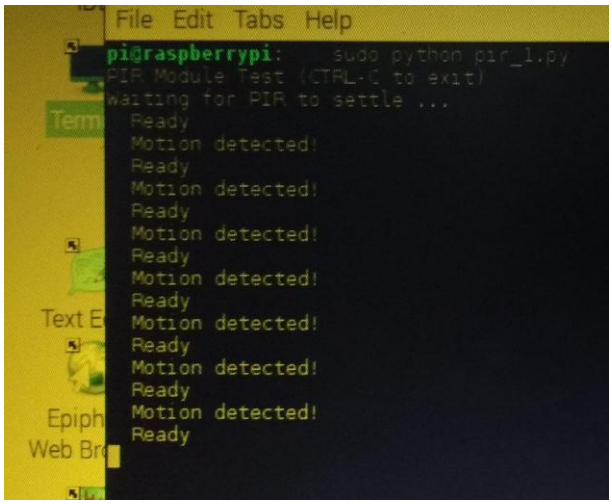

Fig.7 Terminal Output for PIR Sensor

In this module we have the PIR sensor as shown in figure 5. It senses if a person comes in its range and then it activates the camera. As shown in the above figure 7 when we run the program in the terminal the sensor activates and checks for any chances, so in the beginning it displays Ready in the terminal and when the sensor detects something it displays Motion detected!.

3.2 Motor Control Module

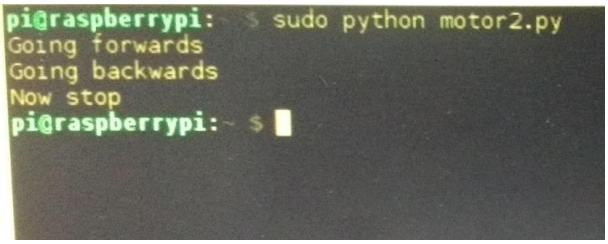

Fig.8 Terminal Output for Motor Driver Circuit

When we run the program of controlling the motors in the terminal as shown in the figure 8 it displays Going forward and the motors run in one direction after a particular time it displays Going backward and it rotates in the other direction and finally it stops. According to the Users need you can modify the

rotation of the motors which is controlled by the IC shown in figure 4.

3.3 Remote Control Module

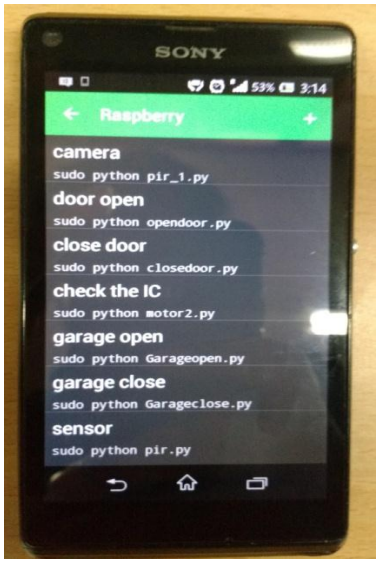

Fig.9 Remotely controlling the Raspberry Pi from a mobile phone

For remotely controlling the Raspberry Pi we use an application which connects to the Raspberry Pi by the SSH connection protocol here we give the IP address of the Raspberry Pi to the Application and we run the terminal commands from the application as shown in the figure 9.

3.4 Messaging via API Module

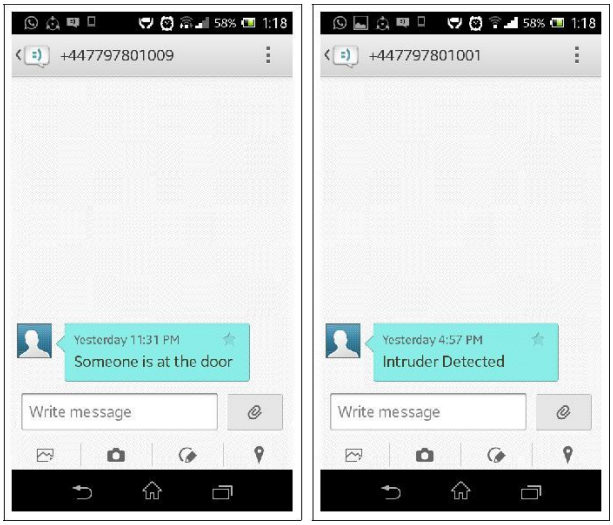

Fig.10 Messages send from the API

As shown in the figure 10 we use the API of a messaging website to send a message to the user's mobile phone which alerts the user about the changes in his house, so he can take the actions according to the message he has received.

4. System Testing

In this section we will be testing the various Modules.

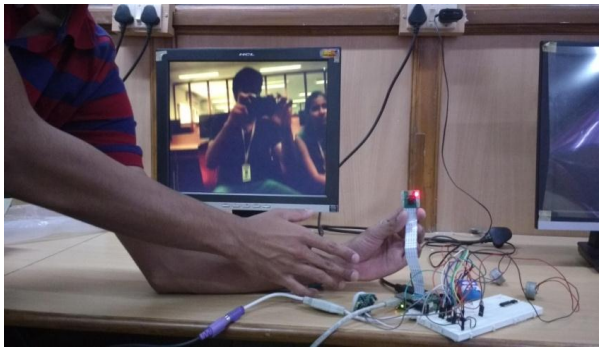

Fig.11 Testing the working of the PIR sensor

As shown in the figure 11 we checked the response time of the PIR sensor and how it activates the camera, the image is clicked and displayed on the monitor. The camera has a red light which indicates that it is active.

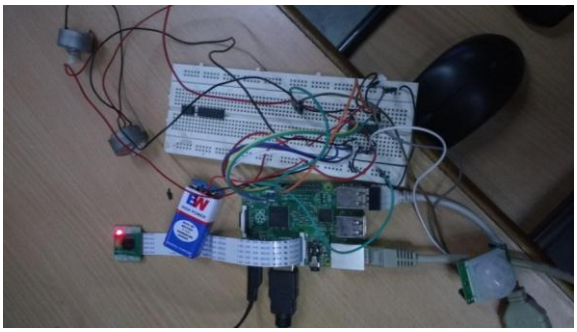

Fig.12 Testing the Motors

In the figure 12 we checked how the motors respond to the signal sent from the mobile phone, also about the time they are active when the signal is sent.

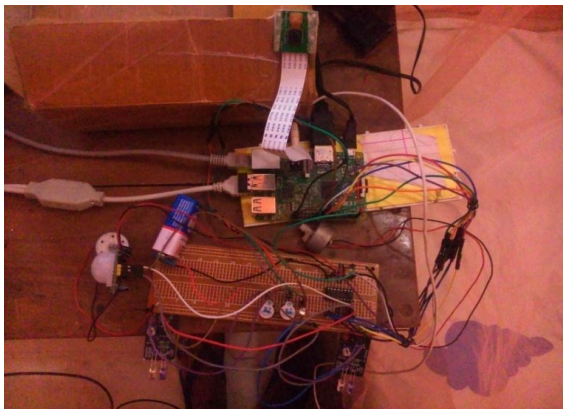

Fig.13 Connections done on PCB

After finalizing the components and testing them as shown above we have connected the components on a PCB and soldered them together as shown in figure 13.

5. System Functionalities

- Security using door lock and open control.
- Video streaming mode.
- Appliance control mode.
- Using FTP server to send image to the user to check.

5.1. Operating Environment

5.1.1. Hardware Requirements

A. Server device

- Raspberry Pi 2 B+ board.
- 5 Megapixel CMOS Camera.
- PIR Sensor.
- IR Sensor's.
- LED array.

B. Host device

- An Android device with minimum of 512 Megabytes of RAM and a 1 GHZ processor.
- 100MB of free space.

5.1.2. Software Requirements

A. Server device

- Raspbian Linux Open OS.
- Python.
- Scratch.
- Espeak.
- Proftpd.

B. Host device

- Minimum required Operating System – Android Gingerbread 2.3.2
- A running FTP client.
- An application to control the pi using SSH server.

5.2. Algorithm

Step1.1. The Raspberry Pi detects a person by the help of the PIR sensor.

Step1.2. It activates the LED array for better lighting conditions which are favorable for better accuracy of the image.

Step2. The camera takes a photograph of the person after the PIR sensor is triggered. Meanwhile the LED array is on.

Step3. After the photo is clicked the image is sent from the FTP server of Raspberry Pi to the user's phone.

Step4. Later a message is sent to the users phone with the help of a Message API, which gives him the message Someone is at the door so he knows that an image is sent to him via FTP.

Step5. The user downloads the image and checks who the person is.

Step6. After checking, the user sends a command using the application in his phone which converts text to speech, and tells the person the message stored in the program or if he wants him to enter then he will send a command to open the door.

Conclusion

The proposed project provides security and various ways to control the devices in the house, it makes ones living comfortable and at the same time easily accessible through portable devices like mobile phones. It gives the administrator all the rights to decide which makes it reliable as it always asks before taking a decision, which helps when there are necessary decisions to be taken and they can be taken fast in case of an emergency.

Future Scope

The Raspberry Pi is a really compact processor which has a good enough computing power for its size. As now there is an increase in technologies and various portable devices in those devices may be one day the raspberry might also be used as it has multiple GPIO pins which can be programmed and used to interface various devices in the real world and can be controlled with a program in Python.

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