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Abstract

This paper attempts to develop a home security and automation system using Raspberry Pi (RPI) module which is a low-cost single-board computer that would transform an electric device to a smart node that can communicate with other smart devices. The system composes of camera, PIR motion sensor, vibration sensor, gas sensor, electric door locker, bulb, and alarm. Therefore, it has a function of 1) detecting thief breaks through the windows by using vibration sensors 2) watching unwanted person inside the house by using camera, motion sensor 3) detecting gas leakage by using gas sensor 4) turning on/off the door locker and the bulb. In addition, the house owner and a policeman will get an alert message if the house is in unsecured situation.

Keywords: home security, home automation, pervasive computing, raspberry pi

Introduction

Nowadays, many researchers are interested in developing technologies that brings computers into a part of life. Many types of appliance are embedded with a very tiny microcontroller and a wifi chipset so that users can control or operate it over the Internet via a smart handheld device. This creates Pervasive Computing Environment (PCE).

Pervasive computing or ubiquitous computing briefly is a concept in software engineering where computing exists everywhere, i.e., occurs anytime, anywhere, any location, any format and using any devices. A microcontroller can be embedded into appliances, including clothes, refrigerator, light, wallet, travelling luggage, etc. Clothes,
for instance, can constantly track human heart rate, and even pay for morning coffee without grabbing a wallet. Refrigerators order eggs before they run out. Lights and air conditions are turned on before members are arriving home. The home door messages the proprietor when unwanted person breaks into the house. These are examples of PCE.

Raspberry Pi (RPI) 3 model B is a low-cost single-board computer that would transform an electric device to a smart node that can communicate with other smart devices.

A few issues are involved in designing and implementing home security and automation system including simplicity (ease of use and setup), scalability, reliability, and pricing. Many researchers have proposed different home security and automation systems using different technologies. In that, Hasan, R., et al (2015) proposed a microcontroller with Bluetooth technology to implement home security system. With Bluetooth technology, the system can be easy to set up and applicable cost. Hudijono, S., et al (2014) discussed a modular home security system that enable to send system activation to home owner via SMS. It ran on Arduino uno platform, so that it is a simple and cost-effective solution. Lee, J. V., et al (2013) implemented a home security system with several sensor nodes. The PIC was employed as a central processing unit. This is too complicated but provides high performance level. Sharma, D. P. et al (2015) use a RPi to control home security and automation via Internet. The system can be controlled from anywhere, but the system designed is complicated and difficult to install. Park, Y. T., Sthapit, P., and Pyun, J. Y. (2009) implemented a digital door lock system and home automation using ZigBee sensor node. It is cost effective, Scalable, and easy to be installed. Sadeque R.K. and Farzana S.D. (2015) introduced a home automation system using an android mobile device. The system has simple security interface. Multi-level passwords are employed to make the whole system adaptable and reliable for the users.

This paper, therefore, attempts to develop a home security and automation system that easy to setup, new devices can be integrated into it, and with an acceptable price in secure and automate manner by means of RPi.
The Proposed System

In the proposed system, all devices are installed in a small house model of 40cm x 40cm. In addition, they connect to a Raspberry Pi (RPI) 3 model B so that the users can communicate with them via a smart handheld device. Camera, PIR Motion Sensor, Vibration Sensor, and Gas Sensor are employed for protecting home from unwanted situation such as robbery or gas leakage. The users can switch on or off the electric door locker and light bulbs via their smart phones. The IEEE 802.11n, which is a standard wireless protocol, is employed for communication between the system and the smart phone.

Figure 1 illustrates block diagram of the proposed system. The following subsection explain features and characteristics of each devices mentioned above.

1. Raspberry Pi 3 Model B Module

The Raspberry Pi (RPI) 3 Model B is a small size and low cost single board computer. It contains 1.2 GHz 64-bit quad-core processor, dual-band wireless LAN, low energy Bluetooth (BLE) 4.1, 4 USB 2.0 Hosts, fast Ethernet RJ-45 10/100 Mbps, HDMI, Audio and Composite Video 3.5mm 4-pole, CSI Camera, DSI Display, Micro SD Card Slot, and GPIO 40-pin. In comparison to the previous Raspberry Pi 2 Model B, this module has faster processing speed and on-board connectivity.

Figure 2 shows the Raspberry Pi 3 Model B module and its GPIO pinout diagram.
Figure 1. Block diagram of the proposed system

Figure 2. Raspberry Pi 3 Model B and its GPIO
2. Passive Infrared Sensor

For detecting human movement inside the house, a Passive Infrared Sensor (PIR), as shown in Figure 3, is employed. It is a small, low cost, low power, and ease of use sensor. It basically comprises of a pyroelectric sensor which can detect levels of infrared radiation from things. The sensor is split into two halves so that the signals are cancelling each other. If one half detects more IR radiation than the other, the output will swing high and vice versa. In Idle state, both halves detect the same amount of IR. The amount of IR radiation is from the walls or home’s appliances such as sofa, dining table, and TV. One half of the PIR sensor will be intercepted when someone pass by. The reverse happens when that person leaves that area.

Figure 4 illustrates how the PIM motion sensor works. This device is employed for detecting whether any unwanted person is inside the house.
3. **Vibration Sensor SW-18020P**

The vibration sensor switch model SW–18020P has two connectors. In idle state, there is no contact between the two. When external force applied on the sensor, two contact pins of sensor are then closed.

The SW–18020P sensor operates in maximum voltage range of 12V and maximum current value less than 5mA. During idle condition or no vibration detected, the sensor produces less than 5Ω. Its response time is as fast as 2ms, and its ambient temperature range is less than 100°C. Therefore, it is suitable for detecting thief breaking through the windows.
4. MQ-5 Gas Sensor

The MQ-5 Sensor is appropriate for home monitoring on LPG, natural gas, and coal gas. It has strong resistance to alcohol and smoke interference. The MQ-5 module has two output terminals: one for analog (A0) and the other one for digital (D0). The analog out is employed for detecting gas leakage as well as measuring volume of gas presence. In addition, the digital out is used for determining gas leakage with capability of triggering an alert system. The digital out has only two possible outputs which are high or low. Hence, it is not appropriate for measuring volume of gas leakage.

![MQ-5 Gas Sensor](image)

**Figure 6. MQ-5 Gas Sensor**

### Software Operation

On the smart phone, after running the application, all devices are initialized. The users can set status of each device individually to be on or off. Additionally, they can set up by using mode setup, which all devices are set up by one click. Three modes are available: Sleep, Evening Time, and Not at Home. On Sleep Mode, all devices are on which means that every device is operated, i.e., the house is in the most secured status. On Evening Time Mode, it is assumed that everyone is home so that camera, motion sensor and vibration sensor do not have to operate. Only the gas sensor and the light bulb are set up in on status. Table 1 shows setting up status of each device in each mode.

After the system is switched on and all the devices were set up, the system run in a normal situation. If any sensor retrieves value “1”, it denotes as an
abnormal situation. For any abnormal situation, the users will be informed via a message through the application, the alarm is on and data is written into the log file.

Figure 7 -

Figure 9 show principle of software operation. Note that the light bulb and electric door locker are only switch on or off, so they might not include in the software operation flowchart.

Table 1. Devices status with mode setup

<table>
<thead>
<tr>
<th>Devices</th>
<th>Sleep</th>
<th>Evening Time</th>
<th>Not at Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>PIR Motion Sensor</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Vibration Sensor</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>MQ-5 Gas Sensor</td>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
<tr>
<td>Light Bulb (in garden)</td>
<td>On</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>Electric Door Locker*</td>
<td>On</td>
<td>Off</td>
<td>On</td>
</tr>
</tbody>
</table>

* Electric Door Locker “On” means “locked”, “Off” means “unlocked”
1981

Figure 7. Software Operation

Figure 8  Set Status Subprocess
Experimental Results

An android software application for operating home security and automation system is developed. A small house model of 40cm x 40 cm size is equipped with Raspberry Pi 3 model B and all the devices. Every device is testing, and the results are shown in Figure 10 - Figure 15.
Figure 10. (a) Log-in Page  (b) Main Menu Page

Figure 11. Controlling light bulb (a) On  (b) Off
Figure 12. Controlling electric door locker (a) Off   (b) On

Figure 13. Testing Vibration Sensor by breaking the window (a) normal situation (b) window is broken down (c) status shown on application

Figure 14. (a) PIR Motion Sensor Testing (b) results
Conclusion

This paper attempts to propose a home security and automation system which operate in pervasive computing environment. All devices (including camera, motion sensor, vibration sensor, gas sensor, light bulb, and electric door locker) are mounted with a Raspberry Pi 3 Model B. An android software application is developed to make control of the devices. The experimental results show that all devices are well operate so that the home will be more secured with some level of automation.

References


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