Development of Smart Security System for Remote Control Using Small Computer

Huda AL-SAFFAR[1], Ergun ERÇELEBİ[2]
[1,2]Gaziantep University, Electrical and Electronics Engineering, Gaziantep, Turkey
[1]**msc.computereng89@gmail.com**

Abstract

The aim of this paper is to develop a smart security system for remote control using a small computer. In this paper, it has been proposed a comparatively inexpensive security system which has the capability to automatically initiate capture a picture by Raspberry Pi Camera Module when any movement is detected by PIR sensor and the Raspberry Pi device will send that picture to the user's smartphone device via Wi-Fi using application. Also, the system will light up the light bulb and LEDs when motion is detected. In addition, this system can be counted the number of moving objects located with the help of the infrared PIR sensor and will be sent that number with notification message "Motion Detection" to smartphone alongside the picture. The proposed system is very effective and crucial choice for energy save and security for home or service buildings. Nowadays, in electronic markets, there are many expensive solutions. However, low-cost solutions are very important for spreading between all people. Knowing that the Raspberry Pi 3 device and Telegram application were used in this proposed system.

Keywords: Raspberry Pi 3, PIR Sensor, Raspberry Pi Camera Module, Relay, Smartphone.

Küçük Bilgisayar Kullanarak Uzaktan Kumanda için Akıllı Güvenlik Sisteminin Geliştirilmesi

Özet

Bu makalenin amacı küçük bir bilgisayar kullanarak uzaktan kontrol edilebilir akıllı bir güvenlik sistemi geliştirmektir. Bu yazıda, PAS hareket sensörü PIR hareket tespit ettiğinde Raspberry Pi Kamera Modülü tarafından otomatik olarak fotoğraf çekebilen ve bu fotoğrafı Wi-Fi üzerinden bir uygulama vasıtasıyla kullanıcının akıllı telefonuna gönderen entelektüel güvenlik sistemi önerilmiştir. Ayrıca, sistem PIR hareket tespit ettiğinde ışık ampulünü ve LED'leri aydınlatır. Buna ek olarak, bu sistem, kızılötesi PIR sensörü vasıtasıyla hareket eden nesneleri tespit ettikten sonra, sayısını ve görüntülerini "Hareket Algılama" bildirim mesajıyla birlikte akıllı telefona gönderir. Önerilen sistem, ev ya da hizmet binalarında enerji tasarrufu ve güvenlik için etkili ve önemli bir seçimdir. Günümüzde elektronik pazarlardaki güvenlik çözümleri çok pahalıdır. Fakat, düşük maliyetli çözümler bu sistemlerin tüm insanlar arasında yaygınlaşması için çok önemlidir. Önerilen sistemde Raspberry Pi 3 cihazı ve Telegram uygulaması kullanılmıştır.

Anahtar Kelimeler: Raspberry Pi 3, PIR Sensörü, Ahududu Pi Kamera Modülü, Röle, Smartphone.

1. Introduction

Security is the first attention in everywhere, every time and for everyone. Each person who wishes to be his home and service buildings in safety [1]. The microcontroller in this system is the small computer is Raspberry Pi 3. Obviously, Raspberry Pi 3 is a single board which, when it is interfaced with the screen, keyboard, mouse and installed the operating system to be able to achieve the functions for any computer. The Operating System (OS) is the collection of programs and instructions that make the Raspberry Pi 3 run. In addition, the operating system whose works in Raspberry Pi 3 based only on Linux operating systems such as Raspbian OS and NOOBs [2]. It is worth to mention that, in this system, Raspbian OS version Jessie with PIXEL is installed in the Raspberry Pi 3 and the python programming language was used to programming the project program.

This project describes a smart security system for all homes and service buildings that can monitor any place in it. The system has been able to detect any object movement, turn ON/OFF light bulb and LEDs when an object moving in light day or darkness, take a picture, count the object moving number and automatically send the data to a smartphone via Wi-Fi using Telegram application. The data include the picture and notification message "Motion Detection" with moving object number located.

The advantage of using this system is that, it is a very crucial choice for energy save and home security. Also, another advantage is that it is a simple circuit and able to work at any time in the light day or darkness [3]. The other major advantage is that it is very economic system and it can be placed anywhere [4].

2. Design and Implementation of Proposed System

The design and implementation of a low-cost system monitoring based on Raspberry Pi 3, a single board computer which interfaced with PIR Sensor, Raspberry Pi Camera Module, LEDs and relay and controlling them by implementing program written in python language in software implementation. The block diagram of this system is illustrated in Figure 1 below.
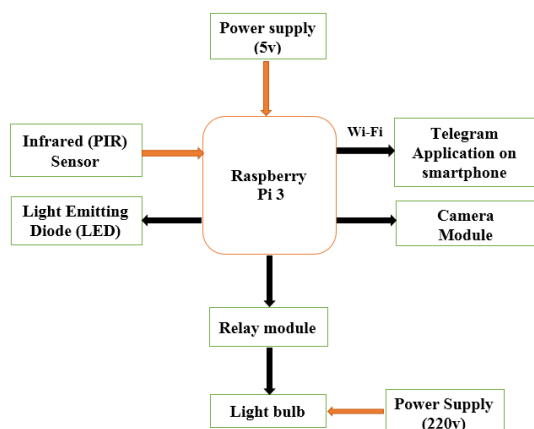

Figure 1. Block Diagram for the proposed system

To improve and facility the algorithm for the proposed system, the algorithm is separate into two parts which are motion detection part and lighting part. The system implementation begins when connecting the Raspberry Pi 3 and relay to the power supply. Knowing that the starting number for image counter is 1.

Firstly, if there is no motion detected by the PIR sensor, the program will turn OFF the LEDs and suspends the program for 1 second and directly return back to check the motion detection.

Secondly, if the motion is detected by PIR sensor the program will turn ON the lighting part and then the camera module will capture the picture and stores it in micro SD card. After that, the program will send the picture taken and notification message "Motion Detection" with the object number located directly to smartphone by Telegram application every time a motion is detected to alert the owner which having a smartphone and then the program will increment the counter image by 1 and subsequently turn OFF light bulb to energy save after that the program will suspend for 10 seconds before return one more time to check the object movement. The lighting part consists of LEDs and light bulb.

Besides that, the security system will stop when separating the power supply. The flowchart for the proposed system is shown in the Figure 2 and the block diagram of the lighting part is shown in Figure 3.
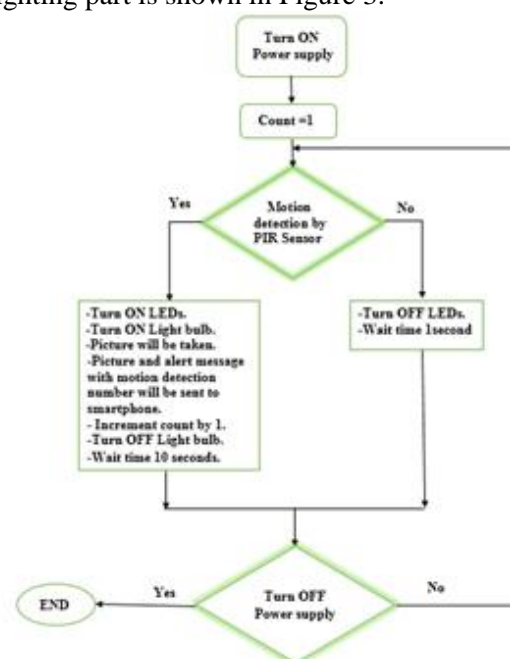

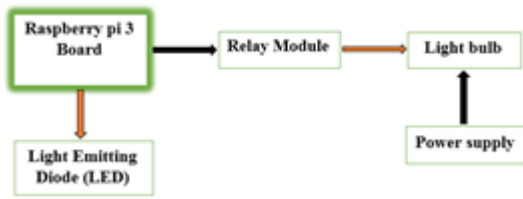**Figure 2.** Flow Chart of proposed system

Figure 3. Lighting system

Power Supply	5V and Up to 2.5 Amps
Audio Output	3.5 mm, 4-track composite video and audio output jack
Dimensions	85.6mm x56mm x21mm
Price	35$

3. System components description

The major components of the proposed system are Raspberry Pi 3 Model B, Passive Infrared (PIR) Sensor, Raspberry Pi Camera Module, Relay, Power supply, LED (Light Emitted Diode), Telegram Application on smartphone and GPIO pins configuration.The block diagram for the proposed system illustrated in Figure 1.

3.1. Raspberry pi 3 Model B

Raspberry Pi is a small credit card sized, single-board computer. It was more useful for projects which require very low power and used for computer science education. The amazing new version of Raspberry Pi is Raspberry Pi 3 Model B. This third generation model developed by the Raspberry Pi Foundation Company in the UK [5].

Table 1. Specification of Raspberry Pi3 Model B.

Specification	Description
SoC (System on Chip)	Broadcom BCM2837
CPU	64-bit, ARMv7 , Quad cortex A53 @ 1.2GHz
GPU	400 MHz video Core IV 3D graphics Core
RAM	1GB SDRAM
SD Card Slot	Micro SD Card Slot (Push-Pull)
GPIO	40 Pin
USB 2.0	4 Ports
Bluetooth	Bluetooth 4.1, BLE(Bluetooth Low Energy)
Wireless LAN	802.11n Wi-Fi
Ethernet Port	10/100 LAN Port
HDMI Output	Full-size HDMI Video Output

The proposed system used Raspberry Pi 3 Model B that consists of the key specifications as illustrated in Table 1 and Raspberry Pi 3 board in Figure 4.
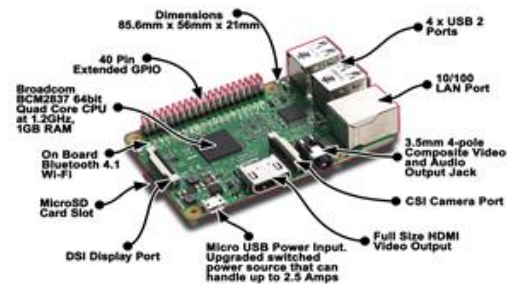

Figure 4. Raspberry Pi 3 Model B board

3.2. Passive Infrared (PIR) Sensor

PIR sensor is an essential part of this proposed system. The object will emit infrared (IR) radiation through his movement. PIR is an electronic sensor that used to detect the object motion by receiving the infrared (IR) radiates light from the external environment. Hence, the sensor compares the intensity of the infrared radiation from time to time. If there is an object movement in the room, then the intensity changes, it causes detecting the object movement. Knowing that the range for PIR sensor can up to 5-7 meters[3]. The PIR Sensor is small in size, inexpensive in price, used low-power, easy in use and connectivity. They are often referred to as PIR, Passive Infrared, Pyroelectric, or IR motion sensors[6]. In this proposed system the HC-SR501 PIR Sensor Module is used.

Figure 5. PIR Sensor

3.3. Raspberry pi Camera Module

The Camera Module Rev 1.3 is a camera that created specifically for Raspberry Pi model A and B. It is manufactured by the Sunny company. It provides high sensitivity, very small PCB design, price almost 25$, lightweight design and 5-megapixel resolution image. The camera module connects to Raspberry Pi 3 by CSI (Camera Serial Interface) connector using a 15cm ribbon cable to the 15 pin CSI connector [7].

Figure 6. Camera Module

3.4. Relay Card

A relay is an electrical switch that is used to control high voltage by using very low voltage and as an input (GPIO pins). It is used to control several circuits by one signal [8]. The relay card consists of two parts. The first part of the right side in Figure 7 below, it consists of a ground, a control pin to switch ON/OFF depending on the state and a 5V power pin for the relay card itself. The second part on the left side, will be connected to the load device, it contains 3 cards:

- NC means (Normally Closed): this indicate to that when the relay card has 0 on the control pin (no input signal), the connected circuit active. COM is connected to this thing when the relay coil is off .
- NO means (Normally Open): this indicate to that, on the reverse, when the relay card has 1 on the control pin (value of 5V applied to the relay card) will switch off the circuit and vice versa. COM is connected to this thing when the relay coil is on.
- COM means (Common): always connected, it is the moving point of the switch.

Besides that, only two relay plugs will be used in accordance with the selected operating mode. The Raspberry Pi sends a low current on its GPIO pins whether at 0 or 1. This a weak current is enough to excite the relay. In this proposed system the SRD-05VDC-SL-C sainsmart 2 relay module is used and the light bulb is load used for relay card. The light bulb was worked like the flashlight for the camera module.

Figure 7. Relay Card

3.5. Power supply

The proposed system needs of two power supplies. The first one used for Raspberry Pi3 board is Micro USB connector that supplied at least 5V at up to 2.5Amps is main for the proposed system. It is worth to mention that,many smartphone chargers are appropriate for Raspberry Pi [9]as shown in Figure 8 below. The second one used for the light bulb is 220V.

Figure 8. Power supply adapter for Raspberry Pi

3.6. LED (Light Emitting Diode)

Electronic pieces resemble small lamps work to convert electricity to light and are available in different colors. In this system, the 5MM white

LEDs are used to improve lighting for an image which captured by the camera module.

Figure 9. White LED

3.7. Telegram Application on a Smartphone

The telegram is a cloud-based mobile and computer messaging application with a focus on security and speed. The telegram-cli is a private library for telegram application which provides a possibility to send any file type from Raspberry Pi to smartphone and from the smartphone to the Raspberry Pi.

Figure 10. Telegram Application on Smartphone

3.8. GPIO Pins Configuration

The Raspberry Pi 3 has two rows of pins that called General Purpose Input Output (GPIO) connector which includes 40 pin connector. The Raspberry Pi 3 allows the peripheral devices such as sensors, LEDs…etc to connect directly to GPIO pins. Also, the GPIO pins allow control and interact directly with the Raspberry Pi processor [10].In addition,the Raspberry Pi 3 needs to install the libraries such as Rpi.GPIO that allows access to the GPIO pins using a programming language such as python. Besides that,the Rpi.GPIO library is used to install these pins as an input or output. The GPIO pins which

used in the proposed system are mentioned in Figure 11.

Figure 11. GPIO pins layout for proposed system

4. Results

The security system is developed which result is represented in the Figure 12 and Figure 13.
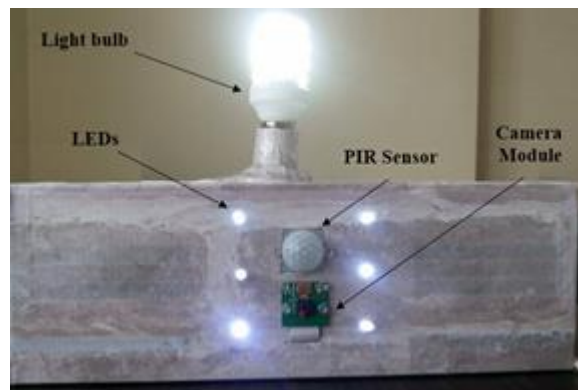

Figure 12. The security system at the moment of take the picture if motion is detected

Transmission of Image, Message and The number of persons located via Wi-Fi internet to a smartphone.

Figure 13. The result of proposed security system in smartphone

5. Conclusion

This paper presents a new smart security system that able to monitor any movement in the room .Besides that, this movement will be detected by using PIR sensor. The smart security system able to give monitoring information (image, a notification message with the numbers of people sites) in real time to alert the user through Telegram Application .Hence, the Raspberry Pi 3 has two basic components interacting with each other: one is the Telegram Application that executes on the smartphone device's browser and server side scripts that run by the Raspberry Pi 3 Hardware tool component. This security system works immediately when turning ON the power supply for the system and no need for the user to execute the smart security system.Additionally, this system is the very effective and the crucial system choice for several reasons belong to inexpensive, consumes low power, simple circuit, and advanced system.

6. References

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