JANUARY,2018 M.Sc. in Electrical and Electronics Engineering HUDA GHANEM ALSAFFAR

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DEVELOPMENT OF SMART SECURITY SYSTEM FOR REMOTE CONTROL USING SMALL COMPUTER

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Prof. Dr.Ergun ERÇELEBİ

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Huda ALSAFFAR

ABSTRACT
DEVELOPMENT OF SMART SECURITY SYSTEM FOR REMOTE CONTROL USING SMALL COMPUTER
HUDA GHANEM ALSAFFAR
M.Sc. in Electrical and Electronics Engineering
Supervisor: Prof. Dr. Ergun ERÇELEBİ
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The aim of this study is to develop a smart security system for remote control using a small computer. In this study, it has proposed a comparatively inexpensive security system, which is able to initiate the capturing picture automatically. Moreover, the system light up the light bulb and LEDs when motion is detected. In addition, the system counts the pictures which are captured by the camera module. The system uses Wi-Fi and Telegram Application to send; the number of captured picture with notification message "Motion Detection", and the picture, to the smartphone device. The proposed system is a very effective crucial choice for saving energy with a security for home and service buildings. Nowadays, in electronic markets, there are many expensive solutions. However, low-cost solutions are very important for spreading between all users.

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

ÖZET

KÜÇÜK BILGISAYAR KULLANARAK UZAKTAN KUMANDA IÇIN AKILLI GÜVENLIK SISTEMININ GELIŞTIRILMESI

ALSAFFAR, HUDA GHANEM
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Tez Yöneticisi: Prof. Dr. Ergun ERÇELEBİ
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66 sayfa

Bu makalenin amacı küçük bir bilgisayar kullanarak uzaktan kontrol edilebilir akıllı bir güvenlik sistemi geliştirmektir. Bu çalışmada, hareket tespit ettiğinde otomatik olarak fotoğraf çekebilen, nispeten ucuz bir güvenlik sistemi önerilmiştir. Ayrıca, sistem hareket tespit ettiğinde ışık ampulünü ve LED'leri aydınlatır. Buna ek olarak, bu sistem kamera modülü tarafından çekilen fotoğrafların sayısını belirler. Sistem çekilen fotoğrafları ve sayısını "Hareket Algılama" bildirim mesajıyla birlikte akıllı telefona Wi-Fi vasıtasıyla kullanıcıya Telegram uygulaması üzerinden 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.

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

To My Family

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LIST OF SYMBOLS/ABBREVIATIONS

PIR	Passive Infrared
Wi-Fi	Wireless Fidelity
LED	Light Emitting Diode
OS	Operating System
PIXEL	Pi Improved X Windows Environment Light weight
IR	Infrared
SD	Secure Digital
TV	Television
USB	Universal Serial Bus
LCD	Liquid Crystal Display
IoT	Internet of Things
SMS	Short Message Service
GSM	Global System Mobile
BLE	Bluetooth Low Energy
SoC	System on Chip
GPU	Graphics Processing Unit
SDRAM	Synchronous Dynamic Random Access Memory
ARMv7	Advanced RISC Machine version7
GPIO	General Purpose Input Output
HDMI	High Definition Multimedia Interface
BCM	Broadcom

HD	High Definition
RJ45	Registered Jack 45
CSI	Camera Serial Interface
DSI	Display Serial Interface
PiTFT	Pi Thin Film Transistor
SDA	Data line
SCL	Clock line
I2C	Integrated Circuit
SPI	Serial Peripheral Interface
MISO	Master Input Slave Output
MOSI	Master Output Slave Input
SCLK	Serial Clock
CE	Chip Enable
UART	Universal Asynchronous Receiver Transmitter
TXD	Transmit pin
RXD	Receive pin
HAT	Hardware Attached on Top
AMD	Advanced Micro Devices
NOOBS	New Out Of the Box Software
RISC	Reduced Instruction Set Computer
VNC	Virtual Network Computing
FAT32	File Allocation Table 32
IP	Internet Protocol
SSH	Secure Shell
FTP	File Transfer Protocol

CLI	Command Line Interface
PCB	Printed Circuit Board
NC	Normally Closed
NO	Normally Opened
COM	Common
API	Application Programming Interface

CHAPTER 1

INTRODUCTION

1.1 Background

In the present day, security is the first attention in everywhere, every time and everyone, everyone wishes to be secured in the home, company, office, etc (PRIYANKA and REDDY, 2015). Service buildings are always exposed to theft or invasion, so the existence of the extremely effective security system is very necessary and crucial in each building. Furthermore, the security system is not used only in a monitoring, but also for other purposes, such as when the baby sleeps alone in the bedroom will need to monitor by his mother, to facilitate this thing placing security system in the baby bedroom.

Usually, the system extremely effective means extremely expensive because the users need to spend a lot of money for the setup system, buy equipment for the system, monthly monitoring fees, and even guarantees of the system (Noorshafiza, 2011). In order to help users with an effective security system with low price to be secured, it is proposed this study to focus on the development of smart security system for remote control using a small computer.

The microcontroller for this system is Raspberry Pi. The Raspberry Pi works at the server and it is programmed using python language. In addition, all other hardware components for this system which attached to Raspberry Pi, the operating system is installed in Raspberry Pi 3 which is Raspbian OS version Jessie with PIXEL from Linux-based operating systems.

1.2 Scope of the thesis

This study investigates a smart security system for homes and service buildings which able to capture an image in the real time when any movement is detected. This system able to count the number of images which captured by the camera. Also, it is able to send the information with notification message "Motion Detection" immediately to the smartphone by using Telegram application via Wi-Fi. The PIR sensor has been used to detect any movement by measuring the changes of infrared (IR) radiation. The camera module has been utilized to capture the image of movements. Furthermore, if the movement is detected by the PIR sensor, the lighting system will be lighted up. The lighting system consists of LEDs and light bulb.

This system is a very effective crucial choice for saving energy with a security for home and service buildings. In addition to that, it is a simple circuit in design with the ability to work at any time in light day or darkness. The major advantage of this security system is a very economical with easy to place it anywhere.

1.3 Objectives of the thesis

The present study has pointed out the need to improve the knowledge about simple security system by using Raspberry Pi 3, the following tasks were achieved in order to accomplish the objective of this study:

- Proposing flash lighting part to improve the resolution of the captured picture when the movement occurred.
- To design and develop low-cost with high-resolution security system using Raspberry Pi 3 Model B.
- Using “Telegram application” smartphone to makes the security system more easy to use.

1.4 Layout of the thesis

This thesis consists of five chapters:

Chapter 1 provides information about the topic and gives brief information about the security system. The objectives of the thesis and research significance are also defined within this chapter.

Chapter 2 provides the literature review of security systems of Raspberry Pi with different devices. Furthermore, the explanation of Raspberry Pi 3 board in details.

Chapter 3 dealing with the realization of proposed smart security system which includes an overview of a proposed system with the preparation of Raspberry Pi 3. Finally, this chapter discusses the hardware components that are used in the system.

Chapter 4 provides results and discussion of the implementation of smart security system.

Chapter 5 provides Conclusions resulted from this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents a background all about literature review that related to the smart security system besides mentioning of the essential device of Raspberry Pi 3 board. It is worth to mention all relevant previous studies that focused on the security smart system, to gain useful knowledge and skills that can use it to develop the scope of this study.

2.2 Review of the previous studies

Nowadays, there are many advanced systems used the mini-computer Raspberry Pi, for instance, security systems. The Raspberry Pi works in many security systems as a microcontroller which is interfaced with different kinds of low voltage devices such as sensors, relays, cameras, LEDs, etc. There are some of the literature reviewed for security systems project:

V. P. Priyanka and K. S. Reddy (PRIYANKA and REDDY, 2015) are proposed a security system that can use to monitor in the home or any other service place. They used Raspberry Pi as a controller connected with two different kinds of cameras; the first one to capture a picture and the second one to record a video and sent it to show it by TV monitor, in addition to interface between different sensors such as PIR sensor and temperature sensor. In this system, when a motion is detected, the captured picture sent it to user by email via Wi-Fi dongle.

H. Nguyen, et al. (Nguyen et al., 2015) have developed a cheap monitoring system based on Raspberry Pi Model B+, it depends on a motion detection algorithm to decrease the cost and storage usage. In this system, when the motion is detected by

using specific algorithm, the camera will transmit live video and show it by web browser or mobile in the same time of occurring.

N. Chowdhury, et al. (Chowdhury, Nooman and Sarker, 2013) developed the system that used to attach any door with the internet network, so this system could be controlled from anywhere in the world. If the user is outside the home and the visitor is at his door steps, then the authorized visitor will be informed about the visitor by Twitter application and the person can see the visitor from the web through the camera from any place. Also, after that, the system will capture the picture of the visitor person and save a record by sending an attachment file through E-mail or tweet in the Twitter application. In addition, if the authorized person requests to give a text message, it can be sent simply through the Internet and it will appear on a screen placed on the front of the door. This system has the ability to control the door lock through the internet.

Y. Narkhede and S. Khadke (Narkhede and Khadke, 2016) implemented smart monitoring system by using Raspberry Pi, USB camera, LCD 16x2, Relay and some sensors (PIR, Light, Temperature). In this system, when motion is detected, the camera starts capturing the picture and recording video for future playback, this informations are sent through the 3G modem to the smartphone using web application.

A. N. Ansari, et al(Ansari *et al.*, 2015) described a security alarm system which used Internet of Things (IoT) with Raspberry Pi. The IoT is a communication between two different things. In this system, the IoT used to helps monitor. Also, when motion is detected, it gets alarms and sends photos and videos captured by USB camera directly to cloud server. This system does not need any amendments to the infrastructure.

R. Chandana, et al. (Chandana, Jilani and Javeed Hussain, 2015) have developed a smart security system using Raspberry Pi Model B with Thing speak. Thing speak is a platform providing various service exclusively targeted for building IOT applications. The Gyro sensor 6-axis real time is visualized in the form of charts

in Thing apeak, this system has feature that the Raspberry Pi camera will only work when signal is detected, hence it can save a lot of power computer to that of the previous surveillance. This system is small portable security system suitable for office security and home.

P. Vigneswari, et al.(Vigneswari *et al.*, 2015) developed the security system to provide high-level security. Whenever a person enters into the room, the fans and light will automatically switch on. At the same time camera is also switched on and it takes the image of the person who has interrupted. The user is alerted by sending an SMS with the link using GSM modem.

P. Patel, et al. (Patel, Choksi, *et al.*, 2016) designed surveillance system that used Raspberry Pi 2 Model B with a good resolution, cheap price and Low power consumption. In this system, whenever motion is detected by PIR sensor the USB camera will captures the picture and stored it in Raspberry Pi and then get notifications with the help of IoT. The android application is used to get the notifications.

S. Prasad, et al. (Prasad *et al.*, 2014) designed smart home security system by using Raspberry Pi model B and PIR sensor. It increases the usage of mobile technology to provide essential security to homes and for other control applications. The proposed home security system captures information and transmits it via a 3G Dongle to a Smart phone using a web application. Raspberry pi operates and controls motion detectors and video cameras for remote sensing and surveillance, streams live video and records it for future playback. It can also find the number of persons located with the help of the Infrared sensor. Neccesary action can be taken in short span of time in the case of emergency conditions such as elderly person falling sick, military areas, smart homes, offices, industries etc.

T. Ahmad, et al. (Ahmad, Studiawan and Ramadhan, 2014) developed relatively cheap security system which has the ability to detecting the object motion, which is a relatively cheap monitoring system which has capability of detecting an object (human), calculating its distance, determining its coordinate and taking its picture. These data are then sent to the user through email. This real time system has made it easier for the user to make a further decision. The experimental result shows

that this proposed monitoring system works well and is appropriate to use, even though in the condition when the light is low.

A. Antony and G. Gidveer(Antony and Gidveer, no date) designed economic system aims to monitor homes and offices based on the Raspberry Pi software. This system used some devices, for instance buzzer, webcam and PIR sensor. In addition to use motion detection software that allows the camera to take a picture and directly send it to the portable devices for live streaming and also send it to the email. This system is a comprehensive solution for secure all homes/offices.

S. Raja, et al. (RAJA *et al.*, 2014) designed and implemented the system of monitor home automation using the minicomputer for Mobile devices that benefit mobile phone technology in order to be provided essential security for our homes and service buildings. It is worth mentioning, the design of this system consists of Raspberry Pi, relay, PIR sensor and web camera.Additionally, the Raspberry Pi controls and manages the system work such as motion detectors by PIR sensor and video Camera for remote sensing and records live video and streams it for future playback. when any motion is detected, the camera automatically initiate recording the video and the Raspberry Pi alerts the user of the possible intrusion. Raspberry Pi consists of two main components operating with each other: the Web application that is used to executes on the mobile device and server-side scripts that run in a cloud which will be operated by the Raspberry Pi hardware tool component.

2.3 General information for Raspberry Pi

Raspberry Pi is the newest kind of computers in the world and many people do not know what any information about it. It can be defined as a small computer, low cost and credit card sized. It is a fully featured computer when runs the Linux operating systems and plugs into a computer monitor or television screen and uses a standard keyboard and mouse. On the other hand, nowadays every person has a special laptop computer, so in a certain way, we can use the screen, keyboard and mouse for the laptop. Raspberry Pi has the ability to doing everything like the computer such as browsing the website internet, playing video, word processing,

playing games, etc (Prajapati, 2015). It is extremely popular in different kinds of electronics projects. Besides that, it is gradually becoming popular among the students and researchers for learning programming in languages that supported by Raspberry Pi (Alee and others, 2013).

2.4 Raspberry Pi 3 Model B

The amazing new version of Raspberry Pi is Raspberry Pi 3 Model B which was released in early 2016.This third generation developed by Raspberry Pi Foundation company in UK whose specification is based on Raspberry Pi 2 Model B but with faster CPU, 400 MHZ video core IV graphics processor, having Bluetooth low energy (BLE) and Wi-Fi internet as shown in Figure 2.1.

Figure 2.1. Raspberry Pi 3 Model B board

Additionally, the Raspberry Pi 3 has achieved two long-awaited expectations. Hence, the faster came from that, the Raspberry Pi 3 is the first quad-core 64bit CPU computer so it is faster than Raspberry Pi 2 which have quad-core 32 bit CPU. The special attribute for Raspberry Pi 3 is that it has the same price for Raspberry Pi 2.

Table 2.1 summarizes major specifications of the Raspberry Pi 3 Model B compared to Raspberry Pi 2 Model B.

Table 2.1. Specifications of Raspberry Pi 3 Model compared to Raspberry Pi 2 Model B.

Specification	Raspberry Pi 3 Model B	Raspberry Pi 2 Model B
SoC (System on Chip)	Broadcom BCM2837	Broadcom BCM2836
CPU	64-bit, ARMv7 , Quad cortex A53 @ 1.2GHz	32-bit, ARMv7-A , Quad cortex A7 @ 900MHz
GPU	400 MHz video Core IV 3D graphics Core	250 MHz video Core IV 3D graphics Core
RAM	1 GB SDRAM	1 GB SDRAM
SD Card Slot	Micro SD Card Slot (Push-pull)	Micro SD Card Slot (Push-push)
GPIO	40 pin	40 pin
USB 2.0	4 ports	4 ports
Bluetooth	Bluetooth 4.1, BLE(Bluetooth Low Energy)	No
Wireless LAN	802.11n Wi-Fi	No
Ethernet Port	10/100 LAN Port	10/100 LAN Port
HDMI Output	Full Size HDMI Video Output	Full Size HDMI Video Output
Power Supply	5V and Up to 2.5 Amp	5V at 900 mA
Audio Output	3.5 mm , 4-track composite video and audio output jack	3.5mm , 4-track composite video and audio output jack
Dimensions	85.6mm x56mm x21mm	85.6mm x56mm x21mm
Price	35$	35$

2.4.1 Peripherals hardware required for Raspberry Pi 3 work

Raspberry Pi comes without any peripheral devices and it cannot start to operate alone, so it requires some additional hardware devices to operate it and to deal with it. These hardware devices are essential and must be used with Raspberry Pi. There is the brief description for each additional hardware device in the following points:-

2.4.1.1 Micro SD card

The Micro SD card is considered the most important additional piece because the Raspberry Pi 3 does not have the real disk drive as in a computer, so the Micro SD card is used with Raspberry Pi 3. It is responsible for storing the operating system and all the files that will be used with Raspberry Pi. Micro SD card as shown in Figure 2.2 (a) must be an area of 4GB up to 32GB as a maximum. Additionally, it is available in different speeds and divided into classes as shown in Figure 2.2 (b). Besides that, whenever the number of the class in increase whenever the Micro SD card is faster, better and certainly more expensive in price. Knowing that the running speed for Raspberry Pi will be affected by the type of the class.

(a) (b)

Figure2.2. Micro SD card (a) Micro SD card with Micro SD adapter (b) The relationship between classes and speed for Micro SD card

2.4.1.2 Monitor

Like any computer, the user needs to a display tool to interact with this minicomputer. Besides that, we can use any screen for TV or computer which have HDMI port to attach it with Raspberry Pi via HDMI cable as shown in Figure 2.3.

Figure 2.3. HDMI cable

2.4.2 Basic Components for Raspberry Pi 3 Board

The overview of the board of Raspberry Pi 3 Model B which contains the essential components as shown in Figure 2.4. Basic components with their benefits in the following points below:-

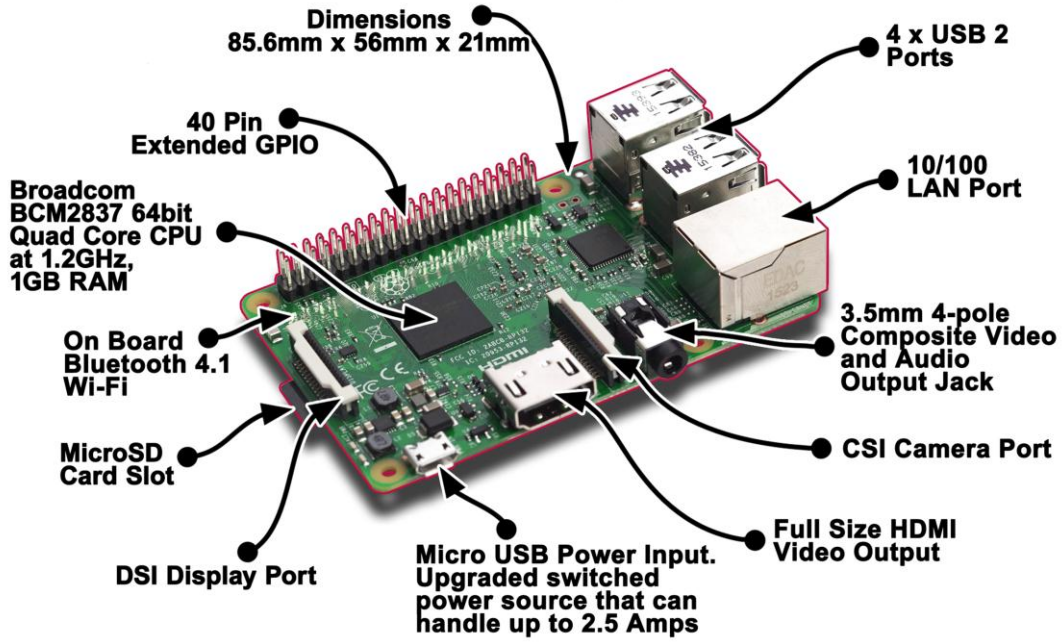


Figure 2.4. The essential components for Raspberry Pi 3 Model B board

2.4.2.1 SoC (Broadcom)

The most important component in Raspberry Pi 3 Model B is System on Chip (SoC) that is a Broadcom chip. This chip represents an integrated computer which consists of GPU, CPU and RAM. In this generation, the chip was upgraded to BCM2837, 64 bits, which provides 1.2GHz ARMv8 (version 8 architecture) quad-core CPU and 1GB RAM and 400 MHz video core IV, 3D graphics core GPU. The main component in this chip is the Central Processing Unit (CPU). It is responsible for executing the instructions of a Raspberry pi 3 programs by mathematical and logical operations. This chip is characterized by small dimensions (in the form of a square and length of 1 centimeter almost).

2.4.2.2 HDMI port

The full High Definition Multimedia Interface output port is used to connect the Raspberry Pi 3 with High Definition (HD) television screen, computer monitor or any screen which consist of HDMI port. This port comes out both audio and video to the HD television screen with a resolution of 640x350 up to 1920x1200 pixels (Pomyen, 2015).

2.4.2.3 Audio port

Audio connector is an audio output port. The Raspberry Pi 3 supports 3.5mm 4-track stereo output and composite video output and additionally, enabling the connection with headphones and speakers.

2.4.2.4 Ethernet port

Ethernet port is a network connector allows the communication between Raspberry Pi 3 and network. Moreover, the Ethernet port supplying a speed of 10/100 Mbit/s by an RJ45 local Area Network (LAN) cable. The LAN connection allows internet access to the Raspberry Pi 3.

2.4.2.5 USB port

The Universal Serial Bus (USB) connector allows the communication between Raspberry Pi 3 and any peripheral USB device such as a mouse, keyboard and webcam. There are four USB ports in Raspberry Pi 3 board each USB port provided is a 2.0 version.

2.4.2.6 CSI port

The Camera Serial Interface (CSI) input connector is used to connect the high-resolution cameras with Raspberry Pi 3 and specially manufactured for Raspberry Pi such as camera module.

2.4.2.7 DSI Display port

The Display Serial Interface (DSI) connector is used to connect Raspberry Pi to touch screens such as screens that used in smartphones, tablets and PiTFT. The PiTFT as shown in Figure 2.5 is a Thin Film Transistor display (Pomyen, 2015). The connection between Raspberry Pi and the display screen is done via a flexible flat cable.

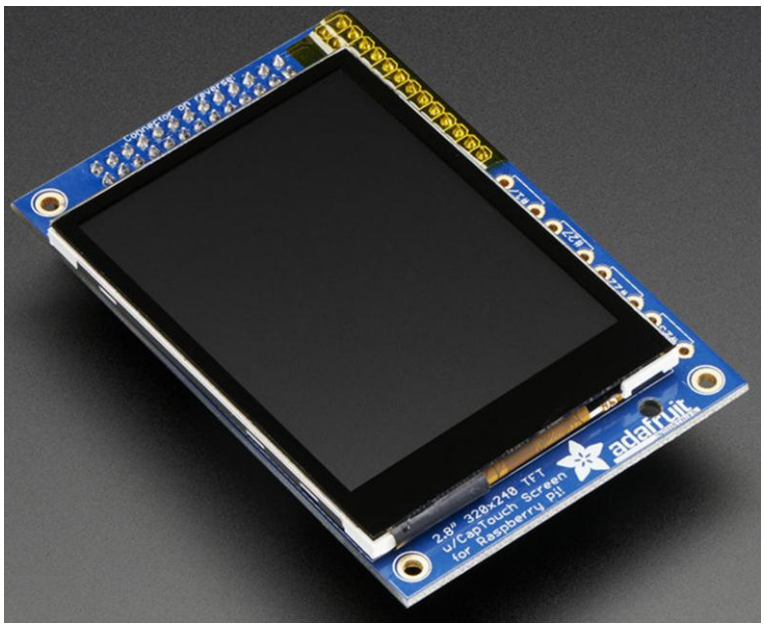


Figure 2.5. The PiTFT touch screen for Raspberry Pi

2.4.2.8 Micro SD card slot

The Micro SD card slot allows a communication between Micro SD card and Raspberry Pi3.Now in the third generation, the way to connect /disconnect Raspberry Pi 3 board with Micro SD card is push-pull.

2.4.2.9 Micro USB power port

The power port is used to supply Raspberry Pi 3 by power. In Raspberry Pi 3, the 5V Micro USB with upgraded switched power source that can up to 2.5Amp used. Additionally, the LED on the board indicates the Raspberry Pi 3 status. Hence, when it is powered, the LED appears red color and when the board connects to the network, the LED appears yellow color.

2.4.2.10 Extended GPIO pins

Raspberry Pi 3 has two parallel rows of pins, 20 pins in each row. The right row has even pins numbers and the left one has odd pins numbers in Physical number. Hence it includes 40 pins, these pins are called General Purpose Input Output (GPIO) connectors.

In addition, there are two types of pins numbering of the GPIO pins to specify which pin we want to use it. There are BCM GPIO number and physical pin number. Firstly, the BCM number is the way of numbering that the CPU uses it to differentiate between pins. For instance, the pins like GND and 5V cannot be addressed because they have one purpose and cannot be changed. Also the BCM number is a reference to the signal name on the Broadcom datasheet for the processor on the Raspberry Pi. The BCM numbering can be defined by a python language using BCM mode (GPIO.setmode(GPIO.BCM)). Secondly, the physical pin number is the easier way to numbering the GPIO pins and the numbering of pins depending on their location on the board and also it can be defined by a python language using BOARD mode (GPIO.setmode(GPIO.BOARD)) (Mayank, 2014). Figure 2.6 shows the GPIO pins in the Raspberry Pi 3 board with the ways for numbering them and note that, the BCM numbering is written inside the side boxes

while the BOARD or physical numbering is written within the circles ranked according to their position.

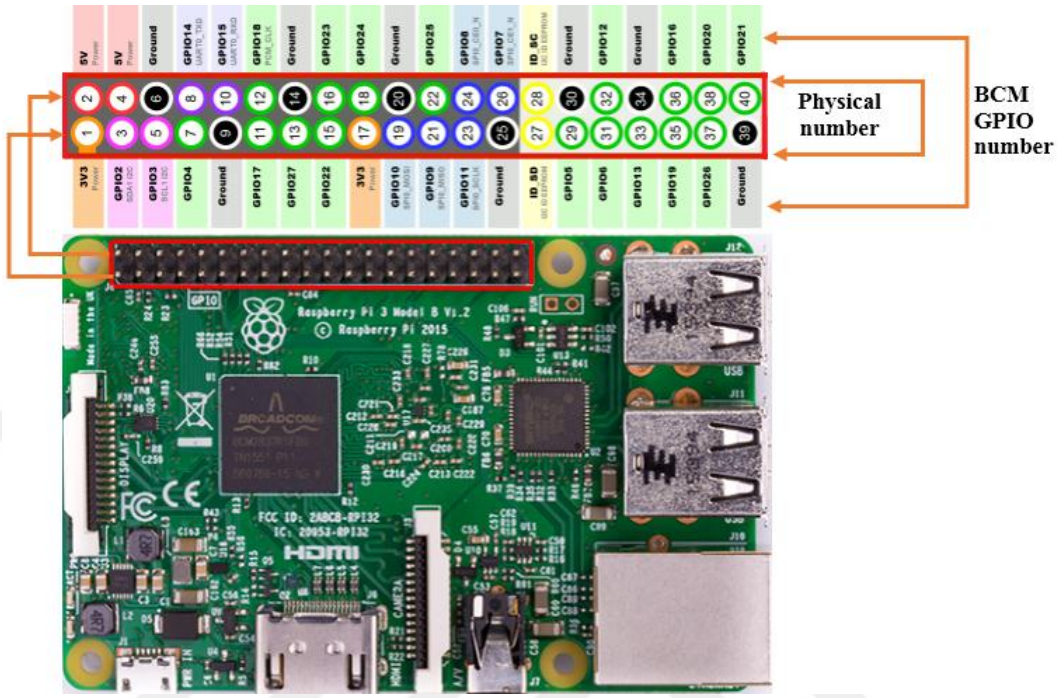


Figure 2.6. The GPIO pins with Physical and BCM GPIO numbering ways

The big advantage of Raspberry Pi 3 is that it allows the peripheral devices such as sensors, LEDs…etc, to connect directly to GPIO pins.Additionally, they allow control and interact directly with Raspberry Pi 3 processor. Besides that, those pins supply of ground, 5V and 3.3V and also it support serial communication interfaces. The some special functions for GPIO pins are illustrated in Table 2.2 and other pins can setup Input or Output pin.

Table 2.2. The special functions for GPIO pins (Pomyen, 2015).

Physical Pin Number	Function	Description
Pin 3	SDA I2C	Data line(SDA) and clock line (SCL)used for serial bus Inter-Integrated Circuit (I2C).
Pin 5	SCL I2C	

		The I2C is a bus which used for communication with peripheral devices such as LCD and temperature sensor.
Pin 21	SPI_MISO	Serial Peripheral Interface (SPI) is a serial bus similar to the I2C bus but much faster (SPI) and it is a communication interface in a form of master and slave providing one master to one or more slaves over four pins or more. Namely Master Input Slave Output (MISO) ,Master Output Slave Input(MOSI), Serial Clock(SCLK) and Chip Enable(CE).
Pin 19	SPI_MOSI	
Pin 23	SPI_SCLK	
Pin 26	SPI_CE	
Pin 24		
Pin 8	UART_TXD	Universal Asynchronous Receiver Transmitter (UART) is a serial port communication,allowing two devices to substitution data across their serial port interface TXD (Transmit pin) and RXD (Receive pin).
Pin 10	UART_RXD	
Pin 27	ID_SD	The purpose of using this pins is to provide connecting to add-on
Pin 28	ID_SC	

		HAT boards. It allows Raspberry Pi to automatically configure GPIO ports and it is work depending to which device connected to I2C EEPROM data and clock it is called ID_SD and ID_SC.

There are two states either "0" or "1" in the case of using the GPIO pins as the input pins.. Those states are represented as voltage levels. The voltages which are higher than 1.7V gives the "1" state. on the other hand, the voltages which are lower than 1.7V gives the "0" state. For example, if the voltage level is 1.65V, the GPIO input pin state is "0".

Also, there are two states, either logical 0 or logical 1 in the case of using the GPIO pins as output pins. If the GPIO pin in the logical state 1, it indicates the voltage level is 3.3V. Besides that, if the GPIO pin in the logical state 0, it indicates the voltage level is 0V .In addition, the voltage for all GPIO pins are 3.3V and if connecting the pins to the higher voltage that will be caused to destroy the Raspberry Pi.

The maximum value for current from any GPIO pin is 16mA, so the GPIO pins possible used only for controlling lights or small devices that consume low current. For example, normal LED (Light Emitting Diode) which maximum current almost 10 mA, so it can be interfaced with GPIO when there is a small resistor connected in serial with it (Yli-Heikkilä and others, 2015).

The Raspberry Pi needs to install the libraries that allow the user to access the GPIO pins using a programming language such as python. Hence, the Rpi.GPIO library allows to the python program to make the connection with the GPIO pins. In addition, the library function is used to enable the pins as either inputs or outputs.

2.5 Operating systems for Raspberry Pi

The Raspberry Pi is a computer, so it needs to an Operating System (OS) in order to achieve the functions in the same way for any computer. The OS is the collection of programs and instructions that make the computer run. Obviously, the OS, which works in Raspberry Pi based only on Linux operating systems.

2.5.1 Linux operating systems

Linux is a free-open source operating system, this means, any user can modify it and distribute it. The Raspberry Pi fan community is made up of a big base of amateur and professional developers around the world and also any of them have developed and derived more than 50 different versions of systems compatible with Raspberry Pi, most of them based on Linux. Additionally, these systems vary in terms of uses, but all execute the same tasks. Obviously, these systems have been developed to facilitate a certain function.

In addition, the Raspberry Pi processor is designed with ARM Cortex architecture like to use in smartphones, which is completely different from traditional computer processors such as AMD X64 or Intel x68. So, all Raspberry Pi OS versions use ARM architecture, but it is not used AMD64 or x68 for traditional computers. Additionally, The ARM Cortex processes have several advantages:

- High Speed: these processors are capable of operating integrated systems and processing video, audio and 3D graphics, so these processors are used in smartphones.
- Price: despite the strength of these processors, but the prices are very low compared to the possibilities offered, for example, ARM 100MHz at 1$ and ARM 450 MHz at 5$.
- The size and integration of small chips: the size of the chips on the Raspberry Pi is very small. However, this small chip contains the CPU, GPU and RAM, all of which are of great potential.

There are many differences of Linux distributions. It is worth mentioning that, the most popular distributions are Red Hat Linux, Ubuntu and Debian GNU

/Linux (Yli-Heikkilä and others, 2015). Obviously, the Raspberry Pi works on special derivatives of Linux operating system such as Raspbian OS and NOOBs OS.

In addition, the derivative operating systems make possible chosen of the best fitting OS as needed. Additionally, the basic derivative of Raspberry Pi is called New Out Of the Box Software (NOOBs) which consists of six different kinds of operating systems called Arch Linux, RISC OS, Rasp BMC, open ELEC, pidore and Raspbian so the user can choose and install any of them as needed (Pomyen, 2015).

2.5.2 Raspbian Jessie with PIXEL operating system

There are several various operating systems used with Raspberry Pi. Among these operating systems, Raspbian OS. It is a free and pure OS and usually uses in Raspberry Pi (Saimon, 2015). Raspbian is the most famous OS which is based on Debian Linux OS. It is worth to mention, it is characterized by a large number of programs for all purposes and also this OS comes with more than 35000 packages, pre-compiled software bundled in a simple form for easy installation in Raspberry Pi.

In addition, the Raspbian OS was established by a group of some developers who were fans and interested in the Raspberry Pi board. Recent versions of Raspbian OS have been based on Debian wheezy. However, nowadays, Raspbian OS has been updated to the modern version of Debian which is called Raspbian Jessie OS. Obviously, there are many of the differences between Raspbian wheezy OS and Raspbian Jessie OS are invisible to the user.

As with any update, there are some modifications to be on the essential system to improve flexibility and performance, especially as regards the control of system processes. Also at the same time as the upgrade to the Raspbian Jessie OS, the group of changes and improvements have been added to the desktop user interface. In this thesis, the Raspbian Jessie OS was chosen to install it in Raspberry Pi 3.

Recently, the Raspberry Pi Foundation company released the amazing new version of the Raspbian desktop with addition new features. Raspbian was the

biggest update to now, thanks to the new desktop environment, it's called PIXEL as depicts in Figure 2.7. Besides that, PIXEL refers to (Pi Improved Xwindows Environment Lightweight) is a dazzling software update version to the desktop environment (Simon Long, 2016). In addition, It introduces the easy new interface and is thriving with new features and programs such as Chromium Browser and RealVNC.

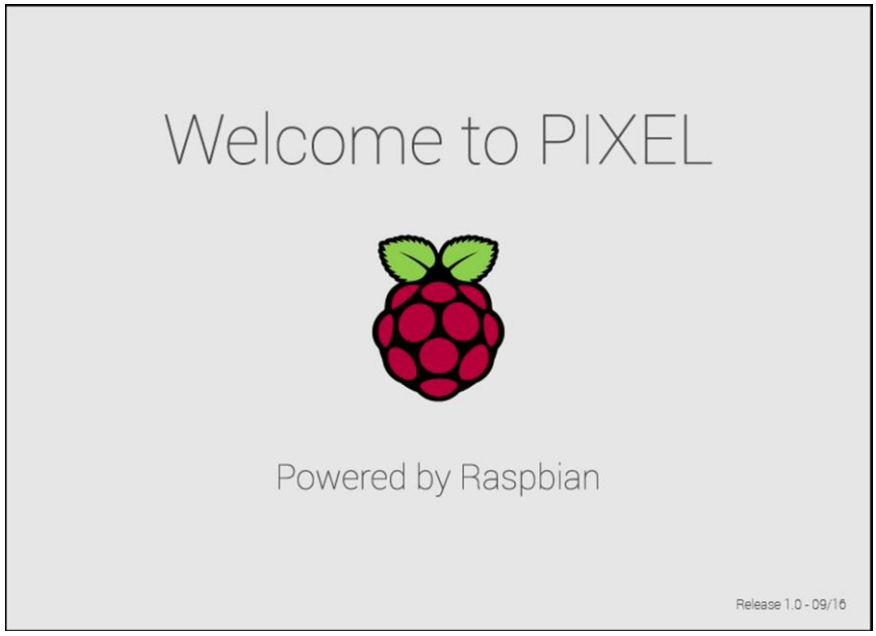


Figure 2.7. Raspbian OS with PIXEL

2.6 Programming languages of Raspberry Pi

There are many programming languages that using with Raspberry Pi such as python, C, C++, Java, and scratch. Essentially, any programming language can be collected for ARM v6 in the first release of Raspberry Pi. Moreover, the ARM v6 can run with all releases of Raspberry Pi. The choice of programming language depended on the type of study. Python language is the most famous language to control the GPIO pins, therefore, it was used in this study.

As for the C language provides superior speed to control the GPIO pins and it can be used to generate electronic signals (vibrations) from Raspberry Pi outputs at speeds up to 250MHz. While scratch language is very easy language, so that a small

child can build sophisticated robotic systems and without need to writing complex programs where this language depended on the graphics (that will transform later to the python language). Hence, the python programming language has been selected to use in this study.

CHAPTER 3

REALIZATION OF PROPOSED SMART SECURITY SYSTEM

3.1 Introduction

This chapter presents the details realization of the proposed smart security system. Besides that, the development of study consists of software sections and many hardware components such as; PIR Sensor which it is used to detect any object moving, Relay which is used to control high voltage by using low voltage and Raspberry Pi Camera Module which is used to capture a picture.

3.2 Overview of Smart Security System

The proposed system designed to develop a smart security system for remote control by using a small computer. It is worth to mention that, the design and implementation of a low-cost system monitoring based on a Raspberry Pi 3, a single board computer which is interfaced with; PIR Sensor, Raspberry Pi camera module, LEDs, and relay. Python language controlled the security system by writing a specific program. In addition, the PIR sensor and power supply act as input while the Raspberry Pi camera module, LED and relay act as an output. The system focused on the ability of reading the input data from the PIR sensor. After then the camera module starts to take a picture. The output of the PIR sensor is high and at the same time, the light bulb act as a flash for the camera module. Meanwhile, LEDs will be lighted up. The captured picture and alert message "Motion Detection" are sent to the user's smartphone via Wi-Fi using Telegram application.

3.3 Preparation and installation of Raspberry Pi 3 Model B

The Raspberry Pi 3 is a microcontroller in this study, for this reason, the smart security system tasks begin with preparation of Raspberry Pi 3. This is done in

four stages which are setup Micro SD card, connect the Raspberry Pi 3 to the laptop using network cable only, setup Wi-Fi by using the PuTTY program and remote desktop connection via the VNC viewer using PuTTY, respectively. The detail description for each of these stages in the next sections.

3.3.1 Setup Micro SD Card

As said earlier, Raspberry Pi 3 is a small computer, but does not have the real disk drive as in a computer. Hence it needs to install an operating system (OS) in the external memory (Micro SD card). The Windows OS has been installed in laptop computer used in this project. The detail description of installation the Raspbian Jessie with PIXEL OS in an empty 16 GB, class 4 Micro SD card in the following steps:

1. Connect Micro SD card with Micro SD adapter and insert it into the card reader in the laptop computer.
2. Check the Micro SD card if it is empty by format it in two ways:

    a. Firstly, format it by right click on the removable Disk on my computer and choose the format and also make sure that the Micro SD card is completely formatted to FAT32 file system type only, the other types do not work.
    b. Secondly, format it using an SD card formatter as shown in Figure 3.1:
        1) Download SD card formatter for windows OS from the website www.sdcard.org/downloads and install it on a laptop.
        2) Run the SD card formatter and choose the drive used and finally click on Format.

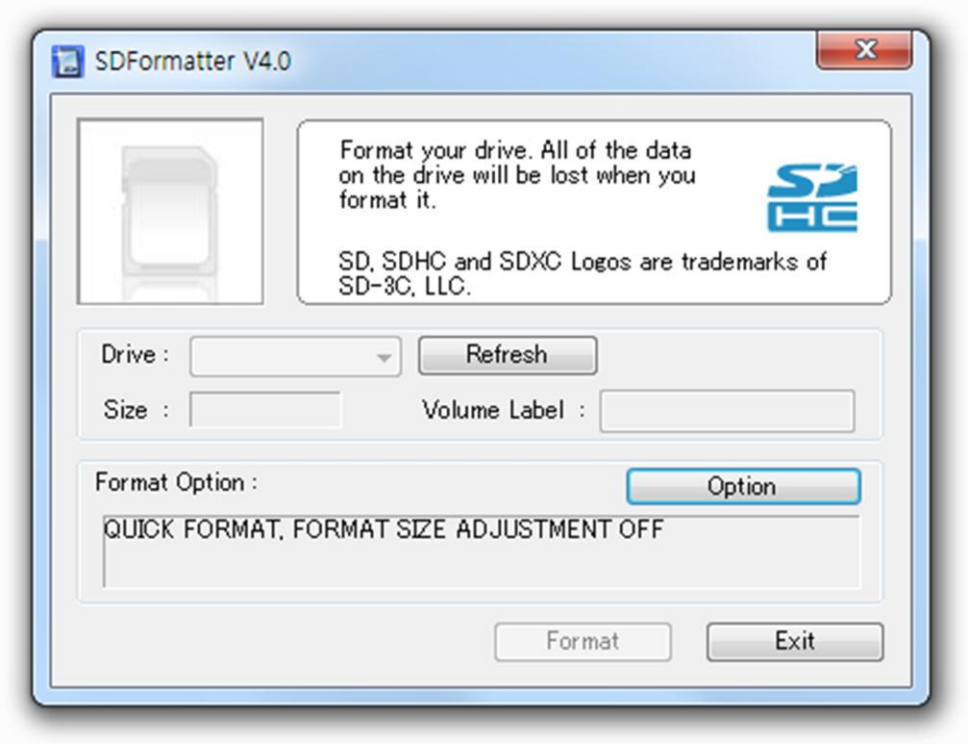


Figure 3.1. SD card Formatter

3. Download the latest version of Raspbian OS, it is Raspbian Jessie with Pixel (Zip file) on a laptop from Raspberry Pi website www.raspberrypi.org/downloads/raspbian as shown in Figure 3.2.

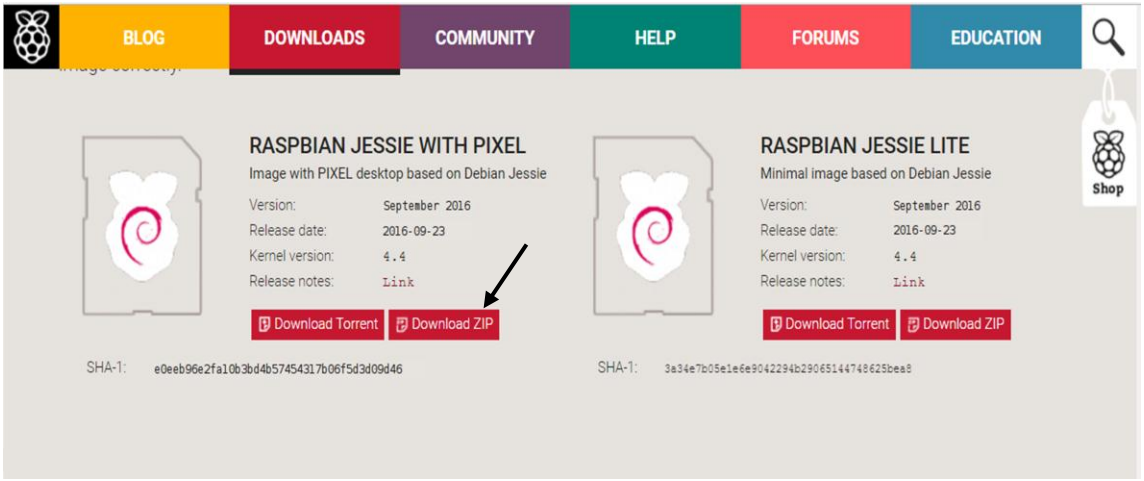


Figure 3.2. Raspbian Jessie OS in Raspberry Pi website

4. Extract the zip file, in order to find the .img file.
5. Download Disk win32 imager from the Internet and install it on a laptop.
6. Run the Disk win32 imager and write the .img file for OS as illustrated in the Figure 3.3.

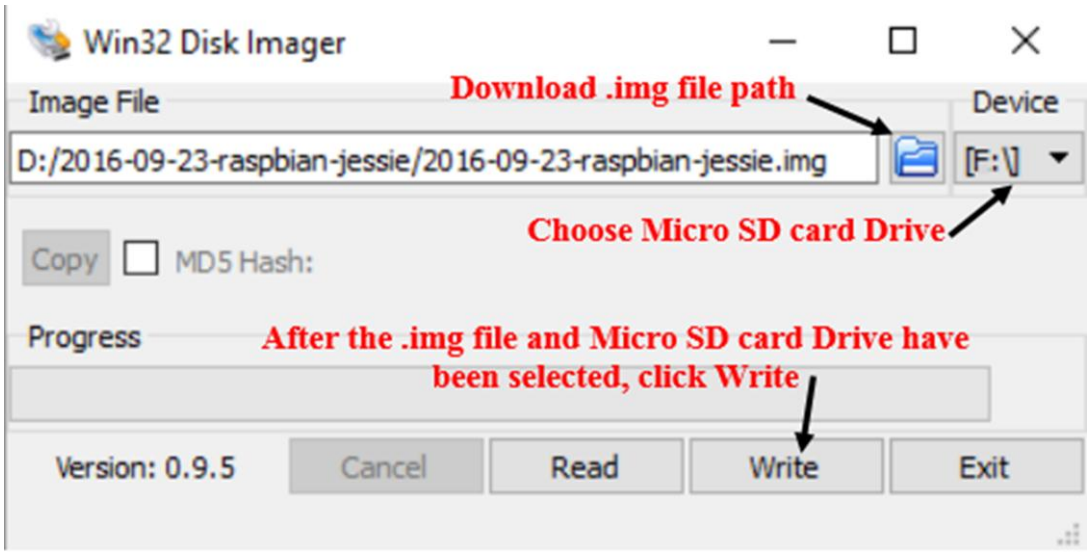


Figure 3.3. Disk Win32 Imager

The writing process takes about 2-3 minutes. Wait until to complete the writing process and appear the newly window "Write Successful".

7. Remove the Micro SD card from the laptop. After the OS has been installed, the Micro SD card is now ready to use it on Raspberry Pi 3 and the Raspberry Pi 3 need to be boot up.
8. Insert Micro SD card in Micro SD card slot into Raspberry Pi 3 board and connect Raspberry Pi 3 board to television screen using the HDMI cable and also connect that screen to the power supply.

After that plugging the power supply to boot up the Raspberry Pi 3 for the first time. A screen will appear similar to screen illustrated in the Figure 3.4.

Figure 3.4. Boot up screen for Raspberry Pi 3 in the first time

Then the Raspbian Jessie OS interface will appear with a letter "Welcome to PIXEL" as depicted in the Figure 3.5.

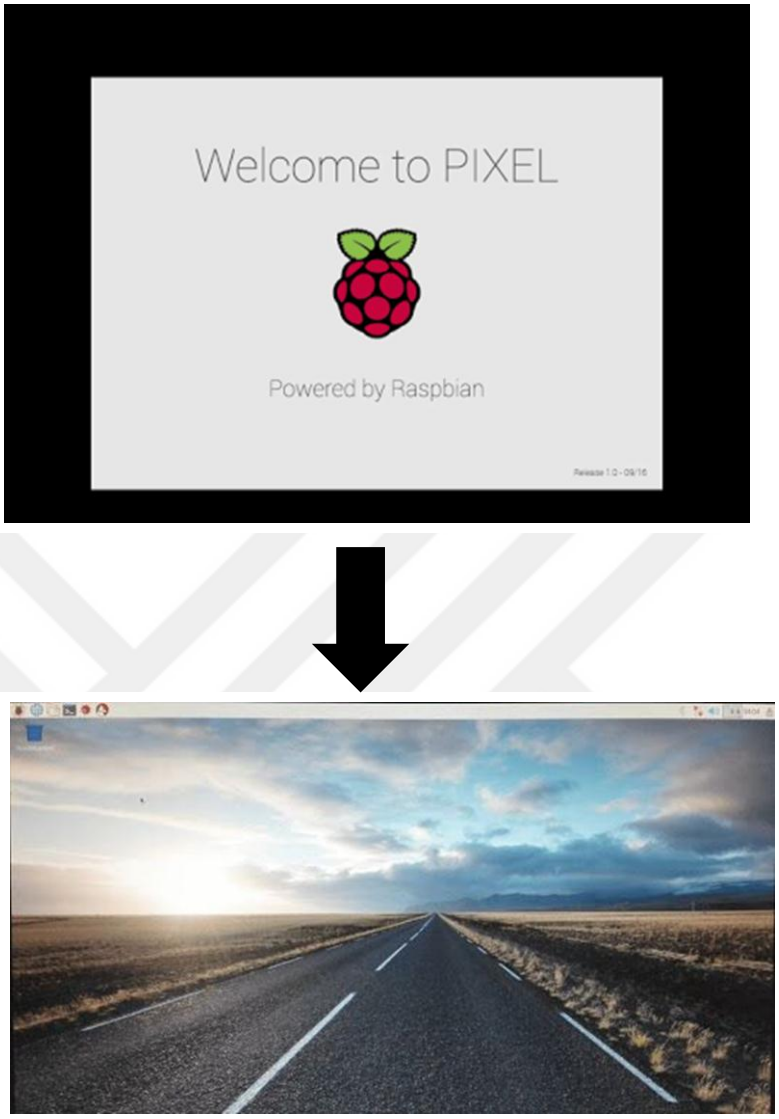


Figure 3.6. Raspbian Jessie OS interface

3.3.2 Connect the Raspberry Pi 3 to the Laptop using a network cable

The connection of the Raspberry Pi 3 to the laptop by using network cable without need to the router, switch or any other device to route the data. This method relies on installing the network IP address from inside the Raspberry Pi3 itself without linking to a particular router which means that the network IP address will remain constant even if it is connected to any network and even if there is no router from the original.This method also gives us the ability to connect the Raspberry Pi 3

with any computer directly by using the network cable without need to any other device (Mat, 2016).

This method is implemented in two steps:

1) **Setting up IP address for Raspberry Pi 3**:

Plug the Micro SD card into the Laptop and in My Computer icon , a new icon will appear called boot as illustrated in the Figure 3.6.

Figure 3.6 . Boot icon for Micro SD card

To become a cmdline.txt file like Figure 3.7, enter the boot folder and open the cmdline.txt file containing the startup settings for the Raspberry Pi 3 and after (rootwait) word makes space and add IP Address for the network as follows:

```
ip=192.168.2.10
```

After finishing from editing the file, save it and plug the Micro SD card inside the Raspberry Pi 3 board again and then plugging the power supply for Raspberry Pi 3.

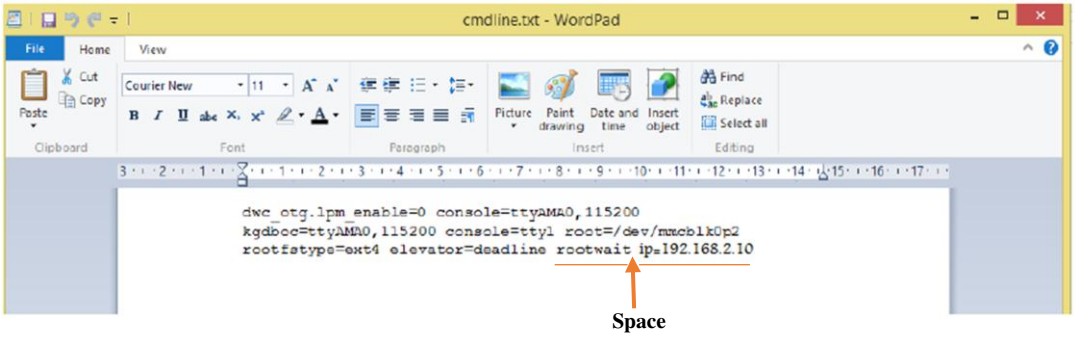


Figure 3.7. Editing cmdline.txt file

2) Setting up the Laptop:

After finishing from the preparation of Raspberry Pi 3, it was connected to the laptop by using network cable RJ-45 as shown in Figure 3.8.

Figure 3.8. Network cable

Then enter the (Open Network and Sharing Center) and then enter to control menu in the network IP Address as illustrated respectively in Figure 3.9.

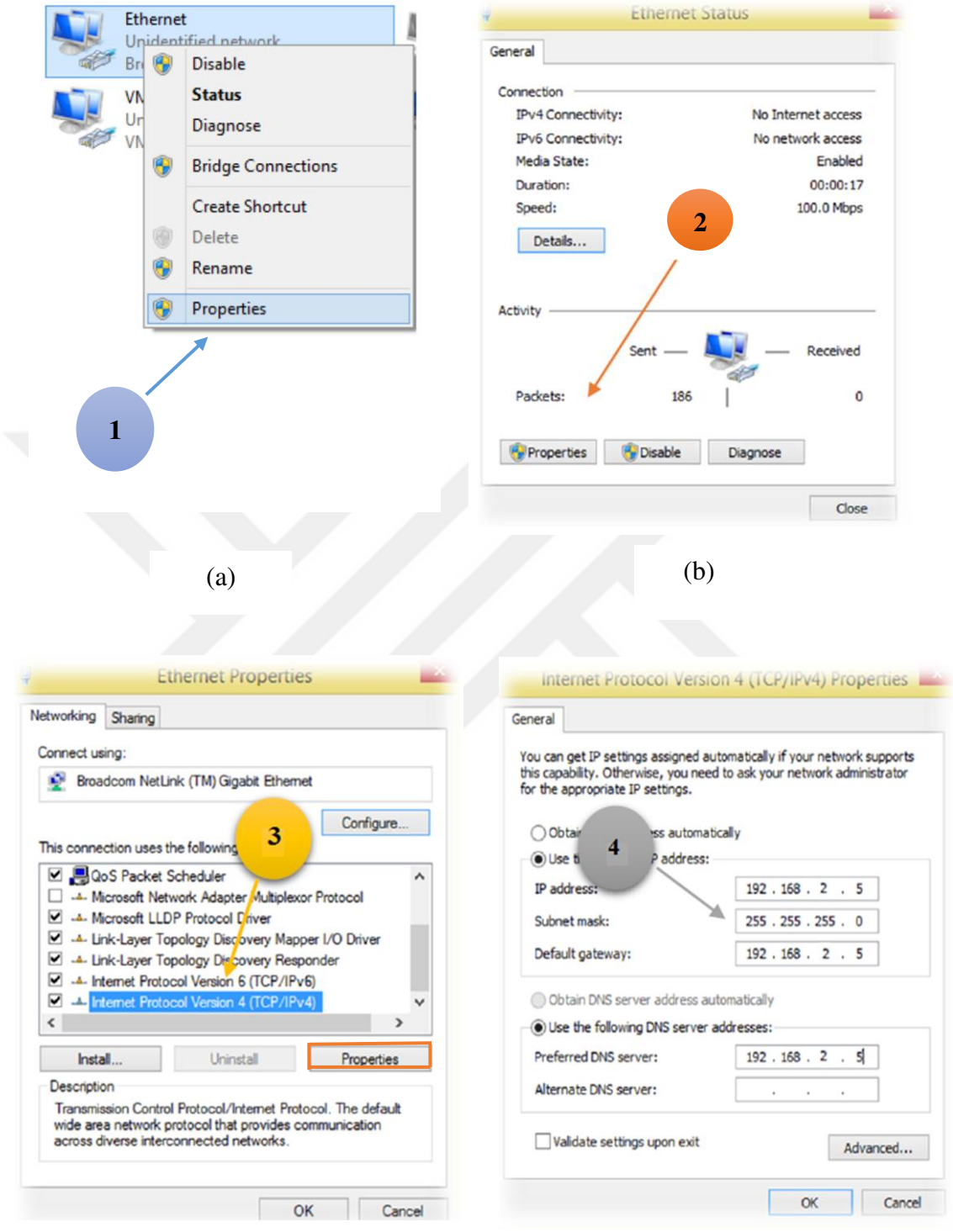


Figure 3.9. Preparation of network IP address (a) Enter properties for Ethernet. (b) Click properties in Ethernet status (c) Select Internet Protocol Version 4 (TCP/IPv4) and click properties (d) Write the network IP Addresses and click ok.

The network settings are as follows:

IP Address: 192.168.2.5

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.2.5

Now the Raspberry Pi 3 was connected to the laptop and it will be used PuTTY program to control the Raspberry pi 3 as defined below.

3.3.3 PuTTY program

PuTTY is the client program which is used to remote control Raspberry Pi 3 by entering to the command line interface or LXTerminal using SSH service. SSH protocol is a service that can be used to remotely control any device that used Linux operating system(Hossain *et al.*, 2016). The service also has high encryption and can be used to transfer files and make connections between devices in a secure and encrypted. The SSH service is divided into two parts: the first part is a server program which is placed on the device (Raspberry Pi) that wants to control it remotely, and the second part is the client program which is used to access the device (laptop) that wants to control it. PuTTY is an open source program that can be freely downloaded from the internet. It is worth to mention that, the SSH server in Raspbian Jessie OS is active by default. Figure 3.10 shows the PuTTY configuration, which is contained several options to connect more than one protocol such as FTP, Serial and SSH. To use PuTTY program; select SSH and write the IP address for Raspberry Pi 3 in the (Host Name) and select port number 22 in the (Port) as shown in the figure below.

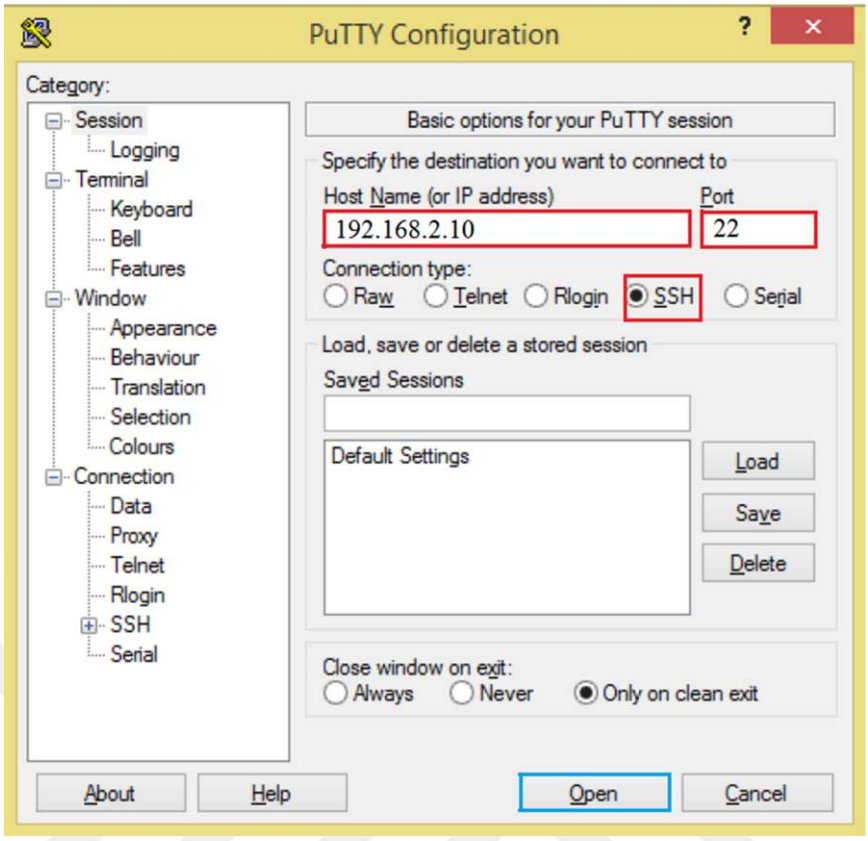


Figure 3.10. PuTTY Configuration

Press the Open to start the connection and then login to Raspberry Pi Terminal using the Raspbian OS default username and password, type 'pi' and 'raspberry' respectively as following in Figure 3.11 .In addition ,on the Raspberry Pi, the default Terminal application is LXTerminal, which is used to run any command on Raspberry Pi.

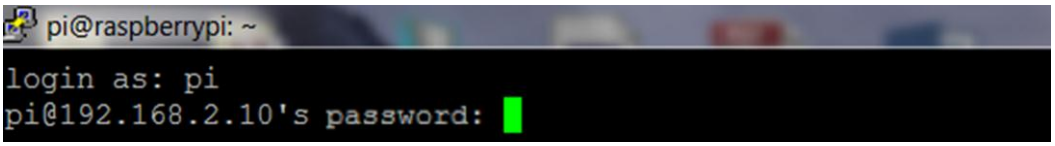


Figure 3.11. Login to Raspberry Pi 3 LXTerminal using PuTTY

After completing installation of PuTTY program, it will be done anything on the Raspberry Pi 3 via the command line interface (CLI) and from any other computer or even a smartphone as long as on the same network. Wherefore, before

doing anything in Raspberry Pi3, there are most important settings that should be changed in configuration menu is called Raspberry Pi Software Configuration Tool (Raspi-config) by entering the command:

```
sudo raspi-config
```

as illustrated in the Figure 3.12.

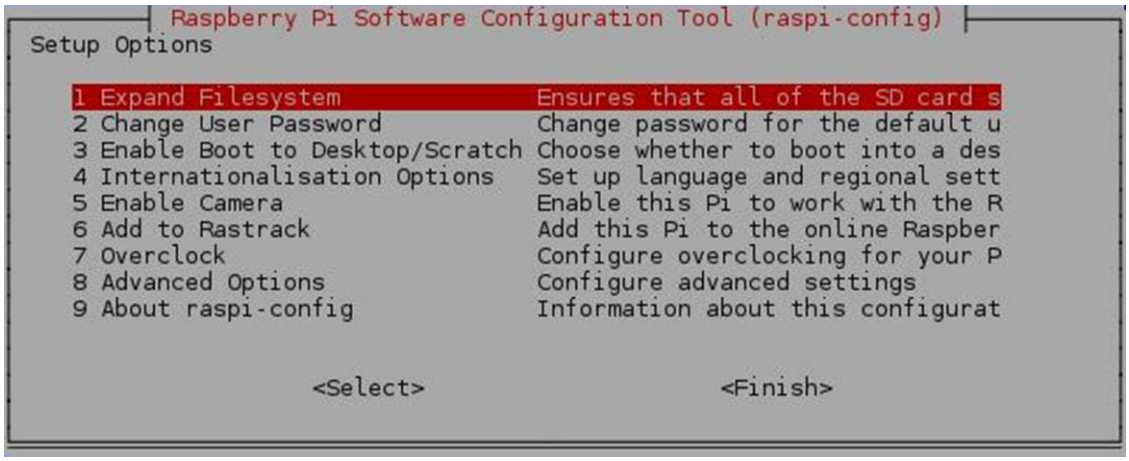


Figure 3.12. raspi-config

- Expand Filesystem, where it is necessary to ensure that the Raspberry Pi 3 can use all of the Micro SD card storage capacity is available to the Raspbian Jessie OS.
- Internationalisation Options, where it can use to select between different languages and the time zones.
- Enable Camera, because it was needed it in the proposed system.

3.3.4 Setting up Wi-Fi using PuTTY

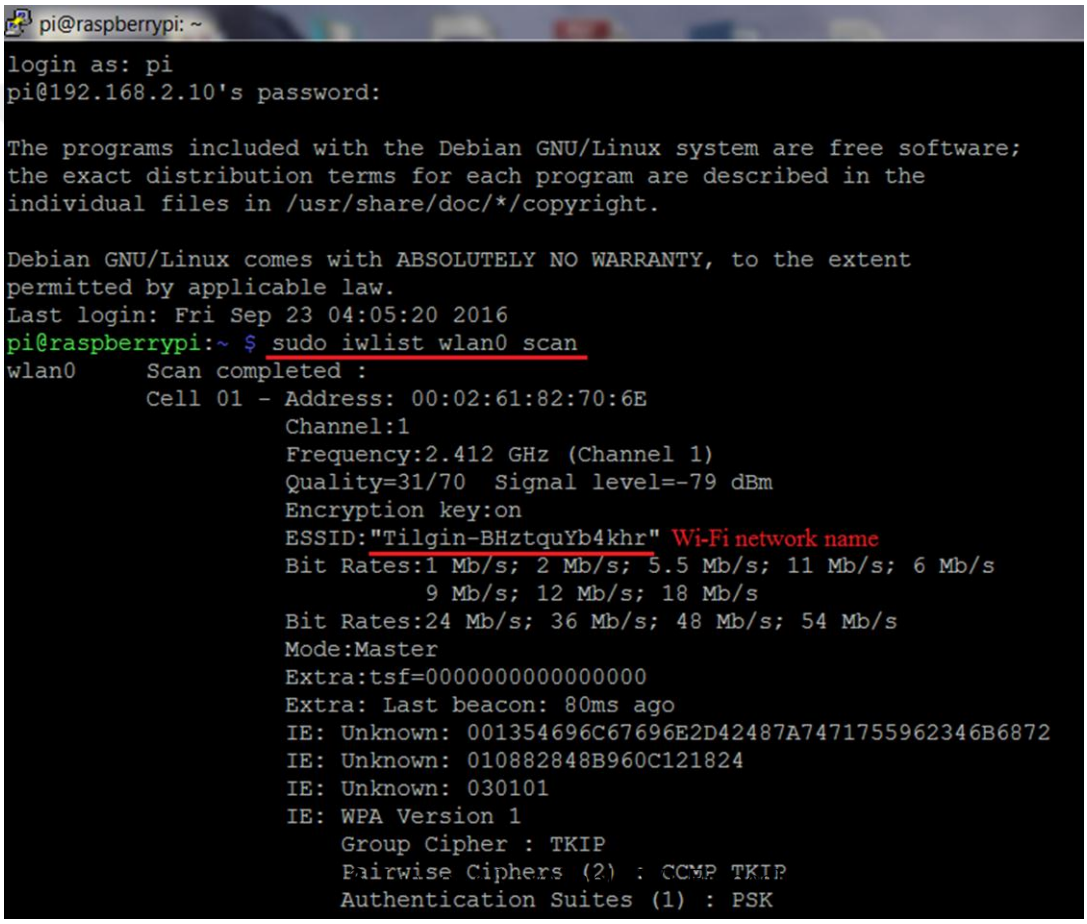
Nowadays the Raspberry Pi 3 has been released with wireless capabilities including Wi-Fi. To setting up the Wi-Fi for Raspberry Pi 3 via command Line Interface (CLI) by using PuTTY client program, as shown in the following steps(MAKER.IO STAFF, 2016):

1) Scan for wireless networks using the command:

```
sudo iwlist wlan0 scan
```

This command shows all available Wi-Fi local networks, with all relevant available information.

2) Assign the Wi-Fi network name in the list, that name will be listed after to ESSID as shown in Figure 3.13. Additionally, it will be needed the password for the located Wi-Fi.



3) Now it will be needed to add the Wi-Fi network settings to the wpa-supplicant configuration file. Write the following command in the LXTerminal to the configuration file:

```
sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
```

Move to the bottom of that file and add the following Wi-Fi settings, adding the Wi-Fi name and password for the wireless network:

```
network={
  ssid="The_ESSID_from_earlier"
  psk="Your_wifi_password"
}
```

Press CTRL+X to save the file and then Y on the keyboard and enter to confirm.

4) Meanwhile, the wpa-supplicant configuration file will be noticed the occurring changes furthermore. To ensure Raspberry Pi 3 was connected to the Wi-Fi network, it can be used the command below:

```
sudo reboot
```

5) It is worth to mention that, the Wi-Fi was connected successfully, moreover, it can check it by writing the command:

```
ifconfig wlan0
```

If the inet addr field has an IP address then the Wi-Fi network has successfully connected as illustratrd in Figure 3.14.

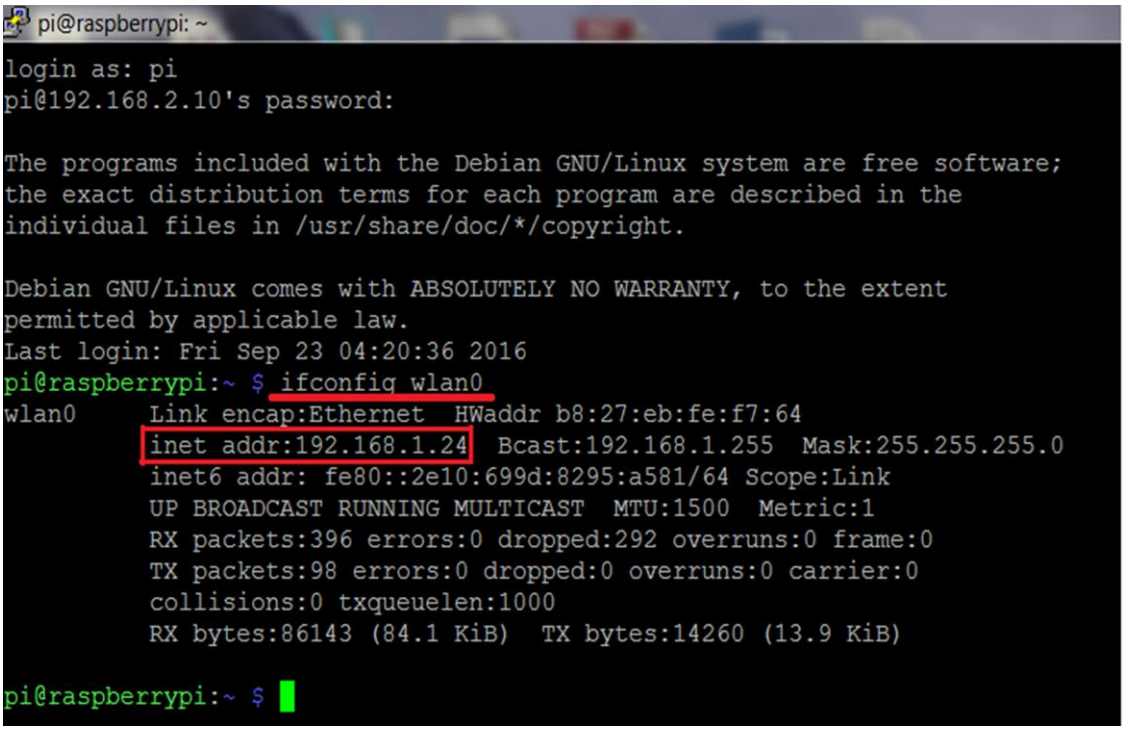


Figure 3.14. IP address for Wi-Fi network

3.3.5 Remote desktop connection via VNC Viewer

The Virtual Network Computing (VNC) is a system used to access the devices by view the desktop and remote it control. The method of connected two devices is installed a program in the device(Raspberry Pi 3) to be controller(server), and the program in the device(laptop) to control from it (Viewer). The advantage of VNC system that it does not depend on a particular operating system.

In order to remote Raspberry Pi card via VNC Viewer by two parts as shown below:

Part one: Setting up the program in Raspberry Pi3 (server) using PuTTY:

1) Connect the Raspberry Pi 3 to the Wi-Fi network.
2) Update the list of programs and install the (tightvncserver) program, that will enable you to remotely control the Raspberry Pi 3 by executing the following commands respectively:

```
sudo apt-get update
sudo apt-get install –y tightvncserver
```

Wait until the program finishes downloading and installing as shown in Figure 3.15.

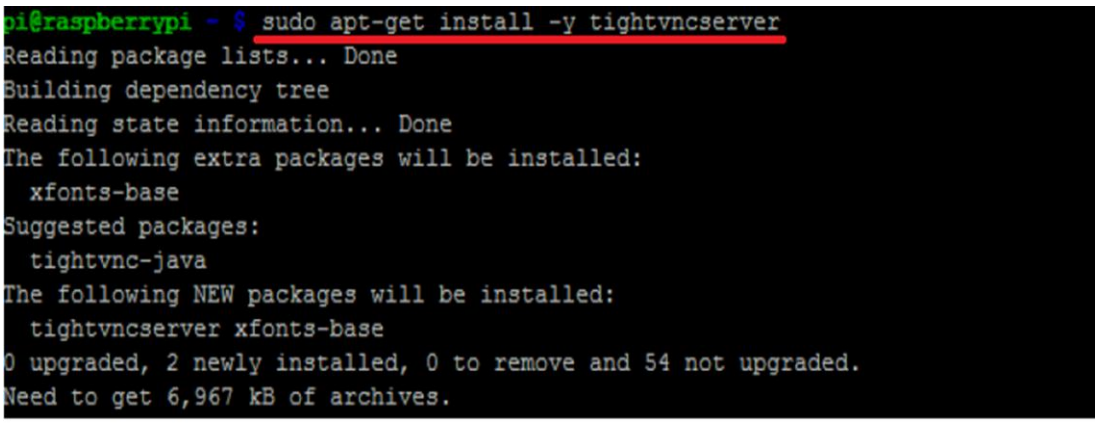


Figure 3.15. Download tightvncserver program

3) After downloading the program, it will be run the VNC server through the following command:

```
vncserver :1
```

At the first time, the program will ask for a special password for VNC server as depicted in Figure 3.16.

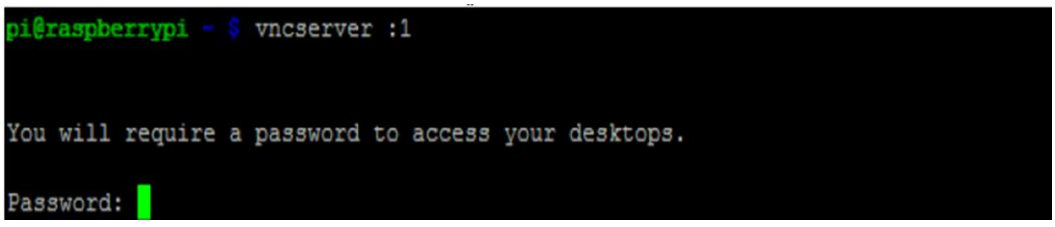


Figure 3.16. Running the VNC server

4) Type the password and then confirm that by log on again, then the program ask if it was needed to add a password to watch the screen of the remote without remote control ,write (n)and then enter to confirm it as shown in Figure 3.17.

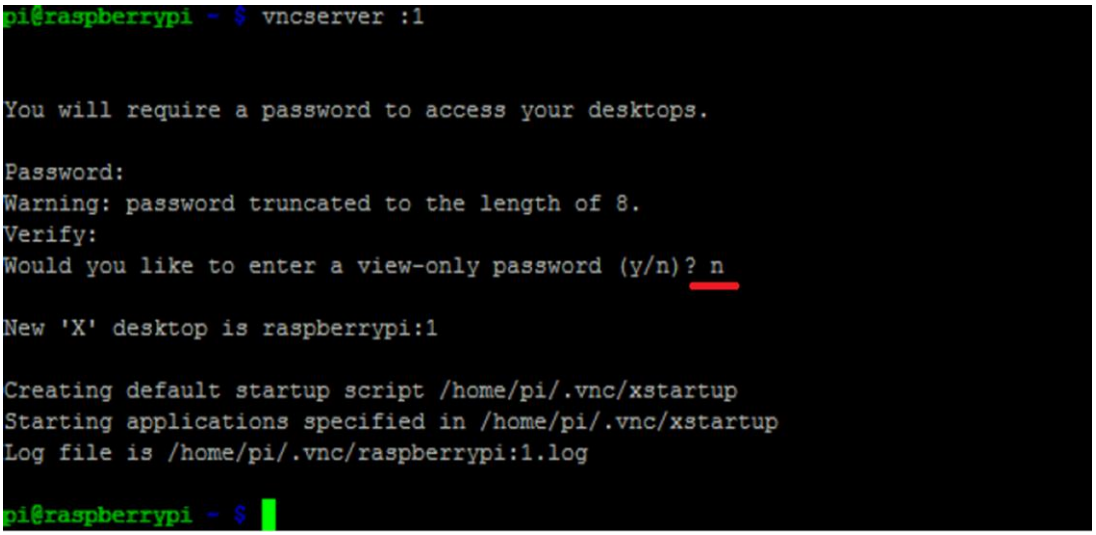


Figure 3.17. The installation of VNC server is complete

5) It was needed to know the IP address for Raspberry Pi 3 with the help of the following command:

```
ifconfig
```

Part two: Setting up the program in the Laptop (viewer)

1) In order to control the Raspberry Pi 3 from the laptop, VNC browser was used to obtained it, such as Real VNC viewer program that can be downloaded free from its official website for all operating system as illustrated in Figure 3.

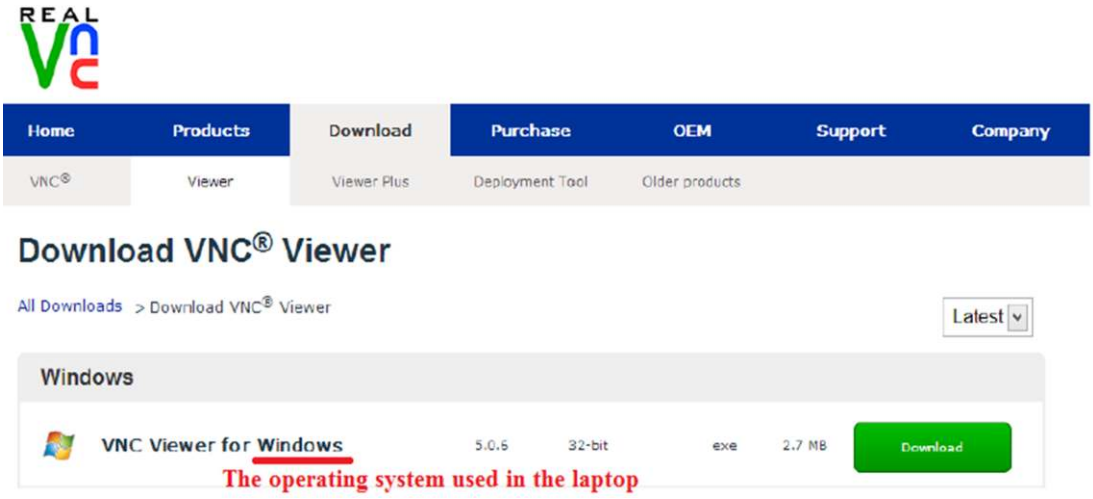


Figure 3.18. Real VNC Viewer website

2) After downloading the program, run it and the login screen will appear and type the IP address for Raspberry Pi 3 followed by a colon and number 1 and then press "Connect" as follows in Figure 3.19.

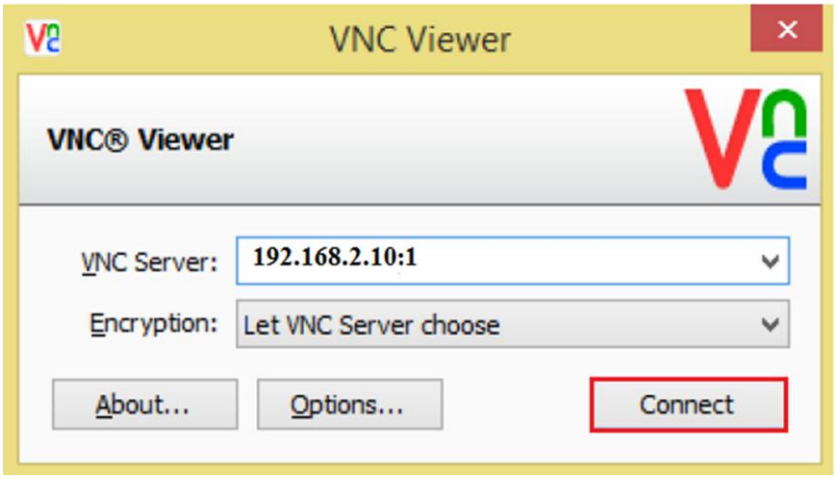


Figure 3.19. VNC Viewer

3) Then type password and press OK and after that, the Raspberry Pi 3 desktop will appear on the laptop screen.

3.4 Smart Security System design

The proposed security system has been designed by components which are compatible to Raspberry Pi 3. Figure 3.20 shows the block diagram of the Smart Security System.

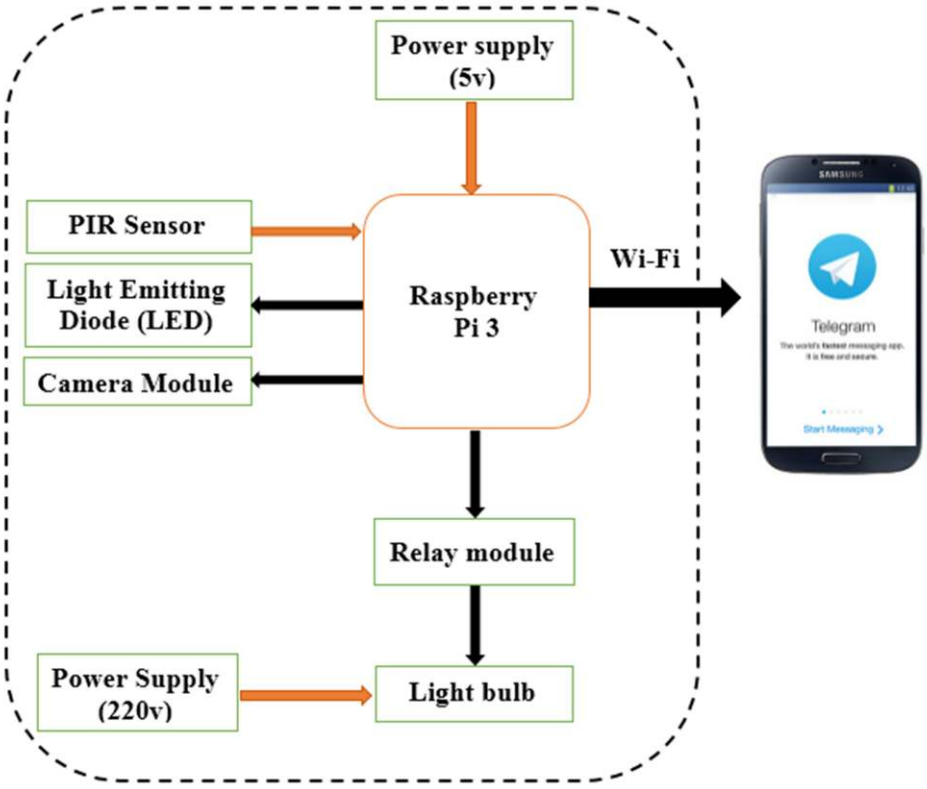


Figure 3.20. Block diagram of proposed system

The overall block diagram of this study has two main parts. The first part is the security system which consists of Raspberry Pi 3, PIR sensor, camera module, LED, relay and power supply. In this part, Raspberry Pi 3 configured as a server and connected to the Wi-Fi internet. The second part is a Telegram application on a smartphone. The Telegram application requires the installation and configuration in Raspberry Pi3 and the smartphone.

3.5 Hardware Design of Proposed System

This system consisted of Raspberry Pi 3, Raspberry Pi camera module, PIR sensor, Relay, GPIO pins configuration, LEDs and Light bulb. Also, jumper wires were used of types (male to male and male to female).

3.5.1 Raspberry Pi Camera Module

The Raspberry Pi Camera Module as shown in Figure 3.21 is a small PCB design with a camera on it, that created specifically for Raspberry Pi model A and B. It is manufactured by the sunny company. It provides high sensitivity, price almost 25$, lightweight design, 5-megapixel resolution image and low noise image capture(Amarnath, 2015) .Besides that, it includes a red LED in corner of a printed circuit .That LED will light up when the camera is active. It is really useful for giving a visual indication that the Camera Module is doing something. Additionally, "Picamera" Python library allows the python program to access to the camera module and use it and also it is necessary to enable the camera module from Raspberry Pi configuration. It is worth mentioning that, 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(Million, 2013). Table 3.1 illustrates the Raspberry Pi Camera Module features.

Figure 3.21. Raspberry Pi Camera Module

Table 3.1. Raspberry Pi camera module features

Features	Description
Dimensions of the card	20 x 25 x 9mm
Resolution Image	5-megapixel (2592x1944 pixels)

HD Video Recording	1080p at 30 frames/sec, 720p at 60 frames/sec and 640x480p
Picture Resolution	2592 x 1944 pixels
Weight	3 g
Power supply	Powering from Raspberry Pi and it uses 250 mA
Version	Rev 3.1

3.5.2 Infrared (PIR) Sensor

PIR sensor as shown in Figure 3.22 is an essential part of the proposed system. The object will emit infrared (IR) radiation through its movement. PIR is an electronic sensor that is used to detect the object motion by receiving the infrared (IR) radiates light from the surrounding objects in its field of view. 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 by checking a HIGH signal on a single input pin. Knowing that the maximum sensing distance for PIR sensor is 7 meters and the angle sensor less than 120 degree(Ahmad, Studiawan and Ramadhan, 2014). In addition, the PIR Sensor is a small in size, inexpensive in price, used low-power, single bit output, easy to use and connectivity. They are often referred to as PIR, Passive Infrared, Pyroelectric, or IR motion sensors (Patel, Bhatt, *et al.*, 2016).

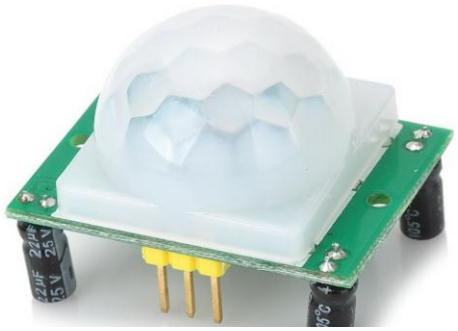


Figure 3.22. PIR Sensor

Figure 3.23 depicts the PIR sensor itself has two slots in it, where each slot consists of a special material that has sensitive to IR. Additionally, when the sensor is idle, both slots will detect the same amount of IR, it is the surrounding amount of IR that radiated from the walls or room or outdoors. Besides that, when a warm body such as a human or animal passes through the sensitive front, it first collides to one-half of the PIR sensor, which causes a positive differential change between the two slots .In addition, when a warm body leaves the sensing area, the sensor will generate a negative differential change. These positive and negative pulses are what is detected (Saimon, 2015)(Kapre, Salunkhe and Thakkar, 2014). It is worth to mention that, the output is LOW when the sensor is idle and it is HIGH when the sensor is busy. In this proposed system the HC-SR501PIR Sensor Module is used which has many specifications as represented in the table 3.2 and also table 3.3 shows the definitions of PIR sensor pins.

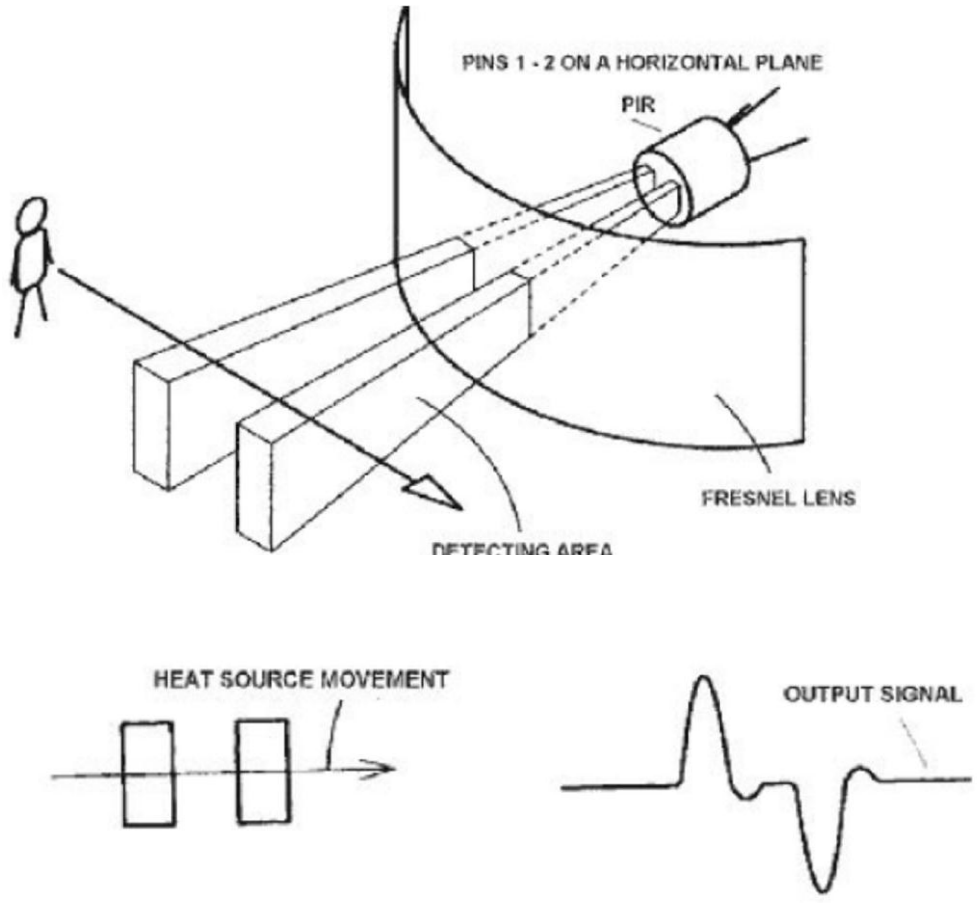


Figure 3.23. Operation of the PIR Sensor

Table 3.2. Specifications of HC-SR501 PIR sensor

Specification	Description
Sensor model	LHi778 (German-made)
Input voltage	5V – 20 V
Output voltage	3.3V (HIGH), 0 V (LOW)
Current consumption	Less than 60 mA
Angle sensor	Less than 120 degrees
Distance sensor	Less than 7 meters
Trigger method	Always HIGH (enable repeat trigger)
Lens	Fresnel : a flat lens made of many concentric rings to help in reduce spherical aberration
Temperature	-20 – 80 C
Dimensions	32 mm x 24 mm

Table 3.3. Definitions of PIR sensor pins

Pin	Function
VCC	Connect to 5 V
GND	Connect to Ground
OUT	Connect to an GPIO I/O pin

3.5.3 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 (Vigneswari *et al.*, 2015). The relay card consists of two parts. The first part of the right side in Figure 3.24 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(*Control of a low voltage device via Raspberry Pi - MesPotesGeek.com*, 2013):

- NC means (Normally Closed): this indicates to that when the relay card has 0 on the control pin (no input signal), the connected circuit active. COM is connected to NC point when the relay coil is off.
- NO means (Normally Open): this indicates 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 NO point 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 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

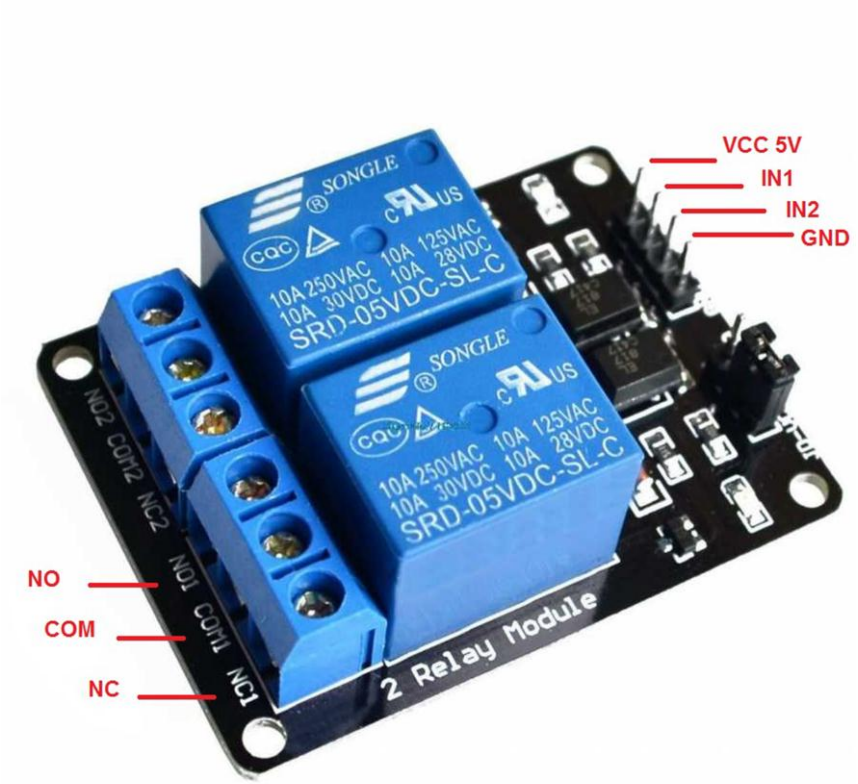


Figure 3.24. Relay Card

3.5.4 LED and Lightbulb

- **LED**

A light emitting diode as shown in Figure 3.25 is an electronic piece resemble small light bulbs work to convert electricity to light and are available in different colors. In addition ,each LED must be connect in serial with small resistor such as 220 ohm resistor to prevent destroy it (Shopify, 2015). In this system, the 5MM white LEDs are used to improve lighting for an image which captured by the camera module.

Figure 3.25. White LED

- **Light bulb**

In this system, the light bulb is operated like the flashlight for the camera module. The light bulb is turned ON before taking a picture and it is turned OFF after taking a picture.

3.5.5 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. It is worth to mention that, the GPIO pins were explained in detail in the previous chapter. Besides that, the GPIO pins which used in the proposed system are mentioned in the Figure 3.26.

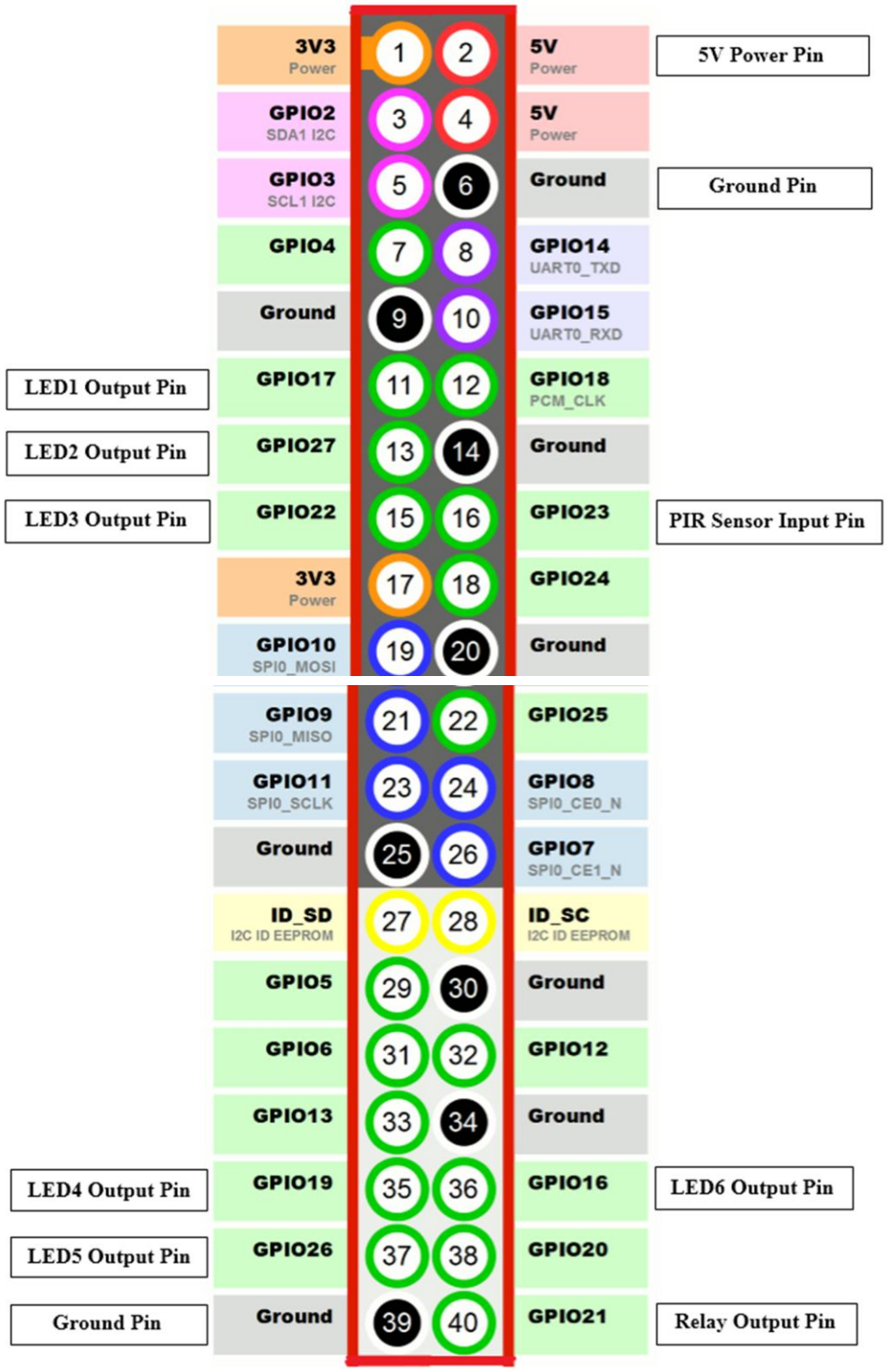


Figure 3.26. GPIO pins which used in the proposed system

3.5.6 Connect PIR Sensor with Raspberry Pi 3 board

Figure 3.27 shows the connection of PIR Sensor with Raspberry Pi 3 board by GPIO pins. The PIR sensor has three pins GND, OUT and VCC. The GND pin will connect with any ground pin in GPIO pins and OUT pin will connect with any output pin in GPIO pins. In this system the OUT pin will connect to pin 16 and also the VCC pin will connect with any 5V pin in GPIO pins.

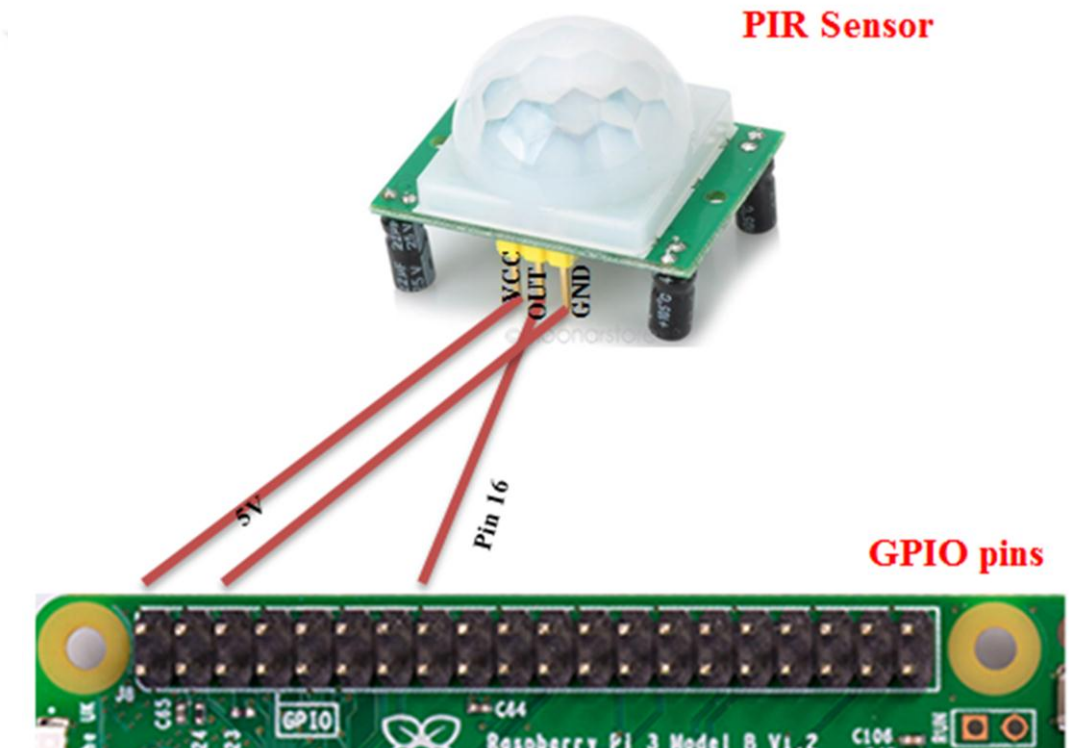


Figure 3.27. The connection of PIR sensor with Raspberry Pi 3 board

3.5.7 Connect Relay card with the Raspberry Pi 3 board

Figure 3.28 depicts the connection of relay card with Raspberry Pi 3 board by GPIO pins. In the left side of relay card, the VCC will connect to 5V pin and GND will connect to any ground pin in GPIO pins and IN1 will connect to output pin 40 in GPIO pin. In the right side of relay card, the COM point will connect to plug. In

this system, the NO point used to connect between the relay card and the light bulb. The connection is done by using jumper wires (male to male and male to female

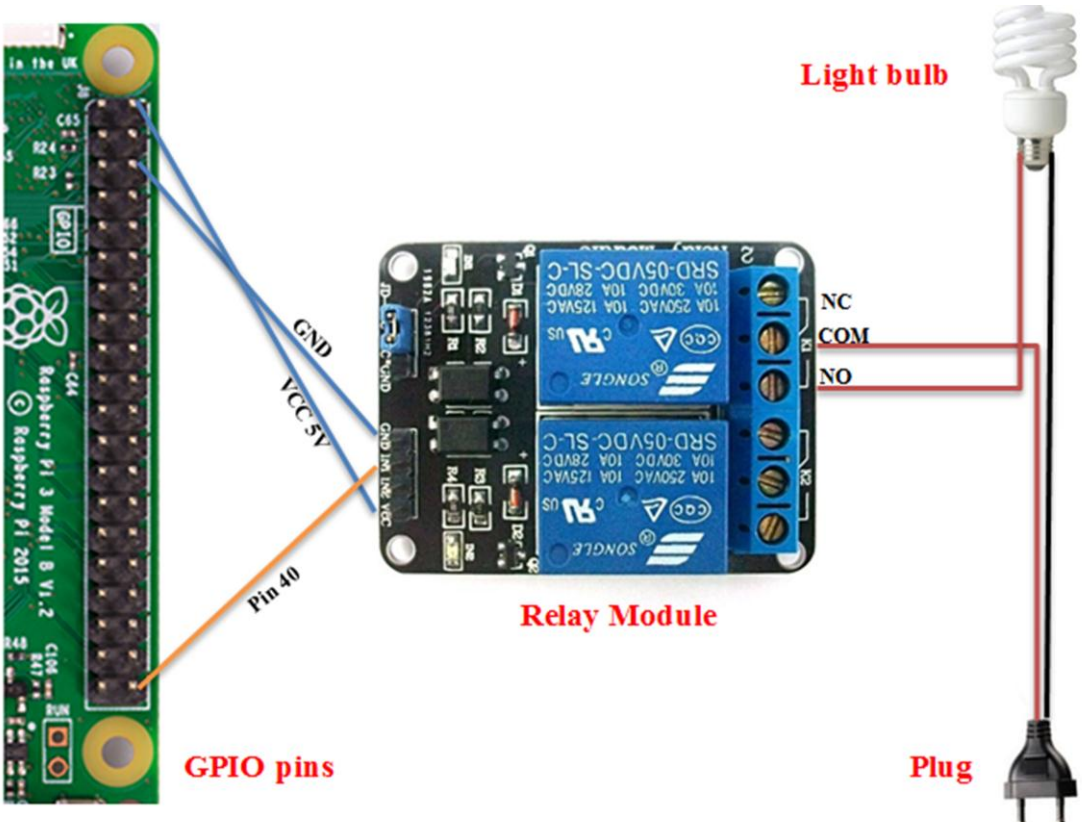


Figure 3.28. The connection of relay card with Raspberry Pi3 board

3.5.8 Connect LEDs with Raspberry Pi 3 board

Figure 3.29 illustrates the connection between LED and Raspberry Pi 3 board. To prevent LED from being damaged, it is connected to Raspberry Pi 3 card through 220 ohm resistor. Each LED has two parties which are cathode and anode. The anode party connected with an output pin in GPIO pins which it is longer party. Cathode party connected with the one resistor party, and the other party of resistor connected with any ground pin in GPIO pins. In this proposed system, the six LEDs are used to connect with 11,13,15,35,36 and 37 pins in GPIO pin.

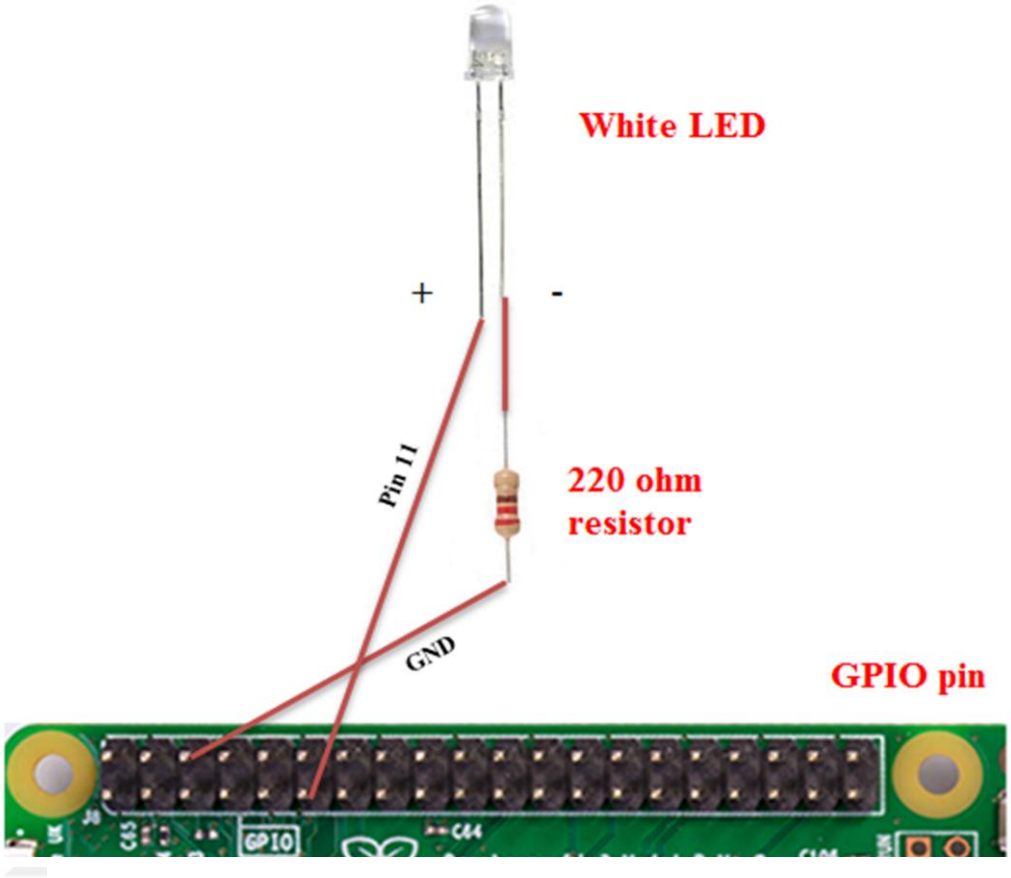


Figure 3.29. The connection between LEDs and Raspberry Pi 3 board

3.5.9 The connection of proposed system components

Figure 3.30 depicts the smart security system experimental setup. When all the hardware devices which are camera module, PIR sensor, Relay, light bulb and LEDs with 220 ohm resistors has been connected to the Raspberry Pi 3 .Besides that, the Raspberry Pi camera module has been activated and the full python program will be executed.

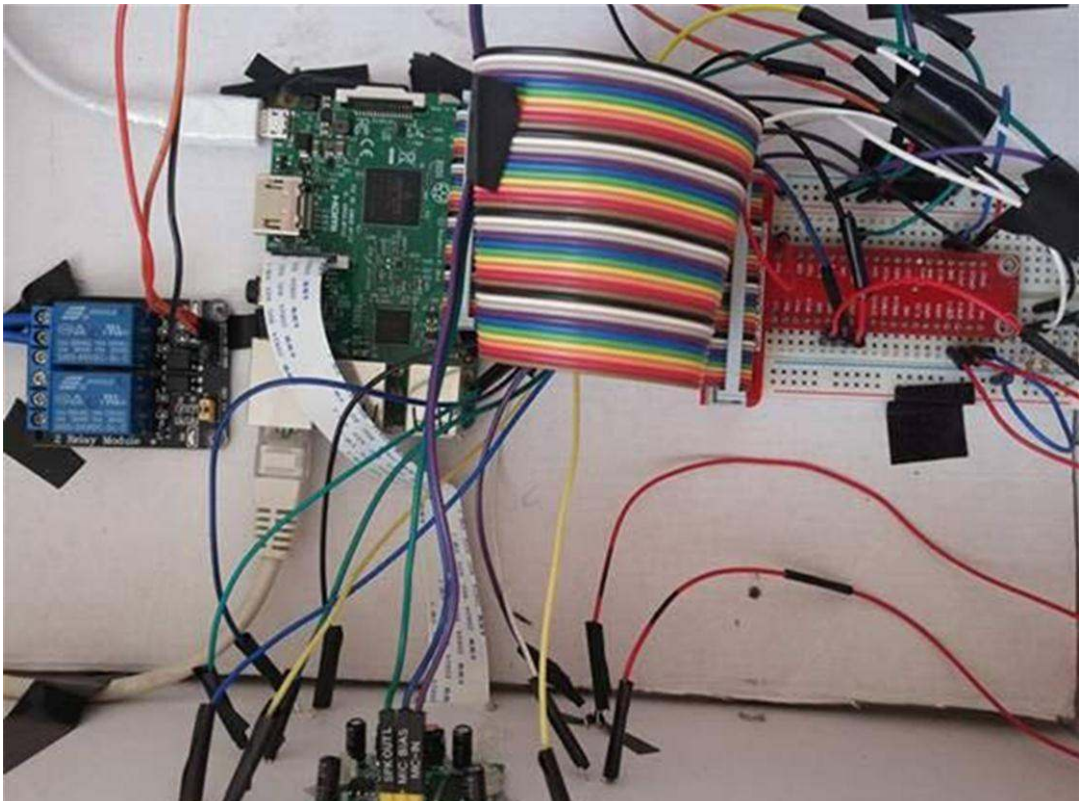


Figure 3.30. The proposed system experimental setup

3.6 Software Implementation

In the software implementation of the proposed system, the Raspberry Pi 3 with the other components which are connected to it, need to be programmed using Python programming language to execute their functions. The python libraries which are used in the programming are: GPIO, picamera, sys, signal and subprocess. Hence, the Raspberry Pi 3 has two basic components interacting with each other, the first one Telegram Application that executes on the smartphone device's browser and the second one the server scripts that it operated by the Raspberry Pi 3 Hardware tool component.

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

Firstly, if there is no motion detected by the PIR sensor, the program will turn OFF the LEDs with suspending the program for 1 second and after that, directly return back to check if there is any motion to detect .

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 notification message "Motion Detection", the number of image counter, and the taken picture directly to the smartphone by Telegram Application.

Every time the motion is detected to alert the owner which has a smartphone. Also, the program will increment the image counter by 1 and subsequently turn OFF light bulb to save energy, 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 proposed system infinity work and will stop when the power supply cut off. The flowchart for the proposed system is shown in Figure 3.31 and the block diagram of the lighting part is shown in Figure 3.32.

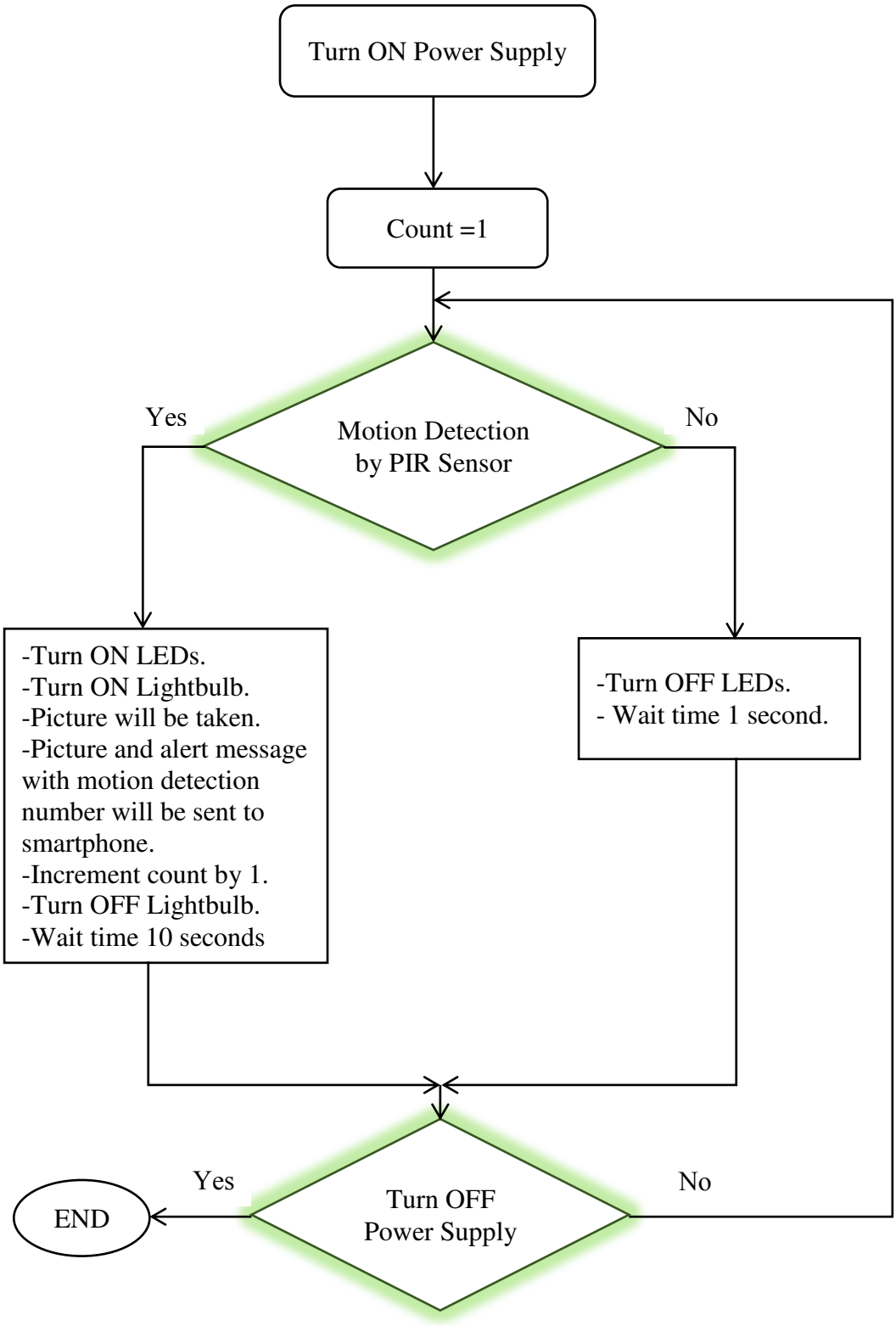


Figure 3.31. Flowchart for the proposed system

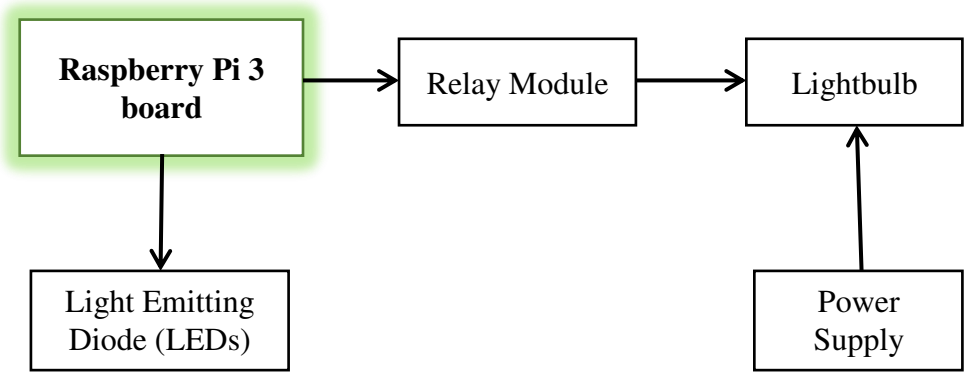


Figure 3.32. Lighting part

3.6.1 Telegram Application

The Telegram is a cloud-based smartphone and computer messaging application with a focus on security and speed(*Telegram Messenger*, no date). Besides that, Telegram Application has several benefits that distinguish it from other applications:

- The possibility of sending any type of documents such as picture and video.
- This application works on the computer and mobile phone .Additionally, it runs on Android, iPhone, iPad, and Windows Phone, Windows, Mac OS X and most Linux systems.
- The different types of messages are synchronized through devices such as phone and computer.
- This application enables to make public chat between all people.
- It has the ability to encrypt data when the device sends it and the receiver will decrypt it.
- Protection from hacker attacks.

Besides that, Telegram Application has many advantages that make from its perfect software for needs:

- It has the privacy for saving the messages.
- It has the ability for access to messages across more than one device.

- It is able to deliver the messages at high speed more than any other application.
- It has servers distributed all over the world for speed and security.
- It has free protocol and an open API for every person.
- This application is free and the user is not required to pay a subscription fee.
- This application has no specific size for chats and media.

In order for transmitting the picture taken and message with the count number for motion detection from Raspberry Pi 3 to the smartphone to be successful during the Telegram Application. Firstly, the Telegram Application must be installed on the smartphone and Raspberry Pi 3. It is worth to mention that, in the proposed system, the operating system which used in the smartphone is an Android.

3.6.2 Installation of Telegram Application in the Smartphone

The installation of the Telegram Application on Android Smartphone starts with installing the application from Play Store as depicted in Figure 3.33.

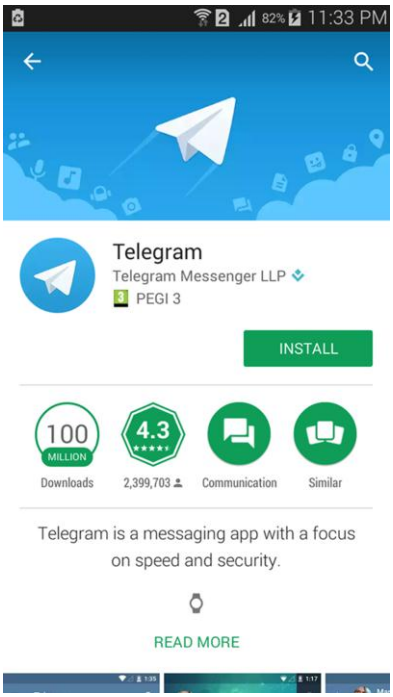


Figure 3.33. The installation of Telegram application from Play Store

Now open the Telegram Application and create a bot. The Bot is the user and creation the Bot Requires start chat with **@BotFather** by send **/newbot** and **@BotFather** will Requested to give the name and the user name. The username must end with the string bot. The **@BotFather** is the basic Telegram bot as shown in Figure 3.34 and Figure 3.35 shows the procedure for creating a bot(Carlo Mascellani, 2016)

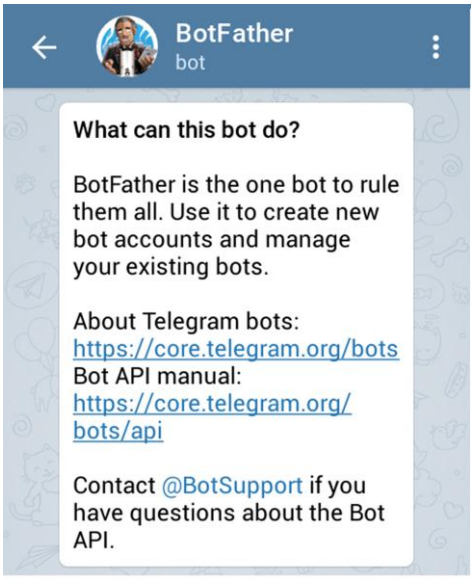


Figure 3.34. BotFather in Telegram

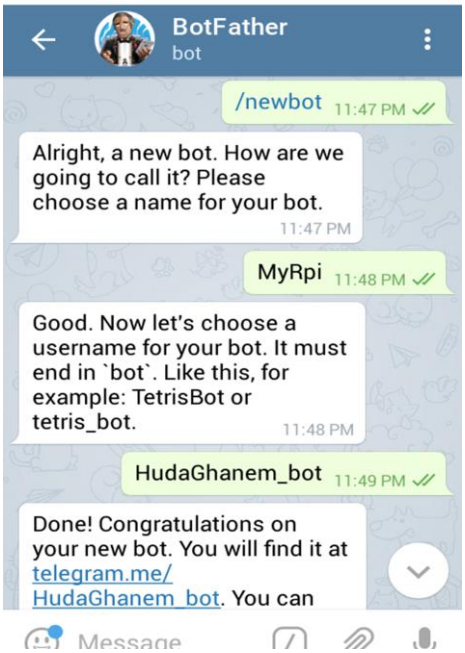


Figure 3.35. The creation of the Bot in Telegram application Application.

Note that, the username is saved in the Telegram Application databases, so the username should not be used before.

3.6.3 Installation of Telegram Application in the Raspberry Pi 3

The installation of Telegram Application on Raspberry Pi is done by installing the telegram-cli library in Raspberry Pi by using command line interface or LXTerminal. 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 vice vers(GmbH, 2014).

Now, to install telegram-cli on the Raspberry Pi 3, type these commands on LXTerminal respectively:

```
sudo apt-get update
sudo apt-get install -y libreadline-dev libconfig-dev libssl-dev lua5.2 liblua5.2-dev libevent-dev libjansson-dev
```

```
cd ~
```

```
git clone --recursive https://github.com/vysheng/tg.git
```

```
cd tg
```

```
./configure
```

```
make
```

The telegram-cli must be now in the folder **/home/pi/tg/bin**.

Now, run these commands to allow to startup the tool without needing to specify all the path and without specifying the path of the public key:

```
sudo cp ~/tg/bin/telegram-cli /usr/bin
```

```
sudo mkdir -p /etc/telegram-cli
```

```
sudo mv ~/tg/tg-server.pub /etc/telegram-cli/server.pub
```

When telegram-cli was started for the first time, it will be authorized. During the authorization, the configuration directory **~/.telegram-cli** will be created. It contains the folders about authorization.To get the authorization for Raspberry Pi, run these commands:

```
cd tg
telegram-cli -W
```

The "-W" will load the information about contacts and without it ,the application didn't have the ability to send messages. Now, it will be asked for a special phone number for this application not previously used for the Telegram. Enter that number Preceded by '+' sign and country code. After that, it will be received the SMS to this phone number includes code. Enter that code and now exit the tool by using this command:

```
quit
```

Now, the two batch files in the /home/pi directory must be created. One to send the text message and the other to send the picture taken. Note that, the /home/pi directory is the same directory for the project program in python language.

The name of the text message file is ' telegram_send_message.sh' and it contains of:

```
#!/bin/bash
telegram-cli -W -e "msg huda_alsaffar $1"
```

And also the name of the picture file is telegram_send_picture.sh and it contains of:

```
#!/bin/bash
telegram-cli -W -e "send_photo huda_alsaffar $1"
```

After that, make those files executable by running this command in the LXTerminal:

```
chmod ug+x telegram_send_message.sh telegram_send_picture.sh
```

Now, Telegram Application is ready to use it in sending the picture with notification message from Raspberry Pi3 to Android smartphone by importing subprocess and useing Popen module to calling and sending the messages to the smartphone by using python language.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter illustrated the experimental results of the implementation of the smart security system.

4.2 Results of the smart security system

The smart security system is developed which result is illustrated in Figure 4.1 that shows the result on the system box when motion is detected and Figure 4.2 that shows the result on a smartphone.

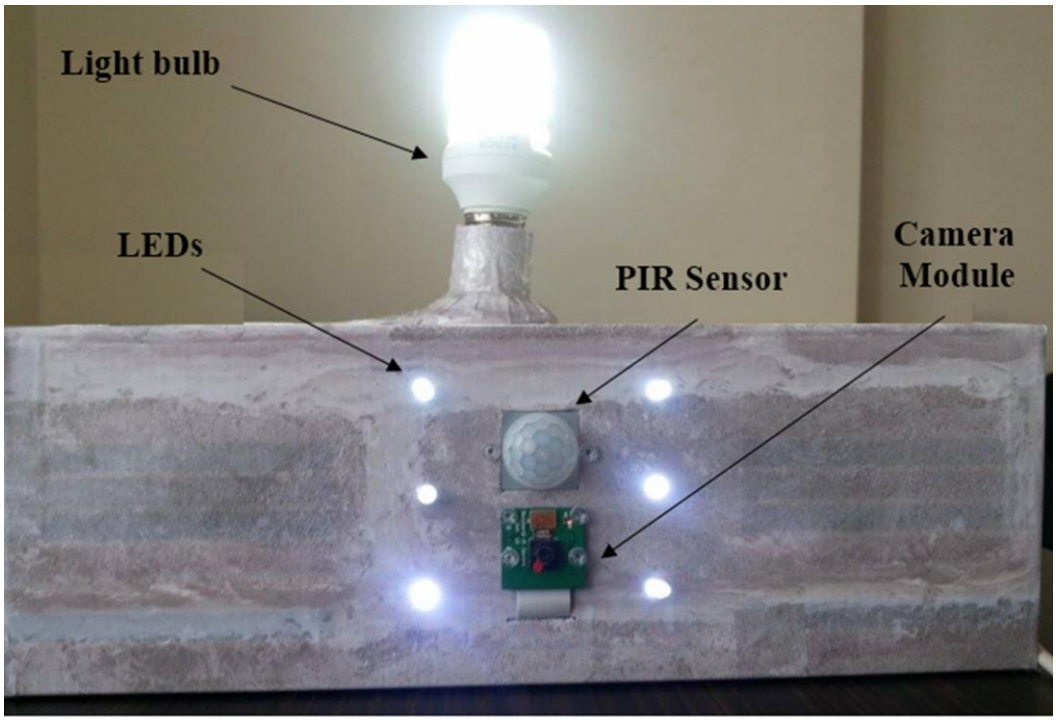


Figure 4.1. The security system at the moment of take the picture if motion is detected

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

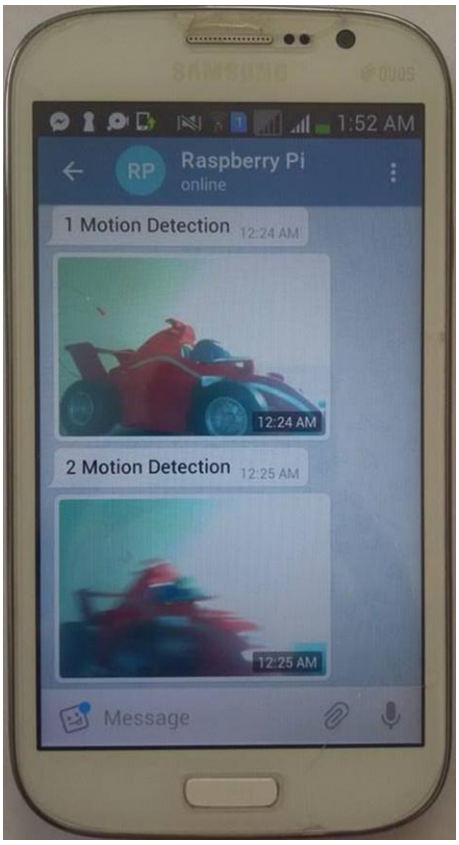


Figure 4.2. The result of proposed security system in smartphone

CHAPTER 5

CONCLSION

5.1 Conclusion

This project presents a new smart security system that able to monitor any movement in the room. Hence, this study was accomplished by using different devices. Additionally, 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. In addition, this security system is the very comfortable system because of using smartphone technology. Also, it is trustworthy and providing particularity on the both sides, in the smartphone device and Raspberry Pi 3 device. Obviously, this system has been designed to fulfill the needs of the user for particular monitoring areas such as small personal office room, any room in the home, parking entrance and bank locker room. Additionally, this system was working infinity until the power is turned OFF. Besides that, this system is an overall solution that can provide a user-friendly home based security system and crucial system choice for several reasons belong to inexpensive, consumes low power, simple circuit, a very effective, advanced system and provide high-level security.

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