Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF SMART DOORBELL USING RASPBERRY PI WITH IOT PLATFORMS

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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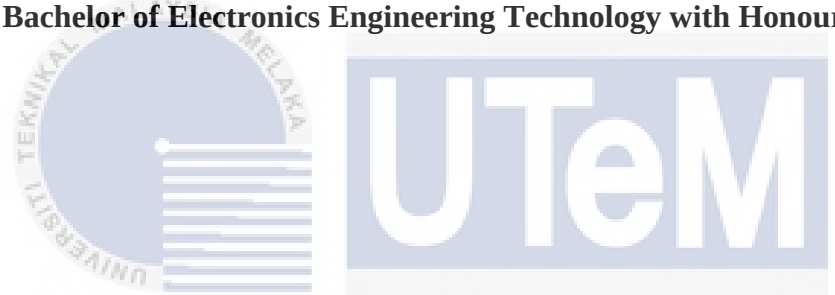
A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled “Development of Smart Doorbell using Raspberry Pi with IOT Platforms” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

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DEDICATION

Special dedication to my beloved mothers, Dingkim Binti Salamat who always given me a lifetime support, my inspiration, encouragement, love and laughter. And to all my beloved siblings, my family member, and my fellow colleagues who always been there and helped me. To my supervisor, who constantly serving as a support system in completing my project and the source of my motivation.

ABSTRACT

The internet of things (IoT) has entered a golden age of rapid growth in this era of globalization. Many technologies have been developed and implemented to make people's lives easier. Home security has become an important issue in our daily lives. Nowadays, anything can happen, such as missing an important visitor or losing a valuable due to potential break-ins or house robberies. This brought up the idea of developing a smart doorbell using raspberry pi with IoT platforms in a cost-effective way. By using these techniques, it will bring advantages in providing a safety and security of identifying people who come to the house. The main component of this project is a Raspberry Pi, and whoever presses the doorbell, the camera is triggered and their face is captured. Furthermore, the PIR Sensor will be used as a motion detector to detect the human body. When an object approaches the door and the doorbell is pressed, it sends an alert message to the owner and allows the owner to view the visitor's image. The goal of this paper is to design and develop an integrated smart doorbell-based IoT that can notify the owner via smartphone once the visitor approaches the door and presses the doorbell. Moreover, to send an email notification with an image attached to the owner. Therefore, to monitor anyone who comes to the house while the owner is away. The smart doorbell can be linked to a network of other smart home devices and accessed via mobile phones or others connected device. This project has a very user-friendly interface and, most importantly, enhanced security. Furthermore, the images are clearly HD, and the owner can easily identify the visitor who came by.

ABSTRAK

Internet of things (IoT) telah memasuki zaman kegemilangan pertumbuhan pesat di era globalisasi. Banyak teknologi telah dikembangkan dan dilaksanakan untuk menjadikan kehidupan orang lebih mudah. Keselamatan rumah telah menjadi peranan penting dalam kehidupan seharian seseorang. Pada masa kini, apa sahaja boleh berlaku, seperti kehilangan kunjungan penting atau kehilangan barang berharga. Kerana ianya sangat berpotensi berlaku pecah rumah atau rompakan rumah. Hal ini telah membangunkan idea dalam membina bel pintu yang menggunakan *Raspberry PI* dengan *platform IoT* dengan cara yang berkesan. Dengan menggunakan teknik ini, ia akan membawa kelebihan bagi semua orang dalam memberikan keselamatan dan dapat mengenal pasti orang yang datang ke rumah tanpa membuka pintu tersebut. Komponen utama projek yang digunakan ini adalah *Raspberry Pi*. Selain itu, untuk sesiapa sahaja yang menekan bel pintu, *Pi camera* digunakan untuk mengambil gambar mereka. Disamping itu, *PIR Sensor* akan digunakan sebagai pengesan pergerakan. Apabila sesuatu objek menghampiri pintu dan bel pintu ditekan, ia akan menghantar pemberitahuan kepada pemilik rumah dan ini membolehkan pemilik tersebut dapat melihat gambar orang yang ada di depan pintu. Objektif utama adalah untuk merancang dan mengembangkan *IoT* berasaskan bel pintu yang boleh memberitahu pemilik rumah melalui telefon bimbit ketika seseorang berada di depan pintu dan menekan bel pintu. Selain itu, untuk menghantar e-mel pemberitahuan dengan gambar yang dilampirkan kepada pemilik rumah. Tambahan pula, untuk memantau sesiapa sahaja yang datang ke rumah semasa ketiadaan pemilik rumah. Bel pintu ini boleh dihubungkan ke rangkaian peranti rumah yang lain dan dapat dibuka melalui telefon bimbit atau peranti yang lain. Projek ini mempunyai sangat mesra pengguna dan keselamatan dipertingkatkan.Tambahan pula, gambar tersebut adalah jelas, dan pemilik tersebut dapat mengenal pasti pengunjung yang datang dengan lebih mudah.

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My highest appreciation goes to my family members for their love and prayer during the period of my study. An honorable mention also goes to my mother, Dingkim Binti Salamat for all the motivation, and understanding. And to my siblings, thanks for the financial support.

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CHAPTER 1

INTRODUCTION

1.1 Background

Door is the first point to access and it must be protected to avoid unwanted thing happens. This is the reason why the smart doorbell must be installed at the door. This project very convenient to everyone for those who want to install in front of the door. Besides, this project implemented to make the owner know who come to the house. For instance, Pi camera will capture of the visitor's face and sends the image to the owner via email. Therefore, owner will receive the notification and clicks on it. From that, owner will know someone at the door and know what kind of people outside the door. With the doorbells it makes their life much easier. This because the device is directly sent an email notification with attached image to the owner, and the owner can take action immediately. Therefore, the visitor are no longer needs to wait for long and simply let the smart doorbell do the job. Moreover, development of these smart doorbell is based on the Internet of Things (IoT) which combine with the hardware, software, programming, and sensors, then works together to produce results. The Raspberry pi interfaced with doorbell is helpful for every type of user and it also best thing to use for every type of project. Therefore, it will become more secure compared to the traditional doorbell. Furthermore, implementation of these smart doorbell is to make secure of the house and to make easy of people. Moreover, this project is a real-time system that will help for every type of user.

Furthermore, the GPIO pin will attached with the Raspberry PI and the PI camera is attached to the camera slot. In the programming code, used raspi-config to enable the Raspberry PI. The doorbell system also enables and disable the notifications based on the user's preference. Limitation of the system is the medium of the course is internet but sometimes if the internet is not stable in user's smartphone it will fails to alert about notification. This system will include message system to give the notification. The user will notify when doorbell rings even though if the user's internet is not stable. Basically, what the program does it wait somebody to approach the door, and press the button at the door, then it will notify the owner by an email.

1.2 Problem Statement

Nowadays, smart home products are entering the market quicker than ever. According to statistics, homes without security systems are not really safe. Since the front door is the first points of access, this time is suitable time to develop a smart doorbell. Smart doorbells are a relatively new technology that produces a wide range of different technology collections. By developing this device is to send a message to the owner. Nearly everything in our lives today is just a simple touch. Owner can know if there's someone approaching the door. However, having a traditional doorbell the owner needs to get near of the door to verify the identity of the visitor. Regarding to this issue, opening the door to see who is outside the door is not really a good thing to do. Because they don't even know what kind of people outside the door. This makes their life in dangerous. Besides that, when the owner not answering or open up the door it can tip off thieves to breaks down of the house. In order to rectify these problems, reconfigurable doorbells were introduced by developing a camera inside the doorbell. This method was effective in preventing home break-ins. The owner able to check who is outside the house without opening the door. Such as when the visitor approaches the front door and presses the doorbell, the buzzer will get triggered to sound and alert the owner inside the house.

Therefore, this smart doorbell has additional features that make it even more secure and useful. These features include a night vision, it can be connected to the home automation system and even accessed using smartphone or others electronic device. The research provided a technique for the efficient development of smart doorbell by adding a buzzer on it.

1.3 Project Objective

The project objectives are as follows:

a) To develop and build an integrated smart doorbell based IoT that can notify the owner via smartphone once the visitor approaches the door and pressed the doorbell

b) To send an email notification with an image attached to the owner

c) To monitor anyone who comes to the house while the owner is away

1.4 Scope of Project

The scope of this project are as follows:

a) Raspberry pi are the head tools in this project and it used to take all the workload. PI camera is use to take a snapshot of visitor's face.

b) PIR Sensor will be used as a motion detector to detect the human, who's approach at the door.

c) This smart doorbell notifies the owner through mobile phone

d) LCD is used to display an information from the system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter, will provide a overview of current state of knowledge, relevant theories, and techniques that have been done from previous paper as guideline and a reference. The specifications of the material used, existing project are discussed in this topic to bring out the greatest suggestion and conclusion for this project. Besides, there are also a several sources in collecting data and the information for this chapter, such as journals, and articles. The research outcome from previous work on this project is to retrieve important information and idea to ensure that this project are running smoothly. Moreover, all of the specifics about the equipment used for this project, such as the Raspberry PI, PI camera, GSM module, LCD, Push button, and PIR sensor, will be described in this chapter.

2.2 Existing doorbell monitoring system

2.2.1 Access Control of Door and Home Security by Raspberry Pi through Internet

Chowdhury, Md. Nasimuzzaman & Nooman, Md & Sarker, Srijon [1] found the opposite to be true that everyday things are getting connected with the internet. Their research was aimed at access control of doors and home security via the internet using a Raspberry Pi. This new system was designed to control the door via the internet. All of the signals are captured by the Raspberry pi microcontroller. It has different both of the interfaces. The input section consists of calling bell, PIR sensor and wireless camera. While the output section contains the led, magnetic look, emailing and tweeting services. The webcam automatically activated and capture a picture of the visitor after the raspberry pi captures the signal. Also, the alarm

buzzer will active. The data of the visitor are then sent to the user by email. With that, the user will know and see from anywhere about the presence of the visitor. This system also keeps the picture of the visitor. By using a command from the internet, user can easily control the door. Besides, the door will open automatically if the user wants to give a permission of people that come to the house. Therefore, the system proposed here it can be used for other things such as industrial automation or any kind of product that are wirelessly. However, limitations of this system that is it completely depends on the Internet connection to communication with the user and send the details. Piyare, R. and Tazil, M [2] proposed the Home Automation Device Protocol as a protocol standard for home automation systems (HADP). It is built on the IFTTT (IF-This-Then-That) model. Their project was aimed to enlarge the scale of home automation with multiple platforms. The communication set of devices will get triggers and then combined it together to achieve the target. However, their system also needs internet connection.

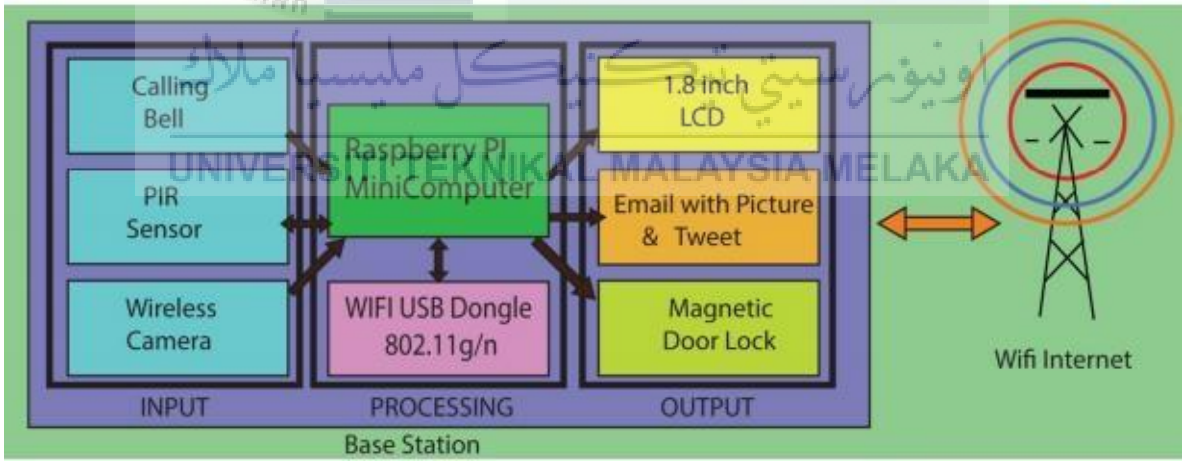

Figure 2.1: Example of main project outline of Access Control of Door and Home Security by Raspberry Pi through Internet

2.2.2 Fingerprint Module Based Door Unlocking system using Raspberry Pi

Abdul Muqeet, Mohd [3] had proposed the idea of unlocking the door by just using a fingerprint and also monitors the door entrance using the webcam. Fingerprint recognition is one of the most popular methods of biometric technology compared to other biometrics. Fingerprint recognition can be considered more natural and it the safest way to identify the person. Two people can't have the same fingerprints. Their proposed system is about to providing home security by giving an access to only the owner or to whom the authentication is provided of the home. Their study uses a Raspberry Pi as the input from the fingerprint module and when the details are match then the system automatically provides access to the owner by unlocking the door using a solenoid lock. Although their study showed that if the internet connection is not working well, the doorbell system will fail to alert the owner. Besides these biometrics can be hacked. Their study is about to captures the image of the intruder or whoever come to the house and sends and email to the owner using IoT based WIFI technology. Limitations of sending the message with the picture is the Internet. Video Door Phone Surveillance System Using Powerline Communication Channel was proposed by Chao-Huang Wei and Shin-An Chen [4]. These projects have a simple structure, cheap, and they are only used for voice communication. Therefore, it cannot be integrated into a smart home network system.

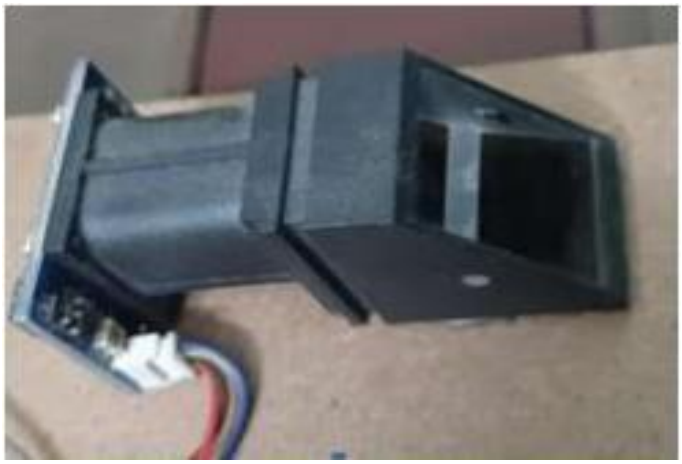

Figure 2.2: Example of Fingerprint Module

2.2.3 Smart Security Surveillance using IoT

Smart security surveillance using IoT by S. Akter, R. A. Sima, M. S. Ullah and S.A. Hossain [5] was aimed to manage effectively the visitors from entering the house by using just a simple and customised technology. Beside it is enhancing the security of home based IoT. This [5] also used a true real time system and it combined with the home network security. Their proposed system enables the owner to monitor of the house. However, there's some limitation too, which the internet connection. Therefore, [5] is an interesting idea to know if there's a motion near at the door. Besides, [5] is used to control the address privacy in very effective way and to make a better security. Both of them are connected with the Raspberry PI with the other components. The development of this project was aimed to monitor of the house. The camera module is used to capture images, which are then sent to the user via mobile phone. Aside from that, the camera module can stream video and improve detection by using face recognition.

same.

2.2.4 Enhanced Smart Doorbell System Based on Face Recognition

The concept of creating an intelligent doorbell system based on human face recognition is demonstrated by A. Ben Thabet and N. Ben Amor, [6]. Their face recognition system research is an intelligent application that can identify or verify a man from advanced sources such as a biometric image or a video stream. For instance, if there's someone approaches the door, they can easily recognize it. Their purpose [6] was to replace the existing image processing systems for facial recognition, which were quite expensive. In addition, the authors [6] propose a system that would be activated as soon as the visitor pressed the doorbell button. When the visitor presses the button, the activated face recognition takes the image with an integrated camera and generates a template to be verified in the visitors'

existing data set. Furthermore, the owner will be notified with all of the visiting details via mobile phone, speakers, and the admin website. The Eigen faces algorithm from the OpenCV library is used to perform face recognition. Through the activities of computer engineering engineers, PCs will be recognizing objects in many human activity recognitions, especially those needing the search of large amounts of data of human faces. [6] The Eigen face and Independent Component Analysis were used as analysis algorithms (ICA). To recognize faces, their project employs the Eigen faces algorithm and the OpenCV library. Their research aimed to outperform high-priced image processing boards by utilizing a Raspberry Pi board with an ARMv7 Cortex-A7 as the core within the OpenCV library.

Furthermore, their research is mainly focused on image processing, with the OpenCV library that has been ported to the Raspberry Pi board. The most important task in face recognition is determining which faces are the most similar between the tested and training faces. Their system can distinguish and recognise faces and has a wide variety of applications, such as crowd and airport surveillance, private security, and increased human-computer interaction. Face recognition is one of the most widely used biometric techniques. A. Ben Thabet and N. Ben Amor also discovered [6] that it is versatile enough to be used in a variety of applications like terrorist identification, safety systems, and access verification. Specifically, an image processing algorithm that has been programmed and implemented based on principal component (PCA).

Furthermore, in the system proposed [7], usually the face recognition system works by scanning the person face with a camera module. If the captured image matches the database, the door's lock will be unlocked. For example, if someone tries to open the door lock, the system immediately notifies the owner via message that there has been an intrusion in his home. Besides, the face recognition system works by identifying aspects of an individual's identity. Their system is regarded as a strong and smart doorbell that is primarily based on

human identification [8]. On the other hand, when using face recognition, the system may identify the person based on a given face image. However, in the worst-case situation, the Eigen Face algorithm only can be used to determine the most likely faces. Aside from that, several issues with face stimulants have been recognised in previous work, specially, when the device is exposed to the environmental changes in the outdoors; this could have significant implications for the use of identification tools similar to eigen face. As a result, the system may use face verification to determine whether a sample matches or does not match, in order to improve the verification.

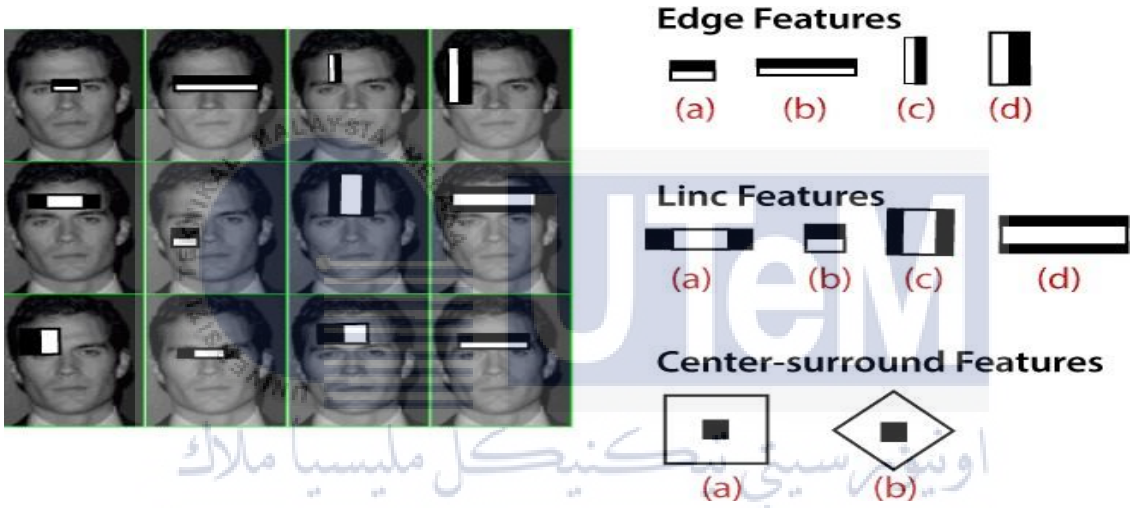

Figure 2.3: Example of Face Recognition using OpenCV

2.2.5 Dash Bell: A Low-Cost Smart Doorbell system for home use

The goal of Quadros, Bradley, Kadam, Ronit, Saxena, Kartik, Shen, Wen, and Kobsa, Alfred's [9] project was to implement a low-cost smart doorbell system for home use. Aside from that, there are a few security and privacy concerns too. Dash bell is enhanced security over a conventional doorbell, and it connected via a home WIFI network [10]. For example, the owner can view the images of a visitor's identity remotely. Furthermore, it enables the home owner to accept or decline a request from anywhere when it is in WIFI or internet range [11]. As a result, the Raspberry Pi detects the Dash button signal and sends it to the

WIFI router. Then it activates the webcam and takes a picture of the visitor before activating the buzzer to alert the owner of their presence. The visitor's image captures will then be uploaded to the cloud. Furthermore, their project is connected to the Internet and it also allowing the user to communicate with the visitor from anywhere. Dash bell has a lot of useful features, but has some limitations too. Because the device is linked to the home network, therefore the intruder can easily collect the information. Thus, the network must be password protected. Despite the fact that such doorbells are quite expensive due to the technical and manufacturing systems. Aside from that, it is always dependent on the internet [12]

2.3 Global System for Mobile Communication (GSM) module

GSM, is widely used wireless technology. GSM was developed by Europeans and initially stood for "Group Special Mobile," but this didn't reflect well, from that the more widely known and enticing name was introduced [13]. GSM is an ETSI-published standard that is now widely used in Europe, Asia, and, increasingly America. GSM is a mobile communication architecture that is used in majority of the countries. Global Packet Radio Service (GPRS) is a GSM extension that allows for faster data transmission rates. This module is used to communicate between a computer and a system. GSM/GPRS modules are consists of a modem, a power supply circuit, and computer communication interfaces such as RS-232, USB, and etc. Modem is a type of wireless device that allows a computer to communicate with the GSM and GPRS networks. One of the most important aspects of GSM is the (Subscriber Identity Module) card, that is used to activate network communication in the mobile phone. They also have an IMEI (International Mobile Equipment Identity) number for identification [14]. Moreover, GSM was designed to be a secured wireless system. GSM, on the other hand, is vulnerable to various types of attacks and each aimed at

a different part of the network. Besides, it employs a number of cryptographic algorithms to prevent attacks.

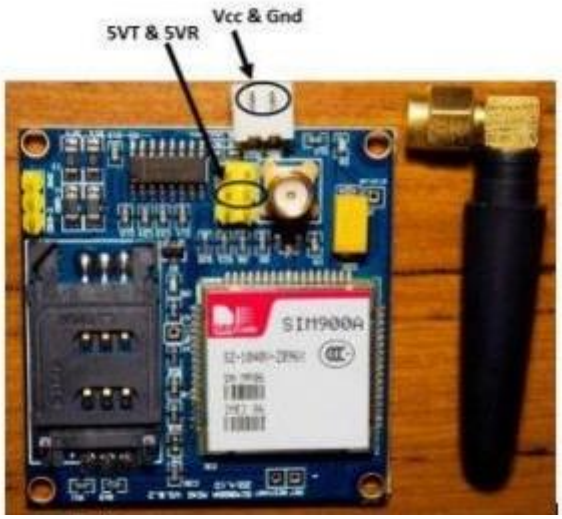

Figure 2.4 : Example of GSM SIM900A module

Table 2.1 Characteristics of the SIM900A module

Communication Solution	SIM900A Specifications
GSM	Quad-Band 850/900/1800/1900 MHz
GPRS Data	GPRS class 10: max. 85.6 kbps (downlink); Coding schemes CS 1, 2, 3, 4; PBCCH support; PPP-stack;
CSD Data	USSD, Non-Transparent Mode
SMS via GSM/GPRS	Point to point MO and MT; SMS cell broadcast; Text and PDU mode;
Voice	Half Rate (HR), Full Rate (FR), Enhanced Full Rate (EFR) Codec; HR & FR AMR; Echo suppression;
Fax	Group 3, Class 1
Software Features	Embedded TCP/UDP protocol; FTP/HTTP;

2.3.1 Communication

GSM is a robust and widely used wireless network technology based on time- division multiple access (TDMA). The GSM SIM900A module is used in this project. Interfacing the GSM module's transmitter, receiver, and ground pins with the Raspberry pi's GPIO pins that allows communication to take place. The speaker with an amplifier and the microphone also connected to the GSM module to enable voice communication. When Personal Computer is

plugged into the Debug/EDBG USB port, it is recognized as a virtual COM port. The geographical area that inside the GSM is divided into the hexagonal cells, which is determined by the power of the transmitter and the load on the transmitter (number of end user). The base station, which is located at the centre of the cell, is made up of an antenna and a transceiver (a combination of transmitter and receiver). The data processing application firmware for EDBG boards is intended to connect with the PC through virtual COM ports. GSM includes an on-board power supply that enables it to connect to a variety of unregulated power supplies. Using simple AT commands, this module can access voice calls, messages, and the internet, as well as phone calls. Furthermore, GSM modems support higher levels of AT commands

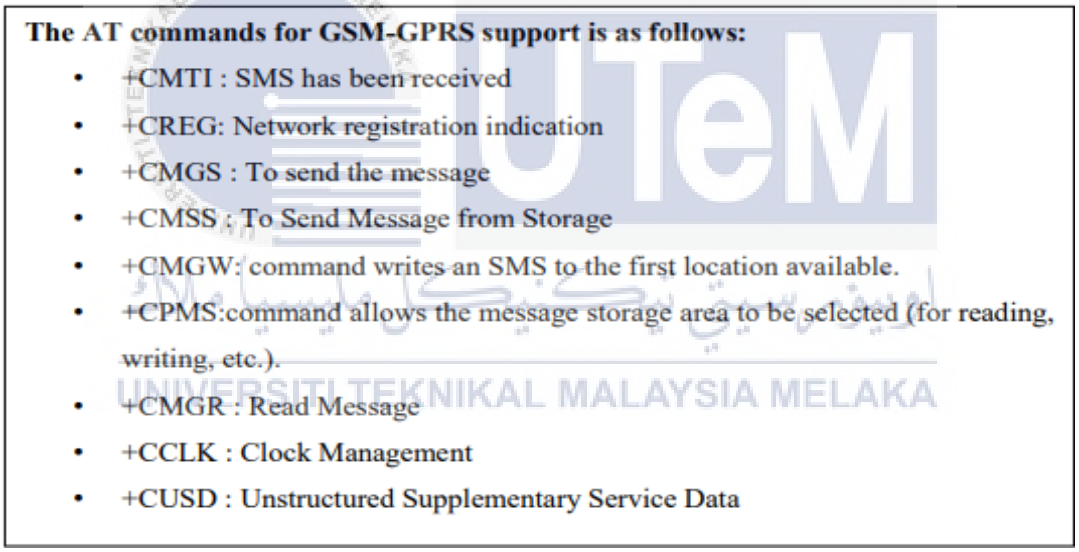

Figure 2.5: Example of GSM commands

2.3.2 GSM specifications

i) Frequency band

The GSM frequency range is 1850 to 1990MHz, and it is used for communication between mobile stations and base stations.

ii) Duplex distance

The duplex distance is 80MHz and the distance is in between of the frequencies of the uplink and downlink. Then it has two frequencies, each 80 MHz apart.

iii) Channel separation

It is 200 kHz in GSM and its located between adjacent carrier frequencies.

iv) Modulation

A process of sending signals by changing the composition of a carrier frequency. In GSM, this is accomplished through Gaussian minimum shift keying (GMSK)

v) Transmission rate

GSM is a digital system with a bit rate of 270 kbps over-the-air.

vi) Access method

The time division multiple access (TDMA) concept is used by GSM. TDMA is a technique that allows multiple calls to share the same carrier. Each call is given a specific time slot.

vii) Speech code

GSM makes use of linear predictive coding (LPC). LPC's goal is to reduce the bit rate. The LPC specifies the parameters for a filter that simulates the vocal tract. The signal is routed through this filter, leaving a residual signal behind. Speech is encoded at a rate of 13 kbps.

2.3.3 GSM Architecture

The GSM architecture is made up of three major interconnected subsystems that communicate with one another and with users via network interfaces [15]. Base Station Subsystem (BSS), Network Switching Subsystem (NSS), and Operational Support Subsystem (OSS) are the subsystems (OSS). The (MS) is also a subsystem [16], but it is included in the BSS. Figure 2.6 shown has a different network area. They are divided into

four categories based on their functionality. All of them are intended to enable reliable mobile communications. The overall network architecture proved to be very successful, and it was further developed to allow 2G evolution to carry data, followed by further evolutions to allow 3G to be established.

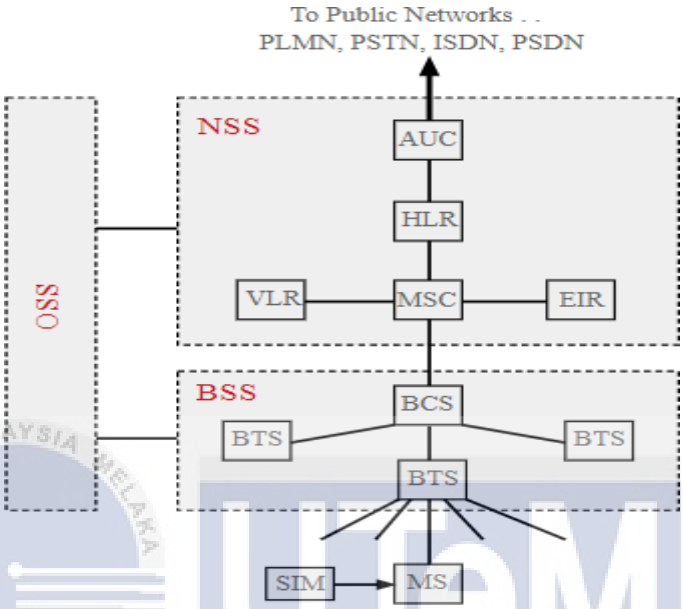

Figure 2.6: Example of simplified GSM Network Architecture Diagram

2.3.3.1 Mobile Station (MS)

The section of a GSM that the user sees and operates is known as a mobile station, also known as a cell or a mobile phone. MS are made up of two parts:

a) Mobile Equipment (ME)

An International Mobile Equipment Identity (IMEI) number is used to uniquely identify mobile equipment. It is used to transmit both voice and data. Furthermore, it also monitors the power and signal quality of nearby cells to ensure good handover. Therefore, it can send SMS messages of up to 160 characters in length.

b) Subscriber Identity Module (SIM)

SIM is a smart card that contains the international Mobile Subscriber Identity (IMSI) number. This function is to communicates the user's identity to the network. Besides, it allows users to send and receive calls and the password or pin are protected. Therefore, it includes encoded network identification information. As a result, it contains critical information for activating the phone. Then it switched from one mobile to another.

2.3.3.2 Base Station Subsystem (BSS)

The Base Station Subsystem (BSS) segment of a 2G GSM network architecture that is fundamentally associated with interacting with the network's mobiles. The BSS, which consists of two elements, performs all radio-related functions.

a) **Base Transceiver Station (BTS)**

The BTS used in a GSM network consists of radio transmitter receivers and it associated with antennas that transmit and receive to directly communicate with mobiles. The BTS is the distinguishing feature of each cell. Each BTS functions as a single cell, therefore based on the number of clients in the cell, each BTS has 1 to 16 transceivers

b) **Base Station Controller (BSC)**

The BSC is the GSM network's next stage. It manages a number of BTSs and is frequently co-located with one of them. It manages radio resources and controls things like handover among BTSs in a group, channel allocation, and so on. The Abis interface is used to communicate with the BTSs.

2.3.3.3 Network Switching Subsystem (NSS)

The primary component of which is the Mobile Switching Centre (MSC), handles the exchange of calls between portable and other settled or versatile system clients, as well as the administration of portable services, for example, verification.

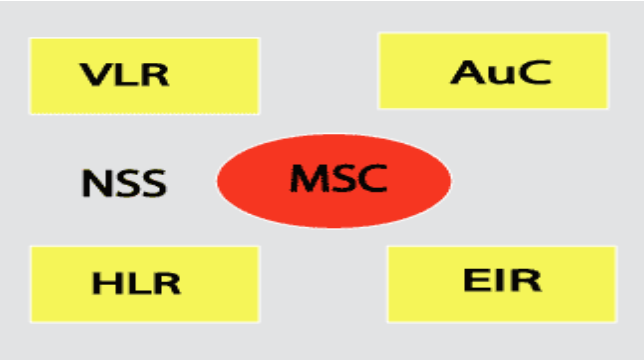

Figure 2.7: Example of Network Switching Subsystem elements

a) Visitor Location Register (VLR)

The VLR is a temporary subscriber database that is updated whenever a new MS enters its areas via the HLR database. So, it reduces the number of queries to HLR. The VLR is consistently linked to the MS. As soon as the mobile station moves into the a new MSC area, the VLR connected to that MSC will then request data about the mobile station from the HLR. VLR's database contains IMSI, TMSI, IMSISDN, MSRN, location, and area authentication keys.

b) Authentication Centre (AUC)

The Authentication Centre (AUC) elements are a secure database containing the secret key, which is also stored in the user's SIM card. This is used for radio channel authentication and ciphering. Furthermore, it keeps the authentication keys and algorithms and provides a security triplet as well (RAND, SRES, Ki).

c) Home Location Register (HLR)

The HLR is a permanent database containing information about mobile subscribers in a large service area. IMSI, IMSISDN, prepaid or post-paid, roaming restrictions, and supplementary services are all included in the database. The HLR is considered as the most significant database because it stores permanent subscriber data such as an endorser's service profile, area data, and activity status. For example, if someone purchases a SIM subscription, all of the information about that subscription is registered in the HLR of that operator.

d) Equipment Identify Register (EIR)

EIR is a database that consists of all valid mobile equipment on the network, including the International Mobile Equipment Identity (IMEI) that defines each MS. The IMEI is marked as invalid if it has been identified stolen or is not sort affirmed.

e) Mobile Services Switching Centre (MSC)

The MSC is the network's heart. It is in charge of communication between GSM and other networks. Furthermore, it handles mobility management tasks such as registration, location updates, and inter BSS and inter MSC call handoff. As a result, it handles call switching between mobile and other fixed or mobile network users, as well as mobile service management. While the subscriber roams to other networks via HLR or VLR, the MSC acts as a gateway.

2.3.3.4 Operating Support Subsystem (OSS)

The (OSS) is a part of the overall GSM mobile communications network architecture. The OSS is linked to the NSS and BSC components. Which is used to monitor and control all the of GSM network, as well as the traffic load of the BSS. Besides, it also supports one or more Operation Maintenance Centres (OMC) that are used to monitor the performance of each

MS, BS, BSC, and MSC within the GSM module [17]. The OSS provides three primary purposes. The first is to keep all telecommunications hardware and network operations which focused on a single market. As a result, all charging and billing procedures are handled by OSS. Finally, all mobile equipment in the system must be managed.

2.4 Hardware specifications

2.4.1 Raspberry Pi

In March 2018, the Raspberry Pi 3 Model B+ was released. It was created with both Opensource Linux-based and non-Linux-based operating systems. This development board is the third generation of Raspberry Pi Foundation's small single board computers. It has a 1.4GHz 64-bit quad-core Arm Cortex-A53 CPU, 1GB RAM, gigabit Ethernet, an 802.11 wireless LAN integrated, and Bluetooth 4.2. Furthermore, it is a low-cost single-board computer the size of a credit card that is controlled by a modified version of Linux. The Raspberry Pi is powered by advanced instruction set computing machine (ARM) technology [18]. This technology is reducing costs, heat, and power consumption. The Raspberry Pi board includes an SD card slot for booting operating systems such as Raspbmc, Pidora, and Raspbian. It has four USB ports for connecting peripherals such as a keyboard, mouse, and Wi-Fi adapter.

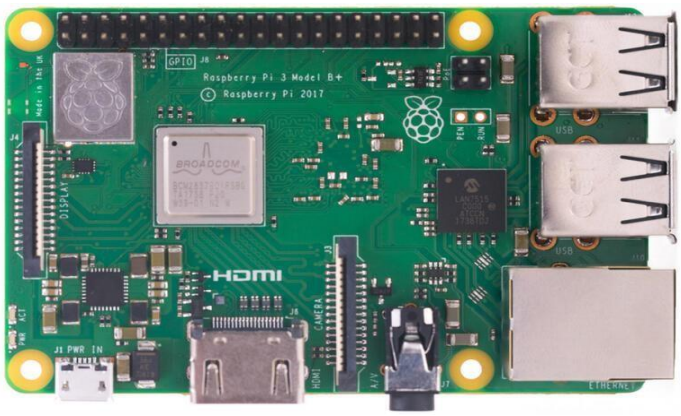

Figure 2.8: Example of Raspberry Pi 3 Model B+

Because older generations of Raspberry Pi models require the installation of a Wi-Fi adapter in order to connect to the internet, the third generation was chosen for this project. In comparison to previous generations, the Raspberry Pi 3 model B+ already has a built-in Wi-Fi chipset, more RAM, and a faster processor. The Raspberry Pi 3 model B+ specifications are listed below.

Table 2.2 Specification details of Raspberry Pi 3 Model B+

Processor	Broadcom BCM2837B0, Cortex-A53 64-Bit SoC @ 1.4 GHz
Memory	1GB LPDDR2 SDRAM
Connectivity	- 2.4GHz and 5 GHz IEEE 802.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE - Gigabit Ethernet over USB 2.0 (Maximum throughput 300 Mbps) - 4 x USB 2.0 ports
Access	Extended 40-pin GPIO header
Video & sound	- 1 x full size HDMI - MIPI DSI display port - MIPI CSI camera port - 4 pole stereo output and composite video port
Multimedia	H.264, MPEG-4 decode (1080p30); H.264 encode (1080p30); OpenGL ES 1.1, 2.0 graphics
SD card support	Micro SD cards are used to load operating systems and store data.
Input power	- Micro-USB connector provides 5V/2.5A DC power. - 5V DC via GPIO header - Enabled Power over Ethernet (PoE) (requires separate PoE HAT)
Environment	Operating temperature, 0-50*C
Production lifetime	will be manufactured until at least January 2023

2.4.2 Raspberry Pi camera Module

The Raspberry Pi camera module was chosen for this project because it is significantly less expensive than the new Pi camera. It connects to the Raspberry Pi via one of the two small sockets on the board's upper surface, which is labelled "CAMERA". This interface makes use of the dedicated CSI interface, which was created specifically for interfacing with

cameras. The CSI bus can handle extremely high data rates and only transports pixel data. The specifications for the Pi camera module v1.3 are listed below.

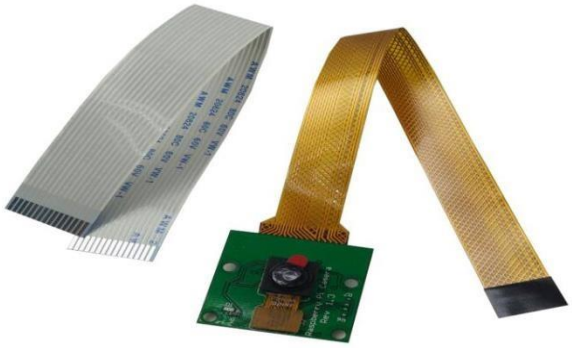

Figure 2.9: Example of 5MP camera Board for Raspberry Pi

Table 2.3 Specification details of Pi Camera module v1.3

	Camera Module v1
Still resolution	5 Megapixels
Weight	3g
Video modes	1080p30, 720p60 and 640 x 480p60/90
Linux Integration	V4L2 driver available
C programming API	OpenMAX IL and other options are available.
Sensor	Omni Vision OV5647
Sensor resolution	2592 x 1944
Sensor image area	3.76 x 2.74 mm

2.4.3 LCD (16x2) Module

The LCD screen is a type of electronic module that displays information [19]. It was used to display the owner's status in this proposed system. If the owner is inside the house, the LCD will display ‘please wait'; if the owner is not available, the LCD will display ‘please come again'. The LCD 16x2 module can only display 16 characters per line, and there are two of them. Each character is displayed in a 5x7 pixel matrix on this LCD. It is made up of 14

pins. There are eight data pins numbered D0-D7 and three control pins numbered RS, RW, and E. The backlight LED is controlled by the LED+ and LED-pins

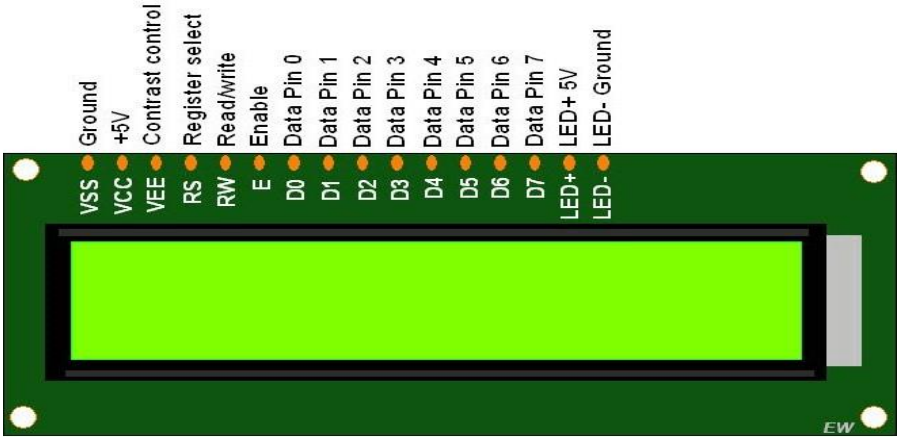

Figure 2.10: Example of Specification details of LCD 16X2 Module

2.4.4 Push Button

An electrical switch is a simple switch mechanism used to control a specific aspect of a machine. Push buttons are usually made of a hard material, such as plastic or metal. Push buttons enable the circuit to be powered or a specific connection to be made only when the button is pressed. In this project, this button serves as a doorbell switch, and when a visitor presses it, the camera is activated. When pressed, it connects the circuit and when released, it disconnects it. It's a switch that requires a triggering pulse.

Figure 2.11: Example of Push Button

2.4.5 PIR sensor

Al-Kuwari, Majid & Ramadan, Abdulrhman & Ismael, Yousef & Al-Sughair, Laith & Gastli, Adel & Benammar, Mohieddine dicovered [21] that PIR sensor are known to detect a motion of a person or any other object that come near to the sensor. In this case, PIR Sensor will automatically active when there's a motion detected. Then the camera will get triggers through the Raspberry Pi and capture the image of the visitor and then notify the owner via email notification.

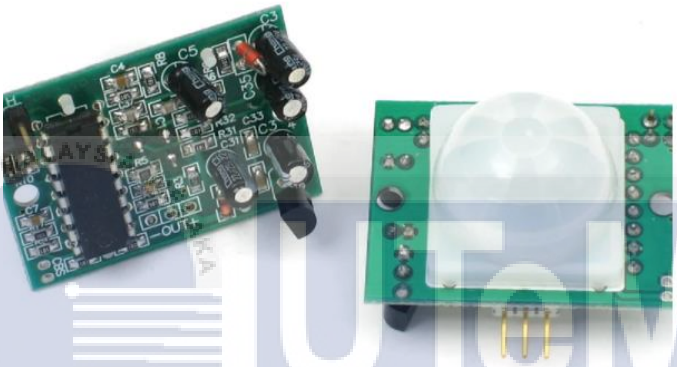

Figure 2.12: Example of PIR sensor

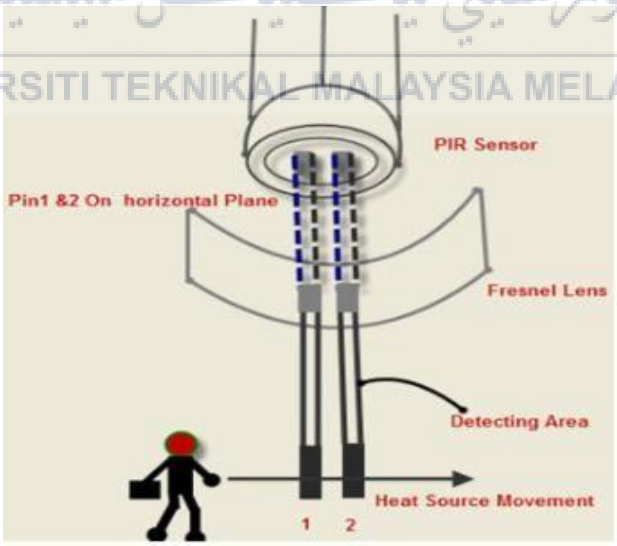

Figure 2.13: Example of detecting area using PIR sensor

When compared to other sensors, the PIR Sensor is quite complicated. PIR sensors have two slots, which are made of sensitive material. The Fresnel lens is used to ensure that the two

PIR slots can see beyond a certain distance. When the sensor is turned off, the two slots detect the same amount of IR. The ambient amount comes from the outside, the walls, the room, and so on. When a human or animal goes by, the first slot of the PIR sensor is detected. This results in a positive distinction between the two bisects. When the body exits the sensing area, however, the sensor produces a negative differential change between the two bisects.

2.4.6 QC Buzzer

Figure 2.14: QC Passed Buzzer

When somebody approach the door and press the button, the buzzer is triggered to sound and alert the owner inside the house. A device that emits a buzzing sound and is used to communicate. The positive pin of the buzzer is connected to the GPIO27 on Raspberry Pi and the negative pin is connnected to the Ground on Raspberry Pi.

Table 2.4 Comparison of the doorbell system

Features	Proposed smart doorbell	Traditional doorbell
Easy installation	Installation is challenging	yes
Snapshot of Visitor	yes	no
GSM text	yes	no
Camera quality	yes	no
Night vision	yes	no
Motion sensor	yes	no
Protection	Enhance security level	No

Table 2.5 Comparison of the existing Doorbell systems

Years	System	Applications	Remarks
2019	Voice Recognition Door Access Control System	Biometrics, Arduino	Give people a quick way to unlock their doors while also ensuring their safety and security.
2012	Controlling door lock in a short range with a mobile application	Communication via Bluetooth	Cheap, flexible and easy installation
2012	GSM Based Digital Door Lock Security	PIC16F877A, GSM	Stable and emerging product in the field of residential and commercial security systems
2015	Access Control of Door and Home Security by Raspberry Pi Through Internet	Raspberry Pi, WIFI, PIR sensor	Low-cost. Furthermore, it stores the visitor's image. The door can be controlled remotely via the internet with a single command.
2016	Dash Bell: A Low-Cost Smart Doorbell system for Home use	Raspberry Pi, WIFI	can remotely view the images of a visitor's identity
2015	Enhanced smart doorbell system based on face recognition	Uses biometrics to map facial features from a photograph or video. Raspberry	based on criteria such as low power consumption, resource optimization, and increased operation speed

Years	System	Applications	Remarks
		Pi board with ARMv7	
2017	Raspberry Pi based smart doorbell system with advanced encryption scheme	GSM Module, Raspberry PI, MAC scheme	to collect and store information via email. It monitors a person's movement.

2017	Smart Doorbell system based on face recognition	Eigen Faces, algorithm using OpenCV library to perform face recognition	can identify or confirm a man using advanced sources such as a computerized image or a video stream
2016	Smart security surveillance using IoT	IoT with PIR sensor and camera module	It allows users to monitor visitors in real time using an IOT-based system.
2018	Voice based Home Automation system using Raspberry Pi	WIFI, Raspberry Pi and Android device	Useful for old age people and disabled people.
2013	Fingerprint Module Based Door Unlocking System Using Raspberry Pi	Raspberry Pi 3 Board, Fingerprint Module, Relay, USB Web camera, Buzzer, Solenoid Lock	Safest way to identify person, faster and accurate
2018	Design and Implementation of a WIFI Based Home Automation System	Arduino Microcontroller, WIFI	low cost, secure, accessible

2.5 Summary

This chapter is elaborating about the existing doorbell monitoring system. This project is all about living in a safe condition and also to make easy of the owner and for those who come to the house while the owner is away. The Raspberry Pi based doorbell system is a head of this project. The Raspberry PI are installed at the door and the PI camera are used to snap a visitor's face. Besides, PIR sensor are case sensitive and it will detect the motion of a person that come near into the house. The Pi camera is used to capture the visitor's face and send an email with the picture attached. LCD screen is an electronic module which is used to displaying the information. Which means when the system is turn on, the LCD will display the current date and time, display to welcome the visitor and display ask the visitor to press the button. This development of smart doorbell is an idea on improving and monitoring and controlling of the house. Moreover, it will give a big impact of the house.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter are described about method and description that is used to complete this project. Some method or findings are mainly in publication that can be used as a reference for others to improve the research. Besides, the clarification of methodology will be elaborate to make the objective achieved. Therefore, methodology is known as topics that contain an explanation of the project material, techniques and data collected in this project. Moreover, this chapter also show the system flowchart on how the whole project is being completed. Furthermore, methodology track begins with the research, collecting data and results. Besides, the project flow will be demonstrated by a flowchart and explained briefly about this project. All of this crucial step will completely elaborate in this topic.

3.2 Prototype Development

This project has crucial phase which is planning, analysis, designing, implementation and system flowchart. All of this will discuss in this topic.

3.2.1 Planning of the Project

This project is beginning with make a planning what the material will be used and what the best project that impact to others. Once the title is selected, then it will be sends and discuss to the supervisor. After the supervisor approved the project title, then started finding a journal, article and book that related about the project title. The planning of the project will be listed up, after the problem statement has been study. All the information needed for the project was gathered. Information includes about the project resources, requirements, literature reviews on previous related work and plan to get data in this study.

Besides, the selected project title is focused on monitoring of the house such as to know who's come to the house when the owner is away and also to make more secure of the house.

3.2.2 Analysis of the Existing Project

This analysis was done to improve the existing on previous works that related to this project. There are so many journal that is related to this smart doorbell can be analyze and examine. From the previous researcher, the existing smart doorbell are using the dash-bell, face recognition, smart surveillance and many more. By doing analysis on the previous works, it will help on choosing the best component and design the project with new features.

3.2.3 Design of Prototype

The design of prototype for the development of smart doorbell using raspberry Pi with IOT platforms will be develop first. The code and the connection for the hardware part are need to check properly to make the connection properly connected and works. Therefore, the code of the smart doorbell project circuit is design, develop and tested first. Then the software part will be tested after the circuit completed.

3.2.4 Implementation of the Prototype

The development of the smart doorbell system is tested once the design of prototype are done. The implementation of this prototype will be using a both of part which hardware and software.

3.2.5 Process flow of Smart Doorbell

The overall process of this project will be shown in flowchart on figure 3.1. It started with planning a project then followed by doing a research and collect data about the project. In this part, it started with discuss about the theoretical background of the project. Besides, this part is to ensure that the project is carried out by using the right information. Furthermore, then write a programming code to make the raspberry pi are working. Then, the programming code is tested to make sure if it's an error occur or

not. A troubleshooting will keep flow until there is no error occurs. Next is selecting the hardware parts. First of all, the selection of the entire component must be correct and suitable. The following step is hardware implementation. The testing and troubleshoot of the project is done when's there is no error occur. If all the design and hardware connection are correct, then run the project again then the analysis can be record to achieve the objective for this project.

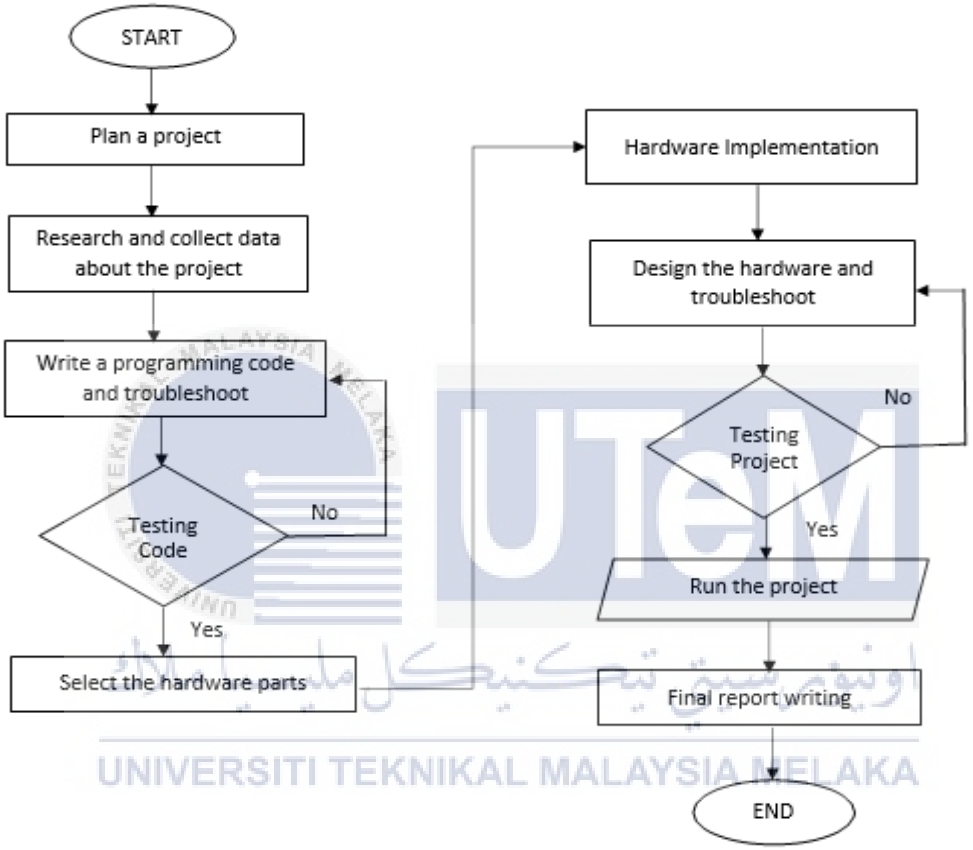

Figure 3.1: Flowchart of the Project

3.3 System Flowchart of Smart Doorbell

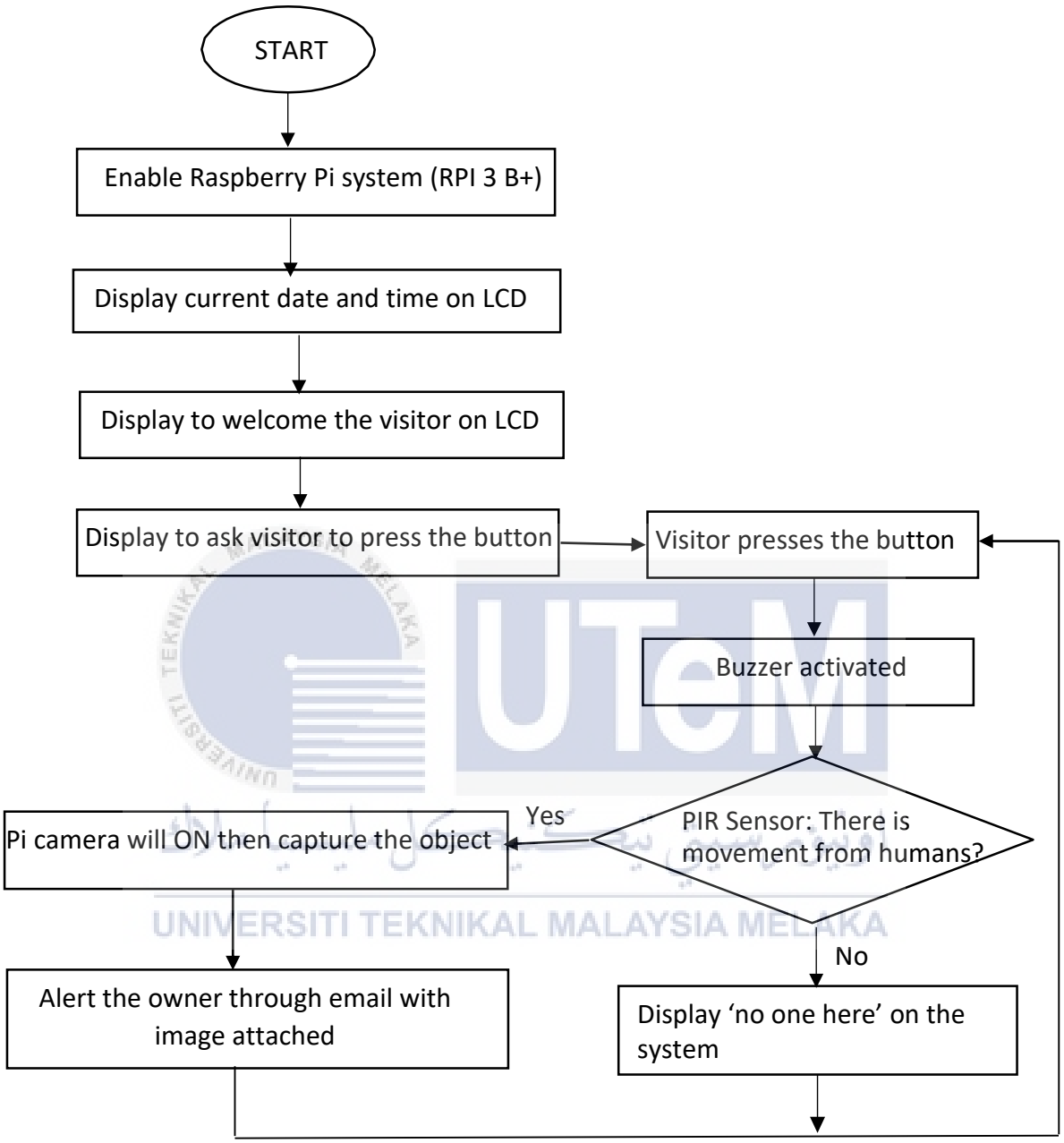

Figure 3.2 The system flowchart of Smart Doorbell

Figure 3.2 above show the system flowchart of the Smart Doorbell where how the process work. This system started with enabling the Raspberry Pi system (RPI 3 B+) then the LCD display current date and time, display to welcome the visitor, display to ask the visitor to press the button. When the visitor presses the push button that installed at the door. The buzzer will be activated to sound and alert the owner inside the house. Then when the sensor is detecting any movement, the Pi camera will straight

away ON and capture the visitor face. The snapshot of visitor will be sends to the owner and notify the owner that there's someone is waiting in-front of the door. Therefore, if the PIR sensor not detect any movements, then it will print no one here on screen. This procedure will repeat until the owner turn off the system.

3.4 Block Diagram of the Prototype

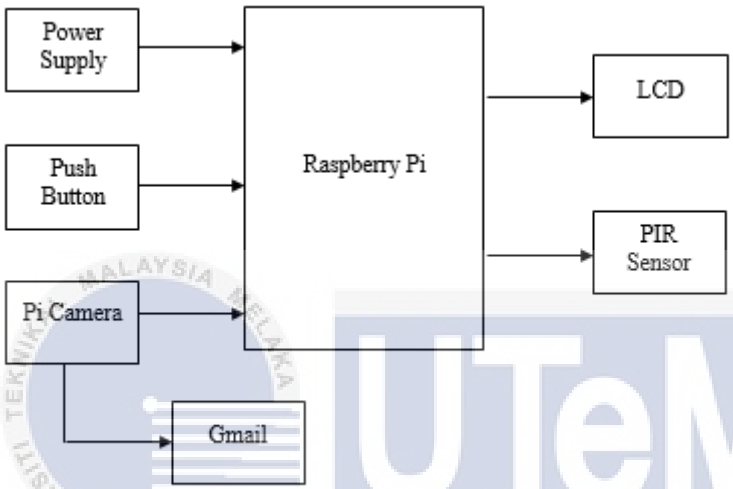

Figure 3.3: The Block Diagram of Smart Doorbell

By completing this project of development smart doorbell, it is used both of part such as hardware and software. Raspberry PI is used as a main component of this project. Raspberry PI 3 Model B+ are designed with open-source Linux-based and non-Linux based operating system and it also take a responsibility all of the workload process. Furthermore, the push button is inserted to the breadboard and connected near to PI camera. Push button is acting as a doorbell. For every single press on the push button will make the PI camera get trigger. PIR sensor is used to detect person. The PIR sensor need to calibrated properly to ensure can detect a presence a person. When there's motion detected, the Raspberry PI camera will take a picture and send an email with the picture attached to the owner. The PI camera is inserted into the RPI Camera port. Raspberry PI camera has been chosen in this project because it more suitable for this project and also quite cheaper compared with another version.

Therefore, the LCD (16x2) that connected to the Raspberry PI is used to display information. Below are the listed up of equipment Smart Doorbell.

3.5 Equipment of the Smart Doorbell

Table 3.1 Equipment of the Smart Doorbell

HARDWARE	QUANTITY	REMARKS
Raspberry PI 3 Model B+, SD card	1	Main component of this project
PI Camera	1	Takes photo of the visitor
LCD1602	1	Display Information
PIR Sensor	1	Detect a motion that come near into the house
RJ45 cable	1	Connected to each end of Ethernet cables and acts as the main source for transferring data
Push Button	1	To power the circuit (act as doorbell)
Buzzer	1	Generate sound when button pressed

3.5.1 Raspberry Pi 3 Model B+ Pinout Diagram

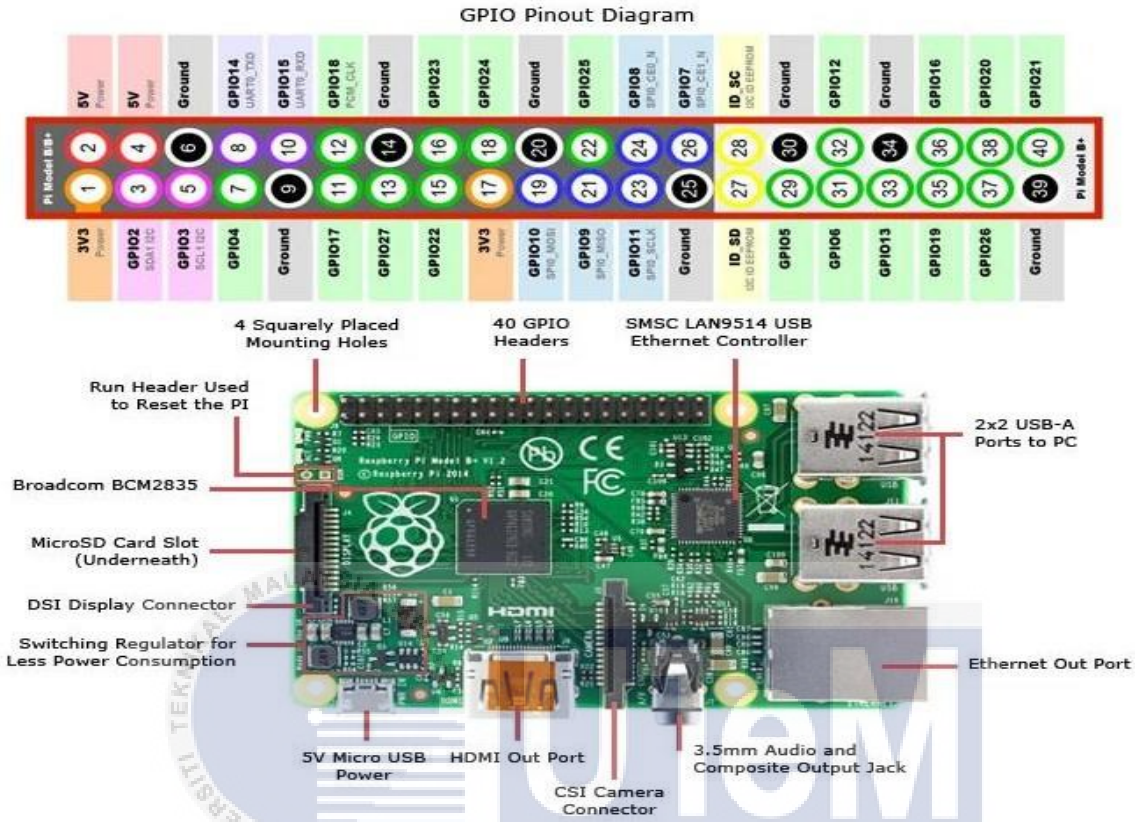

Figure 3.4 Example Raspberry PI 3 Model B+ GPIO pinout diagram

3.5.2 Raspberry Pi 3 Model 3 Model B+ with Pi camera

Figure 3.5: Raspberry PI Model B+ and PI camera

3.6 Software System

3.6.1 Raspbian OS

Raspberry Pi OS is a free Debian-based operating system designed specifically for the Raspberry Pi hardware. First and foremost, install an operating system into Raspberry PI's. Raspbian is the official OS for the Raspberry Pi, and the easiest way to set up Raspbian on the Raspberry Pi is to use NOOBS. NOOBS is stand for New Out of Box Software. After the operating system has been installed, the Raspberry Pi is booted and has a system configuration, which includes changing the log in password, updating the locale setting, changing the hostname and adding a new user.

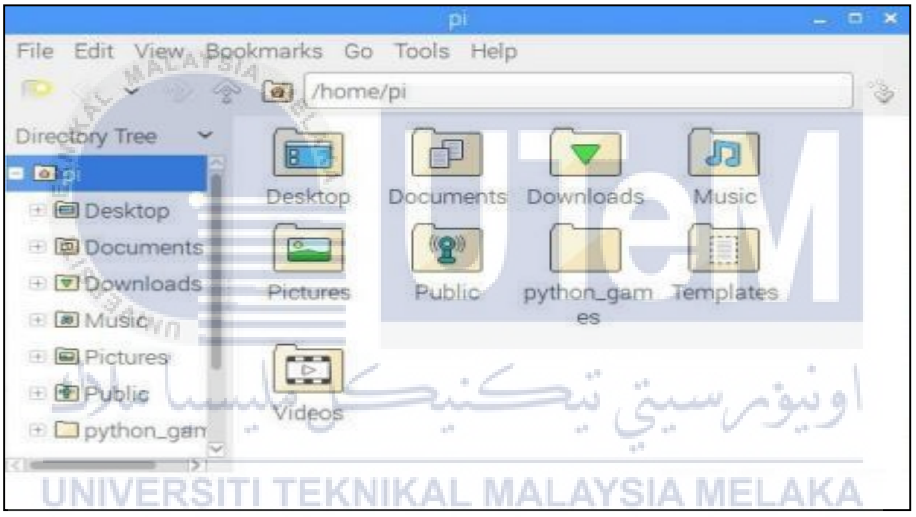

Figure 3.6 : Example of window Raspbian OS

3.6.2 Raspberry Pi link to Gmail

The e-mail is the best solution to alert the owner. This is because nowadays people have all access to the internet and it one of the popular applications to communicate and hardly user ignore the incoming message. This project is using python on Raspberry Pi to send email. The SMTP protocol is used to communicate between both the sending and receiving servers. The message is accepted by the receiving server and delivered to the recipient. The smtplib module in Python defines an SMTP client session object that can be used to send email to any Internet machine that has an SMTP or ESMTP listener

daemon. The SMTP object has a sendmail instance method that is typically used to perform the work of mailing a message.

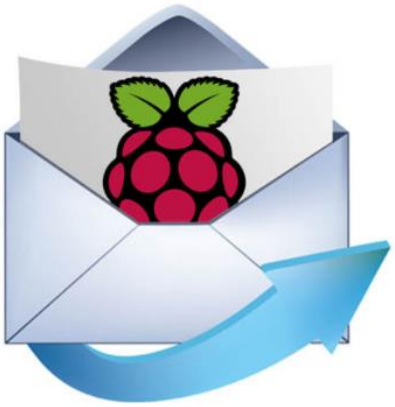

Figure 3.7: Raspberry Pi link to Gmail

3.7 Circuit Design

Connection of the PIR sensor, Pi camera and push button into Raspberry Pi

The PIR sensor has three pins: VCC, output, and GND. The PIR's VCC will be connected to the 5v of Raspberry PI board. The output pin will then be connected to Raspberry PI's GPIO4, pin 7. The last pin, GND, will connect to the Raspberry PI's ground. The code is written in Python and it need the Rpi.GPIO library. Furthermore, the push button attached to the Raspberry PI board is wired with wires from one numbered pin and one GND pin to the same rows as the push button's legs. When the push button is pressed and the PIR sensor detects some movement. The Raspberry Pi camera will then take visitor's face and sent as an email notification to the owner.

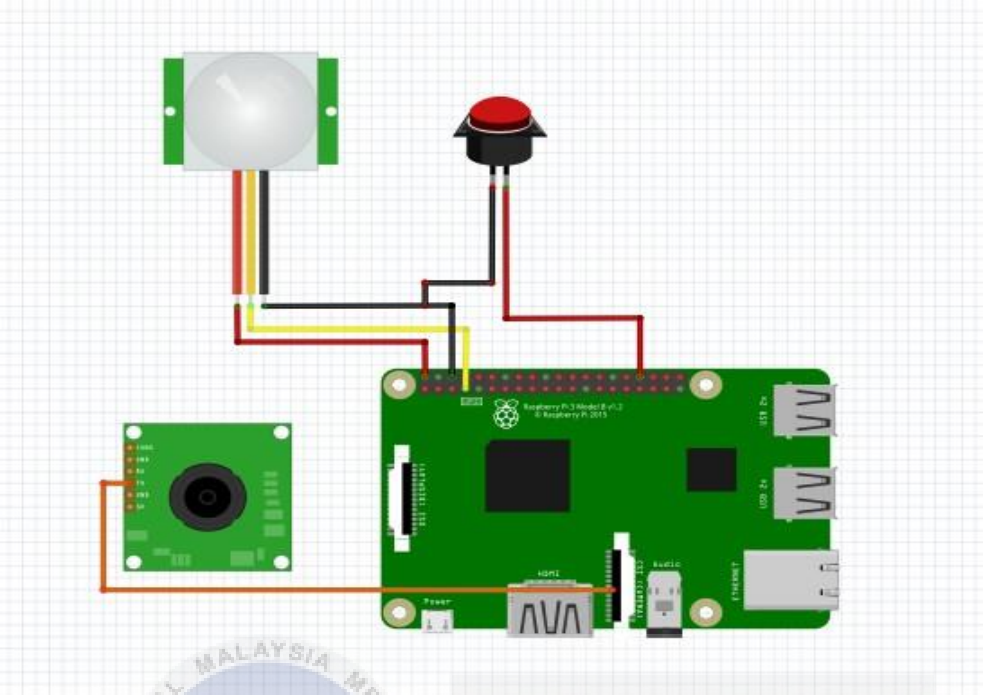

Figure 3.8: Example connection of the PIR sensor, PI camera and push button to Raspberry PI

3.7.1 Connection of the PIR Motion Sensor to the Raspberry Pi

To begin, connect the motion sensor's VCC and GND pins to the Raspberry Pi's 5V and GND, and then connect the motion sensor's OUT pin to GPIO17. Check that the camera is connected to the Raspberry Pi and that it is turned on in the interfacing options. PIRs detect body heat, which causes infrared energy to change. When a sensor detects even the smallest change in temperature within its protective grid, it generates an alert. In the past, incoming sunbeams could trip PIRs, but this problem has been resolved in newer infrared sensors.

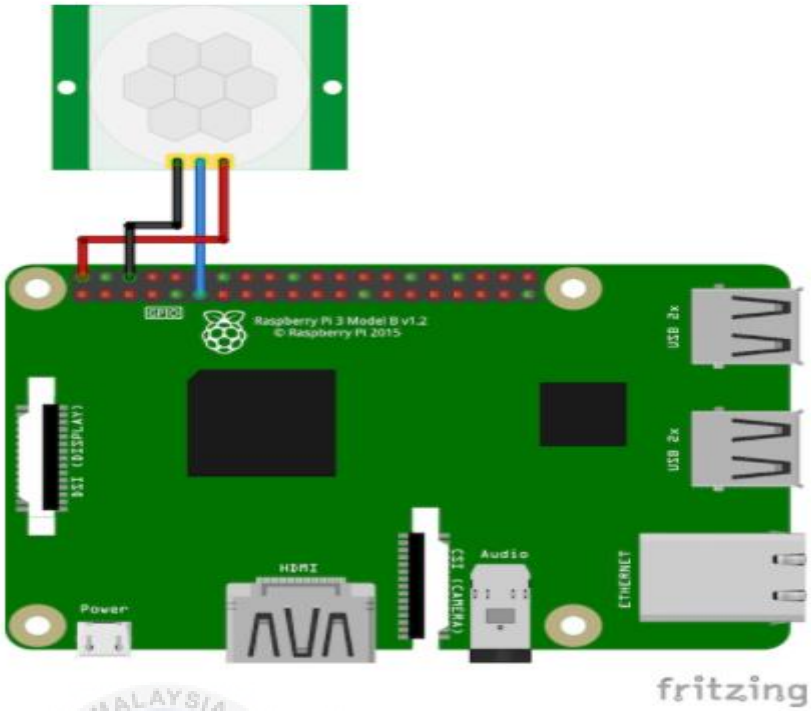

Figure 3.9: Example of connection PIR Motion sensor to Raspberry Pi

3.8 Summary

Methodology part are defined as how the project will be developed. By using system development life cycle, this project can be implemented efficiently and smoothly. Smart Doorbell project is used the waterfall model that one phase needs to be done first before moving to the next phase. First of all, gathering the requirement and analysis of the project is need to be done first. All the possible requirements will be listed up and documented. Once the requirement analysis is done the next step is designing the prototype. This phase is done by analyzed and specified the hardware component and the software of the project. In implementation phase, all the development works are performed and develop the components. Therefore, develop a flowchart of the project. In this phase started with project planning, software development, hardware design implementation and lastly testing the code and the project. Furthermore, this development Smart Doorbell are combined with the hardware and software to get a result.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will show the flow of the project operation and the content of the final product. The result of the hardware and software will be illustrated through this project demonstration. This chapter will discuss on the relation of component and coding that functioning together. Moreover, this chapter will go over the relationship between components and coding and how they functioning together. This project is fully done in almost a year starting by research, literature review and many other processes.

4.2 Results and Analysis

4.2.1 Project Hardware layout

Figure 4.1 depicts the project's final prototype. The Raspberry Pi, as a microcontroller, comes with a wifi module that is already connected to the internet and will handle all of the project's workload. Tanwar S, Patel P, Patel K, Tyagi S, Kumar N, Obaidat MS [22] proposed that the Internet of Things (IoT) is a term that refers to both hardware and software. When motion is detected within the range of the PIR sensor, the system is programmed to turn on the Pi camera and send an email alert with an image attached to the owner. As a result, this project requires the use of an internet connection in order to send emails. This project sends an email using Python on a Raspberry Pi. The SMTP protocol is used to exchange data between sending and receiving servers. The protocol used for data communication is Transmission Control Protocol (TCP) on port55, whereas SMTP uses port 587 to send email. When the owner receives the email with the attached image, he or she can download it and clearly see who is outside the house.

Figure 4.1 : Final Prototype of Smart Doorbell

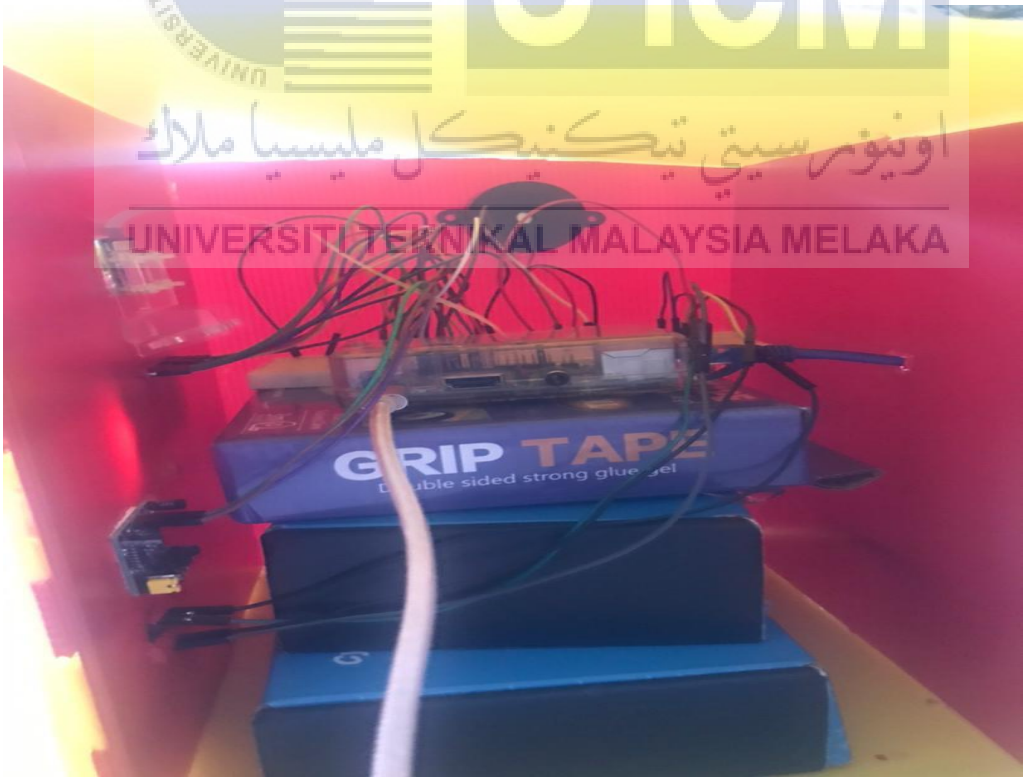

Figure 4.2 : Connection of Smart Doorbell

4.2.2 Testing

Table 4.1 PIR sensor Test Data

Object	Day	PIR sensor's distance (Metres)			
		1	2	3	4
Person	Daylight	Detected	Detected	Detected	Detected
	Night	Detected	Detected	Detected	Not detected
Toys	Daylight	Detected	Detected	Detected	Detected
	Night	Detected	Detected	Not detected	Not detected

Table 4.2 Duration of sending emails to owner

PIR sensor's distance (Metres)	Time (Hour:Minute:Second)		
	Sending from Raspberry Pi	Received through smartphones	Delay
1	18:35:01	18:35:05	4 seconds
2	18:35:09	18:35:13	4 seconds
3	18:37:02	18:37:14	12 seconds
4	18:37:38	18:37:54	16 seconds

4.2.3 Project Demonstration

4.2.4 Smart Doorbell Demonstration

This project aims to keep users connected to their homes and safe when they are not at home. First outcome of this project is the LCD. The LCD will show the current date and time, welcome the visitor then ask the visitor to press the button. When the visitor presses the push button, the buzzer will triggered to sound and alert the owner inside the house. Then, the PIR sensor is used to detect movement. If there is movement detected, the Raspberry PI camera will capture the visitor's face and send an email with

the image attached. Then, it will print movement detected on the system. Therefore, if the PIR sensor not detect any movement, then it will print no one here on system.

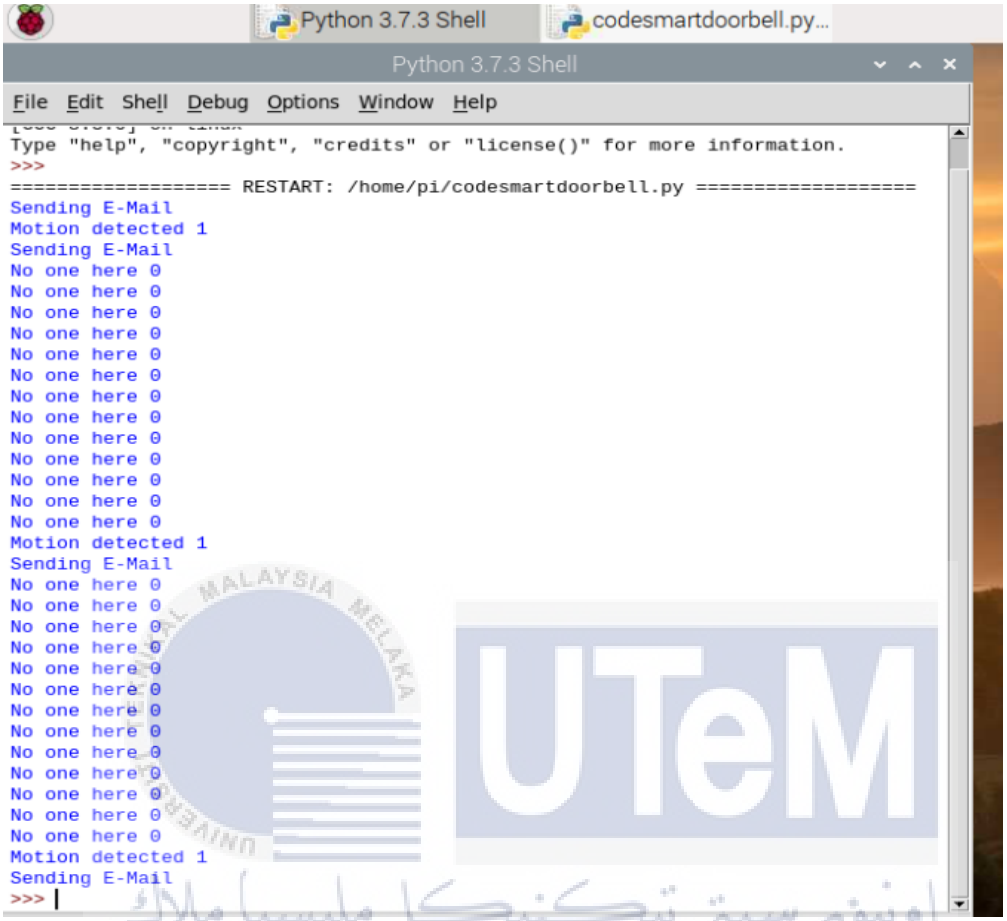

Figure 4.3: Example of when there is movement detected and no movement detected

Figure 4.4: Example of when somebody approach the door and presses the doorbell

Figure 4.4 shows a group of students approaching the door and pressing the doorbell, then their faces are captured by the PI camera. Then the owner will receive the email notification.

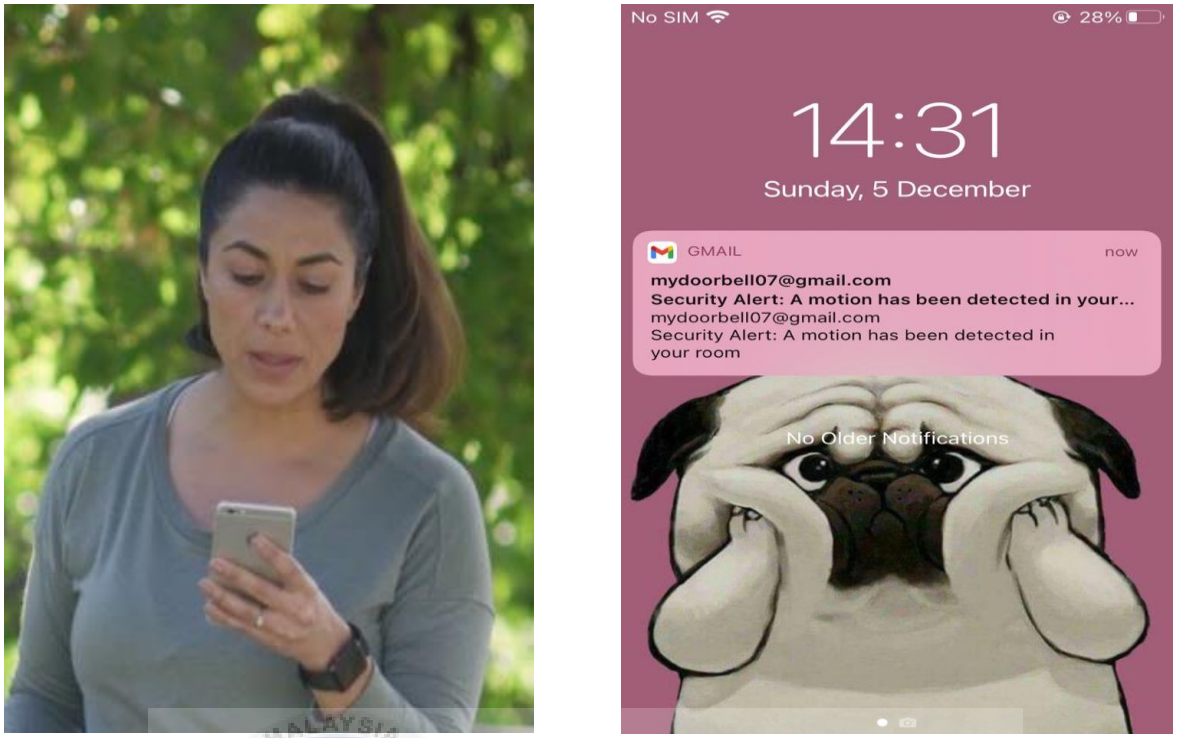

Figure 4.5: Example of owner get an instant email notification through mobile phone

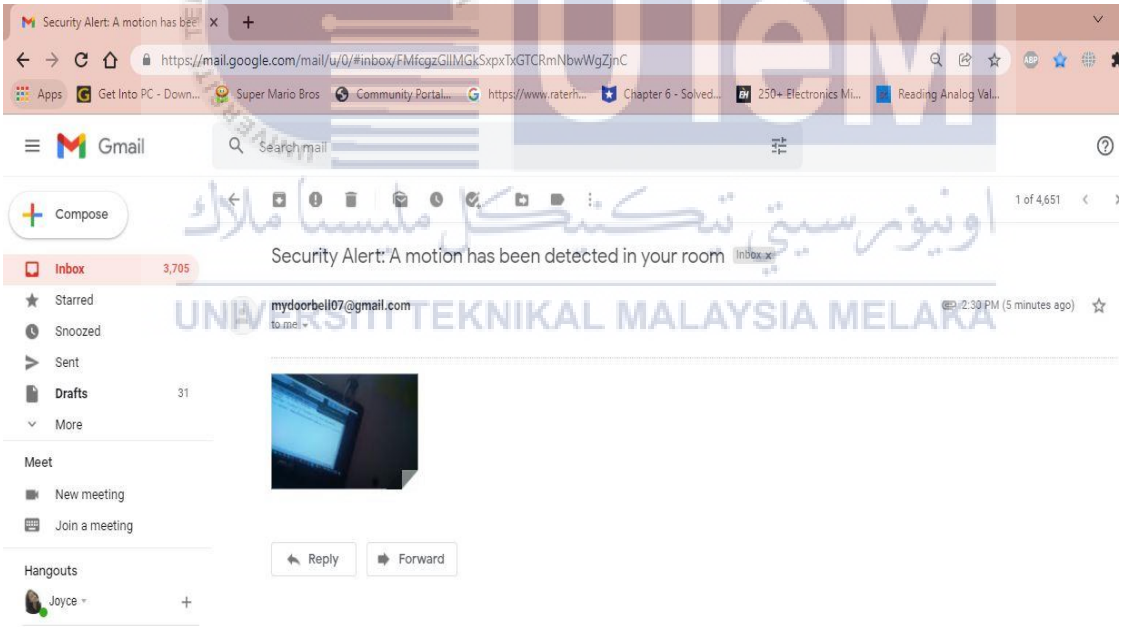

Figure 4.6: Example of owner get an instant email notification from desktop

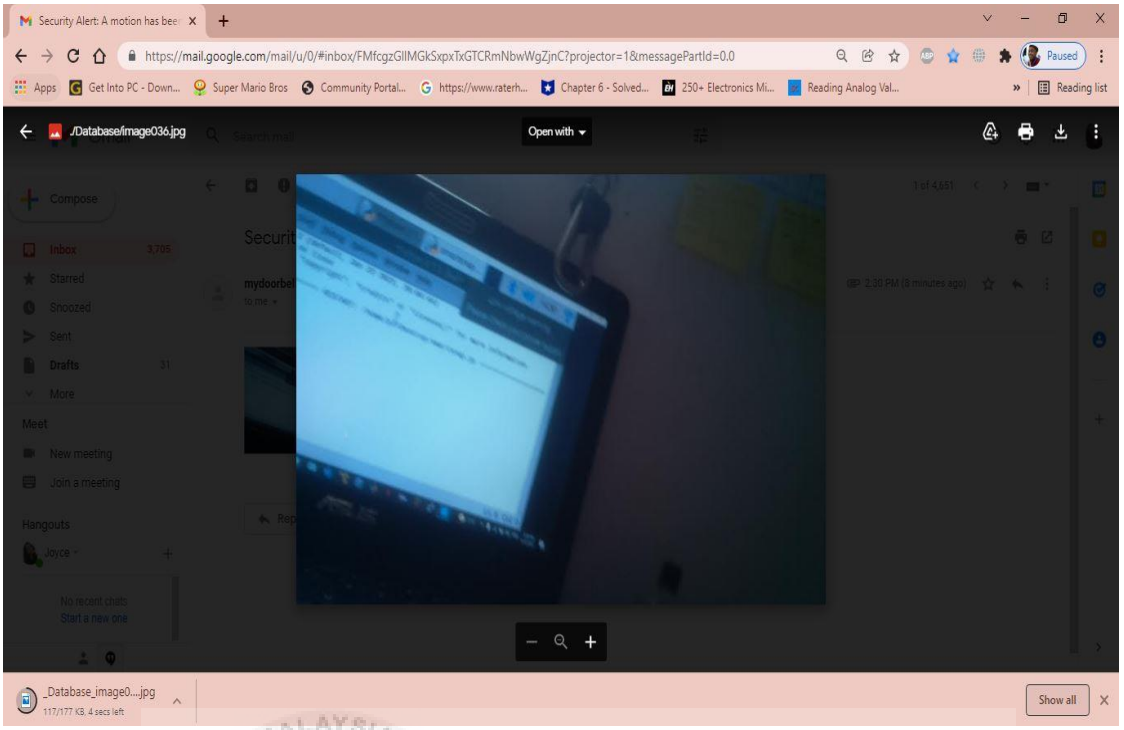

Figure 4.7: Example of image that has been taken from Pi camera when the PIR motion sensor are detected

4.3 Summary

The results and analysis of constructing this project were performed with the python code. The code which was successfully compiled without errors. Minor issues encountered during developing this project is faulty connection of the wires and the creation of the code. Then, after some changes, a second attempt was made by editing the code and repairing the connection into the right connection. This system work best at a distance of 0-4 metres in daylight conditions. It will depending on the quality of the image captured by Pi camera. Therefore, the average time to send an email is 4 seconds.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

At the end of developing of this project, it is clear that there is much to be analyzed and improved. This smart doorbell was introduced to improve on the existing project that has been done on previous paper. The Raspberry PI, as the project's main tool, will handle all of the workload. Raspberry PI has become popular in recent years, and it uses Python programming to communicate with the other components. This smart doorbell is built with the capability of sending a email notification to the owner. Furthermore, the Raspberry PI were used because it is a powerful and reliable system for solving complex and difficult tasks. The development of this project is to bring several benefits in terms of providing safety and security for the owner as well as making whoever comes to the house feel happy. Aside from that, this project contribute to the creation of a smarter and better world through technology. This project was successfully done and compiled without errors. Furthermore, developing this smart doorbell performs similarly to its commercialized counterpart but at a much lower cost. It costs less than compared 250 MYR to 199 USD for a single smart doorbell on the market.

5.2 Future Works

For future works, development of Smart Doorbell could be enhanced as follows:

i) Creating a doorbell system that would better assist hearing impaired people by using a wearable device to notify the user about the person at the door via vibration.

ii) To establish two-way communication with both the owner and the visitor

iii) Install a microphone and speaker that are activated when the doorbell is pressed.

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APPENDICES

Appendix A GANTT CHART OF PSM I

No	Task/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of title & Registration														
2	PSM Title selected and filled the synopsis of title														
3	Meet and discuss the progress with supervisor (through webex and whatsapp)														
4	Submit chapter 1 : Introduction														
5	Research study and understand the synopsis of the title														
6	Find the related information, journal and references book														
7	Review research														
8	Submit chapter 2 : Literature Review														
9	Progress Work 1 Evaluation														
10	Progress Work 2 Evaluation														
11	Design a flow and process of the prototype														
12	Design the block diagram of the prototype														
13	Design circuit and testing coding														
14	PSM1 draft report submission to supervisor														
15	Completion and submission of Final report to supervisor														
16	PSM1 Final Report, Slide & Video presentation submission to Panel														
17	PSM1 Presentation Evaluation														

Appendix B GANTT CHART OF PSM II

No	Task/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Short brief regarding the overall project														
2	Preparing the raw material														
3	Analysis result and data														
4	Drafting result and data														
5	Drafting the conclusion and recommendation														
6	Completion and submission of Final report to supervisor														
7	Preparation for video presentation														
8	PSM2 Final Report, Slide & Video presentation submission to Panel														
9	PSM2 Presentation Evaluation														

Appendix C Python code of Development of Smart Doorbell using Raspberry Pi with IoT platforms

```
#import
import RPi.GPIO as GPIO
import os
import glob
import picamera
import email
import mimetypes
import socket
import fcntl
import struct
from time import sleep
from time import gmtime, strftime, localtime
from gpiozero import Button

# Importing modules for sending mail
from email.mime.multipart import MIMEMultipart
from email.mime.text import MIMEText
from email.mime.base import MIMEBase
from email import encoders
import smtplib
import datetime

sender = 'mydoorbell07@gmail.com'
password = 'smartdoorbell07'
receiver = 'joyceangelmarubin@gmail.com'

DIR = './Database/'
FILE_PREFIX = 'image'

GPIO.setwarnings(False)
GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.IN)  # Read output from PIR motion sensor

def printDateTime():
  textDate = strftime("%d %B %Y", gmtime())
  textTime = strftime("%r", localtime())
  lcd_string(textDate,LCD_LINE_1)
  lcd_string(textTime,LCD_LINE_2)
  return

def pressButton():
  button = Button(20)
  buzzer = Buzzer(27)
  button.wait_for_press()
  button.on()
  time.sleep(1)
```

```
  button.wait_for_press()
  buzzer.off()
  time.sleep(1)

def send_mail():
    print ('Sending E-Mail')
    # Create the directory if not exists
    if not os.path.exists(DIR):
        os.makedirs(DIR)

    # Find the largest ID of existing images.
    # Start new images after this ID value.
    files = sorted(glob.glob(os.path.join(DIR, FILE_PREFIX + '[0-9][0-9][0-9].jpg')))
    count = 0

    if len(files) > 0:
        # Grab the count from the last filename.
        count = int(files[-1][-7:-4])+1

    # Save image to file
    filename = os.path.join(DIR, FILE_PREFIX + '%03d.jpg' % count)
    # Capture the face
    with picamera.PiCamera() as camera:
        pic = camera.capture(filename)

    # Sending mail
    body = 'Smart Doorbell'
    msg = MIMEText(body)
    msg = MIMEMultipart()
    msg['From'] = sender
    msg['To'] = receiver
    msg['Subject'] = 'Security Alert: A motion has been detected in your room'

    attachment = open(filename, 'rb')
    part = MIMEBase('application', 'octet-stream')
    part.set_payload((attachment).read())
    encoders.encode_base64(part)
    part.add_header('Content-Disposition', 'attachment; filename= %s' % filename)
    msg.attach(part)

    server = smtplib.SMTP('smtp.gmail.com', 587)
    server.starttls()
    server.login(sender, password)
    text = msg.as_string()
    server.sendmail(sender, receiver, text)
    server.quit()

# Define GPIO to LCD mapping
LCD_RS = 7
LCD_E  = 8
```

```
LCD_D4 = 25
LCD_D5 = 24
LCD_D6 = 23
LCD_D7 = 18

# Define some device constants
LCD_WIDTH = 16    # Maximum characters per line
LCD_CHR = True
LCD_CMD = False

LCD_LINE_1 = 0x80 # LCD RAM address for the 1st line
LCD_LINE_2 = 0xC0 # LCD RAM address for the 2nd line

# Timing constants
E_PULSE = 0.0005
E_DELAY = 0.0005

def main():
  # Main program block

  GPIO.setwarnings(False)
  GPIO.setmode(GPIO.BCM)       # Use BCM GPIO numbers
  GPIO.setup(LCD_E, GPIO.OUT)  # E
  GPIO.setup(LCD_RS, GPIO.OUT) # RS
  GPIO.setup(LCD_D4, GPIO.OUT) # DB4
  GPIO.setup(LCD_D5, GPIO.OUT) # DB5
  GPIO.setup(LCD_D6, GPIO.OUT) # DB6
  GPIO.setup(LCD_D7, GPIO.OUT) # DB7

  # Initialise display
  lcd_init()

  while True:

    # Display date and time
    index = 0
    while index < 5:
      printDateTime()
      time.sleep(1)
      index += 1

    # Display Hello Welcome
    lcd_string("Welcome To",LCD_LINE_1)
    lcd_string("Joyce's House",LCD_LINE_2)
    time.sleep(2)

    # Display Press Button
    lcd_string("Press Button",LCD_LINE_1)
    press = pressButton()
    time.sleep(0.3)
```

```
  # Display Sending Email
  lcd_string("Please wait...", LCD_LINE_1)
  snap = send_mail()
  time.sleep(0.3)

  while True:
    i = GPIO.input(11)
    if i == 0:  # When output from motion sensor is LOW
       print ("No one here", i)
       sleep(0.3)
    elif i == 1:  # When output from motion sensor is HIGH
       print ("Motion detected", i)
       send_mail()

def lcd_init():
  # Initialise display
  lcd_byte(0x33,LCD_CMD) # 110011 Initialise
  lcd_byte(0x32,LCD_CMD) # 110010 Initialise
  lcd_byte(0x06,LCD_CMD) # 000110 Cursor move direction
  lcd_byte(0x0C,LCD_CMD) # 001100 Display On,Cursor Off, Blink Off
  lcd_byte(0x28,LCD_CMD) # 101000 Data length, number of lines, font size
  lcd_byte(0x01,LCD_CMD) # 000001 Clear display
  time.sleep(E_DELAY)

def lcd_byte(bits, mode):
  # Send byte to data pins
  # bits = data
  # mode = True  for character
  # False for command

  GPIO.output(LCD_RS, mode) # RS

  # High bits
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x10==0x10:
    GPIO.output(LCD_D4, True)
  if bits&0x20==0x20:
    GPIO.output(LCD_D5, True)
  if bits&0x40==0x40:
    GPIO.output(LCD_D6, True)
  if bits&0x80==0x80:
    GPIO.output(LCD_D7, True)

  # Toggle 'Enable' pin
  lcd_toggle_enable()

  # Low bits
```

```
  GPIO.output(LCD_D4, False)
  GPIO.output(LCD_D5, False)
  GPIO.output(LCD_D6, False)
  GPIO.output(LCD_D7, False)
  if bits&0x01==0x01:
    GPIO.output(LCD_D4, True)
  if bits&0x02==0x02:
    GPIO.output(LCD_D5, True)
  if bits&0x04==0x04:
    GPIO.output(LCD_D6, True)
  if bits&0x08==0x08:
    GPIO.output(LCD_D7, True)

  # Toggle 'Enable' pin
  lcd_toggle_enable()

def lcd_toggle_enable():
  # Toggle enable
  time.sleep(E_DELAY)
  GPIO.output(LCD_E, True)
  time.sleep(E_PULSE)
  GPIO.output(LCD_E, False)
  time.sleep(E_DELAY)

def lcd_string(message,line):
  # Cast to string
  message = str(message)
  # Send string to display
  message = message.ljust(LCD_WIDTH," ")

  lcd_byte(line, LCD_CMD)

  for i in range(LCD_WIDTH):
    lcd_byte(ord(message[i]),LCD_CHR)

if __name__ == '__main__':

  try:
    main()
  except KeyboardInterrupt:
    pass
  finally:
    lcd_byte(0x01, LCD_CMD)
    lcd_string("Thank you!",LCD_LINE_1)
    lcd_string("See you again",LCD_LINE_2)
    GPIO.cleanup()
```

Turnitin Report

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