

Faculty of Electrical and Electronic Engineering Technology



Bachelor of Electronics Engineering Technology with Honours

2021

DEVELOPMENT OF IoT BASED HOME SECURITY SYSTEM

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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



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled "Development of IoT Based Home Security System" 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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DEDICATION

To my beloved mother, Nur-al Huda Binti Hashim, and father, Amiruddin Bin Shaari, and To my supervisor Ts. Niza Binti Mohd Idris

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ABSTRACT

With the rapid development of technologies, the Internet of Things (IoT) has been introduced to help users in everyday activities with the aid of the Internet. IoT can be applied to home security systems due to the increasing case of burglary. It's a necessity to enhance home security due to the rise of attempted break-ins. Nowadays, cheaper security systems do exist but they still lack performance. Besides that, some home security uses incompetent and inadequate tools. Lastly, the lack of demand and attention towards security systems due to the cost. For this project, three objectives need to be achieved. First, design a home security system that will display the time of the intrusion. Second, the study of the reaction time of the system to send a notification. Third, analyse the suitable distance for the PIR Sensor to optimise the system functionality. In this project, the idea of developing an IoT-based home security system is to reduce the number of home intrusions. This system will use components such as an Arduino Uno, Arduino ESPWiFi Shield, three PIR Sensors, Buzzer, and a Lamp. The Arduino Uno will be the microcontroller of the project. The Blynk application will be used as the IoT platform. The system connects to the Wi-Fi by using Arduino ESPWiFi Shield. Three PIR Sensors will be used to detect motions and each will be placed near three-door. Whenever one of the PIR Sensors detects the door opening, it will send a notification through the user's smartphone. Not only that, the Buzzer will produce sound and the outside Lamp will be turned on. For the outcomes of the project, the system can allow the user to know when the intrusion happened. Moreover, some experiments will be conducted to study the reaction time of the system to send a notification and to analyse the suitable distance for the PIR Sensor to optimise the system functionality. In a conclusion, this project can reduce the number of home intrusions with the aid of IoT.

ABSTRAK

Dengan perkembangan pesat teknologi, Internet of Things (IoT) telah diperkenalkan untuk membantu pengguna dalam aktiviti harian dengan bantuan Internet. IoT boleh digunakan pada sistem keselamatan rumah kerana kes pecah rumah yang semakin meningkat. Ia adalah satu keperluan untuk meningkatkan keselamatan rumah kerana peningkatan cubaan pecah masuk. Pada masa kini, sistem keselamatan yang lebih murah memang wujud tetapi mereka masih kurang prestasi. Selain itu, beberapa keselamatan rumah menggunakan alat yang tidak cekap dan tidak mencukupi. Akhir sekali, kekurangan permintaan dan perhatian terhadap sistem keselamatan kerana kos. Untuk projek ini, tiga objektif perlu dicapai. Pertama, reka bentuk sistem keselamatan rumah yang akan memaparkan masa pencerobohan. Kedua, kajian masa tindak balas sistem untuk menghantar pemberitahuan. Ketiga, menganalisis jarak yang sesuai untuk Sensor PIR untuk mengoptimumkan fungsi sistem. Dalam projek ini, idea membangunkan sistem keselamatan rumah berasaskan IoT adalah untuk mengurangkan bilangan pencerobohan rumah. Sistem ini akan menggunakan komponen seperti Arduino Uno, Arduino ESPWiFi Shield, tiga Sensor PIR, Buzzer dan Lampu. Arduino Uno akan menjadi pengawal mikro projek itu. Aplikasi Blynk akan digunakan sebagai platform IoT. Sistem bersambung ke Wi-Fi dengan menggunakan Arduino ESPWiFi Shield. Tiga Sensor PIR akan digunakan untuk mengesan gerakan dan setiap satu akan diletakkan berhampiran tiga pintu. Setiap kali salah satu Sensor PIR mengesan pembukaan pintu, ia akan menghantar pemberitahuan melalui telefon pintar pengguna. Bukan itu sahaja, Buzzer akan mengeluarkan bunyi dan Lampu luar akan dihidupkan. Untuk hasil projek, sistem boleh membenarkan pengguna mengetahui bila pencerobohan berlaku. Selain itu, beberapa eksperimen akan dijalankan untuk mengkaji masa tindak balas sistem untuk menghantar pemberitahuan dan untuk menganalisis jarak yang sesuai untuk Sensor PIR untuk mengoptimumkan fungsi sistem. Kesimpulannya, projek ini dapat mengurangkan bilangan pencerobohan rumah dengan bantuan IoT.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Niza Binti Mohd Idris from the Department of Electronics & Computer Engineering Technology for her precious guidance, words of wisdom, and patient throughout this project. I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my parents for the financial support through PSM 1 which enables me to accomplish the project. Not forgetting my classmates for their willingness of sharing their thoughts and ideas regarding the project. My highest appreciation goes to my parents, (my mother, Nur-al Huda Binti Hashim, and my father, Amiruddin Bin Shaari) and family members for their love and prayer during the period of my study. An honorable mention also goes to younger brother, Muhammad Faris Bin Amiruddin for all play a role in completing this project. Finally, I would like to thank all the staff at UTeM, colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being cooperative and helpful.



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LIST OF ABBREVIATIONS

IoT	-	Internet of Things
PIR	-	Passive Infrared

cm - Centimeter



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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the increasing case of burglary is harming society. This phenomenon leads people to want their homes to be secure from the intruder. Crime such as house breakage, theft, and home invasion can be seen on the news. These crimes happen when there's no one at home. However, the risk of an intrusion happening when the occupants were at home is very alarming. The trespasser can effortlessly enter the house unnoticed by the occupants [1]. Thus, a home security system is needed to prevent the possibility of intrusion.

The home security system plays an important role these days, especially with the crime that has been on the news. In the earliest days, occupants secure homes by using locks and keys where nowadays seem very outdated. Now, the home security system has developed gradually to the next level [2]. There are many examples of a home security system that uses a sensor as one of the major components used to create a security system [3].

This project is a security system that can allow the user to monitor on their phone if there's an attempted break-in. The project consists of software and hardware. For the software, the student will use Arduino IDE to create the coding, Tinkercad to design the circuit, and Blynk App to develop to monitor interface. This project consists of an Arduino Uno as a microcontroller, an Arduino ESPWiFi Shield to provide a WiFi link to the Arduino board, a PIR Sensor for motion detection, and a Buzzer to provide an audio signal for the hardware.

The expected outcome is to design a system that will use IoT to notifying the user's smartphone when the PIR Sensor detects any intrusion through the door/window/sliding door. At the same time, a buzzer will produce a sound to scare the intruder away. Thus, this project can help to save a fortune along with many people's lives.

1.2 Problem Statement

Nowadays, the importance of home security is very vital. Thus, there are many types of home security system exist in the market and being used by a lot of people. However, several security systems are expensive and not everyone can afford them. Cheaper security systems do exist but they still lack in performance. For example, some home security systems don't have notification features that show where or when the intrusion happens. [3]. Besides that, some home security use incompetent and inadequate tools. For example, some home monitoring systems are mounted on the wall. When the homeowner is away from the house and there's a break-in, the homeowner won't know that there's an intrusion happening at his/her house . [4] . Finally, the lack of demand and attention towards security systems due to the cost. For further elaboration, some home security has an installation that is so complex and most expensive [5] .

1.3 Project Objective

- To design a home security system that will display the time of the intrusion
- To study the reaction time of the system to send a notification

• To analyse the suitable distance for the PIR Sensor to optimise the system functionality

1.4 Scope of Project

The scope of this project will cover the development of an IoT-based home security system that sends a notification to the user's smartphone when there's an intrusion happening at their home. The notification will come in a message form and vibrate the smartphone when one of the PIR Sensors is set at an appropriate distance to detect any of the door/window being open. This project will be using an application called Blynk App to receive the message when there's a potential break-in. Besides that, the system will be able to display the time of the intrusion. Other than that, the buzzer will produce sound and the lamp in the house will be turned on. From this situation, the user will be alert and take safety precautions. This project will contribute to improving home security at an affordable cost and an easy-to-operate system. Besides that, this system can function at industrial places, banks, etc. Furthermore, this system can benefit old residents and those living alone by notifying them about a possible intrusion. Finally, this project can allow the homeowner to take the necessary precaution when an intruder is trying to invade the house.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature review is a frame of textual content this is used to check the important factors of modern-day information for any associated records to enhance the know-how of the idea and positive terminology that is used inside the project. The sources are received from journals, books, and websites which give extra records on IoT programs in house security researches about constructing security features and notification system.

2.2 Overview

This chapter aims to find knowledge, important information, and any related thesis that are in line with the concept of 'IoT Based Home Security System'. Furthermore, theoretical, methodical, and hypothetical researches about security as well as notification system using Arduino ESPWiFi Shield and IoT emphasize and analysed.

2.3 Review on IoT in security system

IoT (Internet of Things) refers to physical objects that can interface and share information among themselves in a network without the need for human interaction, according to a study conducted by [6]. This is regarded as the "Infrastructure of the Information Society," and it allows users to collect data from a variety of sources, including humans and machines. IoT refers to an object that has been assigned an IP address to allow data transmission over a network. Electronic devices, such as sensors and software, may be added to make an object part of the IoT system. IoT differs from the Internet in that it goes beyond Internet access by allowing ordinary artifacts with embedded circuits to interact and communicate with one another using existing Internet infrastructure [6].

During his speech at the Federal Communications Commission in 1985, Peter T Lewis discussed the idea of the Internet of Things (FCC). Since then, the Internet of Things has expanded dramatically, with more than 12 billion connected devices in use today, and analysts predict that number will rise to 50 billion by the end of 2020. IoT infrastructure has helped in the implementation of efficient decisions by delivering real-time data collection and analysis using accurate sensors and seamless connectivity. The Internet of Things has helped both producers and customers [6].

Manufacturers have gained experience in how their products are used and how they perform in the real world, and they have increased their revenue by providing value-added services that boost and extend the lifecycle of their products or offerings. Consumers, on the other hand, can combine and control several devices for a more personalised and advanced experience [6].

When it comes to home automation in Security, there's a lot to keep in mind. Home security is a key feature of home automation, and it's also one of the most important. Home security has undergone a significant transformation in recent years and is expected to continue to do so in the near future. Previously, home security structures were characterised as having an alarm system that could go off if anyone tried to break in, but a smart safe home can do much more. As a result, the main purpose is to create a device that will notify the

owner of a possible break-in by sending a warning to their smartphones. Furthermore, the user may be able to monitor the alarm system remotely using a smartphone [6].

This system will allow users to track activity through their smartphones and secure their homes by installing the system at the doors or windows. Over the past few years, the number of devices that are connected to the Internet has increased dramatically. All internetconnected devices are part of the IoT infrastructure, which enables them to send and receive data from one another [6].

This highlights the importance of using existing infrastructure in the development of the proposed security framework. When a user isn't at home to take action, a device that involves buzzer sounds isn't useful. They need to know that their home is safe from intruders and criminals. As a result, this system aims to keep the owner up to date on the status of their home's security in real-time. When a possible break-in is detected, the built device alerts the user so that important steps can be taken [6].

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2.4 Review on IoT platforms used in security system

2.4.1 Dweet

Figures 2.1 shows the dweet.io logo. Dweet is an IoT interface messaging service. It can send data from your computer to the cloud through a simple API called "Dweeting." The user will then view the data on a dashboard after collecting it. Dweet works well with freeboard.io, which is produced by the same company (Bug Labs) and offers a slick interface [7].



Figure 2.1 The dweet.io logo

2.4.2 Blynk

Figure 2.2 shows the Blynk logo. Blynk developed a simple and intuitive drag-anddrop dashboarding software that works on both Android and iOS devices. It can be used with a variety of hardware, including Arduino, Raspberry Pi, Ethernet, ESP8266, and others. There are sketch builders and code libraries available on the Blynk website [7].



2.4.3 Cayenne - My Devices

Figure 2.3 shows the Cayenne – My Devices logo. Cayenne offers a wide range of Internet of Things (IoT) services for both personal and commercial use. Users may choose their preferred controller and will receive instructions on how to connect it to their preferred IoT link as well as a system token. Additionally, video tutorials are available, making it even easier [7].



Figure 2.3 The Cayenne – My Devices logo

2.4.4 Particle

Figure 2.4 shows the Particle logo. For IoT ventures, Particle offers both hardware and software. The platform comes with everything users would need to complete an IoT project. The website also offers a device cloud network, connectivity hardware, and even SIM cards for cellular devices. Finally, the website offers tutorials and references on a variety of topics [7].



2.5 Review on the components used in IoT for security system

2.5.1 Arduino ESPWiFi Shield

Figure 2.5 shows the Arduino ESPWiFi Shield, which has a key feature is that can wirelessly link the Arduino to the internet. Using the 802.11 wireless specifications, this WiFi Shield allows an Arduino board to link to the internet. This WiFi shield also includes

an Atmega 32UC3 processor, which offers a network (IP) stack that supports both TCP and UDP. Finally, the WiFi library is used to create drawings that link to the internet [8].



Figure 2.5 Arduino ESPWifi Shield

2.5.2 NodeMCU

Figure 2.6 shows the NodeMCU, which is an open-source IoT platform with a low cost. WeMos and Huzzah are two other versions available. These boards are very similar, but they are made by different companies. The NodeMCU board is simple to use and can be useful for developing small IoT projects with few components. The NodeMCU's drawback is that it has a very small number of GPIO [7].



Figure 2.6 NodeMCU

2.5.3 ESP8266-01 - Wifi module

Figure 2.7 shows the ESP8266-01, which is a low-cost WiFi module that allows MCUs to link to a wireless network. The ESP8266 can also work without the use of a controller. The ESP8266 is a general-purpose WiFi module that can be used in conjunction with any board or component to create an IoT project. The ESP8266's disadvantage is that it has a small number of GPIO [7].



Figure 2.8 shows the SIM800L, which is a portable GSM breakout board. It has all the capabilities of the larger SIM900 shields and making it suitable for small IoT projects. This component can be used in IoT projects that use voice calls, sending text messages, accessing the internet and, listening to FM radio, and accepting AT commands [7].



Figure 2.8 SIM800L - QuadBand GPRS-GSM Module

2.5.5 HC-05 - Bluetooth module

Figure 2.9 shows the HC-05, which has both Master and Slave modes. This feature allows the part to interact with two Arduino boards or other devices. The HC-05 includes a breakout board for easy connection and can also communicate with the Arduino through serial communication. This component is good for sharing a lot of data over a short distance, making it a good fit for electronic products like wireless headsets and speakers, as well as file transfers between devices. The downside of this part is that it only has a range of about 10 meters and consumes a lot of electricity [7].



Figure 2.10 shows the NRF, which is a radio frequency wireless transceiver that is limited in scale. Because of its ease of use, affordability, decent range, and low power consumption, it's a great component for wireless projects. The module has a data rate of up to 2Mbps and operates on the 2.4GHz ISM band, which is license-free. Remote-control vehicles and drones also use RF transceivers. The disadvantage of this component is that it does not have an internet connection, limiting its range as compared to IoT devices [7].



Figure 2.10 NRF24L01 - 2.4G Wireless Transceiver Module

2.6 Review on microcontroller used in security system

2.6.1 Arduino Uno R3

Figure 2.11 shows the Arduino Uno R3, which is the version of the Arduino Uno that was released in 2011 by the company Arduino. This board is built on the ATmega328P chip (open-source board). The consumer can also communicate with other boards and circuits using the I/O pins on this board. There are fourteen I/O pins attached, as well as a USB link port, a power supply connection, an ICSP header, and a reset button. A USB cable can be used to connect the board to the user's personal computer or laptop. The Arduino Uno R3 module, which is based on IoT, is the cheapest and has a variety of online libraries and tools [9].



Figure 2.11 Arduino Uno R3

2.6.2 Arduino Pro Mini 328

Figure 2.12 shows the Arduino Pro Mini 328, which is another excellent microcontroller board produced by the Arduino business. Just for small-scale applications up to 5 volts, this mini board has a 16MHz bootloader. However, the board's disadvantage is that it lacks built-in connections and ports. As a result, the user must solder the link. For those on a tight budget, this microcontroller board is a good option [9].



Figure 2.13 shows the ESP32 microcontroller board, which combines Bluetooth and Wi-Fi features on a single chip (2.4 GHz) that consumes very little power. The ESP32 is one of the best options for applications, but it is also one of the most costly. This microcontroller board is ideal for projects like smart homes and the IoT [9].



Figure 2.13 ESP32

2.6.4 ESP8266

Figure 2.14 shows the ESP8266. When compared to other microcontrollers with IoT capabilities, the ESP8266 is very tiny. It can be used for IoT-enabled projects such as smart homes. This board also has 128 KB of RAM and 4 MB of FLASH memory. This board's key advantage is that it can be used to build a network for other devices to link [9].



Figure 2.14 ESP8266

2.6.5 Raspberry Pi 4

Figure 2.15 shows the Raspberry Pi 4, which was introduced to the world in the year 2019. This is the world's fastest microcontroller board. An onboard wireless LAN, Bluetooth 5.0, two USB 2.0 and USB 3.0 ports, two Micro HDMI ports, and a Gigabit Ethernet port are all included with this microcontroller. Users can create efficient and advanced electronic projects with its 4GB RAM, and it can provide up to 1.2A current for USB devices. It comes with a variety of RAM options, ranging from 1GB to 4GB [9].



Figure 2.15 Raspberry Pi 4

2.6.6 Raspberry Pi Zero W

Figure 2.16 shows the Raspberry Pi Zero W, which is a microcontroller that can connect to the internet via wireless Bluetooth and LAN. This board also has all of the same features as the original Pi Zero. A single-core 1GHz CPU and 512MB RAM are included on this board. The Raspberry Pi Zero W is an excellent platform for developing embedded IoT projects [9].



Figure 2.17 shows the Raspberry Pi Pico, which is the Raspberry Pi Foundation's first microcontroller. The Pi Pico is a low-cost computer that uses a custom chip called the RP2040. SPI, I2C, and Programmable I/O are among the many customizable I/O options available on this board (PIO). This microcontroller features a dual-core Arm Cortex-M0+ processor, 264KB of internal RAM, and up to 16MB of off-chip Flash support [9].



Figure 2.17 Raspberry Pi Pico

2.6.8 MBED LPC1768

Figure 2.18 shows the MBED LPC1768 microcontroller board, which is usually used for prototyping. This board has a USB FLASH programmer built-in. The board is built around the NXP LPC1768, a 32-bit ARM M3 processor with 32K RAM and 512K FLASH. There are also I/O peripherals, a USB port, and built-in Ethernet on this board. MBED has several online communities where users can share prototyping libraries and tools [9].



Figure 2.18 MBED LPC1768

2.6.9 BeagleBone Black

Figure 2.19 shows the BeagleBone Black. In the industry, the BeagleBone Black is a low-cost production board. By connecting the PC with a simple USB cable, the user may begin creating. This board has 512MB of RAM and 4GB of FLASH storage. This board also

includes 46 2 header pins, Ethernet, and 2 USB ports. It's great for electronics projects because it has a lot of I/O pins. Finally, this board uses less electricity and does not need a heat sink [9].



Figure 2.19 BeagleBone Black

2.6.10 Quark D2000

Figure 2.20 shows the Quark D2000 microcontroller, which is one of the most powerful on the market, with more I/O controls than other microcontrollers. This microcontroller is based on an Intel microcontroller from the year 1986. This board is a 32bit microcontroller with 8K SRAM and 32K FLASH that runs at 32MHz. Finally, since it only needs a 3.3 volt DC supply, this board is highly adaptable [9].



Figure 2.20 Quark D2000

2.6.11 Teensy 4.0

Figure 2.21 shows Teensy 4.0. With a 600MHz processor, the Teensy 4.0 microcontroller board. This is the most up-to-date and fastest board currently available. This

board is small in comparison to other boards and can be used for a variety of projects. All commands are sent through two USB ports and can be programmed using the Arduino IDE. A USB cable is used to link the microcontroller to a PC or laptop. Finally, although the Arduino Uno only has 16k RAM, this board has 1024k RAM [9].



Figure 2.21 Teensy 4.0

2.6.12 Launchpad MSP430

Figure 2.22 shows The Launchpad MSP430, which is a useful microcontroller for on-board emulation and debugging with Energy Trace. This board is also a low-power microcontroller with 4k RAM that can be used as a replacement for the Arduino Uno R3. The key feature of this board is that it comes with Energia, a special programming software (IDE) for coding and debugging that is more user-friendly and close to Arduino's IDE [9].



Figure 2.22 Lauchpad MSP430

2.7 Comparison of Size, Weight and Cost of different component for IoT

Name	Size(mm)	Weight(g)	Cost (RM)
Arduino Uno R3	68.6 x 53.4	25	25.00
Arduino Pro Mini	18 x 33	5	9.50
328			
ESP32	54.6 x 27.94	9.3	13.11
NodeMCU Lua V3	49 x 26	60	14.90
ESP8266 WIFI			
Raspberry Pi 4	85.6 x 56.5	46	155.00 - 347.00
Raspberry Pi Zero	65 x 30 x 5	9	46.00
W NAT	ALSIA ME		
Raspberry Pi Pico	21 x 51	8.99	17.90
MBED LPC1768	44 x 26	234.45	287.80
BeagleBone Black	86.40	39.68	279.00
Quark D2000	87 x 64	320.35	128.20
Teensy 4.0	17.78 x 35.56	¹⁰	129.00
		. G. V	J.J.

Table 2.1 Comparison of Size, Weight and Cost of different component for IoT

2.8 Comparison of expansion connectors of different component for IoT

Table 2.2 Comparison of expansion connectors of different component for IoT

Name	Analog Inputs	Digital I/O Pins	USB Ports
Arduino Uno R3	6	14	1
Arduino Pro Mini	8	12	0
328			
ESP32	0	34	1
NodeMCU Lua V3	1	16	1
ESP8266 WIFI			
Raspberry Pi 4	0	40	5
-------------------	----	----	---
Raspberry Pi Zero	0	20	2
W			
Raspberry Pi Pico	3	26	1
MBED LPC1768	0	40	1
BeagleBone Black	6	14	1
Quark D2000	6	14	0
Teensy 4.0	10	24	1

2.9 Related previous works

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2.9.1 Remote Home Security System using Open-Source Electronic Platform

This paper explains how security systems play a role in the protection of lives. This paper was published by a group of researchers (Rachell V. De Guzman, Clarissa Joy M. Lubrido, and Claire N. Reyes) from San Carlos College Bonifacio, San Carlos City Pangasinan, Philippines. These researchers created a home security system that uses the internet and Bluetooth to manage and track home security [10].



Figure 2.23 Remote Home Security System using Open-Source Electronic Platform block

diagram

Figure 2.23 shows the process flow of the security system. The smartphone allows the user to controls and gets notifications when the home security system detects an intruder. The notification will be in a form of SMS (Short Message Service). The remote home security modules consist of Arduino Mega, Bluetooth HC-05, PIR Sensor, GSM Sim900, and Piezo Buzzer [10].



Figure 2.24 Remote Home Security System using Open-Source Electronic Platform circuit diagram

Figure 2.24 above shows the circuit design of the system. The two main components of this home security system are the Bluetooth and GSM modules. The Bluetooth module can monitor the device inside the house manually, while the GSM module can send a message to the owner alerting them to the presence of an unauthorised individual on their property. Finally, the buzzer produces an alarm sound automatically when the PIR Sensor detects a motion [10].

2.9.2 Iot-based Integrated Home Security and Monitoring System

This paper explains how developing remote home security and monitoring systems are needed because home safety remains a critical issue. This paper was conducted by a group of researchers (Taryudi, Davin Bagas Adriano, and Wahyu Apsari Ciptoning Budi) from the Electronics Department Faculty of Engineering, Universitas Negeri Jakarta, Indonesia. These researchers use the Arduino-nano and NodeMCU ESP8266 as controllers to create IoT-based home protection and monitoring systems. This system has some components for smart home purposes such as a flame sensor, rain sensor, solenoid valve, temperature, and humidity sensor. This summary is more focused on the home security system aspect of the project [11].



Figure 2.25 Iot-based Integrated Home Security and Monitoring System block diagram

Figure 2.25 shows the process flow of the system. This system used the Blynk Application as the IoT platform to monitor and communicate the other components. The components of this system consist of Arduino Nano, NodeMCU, PIR Sensor, Buzzer, Lamp, RFID, and Keypad module. The NodeMCU is the medium used for the Blynk application to interface with the other components [11].



Figure 2.26 Iot-based Integrated Home Security and Monitoring System circuit diagram

Figure 2.26 shows the system's circuit architecture. Arduino Nano, NodeMCU, Keypad, RFID Reader, LDR Sensor, and Buzzer are the main components of the protection device. As a controller and an interface for data communication with the user's smartphones through the internet network, this device used Arduino Nano and Nodemcu ESP 8266. Next, using an RFID card and a numerical PIN code mounted in the house door, this device has a two-layer protection feature. The home can be remotely monitored through the internet network. When the owner enters the house using the RFID Reader, the machine sends an

email message to the rest of the family. Finally, if the PIR Sensor senses an intruder, the device will send an email to the user notifying them of the intrusion, and the buzzer will sound [11].

2.9.3 Design and Implementation of a Smart Home Security System Using Voice Command and Internet of Things

The internet of things technology and speech recognition are used in this paper to illustrate how a home protection device consists of different sensors and recorders to automatically provide details on the conditions of a building. This paper was published by a group of researchers (Heru Susanto and Agus Nurcahyo) from Aerospace Engineering Department, Sekolah Tinggi Teknologi Kedirgantaraan (STTKD), Yogyakarta, Indonesia. These researchers aim to design a home security system by monitoring intrusion and fire hazards. Moreover, the security system has voice commands to aid the disabled [12].



Figure 2.27 Design and Implementation of a Smart Home Security System Using Voice Command and Internet of Things block diagram

Figure 2.27 shows the components used in the security system. This system consists of an Arduino Mega 2560, NodeMCU + ESP8266, two Magnetic Door Switches, two VC0706 Serial Camera, two DHT22, LCD, MicroSD Card Adapter, Relay, and two PIR Sensor. Google Assistant is the platform for voice command. The Arduino Mega 2560 used to process information from sensors. The results will be displayed on the LCD, Micro SD Card, and ESP8266 for communication through IoT. The NodeMCU + ESP8266 is used as a medium to connect IoT. It will be in the form of data from voice commands to the relay module to control the lights in the house. The magnetic door switches and PIR motion sensors act as motion sensors. The VC0706 serial camera used to capture the images of objects will only run when both the magnetic door switch sensor and the PIR were triggered. The two DHT22 used to measure the temperature and humidity of the house. All the measurement results are monitored online through an application called Thingspeak [12].

2.9.4 Design and Implementation of an IoT-Based Smart Home Security System

The development of low-cost architectures for IoT-powered home automation and security systems has been enabled by recent developments in smartphones and affordable open-source hardware platforms, according to this paper. This paper was published by a group of researchers (Mohammad Asadul Hoque and Chad Davidson) from the Department of Computing, East Tennessee State University, Johnson City, and the Department of Electrical Engineering and Computer Science, University of Tennessee, Knoxville, Tennessee, USA respectively. These researchers aim to develop a system that used an Arduino Mega 2560 board with the Raspberry Pi 2 board for interfacing with a web server that implements a RESTful API [13].



Figure 2.28 Design and Implementation of an IoT-Based Smart Home Security System block diagram

Figure 2.28 shows the system's process flow. The connectivity between the Arduino Mega and the Raspberry Pi is the subject of this device. These microcontrollers enable other devices to communicate with them. The reed switch is activated when the door is opened, and the transmitter sends an RF transmission to the microcontrollers. The data was sent from the Raspberry Pi to the RESTful Web Server. The details can be viewed on the user's smartphone. The RESTful API is an online platform that stores date and time data for door open events [13].

2.9.5 Smart Door Security Using Arduino and Bluetooth Application

This paper explains how security nowadays is becoming an important issue everywhere. This paper was published by a group of researchers (Ketan Rathod, Prof.Rambabu vatti, Mandar Nandre and Sanket Yenare) from the Department of Computing, East Tennessee State University, Johnson City, and the Department Of Electronics Engineering, Vishwakarma Institute of Technology, Pune, India. These researchers aim to develop a security system using LDR, ultrasonic sensor and servo motor [14].



Figure 2.29 Smart Door Security Using Arduino and Bluetooth Application circuit diagram

Figure 2.29 shows the system's circuit relation. An Arduino Uno, Bluetooth Module, LDR, laser, Ultrasonic Sensor, and Servo Motor make up the device. The MIT Software Inventor is a Google-provided open-source web application that is used to connect with and track the system's other components. The servo motor is used to lock/unlock the door. The user can move the slider on the application to control the servo motor. The ultrasonic sensor and the LDR (with the laser facing it) will be placed in the door frame to detect if the door is open or not. The status of both of these components will be display on the application. When both the ultrasonic sensor and the LDR value rise, the user will receive a notification stating that the door is open [14].

2.10 Comparison of previous projects in term of the main component, method, advantages, and disadvantages of different home security system

Table 2.3 Comparison of previous projects in term of the main component, method, advantages, and disadvantages of different home security system

Author	Components	Method Advantages	Disadvantages
	Arduino Mega	This device detects an Low cost	• • It has a lower
(Rachell V. De	• Bluetooth HC-05	intruder using a PIR • Not required to install an	bandwidth than
Guzman, Clarissa	• PIR Sensor	Sensor, triggers a siren, and application on the user's	Wi-Fi
Joy M. Lubrido	GSM Sim900	sends an SMS (Short smartphone	• It can lose
and Claire N.	Piezo Buzzer	Message Service) to the	communication
Reyes) [10]	UNIVERSITI	designated individual SIA MELAKA	under some
		using a GSM and	circumstances.
Journal		Bluetooth module [10].	

(2019)			
(Taryudi, Davin Bagas Adriano and Wahyu Apsari Ciptoning Budi) [11]	 Arduino Nano NodeMCU Keypad RFID Reader LDR Sensor Buzzer 	This system included a The monitoring system that RF used a PIR Sensor to detect the intruders, an RFID reader, system for users [11].	is system can detectDuring powerFID cards and integrateoutages, RFIEem with a notificationsystems can failstem that sends ancausing somehail to family membersdoors to lock youout or, worse
Journal (2018)	Fasaninn		ssword. leave the doors open, allowing thieves to stea what's inside.
(Heru Susanto and Agus Nurcahyo) [12]	 Arduino Mega NodeMCU PIR Sensor Magnetic Door 	 This system has a camera Image: This sys	 Has not been able Has not been able to transmit camera to more than one shots online device to send
Journal (2020)	 VC0706 Serial Camera DHT22 	and PIR Sensors [12]. int	ruders. alarm data in ar image or tex format through e

				mail or short
				messages.
(Mohammad	Arduino Mega	• This system will notify a	• Use a system that can	• Expensive due to
Asadul Hoque	• RF receiver-	user of door open events in	display the time of the	the use of Arduino
and Chad	transmitter pair	a house or office	door opening	Mega and
Davidson) [13]	(433 Hz).	environment through an	• Have a database system	Raspberry Pi
	• Magnetic reed	Android application [13].		
Journal (2019)	switch.	X X		
	• Raspberry Pi			
(Ketan Rathod,	Arduino Uno	• This system uses an	Low cost	• It allows only
Prof.Rambabu	Ultrasonic Sensor	application to lock or	• Easy to operate	short-range
vatti, Mandar	Bluetooth Module	unlock the door.		communication
Nandre and	HC-05	Furthermore, this system		between devices.
Sanket Yenare)	Servo Motor	uses an ultrasonic sensor to	اويورسيني	
[14]		detect the door opening	1	
	UNIVERSITI	TEKIIIIKAL MALA	YSIA MELAKA	
Journal (2019)				

2.11 Summary

From the several research conducted, home security that uses IoT will provide a lot of benefits. Nowadays, there's a lot of IoT components with unique features that exist in home security. Users can monitor from their smartphones when an intrusion has occurred. For this system, the Blynk App will be the IoT platform due to the website provides sketch builders and code libraries. Furthermore, this system uses the Arduino WiFi Sheild as the IoT component and the Arduino Uno as the microcontroller due to the price. Besides that, both have many example and tutorial that is available on the internet. The PIR Sensor will be the main component in this project due to its reliability compared to other components such as ultrasonic sensor, IR sensor, and LDR sensor. This home security system can be a benefit to the user due to its efficiency and low cost.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will go over the methodology that was used to build an IoT-based home security system. It will include the project framework as well as the technical measures necessary to complete the system's functionality implementation and meet the project's goals.

3.2 Experimental/ Study design

The Development of IoT Based Home Security System project will be analysed and the data will be recorded by using quantitative data method. Quantitative data is information UNIVERSITITEKNIKAL MALAYSIA MELAKA that representing a certain number, quantity, or range. The component to be analyse is the PIR Sensor to determine the suitable distance for the PIR Sensor to optimise the system functionality.

3.2.1 PIR Sensor area of detection

Figure 3.1 shows that motion can be detected inside a 110-degree cone with a range of 3 to 7 meters by the system [15].



Figure 3.1 PIR Sensor Area of Detection diagram



Figure 3.2 PIR Sensor range adjustment diagram

3.2.3 PIR Sensor time delay adjustment

Figure 3.3 shows the time delay adjustment specifies how long the PIR Sensor module's output will remain high after motion is detected. The period ranges from 3 seconds to 5 minutes. Following the completion of the time delay, the output of this system will be blocked for approximately 3 seconds [15].



specifications defined by any system or software application.

3.3.1 Overview of Arduino Uno

The Arduino Uno is an open-source microcontroller based on the Microchip ATmega328P microcontroller. There are many digital and analogue input/output (I/O) pins on this frame. This function allows the board to communicate with other circuits and expansion boards. The board has 14 digital I/O pins and 6 analogue I/O pins, and it can be programmed

using the Arduino IDE software and a USB type B cable. The Arduino UNO also has the ability to be operated by an external 9-volt battery [16].



Table 3.1 The Pin Category, Pin Name and Details of Arduino Uno

	N/NO	
Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external
U	NIVERSITI TEKI	power source. 5V: Regulated power supply used to power
		microcontroller and other components on the board.
		3.3V: 3.3V supply generated by on-board voltage
		regulator. Maximum current draw is 50mA.
		GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output	Digital Pins 0 - 13	Can be used as input or output pins.
Pins		
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.

External	2, 3	To trigger an interrupt.
Interrupts		
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI),	Used for SPI communication.
	12 (MISO) and 13	
	(SCK)	
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5	Used for TWI communication.
	(SCA)	
AREF	AREF	To provide reference voltage for input voltage.

Table 24

Table 3.2 The specifications of Arduino Uno

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input	7-12V
Voltage	C. C. Sur sid
Input Voltage Limits	6-20V
Analog Input Pins	(6(A0-A5)ALAYSIA MELAKA
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

3.3.2 Overview of Arduino ESPWiFi Shield

The Arduino ESPWiFi Shield is a shield for the Arduino that includes the well-known ESP-WROOM-02 WiFi module. Aside from that, it offers Arduino projects a low-cost WiFi solution. This WiFi Shield also works with the Arduino Uno, Arduino Duemilanove, Arduino Mega2560, and Arduino Leonardo. Furthermore, it provides users with a simple and stable UART interface for interacting with onboard WiFi modules via Arduino boards [8].



Figure 3.5 Arduino ESPWiFi Shield pin diagram

No	Description
1	RESET switch to reset your Arduino board.
2	Jumpers to set the select option connect between ESP8266 module and
	Arduino board via the signal pins D0-D7.
3	Soldering points 86 points for experiment.
4	Soldering points for ESP8266 module is ESP-01, ESP-07 and ESP-12
5	ESP RESET switch to reset your ESP8266 module.
6	GPIO0 FLASH switch to upgrade (boot loader process) firmware of your
	ESP8266 module.

Table 3.3 The descrption of Arduino Uno

3.3.3 Overview of Passive Infrared Sensor (PIR Sensor)

Figure 3.6 shows an electronic sensor that senses motion by measuring infrared lights is known as a passive infrared sensor. In other words, as an object passes in front of the sensor, it senses motion. When a form of heat is detected, the sensor will produce a 5V signal for sixty seconds [17].

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Figure 3.6 Passive Infrared Sensor (PIR Sensor)



Figure 3.7 Passive Infrared Sensor (PIR Sensor) pin diagram

ALPHI SIA	
Product Type	HC-SR501
Operating Voltage	DC 4.5V – 20V
Inactivity Current	<50µA
Output Level	High 3.3V / Low 0V
Trigger	'L' position for single trigger/ 'H' position for
ليسيا ملاك	repeated trigger. (Default is repeated trigger)
Delay Time	5s-200s (can be adjusted)
Block Time	2.5s (default and adjustable within 0s-99s)
Board Dimension	32mm x 24mm
Angle Sensor	<100° cone angle
Operation temperature	-15°C to 70°C
Size of Lens sensor	23mm in Diameter

Table 3.4 The specifications of the PIR Sensor

3.3.4 5V High Trigger I/O Buzzer Sound Module

Figure 3.8 shows 5V High Trigger I/O Buzzer Sound Module. The role of this buzzer is the same as that of a Piezo Buzzer. When activated, it acts as a sound indicator. The buzzer runs on 3.5V-5V and has a maximum mean current of 35mA. The speaker buzzer's output is about 95 dBA. This buzzer will play a tone that the user has selected [18].



Figure 3.8 5V High Trigger I/O Buzzer Sound Module

3.3.5 Incandescent Lamp

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Figure 3.9 shows an incandescent lamp which is a form of electric light in which the wire filament glows when heated. Inert gas or vacuum is used to seal the filament in a glass bulb. This procedure is used to keep the filament from oxidising. The filament receives current from wires or terminals mounted in the glass. A bulb socket serves as both an electrical and mechanical link [19].



Figure 3.9 Incandescent Lamp

3.4 Software requirement

The software aids the hardware component by controlling the input and output of hardware components in the development of the system.

3.4.1 Arduino Integrated Development Environment (IDE) software

Figure 3.10 shows the Arduino Integrated Development Environment (IDE), which is a cross-platform application that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards [20].



Figure 3.10 Arduino Integrated Development Environment (IDE) interface

3.4.2 Blynk application

Figure 3.11 shows the Blynk application interface. Blynk is a platform that lets users easily create interfaces for controlling and monitoring hardware projects from your iOS or Android device. A project dashboard can be created by arranging buttons, sliders, graphs, and other widgets on the computer. The widgets allow the user to switch pins on and off as well as show data from sensors.



Figure 3.11 Blynk application interface

3.4.3 Tinkercad website

Figure 3.12 shows the Tinkercad Circuits, which is a website that can be used to simulate circuits with an Arduino. Tinkercad Circuits helps users to design and program Arduino projects digitally, without having to use physical hardware. This website also allows the users to download the coding that has been created.



UNIVERSITI Figure 3.12 Tinkercad Circuit A MELAKA

3.5 Block diagram of the project

Figure 3.13 shows the block diagram of the project which consists of Arduino Uno, Arduino ESPWiFi Shield, three PIR Sensors, a buzzer, a lamp, and a monitoring system. This project will be used to monitor which door is open during a potential break-in. The Arduino Uno is used to run the coding for this project. The Arduino ESPWiFi Shield is used to connect the WiFi to the hardware. Then, to detect motion, three PIR Sensors will be mounted near three separate doors. Furthermore, the buzzer will produce a sound and the lamp will turn on when one of the PIR Sensors detects the door is being open. Finally, the Blynk software was used to create the monitor device, which is used to track which door was open and display the time of the intrusion on the user's smartphone.



Figure 3.13 The block diagram of the project

3.6 Flowchart of system



Figure 3.14 The flowchart of the system

Figure 3.14 shows the project's flowchart. A flow chart is a diagram that shows how a workflow or procedure works. It's a visual illustration of a step-by-step approach to completing the project's mission. The framework for the creation of IoT-based home security systems is depicted in the diagram.

3.7 Prototype sketch of the project

Figure 3.15 shows the prototype sketch of the project. It shows the placement of every component which consists of an Arduino Uno, Arduino ESPWiFi Shield, Buzzer, PIR Sensor, and Lamp at one door. This sketch was designed by using AutoCAD software.



Figure 3.15 The prototype sketch of the project

3.8 Cost of project

No	Components	Quantity	Price (RM)
1	Arduino UNO R3 + USB Cable	1	25.50
2	Arduino ESPWiFi Shield	1	47.40
3	HC-SR501 Infrared PIR Human Motion Sensor Module	3	17.7
4	5V High Trigger I/O Buzzer Sound Module	1	2.90
5	Female to Male Jumper Wire Cable 20cm	40	3.30
6	Male to Male Jumper Wire Cable 20cm	40	3.30
7	Mini Small Breadboard 400 Holes Solderless	3	9.00
8	Large Breadboard 830 Holes Solderless	1	4.20
9	20mA LED 3MM	5	0.50
10	1 Channel Relay Module	3	12.00
	Total	V1	125.80

Table 3.5 The quantity and price of each components for the project

3.9 Summary

The analysis of the best distance for the PIR Sensor to maximise device functionality has been completed. This project's hardware and software selections are justified. The Arduino Uno and Arduino ESPWiFi Shield make a great pair, and they're both inexpensive. The Blynk application as the IoT platform is very beneficial due to many examples and tutorials on the internet. The block diagram explains the functions of each

component in the system. The flowchart of this system is easy to understand and straightforward. The simulation of project circuit design on the Tinkercad website was successful. The prototype sketch shows how the project will be displayed. Finally, the project cost shows the price of each component to design the home security system.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter aims to preview the result and provide discussion from the data collection while undergoing the project process. This includes testing and analysis to measure the accuracy and preciseness of the data. This chapter is to ensure that every objectives of the project are fulfilled.

4.2 Circuit design on Tinkercad

Figure 4.1 shows the circuit design of IoT Based Home Security System on Tinkercad. This circuit contains all the necessary components for the project to run without the WiFi Sheild. This circuit will be used as a reference when constructing the hardware.



Figure 4.1 The circuit design of the project

4.3 Project implementation in a model house

Figure 4.2 shows a model house with the placement of each components of the project. This model house will display a better visual understanding of the system. Furthermore, it will be easier to check the connection whenever there's a problem occur.



Figure 4.2 Model house with the implementation of the project

Figure 4.3 shows the main components in the model house. The Arduino Uno will run the coding for the system. Then, the Arduino ESPWiFi Shield will be used to ensure to system is connected to the WiFi. Next, the three PIR Sensors are place behind three doors to **UNIVERSITY TEKNIKAL MALAYSIA MELAKA** detect if the doors are open or not. Finally, the buzzer and the light bulb is place in house and will turn on when one of the PIR sensors detect any of the doors are being open.



Figure 4.3 Main components in the model house

4.4 Home security system interface

Figure 4.4 shows the home security system interface on the Blynk app. This interface contains widgets such as SuperChart, Notification, and a Button. The SuperChart widget was used to display a graph and the time of the intrusion. Next, the Notification widget was used to send notifications on which door is being open. Finally, the Button widget was used to turn on or turn off the home security system.



Figure 4.4 Home security system interface

4.5 Testing and troubleshooting

4.5.1 Connecting the WiFi to the hardware

Figure 4.5 shows that the system is connecting to the WiFi. It will display the name of the WiFi and also the IP address. Sometimes the serial monitor will display "Failed to connect WiFi" or "Failed to enable MUX". This is due to the user inserting the wrong password in the coding, slow internet connection, wrong circuit connection or the Arduino ESPWiFi Shield is not working.

COM3 (Arduino Uno)	_		×
1		Se	nd
[19] / _)/ / _ / / . / _ / / / / / . / · ./ / _ / . / . / . / . / . / . / . / . / .			
[609] Connecting to DECOL [3825] AT version:1.6.2.0 (Apr 13 2018 11:10:59) SDK version:2.2.1 (6ab97e9) compile time:Jun 7 2018 19:34:26			
Bin version(Wroom 02):1.6.2			
(11274] +CIFSR:STAIP, "192.168.68.112" +CIFSR:STAMAC, "bc:dd:c2:1d:64:df"			
[11284] Connected to WiFi [21995] Ready (ping: 26ms).			
Autoscroll	Both NL & CR $$	9600 baud	~

Figure 4.5 Serial Monitor on Arduino IDE

4.5.2 Testing the notification system on Blynk Application

Figure 4.6 shows a simple circuit that consist of Arduino Uno, PIR Sensor and a red LED. The purpose of this circuit is to test if the notification widget will send a message when the PIR sensor detect motion.



Figure 4.6 Test the notification widget

Figure 4.7 shows when PIR Sensor detects motion, the red LED will be turn on. The red LED will turn off when the PIR stop detecting any motion.



Figure 4.7 The circuit detecting motion

Figure 4.8 shows a message "Front Door Open!". This means the Blynk application can receive a message through the user's smartphone displaying which door is being open.

Figure 4.8 The notification widget send a message

4.6 Result Analysis

4.6.1 Receiving message displaying which door is being open

Figures 4.9 show the Blynk application receiving a message showing which door is being open. The "Front Door Open!" message appears due to the first PIR sensor detecting motion from the front door. Next, the "Side Door Open!" message appears because the second PIR sensor detects motion from the side door. Lastly, the "Back Door Open!" message appears when the third PIR sensor detects motion from the back door.



Figure 4.9 Notification messages

4.6.2 The monitoring system on Blynk Application

Figure 4.10 shows the SuperChart widget from the Blynk App was used to monitor the system which will display which door was being open and also display the time. The blue bar represents the "Front Door", the red bar represents the "Side Door" and the green bar represents the "Back Door". The time of the intrusion will be displayed on the x-axis of the graph. The SuperChart widget allows the user to select the desired time setting. The time setting of the monitoring widget for the system was set to "Live".



4.6.3 Study of the reaction time of the system to send a notification

Figure 4.11 shows a distance and motion detector circuit. This circuit used an Ultrasonic Sensor to measure the distance of an object in front of it. Besides that, this circuit used a PIR Sensor to detect motion. When the PIR Sensor detects motions,
the green LED will turned on. The value of the distance will be display in cm on the serial monitor of the Arduino IDE.



Figure 4.11 Distance and motion detector circuit

4.6.4 Data of the three PIR sensor from various distance from the door versus the average time to receive a notification

The data analysis is recorded for the PIR sensors from different distance from

the door versus the average time to receive a notification from the Blynk application.

Table 4.1 Distance versus the average time to receive a notification for the front door

 $_{\rm sph}$

		Front Door	
No.	Number of	Distances	Average time to receive a
	Attempts	(Cm)	notification (Miliseconds)
1	3	50	78
2	3	100	77
3	3	150	75
4	3	200	76
5	3	250	73
6	3	300	77
7	3	350	76
8	3	400	75
9	3	450	76
10	3	500	78
11	3	550	77

12	3	600	77
13	3	650	75
14	3	700	76

Figure 4.12 shows the graph of the distance versus the average time to receive a notification for the front door. The data from Table 4.1 was used to create the graph. The linear line of the graph shows that the average time to send a notification is independent of the distance of the PIR Sensor from the front door.



Table 4.2 Distance versus the average time to receive a notification for the side door

	Side Door													
No.	Number of Attempts	Distances (Cm)	Average time to receive a notification (Miliseconds)											
1	3	50	75											
2	3	100	76											
3	3	150	76											
4	3	200	77											
5	3	250	78											
6	3	300	75											
7	3	350	75											
8	3	400	76											
9	3	450	78											

10	3	500	75
11	3	550	76
12	3	600	75
13	3	650	78
14	3	700	75

Figure 4.13 shows the graph of the distance versus the average time to receive a notification for the side door. The data from Table 4.2 was used to create the graph. The linear line of the graph shows that the average time to send a notification is independent of the distance of the PIR Sensor from the side door.



Table 4.3 Distance versus the average time to receive a notification for the back door

	Back Door													
No.	Number of	Number of Distances Average												
	Attempts	(Cm)	notification (Miliseconds)											
1	3	50	76											
2	3	100	77											
3	3	150	74											
4	3	200	77											
5	3	250	77											
6	3	300	76											
7	3	350	75											

8	3	400	77
9	3	450	76
10	3	500	75
11	3	550	74
12	3	600	76
13	3	650	77
14	3	700	77

Figure 4.14 shows the graph of the distance versus the average time to receive a notification for the back door. The data from Table 4.3 was used to create the graph. The linear line of the graph shows that the average time to send a notification is independent of the distance of the PIR Sensor from the back door.



Figure 4.14 Graph of the data analysis from the back door

4.6.5 Analysis of the suitable distance for the PIR Sensor to optimise the system functionality

This study shows that the system will send a notification when the PIR Sensors detect an intrusion within 1 seconds in the distance from 50 to 700 centimeters. The

starting distance of the data analysis is 50 centimeters because to avoid the PIR sensor being damaged when the door is being open. The limit distance of the data analysis is 700 centimeters is due to the PIR Sensor's maximum range to detect motion being 7 meters. If the door is outside the range of 7 meters, the PIR Sensor can't detect any motions. Based on this study, the various distance of the PIR Sensors from the doors does not affect the functionality of the system to send a notification within a short time. The graph also shows that the average time to send a notification is independent of the distance of the PIR Sensor from any doors. Thus, the suitable distance for the PIR Sensor to optimise the system functionality between the ranges of 50 to 700 centimeters.

4.7 Discussion

This section would address the entire progression of this project which is the development of an IoT-based home security system and the issues that have been encountered. From the Blynk application, the Notification widget and the SuperChart widget were used to create the monitoring system. The Notification widget will receive a message displaying which door is being open while the SuperChart will display the time of the intrusion. The issue that occurs when using the Notification widget is not receiving any messages from the Blynk app due to a slow internet connection.

Next, a distance and motion detector circuit which consists of an Arduino Uno, PIR Sensor, Ultrasonic Sensor, and LED was built to study the reaction time of the system to send a notification. The distance and motion detector circuit makes it easier to fill in the data of the three PIR sensors from various distances from the door versus the average time to receive a notification. The issue that was encountered during the analysis was the Ultrasonic Sensor has a problem detecting small objects from a far distance.

After troubleshooting the following issues, the security system was able to run successfully. The user will receive a notification displaying which door was being open and the user will also know when the intrusion happened on the monitoring system. When conducting a study on the reaction time of the system to send a notification, the system will send a notification within 1 seconds from the range of 50 to 700 centimeters. Therefore, the different distances of the PIR Sensors from the doors do not affect the time of receiving a notification. Not only that, the suitable distance for the PIR Sensor to optimise the system functionality was able to be analysed from Figure 4.12. Thus, the project's objective was successfully achieved.

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CHAPTER 5

CONCLUSION

5.1 Introduction

The entire performance of the development of an IoT-based home security system is concluded in this chapter. In addition, some significant suggestions for development in the near future would be suggested.

5.2 Conclusion

The purpose of this project is to develop an IoT-based home security system that allows the user to receive a notification on which door is being opened on the user's smartphone. The first objective which is to design a home security system that will display the time of the intrusion was accomplished by using the SuperChart widget on the Blynk application.

The second objective which is to study the reaction time of the system to send a notification also been accomplished by using a distance and motion detector circuit. The system will send a notification within 1 seconds from the range of 50 to 700 centimeters. This circuit was helpful to gather the necessary data for the second objective and third objectives. Finally, the last objective which is to analyse the suitable distance for the PIR Sensor to optimise the system functionality was accomplished when carrying out the second objective. The suitable distance for the system to function fully is to place the PIR sensors between the ranges of 50 to 700 centimeters from the doors. The project has been observed and shown that the system is stable.

5.3 **Recommendations**

A few recommendations are needed for future projects on the development of an IoT-based home security system. The recommendations for creating an affordable IoT-based home security system that is fully wireless. The limitation of this project is that it still required a wires connection from the microcontroller to the other components due to the budget of the project. Next, the recommendation that would be suggested is to have an alternative way to connect to the system without using WiFi. This is due to sometimes the notification will be received late due to the slow internet. Connecting GSM and Bluetooth modules to the project will provide more than one way to connect to the system. Lastly, this project also can be recommended by equipping a camera into the system. The camera can be set to capture a photo of the intruder and send it to the user's smartphone. Not only that, the camera can be set to display live footage of the intrusion on the user's smartphone. This can also allow the user to see whether the one who's entering the house is an intruder or a family member.

5.4 **Project potential**

There are several potentials of this home security system to be used in the community. From referring to the cost of the project and the flowchart, this home security system is a low-cost system and user-friendly compared to other existing systems. Not only this system can be embedded at home, but it can also be used at several places such as universities, schools, and companies. Thus, this home security system can be used in a wide variety of places. With the aid of this home security system, the number of potential intrusions will be reduced at several residences.



REFERENCES

- S. S. Syazlina Mohd Soleh, M. M. Som, M. H. Abd Wahab, A. Mustapha, N. A. Othman, and M. Z. Saringat, "Arduino-based wireless motion detecting system," 2018 IEEE Conf. Open Syst. ICOS 2018, pp. 71–75, 2019, doi: 10.1109/ICOS.2018.8632703.
- S. Suresh, J. Bhavya, S. Sakshi, K. Varun, and G. Debarshi, "Home Monitoring and Security system," *Proc. 2016 Int. Conf. ICT Business, Ind. Gov. ICTBIG 2016*, 2017, doi: 10.1109/ICTBIG.2016.7892665.
- [3] A. B. Arjona *et al.*, "Design and Implementation of an Arduino-Based Security System Using Laser Light," *LPU-Laguna J. Eng. Comput. Stud.*, vol. 4, no. 2, pp. 6–12, 2019.
- [4] "Home Security System Project Using Laser and LDR Environmentalb.com."
 https://environmentalb.com/home-security-system-project/ (accessed Jun. 17, 2021).
- [5] "How Much Does a Home Security System Cost in 2020? | Safety.com®." https://www.safety.com/home-security-cost/ (accessed Jun. 17, 2021).
- [6] A. Anitha, "Home security system using internet of things," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 263, no. 4, 2017, doi: 10.1088/1757-899X/263/4/042026.
- [7] "The Internet of Things for Arduino: Modules, Platform and 6 IoT projects." https://www.circuito.io/blog/iot-projects/ (accessed May 01, 2021).
- [8] T. O. E. P. User, C. T. Sdn, and A. R. Reserved, "G15 Shield User's Manual," no. April, pp. 1–14, 2015.
- [9] "10 Best Microcontroller Boards for Engineers and Geeks Engineering Passion." https://www.engineeringpassion.com/10-best-microcontroller-boards-for-engineersand-geeks/ (accessed May 01, 2021).

- [10] R. V., C. Joy, and C. N., "Remote Home Security System using Open-Source Electronic Platform," *Int. J. Comput. Appl.*, vol. 178, no. 22, pp. 5–8, 2019, doi: 10.5120/ijca2019918941.
- [11] Taryudi, D. B. Adriano, and W. A. Ciptoning Budi, "Iot-based Integrated Home Security and Monitoring System," *J. Phys. Conf. Ser.*, vol. 1140, no. 1, 2018, doi: 10.1088/1742-6596/1140/1/012006.
- [12] H. Susanto and A. Nurcahyo, "Design and Implementation of a Smart Home Security System Using Voice Command and Internet of Things," *Khazanah Inform. J. Ilmu Komput. dan Inform.*, vol. 6, no. 2, pp. 82–94, 2020, doi: 10.23917/khif.v6i2.9320.
- [13] M. A. Hoque and C. Davidson, "Design and implementation of an IoT-based smart home security system," *Int. J. Networked Distrib. Comput.*, vol. 7, no. 2, pp. 85–92, 2019, doi: 10.2991/ijndc.k.190326.004.
- [14] K. Rathod, P. vatti, M. Nandre, and S. Yenare, "Smart Door Security Using Arduino and Bluetooth Application," no. 4, pp. 2394–0697, 2017.
- [15] "PIR Motion Sensor Module HC-SR501 w/ Adjustable Delay Time & Output Signal
 | QQ Online Trading." http://qqtrading.com.my/pir-motion-sensor-module-hc-sr501
 (accessed May 01, 2021).
- [16] Farnell, "Arduino Uno Datasheet," *Datasheets*, pp. 1–4, 2013, [Online]. Available: https://www.farnell.com/datasheets/1682209.pdf.
- [17] "Overview | PIR Motion Sensor | Adafruit Learning System."
 https://learn.adafruit.com/pir-passive-infrared-proximity-motion-sensor?view=all
 (accessed Jun. 17, 2021).
- [18] "Piezo Buzzers Products | APC International."
 https://www.americanpiezo.com/standard-products/buzzers.html (accessed Jun. 17,

2021).

- [19] "Incandescent light bulb Wikipedia."https://en.wikipedia.org/wiki/Incandescent_light_bulb (accessed Jun. 17, 2021).
- [20] M. Fezari and A. Al Dahoud, "Integrated Development Environment ' IDE ' For Arduino," *ResearchGate*, no. October, pp. 1–12, 2018, [Online]. Available: https://www.researchgate.net/publication/328615543%0AIntegrated.



APPENDICES

Appendix A Coding of the Project

```
#define BLYNK_PRINT Serial
#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>
char auth[] = "**********";
char ssid[] = "**********";
char pass[] = "**********";
```

#include <SoftwareSerial.h>
SoftwareSerial EspSerial(2, 3); // RX, TX

#define ESP8266_BAUD 9600

```
ESP8266 wifi(&EspSerial);
int sensorState = 0;
int sensorState2 = 0;
int sensorState3 = 0;
int FDoor, SDoor, BDoor;
void setup()
{
 pinMode(7, INPUT);
 pinMode(6, INPUT);
 pinMode(5, INPUT);
 pinMode(4, OUTPUT); SITI TEKNIKAL MALAYSIA MELAKA
 pinMode(2, INPUT);
 pinMode(13, OUTPUT);
 delay(10);
 EspSerial.begin(ESP8266_BAUD);
 delay(10);
 Serial.begin(9600);
 Blynk.begin(auth, wifi, ssid, pass);
}
void loop()
 Blynk.run();
 sensorState = digitalRead(7);
 sensorState2 = digitalRead(6);
 sensorState3 = digitalRead(5);
   if(digitalRead(2) == LOW)
  {
```

```
if (sensorState == HIGH)
 {
  FDoor=100;
  digitalWrite(13, HIGH);
  digitalWrite(4, HIGH);
  Blynk.notify("Front Door Open!");
  Blynk.virtualWrite(V1,FDoor);
  delay(500);
 }
 else if (sensorState2 == HIGH)
  SDoor=75;
  digitalWrite(13, HIGH);
  digitalWrite(4, HIGH);
  Blynk.notify("Side Door Open!");
  Blynk.virtualWrite(V2,SDoor);
  delay(500);
 }
  else if (sensorState3 == HIGH)
                 WALAYS/A
 ł
  BDoor=50;
  digitalWrite(13, HIGH);
  digitalWrite(4, HIGH);
  Blynk.notify("Back Door Open!");
  Blynk.virtualWrite(V3,BDoor);
  delay(500);
 }
 else
 {
  digitalWrite(13, LOW);
  digitalWrite(4, LOW);
                               EKNIKAL MALAYSIA MELAKA
 }
 }
   else
 {
  digitalWrite(13, LOW);
  digitalWrite(4, LOW);
  delay(500);
 }
}
```

Appendix B Gantt Chart

	Project Planning																																				
Project Activity										N.L.	AY:	21.1					202	1																			
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 1													1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16								
PSM briefing/Module								Ş					V	-						•																	
Propose title							3							1																							
Research title							Ш							1								1	_														
Identify																											V										
project							1	à.									Stu	dy	Wee	ek							T										
scope								3								_																<u> </u>		<u> </u>			
Research journal related to title								eak	1															1			-										/eek
Present progress								<u>p</u>		1122	-		-				Fin	nal I	Exa	n									eak]						
Submit draft proposal							1	erm						1	1		_	• 2	/	_							+	. *	m M								study
Submit Report							-	D	10				~~	5			~~~	-	_	_	ŝ	6	9	19-14-18 		1			Tel								
Literature review								Σ																					Mid								
Circuit design											-						Sem	est	er E	Brea	k								1								
Collection of data							U	N	V	ER	S			in		ľ	A	_	M/	٩L	A		5L	-	M	E		4.7	V	1							
Analysis data																																					
Report Writing																																					1
Log book submission																																					
Presentation																																					