UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF A SMART ANTI-INTRUDER SYSTEM FOR MALAYSIAN FARMING COMMUNITY USING RASPBERRY PI

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunications) with Honours.

By

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DECLARATION

I hereby, declared this report entitled DEVELOPMENT OF A SMART ANTI-INTRUDER SYSTEM FOR MALAYSIAN FARMING COMMUNITY USING RASPBERRY PI is the results of my own research except as cited in references.

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Date: 15/02/2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Internet of Things (IoT) telah menjadikan kehidupan orang lebih mudah dan praktikal di mana ia membenarkan sesiapa sahaja untuk berhubung dengan apa sahaja, di mana sahaja, melalui Internet. Pertanian pintar membolehkan petani mengawasi ladang dengan hanya menggunakan telefon pintar, di mana hal ini dapat meningkatkan pendapatan dari produktiviti dan menjaga ladang. Penceroboh, tidak kira serupa atau sifatnya, seperti manusia atau haiwan akan mencuri ternakan di dalam ladang atau merosakkannya. Oleh itu, projek ini menerangkan sistem anti-penceroboh yang pintar untuk membantu petani mengesan kehadiran penceroboh. Sistem ini disertakan sensor gerakan untuk mengesan, kamera untuk mengambil gambar dan Raspberry Pi untuk memproses data. Hasil yang berlaku dari sistem ini ialah sistem ini dapat mengesan kehadiran penceroboh dan menghantar informasi ke telefon pintar petani mengenai kehadirannya. Kesimpulannya, sistem ini dapat membantu petani untuk memantau keselamatan ladang.

ABSTRACT

Internet of Things (IoT) has made people's life more convenient and practical where it supports any person to be connected to any things, anywhere, via the Internet. Smart farming enables farmers to monitor the farmhouse by just using a smartphone, thus increase income from productivity and maintain the farm. Intruders, in any kind, such as humans or animals tend to steal the livestock or spoil it. Therefore, this project describes a smart anti-intruder system to help farmers to detect the presence of intruders. This system is embedded in a motion sensor to detect, camera to capture and Raspberry Pi to process the data. The outcome of this system is that it is be able to detect the presence of intruders and send a notification to the farmer's smartphone about the presence. In conclusion, this system will help farmers to monitor the security of the farmhouse.

DEDICATION

This project is dedicated to my loved ones and poultry farmers.

ACKNOWLEDGEMENTS

I would like to express my gratitude to my supervisor, Dr AKM Zakir Hossain for endlessly giving guidance and support to complete this project. I would like to thank my loved ones for their encouragement and moral support.

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LIST OF ABBREVIATIONS

Rpi – Raspberry Pi

GSM – Global system for mobile communication

IoT – Internet of Things

PLF – Precision Livestock Farming

RFID – Radio Frequency Identification

GPRS – General Packet Radio Service

SMS – Short Messaging Service

WSN – Wireless Sensor Network

PIR – Passive Infrared

LAN – Local Area Network

GPIO – General Purpose Input Output

ADC - Analog to Digital Converter

LED – Light Emitting Diode

LCD – Liquid Crystal Display

CHAPTER 1

INTRODUCTION

1.1 Research Background

According to a global population forecast by the United Nations, the current world population is 7.8 billion as of March 2020, and the human population will continue to grow and it is expected to exceed approximately 11 billion by the year 2100. Due to this, the agricultural sector, particularly poultry farming faces a serious challenge to feed this ever-growing human population. In Malaysia, the most consumed protein content by humans is in the form of chicken meat. Therefore, it is important to develop long term measures that will significantly increase output to meet the demands of the growing global population. According to the website “The Poultry Site”, there will be 35 percent more demand for animal protein in the next 20 years, where poultry will be expanding about 2 percent. (Ghazal, Al-khatib and Chahine, 2017) stated that precision livestock farming (PLF) is an integration of advanced technologies with software, hardware, processes, and management. Thus, the production runs efficiently to give better output concerning quantity and quality. There are so many smart poultry farming being introduced and embedded to help the farmers to monitor the food consumption, ventilation control, and cleaning system.

Nevertheless, farmers also face problems when their crops or poultry are stolen by an intruder or eaten by other animals. The security of a farm also needs to be given importance. To solve this issue, the development of a smart anti-intruder system for Malaysian farming is proposed. This system consists of Raspberry Pi, a motion detector, a camera, a buzzer, and a smartphone. Raspberry Pi is an inexpensive, small-sized computer that plugs into a computer and uses standard keyboard and mouse. The motion detector senses any movement and alerts the farmer via smartphone and the image is captured via the camera. This system will help the farmer to know if someone is trying to enter the farm, while indirectly helps to monitor the condition and environment of the farm.

1.2 Problem Statement

Smart poultry farming has been around and many researchers have done developments to help the farmers in terms of feeding, temperature control, and ventilation system. On the other hand, the anti-theft system for agricultural sector must also be given priority as in housing area to protect the surrounding from intruders In the paper done by (Islam *et al.*, 2019), fire protection and anti-theft features were done but there is no notification process. (Phiri, Kunda and Phiri, 2018) stated that the cheapest solution to ensure security of a farm is to have a homestead nearby the poultry house, but it does not provide notification to the farmer during any intrusion.

By using features of the Internet of Things (IoT), farmers can keep track and monitor the environment, thus take action when necessary. Therefore, to aid the local poultry farming community to be aware of the farm and get notified about intrusion, a smart anti-intruder system for the Malaysian farming community is proposed.

1.3 Objectives

1. To develop a smart anti-intruder system for the Malaysian farming community using Raspberry Pi.
2. To detect the presence of an intruder or stray animals and alert the farmer using a smartphone.

3. To analyze the performance of the developed system towards poultry farming.

1.4 Scope of Research

The scope of this project focuses only on using Raspberry Pi to communicate with a motion detector, camera, buzzer, and smartphone application which is Telegram Bot to alert the farmer if there is an unknown person or stray animal that tries to enter the farm. The presence of intruder will be detected by the motion sensor, which will be connected to Raspberry Pi and the camera will capture the image of the intruder. The buzzer will be activated to scare the intruder away. Telegram Bot is used to receive notification from Raspberry Pi. Lastly, this project is dedicated to poultry farming only. The performance of the system is analysed by observing the speed of detection in a range of time and distance.

1.5 Thesis Organization

Chapter 1 provides the background of the smart anti-intruder system and poultry farming. A problem statement is stated and objectives are listed to set as a benchmark to be achieved to solve the problems. Lastly, this chapter covers the scope of research and thesis organisation.

Chapter 2 discusses the related research done by researchers based on project implementation and functionality. A comparison between the projects is done to identify the main idea, theory, and provide a wider view of the type of implementation which will be suitable for this project.

Chapter 3 gives an overview of the methodology done to complete this project. The methodology is done by taking specific steps to develop the project while obeying the objectives stated. A flow chart is designed to show the procedures taken.

Details of results are provided in Chapter 4. The data or output of the project will be analysed and discussed in detail. Figures of output will be attached.

Chapter 5 concludes and summarizes the main ideas and states whether the project output has achieved the objectives. This chapter also gives suggestions on further improvement of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the important information and details which are found by study and research from related previous study. The discussion starts with the study of smart farming and smart security concepts. It is important to study these concepts because they are the main idea of this project. Next, as this project comprises the Internet of Things (IoT) technology, it is vital to study the concept of the IoT to have a clear vision of the concept. Lastly, this chapter ends with the comparison of the related previous papers and the type of implementation that will be done in this project.

2.2 Concept of Smart Farming

In general, smart refers to technology that is data-driven, sensor-based, and more automatic or programmable, which also involves artificial intelligence. Smart farming is a method where traditional farming is incorporated with innovative technologies. Smart farming benefits in many ways such as increase production, reduce human force and improve the quality of agricultural products. Adequate irrigation, fertilization and pesticides are important for better farming and food production. It is much simpler if we create an automatic system to automatically perform all these tasks (Mahbub, 2020). Due to that, this technology has done many changes in the farming sector such as:

1. Automatic feeding and watering system
2. Real-time monitoring system
3. Real-time security system

According to (Wolfert *et al.*, 2017), smart farming concept consists of smart devices that are connected to the Internet are able to control a farm. With that, smart devices are devices that are built-in with sensors and intelligence to perform autonomous tasks. Besides, robots will be seen to take part in the control system and machines will be helping humans in planning and analysis. This will cause all operations to be automatic.

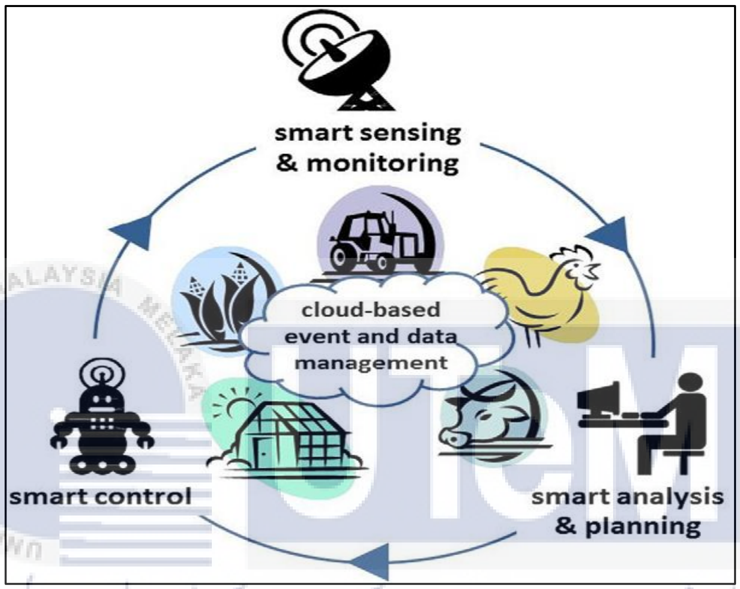

Figure 2.1: The cyber-physical management cycle of Smart Farming enhanced by cloud-based event and data management (Wolfert *et al.*, 2017)

(Bauer and Aschenbruck, 2018) stated that the idea of precision agriculture came from the integration of digital novelties in the agricultural field. Lately, the Internet of Things (IoT) has widened its scope of precision agriculture by adding smart sensors and technologies that are already present in other industrial and home automation. This is considered as Smart Farming which includes data collecting, data processing, analysis and storage. Analytic results can be viewed through the IoT frame to assist farmers to take better actions. (Dagar, Som and Khatri, 2018) mentioned that smart farming enables the process of farming to be economical, less difficult, reduce the cost of labour, thus produce yields that are of good quality.

The usage of a tractor in agriculture has become the starting point of a new transition of traditional farming. Tractors were used to plough, haul loads and live stocks and perform many other tasks. Now, the transition changes to automation and data-centred management. This new evolution is possible to be developed by including fundamental technologies such as the Internet of Things and artificial intelligence (Charania and Li, 2020). Table 2.1 below shows in detail about fundamental technologies in enabling technologies of smart farming.

Table 2.1: Fundamental technologies of smart farming

Internet of Things (IoT)	Micro sensors	Combination of these sensors can measure multiple aspects. For example, sensors that measure liquid levels are now united with sensors that measure temperature that also gives output in digital format. Furthermore, data that was previously unapproachable can now be measured and analysed, such as ammonia level in a poultry farm.
	Networking technology	Output from the sensors must be sent over a network for analysis and processing. Networking technologies have significantly improved such as an increase in bandwidth and range while reducing cost and power.

	Cloud computing	With cloud computing, data from the sensor has a destination where assembly and analysis can happen at greater scale and speed.
	Single-board microcontrollers and computers	Single-board computing devices consist of microprocessors, memory, and input-output pins on a single printed circuit board. It is normally used in industrial applications and embedded with other devices to provide control and interfacing. Arduino and Raspberry Pi are examples of a single-board computer.
Robots	Robots are employed for tasks that are tedious for humans. These machines are designed or assembled of a controller, communication system and autonomy.	

With the growing population worldwide, it is essential to improvise the method of agriculture and farming to the next level. Smart farming has all the opportunities to be implemented with the help of fundamental technologies such as the Internet of Things and robotics. This implementation requires less human involvement and capable of monitoring a farm from all aspects.

2.3 Concept of Smart Security

A smart security system is a system that uses personal smartphones to monitor the house, office or farm wirelessly to ensure it is secured. It is a network that is combined with electronic devices and sensors to protect against thieves and intruders, and can be implemented anywhere to secure its premise. According to (Matthews, Noma-osaghae and Idiake, 2018), most of the security systems consist of a control panel that receives information, analyses and coordinates. It receives signals from the sensors or security cameras and uses that information to decide whether an alarm needs to be triggered. The security system can be remotely controlled using smartphones. Motion sensors are used to detect any movement wherever the sensor is placed while security cameras are used to monitor the surrounding of the premise and also to have evidence of the security breach.

(Patil, Ambatkar and Kakde, 2017) stated that safety is very important to protect ourselves from burglary and thefts, no matter if it a small house or large company. Apart from that, many people are concerned with the security of homes. There are situations where security is highly important for houses that have elderly adults and kids with baby sitters. Due to this issue, a smart home security system is designed to provide security and monitoring remotely from anywhere (Hussein, 2017). This project focuses instead on the security of a farm to protect agriculture or livestock and to enable efficient farming.

Figure 2.2: Smart security system of a farm

2.4 Internet of Things (IoT)

According to Big Data Insights, the term Internet of Things was established by Kevin Ashton, who was a member of the team that discovered RFID tag to be used as a communication link to connect objects to the Internet. The term was first used in 1999 and since then, it has been growing enormously in various types of sectors around the world. Kevin Ashton has also said that the Internet of Things is possible to bring more changes to the world compared to as Internet did. Apart from that, (Krotov, Bauernfeind and Building, 2017) defined IoT as a network that consists of physical, technological and broad socioeconomic environments. Each of the features is tabulated in Table 2.2 below.

Table 2.2: Features of IoT (Krotov, Bauernfeind and Building, 2017)

Technological	Hardware	Wireless devices such as smartphones and RFID tags that are used to connect humans and objects to IoT for communication via a wireless medium.
	Software	Applications that are developed to put value for utilities and execute output for the end-user IoT applications.
	Networking	Wireless networks are commonly used to connect devices and share information. WIFI or satellite links are also used to connect devices.

	Integrated platforms	A cloud-based platform that enables hardware devices, software, and network to work together smoothly.
	Data	Streams of data produced by IoT devices can be taken and evaluated in real-time and provide better decision-making.
	Standards	Technical and operating standards that plan the design of IoT and ensure operations to run internally.
Physical	Human	Any person who holds any wireless device such as a smartphone or laptop to interconnect with IoT.
	Objects	Physical objects such as cars and packages that connect to the network using any wireless device.
	Physical surrounding	Physical space or area where both humans and objects interact with each other. For example, an office building door that is installed with an RFID reader.
Socioeconomic	Customers	Individuals that are aimed by specific IoT applications. For example, IoT security system that targets thefts or burglary.

	Legislative bodies	Bodies that enforce rules and regulations related to IoT. For example, RFID needs to obey the rules of the Federal Communication Commission (FCC) for near-field communication.
	Industry associations	Industry associations could make a change in the way IoT technologies and applications are established. Their aim is to outline standards for auto-identification technologies such as barcodes.
	Consumer privacy groups	Groups that protect IoT users from a security breach and privacy violations.
	Entrepreneur	Entrepreneurs who use their technical knowledge and has desires for self-gain and contribution helps to develop IoT even more. They tend to engage in entrepreneurship and intrapreneurship using IoT.

According to (Shafique *et al.*, 2020), IoT is referred to like things and sensors that are intelligent, addressable exceptionally depending on their communication conventions and independent and adaptable with essential security. The author has categorized IoT in three visions:

i. Internet-oriented: a vision that gives attention to the connectivity between objects.

ii. Things oriented: a vision that gives attention to common objects.

iii. Knowledge oriented: a vision that gives attention to representation, storage and organization of information.

IoT opens-up to numerous business opportunities where companies have the chance to build new business methodologies and models to apply the concept. Besides, inventive research opportunities to researchers and investigators of multi-disciplinary fields also have the chance to learn about IoT. Therefore, engineering skills, science, business studies and humanities are all within the scope of IoT. IoT also makes the world a smart world where everything is simply accessible in less time and energy (Shafique *et al.*, 2020).

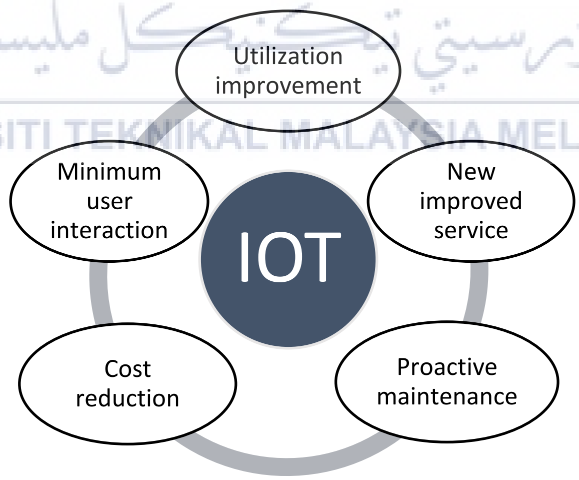

Figure 2.3: Benefits of Internet of Things (IoT)

(Salazar, 2019) defined IoT in three categories such as people to people, people to objects or machines, and things to things, that will be communicating via the Internet. The theory of IoT is that it is omnipresent no matter in any surroundings of humans and objects that interact with each other through wireless or wired links and has unique addressing scheme, which works together with other objects to create new applications and achieve a common target. The aim of the Internet of Things is to allow and support any things and any person to be connected anywhere, anytime with anything using the Internet.

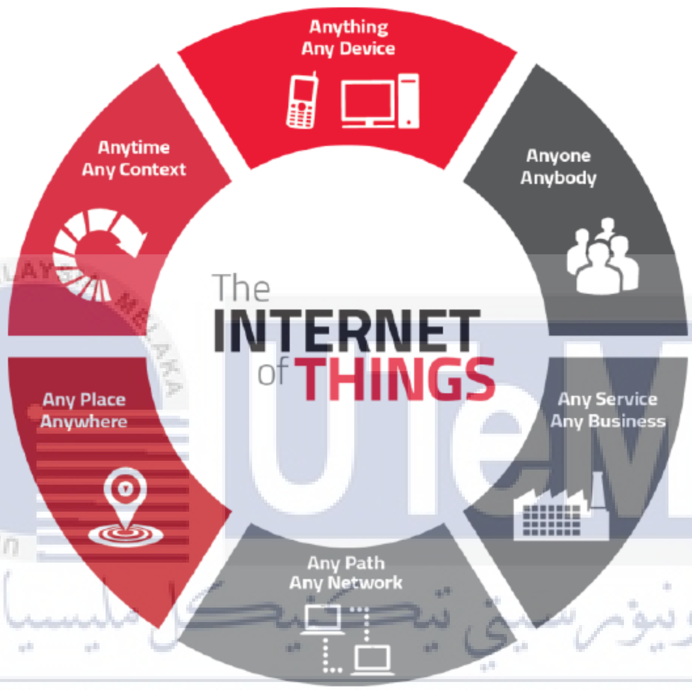

Figure 2.4: Internet of Things (Salazar, 2019)

(Salazar, 2019) also mentioned that the Internet of Things is not a standalone technology, but it is a combination of various hardware and software technology. It gives solutions based on the incorporation of information technology, which refers to hardware and software that includes electronic systems for communication.

Furthermore, the characteristics of IoT are:

i. Interconnectivity – able to connect with global information and communication organization.

ii. Things-related services – able to provide things-related services such as privacy safety between physical and virtual things.

iii. Diversity – different types of hardware are able to interact together in the IoT platform through different networks.

iv. Dynamic variations – the state of devices in IoT are able to change dynamically, for instance, connected and disconnected.

v. A huge scale – a large number of devices are able to connect and communicate with each other.

vi. Protection – safety must be included to protect personal data of users, secure endpoints, networks, and data are being shared across the network.

vii. Connectivity – able to access a network and able to give data.

(Salazar, 2019) stated that the expansion of sensors, smartphones, communications, semiconductor electronics, cloud computing and software is extremely important to enable physical devices to be connected endlessly and perform in changing atmospheres. Hence, the table below shows future developments and research needs of IoT.

Table 2.3: Future developments and research needs of IoT

Technology	Future Developments	Research Needs
Hardware components	-Reduction in size of chipsets -Nanotechnology	-Autonomous circuits -Inexpensive modular devices
Sensors	-Power-saving sensors -Tiny sensors	-Self-powering sensors -Intelligent sensors
Communication	-On-chip antennas	-5G developments

	-Wide spectrum	-Higher frequencies
Network	-Self-learning -Self-organising networks	-Cloud network -Service-based network
Data and signal processing	-IoT complex data analysis -Energy-aware data processing	-Autonomous computing -Energy-efficient data processing
Privacy and security	-Privacy and security profile selection based on the needs -Privacy-aware data processing	-Highly secured, low-cost identification devices
Discovery and search engine	-Automatic route tagging -On-demand discovery service	-Accessible discovery devices for connecting things with services

Internet of Things serves its purpose in various types of fields. IoT has made it possible to develop various applications based on it. The figure below shows the applications of IoT.

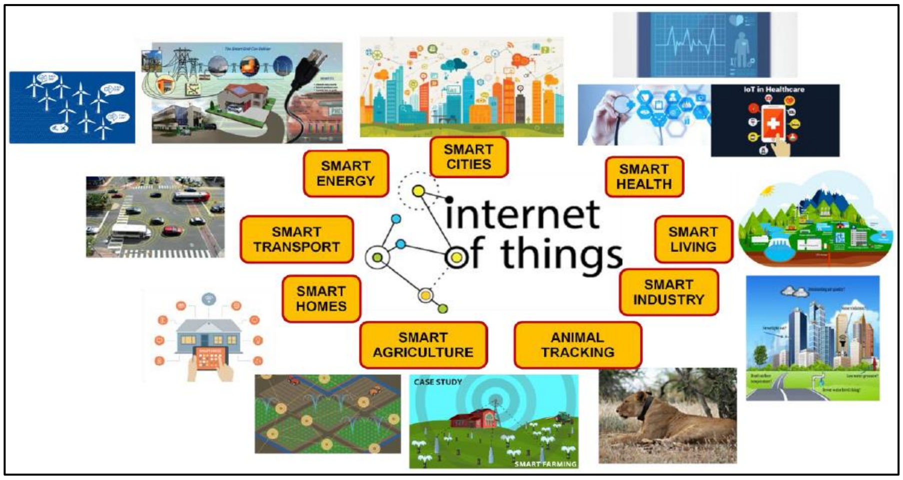

Figure 2.5: Applications of IoT (Salazar, 2019)

In a nutshell, the Internet of Things comprises different types of hardware and software that are connected to the Internet to perform its dedicated purpose. By considering the challenges that will be faced, it is important to design a project with proper planning to achieve the objectives of the project.

2.5 Previous Related Projects

To have a good understanding of the project, the study of previous related projects is important so that fundamental bits of knowledge is gained. This IoT project comprises of smart farming and smart security system. Therefore, this section will be discussing six previous papers that apply a comparatively similar method and have a similar purpose to achieve this paper's main objective.

2.5.1 Smart farming

In the paper done by (Kanjilal *et al.*, 2014), the authors made a study on various ways to do farming. The authors have implemented modified advanced home automation systems on a farm. The automation system proposal consists of several features which include auto-lock and release doors to ensure the security of farm animals so that they do not run away. The author used a keypad system in the safe locking mechanism, where it is opened and closed by an alphanumeric password. The data is then processed by microcontroller 8051 and the relay is triggered by the output from the microcontroller to decide if it is to lock or release the door.

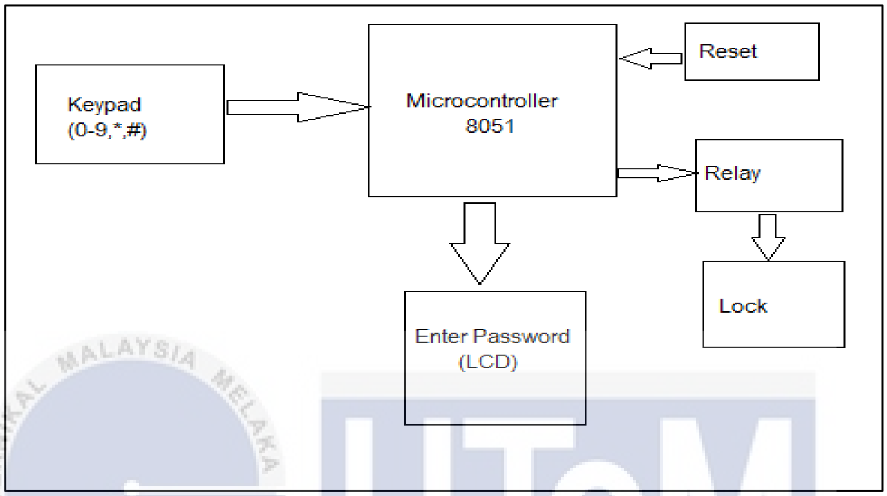

Figure 2.6: Block diagram of auto-lock and release door system (Kanjilal *et al.*, 2014)

2.5.2 IoT-based Smart Farming

In (Phiri, Kunda and Phiri, 2018a), applying the technology of IoT and sensors can help low-income farmers to monitor the surroundings and keep updated on the conditions in the farm. Stock theft can be prevented and enables farmers to take immediate action before the livestock is harmed. Thus, the safety of livestock and the income of the farmer is not affected.

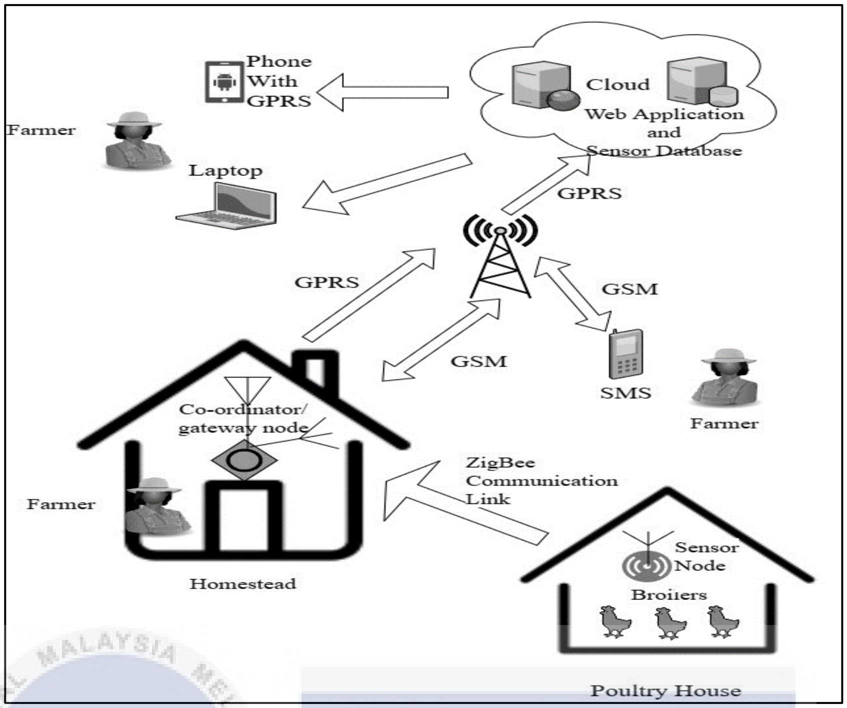

Figure 2.7: Hardware design of IoT model (Phiri, Kunda and Phiri, 2018a)

In this paper, Arduino UNO is used for sensor nodes and gateway. The connection between the farmer, homestead and poultry house is connected by Zigbee, GSM and GPRS. The communication between the nodes in a short distance is done by Zigbee. Besides, communication between remote locations and the farmer's mobile location is via GSM network. GPRS is used to access sensor data from the web application on a phone with GPRS connection and as connectivity the nodes to clouds in the wireless network.

Arduino UNO is equipped with ATMEGA 328p microcontroller and it is placed inside the sensor nodes. Temperature readings and motion detection are done by the microcontroller. Three types of sensors are attached to the Arduino UNO, which are PIR motion detection sensor, DHT11 temperature sensor and lastly ultrasonic sensor which is used to measure the distance of the object triggered by the motion sensor.

XBEE transceiver is used to send the data from sensors to the coordinator/gateway node using Zigbee protocol. To provide a connection to the XBEE transceiver, an XBEE shield of series 2 module is attached to the sensor node. An LCD is connected to an Arduino Mega which is used to provide more input and output pins. The temperature and motion values from the sensor node are received by the coordinator and it is then displayed on the LCD. A buzzer is attached to the coordinator to generate an alarm sound.

Next, the software design is set in the sensor node that has a C/C++ program using Arduino IDE. Motion detection and measurement of the distance from the sensor node to the object is observed by the program. The current temperature and alarm trigger are sent to the coordinator node by the sensor node. The alarm variable is set to no trigger if nothing takes place. The values that are received at the coordinator node is compared with the pre-set values. The buzzer is alerted and a message is sent to the farmer via SMS and sent to the cloud via GPRS if the temperature is not equal to the threshold value.

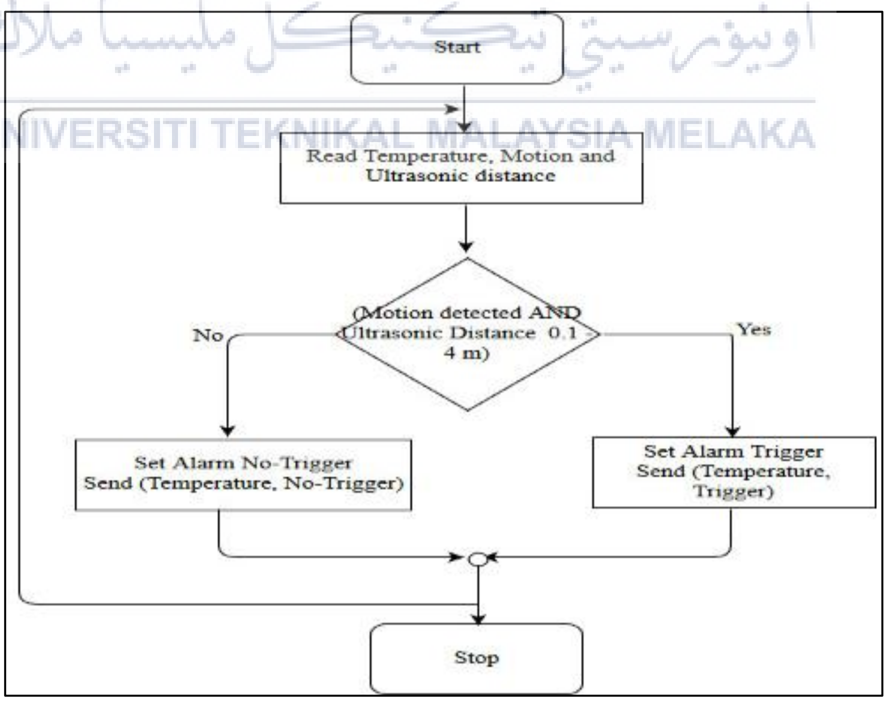

Figure 2.8: Sensor node software logic (Phiri, Kunda and Phiri, 2018a)

On the contrary, for the intruder detection, the buzzer is alerted if the variable is set, and the farmer is notified by phone call and SMS.

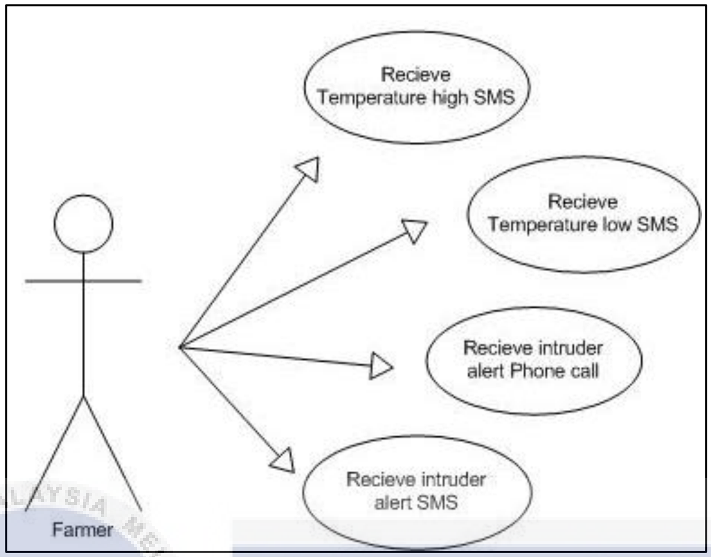

Figure 2.9: Communication between farmer and mobile phone (Phiri, Kunda and Phiri, 2018a)

A device consisting of a web browser and Internet connection is required for the farmers to access the sensor data from the poultry house.

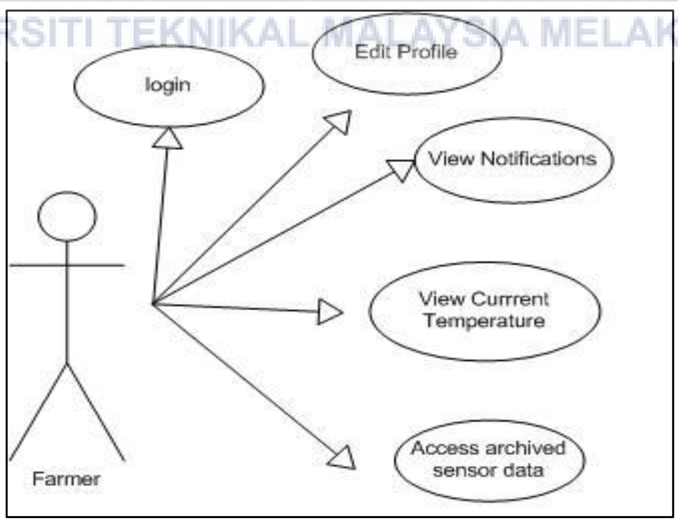

Figure 2.10: Communication between farmer and web application (Phiri, Kunda and Phiri, 2018a)

2.5.3 Farm Monitoring System

In (Onwuka *et al.*, 2018), the author designed a security system architecture that consists of several sensors, surveillance facilities and a base station that communicates with each other and come up with a decision. This is to help farmers who build fences using sticks and ropes around their farm, which is not reliable to secure their poultry farm. The system is built up based on WSN and by using processor board, intrusion detection sensor, camera and alarm. To alert the presence of intruders, the circuit will have an input signal when intruders come in contact with the camera's view. Once the system is initiated, the alarm will be turned on for the purpose of scaring away the intruders to leave the farm. But if the intruder stays at the place longer than 30 seconds, an SMS will be sent to the farmer using GSM module. Moreover, a metallic sensor is used to detect if a human intruder is armed with metallic objects like a knife, gun, etc.

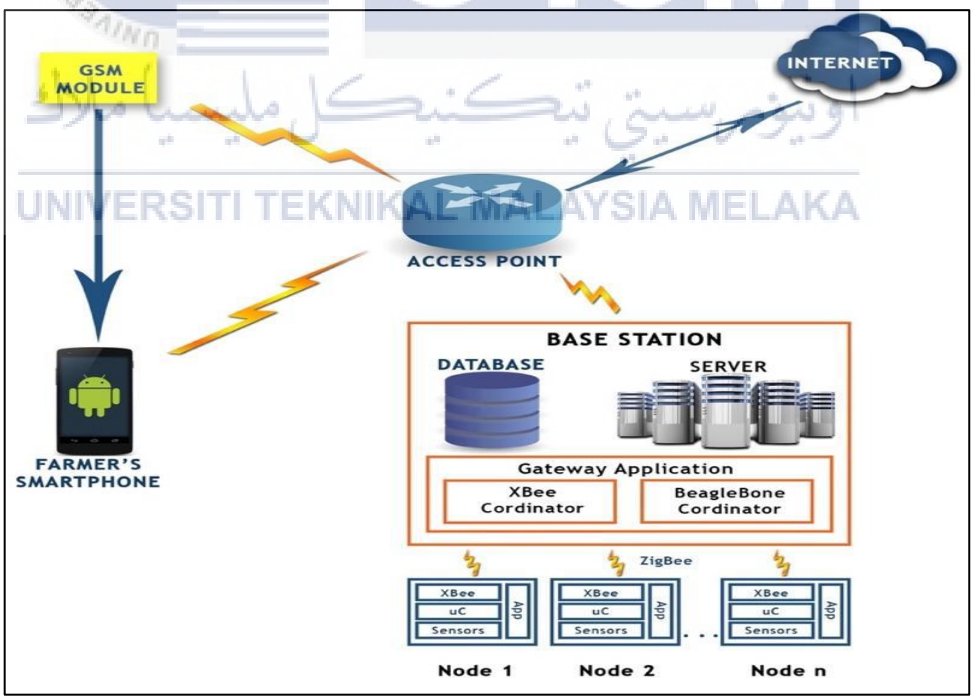

Figure 2.11: Overall system architecture of the farming monitoring system (Onwuka *et al.*, 2018)

Based on the figure above, all equipment is installed at the base station. Each node has a Zigbee radio transceiver, microcontroller and sensors. Values are read at uniform intervals by the sensing node and it is forwarded to the coordinator. XBee modules are configured as a coordinator and routers in base station and sensor nodes respectively. Beaglebone coordinator is connected to the Internet. Beaglebone is a small, open-source hardware single-board computer that can perform all operations using any computer device. Serial interface connection is used to communicate with gateway/coordinator and all accepted values will be sent to Beaglebone for processing. In addition, CCTV is also installed to detect the nature of intrusion whether it is a human being or animal.

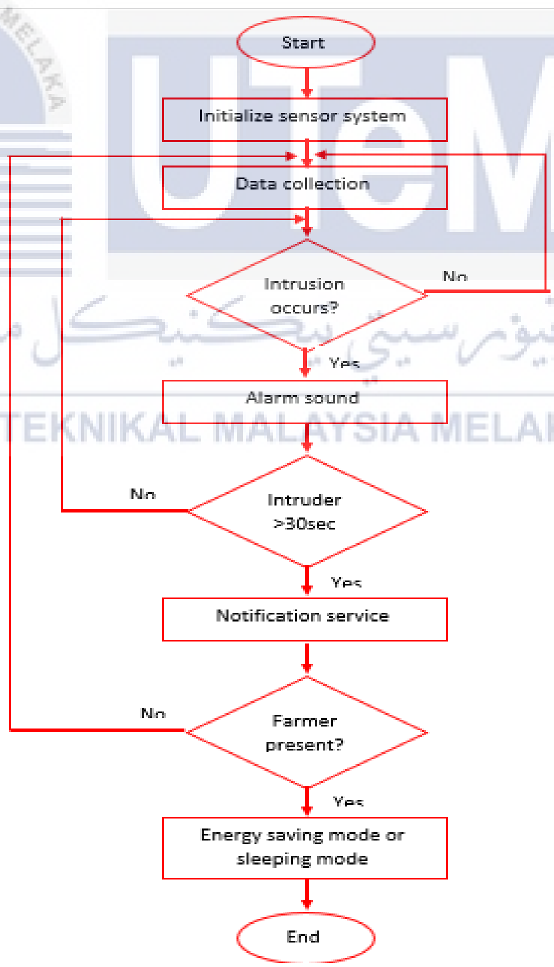

Figure 2.12: Flowchart of the system (Onwuka *et al.*, 2018)

As shown in the flowchart, an intrusion is checked by sensor systems, and information is collected in real-time. If it is detected, an alarm is turned on to scare the intruder away, but if the presence is longer than 30 seconds, the farmer is notified via GSM module and the image is captured.

2.5.4 Iot Enabled Home with Smart Security

In (Chandra, Kumar and Sureshbabu, 2018), the author had designed the project using Raspberry Pi, LM35 temperature sensor, light dependant resistor, PIR sensor with magnetic door switch, smoke sensor, camera, ADC module and LAN connection that are interfaced to the GPIO pins on the pi board.

The intruder's entry is detected by the PIR sensor which generates an electrical signal, and it is fed as an input signal to the pi to trigger the camera to capture the image of the intruder. Then, the image is sent to the owner's mail through LAN. Each of the sensors is used to sense the condition in the house. The sensor values are converted into digital value by the ADC module. These digital values are continuously transmitted to the owner by Message Queuing Telemetry Transport (MQTT) lightweight messaging protocol. The values are shown in the form of graphs in respective fields. By depending on the sensor values, switching ON and OFF home appliances is done by sending commands through the talkback app in thingspeak.com.

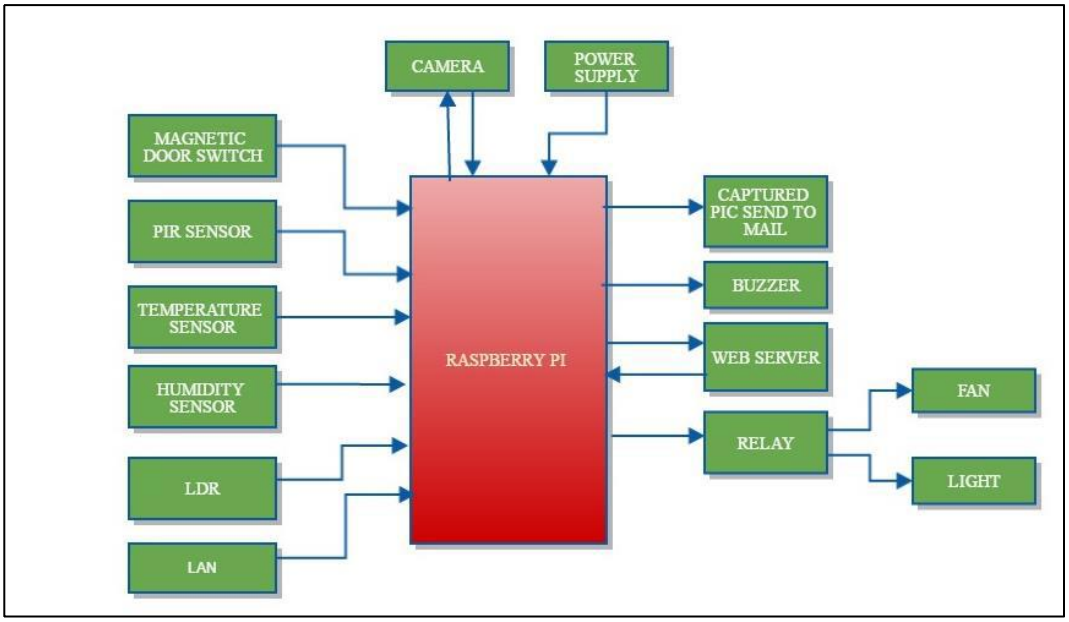

Figure 2.13: Block diagram of the system (Chandra, Kumar and Sureshbabu, 2018)

2.5.5 Security System in Smart Farming

In (Islam *et al.*, 2019), the author has made a proposal to ensure overall surveillance of farmhouse by including safety measures such as the anti-thief system and fire protection. Data is stored through IoT to enable users to take precautionary steps before any harm occurs. In this project, a GSM module is used to notify the farmer in real-time through an SMS to provide real-time protection at any dangerous circumstances. Motors, a microcontroller and a few sensors are used to implement the smart poultry farming system. Arduino UNO is used and it is connected with GSM module, sensors, buzzer, LED display, Wi-Fi module and motor relays which are operated according to the output obtained from the surrounding of the farm.

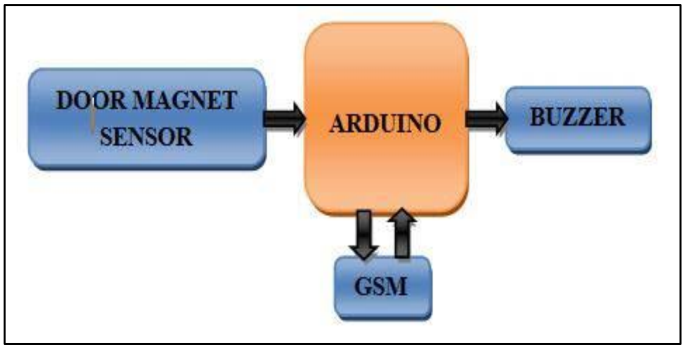

Figure 2.14: Block diagram of the security system (Islam *et al.*, 2019)

Activation and deactivation can be done using a mobile phone. A door magnet sensor is connected to the main gate of the farm. Thief detection mode is activated using an SMS (100) as the password when the farm owner is not in the farm. After the device is activated, the buzzer is turned on and an SMS is sent to the farmer and nearest police station if anyone tries to open the door. The mode can be deactivated when the farmer sets another password for example (101).

2.5.6 Security Alarm System for Smart Home

In (Tanwar *et al.*, 2017), the authors have proposed a project to detect an intruder or any strange event at home when nobody is there. A small PIR module and Raspberry Pi are utilised to shorten the delay during the process of e-mail alert. The authors have also mentioned that the security system that is implemented must be capable to send an alert to the user without any delay by phone, text or email. This framework is used when the user is not at home. When a thief is present, his movement is detected by the PIR sensor and flagged to Raspberry Pi. Another segment is flagged by Raspberry Pi once it has processed the information received. A camera is used to take a picture of his action and the picture is sent back to the Pi which will then send an email to the house owner. The email address is already been registered. Email is sent through IMAP. Raspberry Pi is connected to the Internet using a RJ45 or Wi-Fi module. House owner is still alerted even they are outstation as they can take action by calling their neighbour or police.

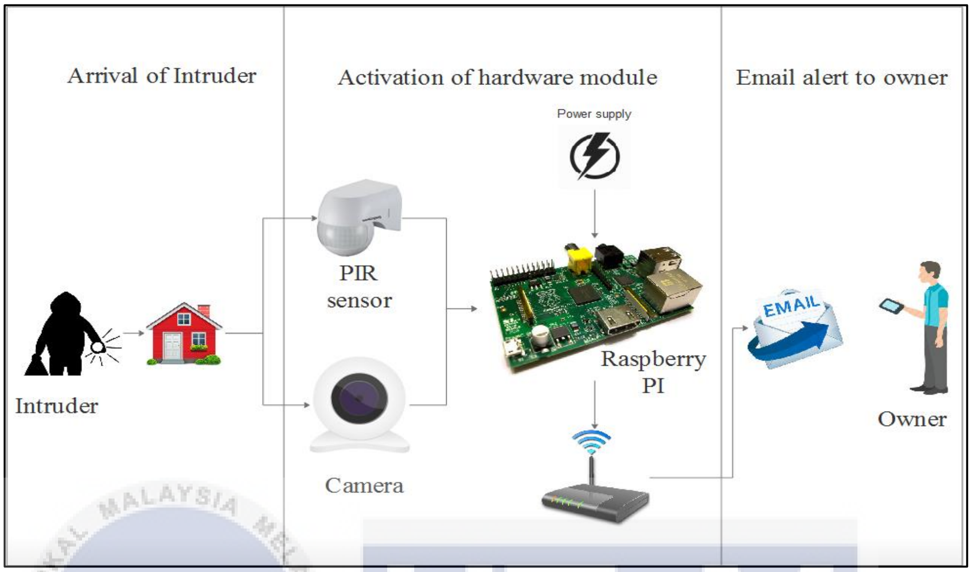

Figure 2.15: Architecture of proposed approach (Tanwar *et al.*, 2017)

2.6 Comparison of previous related projects

Based on the previous research papers that have been discussed, there are some differences can be discussed and compared in terms of the methods used. Therefore, Table 4 below shows the comparison between the research articles in terms of techniques, advantages and disadvantages.

Table 2.4: Comparison of previous related research articles

No	Authors	Technique used	Advantages	Disadvantages
1	(Kanjilal *et al.*, 2014)	IR sensor, Microcontroller, LCD, relay	-Secures the farm's entrance door	-Introduce alarm or siren to alert the farmer

2	(Phiri, Kunda and Phiri, 2018)	Arduino, XBee transceiver, DHT11 temperature sensor, PIR sensor, Ultrasonic sensor, GSM, LCD, Buzzer	-Save cost -Guaranteed notification using GSM	-Introduce a camera
3	(Onwuka *et al.*, 2018)	Zigbee radio transceiver, microcontroller, sensor, Beaglebone, GSM, alarm	-Low-cost -Guaranteed notification using GSM.	-Can use either one gateway, Zigbee or Beaglebone
4	(Chandra, Kumar and Sureshbabu, 2018)	Raspberry Pi 3, LM35 sensor, LDR, PIR sensor, ADC module, camera	-Provides security and also monitoring system -Easy to use	-Notify through SMS or an application to make sure the owner receives an alert on time.
5	(Islam *et al.*, 2019)	Arduino, GSM, sensor, buzzer,	-Easy to design and use	-Introduce a camera

		LED, Wi-Fi, motor	-Save cost	
6	(Tanwar *et al.*, 2017)	Raspberry Pi, PIR sensor, Camera,	-Provides high security -Efficient notification alert	-Can notify the user through SMS or using an application

After a thorough reading and observation done on the previous papers, it is understandable that the traditional microcontroller brings a lot of disadvantages compared to the Arduino and Raspberry Pi as they are the advancement from the old technology. Hence, it is safe to say that Raspberry Pi technology is the best concept that can be implemented in this project due to its faster clock frequency and practical specifications.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter presents the method of how this project will be carried out to achieve the stated objective. There are three parts in this chapter, which are study design and elaboration of process flow and hardware specification. To ensure the flow of the project is uninterrupted, a detail research on the hardware was made to have better knowledge regarding the best equipment to use. To get an overall view on this project flowchart was created. The process flow is then elaborated in detail and followed by hardware specifications. Lastly, a diagram of connection of the project is shown and discussed.

3.2 Study design

The purpose of this project is to develop a smart anti-intruder system for Malaysian farming community. Raspberry Pi is used as the brain of this project. The type of Raspberry Pi that is used is Raspberry Pi Zero. Besides, a PIR sensor is used to detect the presence of intruder and a camera is installed to capture the image or nature of the intruder. The software that is used in this project is Raspbian, which is the operating system of Raspberry Pi and Python software for coding.

First, a flowchart on the tasks of this final year project is shown to ensure each of the tasks is taken and implemented with focus and in detail. Next, a flowchart is created to illustrate the step-by-step procedures that are done to carry out this project.

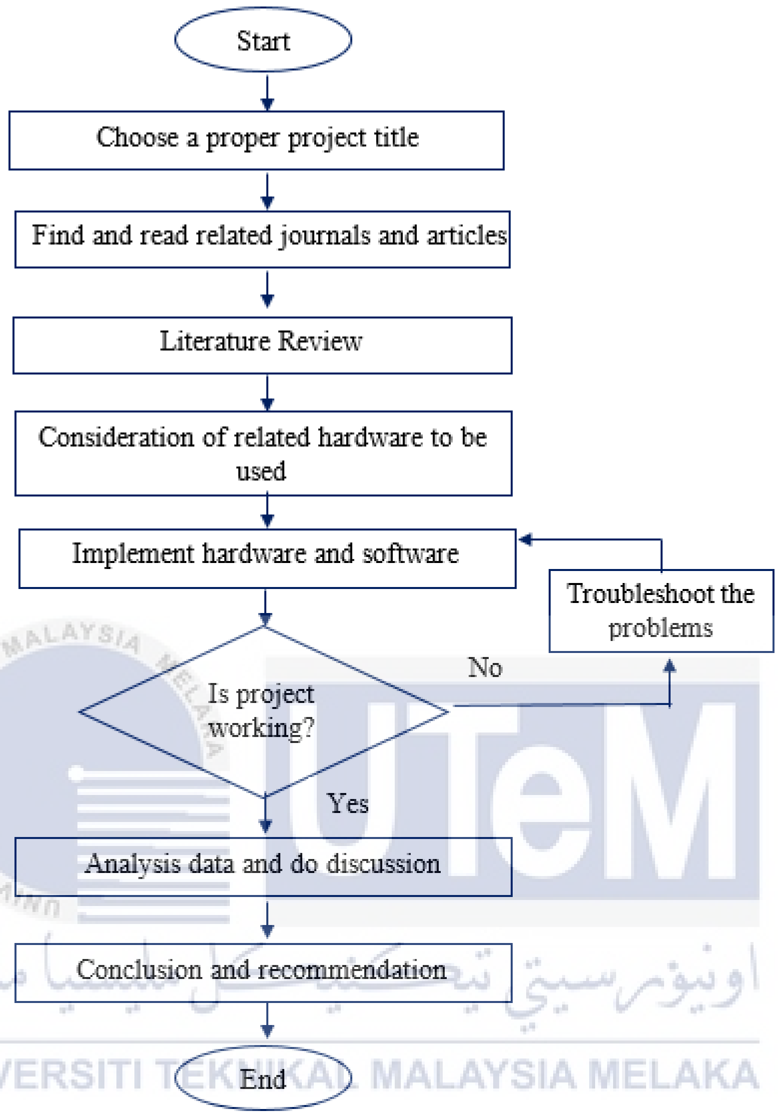

Figure 3.1: Flowchart of final year project implementation

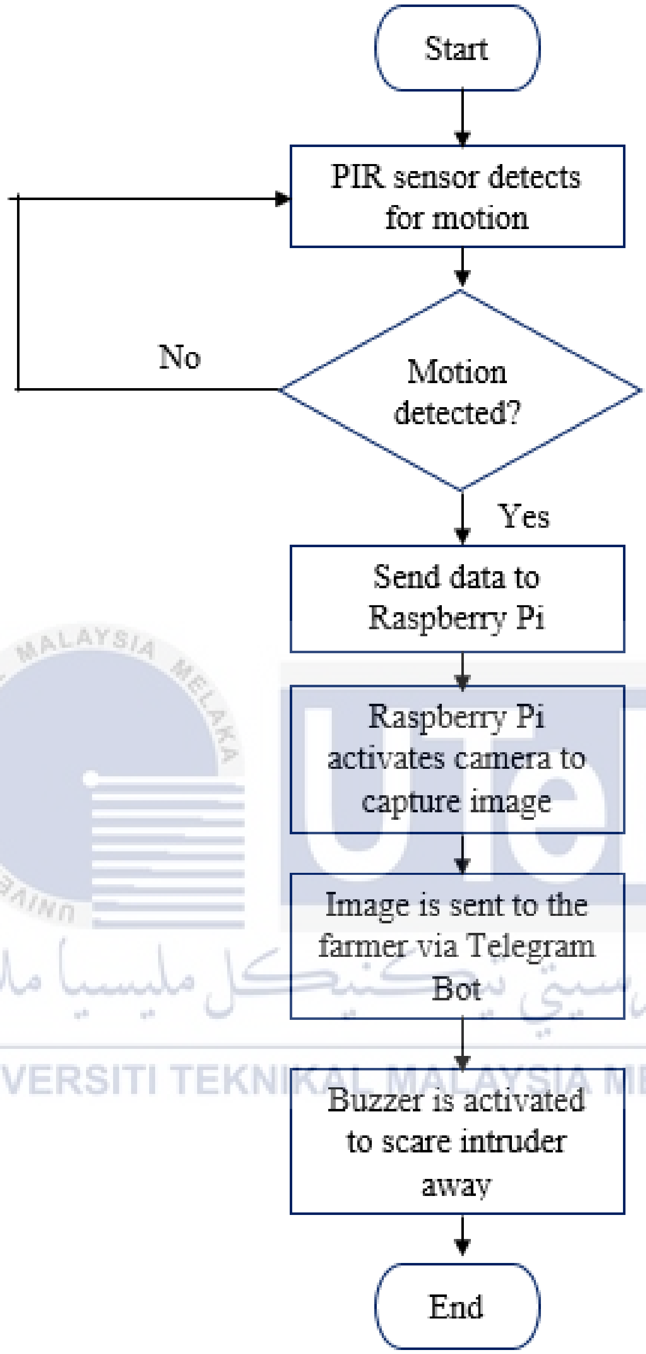

Figure 3.2: Steps of smart anti-intruder system implementation

3.3 Elaboration of process flow

The project started off with the detection of motion at the farm. Passive Infrared Sensor (PIR) consists of a pair of pyroelectric sensors that are used to detect heat energy in the surrounding atmosphere. The pair is placed side by side. The sensor is engaged when the two signals differential between the two sensors is changed, for example, when a person enters the farmhouse. Then, the data is transmitted to Raspberry Pi. Raspberry Pi Zero is a small credit card-sized computer that is connected to a computer. The operating system of Pi is Raspbian and the Pi is coded in Python language. The data is then read and processed by Pi to activate the camera to capture the image.

The captured image is sent to the farmer via Telegram Bot application that is installed on the farmer's smartphone. A buzzer is then alerted to alert the surrounding area and also to scare the intruder away. Lastly, the farmer is notified about the incident and the farmer takes appropriate action.

3.4 Hardware specifications

3.4.1 Raspberry Pi Zero WH

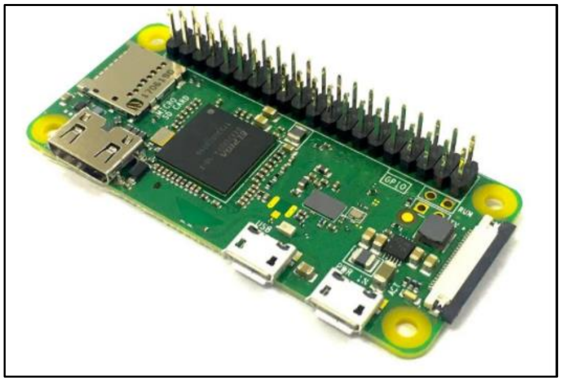

Figure 3.3: Raspberry Pi Zero WH (Ecosystem and Pi, 2021)

The Raspberry Pi Zero WH (Wireless with Header) comes with Wi-Fi and Bluetooth, and it is pocket-friendly compared to other types of Raspberry Pi, and yet it is compatible with any project. The dimension of Pi Zero WH is 65mm x 30mm x 5mm. The processor used is BCM 2835 SOC and the clock speed is 1GHz. It contains 512MB RAM and for external memory, a micro SD can be used. Pi Zero is powered up by micro USB. Mini-HDMI is used for display and audio. The board consists of 2 USB ports, where one is used for power and the other one is used for power and data. Furthermore, it has 40 pre-soldered GPIO pins connector which is used for inputs and outputs. It also has a CSI camera connector interface where cameras are interfaced for use.

Comparing Raspberry Pi with Arduino, Raspberry Pi is more powerful than Arduino because the clock speed is 40 times faster than Arduino. Arduino is a microcontroller, whereas Raspberry Pi is a mini-computer. In Arduino, only one program is executed again and again, contrarily, multiple programs are able to be executed at a time. Since this project requires real-time notification, Raspberry Pi is better than Arduino.

3.4.2 PIR sensor

Figure 3.4: PIR sensor (SN-PIR User's Manual, 2020)

Passive Infrared (PIR) sensor is a motion detector sensor. It measures changes in the level of infrared emitted by surrounding objects. A digital output (HIGH) is given at the input output (I/O) pins when motion is detected. 5V to 20V DC is required to operate the sensor. The delay time is adjusted according to the parameter needed.

There are two slots in the PIR sensor which are made of a material that has IR sensitivity. When a warm object such as human or animal passes by, one half of the PIR sensor is interrupted and a positive differential change is produced between the two halves. Oppositely, a negative differential change is generated when the warm object leaves. These changes pulses are what is detected.

The reason why the PIR sensor is used in this project is that the presence of intruder need to be detected in order to keep the farmhouse secured. The sensor sends an electronic signal to the Raspberry Pi to trigger the alarm.

3.4.3 Raspberry Pi Camera Module

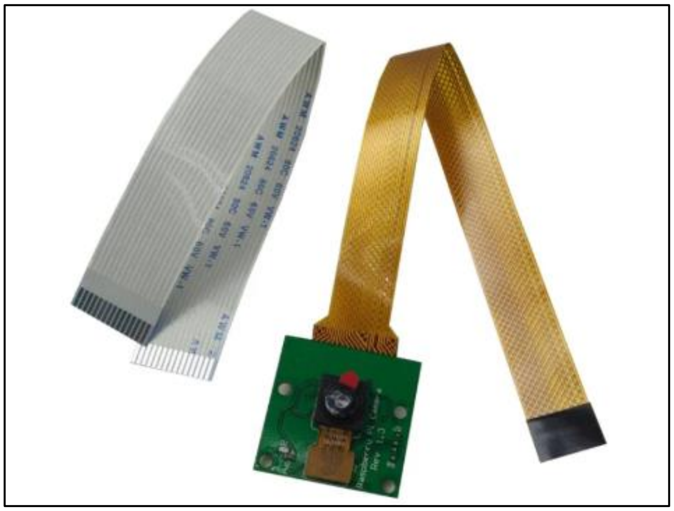

Figure 3.5: Raspberry Pi Camera Module (Ecosystem, 2020)

The camera module is used to capture the image of the intruder. The dimension of the tiny board is 25mm x 20mm x 9mm and its weight is around 3grams. The camera is connected to the BCM2835 processor on the Pi via the camera serial interface. It is attached using FFC (Flexible Flat Cable) cable. Moreover, this camera is supported in the latest version of Raspbian. The resolution of the camera is 5MP (Megapixels) and the video is 1080p, which is a full high definition format.

This camera is versatile as it is compatible with all types of Raspberry Pi, which includes Raspberry Pi Zero W. Therefore, it is suitable to be used in this project after considering the features and specifications.

3.4.4 3-12V Buzzer

Figure 3.6: 3-12V Buzzer

Buzzer is used as an alarming system to scare away the intruders. Piezo buzzer is an audio signalling device which is powered using piezoelectricity. Piezoelectric is created using a material that produces an electric charge when placed under mechanical stress.

3.5 Connection diagram of the project

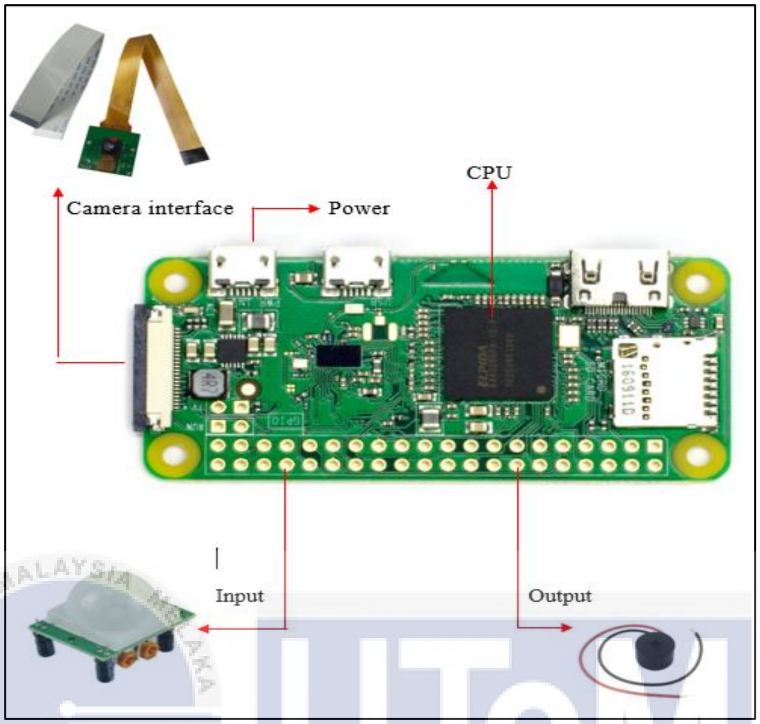

Figure 3.7: Diagram of project implementation

The figure above shows the connection of the hardware to the Raspberry Pi. Raspberry Pi is powered using a USB cable with 5V 2.5A. An appropriate voltage supply is required to prevent the SD card from being corrupted. The motion detected by the sensor will be the input to the RPi. The data is then processed by the Broadcom BCM2835 CPU. The camera is then activated by the RPi to capture the image of the intruder. The camera is connected to the processor on RPi via CSI (Camera Serial Interface) bus. The buzzer as the output is alerted to scare away the intruder. The captured image is sent to the farmer and notified via Telegram Bot about the incident.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 Introduction

This chapter illustrates the overall model of the anti-intruder system in terms of software and hardware and discusses briefly on the implementation of this project. Prototype development is shown and discussed. Analysis of motion detection after testing at different distances and speed of detection are shown and explained.

4.2 Software development

Telegram Bot is used to receive notification from Raspberry Pi to the owner. First and foremost, Telegram Bot is a third-party application that runs in Telegram application. It enables users to integrate with devices and send commands and receive messages. Each Telegram Bot is given a special authorization token called API token that is used in programming to connect to the hardware. In this project, Telegram Bot is used to receive image of intruders to notify the user. Once motion is detected, the image is captured by camera module and the image is sent immediately to Bot. This will help farmers to be alert on the surrounding of the farm.

A Bot account is created by communicating with BotFather. BotFather is used to create new bot account and manage existing bots. First, a '/start' command is sent to initiate the conversation. Command '/newbot' is sent to create new bot account. Then, a bot name and username are created. Once a new bot is created, a unique authorization token is provided that can be used to communicate with Raspberry Pi.

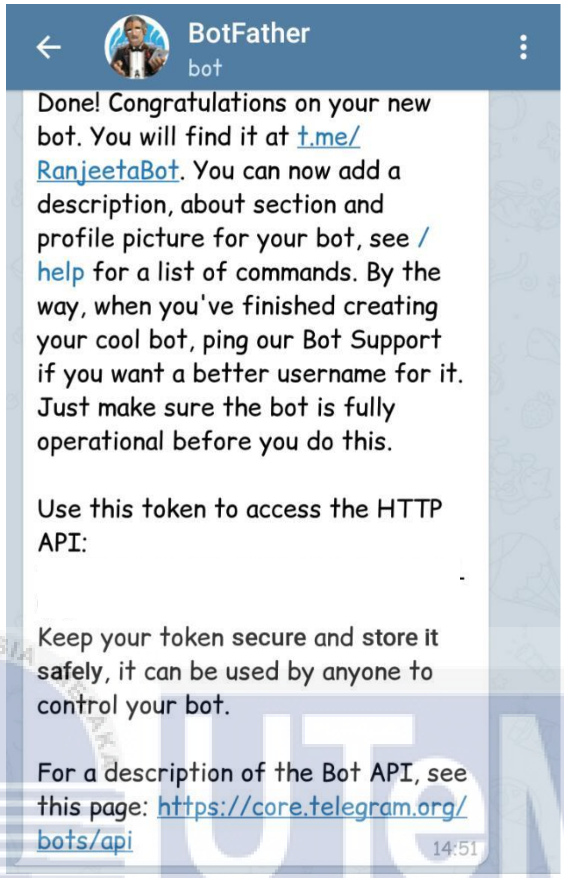

Figure 4.1: Telegram Bot

```
from gpiozero import MotionSensor
from picamera import PiCamera
import telepot
import RPi.GPIO as GPIO
from time import sleep
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
buzzer=24
GPIO.setup(buzzer,GPIO.OUT)

bot = telepot.Bot(':                                         ')
chat_id=1169394641

pir = MotionSensor(4)
camera = PiCamera()
camera.capture('./capture1.jpg')
camera.close()

```

```python
while True:
    if pir.wait_for_motion()==True:
        print("Motion detected!")
        bot.sendMessage(chat_id, "ADA ORANG!")
        bot.sendPhoto(chat_id=chat_id, photo=open('./capture1.jpg', 'rb'))
        GPIO.output(buzzer,GPIO.HIGH)
        print("Beep")
        sleep(3)
        GPIO.output(buzzer,GPIO.LOW)
        print("No beep")
        sleep(1)
    else:
        pir.wait_for_motion==False
```

Figure 4.2: Coding of the project

The programming software used in this project is Python, which is in the Raspbian software. Figure 4.2 shows the Python coding of the project. The program is initiated by libraries and functions that is used in the coding. The libraries must be imported by name at the top of the file. Motion sensor file interface is imported from GPIO Zero while Pi Camera interface is imported from Pi Camera. Next, GPIO is set as Broadcom (BCM) pin numbering for the GPIO pins. Motion sensor is connected to BCM 4 and buzzer is connected to BCM 24 and it is set as GPIO output.

Adding on, Telepot is installed to enable RPi to communicate with Telegram Bot API. The Bot token is hidden as it need to be kept confidential because anyone who has the token will have access to the Bot account. Then, motion sensor is set at BCM pin number 4. Command ‘camera.capture’ is used to capture image and the output file is specified as ‘capture1’. The camera is terminated by the command ‘camera.close’.

The main program is run in while loop which contains if-else statement. When the while loop is running, if the ‘if’ expression is true, the statement inside the body is executed. Contrarily, if the expression is false, the ‘else’ statement is executed. In this project, when motion is detected, the ‘if’ statement is executed where the text ‘Motion detected’ is displayed and ‘bot.sendMessage’ and ‘bot.sendPhoto’ command are used to send ‘ADA ORANG’ text and the captured image to Telegram Bot. At the same time, buzzer is activated to buzz for 3 seconds by setting GPIO.HIGH. The buzzer is stopped by setting GPIO.LOW. No action is done when the ‘else’ statement is executed.

4.3 Hardware development

The hardware used in this project are Raspberry Pi Zero WH, Raspberry Pi camera module, PIR motion sensor and buzzer. The hardware configuration is shown in Figure 4.3.

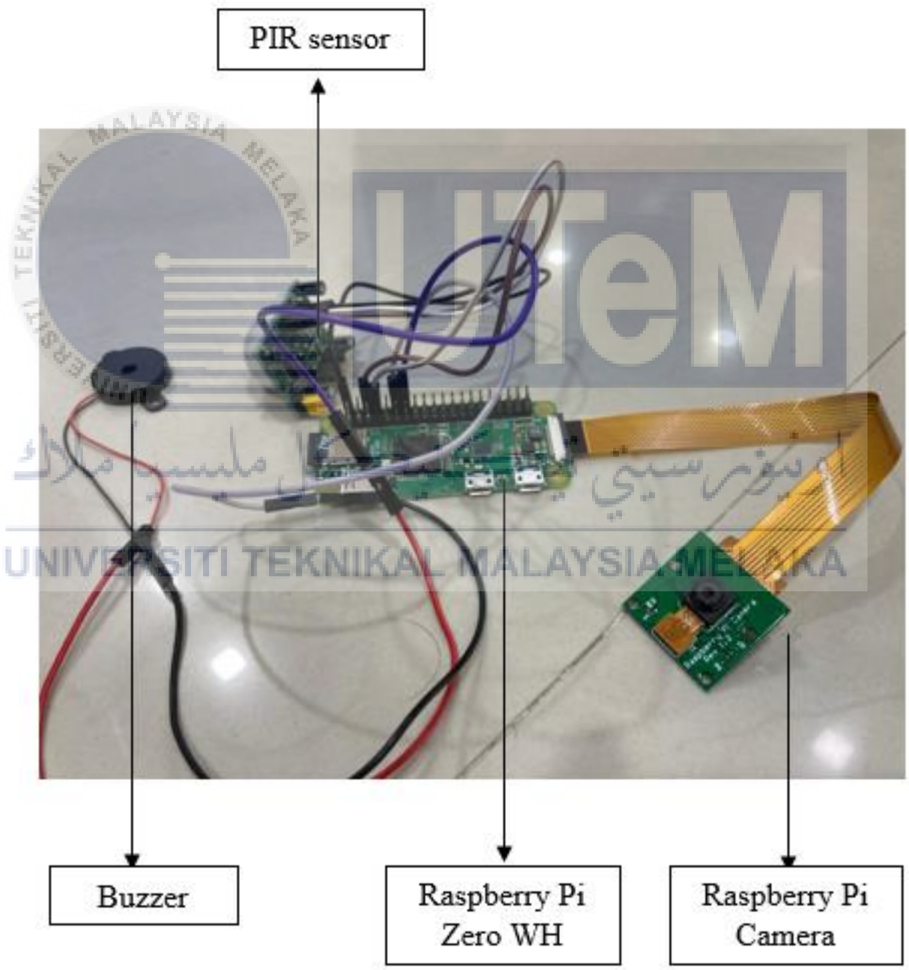

Figure 4.3: Hardware connection

Raspberry Pi camera module in interfaced to the camera serial interface on the Raspberry Pi board. Motion sensor has 3 pins which are VCC, GND and OUT pins. VCC pin is connected to 5V pin, GND to Ground pin and OUT to BCM number 4 pin. Buzzer has 2 wires, red and black wires. Red-coloured wire is connected to BCM 24 while black-coloured wire is connected to ground. Figure 4.4 shows the connection diagram for clearer wire connections image that is created using Fritzing software.

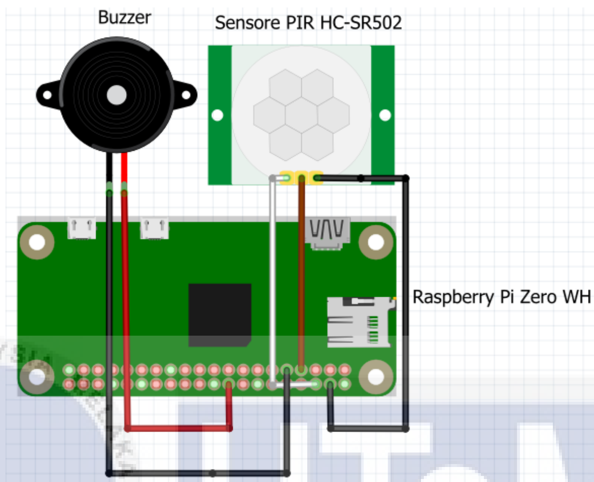

Figure 4.4: Connection diagram

4.4 Prototype development

Figure 4.5: Prototype development

Figure 4.5 shows the prototype model for anti-intruder system. The house is modelled as a farmhouse. Motion sensor and camera are placed at the entrance of the house. The buzzer is placed at the back of the house.

4.5 Interface of the system

The smart anti-intruder system using Raspberry Pi is designed for poultry farming only. This system is able to run continuously if the right amount of power is supplied. The workflow of this project is stated in this section.

At first, the farmer need to turn on the system by connecting it to a laptop. Once the system is turned on, the farmer need to wait few seconds for the Raspberry Pi to boot and to connect automatically to the pre-configured Wi-Fi signal. Important part is that the Wi-Fi signal that is configured in the Raspberry Pi has to be the same as the Wi-Fi connected to the laptop. Once it is connected, VNC Viewer need to be opened in order to access Raspberry Pi desktop.

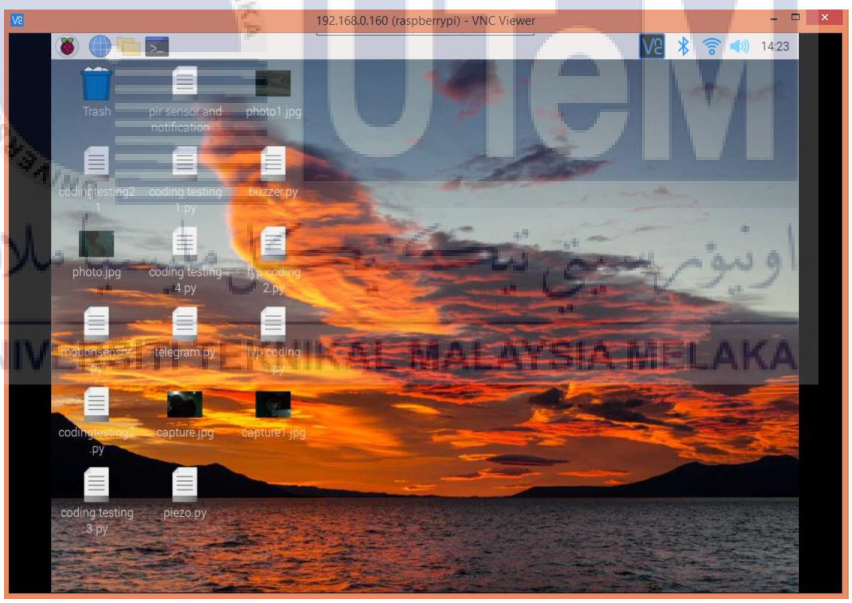

Figure 4.6: Raspberry Pi desktop of Raspbian software

Next, the python file that consists of program need to be opened. Once coding has started running, the hardware of the project is activated to run as well.

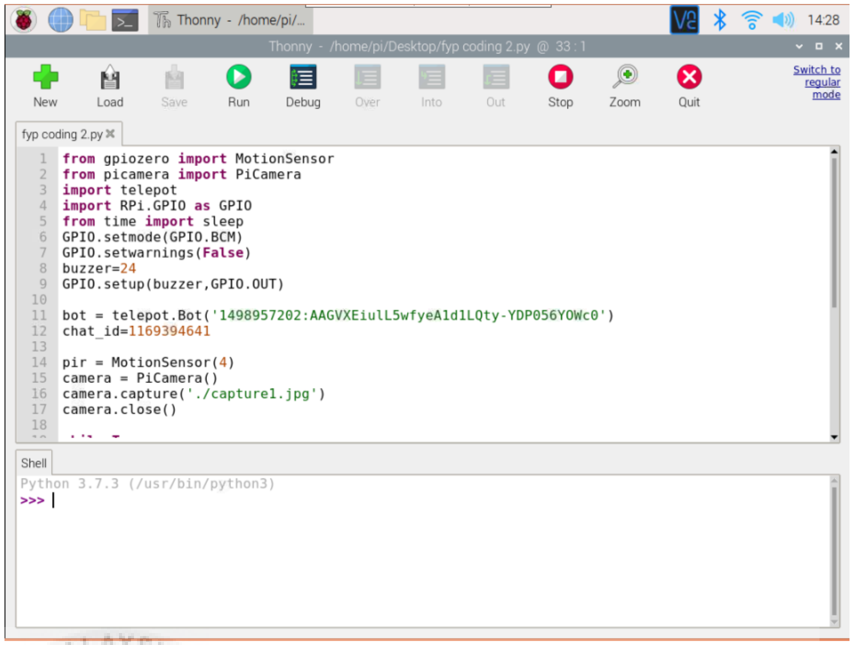

Figure 4.7: Python file of project

Motion sensor will wait for any motion to be detected. Once detected, it will display ‘Motion detected!’ and buzzer is activated to buzz.

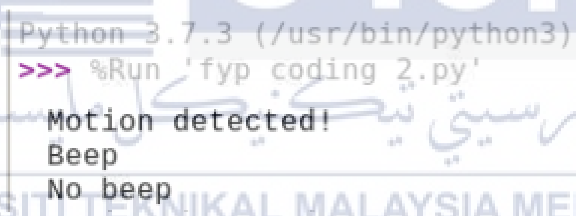

Figure 4.8: Output display in Raspbian OS

Notification in the form of a message and an image are sent to Telegram Bot of farmer. Farmer is required to install and create a Bot account in order to receive real-time notification.

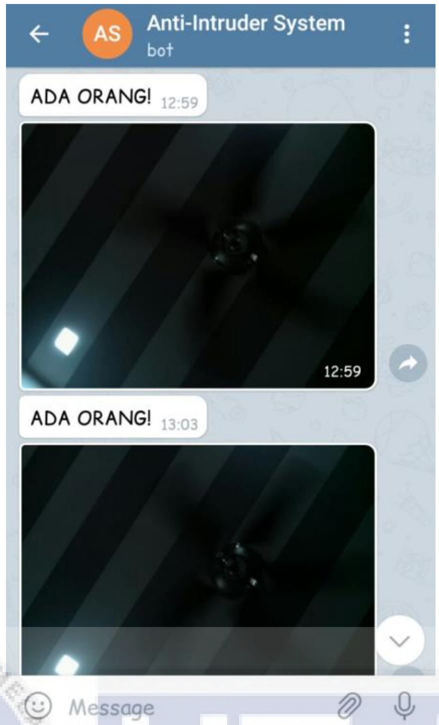

Figure 4.9: Telegram Bot notification

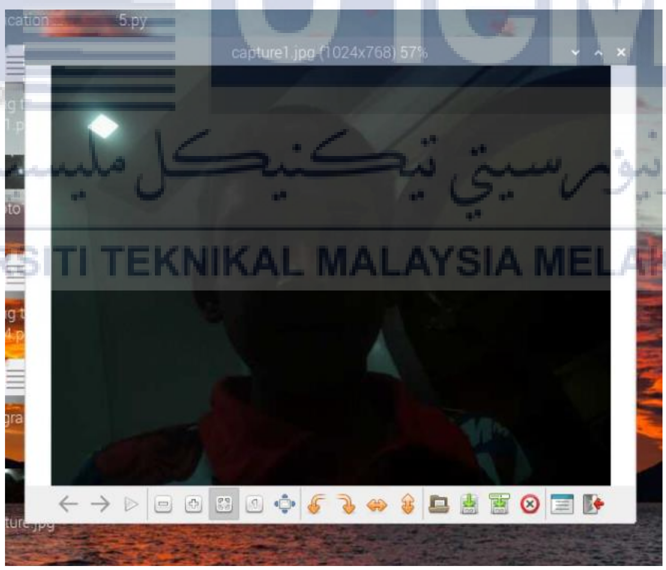

Figure 4.10: Image of intruder

4.6 Data analysis

An analysis is done to study the effect of distance to the level of motion detection. First, the sensitivity is set to the lowest. Distance is taken up to 2 metres due to space constrain.

Figure 4.11: Distance from the motion sensor

At low sensitivity, the sensor is able to detect up 2 metres and at 1 metre range, the angle of detection is wider compared to angle at 2 metres. Besides, the sensitivity is set to high. It is observed that the sensor is able to detect at distance more than 2 metres.

Another analysis is done where the system is turned on for fifteen (15) minutes to analyze the speed of detection of the sensor and speed of notification. The table below shows the reading taken at every two minutes.

Table 4: Analysis table

Minutes	Speed of detection	Speed to send picture
2 minutes	0.7s	0.5s
4 minutes	0.8s	0.5s

6 minutes	0.8s	0.5s
8 minutes	0.9s	0.5s
10 minutes	1s	0.8s
12 minutes	1s	0.7s
14 minutes	1.2s	0.8s

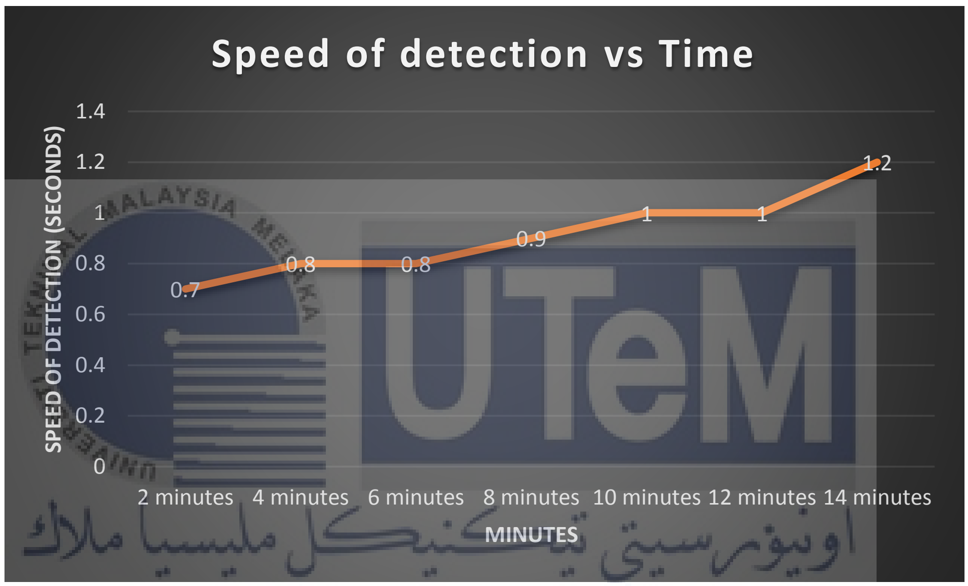

Figure 4.12: Graph of speed of detection taken every 2 minutes for 15 minutes

Based on the data collected in Table 4, a line graph is plotted against speed of detection in 12 minutes using Excel. From the graph, it can be seen that the range of speed is between 0.7 seconds to 1.2 seconds. Therefore, it can be concluded that the speed of detection is fast because it is able to detect at around 1 second, thus provide real-time notification.

CHAPTER 5

CONCLUSION

5.1 Introduction

The overall project implementation is concluded and future recommendations are suggested in this chapter.

5.2 Conclusion

In Malaysia, the most consumed meat is chicken meat. The safety of a poultry farm need to be given importance as it is the main source of income for farmers and also in order to supply food source to the people. Therefore, a security system would be a good solution to prevent any intrusion to occur. This system is incorporated with both hardware and software components to perform an anti-intruder system. The hardware used are PIR sensor, Pi Camera and Raspberry Pi. The Pi Camera is interfaced with Raspberry Pi to capture image once motion is detected by the motion sensor. On the other hand, software involved are Thonny Python and Telegram Bot. Python is a readily installed programming language in Raspberry Pi which enables fast execution of programming. Telegram Bot is a third-party application that runs in Telegram application. It enables users to integrate with devices and send commands and receive messages. It also helps in real-time notification.

The objectives of this project are achieved as the smart anti-intruder system using Raspberry Pi is successfully developed. The developed project is able to detect the presence of an intruder and notify the farmer using smartphone. The performance of the developed system is analysed by observing the response time for motion detection. This system is an effective security system as it alerts the farmer about intrusion on real-time. Lastly, all the results obtained are collected and attached.

5.3 Future recommendations

Although the developed system prevents any intrusion to take place, there are still room for improvements. Latest version of Raspberry PIs can be used to improve the performance of the system as Raspberry Pi Zero WH has only 512MB RAM which causes lagging issues and also it is not able to run many programs at a time. Besides, video recording feature can be added to watch the movement and action of the intruders. More motion sensors can be added to enable wider coverage of detection. Lastly, a light house concept feature can be added to give warning to the intruders.

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APPENDIX

```
from gpiozero import MotionSensor

from picamera import PiCamera

import telepot

import RPi.GPIO as GPIO

from time import sleep

GPIO.setmode(GPIO.BCM)

GPIO.setwarnings(False)

buzzer=24

GPIO.setup(buzzer,GPIO.OUT)


bot = telepot.Bot('1498957202:AAGVXEiulL5wfyeA1d1LQty-YDP056YOWc0')

chat_id=1169394641


pir = MotionSensor(4)

camera = PiCamera()

camera.capture('./capture1.jpg')

camera.close()


while True:

    if pir.wait_for_motion()==True:

        print("Motion detected!")

        bot.sendMessage(chat_id, "ADA ORANG!")

        bot.sendPhoto(chat_id=chat_id, photo=open('./capture1.jpg', 'rb'))
```

```
    GPIO.output(buzzer,GPIO.HIGH)
    print("Beep")
    sleep(3)
    GPIO.output(buzzer,GPIO.LOW)
    print("No beep")
    sleep(1)
else:
    pir.wait_for_motion==False
```

Gantt chart of progress of BDP I

PROJECT ACTIVITY	Academic Week of Semester 1														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Selection of PSM title									S						
PSM title registration									E						
Research on the chosen topic									M						
Collect resources for submit proposal									E						
Proposal submission									S						
Implement Introduction and Literature Review									T						
Identify the hardware component and software used									E						
Preparing Flow Chart of the Methodology									R						
Implement the Methodology									B						
Complete and Review on PSM 1 Report									R						
Correction of Report									E						
Submit PSM 1 Report									A						
BDP I Presentation									K						

Gantt chart of progress of BDP II

PROJECT ACTIVITY	Academic Week of Semester 2														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Prototype planning								S							
Prototype designing								E							
Prototype testing								M							
Analysis evaluation								E							
Preparation of chapter 4								S							
Preparation of chapter 5								T							
First draft report submission								E							
Report editing								R							
Final draft report submission								B							
Report submission to Panel								R							
BDP II Presentation								E							
IDEX Presentation								A							
Hard-bounded report submission								K							