MINI GREENHOUSE MONITORING SYSTEM USING IOT TECHNOLOGY

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This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Computer Networking) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
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2019

DECLARATION

I hereby declare that this project report entitled

[MINI GREENHOUSE MONITORING SYSTEM USING IOT TECHNOLOGY**]**

is written by me and is my own effort and that no part has been plagiarized

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STUDENT : _____ Date : _____
(NORFAZLIANA BINTI JAAFAR)

I hereby declare that I have read this project report and found

this project report is sufficient in term of the scope and quality for the award of

Bachelor of Computer Science (Computer Networking) with Honours.

SUPERVISOR : _____ Date : _____
(DR. NURUL AZMA BINTI ZAKARIA)

DEDICATION

To my beloved parents for their care and support throughout my bachelor' degree and for words of encouragement which helped me complete my final task successfully. To my supervisor, evaluator and lecturer for molding me into a knowledgeable person. To my friend and course mates for sharing information and giving support throughout my education at university.

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ABSTRACT

Mini greenhouse monitoring using IoT technology explains the design and implementation of system monitoring based on Internet of Things (IoT) and cloud computing to sense the data parameters of the plant in the greenhouse. The parameters of the plant including humidity and temperature, light and soil of moisture. All sensors are connected to Raspberry Pi 3 and the data will stored in cloud storage and display at mobile application. Certain parameters that below threshold will be notified to user. This system focused to replace the traditional way which is people must present at greenhouse to monitor their plant. This system is solution for the problem because people can monitor their plant through mobile application.

ABSTRAK

Pemantauan rumah hijau mini menggunakan teknologi IoT menerangkan reka bentuk dan pelaksanaan pemantauan sistem berdasarkan perkara internet (IoT) dan pengkomputeran awan untuk merasakan parameter data tanaman di rumah kaca. Parameter tumbuhan termasuk kelembapan dan suhu, cahaya dan kelembapan tanah. Semua sensor disambungkan ke Raspberry Pi 3 dan data akan disimpan dalam storan awan dan dipaparkan pada aplikasi mudah alih. Parameter tertentu yang di bawah ambang akan dimaklumkan kepada pengguna. Sistem ini memberi tumpuan untuk menggantikan cara tradisional iaitu orang mesti hadir di rumah hijau untuk memantau pokok mereka. Sistem ini adalah penyelesaian untuk masalah ini kerana orang boleh memantau pokok mereka melalui aplikasi mudah alih.

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IoT	**-**	**Internet of Things**
Wi- Fi	**-**	**Wireless fidelity**
DIY	**-**	**Do it yourself**
USB	**-**	**Universal Serial Bus**
RAD	**-**	**Rapid Application Model**
VNC	**-**	**Virtual Network Computing**

LIST OF ATTACHMENTS

CHAPTER 1: INTRODUCTION

1.1 Introduction

Greenhouse is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheds to industrial sized buildings. A miniature greenhouse is known as a cold frame. The interior of a greenhouse exposed to sunlight becomes significantly warmer than the external ambient temperature, protecting its contents in cold weather.

Greenhouse monitoring involves the automatic monitoring and control of climatic parameters that directly or indirectly regulate plant growth and their output. Many parameters measurements are needed in today's greenhouse to monitor and control the good quality and productivity of the plants. To achieve the desired results, there are some very important parameters that come into play, such as temperature, humidity, light, water, which necessary for better plant growth.

This project will develop mini greenhouse monitoring system using IoT technology User can monitor and get the data of the plant through the mobile application. Raspberry Pi provides the features into a network to gather all the connected sensor to make communication with embedded of microprocessor and wireless transceiver.

1.2 Problem Statement

Time is a precious thing, so that everyone needs to save as much time as they can. Therefore, new technologies are being built to save our time. According to Satpute (2018), the problem before developing the system is people must always be present in the greenhouse to monitor their plant.

Mini greenhouse monitoring system using IoT technology was introduced to help owner monitor their plant by blynk application without coming to the garden.

Table 1.1: Problem Statement

PS	Problem Statement
PS1	User have to check the condition of the plant manually.
PS2	User cannot be notified if the soil moisture of the plant is below threshold.

1.3 Problem Question

The problem question is used to differentiate between the issues listed in the table 1.1 above. The following table illustrates the project question based on the problem statement above.

Table 1.2: Project Question

PS	PQ	Project Question
PS1	PQ1	How to monitor the condition of the plant remotely?
PS1	PQ2	How to identify the soil condition of the plant?
PS2	PQ3	How to alert user on certain condition of the plant?

1.4 Project Objective

A project objective describes the desired results of a project, the problem statement and project question must be considered to achieve the objective of the project. For this project, there are three objectives need to achieve:

PO1: To study on greenhouse technology and various IoT technology.

Microprocessor and sensors are important things that must study to develop the prototype of the project. It is because to know the type of microprocessor and sensors that suitable for the project. IoT technology that be used also must suitable for the project.

PO2: To develop hardware prototype using Raspberry Pi and sensors that able to measure parameter of plant.

To measure the parameter of the plant in greenhouse, prototype of the project must develop. The parameter of the plant is including moisture of the soil, humidity and temperature and light.

PO3: To integrate hardware prototype with mobile application to provide alert.

The complete prototype will be integrated to mobile application. The data of parameter will be display to the application and user can monitor their plant remotely. If the moisture of the soil below threshold alert will be send to the user via mobile application. User can take suitable action after getting the alert.

Table 1.3: Project Objective

PS	PQ	PO	Project Objective
PS1	PQ1	PO1	To study on greenhouse technology and various IoT technology.
PS1	PQ2	PO2	To develop hardware prototype using raspberry pi and sensors that able to measure parameter of plant.
PS2	PQ3	PO3	To integrate hardware prototype with mobile application to provide alert.

1.5 Project Scope

The project aims at designing a prototype for monitoring the plant that can be monitor by mobile application. There are scopes for this project:

- **Focus for mini greenhouse:** Build diy mini greenhouse to place the plant.

- **DHT22 Humidity and Temperature sensor:** This sensor used to detect temperature and humidity environment in mini greenhouse

- **Light sensor:** This sensor used to detect light environment in mini greenhouse.

- **Soil Moisture sensor:** This sensor to detect level moisture of soil.

- **Blynk Application:** This application is used to display the parameter of the plant and provide notification to the user.

1.6 Project Contribution

Project contribution determines the expected result from this project and significant contribution of this project. This project uses low-cost Raspberry Pi 3 to connect the wireless application. The first project contribution is knowledge about greenhouse and IoT technology. Users need to know the concept of greenhouse, such as the scale and type of plant they want to use before building a greenhouse. Next, this project can save user time because they can monitor their plant remotely without present to the greenhouse. Lastly, user can know whether them must plant their tree or not. It is because the system will provide alert if the soil moisture below threshold via mobile application.

Table 1.4: Project Contribution

PS	PQ	PO	PC	Project Contribution
PS1	PQ1	PO1	PC1	Knowledge about greenhouse and IoT technology
PS1	PQ2	PO2	PC2	Remotely monitors parameters of plants.
PS2	PQ3	PO3	PC3	Provide alert to the user by mobile application.

1.7 Report Organization

Chapter I: Introduction

Mainly focus of the introduction of project which include the situation and what actually project develop. It also briefs explained the problem statement, project objective, scope of the project, the expected outcome and conclusion to be sure the project can easily understand.

Chapter II: Literature Review

This chapter focus on the explanation of the reading material and publish thesis. Hence, this chapter also described some related publish thesis and journal articles on greenhouse monitoring with IoT. Those publish thesis and articles is analysed the main tools that used in this project. For example, Raspberry Pi and Arduino.

Chapter III: Project Methodology

In this chapter explain about the project method which explain each stage of the selected methodology like waterfall methodology. This chapter also describe the milestone of the project.

Chapter IV: Analysis and Design

In this chapter focus about the problem analysis, analysis requirement and the project design. For the problem analysis, problem statement that stated in Chapter I discussed in here whereas the analysis requirement of the project focus on two side, which are hardware and software requirement. For the design of the project, the logical design of the project and the flow of the project also attached in this chapter.

Chapter V: Implementation

In this chapter, it is focus on how the project was implemented. This project is used the Raspberry Pi 3. The step by step of how to be wiring and configuration the raspberry pi and connection between Raspbian and Wi-Fi.

Chapter VI: Testing

This chapter focuses on the project test plan, test design, result and analysis of the project. Testing plan is done contains test organization, test environment and test schedule. Next, the test design is descriptive in the testing data. The test result is analysed in order to conclude in testing phase.

Chapter VII: Conclusion

This chapter discusses summary the whole project. The conclusion consists the observation on weakness and strengths, proposition for improvement which are future work, project contribution and the limitation of the project.

1.8 Conclusion

This chapter it is discussed about the development of mini greenhouse monitoring using Raspberry Pi3 and sensor. In this chapter was describes the background of project, problem statements, objectives, scope and the summary of all chapter. In the next chapter, the related work of the project will be discussed in literature review.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Literature review is part of important in a project development because it is required to identify information that are related to help in the project. In this chapter, research and currently development of devices for greenhouse monitoring will be discussed. Function of this chapter to get more understanding regarding to this project. Literature review is the best way to meet objectives and scope of the project because can get strong evidence to support implementation justification project through this method.

Figure 2.1 shows the subtopic for this chapter. It includes Greenhouse, Microprocessor and Microcontroller, Sensor, Communication technologies in IoT and Previous development can be figure out through the literature review. This research is done to generate ideas and knowledge that used to develop greenhouse monitoring. Research can be obtained through article, website, reference books and resources.

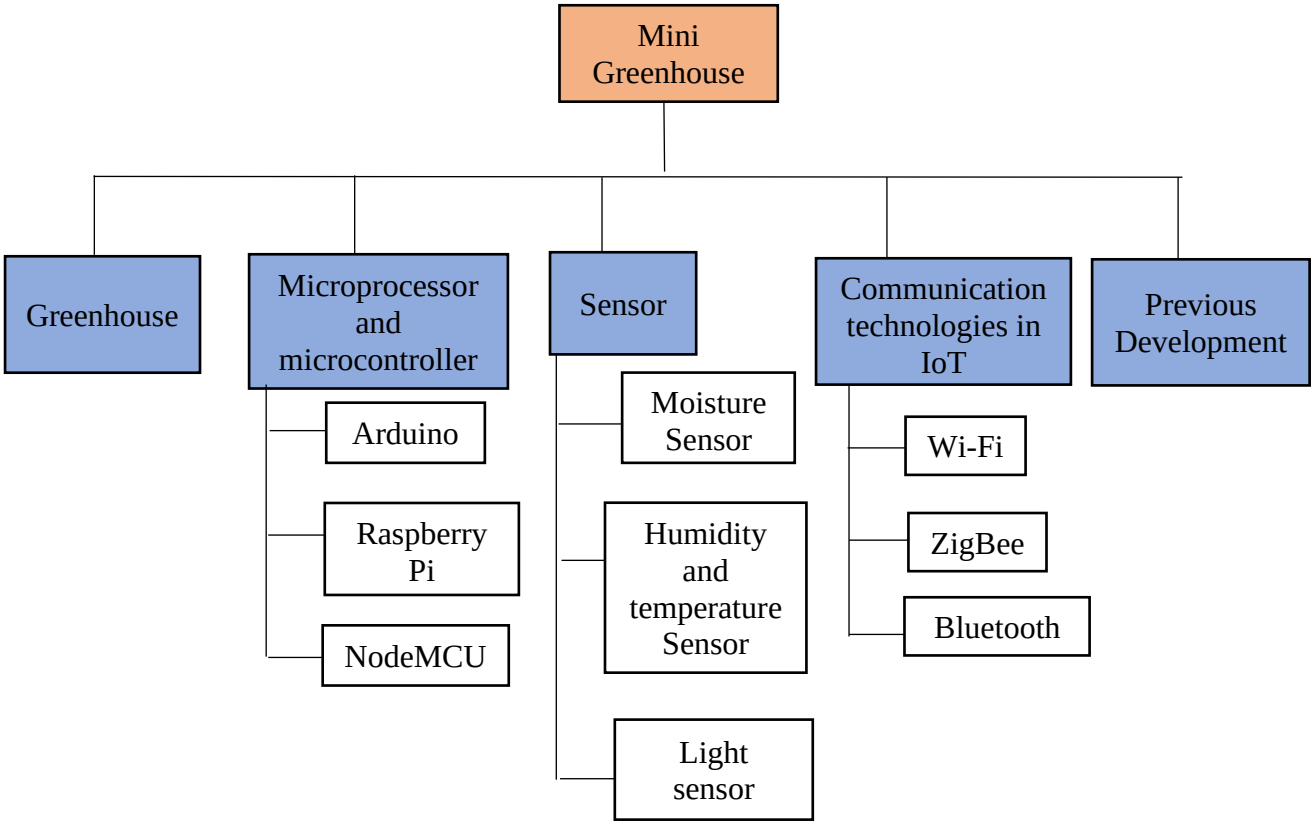

Figure 2.1: Overview of Literature Review

2.2 Greenhouse

Green house is a building or a location where small plants and vegetables are grown. And there are glass or transparent plastic roofs covering the area under the green house (Imam & Gaur, 2018).

Greenhouse provides fresh vegetables and ornamentals worldwide throughout the year; the type and equipment used in any region is generally appropriate to local weather, availability of building materials and crop type (Paper, Teitel, & Baeza, 2012).

2.3 Microprocessor and Microcontroller

An integrated circuit (IC) is a microprocessor that combine core functions of the central processing unit (CPU) of a computer. It is a programmable multipurpose silicon chip, clock driven, register based, accepts binary data as input and provides output after processing it as per the instructions stored in the memory (George, 2019).

A microcontroller is a single chip microcomputer developed by VLSI. The microntroller also called the built-in controller because microcontrollers and their support circuits are often built into, or embedded in, the device they control. A microcontrollers such as microprocessor is available in different word lengths (4bit,8bit,16bit,32bit,64bit and 128-bit microcontrollers are available today) (Vysakh, 2018).

2.3.1 Arduino

Arduino is an open-source development board for microcontrollers. Arduino can be used to read sensors and control things such as motor and lights. It helps to add board programs that can communicate with real-world things. So that, the devices can be create to respond to the whole world and react to it (Randofo, 2016).

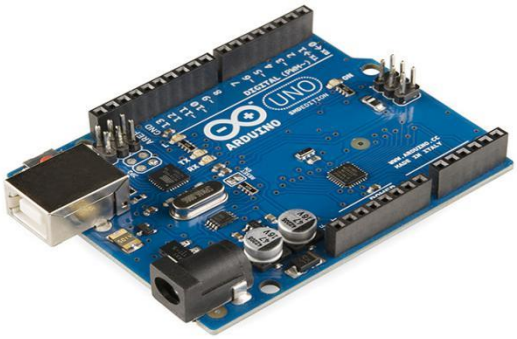

Figure 2.2: Arduino(https://en.wikipedia.org/wiki/Arduino)

2.3.2 Raspberry Pi

The raspberry pi device looks like a motherboard, exposed to the installed chips and ports, but it has all the components you need to connect devices for input, output and storage and begin computing. Raspberry pi has two model of devices which is model A and model B. The addition of Ethernet and an extra USB port is a difference of the model (JOHNSON, 2016).

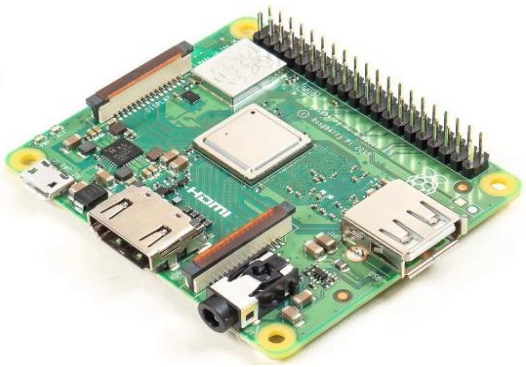

Figure 2.3: Raspberry Pi(https://shop.pimoroni.com/products/raspberry-pi-3-a-plus)

2.3.3 NodeMCU

NodeMcu is open source for IoT platform. By default, the term NodeMCU refers to firmware rather than dev kits. It includes firmware running on the ESP8266 Wi-Fi SoC and hardware based on the ESP-12 module. The firmware uses the scripting language of Lua, C, C++. It is built on the Espressif Non-OS SDK for ESP8266 (Tonage, Yemul, Jare, & Patki, 2018).

Figure 2.4: NodeMCU(https://sea.banggood.com/Geekcreit-NodeMcu-Lua-WIFI-Internet-Things-Development-Board-Based-ESP8266-CP2102-Wireless-Module-p-1097112.html?cur_warehouse=CN)

2.4 Sensor

A sensor is a tool that detects and responds to some type of input from the physical environment. The input may be light, temperature, vibration, humidity, pressure, or any of many other environmental phenomena. Output is generally a signal that is converted to a human-readable display at the location of the sensor or transmitted electronically over the network for reading or further processing (Wigmore, 2012).

2.4.1 Moisture Sensor

A moisture sensor with an oscillator circuit with a frequency of output directly proportional to the percentage of moisture present in the substance of interest like soil. The oscillator circuit consists of two spaced plates in a substance that act as a capacitor. The oscillation frequency changes as the capacitance between the plates changes due to the moisture present between the plates. The device is particularly suitable for use as a soil moisture indicator of the percentage or end points of humidity, such as wet or dry environments (Iltis & Jolla, 1987).

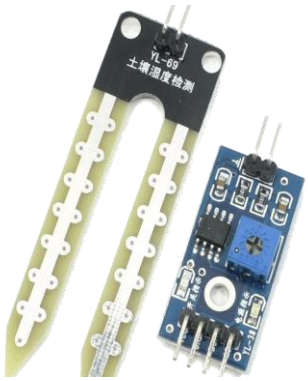

Figure 2.5: Moisture Sensor
(https://www.aliexpress.com/item/32435196705.html)

2.4.2 Humidity and Temperature Sensor

The amount of water present in the surrounding air is known as humidity. The water content in the environment is a key factor in the well-being of mankind. Humidity sensors are very important tools that help to measure in the environment. The tools used to measure atmospheric humidity is technically called a hygrometer. Humidity sensors or hygrometers can be categorized according to the type of humidity used to measure. Humidity sensor is one of the most important tools commonly used for measuring and controlling humidity in residential, commercial, biomedical and environmental applications (Anusha, 2017).

A temperature sensor is a device, typically an RTD (resistance temperature detector) or a thermocouple, which collects temperature data from a particular source and translates data to a system or observer's understandable form. Temperature sensors are used under the hood monitoring and control systems in many applications such as HV and AC system environmental controls, food processing units, medical devices, chemical handling and automotive (Dave, 2019).

Figure 2.6: DHT22 Sensor(https://cityos-air.readme.io/docs/4-dht22-digital-temperature-humidity-sensor)

2.4.3 Light Sensor

The light sensor is extremely sensitive in visible light range. With the light sensor attached to the system when the surrounding natural lights are low, it displays the digital values (Shirsath, Kamble, Mane, Kolap, & More, 2017).

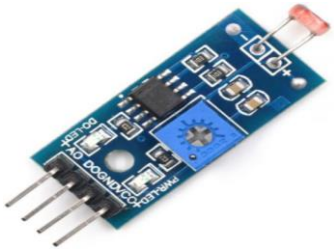

Figure 2.7: Light Sensor(https://www.makerfabs.com/light-sensor-module.html)

2.5 Communication Technologies in IoT

The internet of things (IoT) is a network of physical devices, tools, vehicles, buildings and other devices embedded in electronics, circuits, software, sensors and network connectivity that enables these objects to collect and exchange data. The internet of things enables objects to be sensed and remotely controlled through existing network infrastructure creating opportunities for more effective incorporation of the physical world with computer-based systems, and improving efficiency and accuracy (Gokhale, Bhat, & Bhat, 2018).

2.5.1 Wi-Fi

Wi-Fi is a protocol for wireless networking that enables devices to communicate without direct cable connections. It is technically an industry term that is based on the 802.11 IEEE network standard that represents a type of wireless local area network protocol. Wi-Fi is the most popular form of wireless data communication in a fixed location (Pinola, 2019).

2.5.2 ZigBee

ZigBee is based on the standard of personal-area network 802.15.4 of the IEEE. For some applications such as low-powered devices that do not require a lot of bandwidth like smart home sensors, ZigBee considered an alternative to Wi-Fi and Bluetooth. ZigBee is not focusing on point-to-point communication (maggie Tillman, 2019).

2.5.3 Bluetooth

Bluetooth is primarily used for establishing wireless Personal Area Networks (PANs) communication. It is a popular technology that is generally used to send data from one device to another device. It enables users to create ad hoc networks to transfer data around a wide range of devices (Tsira & Nandi, 2014).

2.6 Previous Development Greenhouse Monitoring

This part of related development to see the existing project. The research has done can give the system to be developed more knowledge or creativity. There are six journals on the greenhouse monitoring project.

From this paper (Kodandaramaiah & Keerthi, 2015) they explains the design and implementation of a GSM-based electronic system (Global Mobile Communication System), cloud computing and Internet of Things (IoT) for the sensing of greenhouse climate parameters. The system can effectively monitor a variety of greenhouse environmental parameters and meet the actual of agricultural production. To demonstrate the proposed system, devices such as temperature sensors, light sensors, relative humidity sensors and soil moisture sensors are integrated. The focus of this research is to develop a system that can automatically measure and monitor changes in greenhouse temperature, light, humidity and moisture. The process used in our system provides details online to the owner irrespective of their on-site presence. The GSM greenhouse monitoring systems use PC or telephone-based devices to keep the owner update about the conditions in the greenhouse.

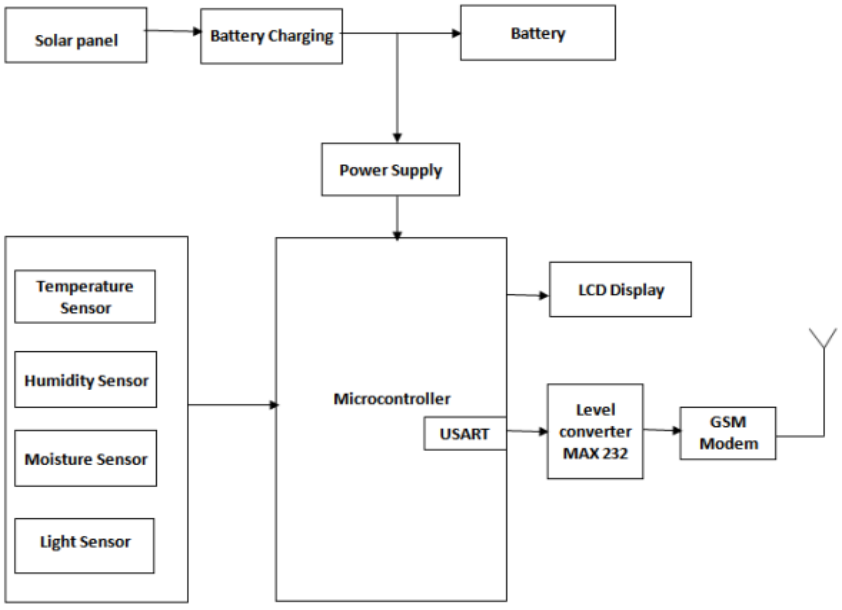

Figure 2.8: Block diagram of system

According to (Shirsath et al., 2017) greenhouse automation system is the technological method in which automated monitoring and control of the greenhouse environment can help farmers in rural areas. This system replaces the human's supervision directly. Nowadays there is a great need to develop greenhouses due to urbanization and lack of land availability, which will be reserved mainly for growing crops. In this paper, data acquisition in the greenhouse was designed for multiple sensors to use data for simulation or processing to improve greenhouse growth. The aim of this system is to provide farmers with accurate information about the sensor status via the IoT web server and to help farmers monitor the greenhouse from remote locations.

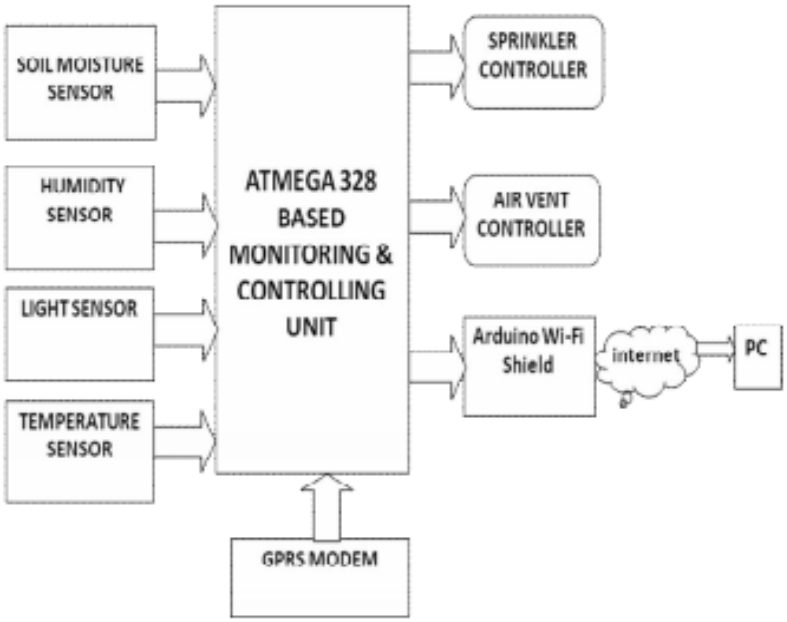

Figure 2.9: Block Diagram

From this article, (Shah, 2017) said it is very labour intensive to maintain a greenhouse and its crop, and most of them conduct essential operations intuitively. This is due to agricultural researches are facing a lack of good data quality that is important to the production of crops. This system consists of three sections: the temperature and humidity sensor node, the soil moisture sensor node and the control system PC or mobile app. Using the internet connectivity, the server sends and receives data from the end user. This system allow people to monitor and manage their greenhouse growing conditions. Use of sensor nodes, internet connection and cloud will provide real-time plant updates.

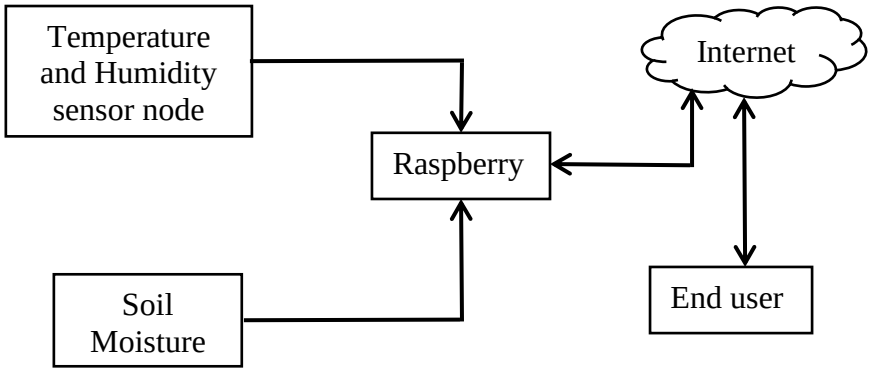

Figure 2.10: System Overview

From this article, (Rupali Satpute, Hemant Gaikwad, Shoaib Khan, Aaditya Inamdar, 2018) stated that greenhouse is primarily used for the year-round growth of certain types of plants or plants which need continuous monitoring to achieve high quality and quantity. The used of Internet of Things concept in greenhouse to increase productivity by detect the environmental parameter using different sensors. Temperature sensor, humidity sensor, light intensity sensor and soil moisture sensor are used to monitor and manually control the system in the greenhouse as proposed for this project. This system was replaced the traditional method of monitoring greenhouse involves human labour and is time consuming.

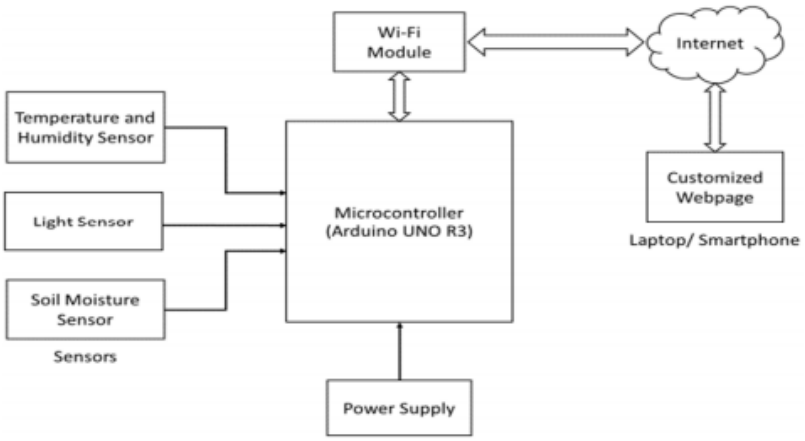

Figure 2.11: Block diagram of the Greenhouse Monitoring System

Publish on International Journal of advanced Research in Electronics and Communication Engineering (IJARECE) wrote by (Imam & Gaur, 2018) said that the Internet of Things is one of the 21st century's most important technologies. It is generally an environment in which simple physical objects are sufficiently accessible via the internet. The purpose of this project is to design a user-friendly, easy to install and monitor parameter values. This system use IoT concept to collect and transfer data over a network. Using arduino and sensors, it will monitor and record different parameter values such as temperature, light intensity, humidity and etc. All these values are continuously updated and optimized in order to achieve maximum yield and growth. This paper describes the different aspects of IoT greenhouse monitoring. They said greenhouse is generally a place where plants such as vegetables and flowers grow and are usually covered with glass.

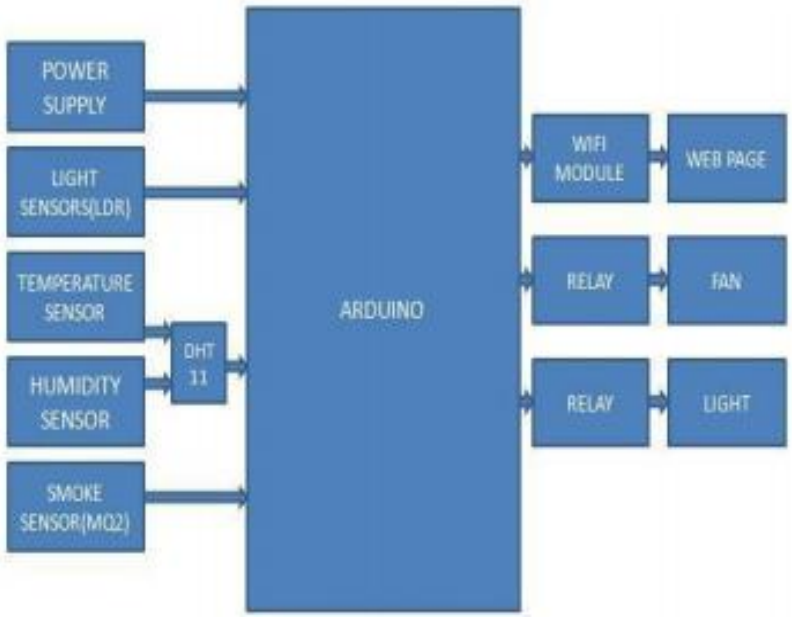

Figure 2.12: Block diagram for this paper

From this paper, (V.Monika, I.Ramalekshmi, D.Roopak, S.Sanjeev Kumar, 2018) stated that older days crop production and cultivation are done manually. This paper proposed cultivate crops covered by the curtains, so that the required sensors, microcontrollers can monitor the crops. Microcontroller that used in this project is arduino and raspberry pi3. All sensors are connected via the raspberry pi3 IoT devices

and data collected and stored in cloud storage. HTML webpage was created to retrieved the data and monitor the crops wherever we are.

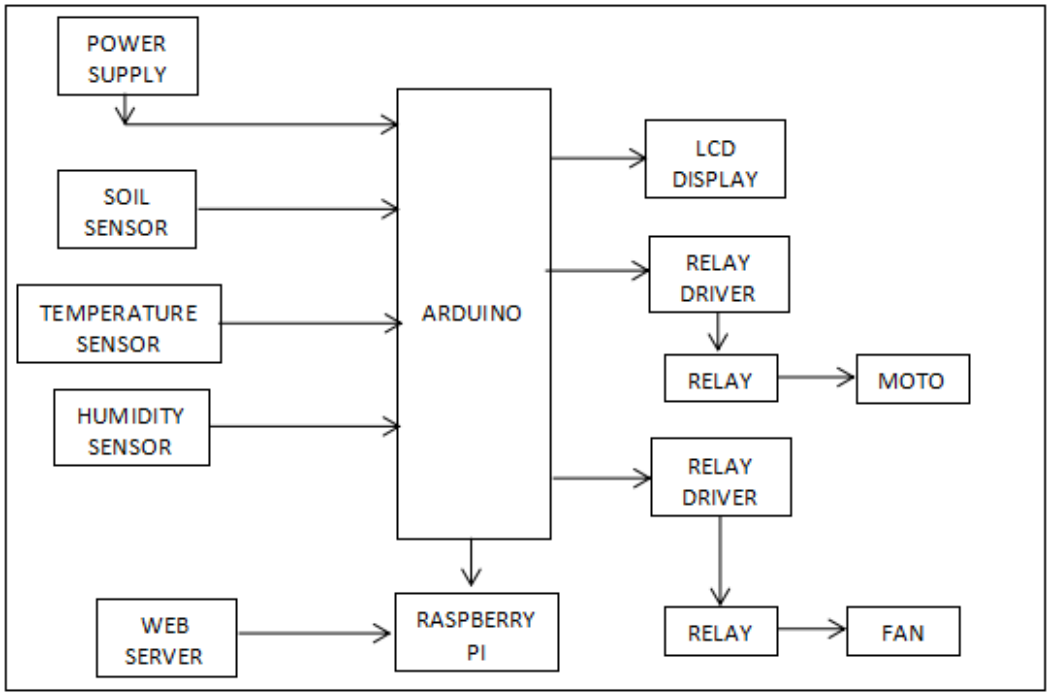

Figure 2.13: Block Diagram

2.7 Discussion

Based on the current project review and the equivalent project that have been research, there are several comparison features have been made. The comparison is made to define improvement of the project to develop. Table 2.1 below shows the comparison of features in greenhouse monitoring. Current project that be research mostly used web application to display the data. In our proposed project, the platform to display the data at mobile application because people nowadays mostly have smartphone. Another improvement for the system is to provide alert of certain parameter of the plant to user through mobile application. It can make user take suitable action if get the alert.

Table 2.1: Comparison of Journal

Journal tittle/Author	Technology Used	Type of Application	Type of microcontroller	Image of plant process	Alert
Cloud Iot Based Greenhouse Monitoring system (Keerthi.v and Dr.G.N.Kodandaramaiah,2015)	GSM module, Cloud Computing, IoT, Thingspeak	Web Application	ATmega328P	✕	✕
IoT Based Smart Greenhouse Automation Using Arduino (Prof. D.O.Shirsath, Punam Kamble, Rohini Mane, Ashiwini Kolap, Prof.R.S.More, 2017)	GSM module, Cloud Computing	Web Application	Arduino Uno (ATmega328P)	✕	✕
Greenhouse Automation And Monitoring System Design And Implementation (Neel P.Shah and Priyang P.Bhatt, 2017)	IoT cloud, Thingspeak	Web Application	Raspberry Pi 3	✕	✕
IoT Based Greenhouse Monitoring System (Rupali Satpute, Hemant Gaikwad, Shoaib Khan, Aaditya Inamdar, Deep Dave, 2018)	Wi-Fi module, IoT	Web Application	Arduino Uno R3	✕	✕ Alarm Alert
Smart Greenhouse Monitoring Using Internet of Things (Aadil Imam and Deepak Gaur, 2018)	Wi-Fi module	Web Application	Arduino Uno	✕	✕
Greenhouse Wireless Network Monitoring and Management Using IoT (V.Monika, I.Ramalekshmi, D.Roopak, S.Sanjeev Kumar, K. Santeesh Kumar, 2018)	IoT, Cloud Computing	Web Application	Raspberry Pi 3, Arduino	✕	✕
Proposed Project- Mini greenhouse monitoring system using IoT technology	Cloud Computing, IoT	Mobile Application	Raspberry Pi 3	√	√ Mobile alert

2.8 Proposed Solution

Based on pervious study, a proposed project is to develop mini greenhouse monitoring system using IoT technology and provide alert to user. Figure 2.14 shows the diagram of mini greenhouse monitoring system using IoT technology. The sensor used in this project can detect the level of humidity and temperature, moisture of soil and the light in the greenhouse. The data of the system will be saved at ThingSpeak cloud computing. In this project, Raspberry Pi as microprocessor to get the data from sensor and display the data to blynk application. The user will get notification if the moisture of soil is below threshold through smartphone.

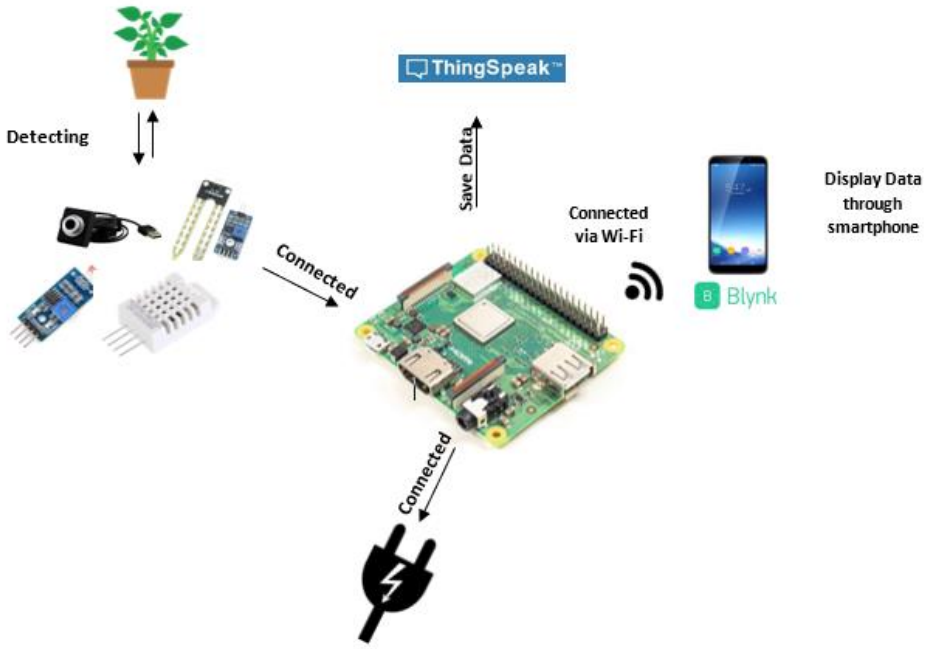

Figure 2.14: Proposed Solution for mini greenhouse monitoring system using IoT technology

2.9 Conclusion

In this chapter is discussing the literature review of the project which is existing project review and the methodology to complete a good project. The analysis of system development will be discussed in detail. The literature review includes data gathering and information and problem analysis and requirements. All the result is derived from the analysis of the data collected and some conclusion and recommendation have been derived from the result of this chapter. From this chapter, we can make a comparison to choose a better project for reference. In the next chapter, methodology used for the project is discussed.

CHAPTER 3: PROJECT METHODOLOGY

3.1 Introduction

This chapter consists of two part which is project methodology and project milestone. Methodology is set of process, methods, tools and documentation to help implement a project or research. It also helps project developer plan and schedule project to make the systematic and organized by collecting data, analysing data and model designed. It is important for project developer to always keep up with project development. In this chapter will explains methodology that be used in Mini greenhouse monitoring system using IoT technology project.

3.2 Project Methodology

Mini greenhouse monitoring project choose Rapid Application Model (RAD) as a project methodology. RAD is a development model that prioritizes rapid prototyping and fast feedback over long-term development and testing cycles. Developers can quickly make multiple iterations and updates to a software without starting a development schedule every time. In other words, RAD is less talk and more action. RAD methodology consists of 4 main phase which is planning, user design, construction and testing.

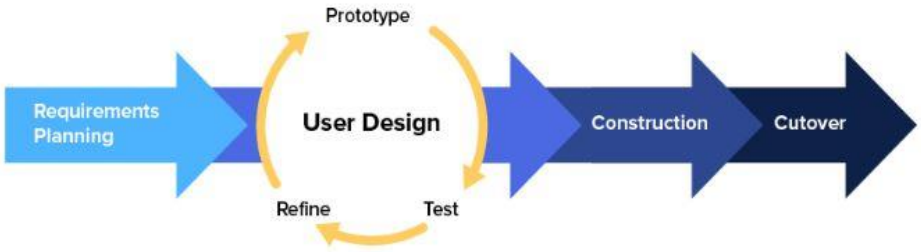

Figure 3.1: RAD model (https://kissflow.com/rad/rapid-application-development/)

3.2.1 Phase I: Requirement Planning

Problem statement, objective and scope of the project will determine in this phase. In this phase, hardware and software requirement that suitable in this project will be identified to achieve the objective project.

1. Software Requirement

i. VNC viewers: Software to view another computer's visual desktop display and monitor it through network connections.

ii. Blynk: Mobile application that display data from IoT platform.

iii. Raspberry Pi Operating system (Raspbian): An operating system is the collection of basic programs and software to run Raspberry Pi.

iv. **ThingSpeak:** A software function to save and process data.

2. Hardware Requirement

i. **Raspberry Pi 3:** A microprocessor computer that implement program to communicate with IoT devices.

ii. **Temperature and Humidity Sensor (DHT22):** A sensor that detect the temperature and humidity

iii. **Soil Moisture Sensor:** A sensor that detect moisture of soil

iv. **Light Sensor:** A sensor that detect light

v. **Breadboard:** A tool that build and test circuits quickly before finalizing any circuit design.

3.2.2 Phase II: User Design

User design is process design teams are used to create products that provide users with meaningful and relevant experience. This phase involves building project prototypes under development using developer tool. The continuous interactive process in user design allow users to understand and modify the project working model which meets their needs. The design of the project is created to design the interaction of Raspberry pi with the sensors.

3.2.3 Phase III: Construction

The phase of construction involves refining the prototypes developed in the previous phase. The aim of the rapid phase of construction is to complete the detailed design of the proposed system. This phase is divided into three parts. First part is configuring raspberry pi 3 to connected to Wi-Fi. Second, configured Raspberry Pi 3 and sensors follow the design that have created. Lastly, configured the notification part to allow users get notifications. Any modification can be made in this phase until the product meet the requirements.

3.2.4 Phase IV: Testing & Cutover

This is the phase of implementation at which the finished product is will be launched. Product will integrate software and hardware for the development of an experimental system and test functionality. For the testing phase, the raspberry pi 3 will connect to internet and send data to Blynk application. Then, users get notification if the parameters in greenhouse insufficient.

3.3 Project Milestone

Project milestones is a management tool used to define a point in the project schedule. The milestone flow should be clear to make sure the project completed according the timeline. The duration of the project can be estimated using project milestone.

Table 3.1: Project Milestone

Week	Activity
1	✓ Identify the title of project with supervisor. ✓ Proposal discussion
2	✓ Proposal correction ✓ Proposal submission ✓ Proposal accepted by supervisor
3	✓ Find article existing project ✓ Study and research the literature review
4	✓ Study and research the literature review ✓ Submit table comparison of existing project ✓ Discuss hardware requirement
5	✓ Chapter 1: Introduction ✓ Install Raspbian
6	✓ Chapter 1: Introduction ✓ Connect Raspberry Pi with Wi-Fi connection ✓ Implement Moisture sensor
7	✓ Implement Moisture Sensor ✓ Implement Humidity and Temperature Sensor
8	MID SEMESTER BREAK
9	✓ Chapter 2: Literature Review ✓ Implement Humidity and Temperature Sensor
10	✓ Chapter 2: Literature Review ✓ Chapter 3: Project Methodology
11	✓ Chapter 3: Project Methodology ✓ Chapter 4: Analysis And Design
12	✓ Chapter 4: Analysis And Design ✓ Implement Light Sensor
13	✓ Chapter 4: Analysis And Design ✓ PSM 1 Report
14	✓ Presentation schedule ✓ Test All Sensor
15	FINAL PRESENTATION

3.4 Project Gantt Chart

No	Activity/week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Identify the title of project with supervisor. Proposal discussion															
2	Proposal correction Proposal submission Proposal accepted by supervisor															
3	Find article existing project Study and research the literature review															
4	Study and research the literature review Submit table comparison of existing project Discuss hardware requirement															
5	Chapter 1: Introduction Install Raspbian															
6	Chapter 1: Introduction Connect Raspberry Pi with Wi-Fi connection Implement Moisture sensor															
7	Implement Moisture Sensor Implement Humidity and Temperature Sensor															
8	Chapter 2: Literature Review Implement Humidity and Temperature Sensor															
9	Chapter 2: Literature Review Chapter 3: Project Methodology															
10	Chapter 3: Project Methodology Chapter 4: Analysis And Design															
11	Chapter 4: Analysis And Design Implement Light Sensor															
12	Chapter 4: Analysis And Design Check PSM 1 Report															
13	Presentation schedule															

	Test All Sensor															
14	FINAL PRESENTATION															

Figure 3.2: Gantt Chart

3.5 Conclusion

Conclusion for this chapter is explained the project methodology of this development project. Basically, it describes every methodology, structure and method of project in details. The methodology that be used in this project is Rapid Application Model (RAD). This chapter are important for development of a project to help the project to be completed on time. Next chapter discussed about analysis and design for the project. It included the problem analysis, hardware and software that be used in the project and the design of the project.

CHAPTER 4: ANALYSIS AND DESIGN

4.1 Introduction

This chapter will discuss about design and the activities that involve in the design phase. To ensure the functionality of the project, all the information hardware and software requirements used on the mini greenhouse monitoring system using IoT technology project are stated. For the architecture, the process diagram clearly stated as an important step that. This process will also identify whether the design can be operated or not.

4.2 Problem analysis

Problem analysis of this project is owner have to check the condition of the plant manually. It is because the owner does not know whether the parameter of the plant is enough or not. It will cause the plant damaged. Besides that, the current system will only display the data in the greenhouse without provide notification to the owner.

4.3 Requirement Analysis

The analysis of the requirements is needed because it is a task to determine the needs and conditions of the project. The thing should also be analysed in this project includes data requirement, functional requirement and non-functional requirement.

4.3.1 Data Requirement

The input of the system is moisture sensor, humidity and temperature sensor, light sensor and pi camera. The moisture sensor is used to detect the level moisture of the soil. Humidity and temperature sensor used to detect the humidity and temperature

inside the green house. The camera is used to capture the condition of plant inside the greenhouse. The detected data from the sensor will display on the blynk application.

4.3.2 Functional Requirement

Moisture sensor, humidity and temperature sensor and light sensor used to detect level of moisture, humidity and temperature and light in greenhouse. The data from sensor transfer to raspberry pi and then the data will display on blynk application. The alert will be sent to user when the parameter in greenhouse insufficient. The connection of raspberry pi and blynk application through wireless connection.

4.4 Technical requirement

Technical requirements are technical issues that need to be considered in order to complete a project successfully. Technical requirements are divided into three hardware requirements are divided into three requirements, including hardware requirement, software requirement and cost analysis.

4.4.1 Hardware requirement

i. Raspberry Pi 3

Figure 4.1: Raspberry Pi(https://shop.pimoroni.com/products/raspberry-pi-3-a-plus)

The newest model for the lightweight Pi fan is the Raspberry Pi 3 Model A+. Like the Raspberry Pi 3 Model B+, it features a 1.4 GHz, 2.4 GHz, 5 GHz wireless L AN, and Bluetooth 4.3/BLE 64-bit quad core processor. This low-cost Pi uses the same processor as the 3 B+ model but reduces the Ethernet jack and three USB ports.

It is still compatible with all Pi operating systems and software has exactly the same 40 pin GPIO connector and camera/display sockets, so any HATs or Pi plates or anything else that plugs into the B+ model will work just the same.

Table 4.1: Raspberry Pi 3 A+ Classification (https://my.cytron.io/p-raspberry-pi-3-model-a-plus)

Features/Specs	Raspberry Pi 3 A+
Release Date	15 Nov 2018
Processor Model	Broadcom BCM2837B0
GPU	VideoCoreIV
CPU lock	1.4GHz
Memory/OS storage	microSD
RAM	512MB
Ethernet	None
USB	1 x USB 2.0
HDMI	1 x Standard
Wireless	2.4GHZ and 5GHz 802.11 b/g/n/ac, and Bluetooth 4.2, BLE
GPIO	40-pin pre-soldered header
Operating System	Raspbian (>Nov 2018)
Power Over Ethernet (PoE)	None

ii. Laptop

Figure 4.2: Laptop

Laptops are fully-functional, compact and convenient computers. Laptop are smaller, weigh less, have less parts and consume less power as compared to a desktop tower computer. Laptop is used to display Raspberry Pi desktop. It also used to configure codes of the sensor and camera.

iii. Smartphone

Figure 4.3: Smartphone

A smartphone is a cell phone with an integrated computer and other features not originally linked to phones such as an operating system, web browsing, and the ability to run software applications. Smartphone have been used to monitor mini greenhouse system using IoT technology through Blynk application.

iv. Power bank

Figure 4.4: Power bank

Power bank is portable batteries that use the circuit to control both input and output power. Using a USB charger, they can charge battery-powered products such as cell phones and a host of other gadgets that will usually require a USB adapter when power is available.

v. Moisture Sensor

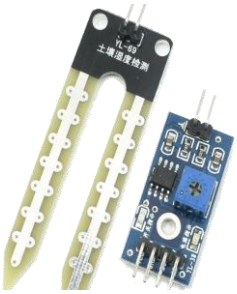

Figure 4.5: Moisture Sensor (https://www.aliexpress.com/item/32435196705.html)

Moisture sensor is used to measure the soil's water content. This sensor deals for monitoring the indoor plants or the soil moisture in the garden. It uses the two probes to pass current through the soil and then reads the resistance to the level of moisture.

vi. Humidity and Temperature Sensor

Figure 4.6: DHT22 Sensor(https://cityos-air.readme.io/docs/4-dht22-digital-temperature-humidity-sensor)

DHT22 is a digital temperature and humidity sensor that is basic and low cost. The DHT22 is combination of humidity and temperature sensor. To measure the surrounding air, it uses a capacitive humidity sensor and a thermistor and spits a digital signal on the data pin (no analog input pins required)

vii. Light Sensor

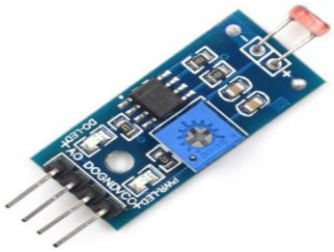

Figure 4.7: Light Sensor(https://www.makerfabs.com/light-sensor-module.html)

Light sensor is a passive device that converts light energy into an electrical signal output, either visible or in the infrared part of the spectrum. Light sensor are commonly known as photoelectric devices pr photo sensor because it covert light energy into electricity.

viii. Pi Camera

Figure 4.8: USB Pi camera (https://www.amazon.com/Ximimark-Camera-Raspberry-Require-Drivers/dp/B07GWP2SGV)

Pi camera models is a lightweight camera that support to raspberry pi. It communicates with Pi using the serial interface protocol of the MIPI camera. It is usually used in image processing, machine learning or monitoring projects.

ix. Breadboard

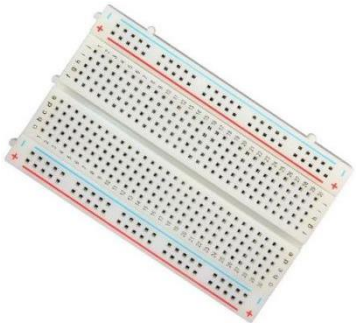

Figure 4.9: Breadboard (https://my.cytron.io/p-breadboard-8.5x5.5cm-400-holes?r=1)

A breadboard is used to quickly build and check circuits before any circuit model is finalized. There are many holes in the breadboard in which circuit components like ICs and resistor can be inserted.

x. Jumper wire

Figure 4.10: Jumper wire (https://www.kitronik.co.uk/c4110-jumper-wires-premium-mm.html)

Jumper wires are simply wire with connector pins at each end, so that two poi nts can be connected without soldering. Usually, jumper wires are used with breadboards and other prototyping devices to make it easy to modify a circuit when appropriate.

4.4.2 Software requirement

i. Raspberry Pi Operating System (Raspbian)

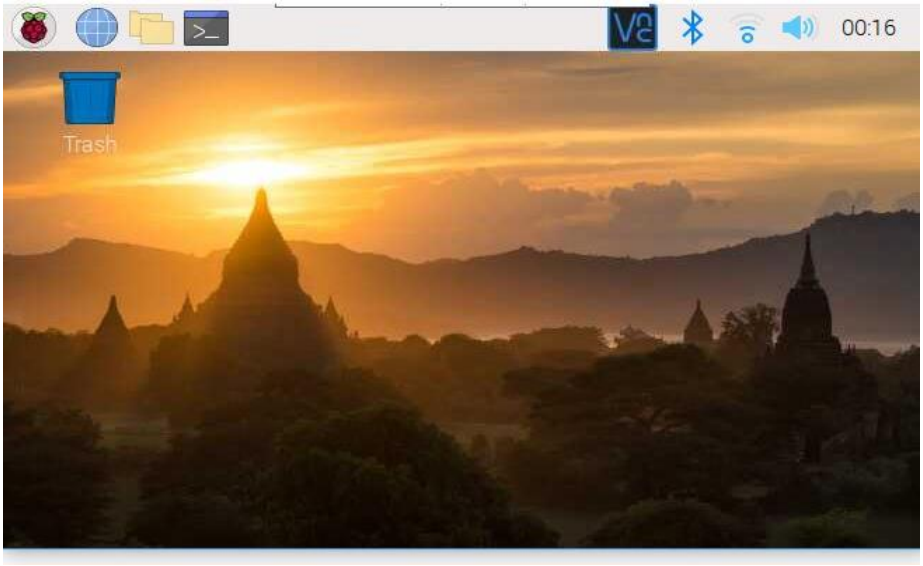

Figure 4.11: Raspbian

Raspbian is a Linux version specially designed for Raspberry Pi. An operating system is the collection of basic programs and software to run Raspberry Pi.

ii. VNC viewer

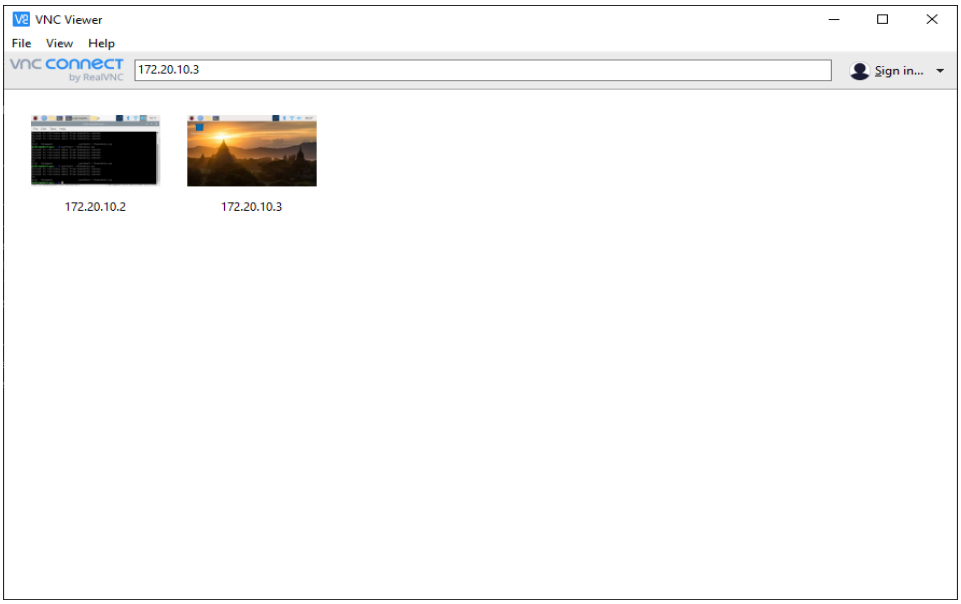

Figure 4.12: VNC viewer

Virtual Network Computing (VNC) is a technology that allows remote sharing of desktops, a type of remote network access. VNC is used to view another computer's visual desktop display and monitor it through network connections.

iii. Python Programming Language

Figure 4.13: Python language

Python is an object-oriented, high-level programming language primarily for web and app development with integrated dynamic semantics. It was designed to be easy to read and simple to implement. Python can run on Mac, Windows, and Unix systems, as well as on virtual machines Java and .NET.

iv. Blynk

Figure 4.14: Blynk application logo

Blynk is an iOS and Android platform to control Arduino, Raspberry Pi through the internet. It can remotely control hardware, display sensor data, display data, etc. It is a virtual dashboard that allows to create a graphical interface for project by simply dragging and dropping widgets.

v. ThingSpeak

Figure 4.15: ThingSpeak

ThingSpeak is a platform IoT analytics service that enables you to aggregate, view and analyze live data streams in the cloud. ThingSpeak provides instant display of information posted to ThingSpeak by the devices.

4.4.3 Cost analysis

Table 4.2: Analysis Cost

No	Hardware	Price (RM)
1	Raspberry Pi	150
2	Laptop	-
3	Smartphone	-
4	Power bank	38
5	Moisture Sensor	15.90
6	Humidity and Temperature Sensor	25
7	Light Sensor	8
8	Pi camera	35
9	Memory card Sandisk 16GB	43
10	Bread board	8
11	Adaptor raspberry pi3	25

4.5 High Level Design

High level design explains the architecture used to build a product. It is including the circuit design and flow chart of the system.

4.5.1 Sketch Circuit Design

i. Moisture Sensor

Figure 4.16 shows the sketch circuit design for soil moisture sensor. This sensor contains 4 pin which is pin 1 connected to 5.0V. Pin 2 is connected to ground and pin 3 connected to GPIO14.

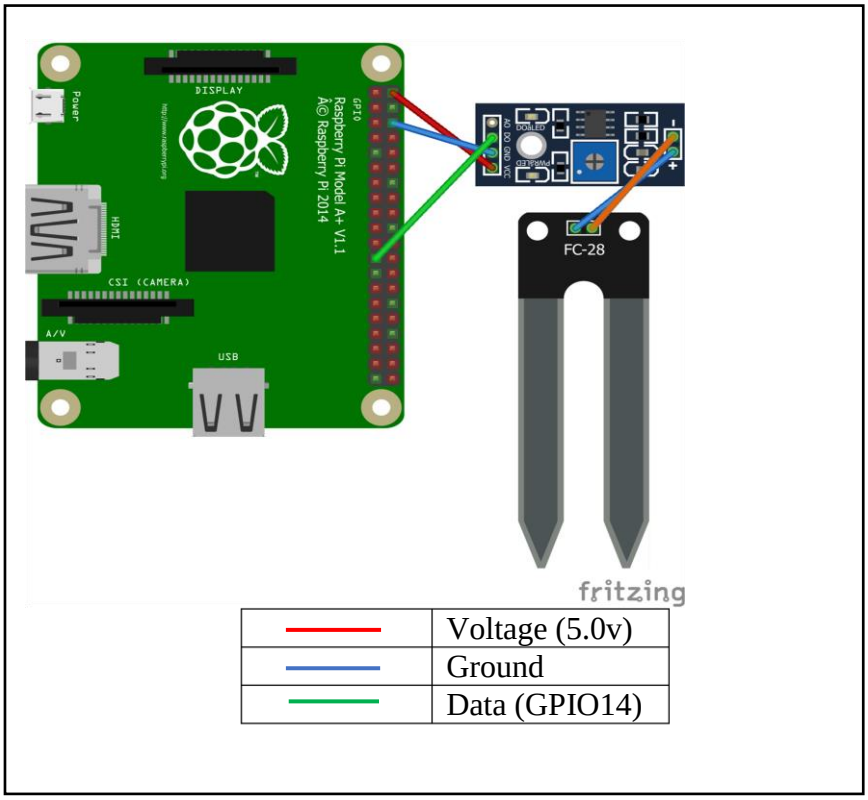

Figure 4.16: Sketch circuit diagram of moisture sensor

ii. Humidity and Temperature Sensor

Figure 4.17 shows the sketch circuit design humidity and temperature sensor (DHT22). This sensor contains 4 pin which is pin 1 connected to 3.3v voltage, pin 2 connected to GPIO7 and pin 3 connected to ground.

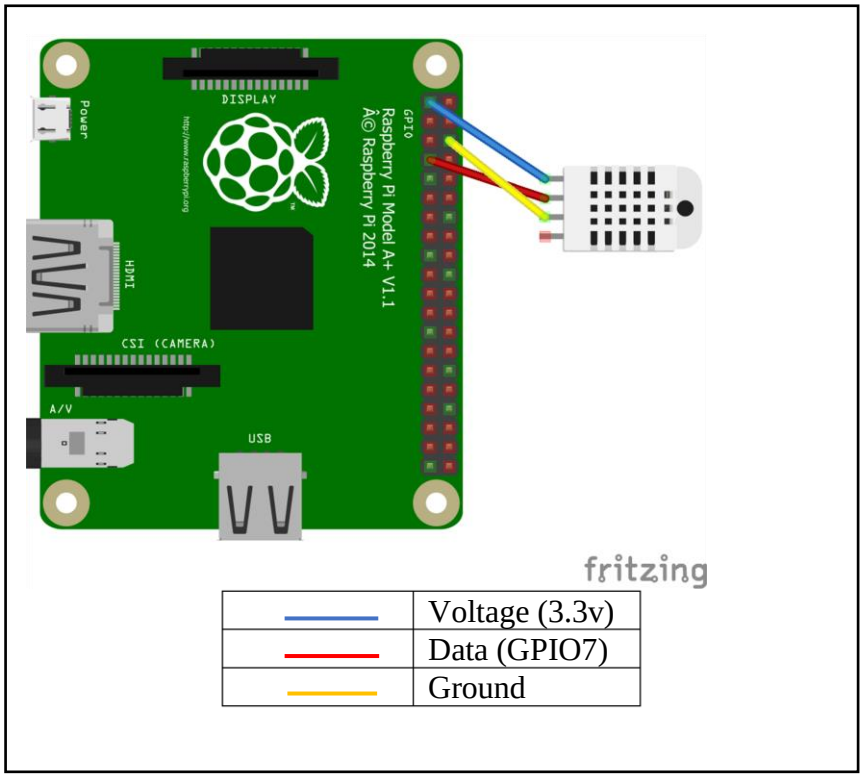

Figure 4.17: Sketch circuit diagram Humidity and Temperature sensor

iii. Light Sensor

Figure 4.18 shows the sketch circuit design for light sensor. This sensor contains 4 pin which is pin 1 connected to 3.3.V, pin 2 connected ground and pin 3 connected to GPIO4.

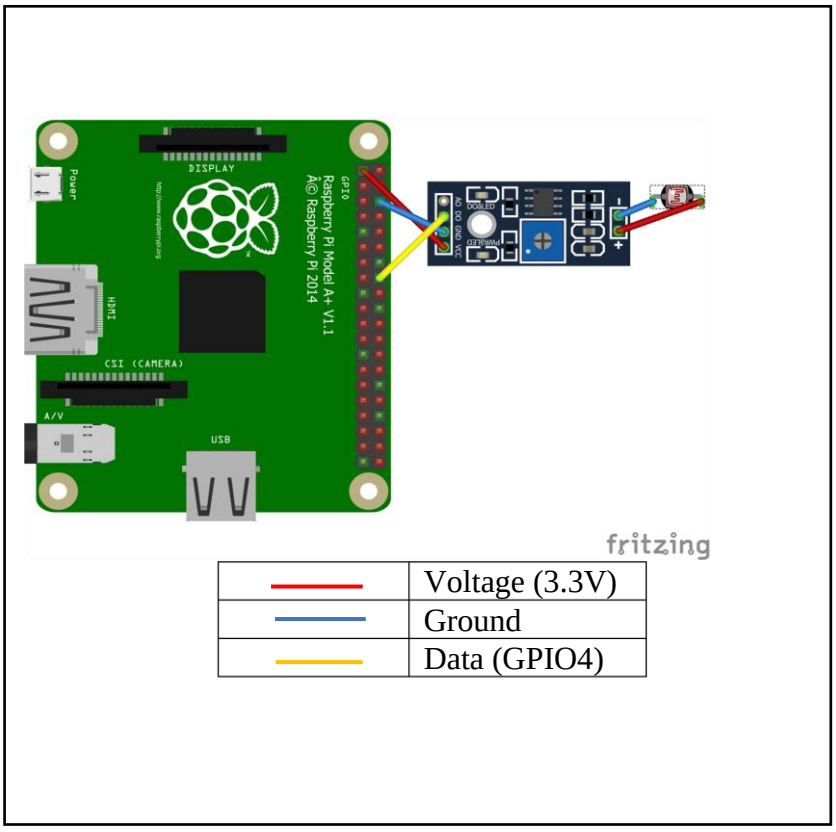

Figure 4.18: Sketch circuit diagram light sensor

4.5.2 Interface Design

Interface design is Design is the process of making interfaces with a focus on looks or style in software or computer devices. Good interface design is user-friendly, and the design is easy to use by whole community. Figure 4.19 shows the sketch design of blynk application. The design will display the parameter of the plant such as humidity and temperature, light and moisture of soil.

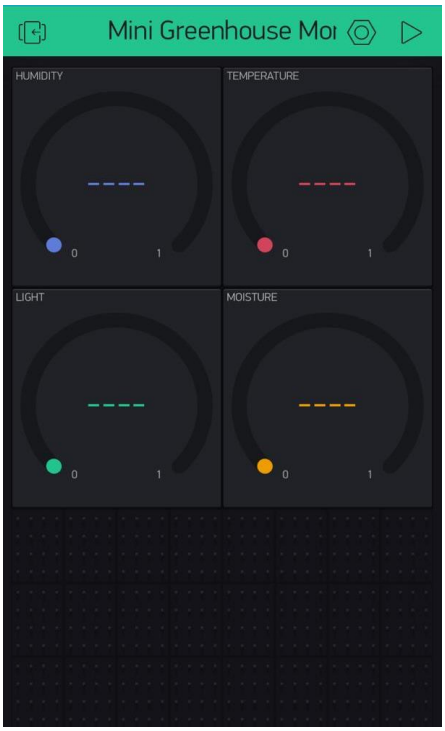

Figure 4.19: Sketch design blynk application

4.5.3 Flow Chart

Figure 4.20 shows the flow chart of the system. The system starts by all sensor detect the data parameter of the plant. The data will transfer to raspberry pi and will display to the blynk application. If the data of moisture soil below threshold, notification will be sent to the owner. The user may take the suitable action to make sure the parameter of the plant gets the enough parameter. If the data reach level parameter, the process will repeat to analyse the data.

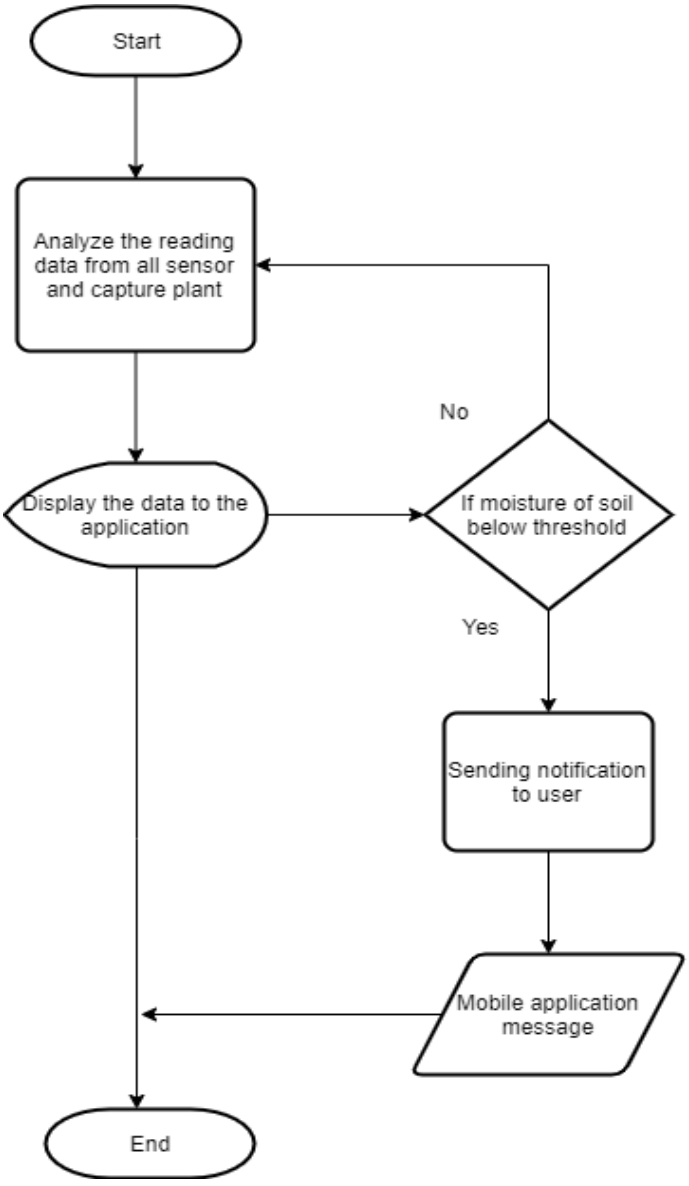

Figure 4.20: Flowchart of mini greenhouse monitoring system using IoT technology

4.6 Conclusion

In conclusion, this chapter important before proceeding to the next chapter which is implementation. This is because all the requirements, including hardware and software requirements are collect in this chapter. During the design phase, a prototype of mini greenhouse system to be develop will be designed. Next chapter is discussed about the implementation of the project.

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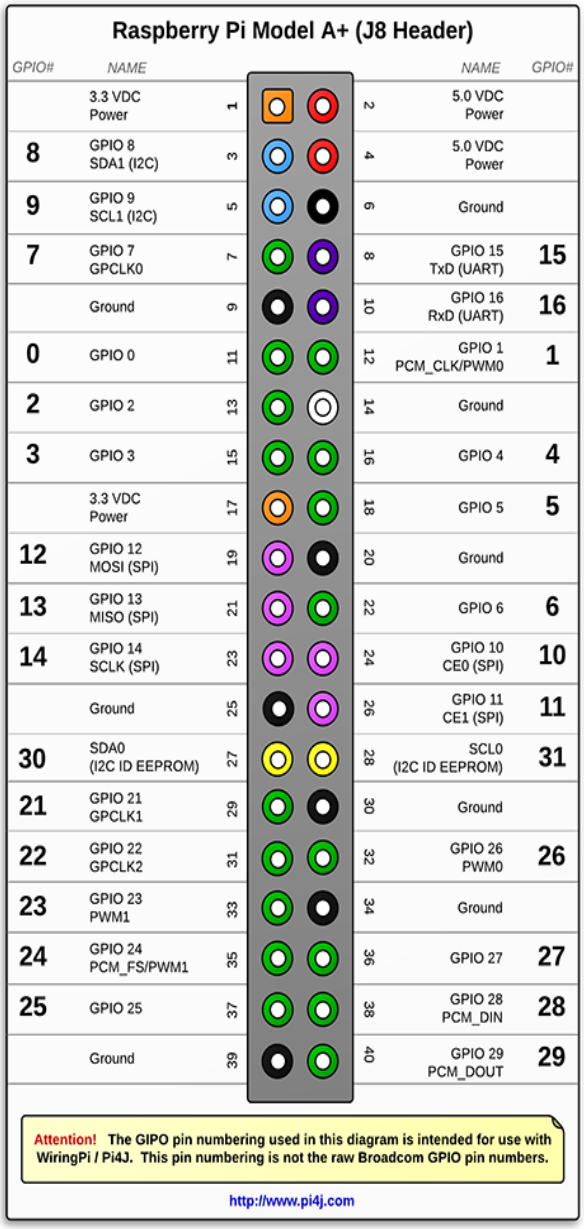
APPENDIX A


Raspberry Pi Model A+ (J8 Header)
GPIO# NAME NAME GPIO#
3.3 VDC Power 1 2 5.0 VDC Power
8 GPIO 8 SDA1 (I2C) 3 4 5.0 VDC Power
9 GPIO 9 SCL1 (I2C) 5 6 Ground
7 GPIO 7 GPCLK0 7 8 GPIO 15 TxD (UART) 15
Ground 9 10 GPIO 16 RxD (UART) 16
0 GPIO 0 11 12 GPIO 1 PCM_CLK/PWM0 1
2 GPIO 2 13 14 Ground
3 GPIO 3 15 16 GPIO 4 4
3.3 VDC Power 17 18 GPIO 5 5
12 GPIO 12 MOSI (SPI) 19 20 Ground
13 GPIO 13 MISO (SPI) 21 22 GPIO 6 6
14 GPIO 14 SCLK (SPI) 23 24 GPIO 10 CE0 (SPI) 10
Ground 25 26 GPIO 11 CE1 (SPI) 11
30 SDA0 (I2C ID EEPROM) 27 28 SCL0 (I2C ID EEPROM) 31
21 GPIO 21 GPCLK1 29 30 Ground
22 GPIO 22 GPCLK2 31 32 GPIO 26 PWM0 26
23 GPIO 23 PWM1 33 34 Ground
24 GPIO 24 PCM_FS/PWM1 35 36 GPIO 27 27
25 GPIO 25 37 38 GPIO 28 PCM_DIN 28
Ground 39 40 GPIO 29 PCM_DOUT 29
Attention! The GIPO pin numbering used in this diagram is intended for use with WiringPi / Pi4J. This pin numbering is not the raw Broadcom GPIO pin numbers.
http://www.pi4j.com