WATER MANAGEMENT CONTROL SYSTEM OF IOT-BASED SOLAR IRRIGATION SYSTEM

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ABSTRACT

In the present era, demand of food is increasing due to increasement of population of people in the world. However, our supply of foods does not meet the demand of food for the people all the around the world. For example, Africa is currently facing the food crisis since 1945. Collision of climate change and population growth has created massive food shortages in Africa, and this would cause millions of dies in coming months. Plant is the main source of food providing us with fruits and vegetables, which are an important source of fibres, proteins, and carbohydrates. But the ways of plantation in our world still not optimise to a high production to produce enough demand for the market. Therefore, to overcome this problem, an automated irrigation system is vital in current situation. Automated irrigation system not only can reduce the amount of manpower but also make the plantation to be more systematic and easier to manage. Just at your fingertips, the irrigation can be control and monitor though the smart device. The aim of this solar irrigation system is to provide a technology of automated irrigation system to the farmer or industry. This technology could be operated in anywhere even there is no supply of electricity as long as there is existing of sunlight. Besides, this system is completed with sensors which could immediately give a notification to the user through application. The objective of our project is mainly about designing of IoT-based solar irrigation system. Therefore, in this thesis, the whole system is developed with assistant of solar power. The system includes the microcontrollers, sensors, solenoid valve and LCD. The present of microcomputer is to control the water flow and give information to the user through device on irrigation system. Solenoid valve is the component which control by the microcomputer meanwhile the sensor is to collect the information of real situation environment. In result, we success to develop a system which able to irrigate the crops or plants using solenoid valve controlled by smartphone with monitoring features. These monitoring features are able to view either in mobile application or browser in any devices and controlling function of valve is able to use through the mobile application. This system is completed with water management features which the information of water pressure, flow rate and total amount of water display on the LCD.

ABSTRAK

Pada era sekarang, permintaan makanan semakin meningkat akibat peningkatan jumlah penduduk di dunia. Walau bagaimanapun, bekalan makanan kami tidak memenuhi permintaan makanan untuk orang di seluruh dunia. Contohnya, Afrika kini menghadapi krisis makanan sejak tahun 1945. Pertembungan perubahan iklim dan pertumbuhan penduduk telah menyebabkan kekurangan makanan di Afrika dan ini akan menyebabkan berjuta-juta kematian dalam beberapa bulan mendatang. Tumbuhan adalah sumber utama makanan yang membekalkan kita buah-buahan dan sayur-sayuran, yang merupakan sumber penting serat, protein, dan karbohidrat. Tetapi cara penanaman kini masih tidak dapat dioptimumkan dengan pengeluaran yang tinggi untuk memenuhi pasaran. Oleh itu, untuk mengatasi masalah ini, sistem pengairan automatik sangat penting dalam keadaan semasa. Sistem pengairan automatik bukan sahaja dapat mengurangkan jumlah tenaga kerja malah juga menjadikan penanaman menjadi lebih sistematik dan mudah diurus. Hanya di hujung jari, pengairan boleh dikawal dan dipantau melalui alat pintar. Tujuan sistem pengairan suria ini adalah untuk menyediakan teknologi sistem pengairan automatik kepada petani atau industri. Teknologi ini dapat dikendalikan di mana saja walaupun tiada bekalan elektrik selagi ada cahaya matahari. Selain itu, ia dilengkapi dengan pengesan yang dapat segera memberi notis kepada pengguna melalui aplikasi. Objektif projek kami adalah terutamanya mengenai merancang sistem pengairan suria berasaskan internet benda (Internet of things, IoT). Oleh itu, dalam tesis ini, keseluruhan sistem dibangunkan dengan pembantu tenaga suria. Sistem ini merangkumi mikrokontroler, pengesan, injap solenoid dan paparan hablur cecair (liquid crystal display, LCD). Kehadiran komputer mikro adalah untuk mengawal aliran air dan memberi maklumat kepada pengguna melalui peranti pada sistem pengairan. Injap solenoid adalah komponen yang dikendalikan oleh komputer mikro sementara itu pengesan untuk mengumpulkan maklumat persekitaran situasi sebenar. Hasilnya, kami berjaya menghasilkan sistem yang dapat mengairi tanaman menggunakan injap solenoid yang dikendalikan oleh telefon pintar dengan ciri pemantauan. Ciri pemantauan ini dapat dipapar dalam aplikasi mudah alih atau penyemak imbas di mana-mana peranti dan fungsi pengendalian injap dapat digunakan melalui aplikasi mudah alih. Sistem ini dilengkapi dengan ciri pengurusan air yang mana maklumat mengenai tekanan air, laju aliran dan jumlah paparan air pada LCD.melalui aplikasi mudah alih. Sistem ini

dilengkapi dengan ciri pengurusan air yang mana maklumat mengenai tekanan air, kadar aliran dan jumlah air yang dipamerkan pada LCD.

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LIST OF SYMBOLS

Ah	Ampere hour
bar	100,000 pascal
cm	Centimetre
g	Gram
kg	Kilogram
kPa	Kilopascal
L	Litre
m	Metre
min	Minute
mm	Millimetre
psi	Pound per square inch
s	Second
V	Voltage
W	Watt

LIST OF ABBREVIATIONS

AC	Alternating current
DC	Direct Current
FTKEE	Faculty of Electrical and Electronic Engineering Technology
IDE	Integrated Development Environment
iOS	iPhone Operating System
IoT	Internet of Things
I/O	Input/Output
GND	Ground
GSM	Global System for Mobile Communications
H	Height
L	Length
LER	Ladang Endau Rompin
LCD	Liquid Crystal Display
LTG	Ladang Tanjung Gemok
PVC	Polyvinyl chloride
RM	Ringgit Malaysia
RTC	Real-time clock
SCL	Serial clock pin
SDA	Serial data pin
SDP	Senior Design Project
SLA	Sealed lead-acid
SoC	System on a chip

USB	Universal Serial Bus
VCC	Voltage Common Collector
W	Width
YPPH	Yayasan Pahang Plantation Holding

CHAPTER 1

INTRODUCTION

1.1 Background of study

Nowadays, there are many technologies that have been developed to be used by us in our daily life. With this development of technology, people had created amazing tools that can be use in various way and it make the work become easier. All the access to industry, medicine, transportation, agriculture, and many more has been simplified due to the current technology.

Now with the advancement of technology, the system use in agriculture has transform from traditional method to modern machinery or automation system. There has been a development in plant operation in agriculture section, which require a high accuracy in processes to optimize output and also the quality of the product or crops. Furthermore, it is also a need to reduce the running cost of the plantation. To achieve the required, we need to have automation system.

With this project, we try to make and automated irrigation system. This system will help to solve the problems of irrigation in plantation such as the consumption of large quantities of water. So that, the error will not affect the crops that has been plant. It also can help in reducing the production cost for the farmers. The system will be controlled automatically, so it will reduce manpower needed and reduce the management cost for plantation.

The importance of irrigation is to encourage the proper growth of plants and to maintain the correct level of soil moisture. Besides, it is also ensuring that contingency protection is provided when there is a short period of drought, as this can support the field enough when water levels are low. Irrigation is to cool the atmosphere and soil which is an ideal environment for plants. With irrigation, the risk of soil piping can be reduced, which can increase subsurface erosion due to the abnormal underwater flow. Soil piping is an alternative method of irrigation, but they can endanger the agricultural output as well as the stability of any surrounding building with movement when soil moisture levels are too high and cause the building to change (MDM Landscape, 2019).

Water, an important resource for crop production, is an increasingly scarce commodity, as the region dedicated to crops continues to expand due to a progressive rise in the world's population. Globally, 11 per cent of the land is planned for agricultural use and is responsible for 70 per cent of water withdrawals. Water intended for agricultural use shall be collected from rivers, streams, wells, sewage treatment plants and seawater desalination systems, as well as from water reservoirs or rafts in areas where there is no continuous flow (SINTECPROOF, 2019).

This project also will have a collaboration with Yayasan Pahang Plantation Holding Sdn Bhd (YPPH). YPPH was establish in 1985 as a subsidiary of Yayasan Pahang. Formerly YPPH was known as Sumber Perindu Sdn Bhd. On 24 January 2003, the name Sumber Perindu Sdn Bhd was changed to YP Plantation Holding Sdn Bhd (YPPH) where the selection of this new name was on recommendation of YAB Menteri Besar of Pahang, Dato' Sri DiRaja Haji Adnan bin Haji Yaakob, as the chairman of the company.

Figure 1. 1 YPPH Structure

YPPH had started the operation of palm oil plantation in 1994 at Pulau Manis, Pekan, Pahang with an area covered of 1,171 acres. In 1996 YPPH increase their plantation area with 10,000 acres in Endau-Rompin and had opened up about 32,000 acres in Rompin in 2002. Then in 2004 they take over Ladang Gambang, Kuantan with an area covered 12,000 acres. YPPH continue to expand their plantation area by opening a new nursery at Pekan in 2009 with an area 27,000 acres. Now they are developing 10,000 acres of new farm located at Pekan, Pahang.

Table 1.1 YPPH Farm Area

FARM	AREA (ACRES)
Kuantan	7,149
Rompin	21,080
Pekan	21,995
(In Development) Pekan	30,021
Total Area	80,205

YPPH also have a nursery plant in Bukit Payong with an area 80 hectare. The capacity for this nursery is 1 million seeding and have water source from the lake nearby. The objective of this nursery is to prepare a high-quality seedling for replanting program at Ladang Tanjung Gemok (LTG) and Ladang Endau Rompin (LER). This is where we are planning to use the automated irrigation system to get the quality output with efficient monitoring.

1.2 Problem statements

Agriculture is one of important sector of economy in Malaysia, such as rubber and palm oil. Therefore, it is very important to have a good quality of the crops. The traditional way of plantation is usually using sprinkler to irrigate the crops or plants. This way of irrigation requires high water pressure. Therefore, diesel fuel water pump will be used to provide high pressure of water.

Using diesel fuel may create many harmful emissions when it is burned and this phenomenon lead to air pollution, such as ground-level ozone and particulate matter (U.S. Energy Information Administration, 2020). Meanwhile, if this diesel fuel water pump is replaced with an electric water pump that powered directly by main electricity will also cause air pollution as the main electricity is produced through nonrenewable resource. Although most of the time the main electricity is produced by renewable resources, but when the peak period of using electricity, boost electricity is supply through combustion of nonrenewable resources.

Hence, farmers have to focus on some important matter such as the appropriate amount of water supply for irrigation of crops, as well as the usage of electricity for the irrigation system. Furthermore, farmers also want to cut the cost of production by reducing manpower. Manual way of irrigation requires manpower and this lead to the increasement of cost. Different type of irrigation system has different consumption of water. A suitable irrigation system may reduce the amount of water usage. This project will be an automated irrigation system controlled using mobile application. With this system, farmers can reduce the manpower in plantation, control the irrigation wirelessly, save water and electricity, and monitor the surrounding conditions of crops or plants.

1.3 Objectives

This project has objectives as below:

1. To design a system that can optimize water management using IoT.
2. To produce semi-automated irrigation system.
3. To optimize the system with monitoring features.

1.4 Scope

The aim of this project is to design a system which is affordable by the farmer and it may help to reduce the cost on the manpower. The objectives that listed give us an insight to develop an IoT-based solar irrigation system with monitoring features. This innovation is used the developed solar water pump to attach into the irrigation system. Hence, the solar water pump not only portable use to irrigate the plant but also be a controlling system to this project.

The solar water pump was developed by previous SDP students. The water pump powered by solar is portable and it has 2 sensors which are soil moisture sensor and temperature & humidity sensor. This water pump can be controlled and monitor using mobile application. This solar water pump will make the irrigation process easier to control and monitor. But in our project, we improve this solar water pump to be used to control the solenoid valve. Water pump had been replaced with solenoid valve as we do not need high water pressure to irrigate the plants as we use the drip system that using low pressure of water. And this problem we had solve by using the tank that placed above ground with 3 metres that will produce gravity force and provide low water pressure.

Furthermore, we improve the monitor features with raindrop sensor which able to detect overflow water to the plants. Besides, a water flow sensor and pressure gauge are placed before the solenoid valve which provide water flow monitoring system. The previous project is only can be monitored in mobile application and we upgrade this feature to be displayed in web through browser. It can be displayed in any device as long as it has internet.

This IoT-based solar irrigation system can be used at any plantation or nursery. The main component needed for this system consist of Arduino Uno, NodeMCU, Raspberry Pi, solenoid valve and sensors. Lastly, the scope for this project is to create a programming code for NodeMCU ESP8266 and Arduino Uno microcontroller to enhance the system as it provides remote function towards the user.

1.5 Organization of thesis

In this paper there will be 5 chapters including introduction, literature review, methodology, result and discussion, and conclusion. Introduction would briefly explain the project in general such as the project background, project statement, objectives and also the scope of the project. For Chapter 2, it contains all the past research from related field researcher which give an idea and reference for this project. These past research act as guidance and improvisation that combining the benefit of few past project can be seen in this project. In Chapter 3, the information of design, electrical part, and component sizing. Result and discussion contain of the changes and process of uncompleted project until the finished project which contain the finding of the project process. Finally, Chapter 5 is the part of summarize all the important feature of this project and the suitable recommendation that can be modify in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, will discuss about the irrigation system concepts, the details of irrigation system and the type of system use in irrigation system. Related works from different country will be discussed below.

2.2 Concept of irrigation

Irrigation defines as a process of supplying water to the crops or plants artificially to fulfil their water requirements. Nutrients may also be supplied to the crops through irrigation. There are many sources of water for irrigation such as wells, canals, ponds, lakes, tube-wells and dams. Irrigation offering moisture that needed for growth, development, or germination of the plants. The type of irrigation also divides into many ways such as surface irrigation, localized irrigation, sprinkler irrigation, drip irrigation, centre pivot irrigation, sub irrigation, and manual irrigation. The time taken, frequency, rate, water amount of irrigation is different according to the types of irrigation, soil, and seasons. For example, summer crops require a higher amount of water as compared to winter crops (BYJUS, 2020).

2.3 Comparison of manual and automatic irrigation systems

In Switzerland, the major part of the 500 ha strawberry production area is cultivated with drip irrigation. Traditionally, the irrigation management is based on the monitoring of the soil moisture combined with a manually operated irrigation system, which is quite time consuming. In Switzerland, salaries are high and are a major production cost. The use of fully automatic irrigation systems might help to reduce production costs and eventually reduce the amount of water used for irrigation. From 2013 to 2015, a field experiment was carried out to compare two manual irrigation systems (traditional producer manual approach and optimised) and two automatic irrigation system (Watermark and PlantCare) on yield and fruit quality (fruit size, acidity, sugar, firmness) of strawberries. During the irrigation period, the average daily water volume was 1.1 - 1.2 L m-2 for the optimised irrigation systems (manual or automatic) and 1.6 L m-2 for the traditional manual producer irrigation system. This important reduction of the irrigation water volume had no impact on yield and fruit quality. The optimised manual irrigation system could save as much water as the automatic irrigation systems but increased the workload (A. Ançay, V. Michel and C.A. Baroffio, 2017).

Manual producer system

The irrigation system was based on the reading of three tensiometers twice a week. When the median of three tensiometer values reached the threshold value, irrigation was activated manually to dispense a predefined water volume.

Manual optimised system

The irrigation system was also based on tensiometer measurements, which occurred at a higher frequency than in the Manual producer system. When the threshold was reached (median of three tensiometers), the irrigation was manually started to dispense a predefined water volume, which was different from the Manual producer system.

Automatic Watermark (WEM) system

The automatic WEM system was based on measurements taken from three Watermark sensors connected to an electronic control module. The sensors measured the soil moisture four times per day (9 am, 11 am, 1 pm, 3 pm). When the threshold value of 20 kPa was reached at one of the four measuring moments, irrigation started automatically to dispense 0.75 L m-2.

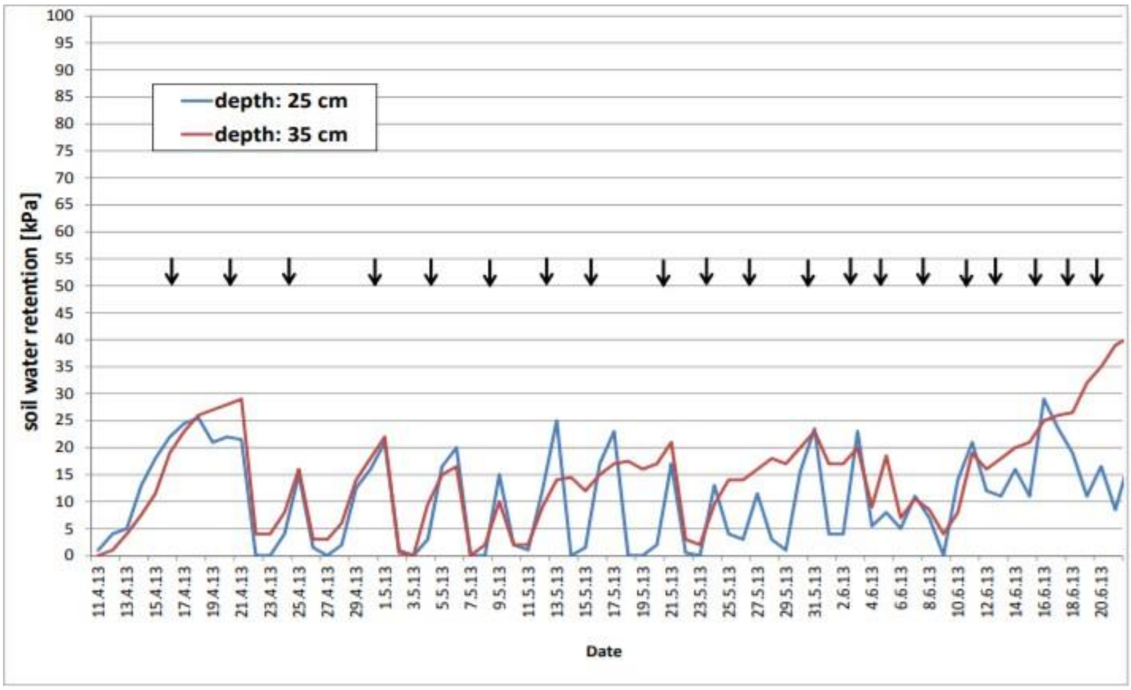

Figure 2.1 Soil moisture of the manual producer system (median of 3 Watermark sensors for each depth). Each arrow indicates an irrigation cycle.

In the manual producer system, a continuous change of soil moisture between 0 and 20 kPa, was measured at a depth of 25 and 35 cm (Figure 2.1), which indicates an excessive volume of water applied for irrigation.

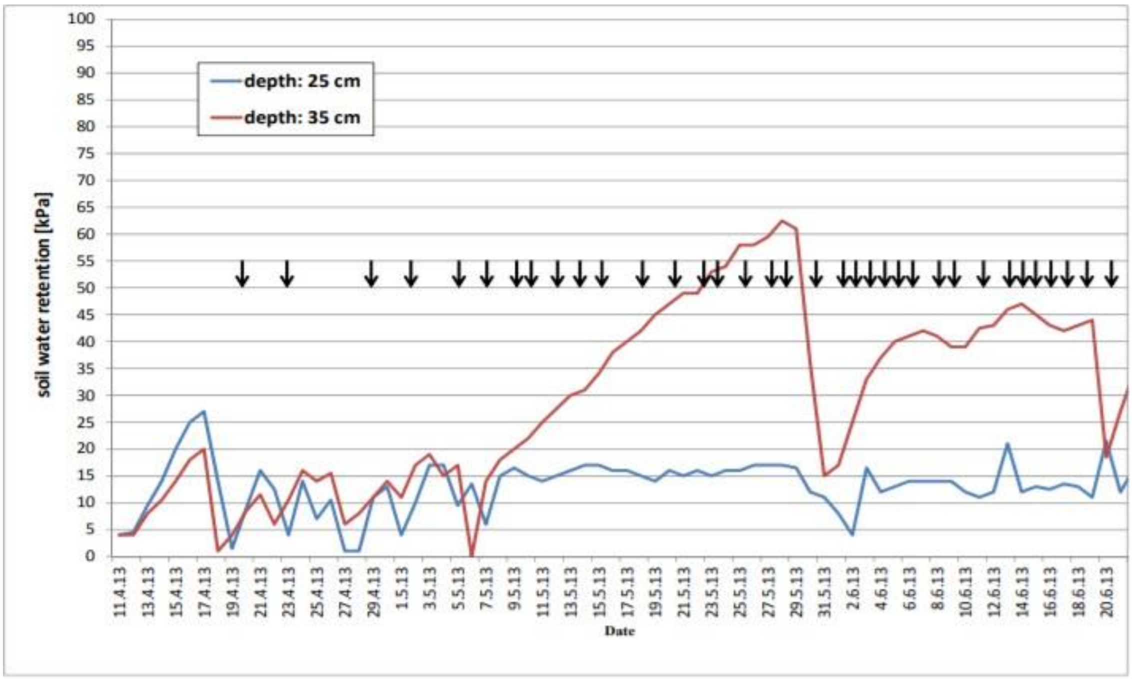

Figure 2.2 Soil moisture of the manual optimised system (median of 3 Watermark sensors for each depth). Each arrow indicates an irrigation cycle.

In the manual optimised system, a similar soil moisture pattern was measured until mid-May (Figure 2.2). Starting from this moment, the soil moisture level at 25 cm depth did no more climb higher than 15 kPa, this was caused by the rising temperatures. This effect was even stronger at a depth of 35 cm. There was no visible loss of water, the water was consumed in the top 25 cm soil layer. The WEM system showed a continuous change in soil moisture at 25 cm depth, where it varied between 0 and 15-20 kPa. At 35 cm depth, in contrast, the soil moisture decreases from the beginning of the irrigation period. This could be the result of the higher irrigation frequency (max. 4 times per day), but a quite lower water volume per irrigation.

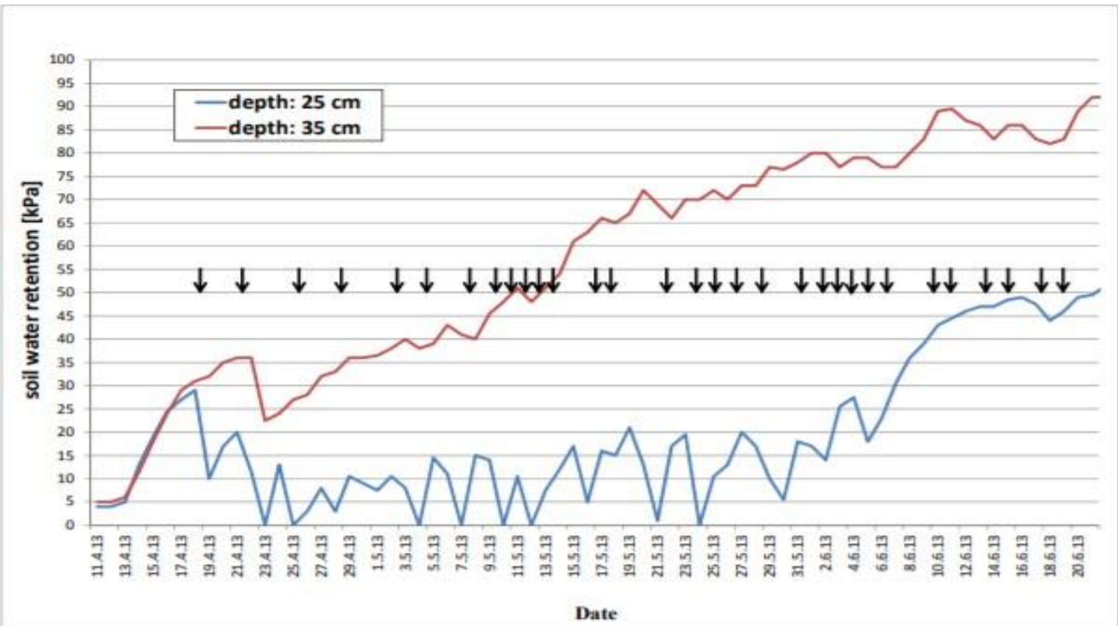

Figure 2.3 Soil moisture of the WEM system (median of 3 Watermark sensors for each depth). Each arrow indicates an irrigation cycle.

The investigation carried out on different irrigation systems in strawberries showed that with higher workload in a manual or with an automatic irrigation system, an important volume of irrigation water can be saved. The automatic systems have a potential to reduce labour and water at the same time. There were no statistically significant differences in yield, fruit size and fruit quality of the different irrigation systems.

2.4 Smart Irrigation System using Arduino

Water plays an important part in a human's daily life. In India for example many agricultural land and industries already are facing the problems of drought, so this issue can be solved with the help of current technology. Today's technology requires an easy-to-use device which is economical and effective such as Arduino. The system has two different part. For the first part is setting up an Arduino and interface it with a few sensors. For the second part is the integration with the IoT platform which is using ESP 8266 Wi-Fi moduled. It is used for transmission to becomes simpler and faster. It will help the farmers to monitor the system easily. (S. Thakare, P. H. Bhagat 2018)

2.5 Microcontroller Based Automatic Plant Irrigation System

In this system the sensor of soil moisture is placed in the plant. The sensor will send an information to the microcontroller and passes the data on. An algorithm was developed for measuring the threshold value of the soil moisture sensor, which was programmed into a microcontroller to monitor the soil moisture content. This system is based on microcontroller ATMEGA328. Farmer will get the information through GSM module without going to the nursery. (BD Kumar, P Srivastava, R Agrawal, 2017)

2.6 Precision Water Saving Irrigation Automatic System

There are some studies show that moisture and temperature are two main environmental factors for plants growing. The impact on different soil water handling on stem weight, and root weight, total biomass is notable, plant leaves relative moisture content and water consumption volume per plant decrease with the reduction of soil water. When soil water content is higher than a certain value, the plants could survive. However, when soil water content is too high, it will not only cause the root to decay, but also a waste of water at the same time, and as a result of too much irrigation, water infiltration will take away large fertilizer, which causes a waste of fertilizer, pollution of groundwater resources. Therefore, controlling soil water content near root of plants in a certain range between plant survival threshold value and plant water requirement with the largest biomass could ensure a large number of waters saving and plant's appreciation. (Y. Zhao, J. Zhang, J. Guan and W. Yin, 2009)

2.7 Control and Automation in Citrus Microirrigation

Microirrigation (drip and microsprinklers) is the predominant method of irrigation for citrus in Florida. With chemigation, microirrigation systems it can also provide an economical method of applying fertilizer and other agricultural chemicals on a time basis. Microirrigation systems require a high level of management expertise compare to other irrigation methods. Microirrigation systems are more complex, which it requires greater filtration and water treatment, and have high maintenance costs compared to other types of irrigation. Irrigations generally must be scheduled more frequently with microirrigation systems, since they reach only a fraction of the root zone as compared to other types of systems (Brian Boman, Steve Smith, and Bill Tullos, 2006).

There is a way to manage the higher demands of microirrigation is by using of automation and central control systems. With these technologies, it allows efficient control of water flows to various zones; injection of water conditioners, fertilizers, and agricultural chemicals; allow remote checks of system performance; control filter backflushing; and provide extensive records of water use. More sophisticated systems allow irrigations to be scheduled based on evapotranspiration (ET) calculations from nearby weather stations. In many citrus microirrigation systems, a controller is an important and integral part of the irrigation system.

Controllers can help to achieve labour savings in addition to applying water in the necessary quantity and at the right time to achieve high efficiency in water, energy, and chemical uses. Irrigation controllers have been available for many years in the form of mechanical and electromechanical irrigation timers. These devices have evolved into complex computer-based systems that allow accurate control of water, energy and chemicals while responding to environmental changes and crop demands.

There are two control strategies in this project, which is by using two general types of controllers to control irrigation systems: open control loop systems and closed control loop systems. Open control loop systems apply a preset action, such as is done with simple irrigation timers. Closed control loops receive feedback from sensors, make decisions and apply the results of these decisions to the irrigation system.

2.7.1 Open Loop System

In an open loop system, the operator makes the decision on the amount of water to be applied and timing of the irrigation event. The controller is programmed correspondingly, and water is applied according to the desired schedule. Open loop control systems use either irrigation duration or a specified applied volume for control purposes. Open loop controllers normally come with a clock that is used to start irrigation. Termination of the irrigation can be based on a pre-set time or may be based on a specified volume of water passing through a flow meter.

2.7.2 Closed Loop System

In closed loop systems, the operator develops a general control strategy. Once the general strategy is defined, the control system takes over and makes detailed decisions on when to apply water and how much water to apply. This type of system requires feedback from one or more sensors. Irrigation decisions are made, and actions are carried out based on data from sensors. In this type of system, the feedback and control of the system are done continuously. Closed loop controllers require data acquisition of environmental parameters (such as soil moisture, temperature, radiation, wind-speed, etc) as well as system parameters (pressure, flow, etc.). Figure below show that a simple version of a closed loop control system is that of an irrigation controller. A moisture sensor interrupts the irrigation process. When soil-moisture drops below a certain threshold, the sensing device closes the circuit, allowing the controller to power the electrical valve and the irrigation starts.

Figure 2.4 Simple version of a closed loop control system.

2.7.3 Controllers

In the simplest form, irrigation controllers are devices which combine an electronic calendar and clock and are housed in suitable enclosure for protection from the elements. The controller provides a low-voltage output (typically 12 or 24 volts DC or 24 volts AC) to the valves and control devices for specific zones. As long as the voltage is applied, valves stay open and irrigation water is applied. Most remote-control valves are “normally closed” meaning that the valve is closed until the solenoid is actuated by the controller. A “normally open” control valve remains open until such time as the solenoid is actuated. Normally open valves are sometimes used as master valves in systems when it is desirable to have a continuously pressurized mainline but still have a primary valve that can be closed in the event of excessive flow or other alarm conditions.

2.7.4 Sensors

A sensor is a device placed in the system that produces an electrical signal directly related to the parameter that is to be measured. In general, there are two types of sensors: continuous and discrete. Continuous sensors produce a continuous electrical signal, such as a voltage, current, conductivity, capacitance, or any other measurable electrical property. Continuous sensors are used when just knowing the on/off state of a sensor is not sufficient. For example, to measure pressure drop across a filter (Figure 2.5) or determine tension in the soil with a tensiometer fitted with a pressure transducer (Figure 2.6) requires continuous-type sensors.

Figure 2.5 Control panel for automatically backflushing filters based on pressure differential between inlet and outlet of filter.

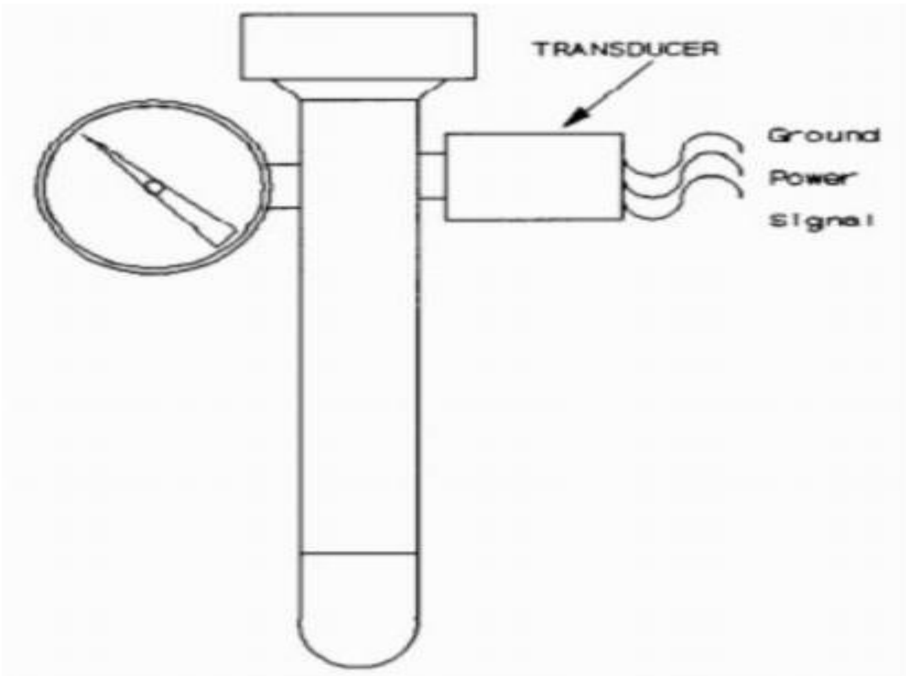

Figure 2.6 Tensiometer fitted with pressure transducer to provide continuous feedback of soil tension status.

2.8 Real-Time Automation and Monitoring System for Modernized Agriculture

The technological development in Wireless Sensor Networks made it possible to use in monitoring and control of greenhouse parameter in precision agriculture. Due to uneven natural distribution of rain water it is very crucial for farmers to monitor and control the equal distribution of water to all crops in the whole farm or as per the requirement of the crop. All the parameters of greenhouse require a detailed analysis in order to choose the correct method. With the evolution in wireless sensor technologies and miniaturized sensor devices, it is possible to use them for automatic environment monitoring and controlling the parameters of greenhouse, for Precision Agriculture (PA) application. In the Field bus concept, the data transfer is mainly controlled by a suitable wired communication system, now can be replaced with the hybrid system (wired and wireless) to extract the benefits of both and to automate the system performance and throughput. ZigBee protocols based on IEEE 802.15.4 – 2003 for wireless system are used. The atmospheric conditions are monitored and controlled online by using Ethernet IEEE 802.3. Partial Root Zone Drying Process can be implemented to save water at the maximum extent. Online interaction can be made with the farmers by the consultant to give them the knowledge about this technique and implement it effectively in their farms to extract more yield with advanced technology (V.Vidya Devi and G.Meena Kumari, 2013).

2.9 IoT Based Smart Irrigation System

Automation of farm activities can transform agricultural domain from being manual and static to intelligent and dynamic leading to higher production with lesser human supervision. This paper proposes an automated irrigation system which monitors and maintains the desired soil moisture content via automatic watering. Microcontroller ATMEGA328P on arduino uno platform is used to implement the control unit. The setup uses soil moisture sensors which measure the exact moisture level in soil. This value enables the system to use appropriate quantity of water which avoids over/under irrigation. IOT is used to keep the farmers updated about the status of sprinklers. Information from the sensors is regularly updated on a webpage using GSM-GPRS SIM900A modem through which a farmer can check whether the water sprinklers are ON/OFF at any given time. Also, the sensor readings are transmitted to a Thing speak channel to generate graphs for analysis (S. Raval, 2017).

2.10 Summary

Irrigation can be categorized into many types and ways. A suitable way of irrigation is crucial to ensure that the crops or plants get enough of water and at the same time the irrigation system is benefit to the farmers where it can reduce the burden of them. It cannot be denied that an irrigation system has many benefits and importance. The importance of irrigation is increasing the availability of water supply which increase the income of farmer, stabilizing the output of plantation, and helping to bring most of the fallow land under cultivation (BYJUS, 2020). Irrigation should be optimised because ever over-irrigation could spoil the production of crops. Excessive water supply to the crops or plants would cause root diseases.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is a study or description of methods which includes the specific procedures or technique to achieve the successful of solving the problem. In this chapter will explained in detail of the steps or ways to develop the control system of the IoT-based solar irrigation system. These methods are used to achieve the objectives of the project which to get satisfying results or outcomes on the performance of this IoT-based solar irrigation system.

3.2 Proposed system

In our proposed system, the control system of IoT-based solar irrigation system is divided into two parts which are valve control part and water monitoring part. Valve control part is the part which include the methods or operations of the solenoid valve to close or on the irrigation. Meanwhile, for the water monitoring part, this is where the explanation of the water flow monitoring feature.

Figure 3.1 is the system flow diagram of the valve control part in IoT-based solar irrigation system. This flow diagram shows the solar energy harvesting process where the solar panel is used to collecting the solar energy and convert into electric energy. Next, the electric energy is stored into the rechargeable battery and it is a source of power to control the solenoid valve. Solenoid valve in this system is a controlling component to allow or cut down the water supply from the water tank to the irrigation of crops or plants. This solenoid valve is commanded by a microcontroller which is NodeMCU. Sensors are attached to the surrounding of the plants or crops to gain information and display to the user with the help of microcontroller. The microcontroller can be coding to customise the interface of the information provide by sensors.

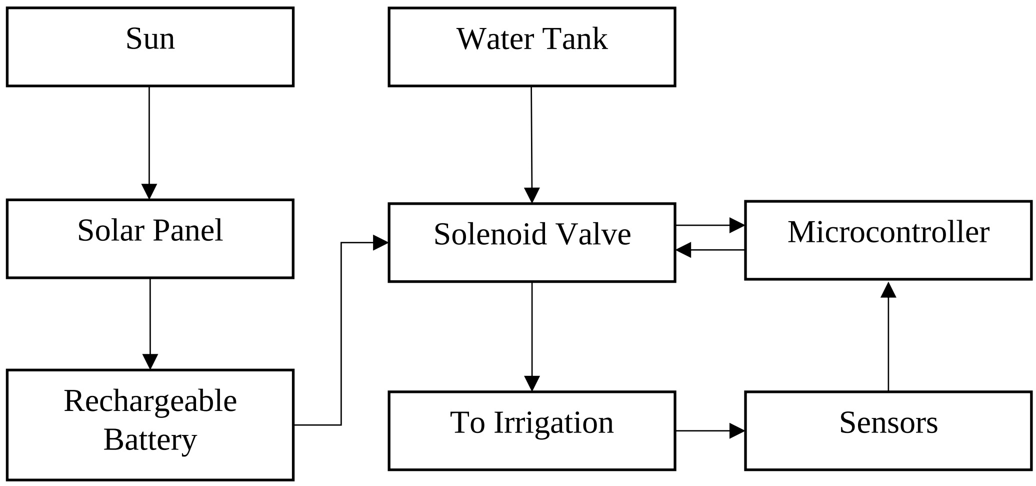

Figure 3.1 System Flow Diagram of Valve Control

Figure 3.2 below is representing for the block diagram of water monitoring part in the IoT-based solar irrigation system which show the connection between all the components such as sensor, battery, microcontroller and LCD. The microcontroller we used in this water monitoring part is Arduino Uno. The Arduino Uno is one of the simple microcontroller that can be used to work with sensor and also LCD. The battery is connected to Arduino Uno to operate the system and also give power supply to the LCD. Water flow sensor is used to gain the information of water flow through the pipe. The information such as water flow rate and total amount of water flow can be displayed in the LCD which had been connected to the Arduino Uno. The rate of water flow and total amount of water flow can be programmed in any unit. In this project, we programmed the water flow rate in litres per minute and the total amount of water flow in litres by using Arduino IDE. The coding is programmed in Arduino IDE and then uploaded to the Arduino Uno.

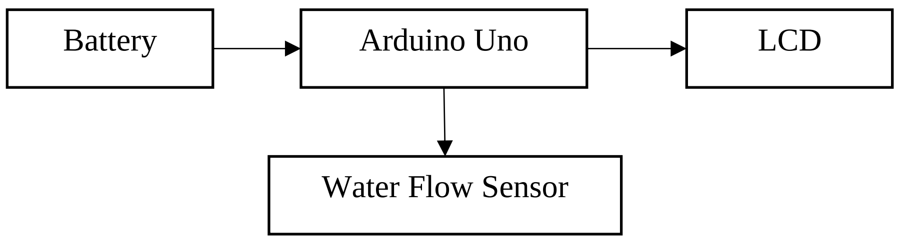

Figure 3.2 Block Diagram of Water Monitoring

3.3 Proposed design

In the proposed design, it will be explained in detail for the flow charts, circuits, components used and pseudocode.

3.3.1 Valve control

Figure 3.3 below shows the flowchart of valve control part in the IoT-based solar irrigation system. This flowchart is used as a guidance to the user to understand how the command system flow and the corresponding of the system.

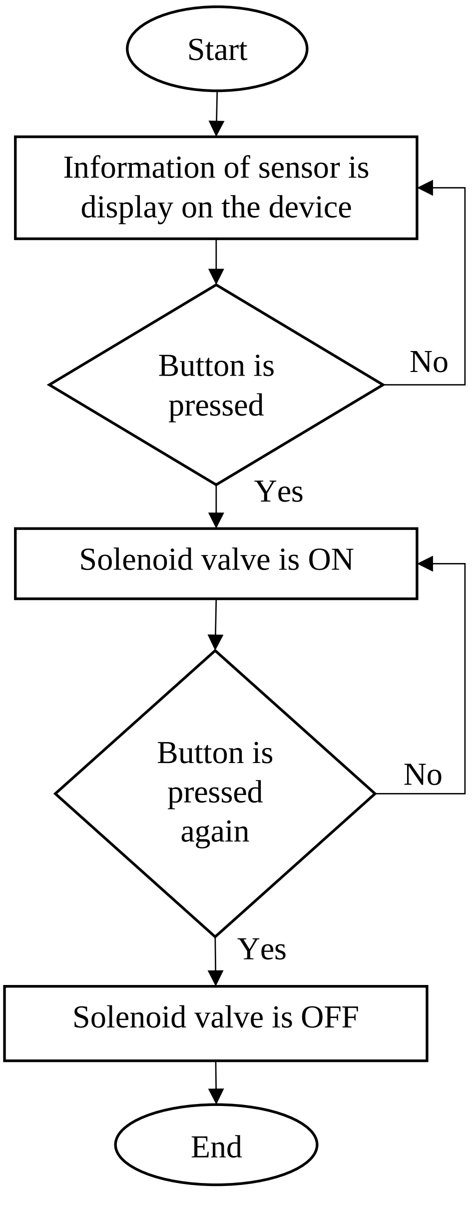

Figure 3.3 Flowchart of Valve Control

The Figure 3.4 below shows that the circuit design of valve control part in IoT-based solar irrigation system. The electric components such as NodeMCU, relay, 9V battery, 12V battery and solenoid valve are show in the figure how it connected in the circuit.

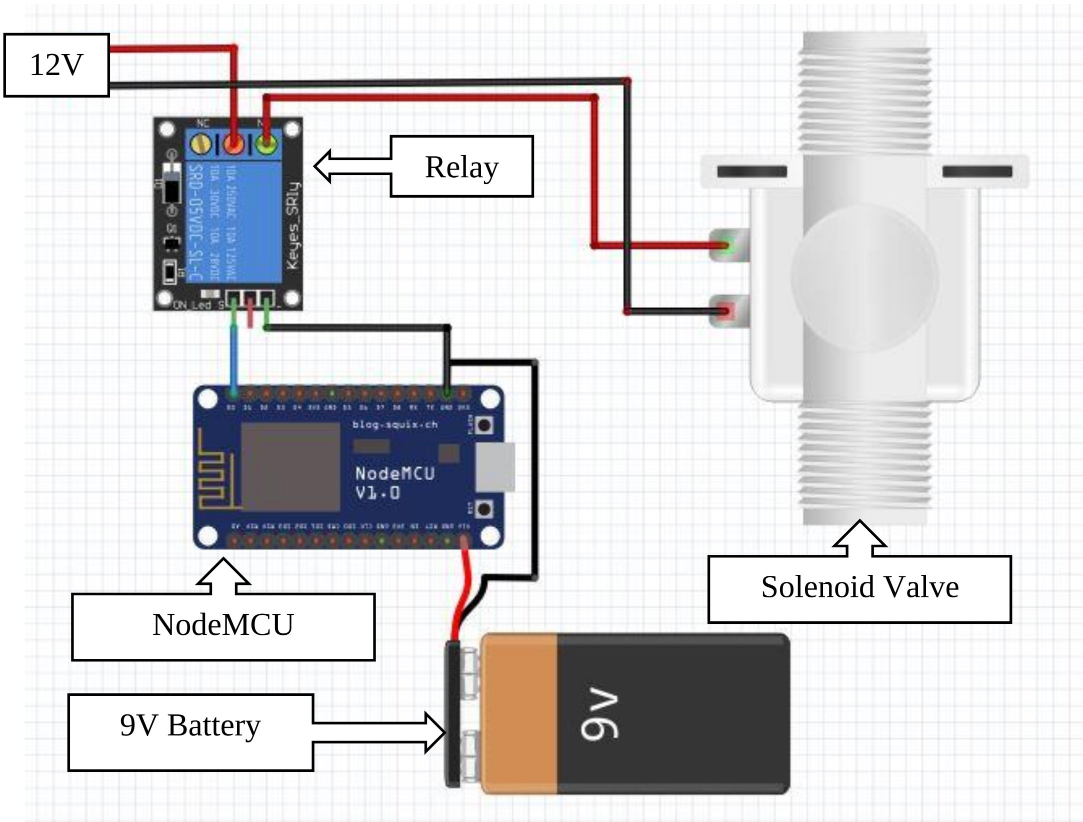

Figure 3.4 Circuit Design of Valve Control

The microcontroller use in the valve control is NodeMCU. Figure 3.5 has been chosen as it can develop quickly an IoT application with less integrated circuits. It is an open-source firmware and development kit that plays a vital role in designing a proper IoT product using a few script lines. This module is mainly based on ESP8266 introduced by manufacturer Espressif Systems that is a low-cost Wi-Fi microchip incorporating both a full TCP/IP stack and microcontroller capability. It is complex device combining some features of the ordinary Arduino board and connecting to the internet. Arduino Modules and Microcontrollers have always been a great choice to incorporate automation into the relevant project. But these modules are not perfect as they do not feature a built-in WiFi capability. Therefore, a NodeMCU which is based on ESP8266 WiFi SoC is used to replace the Arduino Modules as it is a device that has some features of the Arduino board. This NodeMCU is also an open-source firmware and development kit that helps you to prototype your IoT product within a few lines of LUA script and it can be programmed easily using C or C++ language in Arduino IDE (A.A.Dahoud and M.Fezari, 2018).

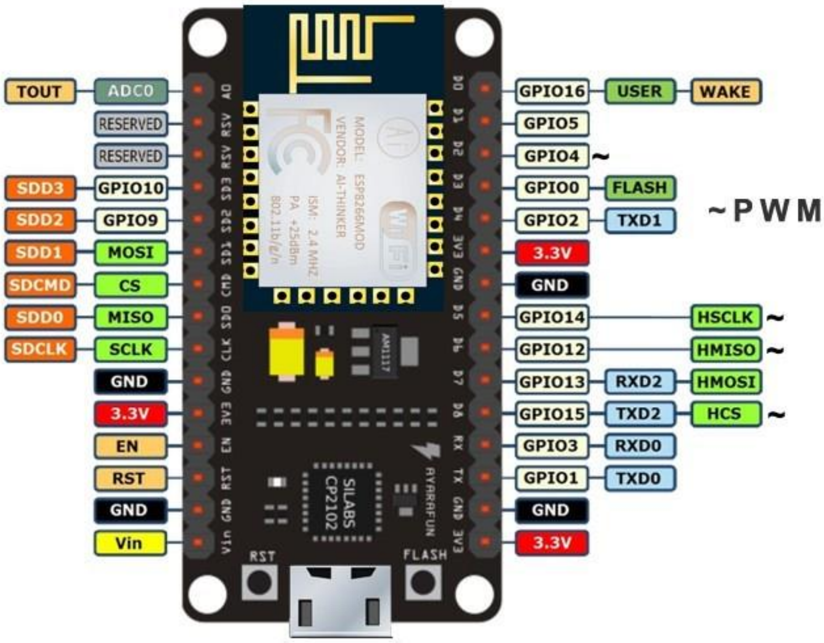

Figure 3.5 NodeMCU and Pinout function

Programming NodeMCU with Arduino IDE:

1. Open Arduino IDE and navigate to File > Preferences.
2. In the space marked "additional Boards Manager URLs" add the following url:

http://arduino.esp8266.com/stable/package_esp8266com_index.jso

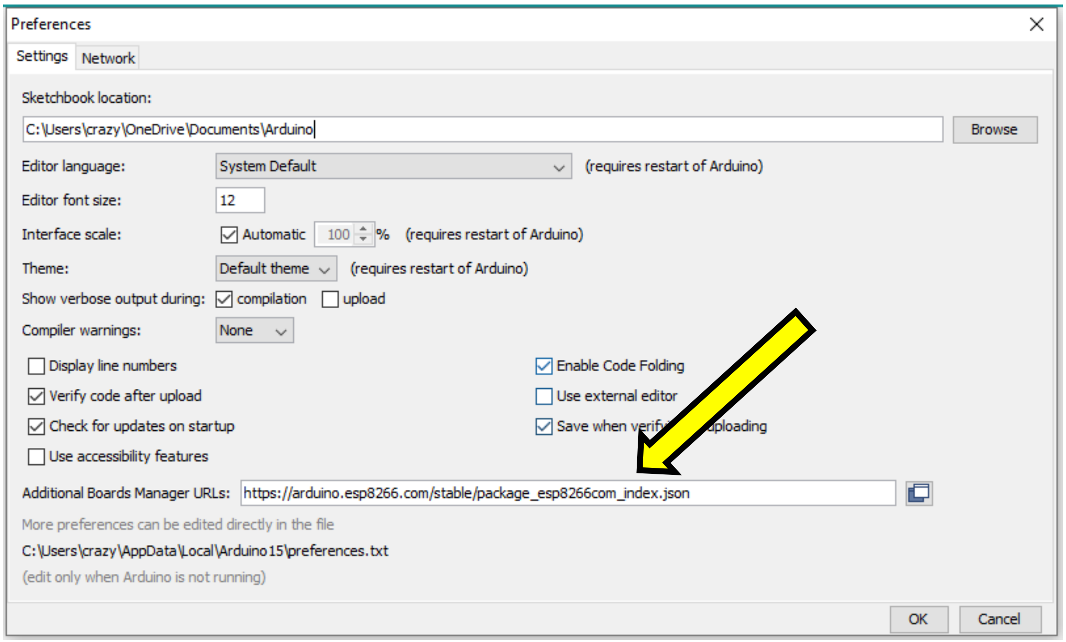

Figure 3.6 Programming NodeMCU with Arduino IDE

3. Click "OK".
4. Navigate to the Boards Manager. You'll find it under Tools > Board > Boards Manager.
5. Type "ESP8266" into the resulting search bar. Then install the package.

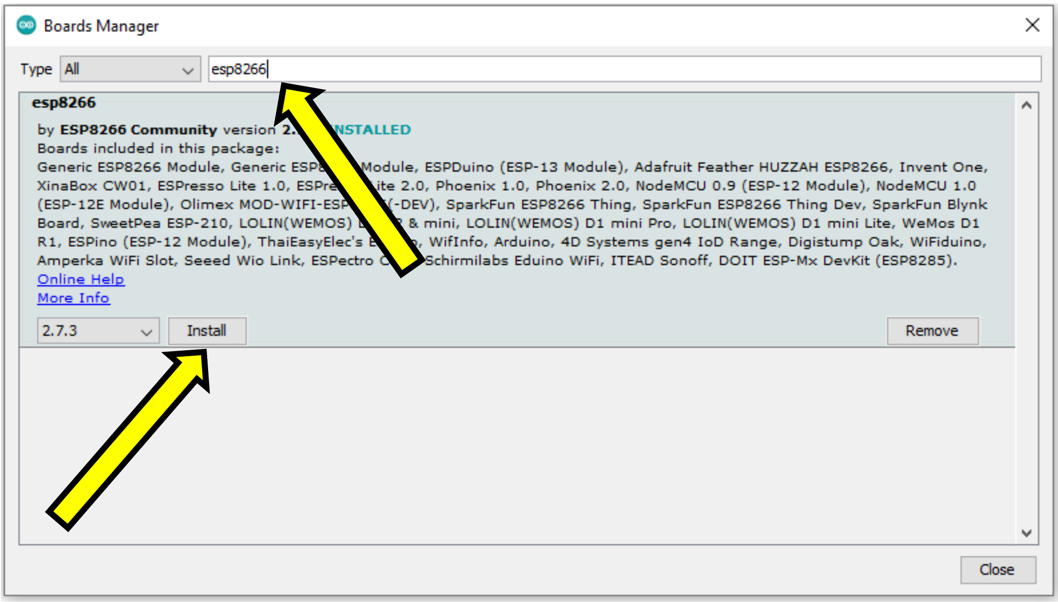

Figure 3.7 Board manager for ESP8266

6. Select the exact model. Go to Tools > Board and select "NodeMCU1.0 (ESP-12E module)."

Now ready to start uploading code to our ESP.

Solenoid valve is used in this project as a controller in the valve control system to control the water flow to the plant. Figure 3.8 show that the 12V Pressurized Solenoid Valve with a dimension of 84mm (L) x 34mm (W) x 57mm (H) and weight of 100g. This solenoid valve is applicable for water pressure of 0.02-0.8Mpa. Solenoid valves are frequently used to control elements in fluidics as its tasks are to shut off, release, dose, distribute or mix fluids. It is found in many application areas because it come with the advantages of fast response time switching, low power consumption, cheap replacement parts and can be installed vertically or horizontally (Pro Water Part, 2019). The disadvantages of solenoid valve are sensitive to voltage and control signal must stay on during operation.

Figure 3.8 12V Pressurized Solenoid Valve

Figure 3.9 show that the relay module that use in this project. A power relay module is a switch that operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close a circuit. A simple relay consists of wire coil wrapped around a soft iron core, or solenoid, an iron yoke that delivers a low reluctance path for magnetic flux, a movable iron armature and one or more sets of contacts. The movable armature is hinged to the yoke and linked to at least one or more set of the moving contacts. Held in place by a spring, the armature leaves a niche within the magnetic circuit when the relay is de-energized. While during this position, one among the 2 sets of contacts is closed while the opposite set remains open.

When electrical current is skilled a coil, it generates a magnetic flux that successively activates the armature. This movement of the movable contacts makes or breaks a reference to the fixed contact. When the relay is de-energized, the sets of contacts that were closed, open and breaks the connection and vice versa if the contacts were open. When switching off the present to the coil, the armature is returned, by force, to its relaxed position. This force is typically provided by a spring, but gravity also can be utilized in certain applications. Most power relays are manufactured to work during a quick manner (GEP Power Products, 2020).

This relay module act as a switch to allow the electrical flow from the 12V battery to the solenoid valve by giving a signal from the microcontroller NodeMCU.

Figure 3.9 Relay Module

GP1270 12V 7.2aH Rechargeable Battery is used in this project. This Seal Lead Acid (SLA) Rechargeable battery is the most common general-purpose battery. The advantages of this battery are low cost, robust and less maintenance required. But it is considered heavy weight for certain robotic application. This SLA batteries can be charge by using any general DC power supply if it provides the correct voltage to the battery. It has a dimension of 15cm (L) x 6.5cm (W) x 9cm (H) and weight of 2.32kg. The battery fully discharge is around 80 W while the operating time will depend on load given and power withdraw rate of the electronic component. Figure 3.10 show the battery that use in this project cope with the diaphragm water pump. The battery capacity can supply electricity to the motor up to 2-3 hours. The advantages of the lead–acid battery is the cheapest secondary power source, fully recyclable and safe equipment while the disadvantage is the low specific energy (Detchko Pavlov, 2017).

Figure 3.10 GP1270 Lead Acid Rechargeable Battery

The nine-volt battery, Figure 3.11 is a rectangular prism shape with rounded edges and a polarized snap connector at the top. It is commonly used in walkie-talkies, clocks and smoke detectors. The purpose of using this 9V battery is to supply power for the microcontroller.

The nine-volt battery format is usually available in primary carbon-zinc and alkaline chemistry, in primary lithium disulfide, and in rechargeable form in nickel-cadmium, nickel-metal hydride and lithium-ion. Mercury-oxide batteries of this format, once common, have not been manufactured in a few years due to their mercury content. Designations for this format include NEDA 1604 and IEC 6F22 (for zinc-carbon) or MN1604 6LR61 (for alkaline).

Figure 3.11 9V Battery

3.3.2 Water monitoring

Figure 3.12 below shows the flowchart of water monitoring part in the IoT-based solar irrigation system. This flowchart is used as a guidance to the user to understand how the command system flow and the corresponding of the system.

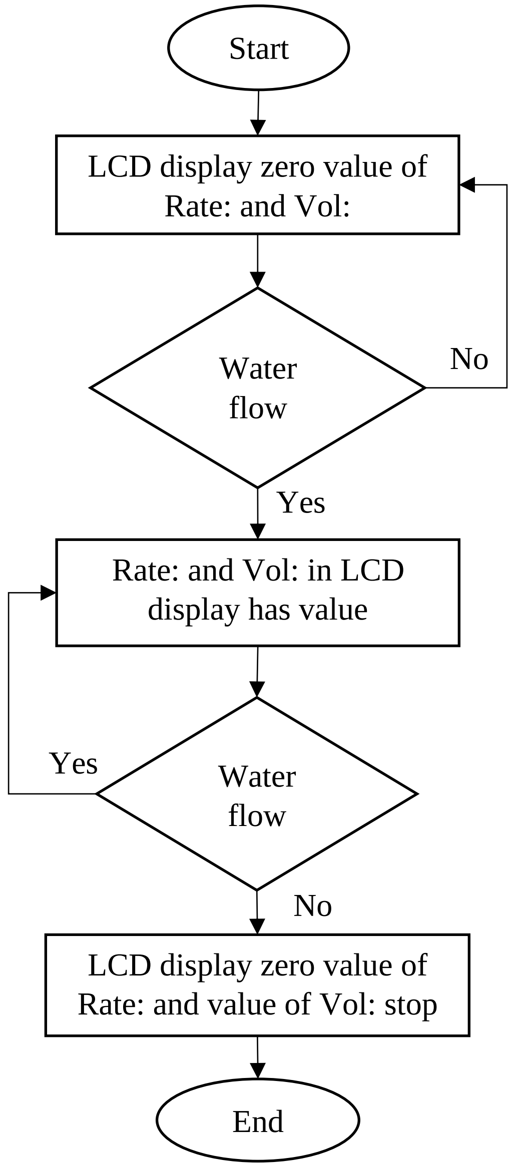

Figure 3.12 Flowchart of Water Monitoring

The Figure 3.13 below shows that the circuit design of water monitoring part in IoT-based solar irrigation system. All the electric components such as Arduino Uno, YF-S201 Hall Effect Water Flow Sensor, and 2x16 LCD with I2C are show in the figure how it connected in the circuit.

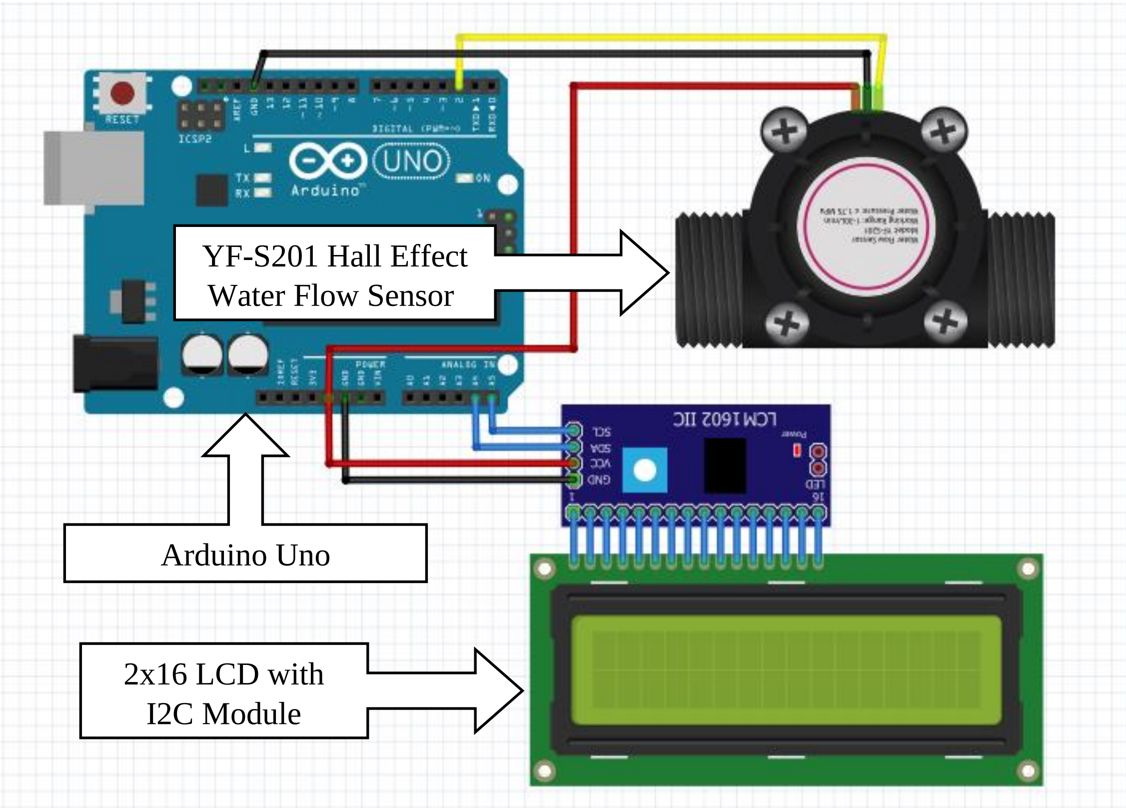

Figure 3.13 Circuit Design of Water Monitoring

Arduino Uno is the microcontroller that use in the water monitoring system. Figure 3.14 is an open-source microcontroller board based on the Microchip ATmega328P. This board is equipped with sets of digital and analog input/output (I/O) pins which can interface to various expansion boards and other circuits. It has 12 digital I/O pins (6 capable of PMW output), 6 analog I/O pins, and can be programmable easily using C or C++ language with Arduino IDE (Integrated Development Environment) by connecting with type B USB cable. This microcontroller can be powered by 9V battery or the USB cable. In this project, this Arduino Uno use to receive the signal from water flow sensor and displaying the water flow rate in the LCD.

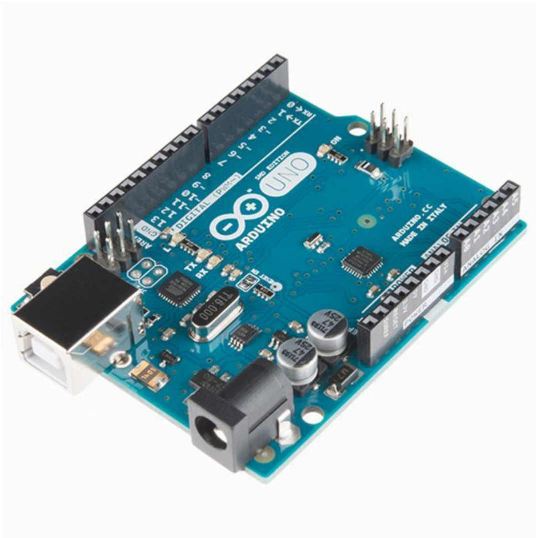

Figure 3.14 Arduino Uno

Programming Arduino Uno with Arduino IDE:

1. Download the ZIP library file from the link below:

   https://github.com/fdebrabander/Arduino-LiquidCrystal-I2C-library

2. Open Arduino IDE > Sketch > Include Library > Add .ZIP Library…

3. Find your downloaded ZIP file in step 1 > Select on the file > Open

Now it is ready to start the programming.

In the Arduino IDE, you must include the library file in the coding as Figure 3.15 in order to use the LCD. The LCD would not success to display if the library file is not including.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
```

Figure 3.15 Including LCD library

In this project, the water flow sensor that use is YS-S201 Hall Effect Water Flow Sensor as in Figure 3.16. The water flow sensor is installed at the water source or pipes to measure the speed of flow of water and calculate the quantity of water flowed through the pipe. Rate of flow of water is measured as litres per hour or cubic meters. Water flow sensor consists of a plastic valve from which water can pass. A water rotor along with a hall effect sensor is present the sense and measure the water flow. When water flows through the valve it rotates the rotor. By this, the change is often observed within the speed of the motor. this alteration is calculated as output as a pulse signal by the hall effect sensor. Thus, the speed of flow of water are often measured (ElProCus, 2019).

The main working rule behind the working of this sensor is that the hall effect. consistent with this principle, during this sensor, a voltage difference is induced within the conductor due to the rotation of the rotor. This induced voltage difference is transverse to the electrical current. The water flow sensor is often used with hot waters, cold waters, warm waters, clean water, and dirty water also. These sensors are available in several diameters, with different flow ranges.

Figure 3.16 YF-S201 Hall Effect Sensor Water Flow Sensor

In the water flow monitoring system, LCD is used to display the value of flow rate (L) per minutes (min). LCD (Liquid Crystal Display) screen is an electronic display module. The LCD used in this project is a 16x2 LCD display and it is very commonly used in various devices and circuits. This LCD can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16x2 intelligent alphanumeric dot matrix display can display 224 different characters and symbols. This LCD has two registers, namely, Command and Data (Instructables, 2020). Figure 3.17 show that the LCD is connecting with a I2C (Inter-Integrated Circuit). The purpose of using I2C is to make the connection easier as the LCD pins from 16 is reduced to 4.

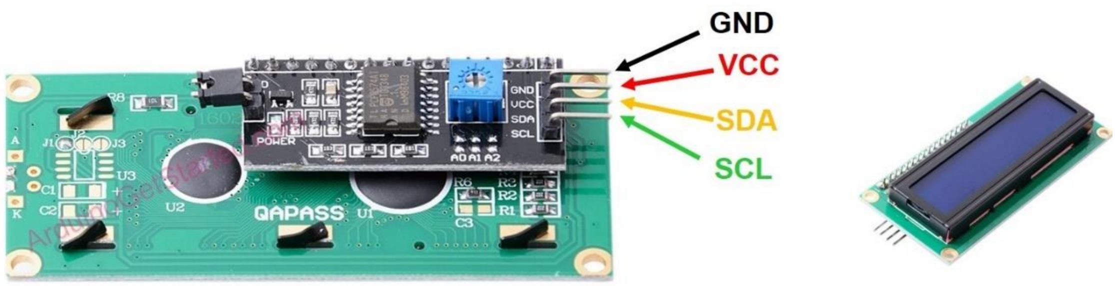

Figure 3.17 2x16 LCD with I2C

3.4 Summary

In the control system of IoT-based solar irrigation system, the exist of valve control part and water monitoring part is very crucial in this system to allow the user controlling the irrigation and at the same time user can monitor the information of the water flow. The information of water flow is important as it can be used to supervise the usage of water in the irrigation system.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results and outcomes of the project will be listed and showed in detail. The information and actual design of the system is showed by figure in below.

4.2 Developed water control system

The drip system of irrigation was setup in the rabbit site of FTKEE. This setup is to mock the same irrigation system that use by YPPH Sdn. Bhd. in their pre-nursery. The way of irrigation is using 16mm of driptape (Figure 4.1) which contain holes on the wall of the tape. The water droplet will drop out from the driptape through these holes. The driptape are placed on the top of Parit Tray (Figure 4.2). Parit Tray has drain along the tray which will be filled with medium or soil. This drain is used to collect the water droplet that supply by the driptape and then later absorb by the medium which placed along the side of the drain. Parit Tray is placed above ground with a 63cm of height to avoid disease infection and pest.

Figure 4.1 16mm Driptape

Figure 4.2 Parit Tray

Meanwhile, for the water supply, we also using the same concept as YPPH Sdn. Bhd. idea that used in their pre-nursery. A water tank is placed above the ground with 3 metres. The purpose of placing the water tank higher from the ground is to produce a gravity force which may create water pressure. As a result, this water tank able to provide a 4psi or 0.28bar of water pressure. Hence, this low pressure of water pressure is suitable to use for the driptape which has a thin layer of wall that cannot withstand high pressure of water.

Figure 4.3 Water Tank in Rabbit Site

The valve control system and water monitoring system are constructed before water distribution of driptape. Figure 4.4 show that the combination of valve control and water monitoring system at the water entering part before the distribution of driptape. Figure 4.5 show the driptape is built with 12 metres long start from the water entering part to the end of irrigation area.

Figure 4.4 Water Entering Part

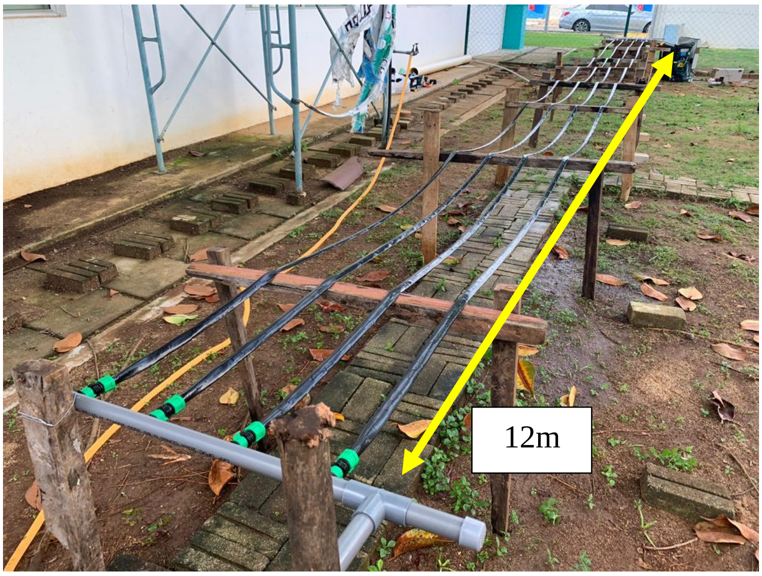

Figure 4.5 12m of Driptape

4.3 Developed design

The developed design is divided into two parts which are valve control and water monitoring. The actual design of the circuit will be showed in figure below.

4.3.1 Actual valve control

The solenoid valve is installed with 20cm PVC pipe in middle of the water entering part as Figure 4.4 which is in between of the distribution of driptape and the water monitoring part. The solenoid valve is powered by the solar water pump as Figure 4.7. The solar water pump is placed beside the Parit Tray because of the sensors have to place nearby the plants or crops to get the real surrounding information.

Figure 4.6 Solenoid Valve

Figure 4.7 Solar Water Pump

In this project, the solenoid valve is controlled by the mobile application "Blynk". This application is applicable to use in iOS or Android operating system and it can be downloaded through App Store or Google Play Store. Blynk is an application which could be synchronized with the server. During the synchronization process, the targeted server address is required, followed by the host port, the username and the specified authentication token given by the server as in Figure 4.8.

```
// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "FqL29ghfSfstbk0lle79NGsvTcn7-CQh";
```

Figure 4.8 Authentication token in Blynk

Figure 4.9 shows the mobile data and hotspot identification for the open networks to generate the system in the Blynk application. The username and password identification can be customized by users through their smartphone and both of these are belonging to the users to operate the system using Blynk application.

```
// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Aiman's Iphone";
char pass[] = "aiman123";
```

Figure 4.9 Username and password mobile hotspot

Figure 4.10 show that the programmed coding in Arduino IDE to command the solenoid valve to ON or OFF. The coding pinMode(D1,OUTPUT) is to configure pin D1 to behave as an output. And this output is connected to relay which use to control the electric flow from battery to solenoid valve.

```
pinMode(sensorPin, INPUT);
dht.begin();
pinMode(D1,OUTPUT);
digitalWrite(D1,HIGH);
```

Figure 4.10 Valve control coding

4.3.2 Actual water monitoring

Water monitoring is the part where involving the use of water pressure gauge, water flow sensor, Arduino Uno and LCD as in Figure 4.11. The water pressure gauge and water flow sensor are installed with the 20cm PVC pipe to get the information of water pressure and flow rate. The water pressure can be gained when the piping system in close or non-leakage condition. Meanwhile, the flow rate can be achieved when there is water flow through the sensor.

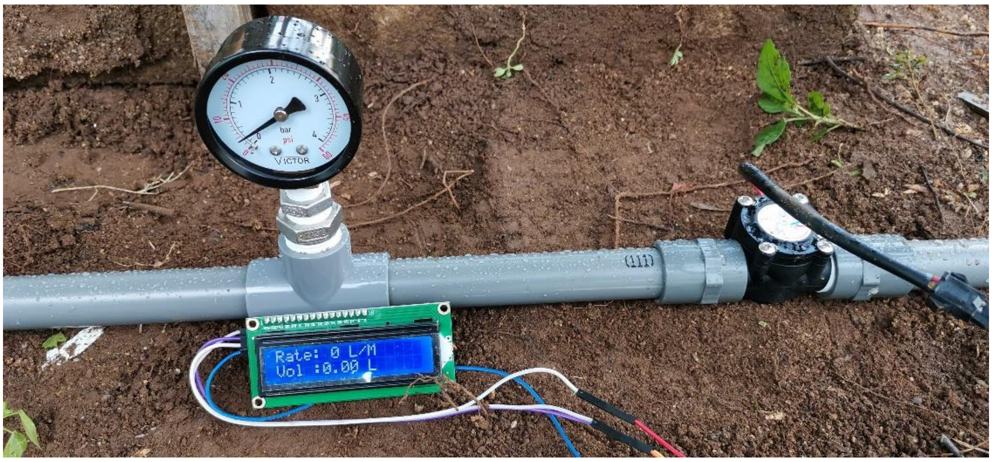

Figure 4.11 Water Monitoring

As an outcome for the project, we had taken the results of the water monitoring before and after the solenoid valve is ON. The Figure 4.12 and Figure 4.13 show the different of water pressure gauge and LCD. Before the solenoid valve is ON, the water pressure gauge show that the water pressure is 4psi or 0.28bar and the LCD do not have any increasement of values. After the solenoid valve is ON, the water pressure gauge drops to 0 and the LCD value is keep increasing according to the time.

Figure 4.12 Before solenoid valve is ON

Figure 4.13 After solenoid valve is ON

The time taken to flow along the driptape and irrigate until the water is overflow from the medium of Parit Tray was tested in two conditions which are in empty and residue water. Both conditions are tested under the same condition of water pressure which is 4psi or 0.28bar. When the condition of driptape is in empty, the time taken for water overflow is 9 minutes and 54 seconds while when the driptape is in residue water condition, the time taken for water overflow is 7 minutes and 21 seconds.

Table 4.1 Results of Irrigation

Condition of Driptape	**Time Taken for Water Overflow**
Empty	9min 54s
Residue Water	7min 21s

4.4 Summary

In summary, the results show that there is different between the before and after the solenoid valve is ON. This result means that the information of water pressure is vital to let the user or farmer alert with the condition of water pressure. If the water pressure is low than normal condition although the solenoid is OFF, this may cause by some factors. The factors of this condition are the water level in the water tank is low, water leakage happening and faulty of solenoid valve. For the results of irrigation, it shows that the time taken for water overflow is different corresponding to the condition of driptape. This means the farmer required higher time for irrigation to achieve enough water for the plants or crops if he or she had performed flushing on the driptape in order to clean up the blockage in the piping system. But, for the next irrigation, the time taken is much lesser which is only 7 minutes and 21 seconds.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

In the conclusion part, the overall project will be summarized, the recommendations of the project will be stated, and future work is suggested to give an idea to other researcher who refer to this thesis.

5.2 Conclusion

In conclusion, the objectives of this project are achieved. This project successfully to develop an IoT-based solar irrigation system which can be operated by solar energy. The solenoid valve of this system can be controlled and monitored by the microcontroller through mobile application. The mobile application Blynk can be downloaded from the store in iOS or Android system smartphones. The usages of water and electricity can be optimized by using this system. With the help of this system, farmers able to monitor and control their irrigation using technology and make their works more systematic. Furthermore, this system is using a low-cost material with RM468.70 which make it affordable by many small scales of farmers. Our developed product can be defined as an environment-friendly product as it is powered by solar energy. Using the renewable resources has be a trend nowadays as the pollutions in our world keep increasing and lead to many climates change. Solar powered product not only environment-friendly but also reduce the cost of using electricity.

5.3 Recommendation

This system may not define as a perfect project as it has some improvement can be done to increase the performance, safety, and functionality. In this project, there is some limitations found during the testing phase. The limitation is the microcontrollers use in this project is more than one. This way of designing may increase the complexity of system and the cost of product. In recommendation, the complexity of this system can be solved by using a microcontroller that has more pin and able to handle large amount of tasking.

Besides, this system also not a fully automated system that able to stop the irrigation when the soil moisture is achieved the appropriate amount of value. This problem can be solved by further study in the programming part of the microcontroller. Furthermore, this limitation of this system is only can be commanded to on or off the solenoid valve. This controlling system can be improved to let the user able to choose duration of the valve on by adding a real-time clock (RTC) module to the microcontroller. Real-time clock module provides the system with a time that allow the microcontroller to be improved in any features that has relationship with time.

5.4 Future work

In future, this IoT-based solar irrigation system may be improved to be a system that not only using solar to operate. There are many other renewable resources can be used to power this system such as hydropower, wind energy and biomass energy. A good system should not only depend on using solar energy as the weather of each day may different. Cloudy day and raining season will decrease the performance of solar panel. Therefore, other renewable resources can be used to replace the solar energy.

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APPENDICES

A COSTING

Table A1 List of Items with Price

No.	Items	Unit Price	Quantity	Amount
1	NodeMCU Board with Baseboard	RM24.80	2	RM24.80
2	3/4" PVC Pipe	RM9.00	1	RM9.00
3	3/4" PVC Pipe Fittings	RM4.80	1	RM4.80
4	16mm Drip Tape Fittings	RM22.00	1	RM22.00
5	16mm Drip Tape (50m)	RM30.00	1	RM30.00
6	PVC Socket Reducer 3/4" x 1/2"	RM0.45	1	RM0.45
7	LCD Module 16x2	RM20.30	1	RM20.30
8	Rain Sensor	RM7.00	1	RM7.00
9	Soil Moisture Sensor	RM7.00	1	RM7.00
10	40P Jumper Wires 20cm	RM4.00	3	RM12.00
11	12V DC Solenoid Valve	RM28.00	1	RM28.00
12	Water Flow Sensor	RM23.00	1	RM23.00
13	9V Battery Holder and Connector	RM3.00	1	RM3.00
14	1/2" PVC Pipe Fittings	RM5.35	1	RM5.35
15	1/2" PVC Pipe (1m)	RM1.60	1	RM1.60
16	Orange PVC Hose (5m)	RM13.00	1	RM13.00
17	2" 4bar Water Pressure Gauge	RM25.00	1	RM25.00
18	1/4" x 3/8" Bush	RM3.50	1	RM3.50
19	3/8" x 1/2" Bush	RM4.00	1	RM4.00
20	2 Core PVC Twin Flat Cable 23/0.14x2C (per m)	RM1.00	18	RM18.00
21	Raspberry Pi 3 Model B+ with Micro SD Card	RM192.00	1	RM192.00
22	Arduino UNO	RM14.90	1	RM14.90
		Total		RM468.70

B GANTT CHART

B1. GANTT CHART I

	FEBRUARY 2020				MARCH 2020				JUNE 2020				JULY 2020			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
SDP 1 Briefing	■															
Project Meeting	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Gather Information	■	■														
Project Statement & Design Features			■	■	■											
Evaluate Design Concept						■										
Cost Analysis							■									
First Draft of Proposal								■	■							
Second Draft of Proposal										■	■					
Third Draft of Proposal												■	■			
Presentation Rehearsal														■		
SDP 1 Presentation Day															■	
Procurement															■	■

B2. GANTT CHART II

	OCTOBER 2020				NOVEMBER 2020				DECEMBER 2020				JANUARY 2021			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
SDP 2 Briefing			■													
Project Meeting			■	■	■	■	■	■	■	■	■	■	■	■	■	
Specify Detail Requirement			■													
Develop Prototype			■	■	■											
First Draft of Thesis						■	■									
Apply Final Correction							■	■	■							
Second Draft of Thesis									■	■						
Implementation (Roll-out Final Design)											■	■				
Third Draft of Thesis												■	■			
Presentation Rehearsal														■	■	
SDP 2 Presentation Day																■
Thesis Evaluation																■

C Programming Coding

C1. Water monitoring (Arduino)

```
volatile int flow_frequency; // Measures flow sensor pulses
// Calculated litres/hour
float vol = 0.0,l_minute;
unsigned char flowsensor = 2; // Sensor Input
unsigned long currentTime;
unsigned long cloopTime;
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

void flow () // Interrupt function
{
   flow_frequency++;
}
void setup()
{
   pinMode(flowsensor, INPUT);
   digitalWrite(flowsensor, HIGH); // Optional Internal Pull-
Up
   Serial.begin(9600);
   lcd.begin();
   attachInterrupt(digitalPinToInterrupt(flowsensor), flow,
RISING); // Setup Interrupt
   lcd.clear();
   lcd.setCursor(6,0);
   lcd.print("ISIRS");
   lcd.setCursor(0,1);
   lcd.print("Water Flow Meter");
   currentTime = millis();
   cloopTime = currentTime;
}

void loop ()
{
   currentTime = millis();
   // Every second, calculate and print litres/hour
   if(currentTime >= (cloopTime + 1000))
   {
    cloopTime = currentTime; // Updates cloopTime
    if(flow_frequency != 0){
      // Pulse frequency (Hz) = 7.5Q, Q is flow rate in L/min.
      l_minute = (flow_frequency / 7.5); // (Pulse frequency x
60 min) / 7.5Q = flowrate in L/hour
```

```
      lcd.clear();
      lcd.setCursor(0,0);
      lcd.print("Rate: ");
      lcd.print(l_minute);
      lcd.print(" L/M");
      l_minute = l_minute/60;
      lcd.setCursor(0,1);
      vol = vol +l_minute;
      lcd.print("Vol :");
      lcd.print(vol);
      lcd.print(" L");
      flow_frequency = 0; // Reset Counter
      Serial.print(l_minute, DEC); // Print litres/hour
      Serial.println(" L/Sec");
    }
    else {
      Serial.println(" flow rate = 0 ");
      lcd.clear();
      lcd.setCursor(0,0);
      lcd.print("Rate: ");
      lcd.print( flow_frequency );
      lcd.print(" L/M");
      lcd.setCursor(0,1);
      lcd.print("Vol :");
      lcd.print(vol);
      lcd.print(" L");
    }
   }
}
void countPulse()
{
  count++;
}
```

C2. Valve controlling (NodeMCU)

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <DHT.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "FqL29ghfSfstbk0lle79NGsvTcn7-CQh";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Aiman's Iphone";
char pass[] = "aiman123";

int sensorState = 0;
int lastState = 0;
int sensorPin = A0;
int sensorValue = 0;
int percent = 0;
#define DHTPIN 0  // D3
// Uncomment whatever type you're using!
#define DHTTYPE DHT11     // DHT 11
//#define DHTTYPE DHT22   // DHT 22, AM2302, AM2321
//#define DHTTYPE DHT21   // DHT 21, AM2301
DHT dht(DHTPIN, DHTTYPE);
BlynkTimer timer;

// This function sends Arduino's up time every second to
Virtual Pin (5).
// In the app, Widget's reading frequency should be set to
PUSH. This means
// that you define how often to send data to Blynk App.
void sendSensor()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature(); // or
dht.readTemperature(true) for Fahrenheit

  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  // You can send any value at any time.
  // Please don't send more that 10 values per second.
  Blynk.virtualWrite(V5, t);
  Blynk.virtualWrite(V6, h);
}
```

```
void setup()
{
  // Debug console
  Serial.begin(9600);

  Blynk.begin(auth, ssid, pass);
  // You can also specify server:
  //Blynk.begin(auth, ssid, pass, "blynk-cloud.com", 8442);
  //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100),
8442);
  pinMode(sensorPin, INPUT);
  dht.begin();
  pinMode(D1,OUTPUT);
  digitalWrite(D1,HIGH);

  // Setup a function to be called every second
  timer.setInterval(1000L, sendSensor);
}
void loop()
{
  Blynk.run();
  timer.run();

  sensorValue = analogRead(sensorPin);
  percent = convertToPercent(sensorValue);
  printValuesToSerial();
  delay(1000);
  }
int convertToPercent(int value)
{
  int percentValue = 0;
  percentValue = map(value, 1023, 465, 0, 100);
  return percentValue;
}
void printValuesToSerial()
{
  Serial.print("\n\nAnalog Value: ");
  Serial.print(sensorValue);
  Serial.print("\nPercent: ");
  Serial.print(percent);
  Serial.print("%");
  Blynk.virtualWrite(V4, percent);
}
```

D SITE VISIT PHOTO

Figure D1 Site Visit to Merchong Nursery

Figure D3 Hyplug Tray

Figure D2 Sprinkler Irrigation

Figure D4 Diesel Water

Figure D5 Site Visit to Endau-Rompin Nursery

Figure D7 Discussion on Lake

Figure D6 Drip Irrigation

Figure D8 Water Tank in Pre-Nursery