

Faculty of Electrical and Electronic Engineering Technology



MUHAMMAD MUADDIB BAKHTIAR BIN MUZAFAR

Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

2023

DEVELOPMENT OF DEMAND DRIVEN IRRIGATION SYSTEM USING IOT

MUHAMMAD MUADDIB BAKHTIAR BIN MUZAFAR

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



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this project report entitled "Development Of Demand Driven Irrigation System Using IoT" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



APPROVAL

I approve that this Bachelor Degree Project 2 (PSM2) report entitled "DEVELOPMENT OF DEMAND DRIVEN IRRIGATION SYSTEM USING IOT" is sufficient for submission.



APPROVAL

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

Signature :	
Supervisor Name : Mohamad Shazali Bin Syed Abdul Hamid !	••••
Date : 27/01/2023	
اونىۋىرىسىتى تىكنىكل ملىسىا ملاك	
Co-Supervisor : UNIVERSITI TEKNIKAL MALAYSIA MELAKA	••••
Name (if any)	
Date :	••••

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DEDICATION

To my beloved mother, Salemah Binti Salleh, and father, Muzafar Bin Maarof, and To brothers, Muhammad Mujahid Danial and Muhammad Murshid Anuar and My sister, Nurul Umairah



ABSTRACT

Good irrigation system has the potential to transform the agricultural sector from one that is manual and static to one that is intelligent and dynamic, resulting in improved productionwhile requiring less human supervision. A job that takes a lot of people can be turned into a job that requires very little manpower and imprecise data collecting can be turned into a very good, automated irrigation system with zero-error accurate reading. This research proposes thedevelopment of an IoT-based demand-driven irrigation system that autonomously checks and maintains the appropriate soil moisture content. The Arduino Uno microcontroller platform issued to build the control unit. Finding a way to calibrate the sensors so that an accurate readingmay be obtained will be a key breakthrough throughout the project. Soil moisture sensors are used in this configuration to determine the exact moisture content of the soil. This number allows the system to use the correct amount of water, preventing over- and under-irrigation. The Internet of Things (IoT) is utilized to keep farmers up to date on all data acquired during the irrigation process. All the data obtained by the sensors is sent to the cloud on a regular basis, allowing a farmer to verify whether the water pump watered the crop according to the pre-determined timetable. The sensor data is also sent to a Blynk application, where it is graphed for study.

ABSTRAK

Sistem pengairan yang baik berpotensi untuk mengubah sektor pertanian daripada yang manual dan statik kepada yang pintar dan dinamik, menghasilkan pengeluaran yang lebih baik di samping memerlukan pengawasan manusia yang kurang. Pekerjaan yang memerlukan ramai orang boleh ditukar menjadi pekerjaan yang memerlukan tenaga kerja yang sangat sedikit dan pengumpulan data yang tidak tepat boleh diubah menjadi sistem pengairan automatik yang sangat baik dengan bacaan tepat sifar ralat. Penyelidikan ini mencadangkan pembangunan sistem pengairan berasaskan permintaan berasaskan IoT yang secara autonomi memeriksa dan mengekalkan kandungan lembapan tanah yang sesuai. Platform mikropengawal Arduino Uno digunakan untuk membina unit kawalan. Mencari cara untuk menentukur penderia supaya bacaan yang tepat boleh diperolehi akan menjadi kejayaan utama sepanjang projek. Sensor kelembapan tanah digunakan dalam konfigurasi ini untuk menentukan kandungan lembapan tanah yang tepat. Nombor ini membolehkan sistem menggunakan jumlah air yang betul, mengelakkan pengairan berlebihan dan kurang. Internet of Things (IoT) digunakan untuk memastikan petani mendapat maklumat terkini tentang semua data yang diperoleh semasa proses pengairan. Semua data yang diperoleh oleh penderia dihantar ke cloud mengikut jadual yang ditetapkan, membolehkan pengguna mengesahkan sama ada pam air menyiram tanaman mengikut jadual waktu yang telah ditetapkan. Data sensor juga dihantar ke aplikasi Blynk, di mana ia digraf untuk kajian.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Sir Syed Mohamad Shazali Bin Syed Abdul Hamid for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my faculty for the financial support which enables me to accomplish the project. Not forgetting my fellow colleagues, for the willingness of sharing their thoughts and ideas regarding the project.

My highest appreciation goes to my parents and family members for their love and prayer during the period of my study.

Finally, I would like to thank all fellow colleagues and classmates, the Faculty UNIVERSITITEKNIKAL MALAYSIA MELAKA members, as well as other individuals who are not listed here for being co-operative and helpful.

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CHAPTER 1

INTRODUCTION

1.1 Background

Since it comes to giving water to plants, an irrigation system is a must, especially when climate change is not on our side. Irrigation systems, also known as sprinkler systems, drip irrigation systems, landscape irrigation systems, and lawn drip irrigation systems, are artificial means of providing water directly to plants or indirectly via land or soil. They come in a variety of types, including sprinkler systems, drip irrigation systems, landscape irrigation systems, and lawn drip irrigation systems, to complement various geographical surfaces or regions. In dry places and during seasons of little rainfall, it is essential for growing crops, landscape upkeep, and the vegetation of disturbed soils.

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A water source, a destination, and a conveyance system are all required components of an irrigation system. A pond, reservoir, or lake is a more popular choice for water confinement since it is easier to maintain and keep the proper amount of water than the other options. Streams, in particular, can be unpredictable in terms of volume throughout the rainy season as well as during periods of drought. If an appropriate irrigation system is not in place, this climatic inconsistency will have a severe influence on agricultural produce. The rainy season may result in agricultural or plant floods, in which case too much water will do more harm than benefit. During dry spells, on the other hand, evaporation is higher, therefore water is not adequately utilised unless a good irrigation system of water running straight to the root is in place. You end up spending more money watering the plant while potentially missing out on abundant harvests.

Agriculture was the important development of a country in this age of globalisation, providing the major source of food, money, and jobs for rural areas, but the global food system is beginning to sag as the world population is expected to reach 9.7 billion by 2050. In addition to population growth also increases the demand for food. Food demand is anticipated to rise between 59% to 98% by 2050 hence the planet's arable land is estimated to be half of what it was in the 1970s by that period. Land use change, as represented in land cover change, is the most significant component of global environmental change, influencing climate, biodiversity, and ecosystem services, as well as land use decisions.

The Internet of Things (IoT) is an emerging paradigm that is a crucial part of our lives. The terms "Internet Of Things " was coined by Kevin Ashton in 1999 when he included it in the title of a presentation he made at Procter & Gamble . It allows sensors and electronic devices to communicate with each other through the internet to facilitate maintenance management . For example, with the implementation of smart devices, it able to automate aquaponics maintenance system. This show that IoT became essential to our life.

The two important words in IoT are "Internet" and "Things". The internet is an electronic communications network that connected computers network and lets people share and receive information around the world. The definition of term "things" in the dictionary is an object that eminent from a living being. Simply to said, the IoT means that a system interlinks devices, mechanical and digital equipment, objects or people to transmit data across the network without the need for human- to-human transmission . Generally, IoT

began with the best tools for communication. The devices can be monitored, operated by mobile phones or computers that connect through the Internet. Cloud serves as a great IoT partner as a forum for all sensors and it can store and access data.

NodeMCU is a free and open-source LUA-based firmware for the ESP8266 wifi chip. NodeMCU firmware comes with the ESP8266 Development board/kit, i.e. NodeMCU Development board, as a result of investigating capability with the ESP8266 chip.

Smartphones have become a highly frequent source and primary means of communication for everyone in the world to communicate or update most of the farming community as development of technology. A smart agriculture system with IoT based system helps to monitor and maintain the optimal condition for aquaponics system. IoT based smart agriculture able to help users to control the pH value, water level, water temperature, light and fish feeder through the internet with improve services. Users allow to manually control it by using smartphone and it also can be automated by controlling the aquaponics system to reduces the manpower in process of care and planting of fish and vegetables respectively. This will save them a lot of time.

The rate of growing vegetables is increasing proportionally to the good maintain of optimal condition. Smartphone development encourages users to prefer using mobile app. Growth of IoT allows the communication between the networking devices based on requirements. This mobile application developed to allow users check the current situation of irrigation system whenever they want

1.2 Problem Statement

Agriculture is the lifeblood of all industrialised nations. It consumes 85 percent of the world's fresh water resources, and due to population expansion and growing food demand, this percentage will continue to be dominating in water use. As a result, efficient water management is a key challenge in many arid and semi-arid farming systems. To maximise water utilisation for agricultural crops, an automated irrigation system is required. The goal of an automated irrigation system is to avoid overwatering and underwatering. Over irrigation happens as a result of inefficient waste water distribution or management, resulting in water contamination. To solve these issues and save manpower, a smart watering system is needed

1.3 Project Objective

The objectives for this project are:

- a) To design and develop an IoT based irrigation system by using NodeMcu ESP8266.
- b) Providing good soil moisture level to plant requirement for them to grow healthily.
- c) Achieving accurate and error-free data during data collecting process and reduceman work.

1.4 Scope of Project

An Demand Driven Irrigation System using IoT is my conducted research in this proposed study. The scope of this project are as follows:

- a) Using NodeMcu ESP8266 microcontroller as a brain to control the components in this project
- b) Wi-Fi connection was used for communication between the NodeMcu ESP8266 and the mobile application.
- c) Mobile application is developed to display the information received and perform monitoring toward NodeMcu ESP8266.
- d) A soil moisture sensor used to monitor moisture level of the crop
- e) Water pump used to distribute water to the crops when the moisture level of the crop is below than it should.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The fundamental irrigation system has been explained in this chapter. Other study has done several irrigation systems; therefore, a comparison of their trade off has been made toward other irrigation systems to give an upgrade to the present irrigation system. Finally, the assessment results were summarized and written in the last portion of this section.

Aside from that, other experiments were undertaken in this area that are also connected to prior research on irrigation systems and parameter management. The research process began with gathering materials such as journal articles, books, website documents, and conference papers and evaluating them to extract usable information. The information gathered was compiled to clearly highlight the comparison between each finding. The findings were then synthesized to generate new knowledge by merging them. Finally, the examined and synthesized data were reviewed by comparing their trade-offs to determine the optimum technique to use in this project. The evaluation results were then summarized and reported in the final portion of this section.

The summary of material acquired from multiple articles was searched online using keywords like irrigation, automation, and IoT. All these publications were specifically chosen to be included as a reference for this research due to their content, which adequately covered all of the material required. Furthermore, these publications were obtained from reputable sources such as Google Scholar, IEEE Access, Sematic Scholar, and Science Direct. These databases give high-quality articles with reliable information for others to use

2.2 Irrigation system in general

Irrigation is the agricultural technique of applying regulated amounts of water to land to aid in crop development, whereas watering is the agricultural method of applying regulated amounts of water to land to aid in crop growth[21]. Agriculture that does not use irrigation and relies only on rainfall is known as rain-fed agriculture[22]. Irrigation has been a crucial part of agriculture for almost 5,000 years, and it has evolved in diverse ways by different cultures throughout the world[23].

Irrigation aids in the growth of agricultural crops, the preservation of landscapes, and the revegetation of damaged soils in desert places and during seasons of below-average rainfall. Irrigation is used in crop production for a variety of objectives, including frost protection, weed management in grain fields, and soil compaction avoidance. A number of other irrigation systems are in use.

2.3 Traditional and modern irrigation systems

2.3.1 Traditional irrigation systems

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Previously, these irrigation systems were used. However, some small farms in rural areas still utilise them today. They are less costly than conventional methods, yet they are ineffective. Because they are powered by human or animal labor[32].

2.3.1.1 Moat irrigation

The visual of the moat irrigation system is shown in Figure 2.1. It's also known as the pulley method, and it involves irrigating the land using water drawn from a well or other similar source [33]. This is a time-consuming and labor-intensive procedure, yet it is extremely cost- effective. Water waste is also reduced when a moat is used [34].



Figure 2.1 Moat Irrigation System

2.3.1.2 Chain pump irrigation

A chain pump, as seen in Figure 2.2, is made up of two large wheels connected by an endless chain. In the lower wheel, the water supply is partially immersed. When the wheel is revolved, the connected buckets dip into the pool and collect water. After that, the chain elevates them to the upper wheel, which carries the water from the buckets to the pool. The empty buckets are then transported back down the chain to be replenished, and the process repeats itself. For ages, chain pumps were utilized in the ancient Middle East, Europe, and China [35].



Figure 2.2 Chain Pump Irrigation

2.3.1.3 Dhekli irrigation

Farmers irrigate their fields by filling a bucket from a well and emptying it into pipes that lead to the field's end, as shown in Figure 2.3. In the dhekhli method, water is drawn from a well with ropes and a container and utilized to irrigate the ground [34].



Figure 2.3 Dhekli Irrigation

2.3.1.4 Rahat irrigation

As seen in Figure 2.4, Rahat is a method of irrigation that saves water. A bull is used instead of a pump in this system, which is comparable to a chain pump system. The Persian Wheel is a term used to describe it. The Persian wheel is another name for the system, which is an Urdu phrase. It uses two large wheels linked by a belt to collect water from beneath many water pots. The wheel has traditionally been spun by large animals like oxen.

Using an animal, an axil is turned. This axil is connected to gears, which are connected to a circular item through another axil. A circular object may be found near the sea, and another can be found on the beach. The chain with the pots circles when the animal moves the gears and the circular item [34].



Figure 2.4 Rahat Irrigation System

2.3.2 Modern irrigation systems

Table 2.1 Type Of Irrigation

Type of irrigation	Advantages	Disadvantages
	 Water is being used to its full potential. When water is administered locally, fertilizer/nutrient loss is reduced, and leaching is reduced. Because there isn't any water, weeds can't absorb it, thus they grow in lower quantities. Crop production is at an all-time high. Fertilizers may be used efficiently. Lowest operating expenses achievable There is no erosion of the soil. The infiltration capacity of the soil has beenimproved. Fertilizers are not combined with groundwater. The germination of seeds has improved. 	 The initial expense is hefty. Clogs might occur if the water isnot adequately filtered. Problems with moisture distribution. A difficulty with salinity.

Type of	Advantages	Disadvantages
irrigation		
	 recycled water. The fields do not need to be levelled. We can irrigate water on ground that is irregularly formed. Fertilizer waste has been reduced by 50%. It uses less energy than conventional irrigation technologies since it operatesat a lower pressure. 	
Sprinkler	• It's both cheap and	• Purchasing the sprinkler
	 easy to put up; you won't have to spend a lot of money on labour, and you won't have to take up alot of space in your field to do so. When installing sprinkler irrigation, there is usually little disruption to farming. As a consequence, you will notlose a Considerable amount of money. Water may be provided to the plants on aregular basis, removing the need for you to do so. At all times, water will be dispersed uniformly. You will be able to conserve water basedon plant demands and requirements sincethe amount of water delivered may be modified. 	 irrigation system's equipment is an expensive investment. It's possible that using sprinkler irrigation to provide salty water willcause problems. To spray water droplets equally, you'll need a continuous flow of water. If the surrounding environment is windy and humid, the water from the sprinkler irrigation system mayevaporate. The deposit of debris and sediments from the water used may cause the sprinkler nozzles to get clogged. The sprinkler watering system requires a steady power supply to operate.
	• The sprinkler irrigation system may be installed in any type of soil. This technique can also be	

Type of	Advantages	Disadvantages
	utilised for other reasons, such as cooling in hot weather.	
Center pivot	 There is no need to level the land, which saves money and protects the ecology. The service life is often greater than 20 years, with a reasonable investment per unit area. Low-cost operation and maintenance 	 At the end of the unit, the sprinkler intensity is frequently more than 100mm/h, making it easier to createshort-term surface runoff. The leakage spray area is huge without the ground angle (arm) system, accounting for about 25% of the total area; with the ground angle (arm) system, the investmentper unit area is too expensive; dragging the transfer plot is inconvenient.
2	No. In the second secon	meonvement.

2.3.2.1 Surface irrigation

There are three types of surface irrigation systems: basin (figure 2.5), border (figure 2.6), and furrow (Figure 2.7). (Figure 2.7). Because it is extensively used, it is a well-known system that can be operated without the need of any high-tech apps. It necessitates a greater amount of work than traditional irrigation systems. A surface irrigation system's design considers soil type (texture and input rate), slope, field levelness, stream size, and run length. Water distribution homogeneity in long fields is more difficult to accomplish on coarse textured soils (gravel and sands) than on fine textured soils (loams to clay) (HILL 2008). Although it is costly to level the fields and construct water canals and reservoirs, once completed, costs are cheap and self-help capability is strong [24].



Figure 2.5 Basin Surface Irrigation



Figure 2.6 Border Surface Irrigation



Figure 2.7 Furrow Surface Irrigation

There are various advantages and disadvantages to the method. The advantages of this method are that it is widely utilized by local irrigators, who often have a basic or rudimentary grasp of how to use or operate it. The system may be operated at a farm level with minimum capital expenditure, thus getting started with the system is simple and inexpensive. The capital cost can also be reduced if the landscape is not excessively undulating. Some people who had local traditional knowledge did not require a lot of money. You may also use little lands to your advantage. If you just have a limited supply of water, this is the ideal method for you. If you have a long drainage system, you just need longer tubes. You may use rainwater in this system, which is environmentally good. It also performs well at low filtration rates. There's no need for a lot of money and there's no need for energy. This irrigation method may be used on sloping plains and lengthy fields [25]. The soil, which must be used to move water around the field, has a wide range of properties, both geographically and through time.

Aside from that, in terms of water application, surface irrigation systems are frequently less efficient than sprinkler or trickle systems. Fields must be suitably graded if they are to be utilised as a conveyance and distribution facility. Surface systems can be timeconsuming to install [25].

2.3.2.2 Localized irrigation

Figure 2.8 shows how localized irrigation systems supply water directly to the plant, reducing water loss due to evaporation from the soil. Drip irrigation, porous clay pots, porous pipes, and perforated plastic sleeves are examples of localized irrigation technologies [26].



Figure 2.8 Localized Irrigation

This method has its own set of advantages and disadvantages. The advantages of this approach are that it is inexpensive in terms of labor and energy. This system's application is extremely efficient. This is because the water is supplied directly to the root, resulting in fewerlosses due to evaporation. Most types of soil will operate with this system since it has a high level of adaptability to different types of soils. This technique will also keep the soil wet and devoid of oxygen. The irrigation will not be limited by the wind or the slope [27]. This system also have its own cons. The cost of starting this system is high due to large quantity of pipes used in this system. It quite hard to maintain this system as this system is very sensitive to clogging of water holes. The root depth is also affected due to constant availability of water, as result the plant stability will be decreased.[27]

2.3.2.3 Drip irrigation

It delivers water and nutrients directly to the plant's root zone in the perfect amounts and at the right times, ensuring that each plant gets exactly what it needs, when it needs it, to thrive. Farmers may boost yields while reducing water, fertilizer, and energy use [30].

The large volume of water utilized in this method works as a buffer, enabling the temperature to remain more consistent, minimizing stress on the fish and worries about water quality. Consequently, the DWC method allows plant roots to quickly absorb nutrients in the water while also optimizing floor space by generating a process line, resulting in higher crop yield. The plants are also easier to harvest than those planted on a media bed since the roots are submerged in the water without any medium. The drawback is that a significant initial expenditure is required. Surface drip irrigation system replacement is a recurrent capital expense (damage due to movement of equipment, UV-radiation). Drip irrigation emitters are prone to clogging and malfunction (water filters required, regular flushing of pipe system). To achieve successful water distribution, irrigation water management demands a high degree of skill [31].

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2.3.2.4 Surface drip irrigation

Surface drip irrigation, as seen in Figure 2.9, is far more common and employs a variety of drip emitter types. The lateral lines on the surface are fed by a field main. They are generally perforated or equipped with specific emitters and have a diameter of 10 to 25 mm. Water is dripped into the soil at a regulated rate of 1 to 10 liters per hour by the latter. In the field, water pressure is normally between 0.5 and 2.5 atmospheres. At atmospheric pressure, the water leaves as drops rather than a jet or spray because friction in the flow through the emitters' small channels or orifices lessens the pressure[31].



Figure 2.9 Surface Drip Irrigation

2.3.2.5 Sub-surface irrigation

As illustrated in Figure 2.10, sub-surface irrigation (SDI) employs tiny plastic tubes with a diameter of around 2 cm. Because it is a more complex technique, it is more costly anduncommon. These are buried at a depth of 20 to 50 cm in the soil, deep enough down to preventobstructing ploughing or traffic. The tubes are either fully porous or include emitters or holes that are evenly distributed. If the tubes are permeable, they will leak water all the way down. They only discharge water at certain locations when fitted with emitters. The water is subsequently dispersed or diffused throughout the soil. The wetness pattern is determined by the quality of the surrounding soil, as well as the distance between neighboring emitters and their discharge rates [31].



Figure 2.10 Sub-Surface Drip Irrigation
2.4 The plants

Almost every plant may be grown in an irrigation system, however certain plants will perish in new irrigation systems since each one has its own set of requirements. The types of plants that choose to grow in the irrigation system, on the other hand, are crucial since different plants require different conditions to thrive. Over 60 different food crops and types were researched in the Alberta greenhouse, including herb crops, leafy green vegetables, fruiting crops, flowers, and beans. The system design should be used to categorize plants.

Brazilian spinach is a low-growing perennial leaf vegetable that forms a compact mound of up to 30 cm in height rather than a mat. It's an excellent plant for edging walkways, especially in partial shade, due to its shade tolerance. The leaves are round and crinkled, and they have a medium green color. The blossoms are small, white, and hardly noticeable. It can only grow in subtropical and tropical regions, thus it's impossible to find it south of Sydney. It thrives in a wide range of soil conditions, favoring a moderate to rich loam and avoiding waterlogging. Plant in a location that receives full sun to partial shade [36].

The kind of plants chosen are determined by several criteria, including the plants' willingness to grow, the weather, and the plant's ability to endure. The most appropriate plant for the system must be chosen. Brazilian spinach, sometimes known as "poor man spinach" [37] and seen in Figure 2.11, is a popular species that is suitable for beginners. They are a low- growing perennial leaf vegetable that grows to a height of 30 cm [36]. It dislikes waterlogging but is a prolific, hardy plant that will tolerate most soil types and hot, dry conditions [44]. They're plant components that can be eaten. Although it blooms, no viable seeds are generated. Cuttings are used to spread it. After soaking the cuttings in a small dish of water for 3-4 days, the roots will appear [37]. It thrives in around half-shade and has less insect problems [38]. Worms, flea beetles, slugs, and snails are some of the typical pests that

affect Brazilian spinach. However, some methods may be used to avoid this sort of pest. There are several advantages to spinach, including high levels of folate, iron, vitamin K, magnesium, calcium, and phytonutrients [39].



Figure 2.11 Brazilian Spinach

2.5 Water source

Regarding the project's water supply. Well water supply (figure 2.12) or a water tank are the two major possibilities for a water source (figure 2.13). Table 2.2 shows the comparison. UNIVERSITI TEKNIKAL MALAYSIA MELAKA



Figure 2.12 Well water supply



Figure 2.13 Well tank supply

Table 2.2 Comparison of wat	er supply options
-----------------------------	-------------------

Well water supply	Water tank supply
 Chlorine and other contaminants are not present in well water. This is particularly encouraging news for those who have farms [42]. Groundwater is a renewable resource [42]. a sufficient amount of ground water since a tube well can irrigate 2 hectares per day compared to 0.2 hectares per day for a conventional well [43] 	 In drought-prone areas that rely on well irrigation, water storage tanks may significantly replenish groundwater.[40] Agricultural activities are no longerreliant on periodic rainfall, tank irrigation may benefit both landowners andlabourers. With water available for perpetual irrigation, farming can continue all year, resulting in increased crop yield [40] The cost to maintain the tank are very cheap, and this method are commonly used in irrigation system [41]

2.6 Controlling irrigation

Inspection and control of the irrigation system on a regular basis is crucial for spotting potential issues and correcting them before they affect the plant. Plants must be visually monitored, but with the aid of sensors, users can monitor their irrigation systems without having to be physically near them. This saves time and reduces workload. Data acquisition, a system rectification unit, processing units, a graphical user interface (GUI), internet of things (IoT), and cloud-based solutions are the five components that make up the project's control system.

2.6.1 Data acquisition unit

The data gathering units are made up of several sensors that continuously collect data from the aquaponics system. After the data from the sensor is sent to the IoT analytics platform, it will be visualized and analyzed in real time. If these data are monitored and necessary system improvements are made, the irrigation system uses less water than traditional farming.

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Table 2.3 Type of sensors

TYPE	MODEL	SPECIFICATION
Moisture level sensor [10][11][12][15]	DFRobot Moisture Sensor [1][2][8]	 Power supply: 3.3v or 5v Output voltage signal: 0~4.2v Current: 35mA Pin definition: Analog output(Blue wire) GND(Black wire) Power(Red wire) Size: 60x20x5mm Value range: 0 ~300 : dry soil 300~700 : humid soil 700~950 : in water

ТҮРЕ	MODEL	SPECIFICATION
	EF04027	• Power supply: 3.3v or 5v
	Octopus Soil	• Output voltage signal: 0~4.2v
	Moisture Sensor	• Current: 35mA
	Brick [4]	• Pin definition:
		• Analog output(Yellow wire)
		• GND(Black wire)
		• Power(Red wire)
	Decagon 10HS Soil Moisture	• Measures a large 1-liter sample of soil, providing amore accurate picture of
		volumetric water content instantly: •
		High-frequency (70 MHz) circuit
		provides good accuracy even in high-
		salinity and sandy soils; Dimensions: 1
		(air) to 50 (each)
		• VWC: dependent on calibration: 0-57 percent VWCwith polynomial equation
181	decagon ECH2O	• Range: 0-100% VWC
		• Resolution: 0.1 Dielectric
ST.	2	• Accuracy:
EK I	Ş	Mineral Soil: ± 2.5 up to 50 dielectric
F		permittivity
E		$\pm 2\%$ V WC soft specific calibration, up to 8
100		$\frac{US}{III}$
	(n	• Rockwool. $\pm 3\%$ VWC, 0.5 to 8 dS/III
shl.	1.14	• Poluing Soil: ±3% VWC, 5 to 14 dS/m
200	_ مىيسىيا	• Output: voltage, correlated inlearly with VWC, independant of excitation voltage
UNIVE	RSITI TEKNI	• Measurement Time: 10 ms
		• Dimensions: 14.5 cm x 3.3 cm x 0.7 cm
		• Temperature: -40° C to $+50^{\circ}$ C
		• Power: 3 to 15 VDC, 12 mA @3V, 15 mA
		@ 15V
		• Cable Length: 5 m
		• Connector Types: 3.5 mm "stereo" plug or
	VI (0 '1	stripped and tinned lead wires (3)
	YL-69 soll	• Voltage Range: 3.3V to 5V DC
	moisturesensor	Operating Current: ISmA • Output Digital: 0V to
	[9]	5V, Adjustable Trigger Level from Preset •
		radiation from aburning flame landing on the
		sensor
Water level sensor	Capacitive	• Flexible operating voltage of 3.3V to 5V
		• Current consumption of < 20mA
		• Operating temperature of 10 to 30
		degree C
		• Dimension of 6.2cm * 2cm * 8cm

ТҮРЕ	MODEL	SPECIFICATION
	Gravity : non-	• 5V supply voltage
	contact	• Applicable Medium: 0-100°C
		conductive liquid Sensing Distance:
		3mm (can only detect non- metallic
		containers)
		• High/low output mode (low level output)
		• 5mA working current • -5~80°C
		workingtemperature
		• -20~85°C storage temperature
		• IP67 protection level
	Vertical float	Mechanical Specification
	switch &liquid	• 1/8" NPT & M10 mounting
	level sensor	• 200mm Cable length
		• 0.1A switching current max.
		Float SG PVC
		(0.7),Polypropylene (0.5)
		Acetal (0.6) and Nylon (0.6)
3	LAYSIA	Electrical Specification
at m	Mo	• Form A Switch, I Watt max.
S.	E.	• 24v DC switching voltage max.
N.	3	• 0.1A switching current max.
Ŧ		• 1500 DC breakdown voltage mm.
Humidity sensor	DHT22 [1][2][3]	
and temperature	D11122 [1][2][3]	• Temperature range: -40-80°C (2% RH error)
sensor [14]	(n	Moisture sensor and temperature measurement
		element included
ملاك	_ مايسيا	• Temperature range: -40-80°C (2% RH error)
		• Interface sequence: VCC, GND, S
UNIVE	DHT11 TEKNII	Temperature-Humidity Sensor
	[4][10][11][12]	• DHT11 Onboard
		• Weather station, humidity
		controller, test & detection device
		• Standard single-wire interface
		• Humidity Measuring range : 20%RH
		~ 90%RH(25°C)
		• Temperature Measuring range : 0°C ~
DH sensor [10]		JU'U Voltage for heating: 5.0.2V (AC DC)
		• voltage for heating: 5 0.2 V (AUDU)
		• Detectable concentration range: PH0-14 Temperature detection range: 0.00
		• Temperature detection range: 0-8() • Response time:59
		Working ourrant: 5, 10m A
		• WORKING CUITERIT. 5-TORIA
		• 00 seconds to settle.
		• working temperature: $-10 \sim 50^{\circ} F$ •
		ComponentPower: 0.5 w (nominal

ТҮРЕ	MODEL	SPECIFICATION				
		temperature 20)				
		• Humidity: 95% relative humidity (nominal				
		humidity 65 percent RH) • Size Output:				
		analogue voltage signal output With 4 M3				
		Mounting Holes 42Mm				
		32mm 20mm module				
PIR sensor [10]		• Adjustable sensitivity and holding time				
		• Detecting Range: Approx. 7m / 23 feet				
		• Detecting Angle: Less than 100 degrees				
		• Operating Voltage : DC 4.5V-20V				
		 Infrared sensor module 				
		Adjustable sensitivity				
		• Holding time (0.3s to 10 mns.)				
		 Detecting Range: Approx. 7m / 23 feet 				
		Detecting Angle: Less than 100 degrees				
		• Operating Voltage : DC 4.5V- 20V				
Ultrasonic sensor [1]	2][14]	• Power Supply: DC 5V				
		Working Current: 15mA				
M	LATSIA	Working Frequency: 40Hz				
5		• Ranging Distance : 2cm – 400cm/4m				
E S	2	• Resolution : 0.3 cm				
	P	• Measuring Angle: 15 degree				
1		• Trigger Input Pulse width: 10uS				
The second		• Dimension: 45mm x 20mm x 15mm				
Conductivity sensor	[14]	Conductivity				
	<i>in</i>	Ranges:				
5 10	1	• 0 to 200				
-)~		μS/cm				
		• 200 to 2000 µS/cm				
UNIVE	ERSITI TEKNI	$(AL \bullet 1/2 \text{ to } 20 \text{ mS/cm} ELAKA)$				
		• 20 to 200 mS/cm				
		• 200 to				
		2000 mS/cm				
		Temperature				
		Range				
		• 23 to 158°F (-5 to 70°C)				
		Conductivity Resolution				
		• 0.1 uS/cm				
		• $1 \mu\text{S/cm}$				
		• 0.01 mS/cm				
		• 0.1 mS/cm				
		• 1				
		mS/cm				
		Temperature				
		Resolution				
		• $0.02^{\circ} F(0.01^{\circ} C)$				
		Output				
		• Dual				

ТҮРЕ	MODEL	SPECIFICATION				
		4-20 mA				
		Temperature				
		Response				
		• 99% in				
		<20 seconds				
		Maximum				
		Pressure				
		• 35 psi (82				
		ft (25m))				
		Immersion Depth				
		• 1.4 inches				
		(36 mm)				
		Operating				
		Voltage				
		• 10-36 VDC				
		Current Draw				
		• 20 mA plus the sum of both				
	AYSI	sensor outputsWarm-Up Time				
- MANCONA MAN		• 3 seconds				
S.	Ŷ,	minimum				
KM	5	Operating				
Ш Н		Temperature				
E		• $23 \text{ to } +158^{\circ}\text{F} (-5 \text{ to } +70^{\circ}\text{C})$				
2		Storage Temperature				
211	10	• -4 to $+212^{\circ}$ F (-20 to $+100^{\circ}$ C)				
1.1	1 1 1 2	Dimensions				
کل ملیسیا ملاک		• 8 inch L x 0.86 inch Diameter (202				
	0	mm L x 22cm D1a.)				
115.05.75	DOITI TEIZAU	weight				
UNIVE	KSIII IEKNI	\bullet				

2.6.2 System rectification unit

After that, a smartphone app is connected to the internet to establish the smart watering system. The system may either self-correct or provide a notification to the user through their mobile app. By activating the outputs, the system may make changes during rectification.

Type Of Modules	Function / Description	Specification
Wireless module	utilised to create wireless	ADF7023 transceiver, Cortex-
XBEE PRO 900HP	connectionbetween the	M3 EFM32G230 at 28MHz
[1]	automated irrigation	processor
	system's monitoring unit	 Software adjustable channel
	and the irrigation pipeline	mask for interference
	valves	immunityfrequency band from
		902 to 928MHz
		• Antenna choices include wire,
		U.FL, allu KPSIVISA.
		• KF data fales of fokops or200Kbps
		 Indoor/outdoor range of up
		t_{0} to 610m (2000ft)
		• Outdoor/Line-of-With a
		dipoleantenna, vou can get up
		to 9 miles (14 kilometres) of
A.A.	LAYSIA	range, and with a high-gain
S*	40.	antenna, you can get up to 28
E S	2	miles (45 kilometres).
EK	S I	Software-selectable transmit
F		power of up to 24dBm (250mW)
E		• -101dBm at 200Kbps, -
843A		110dBmat 10Kbps receiver
-OIN	0	sensitivity
shla	1.16.6	ILART (3V) SPI data interface
2)~		Un to 15 Digital I/O. 4 10-bit
		ADC inputs, 2 PWM outputs
UNIVE	RSITI TEKNIKAL MA	LAYGPIOMELAKA
		• DigiMesh, Repeater, Point-to-
		Point, Point-to-Multipoint,
		Peer-to-Peer network topologies
		• FHSS (Software Selectable
		Channels) spread spectrum
		• $2.1V_{DC}$ to $3.6V_{DC}$ rated voltage
		• 215mA transmit current
		• 29mA receive current
GSM module [2]	A GSM or GPRS module	Operating Frequency
[15] [10] [9]	is a chip orcircuit that	• EGSM900 and
	connects a mobile device	DCS1800Transmitting
	or computer to a GSM or	Power Range
	GPRS net. A key	• 2V for EGSM900 and 1W for
	component of this process	DCS1800
	is the modem (modulator-	Data Transfer Link
	demodulator).	• Download:
		85.6kbps.

Table 2.4 Type of modules

Type Of Modules	Function / Description	Specification
		Upload:42.8kbps
		SMS
		• MT, MO, CB, Text and PDU
		mode.
Relay driver	The relay module is	• The electrical capacity of this
module [2] [15]	made up of screws	module is 10A.
	that connect wires	• It can work with direct circuit
	and cables. This	and alternating circuit. It can
	module can handle a	withstand 5V pressure from the
	maximum current of	NodeMCU.
	10A and a maximum	
	contact voltage of	
	250VAC and 30V	
	DC. When a large	
	voltage and current	
	load is present,	
	thick main cables are	
	oftenemployed.	
Home Solar	The Roy Solar Charge	• LCD,DIGITAL, 12V/24V
Controller with CE	Controller LD2420C	Overcharge protection
-LD2420C [8]	is a multi-purpose	 Deep discharge protection
<u> </u>	solar charge and	Reverse polarity production of
-	discharge	module load and battery
6	controller with	Automatic electronic fuse
2010	intelligence. The	Short circuit protection of load
	most up-to- date	and module
5Ma	charging	 open circuit protection
	paired with a new	withoutbattery
	state of	Reverse current protection at
UNIVE	charge determination	LAYnight MELAKA
	that hasheen greatly	Overload protection
	enhanced once again	Battery overvoltage shutdowm
	With the help of	
	symbols a huge	
	display informsthe	
	user about all	
	operational modes. A	
	tank display is used	
	to graphically depict	
	the state of charge.	
	Voltage, current,	
	andcharge status can	
	all be	
	presented digitally as	
	figures on the screen.	
ESP8266 WiFi	The Wi-Fi module is a	NodeMCU Compatible
module [10] [14]	system-on- chip (SOC)	• 11 Digital I/O pins
	semiconductor that is	

Type Of Modules	Function / Description	Specification
Ph module [14]	primarily used to build end-point Internet of Things (IoT) applications. It's known as a stand- alone wireless transceiver, and it's quite affordable. It's used to connect a lot of embedded systems apps to the internet. pH measuring circuit	 1 Analog Input pin OTA Wireless Upload(Program) On board switching power supply Max 24V input, 5V 1Aoutput. Module Power : 5.00V
	board. It's commonly used in conjunction witha computing module, such as a Raspberry Pi minicomputer, an Arduino controller, or an ESP8266 module. Over the pH range of 0 to 14, an accurate and reliable voltage measurement ensures a precision of 0.01 pH.	 Module Size : 43mm×32mm Measuring Range:0-14PH Measuring Temperature :0-60 °C Accuracy : ± 0.1pH (25 °C) Response Time : ≤ 1min pH Sensor with BNC Connector PH2.0 Interface (3 foot patch) Gain Adjustment Potentiometer Power Indicator LED Cable Length from sensor toBNC connector:660mm
Max 232 [15]	Maxim Integrated Products has created an integrated circuit that converts signals from a TIA-232 (RS- 232) serial port to digital logiccircuits that are TTL compatible. The MAX232 is a dual transmitter/receiver with RX, TX,CTS, and RTS signal conversion capabilities.	 Drivers per package : 2 Receivers per package : 2 Logic voltage (Min) (V) : 5 Data rate (Max) (kbps) : 120 Main supply voltage (Nom) (V) : 5 ESD HBM (kV) : 2 Rating : Automotive, Catalog Operating temperature range (C) : -40 to 85, 0 to 70 Vout (Typ) (V) : 9

2.6.3 **Processing unit**

Through sensors, physical values are turned into electrical current. As a result, a microcontroller is required to turn the data into user-friendly information. Arduino is a 5V microcontroller that can be programmed using a simplified form of C++ and quickly uploaded over USB. Relays can be used to drive higher voltage actuators by turning on or off compatible electric circuits for electric equipment with a voltage greater than 5V.

Microcontrollers are great at reading sensor data, but they aren't designed to display or store data for the user. As a result, the Central Control Unit of the system must be a genuine computer. The Rasberry Pi is a popular choice since the current versions of built-in Bluetooth and Wi-Fi allow the CPU to send the data. The user will need a Graphical User Interface (GUI) to access the data after connecting to the Pi, or a webpage can be hosted on the Pi. However, because the Rasberry Pi is more expensive than the NodeMcu ESP8266, a low-cost microcontroller. Wi-Fi used to communicate between the NodeMcu ESP8266 and the dashboard online. The NodeMcu ESP8266 enables the user to receive a message, as well as perform other tasks. Through the application of IoT, th NodeMcu ESP8266 allows the user to receive a message, perform data recording, and more. As a result, anyone can operate their systems from anywhere in the globe. But first, the Arduino Integrated Development Environment (IDE) software must be customized to particular instructions for all components, as required by the project.

Type of controller	Pric	e	Connectivity		I/O pins	Flash memory	Wireless connection	Program Language
Arduino atmega [1] [5]	RM179	11eg	USB	-	54 digital inputand output pins 15 can be used as PWM output	256kB	No (Shield or WiFi module canbe installedto enable)	C,C++
		SOLT TEKI	Ē	•	16 analog inputs 4UARTs which isa hardware serial port		ЭМ	
Raspberry PI3 [3] [12]	RM170	لاك الم	بسبام VERSITI	ند مار	26 I/O Although these some pins have multiple functionsthey canbe considered as I/O pins.	16GBSSD memorycard	10/100 Ethernet • BCM43143 (802.11 b/g/n Wireless LANand Bluetooth4.1)	C/C++, Python 2/3,and Scratch
Arduino uno [2] [3] [4] [5] [9] [10] [11] [15]	RM96		USB	•	 14 Digital pins with 6 of them having PWM 8 analog inputpins 	32kB	No (Shield or WiFi module can be installedto enable)	C/C++

Table 2.5 Type of microcontroller

Type of	Price	Connectivity	I/O pins	Flash memory	Wireless connection	Program		
controller						Language		
PIC	Rm19.90	Trainer	• 40- or 44-pin	14kB	No (Shield or WiFi	C/C++		
Microcontroller		startup kit	• An ICD, 2		module can be installed to			
PIC16F877A			Comparators, 8		enable)			
[6]			channels of 10-					
		ALAYSIA	bit					
NodeMcu	Rm25.00	USB	• Digital I/O Pins	4 MB	Buit in ESP8266 module	C/C++		
ESP8266	3		(DIO): 16					
	S		 Analog Input 					
	2		Pins (ADC): 1					
	<u> </u>							
NING STREET								
اونوم ست تكنك مليسا ملاك								

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2.6.4 Internet of Things (IoT) and Cloud-Based Solutions

In today's world, smart and linked things are becoming increasingly common. The major purpose of the Internet of Things (IoT) is to link industrial machinery and create a framework for data-driven decisions to be made without the need for human intervention. Some of the components required to build the IoT include the ESP8266 ESP-01 Wi-Fi module, GSM shield, and Bluetooth module HC-06. MQTT broker, Node-RED, Ubuntu IoT Cloud, ThingSpeak, and the MIT app are examples of solutions for monitoring IoT elements in real time through the internet network. The key benefit of utilizing these technologies is that much of the programming has already been completed. Existing code for various purposes, such as monitoring interfaces, remote applications, and wireless technologies, can be merged and used for the project as needed. Remote control programs allow you to tell system actuators how to interact with or alter certain parameters. Open-source solutions are frequently selected because they are well-documented, updated on a regular basis, and do not require the involvement of a corporate body to function

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Table 2.6 Type of software

Software	CloudBased	Database	Source	Accessibility	Description
online Google®	Yes	Free MALAYSIA	• Open	Application	The Docs suite backs up yourdata automatically
spreadsheet	S. T		A.C.		and makescollaboration simple for everyone.
Web	Yes	Need to be	• Open	Web Browser	• A Web application (Web app) is a piece of
Application	3	prepared	>		software that is hosted on a remote server
	F-				and distributed through the Internetusing a
	5				browser interface. Webservices are Web
	20				applications by definition, and many, but
					for an, websites include web apps.
		1/1/0			• Commonly used web apps include
		1			 calculators and e-commerceshops
Line Notify	No	Free of	• Close	LINE	A Line Notice is an alert from the LINE
		charge. But	• 01030	Notify'sofficial	programme, which can send messages to
		When	· ·	account	the feeders' accounts.
		linking to			• The LINE programme is a freetalking
	UNI	other web	TEKNIKAL	MALAYS	application that is used in this study to
		services,			notify users, aswell as the Mackerel
		there may be			platform, which is a platform for examining
		featuresthat			servers for GitHub engineering and a web
		can only be			service that can work with IFTTT software.
		used with			The NodeMCU in this investigation worked
		accounts			by sending notifications to the feeders via the LINE programme
		accounts,			feeders via the LINEprogramme.

Software	CloudBased	Database	Source	Accessibility	Description
		depending on			
		the service.			
Blynk	Yes	Free	• Open	Application	Blynk is an IoT platform for iOS and Android
					smartphones that allows you to operate
					Arduino, Raspberry Pi, and NodeMCU from
		MALAYSIA			anywhere in the world. This application is used
	~	-	Ma		to create a graphical interface or human
	5		8		the appropriate
	145		NK		address on the available widgets(HMI).
Microsoft excel	Yes	Free	Open 👘	Web browser	Microsoft Excel is a spreadsheet tool developed
	-			/ Application	by Microsoft for Windows, macOS, Android,
	E				and iOS. Visual Basic for Applicationsis a
	6				macro programming language that contains
	23				calculation and computing tools, graphing
		WND .			tools, pivot tables, and visual Basic for
		1		-	applications (VDA). Excel is an
	50		1. 5.	5.	product suite
Thingspeak	Yes	Free service	• Open	Application	-basedIoT analytics
81		for non-	open	II	application for collecting, visualising, and
		commercial	TELZALUZAL		analysing real-time data streams.
	UNI	small	TEKNIKAL	MALAYS	ThingSpeak allows you to send data from
		projects			your devices, create real-time visualisations
					of live data, andset alerts. Thing Speak
					Features
					Works With
					MATLAB® & Simulink®
					• Arduino®
					Particle devices

Software	CloudBased	Database	Source	Accessibility	Description
					• ESP8266 and ESP32 WifiModules
					• Raspberry Pi [™]
					LoRaWAN®



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2.6.5 Actuators and Motors

Table 2.7 Type Of actuator & motor

Types	Function/Description	Specification
Solenoid	Water flow is	Valve Type
Valves (regulated by an	• 2 Way, Normally Closed
1)(2)(5)(6)(7)	electronically	(NC)Action
	controlled valve. The	• Direct
	valve opens when a	ActingOrifice
	voltage is applied to	• 5.0mm
	the coil, allowing	Operating
	liquid to flow	Pressure
	through.	• Vacuum to
	Electromagnetic	50PSIPort Size
	valves, also known as	(Tube OD)
4	water valves, electric	• Options: 3/8" OD Tube
Kin	valves, or electro	3/8" Push-In
- E	solenoid valve	Fitting3/8"
Ŧ	solellolu valve.	Female NPT
		Wetted Surfaces
	AIND	• Valve Body: Delrin Plastic (can be
		customized to any type of plastic)Seals:
5	کے ملتشیا ملا	NBR(Buna N), Silicone, Viton Double
	0	Seals (Fluing Connection
1.11		Only)Affiature Assembly: Stamess
U	IVERSIII IENNI	Coil Duty
		H Class IP65 100% ED Continuous
		DutyVoltage Options:
		• 12 24 VDC \cdot 24 110/120 (50/60Hz)
		220/240 VAC (50/60Hz)
		Voltage Tolerance
		• +/-10% of Specified
		VoltageCoil Power
		• 20W
		Electrical Connections
		• DIN43650A, Option: Molded Cable,
		ATEXExplosion Proof
		Installation
		• No Orientation (Optimum Position:
		FlowHorizontal & Solenoid
		Vertical)
		Service
		Air, Water, Liquid

Types	Function/Description	Specification
Water pump	Generate sufficient	Operating voltage: 12VDC
[1] [2] [3]	force to transferwater	• Rated current: 0.5A
[4] [9] [14]	from the water source	• Power: 6W
[15] [8] [10]	to the irrigated land	• Flow Rate: $1.6L \pm 0.1L / min$
	This is normally	• Water pressure at inlet: 0.3Mpa
	accomplished by	(MegaPascal), or
	connecting a water	• 43.51 psi
	pump to the irrigation	• Max continuous operating hour: 12 hours
	pipes and a water	• Operating Temperature: 5°C to 40°C
	supply.	• Operating Water Temperature: 5°C to 45°C
		• Recommended working hour per day: 8 hours
		• Inlet and output host diameter: 7mm
Relays [1]	Switches that work	• Trigger Voltage (Voltage across coil)
[2] [6] [8]	both electricallyand	: 5VDC
[11] [12]	electromechanically	• Trigger Current (Nominal current) :
[15]	to close and open	70mA
	circuits. It controls	• Maximum AC load current:
	how an electrical	10A @250/125V AC
	circuit's circuit	Maximum DC load current:
	connections open and	10A @30/28V DC
EK	close. When the relay	Compact 5-pin configuration with
F	contact is open, the	plasticmoulding
E	relay does not activate	• Operating time: 10msec Release
	with the open contact	time:Smsec
	(NO).	Maximum switching: 300 operating/minute
DCD lighta	By altering the	(mechanically)
	intensity of each LED	• 12 V DC input voltage
	you may create red	2.2 W / 180mA power consumption per loot
1U	green, and blue light,	- Maximum Lumens per Foot of Rated Fixture:
	as well as additional	• Maximum Luminous Efficacy: 32 lm/W
	colours. To create	• Type of LED Chip: 5050 Tri-chip SMD
	pure blue light, set the	• Field Cuttable: every 4 inches • Chips per
	blue LED to highest	foot: 9
	intensity and the	• 1.3 in. LED spacing (between centers)
	green and red LEDS to	• Height: 0.1 in. • Width: 0.4 in.
	example	• Max. Run: 16.4 ft. / 100 ft. • Spool Length:
	example.	16.4ft. / 100 ft.
		• Control: Only for use with a 12V DC RGB
		Contifications: III Listed Della
		• Certifications: UL Listed, KOHS
		• Amotent Operating Temp.: -40 \sim +1/60 F (-
		20°
		$\sim - 00 \text{ C}$
		• Operating Temp.: $+000 + 90^{\circ} \Gamma$ (+200 $\approx \pm 320 \Gamma$)3M Adhesiye Sticky Backing for
		Mounting

Types	Function/Description	Specification
		• Connectors: Each spool comes with 8 inches of 20/4 AWG splice wire on both
		ends. • Rated
		Lamp Life: 50,000 hours
Membrane	When keytop regions	MECHANICAL SPECS
keyboard	are pushed, electrical	• Switches feedback : tactile
[14]	between the keyboard	• Switch technology : thermoformed,
	surface and the	dome-type membrane Switch travel :
	underlying circuitry.	• Shielding type : Clicktouch 5-layer (*)
	These versionswere	• Operating force : 4 N typ.
	widely used in consumer electronics	• Switching life : >6 million operations per
	products in the early	Switch Surface : LIV hardened polyester
	1980s, and they were	chemical resistant (*) Metal parts · -
	utilised with several	Carriers (panel mount versions) :
	early home	aluminium - Protection covers : stainless
	computers.	steel (*) - Enclosures : steel with anti-
	when the	corrosion treatment and industrial coating
-	Y Y	• Protection class : IP65 (*)
Ka	KA.	• Keyboard colours : see individual
-		datasheets
E		• Output cables : shielded straight 1,6 m
		long (*)
	A/NO	ELECTRICAL SPECS
الح	N. L.K	 Supply voltage : standard PC port
	_ مىسى مار	• Current drain : 60 mA max.
		• PS/2 output : via 6-pin mini DIN plug (*)
U	IVERSITI TEKNI	USB output : via USB type A plug (*)
Peltier cooler	A peltier cooler is one	• Max Current: 10.1A
	that employs peltier	• Max Voltage: $16V$ (Hot side at 27° C),
	element to keep the	17.2V(Hot side at 50°C)
	(TFC) Peltier coolers	• Wax Keingeraung Power: 101.1W (Hot side at 50°C)
	are made up of the	• Difference Range: >70°C
	peltier element and a	 Dimensions (excluding wires): 40mm
	strong heatsink/fan	(1.58in)length, 40mm $(1.58in)$ width,
	system to keep the	4mm (0.16in) height
	TEC cold.	Wire 18AWG, length: 30.48cm (12")

2.6.6 Graphical User Interface

The user's interaction with the aquaponic system and sensors is the Graphical User Interface (GUI) (GUI). A graphical user interface (GUI) may show the condition of several sensors and operate multiple actuators. The group, on the other hand, could be able to achieve the same result while spending less time learning the language. The most important precaution to take when creating a GUI is to make sure it can be accessible via the internet. Table 2.8 Type Of presentation element

Туре	Function
16×2 LCD [6] [8] [10] [11] [14]	LCD (Liquid Crystal Display) is a type of
[15]	flat panel display that operates primarily
L MAN AN	using liquid crystals. LEDs are widely used
E.	in cellphones, televisions, computer displays,
100	and instrument panels, and they have a wide
· · · · · · · · · · · · · · · · · · ·	range of applicationsfor consumers and
	enterprises.
Sugarina -	

2.7 Overview of studies

In this section, several studies that related to previous researchers on irrigation systems. Based on the information acquired thus far and the fact that the plant in question is spinach, the surface drip irrigation was chosen since it required few supplies to set up and allowed for easy inspection of the spinach roots for symptoms of illness. Furthermore, the root of the spinach plant should not be submerged too deeply since it may deteriorate and cause the plant to perish. However, the NodeMcu ESP8266 was chosen since just one analog sensor in use. Many researchers used the Rasberry Pi because it has built-in Bluetooth and Wi-Fi, which allows the microprocessor to send data to the user.

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However, the function also can be found in NodeMcu ESP8266 and the price was far more cheap and since this project only uses wifi and not the Bluetooth feature. NodeMcu will be the best choice.

As for water supply, water tank been chosen to many benefits that it can give to the systems as in drought-prone areas that rely on well irrigation, water storage tanks may significantly replenish groundwater. It also beneficial as the system are no longer reliant on periodic rainfall, tank irrigation may benefit both landowners and laborer. With water available for perpetual irrigation, farming can continue all year, resulting in increased crop yield. However, the Rasberry Pi's replaced with NodeMcu ESP8266 as the price was far more cheap and since this project only uses wifi and not the Bluetooth feature. In terms of water supply, water storage tanks have been chosen because of the various benefits they may provide to systems, such as replenishing groundwater in drought- prone areas that rely on well irrigation. Tank irrigation may be helpful to both landowners and laborer because the method is no longer dependent on periodic rains. Agriculture may continue all year with water available for constant irrigation, resulting in higher agricultural yields.

CHAPTER 3

METHODOLOGY

3.1 Introduction

From the beginning, when the project was in the planning stages, until the end, when it was done, this chapter will look at the project's approaches. To achieve the project's purpose, the project methodology takes a few steps. As previously stated, a soil moisture sensor was selected to be employed in this project to monitor the moisture content of the soil during the duration of the project. NodeMcu ESP8266 are the microcontroller and wireless communication technology utilized in this project. The user may watch the data collected over time using the Blynk application, which serves as the project's platform. The hardware and technique for the project will also be discussed in this chapter. This chapter also includes a flow chart, hardware and software implementation, and a project block diagram.

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3.2 Project workflow UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Flowcharts are a useful tool for designing project management approaches because they provide a visual representation of the project. To produce a successful project on the next project, you must have an amazing flowchart. The initial stage in the research procedure was to comprehend the title. Each thesis' logic, dispute, and flaws were then analysed. Engineering research and studies published in peer-reviewed journals serve as a road map for constructing a highly desired or specific project. After that, I started working on a research canvas based on previous articles and journals related to the issue, which I discussed with my supervisor for approval. The obstacles, aims, questions, theoretical or conceptual framework, a strategy to answer the question section, expected findings, conclusion, and future work based on own title were determined and got supervisor approval once more after the research canvases were approved.

For better grasp, the key knowledge of the project's aspects was altered. After that, he plans and discusses the project's flow system, design, and construction with the supervisor. Look into the best suitable component for this project. After the component used for this project has been identified, the analysis approach will be carried out using these needed factors and features linked to the component's benefits and drawbacks. Once everything was agreed upon, the scheduled trials were completed to the predicted end.



Figure 3.1 General flowchart of the project

3.3 Process Flow of the system

Figure 3.2 shows the flow chart of the irrigation system. The system will be on according to schedule.



Figure 3.2 Flowchart of the system

3.4 System design



Figure 3.3 Illustration of irrigation system

The design for an IoT-based garbage monitoring system employing a microcontroller is shown above. The small plant tray utilized as a prototype for this project, it is because its small, measuring at 25 cm x 31 cm x 8 cm. This size was chosen as a prototype since it is the cheapest. It can be bigger in size depending on the farm or garden size. This tray also been chosen as we can minimal the number of soil moisture sensor in this prototype. It also used 26 cm height water tank; it can store 10 liters of water at its fullest. In this project, it uses three float switch water level sensors, it will be spread at three level with 8 cm gap with each sensors. Water pump that been used in this project will be 6v-12v water pump to spread water across the tray.

3.5 Block diagram

The block diagram represents the whole system, including the sensor unit-equipped system. The first soil moisture sensor will be installed on the plant tray and will be used to detect soil moisture. The float switch will then be inserted in the water tank to monitor the water level. After controller receive input from float switch and soil moisture level sensor, it will control the water pump to make the water tank release water to the system. All the process will be conduct according to coding preset. After the process is done, data will be collected. Users can see all the data collected by using the Blynk app via mobile phone.



Figure 3.4 Block diagram of irrigation system

3.6 Hardware Development

In this project covering microcontroller, sensors, and actuators for the irrigation system. The function and application of each of the components are discussed in this chapter.

3.6.1 NodeMcu ESP8266

In this irrigation system system, the total pins used for analog inputs is 1 which is pin for the soil moisture sensor. Then fore digital pins, the total pins used for digital I/O is 6 which for float switch water sensors, LCD display and for the water pump. Most of the standard voltage required for actuators are below 5V. Figure below clearly shows the pins requirement and connection. The Arduino is chosen for this prototype due to it has 1 analog pin and 16 I/O digital pins, hence still has some pins that are unused be backup pins. Compared to the Raspberry Pi which more expensive, using NodeMcu ESP 8266 also can



Figure 3.5 NodeMcu ESP8266 pinout

3.6.2 Float switch

In this project, the float switch will act as water level sensor that will be put in the water tank to measure the level of water. The switch will be placed in three level in the tank to indicate the water level in the tank that will be at "FULL", "MID", "LOW", and "EMPTY".

A float switch opens or closes a circuit when the level of a liquid rises or falls. When the float is at its lowest point, resting on its bottom clip, most float switches are "usually closed." This indicates that the two wires that go from the switch's top complete a circuit (for example, when a tank is dry).



Figure 3.6, shows the connection of the switch and NodeMcu

Figure 3.6 NodeMcu ESP8266 and float switch connection

The magnetic reed switch of a float switch is hermetically sealed inside a stem, which is typically composed of plastic or stainless steel. The float's sealed magnet slides up and down the stem as the fluid level increases and lowers. The enclosed reed switch's contacts make contact and complete a circuit between the two lead wires when the magnet goes past, as seen in the cutaway in figure 3.7 below.



Figure 3.7 Switch cutaway

3.6.3 Soil moisture level sensor

As for soil moisture level sensor, Octopus Soil Moisture Sensor will be used in this project to measure the moisture level in the soil. Table 3.1 shows the sensor features.

Table 3.1 soil	l moisture sensor features
Power supply	Compatible with 3.3v or 5v
bl (112	
Output voltage	او بيو 4.2 v م
Current	
NPin definition	Analog output (Yellow)
	• GND (Black)
	• Power (Red)

The moisture level is determined by passing current through the soil using the two probes and reading the resistance. More water allows the soil to transmit electricity more freely (low resistance), but dry soil does not (high resistance). Figure 3.8 shows the connection between Arduino and the sensor.



Figure 3.8 Connection between NodeMcu and sensor

3.6.4 6-12v water pump

This project will be using 6-12v water pump as water pump to distribute water across the soil tray. This pump will be suitable for this project as the project just a prototype and the area to cover not too big.

The connection between the water pump and Arduino can be seen in figure 3.9



Figure 3.9 Connection between NodeMcu and water pump

3.6.5 16 x 2 LCD

Used in this system to project the reading of the soil moisture level sensor and the water level conditions.

Figure 3.10 shows the connection between LCD and NodeMcu



Figure 3.10Connection between NodeMcu and LCD

3.7 Software Development

ALAYSI

3.7.1 Arduino IDE

The Arduino Software (IDE) is a free and open-source cross-platform program (for Windows, macOS, and Linux) that makes it simple to write code and upload it to the Arduino microcontroller board. It allows the user to program the Arduino microcontroller by simply selecting the relevant port and Arduino model in the program settings, after which the coding is retrieved into the appropriate microcontroller. This application has a basic user interface and is easy to create with; thousands of libraries can be readily loaded and utilized. This software is compatible with all Arduino boards. The Arduino programming environment includes a text editor for writing code, a message box, a text terminal, a toolbar with buttons for basic activities, and a series of menus. It communicates with the Arduino hardware and transfers programming to it.



Figure 3.11 Arduino IDE interface

3.7.2 Blynk

Blynk is an iOS and Android platform with apps for managing Arduino, Raspberry Pi,and other Internet-connected devices. The Google Play Store for Android and the Apple App Store for iPhone both have these apps available for download. It's a digital dashboard that letsyou drag and drop widgets to create a project's graphical interface. Blynk isn't bound to any one board or shield. Instead, it is compatible with the hardware you want to use. The platformis made up of three major components:

- Blynk App with the help of our various widgets, you may create gorgeous interfaces for your projects.
- Blynk Server manages all phone-to-hardware interactions. You may use our Blynk Cloudor set up your own private Blynk server on your own computer. It's free and open source, with the ability to support thousands of devices. It can even operate on a Raspberry Pi.
- Blynk Libraries on all main hardware platforms, allow connectivity with the server and process all incoming and outgoing commands.

3.8 Physical Test Planning

Some testing plans have been made in preparation for the next round. The test will be carried out in phases, according to each category.

3.8.1 Mobile application

The selection of mobile application developers is Blynk, as indicated in the previous chapter. The capacity of Blynk to engage with sensor data will be put to the test. Furthermore, the factors of neatness and elegance on each application layout will be considered.

3.8.2 Sensor Part

Components such as sensors and actuators will be tested for the sensor section. The water level sensor, and soil moisture level sensor will all be put to the test. Tests will be carried out at this early stage to examine how each sensor works and interacts with the actuator. Furthermore, the purpose of this test is to determine the efficacy of coding that will be employed later.

3.9 Expected result

Expected results will be mentioned in this section, depending on the sort of test that will be done.

3.9.1 Mobile application

This is where the synchronization between the mobile application, the hardware, and the cloud system will be seen. Blynk app will be used.

3.9.2 Sensor Part

A few characteristics will be monitored to confirm that the sensor is functioning properly. The theory value will be referred to in the test, and then the test value will be compared to it.

3.10 Summary

In brief, if all phases have been completed and all the prerequisites, including software and hardware, have been met, this project may be accomplished. Any challenges that arise throughout the project's execution will be handled to meet the objectives. Data will be collected and analyzed, as stated in the next chapter.
CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The goal of this project is to develop an IoT-based system for monitoring and regulating the whole irrigation system. This chapter will go through the design and hardware implementation for the Development of demand driven irrigation system using IoT. Some tests were carried out to monitor and analyse the system's correctness and outcome analysis.

4.2 Results and Analysis

4.2.1 TinkerCad simulation

For the sensor simulation, The NodeMcu will be replaced with an Arduino Uno to make a simulation as the TinkerCad only have Arduino to acted as a microcontroller.

4.2.1.1 Testing the implementation of soil moisture level sensor

In this testing, soil moisture sensor used to measure the soil moisture level in the system and the servo will act as a substitute for water pump to irrigate the system. The buzzer and the LED will act as indicator that the moisture level have reached a low level at moisture in the soil and the servo will be move to 90-degree angle to indicate the water valve has been turned on. Figure 4.1 shows circuit diagram for the soil moisture sensor.



Figure 4.1 Circuit diagram for the sensor

Figure 4.2 shows the indication that the moisture level have reached at low level of moisture in the soil. The servo will move to 90 degree angle, the buzzer and the LED will be turned ON.

Figure 4.2 Indicate the moisture level at low level

Figure 4.3 shows the indication that the moisture level have reached at high level of moisture in the soil. The servo will stay at rest angle, the buzzer and the LED will be turned OFF.



Figure 4.3 Indicate the moisture level at high level

4.2.1.2 Testing the float switch as water level sensor



Figure 4.4 red LED indicates water low level

Figure 4.5 shows the switch for yellow LED turned ON indicate that the water reached at mid level float switch.



Figure 4.5 yellow LED indicates water mid level

Figure 4.6 shows the switch for green LED turned ON indicate that the water reached at high level float switch.



This simulation project the early plan to implement the water sensor to the project.

But after facing some difficulties implementing this plan. Another plan used to replace this implementation. The plan can be seen in the next sub-topic.

4.3 Testing the float switch as water level sensor

The water tank will be 26cm tall and will be supplied. It will use a float switch to act as water level sensor to detect a maximum value of the water. The LCD will show 4 condition of water level.

The LCD will display "FULL" when the condition of the float switch is switch 1 is on, switch 2 is on, and switch 3 is on.



Figure 4.7 Full water level display

Figure 4.8 shows the LCD display "MID" when the condition of the switch is switch

1 is off, switch 2 is on, and switch 3 is on.



Figure 4.9 shows LCD display "LOW" when the condition of the switch is switch

1 is off, switch 2 is off, and switch 3 is on.



Figure 4.9 Low water level display

Figure 4.10 shows LCD display "LOW" when the condition of the switch is switch

1 is off, switch 2 is off, and switch 3 is off.



Figure 4.10 Empty water level display

4.4 Soil moisture calibration

Before start using the sensor in the system, calibration for the sensor must be done.

The calibration been done as shown in figure 4.7 below.



First, make connection between the sensor and controller as shown in figure above.

The signal pin must connect to the analogue pin.

```
$include <Wire.h>
int sensor=A0, soil;
void setup() {
   Serial.begin(9600);
   pinMode(A0, INPOT);
   Serial.println (" serial begin ");
   delay(2000);
}
void loop(){
   soil = analogRead(sensor);
   Serial.println(soil);
   delay(2000);
}
```

Figure 4.12 coding for reading output

Then, start doing coding as shown above. The coding is just to make a reading output in the IDE monitor. After finish writing the coding, start collecting the highest and lowest reading for the sensor. The sensor read the highest for dry and lowest for wet as shown in figure below.



Figure 4.13 sensor in wet condition

COM6	- 0	×
1		Send
1024		2
803		
307.		
314		- 1
115		
120		
121		
126		
127		
136		
143		
149		
154		
154		
156 151		
156 150 160		

Figure 4.14 reading for wet state before calibration



Figure 4.16 reading for dry state before calibration

After taking the sensor reading, start writing coding to correct the sensor reading to be in line with the study that will be conducted. and this will correct the reading as the reading

will be lowest is dry and high is wet. As the figure shown above, the wet reading is 307 and dry reading is 1024.

```
void loop() {
   Serial.print("MOISTURE LEVEL : ");
   value= analogRead(sense_Pin);
   //value= value/10;
   int value_baru = map (value, 1024, 307, 0, 100);
   //serial.println(value);
```

Figure 4.17 coding for calibration

After that, the reading output will be 0 as the driest and 100 as the wettest.



Figure 4.19 reading for wet state after calibration

As shown above, can be conclude that the calibration for the sensor succeed.

4.5 The Developed Irrigation System

The design of the smart agriculture system had been discussed in this section. Figure below show the development of the prototype in the irrigation system.



Figure 4.20 top view of the prototype



Figure 4.21 water pump placement



Figure 4.22 control box

The result of mobile application and the real-time situation are synchronized. Initially, users open the app to monitor and control the system. All the actuators turn ON only when the sensors' value out of predetermined value, however, the user can be manually operating the actuators by pressing the manual button on mobile app for additional part. When the soil moisture sensor reaches certain level of dryness, the water pump will pump water from the tank and drip water until the reading of the sensor reaches the wet level.

The figure 4.19 below shows the interface of the Blynk app that shows the chart for the reading, the reading of the soil, water level reading, and control button for the water **UNIVERSITITEKNIKAL MALAYSIA MELAKA** pump.



This section is to discuss the accuracy of various types of sensors, including soil moisture sensor and water level sensor in both automated and manual settings. To collect the reading, both of reading display; Blynk app reading and LCD display reading were put side by side to compare the time respond of the data transfer. The result shows that the time respond was depends on the internet. If the connectivity of the internet is good, the time respond will be shorter.

The accuracy of the soil moisture can be seen in the sub-topic 4.3 soil moisture sensor calibration. As the calibration was done, the result shows good result as the reading of soil when dry is 0 and when wet is 100. So, the accuracy of the reading is good.

The accuracy of the soil moisture level sensor and water level sensor time response shown in the table and figure below. The test was run three time.

Test	Time(s)
1	1
2	1
3	1

Table 4.1 soil moisture level and water level sensor time response



Figure 4.24 soil moisture level and water level sensor time response

As the results show above, the time respond show all test results were 1 second in each run. Can conclude that the time response of the soil moisture level and water level sensor time response was good.

4.6.2 Parameters result

There are many parameters needed to complete the data collecting process. The data collected by the sensors will be observed and analysed to see the capability of the system to irrigate the plant. The readings also been compared day by day in a week to see the trend that the system collected.

4.6.2.1 Soil moisture level sensor



Data collected every hour while the system operates every in the week of observation. And in the 4 days of the observation, the weather was hot every day.

Figure 4.26 day 2 data



Figure 4.28 day 4 data

The soil moisture sensor used to get the reading of the soil moisture level. The ideal level for the plant to survive is the soil must not be too wet or waterlogging. So, the system has been set to only irrigate the soil until level of the soil moisture under 70 as the moisture level reading start at 0 and end at 100. Can be concluded that this system is effective as the

graph show that by using the system, the moisture level of the never drop below minimum level of soil moisture as the irrigation started when the soil moisture level drop below 70.

4.6.2.2 Water level sensor

Data of the sensor collected at 12PM every single day in the week of observations. The result shown in figure below. The number represents level of the water; 4 represents Full, 3 represents Mid, 2 represents Low, 1 represent Empty.



UNIVERSITI Figure 4.29 Water level usage A MELAKA

From the figure above, it shows that the water usage for this system is good as the prototype tank can supply 8 liters of water at its fullest. Can be concluded that the water wasted can be avoided by using this system as the water only supplied to the crop once the soil moisture level of the crop drop below 70.

4.6.2.3 Growth of the spinach

When the irrigation system is being set up, spinach is planted in the soil. Once the system is fully set up, the spinach is moved from the soil to a crop tray. The height of plant

also be measured with a ruler. For 7 week the spinach will be measure from week by week. The height and growth are recorded in the table.



Table 4.2 Spinach growth

Figure 4.30 Spinach growth

From the figure and table above, it shows that the growth from week 6 to week 7 recorded the highest growth; 3.2 cm and the other weeks show the height increase relatively from 1cm to 3 cm growth. So, this show that the system works wonderfully to ensure the plant can survive in this system.

4.7 Summary

By the result of the data collected, it can be concluded that this project was successful in designing and developing irrigation system prototype. The system has a water tank that will supply the water for the crop. And the irrigation system that been used was the modern drip irrigation system. The system has sensors that measure important parameters and display them on user's mobile and LCD on the control case for monitoring purposes. Thus, the user does not need to manually check on the plant. All the important parameters' data is analyzed in real-time as it is collected from the sensors and sent through the internet via the Wi-Fi module. This system's design has been registered as a Development of demand driven irrigation system using IoT.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, the demand driven irrigation system using IoT is indeed a viable and reliable system that can be used to overcome the wasted water problem. The main objective of this project is to achieve accurate and error-free data during data collecting process and the result can be seen in chapter 4. As stated in the introduction, the first objective of this research is to design and develop an IoT based irrigation system by using NodeMcu ESP8266. This objective was successfully achieved. In this project, implementation is done only for a small-scale crop. The hardware prototype is constructed with a NodeMCU ESP8266 module and an soil moisture sensor to monitor the level of soil moisture and actuators of the servo motor and LCD. For the software part, the language used in this project is C++ programming. Then the Blynk cloud application was used to construct the function set in the Blynk mobile app. Mobile applications enabled users to preview the soil moisture level and water level.

As for the second and third objectives of this research, which are to providing good soil moisture level to plant requirement for them to grow healthily and achieving accurate and error-free data during data collecting process. Experiments been conducted to test the success rate in achieving the objectives. The first experiment was to make water pump spread water to the crop automatically. As can be seen in Figure 4.25 to Figure 4.28; the recorded data from the observation shows that the soil moisture level never reaches below minimum level that been pre-set. The minimum level of soil moisture has been set to 70 as the Brazilian

spinach need mild level of wetness in the soil and not waterlogging. Can be concluded that the system has provided good soil moisture level to the crop to survive.

Lastly, the outcome of the third experiment, which achieving accurate and errorfree data during data collecting process. As seen in topic 4.3 and 4.6.1, the calibration and the time response for the sensor been done to prove that the data collecting process were accurate and the outcome were successful.

As shown in spinach growth result in chapter 4, the growth shown consistent growth through 7 weeks of observation process. This show that the system works wonderfully to ensure the plant can survive in this system.

Overall, the system performed admirably, but its performance fell short of expectations. So, if there are any possibilities to improve the performance of this system, then it would be highly recommended.

Future Works

For future improvements, demand driven irrigation system using IoT could be enhanced as follows:

- The system cannot detect any malfunction of the sensors or actuator. This can be improved by research ways to alert the users if any malfunctions of the sensors and actuator.
- Water tank and water pump sometime leaks at the water hose connector, this can improve by researching new ways to seal for the connector and the pump seam.

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APPENDICES

BDP 1 GANTT CHART

Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PSM1 briefing									Μ					
Find related project									T					
Find journals or research paper									T					
Chapter 1									D					
Do comparison table from	4.													
previous	2							-	S					
project		KA							V.					
Flow chart and block diagram for									E					
the 🙀							1							
MAININ									N					
project	1	/		. /		1 ²			IVI					
Chapter 2 No Lun	Jo,	کر	2		2	10,0		M.	يہونہ	91				
Finalize component used and									14 m					
design NIVERSIT	ITE	KN	KA	L M/	AL/	AYS	IA	ME	LAK	A				
project									В					
Chapter 3														
Chapter 4									R					
~ ~ ~														
Chapter 5									E					
Draft report submission														
Slide presentation									A					
Final report submission					<u> </u>		<u> </u>		K					
Presentation PSM1														

BDP2 Gantt Chart

Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PSM 2 briefing									Μ					
Find components														
Build actual project														
Find components									D					
and other things														
Build actual project									S					
Build actual project									г					
Mobile Application									E					
Mobile Application									Μ					
Build actual project														
Update report	ALAY	SIA												
Build actual project		4	2						В					
Build actual project			NKA											
Draft report									R	1				
submission								5						
Final report	Nn .								E					
submission	. (14	-	4	-		19. 19.	А		1			
Presentation PSM2	**	**	5				- (S:	-0-	1.2				
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