UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical and Electronic Engineering Technology

IoT BASED FERTIGATION WATERING SYSTEM

MUHAMMAD HAIKAL BIN KHOLIL

Bachelor of Electrical Engineering Technology with Honours

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A project report submitted
in partial fulfilment of the requirements for the degree of
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DEDICATION

This project is dedicated to both my parents. My mother, Zaharah Binti Salludin who did not only raise and nurture me but also a source of motivation and strength during moments of despair and discouragement. Her motherly care and support have been shown in incredible ways recently. My father, Kholil Bin Ahmad has been supporting me in my education and intellectual development by going through blood, sweat and tears over the years.

ABSTRACT

Today's technology development in our daily lives has led us to a better way of living. Internet of Things (IoT) is one of the new trend technologies that helps to ease people doing their daily chores. IoT helps to link physical devices around the world to link to the Internet for remote control. This application of technology can help people in the agriculture field in many ways. Fertigation is a process in which fertiliser is being applied with the irrigation water. The traditional way of farming often wastes a lot of time and requires a lot of workloads. The main problem with having traditional fertigation is the user cannot monitor their plant efficiently and can cause the plant to die due to insufficient nutrients. This is because monitoring traditional planting is not as efficient as monitoring using sensors. IOT Based Fertigation System is proposed to solve this problem and helps users to monitor and control their plant using sensors and mobile devices. This proposed system is ideal for housewives, teachers, any other full-time workers, and farmers that having a lack of time in monitoring their plants. These sensors will collect and send data from surrounding to the Microcontroller. The system is connected to the Internet by using Wi-Fi and the user can enter the parameters in the mobile application. Then, it will transmit the data to the system over the Internet. Overall, this thesis introduces the background of the system, methodology that is used, system design, system prototype, achievements of the system, and the future enhancements that can be done.

ABSTRAK

Perkembangan teknologi pada hari ini telah membawa kita ke arah kehidupan yang lebih baik. Objek Rangkaian Internet (IoT) merupakan salah satu teknologi trend terkini di mana dapat membantu memudahkan manusia melakukan kerja-kerja harian. IoT membantu menghubungkan peranti fizikal sekeliling dunia untuk dikawal secara kawalan jauh. Aplikasi teknologi ini dapat membantu mereka di dalam bidang pertanian dengan pelbagai kaedah. Fertigasi merupakan satu proses di mana baja disalurkan dengan irigasi air. Pertanian secara tradisional telah merugikan banyak waktu dan memerlukan banyak tenaga kerja. Masalah utama menggunakan fertigasi tradisional ialah pengguna tidak dapat memantau tanaman mereka dengan efisien dan boleh meyebabkan tanaman mereka mati akibat kekurangan nutrisi. Hal ini demikian kerana, penanaman tanaman secara tradisional tidak secekap memantau menggunakan sensor-sensor. Sistem Penyiraman Fertigasi Berasaskan IoT dicadangkan bagi menyelesaikan masalah tersebut dan membantu pengguna memantau dan mengawal tanaman mereka mengunakan sensor-sensor dan peranti mudah alih.. Sistem yang dicadangkan ini sesuai digunakan oleh suri rumah, guru-guru, pekerja sepenuh masa yang lain serta petani-petani yang mempunyai kekurangan masa bagi memantau tanaman mereka.. Sensor-sensor tersebut akan mengambil dan menghantar data dari sekeliling kepada mikrokontroler. System tersebut dihubungkan kepada internet melalui Wi-Fi dan pengguna boleh menggunakan parameter di dalam peranti mudah alih. Seterusnya, data tersebut akan dihantar kepada system melalui internet. Keseluruhan projek ini ialah memperkenalkan latar belakang system, metodologi yang digunakan, reka bentuk system, prototaip system, pencapaian sistem, dan peningkatan yang boleh dilakukan pada masa akan datang.

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cb	-	centibar
kPa	-	kilopascals

LIST OF ABBREVIATIONS

IoT	-	Internet of Thing
I/O	-	Input/Output
EC	-	Electrical Conductivity
TDS	-	Total Dissolved Solid
MCU	-	Microcontroller Unit
CPU	-	Central Processing Unit
PCB	-	Printed Circuit Board
PC	-	PC
V	-	Voltage
A	-	Ampere

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CHAPTER 1

INTRODUCTION

1.1 Background

Fertigation is a process in which fertilisers are being applied with the irrigation water. It is a process that combines fertilisation and irrigation and most commonly used by commercial growers ("What Is Fertigation – How Does Fertigation Work and How To Do It," n.d.). Besides, the Internet of Things (IoT) refers to physical devices around the world link to the Internet for remote control. People need to grow as fast as technology. Make use the technology to upgrade life to another level. Farmers can make use of IoT in the agriculture field. This is because, agriculture is one of the vital industries in Malaysia, so the user needs a very efficient system to ease their work for enhancing product quality and volumes. One of the solutions is by using a fertigation system with IoT. The benefits of fertigation systems include high-quality crops, no soil-borne disease, environmentally friendly, and more efficient usage of water and fertilisers.

1.2 Problem Statement

Problems that occurred in agriculture are the accuracy of fertiliser and water supply to plants. The fertilisers and water sufficiency are important for the cultivation to stay alive and produce good quality of products. For instance, whether the plant is lack of water or fertilisers based on data collected by sensors used. Farmers also face confusion even though the use of the fertiliser system and wonder how much water or fertiliser needs to be supplied to the crop. From their point of view, the water and fertiliser given are adequate as long as

the plant is adequately moist.

The main problem with having traditional fertigation is the user cannot monitor their plant efficiently and can cause the plant to die due to insufficient nutrients. It is not as efficient as monitoring using the sensor. The user also tends to overestimate the fertigation of their vegetables.

1.3 Project Objective

The primary goal of this project is to propose a systematic and effective methodology for accurately estimating and monitoring fertigation systems. The following are the types of objectives:

a) To study on the process of mixing fertilizers in the automated fertigation system to avoid ground water pollution.

b) To design and develop a low-cost prototype for mixing process to reduce large work labour.

c) To monitor the soil moisture content and electrical conductivity using open-source Arduino and accordingly fertigate the fields when needed.

1.4 Scope of Project

The scope of this project are as follows:

a) Concentrate on the watering system and the systematic fertigation system.

b) This IoT based system is for monitoring the fertigation plant that places in an open space or outdoor.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review is one of the vital parts of the project were research based on the selected area of study. A literature review is a search and evaluation of the available literature in your given subject or chosen topic area ("What is a literature review?" n.d.). This chapter provides a description of the existing system, comparison between the traditional fertigation system and the proposed system using the Internet of Things (IoT) with the specifics of hardware or tools technology in the development of the proposed system.

The traditional fertigation system has some issues that make it ineffective in agriculture. The quantity and time of irrigation control are manual and estimate. Besides, the quantity of added fertigation is approximate[1]. Then, some fertiliser affects plants and productivity. Moreover, this traditional system is highly cost of irrigation and fertilisation.

IoT Based Fertigation Watering System is a hardware and software embedded system that helps the user to control and monitor the growth of crops by using sensors. This system is built to achieve the following goals:

i) To study on the process of mixing fertilizers in the automated fertigation system to avoid ground water pollution.

ii) To design and develop a low-cost prototype for mixing process to reduce large work labor.

iii) To monitor the soil moisture content and timer using open-source Arduino and accordingly fertigate the fields when needed.

2.2 Fertigation Method in Planting System

Fertigation method involves spraying water-soluble nutrients into irrigation systems from reservoirs. In most cases, injectors and a pressure-controlled valve are used. Several criteria distinguish fertilisation systems[2].

Table 2.1: Criteria Distinguish Fertilisation Systems

Size and Scale of Application	In a major company a large-scale fertigation system is used. Small fertigation systems are therefore ideal for small farms or greenhouses.
Management	Manual and automated fertigation control systems are available. It is possible to connect timers into the irrigation system, allowing fertigation at fixed periods.
Irrigation methods	Flood irrigation, nozzle and head sprinkling, and drip fertigation.

2.2.1 Fertigation Effect in Planting System

Fertigation is a process that combines fertilization and irrigation. Fertigation is the application of fertilizer with irrigation water. Fertigation enables farmers to simply apply fertilisers throughout the growing season. Any nutrients in a soluble form are immediately accessible for plant absorption, giving the farmer better control over nutrient availability to the crop[3]. These considerations may result in more efficient fertiliser usage. Nutrients may be administered daily, weekly, or less often, depending on the crop's overall nutrition management strategy. Growers may limit nutrient loss from the root zone by applying fertilisers just before they are required. This is especially significant in locations with a lot of rain, as well as for dissolved nutrients that drain easily, such nitrogen[4]. Fertigation decreases the risk for

compaction and is less reliant on weather conditions as compared to techniques of providing nutrients throughout the season that involve tractors or foot movement.

2.2.2 Accuracy and Distribution Of Nutrients With Fertigation Implementation

Root fertigation provides the root zone with appropriate supply of nutrients, with minimum losses. It mainly minimises runoffs and trash, particularly due to runoffs or flooding. Most fertigation systems are fitted with pH-level monitors. The fertigation schedule is based on crop needs within the necessary time frames[5].

The optimal use of resources is accomplished by fertigating the root zone, which delivers humidity directly to the plant's root. Water (and nutrients accordingly) will be surrounding and under the emitter. Horizontal moisture propagation depends on the soil conditions, irrigation rate and plant duration respectively. Sulphate and nitrates do not stick to the particles of the soil, while potassium and phosphorus do[1].

2.3 Overview of Existing Project System

The vital task in this phase is to identify the similarities, differences, advantages and also disadvantages of the existing system. Fertigation monitoring system has existed for years. There are three chosen fertigation monitoring system will be studied and compares with each other and the proposed system, IoT Based Fertigation Watering System. Those three chosen fertigation systems are A Design of an Automated Fertigation System Using IoT, Automated Plant Watering System, and Smart Gardening Automation using IoT with BLYNK App

2.3.1 A Design of an Automated Fertigation System Using IoT

The project proposes a multidisciplinary smart agriculture model based on the following key technologies: the Internet of Things (IoT), sensors, cloud computing, mobile computing, and big data analysis[4]. The proposed methodology is advantageous for agricultural production expansion and agro-product cost containment. To activate and deactivate the pumps, the researchers used e-mail. It will help farmers reduce disease by initiating preventative measures early on. It is hoped that this information will help farmers prevent disease and intervene early in the disease cycle.

The system is primarily intended to be used as an automated fertigation and irrigation control system via IoT technology. The system is divided into four sections: three sensor nodes (nodes 1, 2, and 3), and a central node. Each sensor node is constructed identically (Arduino, soil moisture sensor, pH sensor, Ec sensor, XBee, solenoid valves, and relay)[4]. Sensor nodes are installed in the field to monitor the soil's properties (soil moisture, pH, Ec). The automatic system adjusts the watering and fertilisation processes based on these parameters. XBee then transmits the sensor node parameters to the main node for website monitoring, database storage, and analysis[4].

2.3.2 Automated Plant Watering System

Gardening is the most vital cultural activity and also the most labour-intensive. The project makes use of an ATmega328 microcontroller that has been programmed to detect the moisture content of plants at a specific point in time. It is set to water plants twice daily, in the morning and evening[6]. The system is constructed in such a way that it notifies the user of its current state and reminds them to refill the tank with water. All of this information is communicated via a smartphone application. The initiative hopes that by developing this

prototype, we would all be able to enjoy keeping plants without having to worry about being absent or forgetful.

Water is supplied to plants using a humidity sensor and a motor / pump. A defined range of soil moisture and temperature is established specifically for the needs of specific plants. The user is notified of overall activity via a mobile application. Programming the Arduino board is accomplished through the use of the Arduino IDE software.

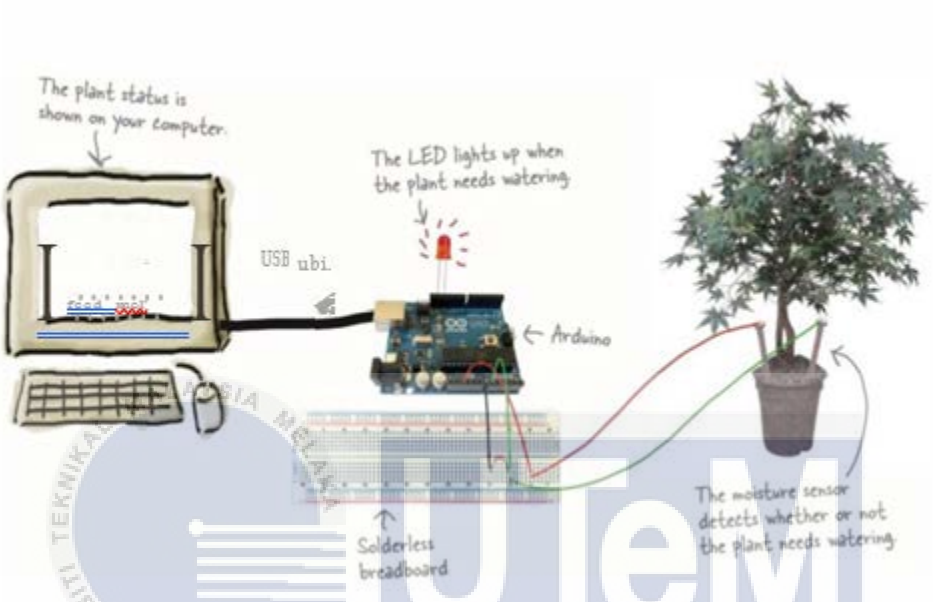

Figure 2.1: Real-time view of proposed Automated Gardening System

2.3.3 Smart Gardening Automation using IoT With BLYNK App

This automation is based on the Internet of Things, which connects a large number of devices via the internet. Water is supplied to the plant via a water pump in this smart gardening automation. This system or approach determines the fertility of the soil and supplies it with water via a water pump using a soil and moisture sensor. Sensors for temperature and humidity have a significant impact on harvest growth. Maintaining proper temperature and humidity levels also ensures crop health and survival. Sensors detect the plant's need for water and provide it as the soil loses moisture in this IoT-based gardening automation. Because different soils have different levels of productivity and wetness, this methodology uses soil and moisture sensors to pinpoint the problem. Our country has six distinct seasons, and each day has a

different temperature and humidity level. Temperature and humidity sensors are used to monitor the temperature and humidity for the plant's health and survival, and they typically send data to the Blynk application [6].

2.4 Background of IoT

The Internet of Things (IoT) is a network of physical objects or "things" that have been embedded with electronics, software, sensors, and connectivity to collect and exchange data (Ahmed, Osman, & Awadalkarim, 2018)[4]. Nowadays, IoT is a new trend technology that helps physical devices around the world link to the Internet for remote control. There are various inventions from different industries that make use of this IoT as their system based. The same goes to agriculture, this field is also put a lot of effort to improve the efficiency of planting to be more reliable and more ease. Fertigation is one of the examples of planting that requires precision control and regular monitoring to ensure the positive rate of production. In the system based on IoT, there are a few existing systems with different approaches that have been introduced in past years[7].

2.5 Microcontroller

In an embedded device, a microcontroller is a small integrated circuit that controls a single operation. A microcontroller is a single chip that includes a central processing unit (CPU), memory, and I/O peripherals. Microcontrollers, also known as embedded controllers or microcontroller units (MCUs), are used in a variety of products, including automotive, robotics, office computers, medical devices, handheld radio transceivers, vending machines, and home appliances[7]. They are essentially small personal computers (PCs) that are programmed to monitor minor aspects of a larger component and lack a sophisticated front-end operating