Faculty of Electrical and Electronic Engineering Technology

SOLAR POWERED AUTOMATED FERTIGATION SYSTEM (I-SIRAM)

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Bachelor of Electronics Engineering Technology with Honours

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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 Electronics Engineering Technology with Honours.

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ABSTRACT

The use of digital agriculture, sometimes known as smart farming or e-agriculture is the new frontier to empower the agriculture sector by infusing IR4.0 technologies, such as the Internet of Things (IoT) in agriculture. The emergence of IoT technology has contributed to the progress of intelligent farming from manual and conventional farming through trial and error to precision agriculture through digital technology. Therefore, I-SIRAM has been developed as a digital solution for precision and smart agriculture. I-SIRAM is an IoT-based automated fertigation system that uses solar-powered to control the injection of fertilizer intake with the intention of tackling the overdose of fertilizer and watering intake. I-SIRAM is developed to automatically agitate a proper proportion of fertilizers, and watering and to implement solar-powered automatic fertilizer that can cut the electricity accessibility issues. Arduino UNO is selected as the microcontroller to program the system while pumps, motors, and sensors are used to initiate the agitation of fertilizer A, fertilizer B, and water into the mixer tank. The system has been built accordingly and the performance of the system has been tested. What makes the project unique is that it is automatic, energy sufficient, 100% accurate, and fully electronic control. With the aid of solar energy and IoT implementation, the automatic fertigation system will bring lots of benefits regarding cost, productivity, labor, human health, and the ecosystem. This system has been tested in real-time and now is ready for commercialization

ABSTRAK

Penggunaan pertanian digital, kadangkala dikenali sebagai pertanian pintar atau e-pertanian merupakan sempadan baharu untuk memperkasakan sektor pertanian dengan menerapkan teknologi IR4.0, seperti Internet Perkara (IoT) dalam pertanian. Kemunculan teknologi IoT telah menyumbang kepada kemajuan pertanian pintar daripada pertanian manual dan konvensional melalui percubaan dan kesilapan kepada pertanian jitu melalui teknologi digital. Oleh itu, i-SIRAM telah dibangunkan sebagai penyelesaian digital untuk pertanian jitu dan pintar. I-SIRAM ialah sistem fertigasi automatik berasaskan IoT yang menggunakan kuasa solar untuk mengawal suntikan pengambilan baja dengan tujuan untuk menangani lebihan dos baja dan pengambilan air. i-SIRAM dibangunkan secara automatik dengan memberi kuantiti baja yang betul, dan menyiram serta melaksanakan baja automatik berkuasa solar yang boleh mengurangkan isu kebolehcapaian elektrik. Arduino UNO dipilih sebagai mikropengawal untuk memprogramkan sistem manakala pam, motor dan penderia digunakan untuk memulakan pengadukan baja A, baja B dan air ke dalam tangki pengadun. Sistem telah dibina dengan sewajarnya dan prestasi sistem telah diuji. Apa yang menjadikan projek itu unik ialah ia automatik, cekap tenaga, 100% tepat dan kawalan elektronik sepenuhnya. Dengan bantuan tenaga suria dan pelaksanaan IoT, sistem fertigasi automatik akan membawa banyak faedah berkaitan kos, produktiviti, buruh, kesihatan manusia dan ekosistem. Sistem ini telah diuji dalam masa nyata dan kini sedia untuk dikomersialkan.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

SYMBOLS	SCALES
°C	Temperature
$mScm^{-1}$	Electrical Conductivity (EC)

LIST OF ABBREVIATIONS

ICT	-	Information and Communication Technology
IoT	-	Internet of Things
UAV	-	Unmanned Aerial Vehicle
ML	-	Machine Learning
WSN	-	Wireless Sensor Network
EC	-	Electrical Conductivity
TDS	-	Total Dissolved Solids
AI	-	Artificial Intelligence

CHAPTER 1

INTRODUCTION

1.1 Background

In recent years, automation and IoT have been merged with traditional farming. Remote sensing technologies, for example, Big Data, Internet of Things (IoT), and Unmanned Aerial Vehicles (UAVs), are particularly promising. They have the potential to provide a new way in agricultural techniques. In a wide range of agricultural parameters can be monitored to help with smart farming, increase crop yields, lower costs, and optimise process inputs such as environmental protection circumstances, growth status, soil quality, irrigation water, insect, and disease problems, and so on. But these technologies are a barrier for a small farmer to improve their plant management. This is because the capital to use the technologies is high. In this era of modernity, everyone should experience the greatness of technology that can simplify daily affairs. Therefore, in this project, we proposed a smart system agriculture that can be used by everyone that love to cultivate.

1.2 Problem Statement

The increased demand for food, in terms of quality and quantity, has accelerated the need for agricultural modernization and intensive production techniques. To determine the exact amount of water and Electrical Conductivity (EC) necessary for the plant is a huge challenge. A farmer will find it difficult to water and give enough nutrient for their plant. It is either the water is too much or too less. An EC meter, pH value, and temperature sensor is placed and operated utilising several IoT strategies to prevent those problems. EC meter monitoring also has been one of the most difficult tasks in agriculture for both cultivator and farmers. Soil testing raises a few environmental issues that have an impact on agricultural output. Soil management requires determining several soil properties including pH and EC value. These metrics can be easily computed with the help of IoT sensors.

Next, existing technology in agriculture is too expensive for a small farmer. Based on market price, a starter UAV can be around $850 (Lawson, 2017). In Malaysia, the cost for manage a Greenhouse structure can be around RM 20,000 per unit (Anem, 2010). The price may increase from year to year. This amount of price is way too much for a small farmer. A low-cost technology must be proposed to help the small farmer. Next, EC meter, pH value, and temperature of the plant is difficult to monitor without using the IoT. Nowadays, most of the technology are using IoT such as connected vehicle, traffic management, smart buildings and smart homes, smart cities, supply chain management, and more (Pratt, 2022). Other than monitoring the plant, IoT also can enhanced the productivity of the crop and provide better quality control.

1.3 Project Objective

The main aim of this project is to propose a systematic and effective methodology to develop an Internet of Things (IoT) fertilization system for smart agriculture. Specifically, the objectives are as follows:

a) To design an affordable fertilization system using Arduino and IoT.

b) To analyse the measurement of the fertilization system based on pH value, EC meter, and temperature.

c) To evaluate the performance of transmission of the sensor's data to the cloud data is done in real time.

1.4 Scope of Project

To avoid any uncertainty of this project due to some limitations and constraints, the scope of the project is defined as follows:

a) The sensor has three different types which is EC meter sensor, temperature sensor, and pH value sensor.

b) The type of plant is limited to houseplant, annuals and biennials, alpines. This project is not involved aquatic plants, cacti and succulents, and the others.

c) Type of software used is Blynk and Arduino. Platform used is Windows and Android.

1.5 Thesis Outline

In Chapter 2, this thesis explains about the literature review. Based on five articles in the recent years, there is a lot of technology fertilization system for smart agriculture. This chapter will focus more on the theory about the existing technology such as UAV, wireless sensor, and more.

In Chapter 3, this thesis will focus more on the development of this project. Type of sensor, hardware, and software will be discussed.

In Chapter 4, the result of this project is presented. All the analysis and result will be discussed based on the research methodology.

In Chapter 5, the development of this project will be concluded, and the future potential work will be discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

After studying the development of an IoT in fertilization system for smart agriculture from previous articles, (Ayaz, 2019) state that the potential of wireless sensor must be implement into the agriculture sector. From others article, (Dr. Bam Bahadur Sinha, Dr. R. Dhanalakshmi, 2022), farmers can connect to their farm from almost anywhere by using IoT technology. Sensors and actuators are used to control farming processes, wireless sensor network is being used to monitor the farm. In this article, wireless cameras and sensors were used to remotely monitor the farm and collect all the data. (Achilles D. Boursianis, 2020) had described the main principles of IoT technology, including intelligent sensors, IoT sensor types, networks and protocols used in agriculture. The researcher focuses more on the role of Unmanned Aerial Vehicle (UAV) technology in smart agriculture, by analyzing the applications of UAV in various condition. Next, (G. Valecce, 2019) use the concept of solarfertigation which is an IoT system that are designed specifically for smart agriculture. Lastly, (Raheela Shahzadi, 2016) use sensors to collect the real-time data and send to the server to be deployed for extracting the information from sensor data.

2.2 What is Agriculture

Agriculture is the broadest term for the various methods in which crop plants and domestic animals support the worldwide human population by supplying food and other necessities products. Agriculture is derived from the Latin words *ager* (field) and *colo* (farm) or (cultivate). When the Latin words agriculture and tillage are combined, the result is agriculture. However, the word has arrived to encompass a broad range of activities that are essential to agriculture and have their own distinct identities such as cultivation, domestication, horticulture, arboriculture, and other descriptive phrases (Harris & Fuller, 2014). In Malaysia, agriculture sector has been introduced around 1780s with the arrival of British in Penang. British interest to develop a plantation agriculture which is pepper in Penang (Joseph, 2008). Pepper planting in Penang continue from 1790-1825 and it was the first exported agriculture products in Malaysia. In India, there are various type of farming systems including subsistence farming, shifting agriculture, plantation agriculture, intensive farming, dry agriculture, mixed and multiple agriculture, crop rotation, and terrace cultivation (Anon., 2016). All these types of farming have different ways and roles, but the output is same which is to produce agricultural products. Malaysia should take the example of the action taken by India to improve our product quality and quantity in agriculture.

2.3 Wireless Sensor in smart agriculture

The purpose of wireless sensor in smart agriculture is to obtain the variety of environmental parameters such as temperature, pH value, soil moisture, and humidity. By using this sensor in agriculture, it can enhance the quality and quantity of the crops by farmer. In agriculture, the amount of moisture in the soil has an important effect in plant growth. Directly checking the wetness of the farm field is possible. An agricultural field's moisture and temperature can be measured with a thermometer and a hygrometer. Wireless sensor network (WSN) can be used to obtain data from a wireless sensor network so that the server can provide typical server services to all clients at all times and from any location. To assist smart farming, a WSN Server is required to service all agricultural data needs so that the data may be analysed and optimised for smart farming demands. The wireless sensor network server acts as a server, receiving data from many sensors over WSN. The data is subsequently saved in real time to a database, then visualised as a website that can be acquired via the Internet. A (WSN) is a network system that connects sensors and transmission devices to a WSN server to receive information or data. WSN is typically used to monitor the environment in agricultural or plantation settings.

2.4 Role of UAV technology in smart agriculture

In recent years, unmanned aerial vehicles have emerged as a low-cost alternative in sensing technologies and data analysis techniques. Remote sensing is a technique that uses electromagnetic energy to identify the qualities of a target object from a distance. It has the advantages of being comprehensive, non-invasive, timely, and flexible. UAV can be used in agriculture to collect data in the field. The advantages of a UAV are that it can capture images of a farmer's crop with a variety of camera filters, providing multiple spectral imaging, allowing image processing and analysis, and providing better information on their crop's health while also identifying areas of the crop that require special attention. Fixed wing and multirotor UAVs are the two types of UAVs available. Multirotor UAV can load multiple types of sensors and due to that it may limit the battery lifetime and flight time. Fixed wing has a better flight time but has a lower speed compared to multirotor.

2.5 Solar fertigation

Solar fertigation is a precision irrigation system that uses photovoltaic solar power energy and an Internet of Things technology. Temperature, radiation, humidity, soil moisture, and other physical characteristics are all monitored by the system. Solar fertigation makes use of renewable energy sources photovoltaic panels for smart irrigation and decision-making assistance for farmers using Internet of Things technologies. Using a hybrid predictive model, a novel irrigation control technique has been developed. Real-time sensors and a model based on weather and crop data were described. Solar fertigation relies on a low-cost WSN that monitors and transmits locally or to an on-cloud software platform. WSNs are practically energy independent. The prototype detected soil and environmental characteristics in the field to check crop growth and assist farmers in decision-making phases related to the growth processes of grown crops.

2.6 IoT in Agriculture

In agriculture, the development of IoT has high potential to produce a better product. With this kind of technology, the farmer or administrator can control or manage the plant needed. With the used of web-based and mobile application, farmer can manage agricultural plots and control the watering systems. Furthermore, IoTs were used in the agro-industrial production chain. They suggested a unique architecture based on the IoT, combining wireless and distributed sensor devices with environmental simulation to follow the evolution of grapes for wineries (Jirapond Muangprathub, 2019). An IoT-based farm information system with a distributed design is presented. The IoTs servers were used to track and trace the entire agricultural production process. Several studies have been conducted to increase the functionality of IoTs. For this purpose, several sensors have been used to measure temperature, solar radiation, humidity, and rain with the control of an electronic device which is Arduino and Android-based smartphone.

2.7 Smartphone's User in Malaysia

In IoT platform, smartphones are important because it is related to each other. Without smartphone, whether it is Android or Internetwork Operating System (IOS), IoT cannot be implemented. In Malaysia, smartphone's user is seeming to be increase throughout the year up to 2025. The increasing number in smartphone user is due to increasing growth population. Based on research, the number of smartphone's user in Malaysia is about 29 million in 2021 and is expected to increase as much as 1.74 million in 2025 [1]. This is a positive result in term of IR 4.0 to implement the IoT platform. Graph below shows the number of smartphone user in Malaysia from 2010 until 2025. The data is taken from Statista that run the statistical analysis.

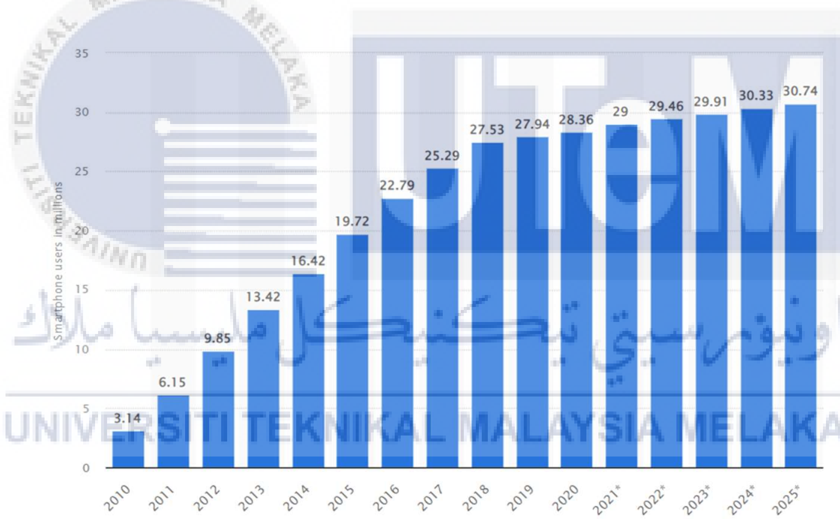

Figure 2.1 Number of Smartphone's User in Malaysia (Taken from Statista)

2.8 Productions of Vegetables in Malaysia

The productions of vegetables in Malaysia are increasing from 2015 to 2021. But it is not enough comparing to other countries especially in Asia region. For example, Vietnam produces 17 million metric tons of fresh vegetables in 2020 and Malaysia produces lower than that. The IoT in smart fertigation can affect the production of vegetables in positive term. Vegetable production on global scale increased significantly between 2000 and 2020, rising from 682 million metric tonnes in 2000 to more than 1.15 billion metric tonnes in 2020 [2]. Graph below shows the top ten producers of vegetables in 2020.

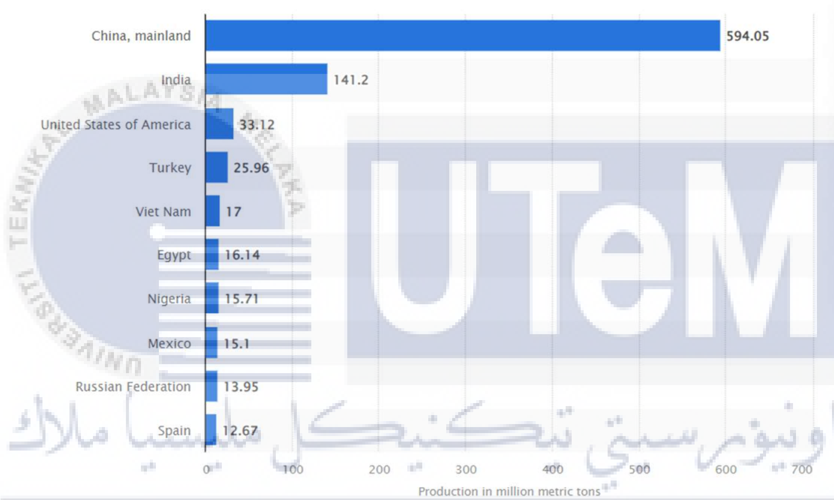

Figure 2.2 Producers of Fresh Vegetables Worldwide (Taken from Statista)

2.9 Traditional Farming versus Modern Farming

Traditional farming is describing as a primitive method of agriculture that uses labour-intensive, traditional knowledge, tools, resources, organic fertiliser, and the farmers' long-standing cultural traditions. Modern farming methods refers to a style of agricultural production that makes extensive use of technology to boost crop yields and productivity. Table below show the main differences between traditional and modern farming.

Traditional Farming	**Modern Farming**
Based on labour-intensive	Based on capital intensive
Crop, slash, and agroforestry is some of the technique used	Monocropping, automated fertigation, is some of the technique used
Natural fertilizers	Chemical fertilizers
Production rate is low	Production rate is high
High inputs required	Low inputs required

Table 2.1 Difference between Traditional Farming and Modern Farming

From the table above, modern farming has a better benefit in terms of production. When modern farming is applied into every house, it can increase the crop yield so that it can benefits the user.