DEVELOPMENT OF PRECISION FARMING IRRIGATION AND FERTIGATION

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DECLARATION

I declare that this thesis entitled “Development of Precision Farming Irrigation and Fertigation” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : Nurul Qadriyah Binti Mohd Rizal

Date : 10 January 2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (BMMV) with Honours.

Signature : 

Supervisor Name : Ts Dr Mohammad Haidir Bin Maslan

Date : 10 January 2023

DEDICATION

Full dedication and congratulation to dearself Nurul Qadriyah for completing this thesis and a big thanks to everyone who gives cooperation and motivation for this journey especially for my parents, supervisors, leturers and friends

ABSTRACT

Plants are living things that are the main sources for other living things. It contributes the important resources to humans which are oxygen and food supply. But in the life process of the tree, it needs four basic things in their life: water, sun, nutrients and carbon dioxide. In complementing these four things, water and nutrients become a problem for many farmers and people who plant trees just as a hobby. This is because watering and fertigation must be done regularly according to the plant's needs. Time constraints and many trees also cause irrigation and fertigation cannot be done properly. In solving this problem, automatic irrigation and fertigation devices are needed to develop. The main components for this project are soil moisture sensor, electrical conductivity sensor, water pump, power supply, multiple relay channel, and the most important are, Arduino UNO. Arduino UNO will act as a microcontroller to deliver data from sensors to devices to get the desired output. One of the sensors used is Capacitive Soil Moisture sensor that will detect the level of soil moisture that have been setup in the coding uploaded in the Arduino while Total Dissolved Solid sensors used for fertigation systems can detect the conductivity value. The programming system is built using Arduino software by implementing the required system. The pump to irrigate water and fertiliser worked as output of the systems. Both irrigation and fertigation systems are built separately but will work simultaneously. In order to make sure that the prototype of Arduino Precision Farming can be used as intended, it will be put through function testing. Before that, the sensors correct parameters were established using calibration code written in the Arduino IDE. The performance will then be evaluated by comparison with a few readily available devices on the market. Thus, the development of the prototype for Precision farming irrigation and fertigation is completed.

ABSTRAK

Tumbuhan ialah benda hidup yang menjadi sumber utama kepada hidupan lain. Ia menyumbang sumber penting kepada manusia iaitu oksigen dan bekalan makanan. Tetapi dalam proses kehidupan pokok, ia memerlukan empat perkara asas dalam kehidupan mereka: air, matahari, nutrien dan karbon dioksida. Dalam melengkapkan empat perkara ini, air dan nutrien menjadi masalah kepada ramai petani dan orang ramai yang menanam pokok hanya sebagai hobi. Ini kerana penyiraman dan fertigasi mesti dilakukan secara berkala mengikut keperluan tumbuhan. Kekangan masa dan pokok yang banyak juga menyebabkan pengairan dan fertigasi tidak dapat dilakukan dengan baik. Dalam menyelesaikan masalah ini, alat pengairan automatik dan fertigasi diperlukan untuk dibangunkan. Komponen utama untuk projek ini ialah sensor kelembapan tanah, sensor kekonduksian elektrik, pam air, bekalan kuasa, saluran geganti berbilang, dan yang paling penting ialah, Arduino UNO. Arduino UNO akan bertindak sebagai mikropengawal untuk menghantar data daripada sensor ke peranti untuk mendapatkan output yang dikehendaki. Salah satu sensor yang digunakan ialah Capacitive Soil Moisture sensor yang akan mengesan tahap kelembapan tanah yang telah ditetapkan dalam pengekodan yang dimuat naik dalam Arduino manakala Total Dissolved Solid sensor yang digunakan untuk sistem fertigasi dapat mengesan nilai kekonduksian. Sistem pengaturcaraan dibina menggunakan perisian Arduino dengan melaksanakan sistem yang diperlukan. Pam untuk mengairi air dan baja berfungsi sebagai output sistem. Kedua-dua sistem pengairan dan fertigasi dibina secara berasingan tetapi akan berfungsi serentak. Untuk memastikan bahawa prototaip ketepatan penanaman Arduino boleh digunakan seperti yang dimaksudkan, ia akan dimasukkan melalui ujian fungsi. Sebelum itu, parameter betul sensor telah ditubuhkan menggunakan kod penentukuran yang ditulis dalam perisian Arduino. Prestasi kemudiannya akan dinilai dengan perbandingan dengan beberapa peranti yang tersedia di pasaran. Oleh itu, pembangunan prototaip untuk ketepatan pertanian pengairan dan fertigasi selesai.

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LIST OF SYMBOLS AND ABBREVIATIONS

IDE	-	Integrated Development Environment
USB	-	Universal Serial Bus
IoT	-	Internet of Things
EC	-	Electrical Conductivity
LED	-	Light Emitting Diode
AC	-	Alternating Current
DC	-	Direct Current
EEPROM	-	Eletrically Erasable Programmable Read Only
KB	-	Kilobyte
TX	-	Transmitting Pins
RX	-	Receiving Pins
PWM	-	Pulse Width Modulation
CF	-	Compact Flash
µ	-	Micro
cm	-	Centimetre
BNC	-	Bayonet Neil Concelman Or British Naval Connector
V	-	Volts
$\bar{x}$	-	Average
x	-	Each value of the data
S	-	Siemens
n	-	The number of data
TDS	-	Total Dissolved Solid

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CHAPTER 1

INTRODUCTION

This final year project involves the development of precision farming irrigation and fertigation. To implement latest technology applications in this final year project, the development system is based on Arduino programming and various sensor devices. This project has two main systems: irrigation and irrigation, that works simultaneously. This chapter considers the background for the problem statement and introduces the objectives that need to be done and the project scope, which is the limit of this study. This chapter also contains the groundwork of the report, which can generally represent the dissolution. Furthermore, the course project's outline also illustrates how this project works.

1.1 Background

Agriculture 4.0 is the revolution of the precision farming concept that getting a lot of attention in these days. This evolution refers to all strategies and tools that apply technologies in an interconnected manner to improve and optimise production that starting with data. Precision farming is a set of strategies and tools that helps farmers to improve soil quality and productivity by implementing a series of targeted vital interventions enabled by the introduction of increasingly advanced technologies. It is called "precision" because to the cutting-edge tools used, the proper intervention can be performed in the right place, at the right time, responding to the specific demands of individual crops and individual areas of land with superior levels of precision.

Irrigation which also known as watering, is one of agricultural process of applying the right water amount to soil or land in the production and growth of crops, landscape plants or lawns. Water is artificially applied to the soil via various tubes, pumps and spray. Micro-irrigation, which sprays a litttle amounts of water near the plants. Sprinkler systems work by spraying the water through nozzles and then the gravity systems makes the field flood or run down furrows. These two are both examples of irrigation technologies. Furthermore, irrigation scheduling can help farmers avoid over-irrigation. Precision agriculture technologies like computer, smartphone decision support tools and remote irrigation equipment can also assist farmers in optimising their operations..

Fertigation is a precise, controlled and time-tested method of applying fertilisers, nutrients and other water-soluble products via drip lines and in some cases, micro-sprinkler irrigation systems based on crop requirements such as crop stage, canopy size, soil or season. During this technological era, fertilisers were injected into irrigation systems and used for water amendments, soil amendments, and other water-soluble purposes. Chemigation or the injection of chemicals into an irrigation system was involved. These two terms are sometimes used interchangeably as it was similar but chemigation is generally a more controlled and regulated process due to the nature of the chemicals used. The fertiliser used will affect the pH and conductivity of the soil. As a result, the pH and conductivity of the nutrient solution should be such that it does not harm plant roots and allows all essential nutrients to dissolve, preventing the formation of precipitates that clog irrigation systems and reduce plant nutrient availability.

In response, this project was established to help many farmers or people who love farming in their irrigation and fertigation systems using Arduino technology. Hence, they can keep their crops in good quality condition effortlessly.

1.2 Problem Statement

The problem statement is a complication that needs to be listed and resolved with the ambition to accomplish the project's objectives and need to be further informed about the problem.

Irrigation and fertigation are essential systems in agriculture. Based on the observation, there are some problems which the farmer or gardener faces. For agriculture on a large scale, it is pretty tricky for irrigation and fertigation to be carried out. This problem caused the crop to receive uneven fertiliser or water due to less workforcer to do the work.

In addition, farmers cannot accurately control the amount of water and fertiliser released to the plants. It often happens due to manual irrigation and fertigation systems. The water and fertilise independently and do not use the correct conductivity level of water and fertiliser. Even the fertiliser stills need to be supplied using manpower without any accurate value. Hence, it affected the quality of the crop produces.

Gardeners who grow plants on a small scale such as flowering plants at home usually need more time to water and fertilise their plants because of their busy lives. A busy working day and a very hectic week can also lead to a lack of attention to their garden. It would be easier for them to have an automatic irrigation and fertigation system to control the amount of water and nutrient plant. Even though the existing devices in the market are more pocket-friendly to automatically irrigate the plant, they have less convincing accuracy.

This Development of Precision Farming Irrigation and Fertigation project helped to solve all the problem highlighted.

1.3 Research Objectives

Based on the introduction and problem statement, the objectives of this project are:

a) To develop an automatic irrigation and fertigation system by utilising Arduino.

b) To implement the Internet of Things in precision farming.

1.4 Scope of Research

This project's scope focused on the devices and programming coding in the development of precision farming irrigation and fertigation. In this project, coding programming used was in Arduino software and other related software to design the circuit. The coding tested using a real Arduino system. The project scopes as follows:

1. Water amount based on the soil moisture condition
2. Use liquid fertiliser
3. Arduino UNO as a microcontroller
4. System development and programming coding using Arduino 1.8.16 software
5. In an irrigation system, sensors and devices were used :
    - Water pump
    - Capacitve soil moisture sensor
    - 4-way channel relay module

6. Fertigation sensor and devices:

- Total Dissolved Solid sensor
- Water pump
- Fertiliser pump

CHAPTER 2

LITERATURE REVIEW

2.1 Precision Farming

According to United Nations' latest World Population Data Sheet for 2020 entailed that the global population will grow from 7.8 billion in 2020 to 9.9 billion in 2050. This is a more than 25% increase over the 2020 level. It happened because of changes in food intake, including dairy and grains, especially in underdeveloped countries and this growth will necessitate additional nutrition.

The efficiency of the existing farming areas can be improved through a more reliable food chain and the use of pesticides (Cooper & Dobson, 2007).

Farming has been crucial throughout human history, not just to feed an ever-increasing population but also to meet other needs like the manufacturing fuel, medicine and fibre. Agrochemicals and genetically modified foods have been introduced to agriculture due to new advancements in science, technology and equipment to achieve a high yield while minimising labour costs (Ryu et al., 2015)

A farm management system based on information and technology determine analyses and adjusts the variability in fields by implementing activities of production crop at the optimal time, location and method for maximum sustainability, proffitability and land conservation resources. Despite extensive research, only a minor of farmers applied precision agriculture or precision farming technology system strategies in reorganising the entire agricultural system toward high efficiency, low-input and eco-friendly agriculture.

Precision farming or precision agriculture, is a primary term for more controlled and precise Internet-of-Things-based farming methods. When crops and cattle are monitored by

machines with superhuman precision, they will get complete needs. The difference between precision farming with traditional farming is that decisions can be made per square metre or even per plant/animal rather than per field (Sciforce, 2020).

2.1.1 Definition of Precision Farming

Precision farming, also known as smart farming combines agricultral science and information to improve crop yield and quality while remaining economically and environmentally sustainable. Example of precision farming technologies include variable rate input application, in-field electronic sensors, sprayers, yield monitoring, fertiliser applicators, remote sensing, section and row control on planters and spatial data management systems. Essentially, it adapts existing practices while incorporating new ones to create new tools for farmers to increase crop productivity while minimising environmental impact and conserving resources (Beluhova-uzunova & Dunchev, 2019)

Precision farming, according to Singh, is a farm management method that identifies, analyses and manages variability within fields for maximum profit, sustainability, and land resource protection. In this type of farming, new information technology can be used to make better decisions about many aspects of crop production. Precision farming is concerned with the increased efficiencies obtained by understanding and dealing with a field's natural variability. The goal is to manage and distribute inputs on a site-by-site basis to long-term benefit. (Singh, 2010).

The researcher also stated that precision farming is assists many farms worldwide in maximizing crop input effectiveness. Precision agriculture is frequently defined by the technologies that enable it and it is sometimes known as GPS agriculture or variable-rate farming. As crucial as the gadgets are, it takes a moment of reflection to recognise that information is the most crucial precision farming component. Farmers who use information

efficiently receive higher returns than those who do not. Precision farming differs from traditional agriculture in that instead of managing entire fields as a single unit, management is adapted for specific sections within fields.

Based on Auernhammer in his journal, precision farming is an application of information technology in agriculture. Time and position may be linked to all farming procedures using electronic communication standards and satellite positioning systems. Precision farming is currently mainly aimed on site-specific fertiliser applications, with relatively low cost advantages. Thus, precision farming will likely gain importance only when potential extra benefits, such as reduced environmental loads and increased information flow, are recognised, analysed and included as part of the reward itself (Auernhammer, 2001)

2.1.2 Precision Farming Tools

There are various precision farming technologies available in this world. However, none can replace people's professional knowledge working in the farming field, even though they all provide valuable support to increase performance and results.

Two of the most common instruments are semi-automated directed vehicles and variable dosage rates, but many more alternatives are continually improving. Innovative technologies employ integrated frameworks to collect data and implement a sequence of activities to increase productivity.

2.2 Types of Precision Farming

Possible Internet of Things be using cases will most likely vary depending on the farm's focus. The following are some of the most common types of precision farming systems: