Faculty of Electrical and Electronic Engineering Technology

SMART PLANT MONITORING UTILIZING IOT AND ARDUINO: SOFTWARE DEVELOPMENT

NURFADZILAH BINTI MOHD SANI

Bachelor of Electrical Engineering Technology with Honours

2021

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**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology with Honours**

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek: Smart Plant Monitoring System Utilizing IoT and Arduino: Software Development

Sesi Pengajian: Semester 1 2021/2022

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(COP DAN TANDATANGAN PENYELIA)

AZHAN BIN AB. RAHMAN
Pensyarah
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik
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I declare that this project report entitled "Smart Plant Monitoring System Utilizing IoT and Arduino: Software Development" 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.

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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 Electrical Engineering Technology with Honours.

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Supervisor Name : DR. AZHAN BIN AB RAHMAN

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DEDICATION

I acknowledge my sincere dedication, honours, and gratitude to both of my parents for them love, encouragement, supports, and sacrifices throughout whole of my life. Without them sacrifices and encouragement, I cannot possibly reach this stage. Special gratitude also dedicated to my siblings which always support and advise me in whatever I do in my life and who have been my source of inspiration and continually provide their moral, spiritual, emotional, and financial support. Special thanks to all of lecturers especially my supervisor Dr. Azhan Bin Ab Rahman and my academic advisor who had taught and guided me throughout my studies and during this Bachelor Final Project 1 progress. I would like to thank all my friends who always been with me throughout this challenging semester and help me during movement control order (MCO). I hope all their supports and encourage will help me make this project a success.

ABSTRACT

This paper is about Internet of Things (IoT) and Arduino -based smart plant monitoring systems that represent the idea of controlling crop problems in an integrated system. The project aims to design a crop monitoring system to maintain crop health to maximize crop growth. Combining smart systems with crop monitoring makes farming easier. Growers face problems in maintaining crop health outcomes. Therefore, a system was built to maintain the health of the crop which is the first Arduino board system used to deal with input and output signals which contains the use of several sensors according to the characteristics of the crop. Further, the second system is a server that sends data from the Arduino to the Firebase and the third system is the app inventor of the Android Studio to deliver information to the user about the health condition of the plant can only be seen through the app on the user's smartphone. The provided implementation works in conjunction with cloud -based servers and mobile -based devices (ideally Android / iOS devices) that help users to control and view crop status monitored by hardware devices. Finally, the project was successfully implemented and achieved the objective of developing a prototype for an IoT -based crop health monitoring system and with the advancement of innovative techniques, could help produce more results with less manpower while maintaining crop health to maximize growth.

ABSTRAK

Kertas kerja ini adalah mengenai Internet of Things (IoT) dan sistem pemantauan tumbuhan pintar berasaskan Arduino yang mewakili idea mengawal masalah tanaman dalam sistem bersepadu. Projek ini bertujuan untuk mereka bentuk sistem pemantauan tanaman untuk mengekalkan kesihatan tanaman untuk memaksimumkan pertumbuhan tanaman. Menggabungkan sistem pintar dengan pemantauan tanaman menjadikan pertanian lebih mudah. Penanam menghadapi masalah dalam mengekalkan hasil kesihatan tanaman. Oleh itu, satu sistem dibina untuk mengekalkan kesihatan tanaman iaitu sistem papan Arduino yang pertama digunakan untuk menangani isyarat input dan output yang mengandungi penggunaan beberapa sensor mengikut ciri tanaman. Selanjutnya, sistem kedua ialah pelayan yang menghantar data daripada Arduino ke Firebase dan sistem ketiga ialah pencipta aplikasi Android Studio untuk menyampaikan maklumat kepada pengguna tentang keadaan kesihatan loji hanya boleh dilihat melalui aplikasi pada telefon pintar pengguna. Pelaksanaan yang disediakan berfungsi bersama-sama dengan pelayan berasaskan awan dan peranti berasaskan mudah alih (idealnya peranti Android / iOS) yang membantu pengguna mengawal dan melihat status tanaman yang dipantau oleh peranti perkakasan. Akhirnya, projek itu berjaya dilaksanakan dan mencapai objektif untuk membangunkan prototaip untuk sistem pemantauan kesihatan tanaman berasaskan IoT dan dengan kemajuan teknik inovatif, dapat membantu menghasilkan lebih banyak hasil dengan kurang tenaga kerja sambil mengekalkan kesihatan tanaman untuk memaksimumkan pertumbuhan.

ACKNOWLEDGEMENTS

First and foremost, I thank Allah (SWT) for providing me with everything I needed to complete this project and the programme for which it was undertaken. There was never a time when there was a shortage or a need. Throughout this study, He took care of everything that could have stymied me and strengthened me in the face of adversity. That is something I will always be grateful for. I am grateful to Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform.

Next, I'd like to thank my supervisor, Dr. Azhan Bin Ab Rahman of the Faculty of Electrical and Electronic Engineering Technology, for her invaluable guidance, support, and encouragement in the completion of this thesis. I'd be lost if it weren't for her. Thank you for your encouragement and support.

Finally, I'd like to express my gratitude to my beloved father, mother, family, and all my friends for their emotional support in helping me complete this study. I can't do it without you. Every day, I thank Allah (SWT) for that.

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LIST OF SYMBOLS

T	-	Time
C	-	Speed of sound
V	-	Voltage
A	-	Current
W	-	Power
°C	-	Temperature
Hz	-	Frequency
CO_2	-	Carbon Dioxide
O_2	-	Oxygen
nm	-	Wavelength (nanometers)
δ	-	Voltage angle

LIST OF ABBREVIATIONS

IoT	-	Internet of Things
LDR	-	Light Dependent Resistors
MIT	-	Massachusetts Institute of Technology
SoC	-	System-On-a-Chip
kB	-	kiloBytes
MB	-	MegaBytes
IDE	-	Integrated Development Environment
XML	-	Extensible Markup Language
RH	-	Relative Humidity
ID	-	Identifier
MIPI	-	Mobile Industry Processor Interface
DC	-	Direct Current
LCD	-	Liquid Crystal Display
UI	-	User Interface
V	-	Voltage

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CHAPTER 1

INTRODUCTION

This section provides an overview of the project's history as well as the project's main goals and priorities. This section describes the scope of the analysis that will be performed throughout the project. The problem statement explains why the discovery was made and how it will be solved.

1.1 Background

Because of the world's rapidly growing population, agriculture is becoming increasingly important. Rather than buying flowers and vegetables, more people are opting for a personal garden where they can grow their own. Plants are required for the proper functioning of the ecological cycle. Crop growers are increasingly using modern farming techniques to produce their crops. Improving the tools and technologies that enable growers to increase their output, such as modern irrigation methods, crop management, and crop management using mobile technology, is the most difficult aspect of increasing crop yields.

The Internet of Things (IoT) is a concept that enables objects to communicate with one another over the internet. It refers to the interconnections between everyday objects and the Internet that allow people to meet more frequently and efficiently. The Internet of Things (IoT) is a scenario in which all sensors and devices are connected to wireless communication devices so that they can communicate with one another, send, and receive data, and control parameters without the need for human intervention. Cloud computing and the Internet of Things are linked in terms of data storage.

An automatic method for monitoring and irrigation system is proposed to continuously monitor the health and growth of the plant in a regulated environment. The system's main goal is to learn how plants behave by observing and analyzing the factors that influence their growth. This allows the user to monitor and control his or her health from a distance. With the introduction of the Internet of Things, plant health monitoring has entered a new era (IoT). Sensors are linked to Arduino, which logically connects all the circuits. The system uses IoT technology to provide real-time monitoring of key environmental parameters that affect plant growth, such as soil moisture, light intensity, temperature, and water acidity.

Irrigation is a critical component of agricultural production. Soil properties such as moisture determine the amount of water required by the soil. An irrigation system that is well-designed can have a significant impact on the entire growth process. Hand-operated irrigation systems account for most irrigation systems. In place of this technique, an automatic irrigation system can be used to provide enough water for the plants. The sensor - based automatic watering system provides a promising solution to the user as it can reduce manual intervention. In this system, soil moisture sensors are used to detect crop soil moisture[1]. Based on the soil moisture level, the system will send information on the soil moisture level if there is insufficient water, or the soil condition is too dry to the user.

Plant growth productivity is influenced by factors such as water acidity, soil humidity, and light intensity. As a result, sensors like pH level sensors, ultrasonic sensors, and soil moisture sensors are used to detect any changes that may affect the plant. The user can remotely monitor the plant using their smartphone after analyzing and storing the data in the cloud.

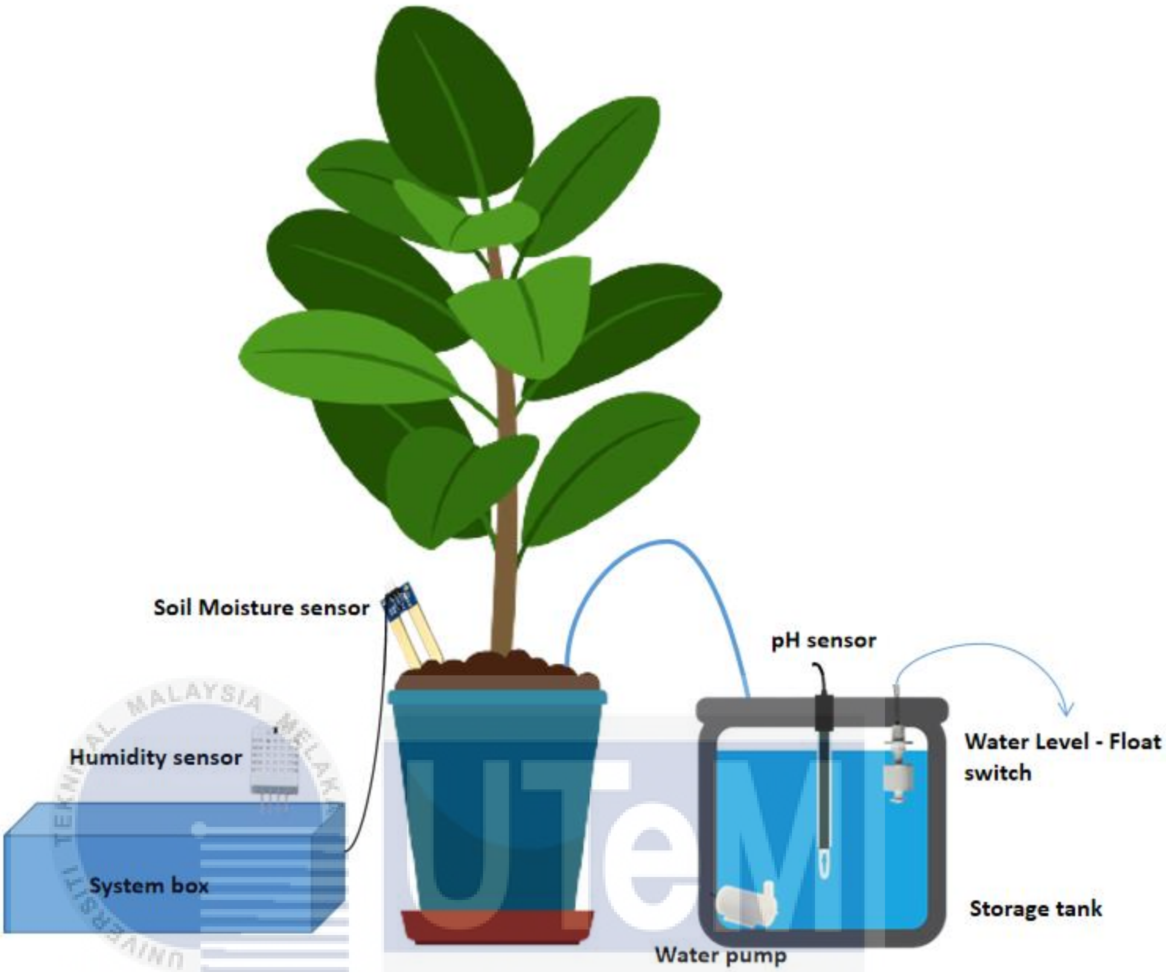

Figure 1.1 Concept design of the system

1.2 Problem Statement

Plant health is a prerequisite for long-term land sustainability. It can expose them to a variety of issues that can endanger their health, leading to serious consequences such as decreased crop yield and quality, as well as plant death. Plant health issues can be caused by a variety of factors, including moisture, lighting, and acidity. It can affect the flowers, leaves, stems, branches, growing tips, and roots of plants in a variety of ways. Dry soil, for example, can cause root damage and death. Furthermore, too much direct sunlight can cause the leaves to dry out. If one of these parameters is outside of the plant's ideal range, it will affect its growth and health. As a result, in order to produce healthy crops, many farmers and growers must pay more attention to the plants [2].

In recent years, there has been a surge in interest in indoor plants which can be utilized to produce food or simply for decoration and health benefits. The rising city congestion and less available area for outside plants have caused the use of indoor plants to soar to maintain a connection with nature[3]. Furthermore, flowering plants, for example, require at least six hours of direct sunlight every day, although direct sunshine can affect the plants. Especially when the sun is up strongly. It is best to put the plant somewhere that gets plenty of morning and evening sun but is partially shaded from direct sunlight. For good growth, flowering or vegetable crops require little soil moisture throughout their root zone[2]. Watering too often or too lightly can cause a shallow root system. Majority of people spend their time indoors, either at home or working in an office environment. As such, it is important to ensure the air quality is clean. An average home has dangerous toxins such as carbon monoxide, formaldehyde; found in synthetic fabrics, benzene; found in tobacco smoke and paint, and ammonia; found in cleaners and waxes. Indoor plants are most likely filters and purifies the air inside the house as it absorbs up to 90% of indoor air pollutants.

One of the common problems growing plants indoor is difficulties on watering the plants. The right amount of water to irrigate the plant is crucial as overwatering could lead to some other problems that can reduce the crop yields. Many people are lack of knowledge regarding this matter as different plants require different amount of water. In addition, monitoring the soil moisture content also important to avoid from overwatering. Hence, developing irrigation system utilizing soil moisture sensor and motor pump to irrigate the plants helps to lighten the burden of the user. The goal of this system is to detect the water content of soil moisture, which is dependent on the crop's demands.

Moreover, for people who lives in high-rise building such as apartment or condominium are facing difficulties to grow plants as the space might not be able to receive a proper sunlight. In addition, every plant has different light requirements and exposing them to direct sunlight for a long time can be hazardous to this plant especially when the sun is scorching hot.

This project aimed to create a monitoring system that can automatically irrigate enough water to the plant without requiring any manual labor, as well as a monitoring system that can solve the lighting issue. Furthermore, using a smartphone, the user can remotely monitor the plant's health.

1.3 Project Objective

Crop health can deteriorate day by day due to lack of maintenance. An important aspect of this project is to create a system that can reduce the workload of manual intervention, as well as solve most agricultural problems by reducing crop mortality from environmental parameters that can affect crops. The main aim of this project is to propose a system that helps growers monitor the health status of crops. Specifically, the objectives are as follows:

a) To design and develop an internet-of-things-based (IoT) system for monitoring plant health.

b) To test the proposed system's functionality based on soil moisture, humidity, water level, and pH level.

c) To verify the effectiveness of the proposed system with a real-life case study will be used.

1.4 Scope of Project

The scopes of this project can be described as follows:

a) The system is built with MIT applications that can show crop parameters including soil moisture, water pH, and lighting intensity for plant health monitoring and by giving safe access to the database directly from grower, Firebase can store and sync data amongst your users in real time and collaborative apps.

b) The proposed system is tested with real crops and a monitoring system made up of Arduino board signals that use sensors to measure crop parameters, as well as data collection using cloud-based servers from Firebase and mobile devices.

c) Validate effectiveness of the proposed system is demonstrated by the display results on the grower's phone application.

1.5 Thesis Outline

There are a total of five chapters in this thesis, including introduction, literature review, methodology, outcome and discussion, and conclusion and recommendation. The outline of the project and the progress of the work are discussed and written in detail corresponding to each chapter.

The main objective of Chapter One is to introduce the project to the target audience by identifying the reasons and the kick-starter for starting this project. This chapter is detailed explains the background of the project with its related real-life problems.

Chapter Two reviewed the past research journal and the related case study. This chapter mainly discusses and analyses the literature on automated monitoring systems and their equivalents. Information from different research papers related to the system before