Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF INTERNET OF THINGS (IOT) BASED INDOOR FARMING

OW JUN SHENG

Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

2021

DEVELOPMENT OF INTERNET OF THINGS (IOT) BASED INDOOR FARMING

OW JUN SHENG

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

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

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 (Industrial Automation & Robotics) with Honours.

Signature :

SITI NUR SUHAILA BINTI MIRIN
PENSYARAH
JABATAN TEKNOLOGI KEJURUTERAAN ELEKTRIK
FAKULTI TEKNOLOGI KEJURUTERAAN ELEKTRIK DAN ELEKTRONIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Supervisor Name : PUAN SITI NUR SUHAILA BINTI MIRIN

Date : 11. 01. 2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development Internet of Things (IoT) Based Indoor Farming

Sesi Pengajian : 2021/2022

Saya OW JUN SHENG .... mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

SITI NUR SUHAILA BINTI MIRIN
PENSYARAH
JABATAN TEKNOLOGI KEJURUTERAAN ELEKTRIK
FAKULTI TEKNOLOGI KEJURUTERAAN ELEKTRIK DAN ELEKTRONIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Alamat Tetap:

4, LORONG TENGGIRI 24,
13700 PERAI,
PULAU PINANG

Tarikh:

Tarikh:

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this project report entitled "Development of Internet of Things (IoT) Based Indoor Farming" is the result of my research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature :

Student Name : OW JUN SHENG

Date : 11. 01. 2022

DEDICATION

To my beloved mother, Tan Mee Chin, and father, Ow Ah Kiang for always motivate and giving courage to complete my final year project.

And

To my supervisor, Pn Siti Nur Suhaila Binti Mirin for her guidance and advices throughout this project. Also, to all my fellow friends in BEEA and the people that provide supports along this studies.

ABSTRACT

Indoor farming has been a topic that is most discussed in the agriculture field. It is a technique that significantly conserves natural resources such as water and land without affecting the surrounding environment. This is crucial because it improves the productivity of the plant. All the environmental factors like temperature, humidity, and soil moisture level are being tracked with the implementation of IoT Technology. The main objective of this project is to build an automated lighting and irrigation system that increase the productivity of the plant and feedback the status of the plant at anywhere and anytime. In this project, sensors such as right-angle floating switch (water level sensor), DHT11 (temperature and humidity sensor), FC-28 (soil moisture sensor), and BH1750FVI (light sensor) are installed to monitor the growth conditions of the plants. At the same time, the data collected from the sensors will be displayed to Blynk, an open-source platform through the ESP-01 Wi-Fi serial transceiver module and processed by Arduino Uno. With such development, the productivity and growth will be tracked from time to time without having the user at the event.

ABSTRAK

Pertanian dalaman merupakan satu topik yang hangat dalam bidang pertanian. Ia merupakan satu teknik yang dapat mempeliharakan sumber semula jadi seperti air dan tanah dengan tidak menjejaskan persekitaran sedunia. Teknik ini amat penting dalam pertanian sebab ia merupakan teknik yang dapat menambahkan produktivity tanaman tanpa mengehadkan syarat-syarat perkembangan tanam-tanaman. Faktor-faktor persikitaran dapat dikesan dengan pengimplimentasi teknologi IoT. Objektif projek ini adalah untuk membinakan satu sistem pencahayaan automatik dan sistem pengairan automatik yang dapat menambahkan produktiviti tanam tanaman dan dapat mengesan status tanaman dengan tidak mengira bila-bila masa atau mana orang itu berada. Demi mendapatkan status tanam-tanaman dari semasa ke semasa beberapa sensor telah dipasang untuk kegunaan pemantauan. Antara sensor yang telah dipasang ialah suis terapung bersudut 90 darjah (sensor paras air), DHT11 (sensor suhu dan kelembapan udara), FC-28 (sensor mengesan kelembapan tanah), dan BH1750FVI (sensor cahaya). Pada masa yang sama, data yang dikumpul oleh sensor akan dipaparkan dalam aplikasi Blynk, platform sumber terbuka melalui ESP-01 Wifi serial transceiver modul dan diprocess oleh Arduino Uno. Produktiviti dan pertumbuhan tanam-tanamn dapat dikesan dan dipantau melalui perkembangan teknologi tersebut tanpa penggunaan sumber manusia.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Puan Siti Nur Suhaila for her precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) who has given me the precious opportunity to accomplish the project with professional guidance from experienced supervisor.

My highest appreciation goes to my parents, and family members for their love and prayer during the period of my study. An honorable mention goes to my parents for all the motivation and understanding.

Finally, I would like to thank all my friends and classmates, as well as other individuals who are not listed here for being co-operative and helpful.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

TABLE	TITLE	PAGE

LIST OF FIGURES

LIST OF SYMBOLS

cm	-	Centimeter
lx	-	Lux
°C	-	Degree Celcius
V	-	Voltage
±	-	Plus-Minuis Sign
ml	-	milimeter

LIST OF ABBREVIATIONS

IoT	-	Internet of Things
iOS	-	iPhone Operating System
UTeM	-	Universiti Teknikal Malaysia Melaka
Wi-Fi	-	Wireless Fidelity

LIST OF APPENDICES

APPENDIX	TITLE	PAGE

CHAPTER 1

INTRODUCTION

1.1 Background

Indoor farming is designed to grow the plant in a controlled environment so that the status of the plants can be monitored from time to time. As owner can control the climate, indoor farming enable user to grow and harvest any crops almost anywhere when indoor farming is applied[1]. In Malaysia, which is hot and humid, indoor farming is suitable to maintain temperature and humidity for a specific plant to grow. As the world's population is expected to reach 9.7 billion in 2050, there will be a high demand for food[2]. Therefore, indoor farming is needed as it beneficial for agriculture production for the other countries that experienced extreme climate changes or natural disasters such as hurricanes, floods, and droughts.

Additionally, indoor farming drastically minimizes plant contamination, unlike traditional agriculture, which is vulnerable to contamination from animal waste, tainted groundwater, or toxic chemical substances to eliminate the pest. Indoor farming ensures food safety and production quality by tracking all the data collected from the sensors. Traditional agriculture uses human resources to manage plants, such as watering and harvesting, which takes a long time and is costly to hire more workforce. By practicing indoor farming with automation technology, all the plant growth can be monitored 24/7 while combining software and automation with industrial process management to optimize production.

Also, indoor farming no longer depends on large-scale land use cause this practice can be implemented inside buildings and cities. This is very important for an overpopulated area especially developed and advanced city which mostly have a higher concentration of carbon dioxide. Indoor farming can take advantage of unused space in the buildings and create a sustainable environment even in an urban area.

1.2 Problem Statement

Traditional agriculture is easily affected by the external environmental condition and requires many labors to manage the crops. Temperature and humidity are the main issues affecting plant growth for a country with a hot and humid climate. Moreover, no regular feedback of the crop's status causing much wastage of resources such as water and land aregetting limited. Nowadays, people are going to IoT trends, increasing their productivity in managing their crops as they are usually busy with works. An increase in population is alsocausing a lack of land resources for farming and decreased air quality in an urban area. Thereis a lack of platforms to access plant information in real-time. Constantly monitoring is required to evaluate and check the plant status, which will increase the cost and time to maintain and take care of the crops.

1.3 Project Objective

This project aims to propose a system that helps to monitor the growth of crops and helps increase productivity with limited resources. Specifically, the objectives are as follows:

a) To apply an Internet of Thing, IoT-based smart indoor farming system to enhance crops production with adequate resources.

b) To monitor and analyze the growth of crops through Blynk application by using ESP-8266(01) module and Arduino Uno to read sensors data.

c) To apply automatic lighting system and irrigation system to reduce the use of labor.

1.4 Scope of Project

The scope of this project are as follows:

a) To monitor the condition of crops with the various sensors.

Parameter	Sensor
Soil moisture	FC-28
Humidity and temperature	DHT11
Light Intensity	BH1750FVI

b) Monitoring the status of environment by receiving the data collected by various sensors and show in the Blynk application to end user.

c) Applying automatic lighting system and automatic irrigation system when reaching a threshold limit set.

d) A farming box with a base of 60cm x 40cm x 20cm (Length x Width x Height) dimensions is applied to grow the plant vertically to reduce the space required.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Indoor Farming

At the beginning of the 20th century, farmers struggled to protect their crops from being damaged by natural disasters. The protection is first started by building a box with a flat glass roof on top that covers the crops in the fields. A few years after, a small size of greenhouse is developed. Eventually, these small-scale greenhouses evolved into the first greenhouse as known today[3].

Figure 2.1 History of Indoor Farming

However, the greenhouse will experience climate variation when the internal temperature is too different from the external temperature. This often limits the plant growth, causing the plant's productivity to decrease and even reduce the nutrition of the plant.

Scientists and engineers tried to create more optimal and fixable circumstances for plant growth in greenhouses to solve the climate variation. Researchers carried out many experiments with a variable such as a temperature and CO_2. Scientists and engineers also studied the effects of these variables on plant growth and changed this variable on the greenhouse. As a result, the agricultural carbon footprint was reduced, and better-quality crop yields increased.

Figure 2.2 History of indoor farming 2

Later on, technical innovations such as hydroponics and artificial lighting were used to optimize growing conditions. In the second decade of the 21st century, light-emittingdiode, LED lighting was introduced in greenhouses. This innovation paved the way for farming crops indoors.

Plant scientists and engineers realized that it is not sustainable to control the plants to fit in the environment they create. Instead, they developed a wholly controlled indoor system where the environment is fully controlled based on the plants' needs. This furhter developed into vertical farming, where the plants are growing in vertically stacked layers.

2.2 MicroCEA

In 2018, Joseph D Stevens developed a personal urban smart farming device that automates growing vegetables in an urban indoor residential setting. The system he proposedconsists of an LED lighting system, humidity control, CO2 control, temperature control, andalso pH and electrical conductivity for the water. During development, Joseph prioritizes the feasibility and simplicity of the installation of the system. Also, the researcher aimed to provide IoT accessibility through the cloud for monitoring, controlling, and data analysis. The researcher believed that the system developed could contribute to the urban food supplyin a healthy, sustainable way.

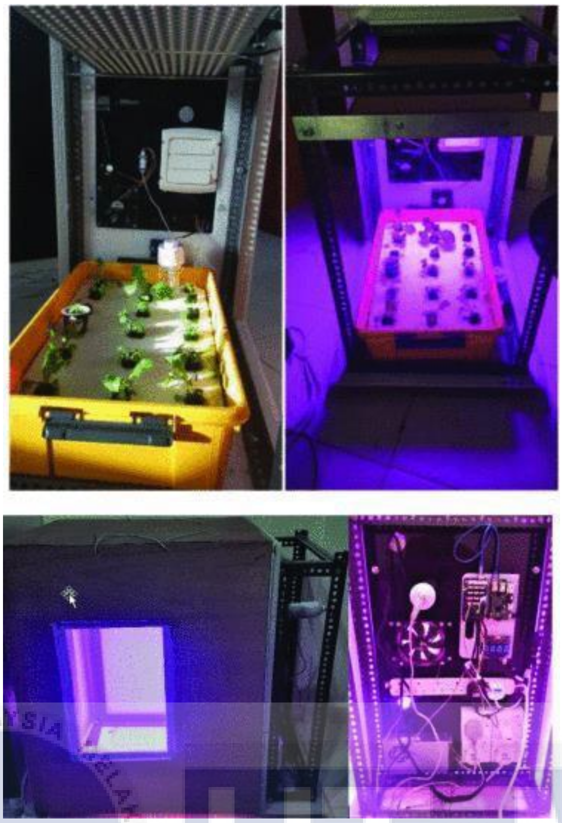

Figure 2.3 MicroCEA system overview

MicroCEA is designed to be implemented with RPIv2 for computing and Arduino Mega 2560 with a Grove Base Shield v2 for sensing, and a standard 4 channel relay block for actuation. The installed actuators include a growing LED, humidifier, and fan vent. The system sends the sensor data to the cloud version of Node-Red through MQTT protocol for network architecture, then Node-Red will perform data analysis or data store. For Graphical User Interface, GUI part, users can access all the information from a simple web page and control the system through the GUI. For example, when the temperature is too high, the user can manually turn on the fan vent to lower the temperature using a mobile device with a web browser[4].