REAL-TIME OPTIMIZATION AND MONITORING OF AN AUTOMATED MUSHROOM FARMING SYSTEM

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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I declare that this report entitled "Real-time optimization and monitoring of an automated mushroom farming system" is the result of my own work except for quotes as cited in the references.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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Supervisor Name	:	DR. Zul Atfyi Fauzan bin Mohammed Napiah
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DEDICATION

This project is dedicated to my parents for their continuous love and support during the making of this project and until I reach this level.

ABSTRACT

Mushroom farming requires diligent care and close monitoring. There are 6 stages in the process includes composting, spawning, casing, pinning and cropping. These processes are labour intensive and physically demanding. Throughout the processes, the green house will need to be at the right temperature and humidity to produce maximum crop. The compost which is wrapped in a plastic block need heating process for pasteurization. Therefore, as part of semi-automated monitoring and control, an Internet of Things (IoT) based system will help control and regulate the temperature and humidity of the greenhouse.

ABSTRAK

Pertanian cendawan memerlukan penjagaan yang kerap dan pemantauan yang teliti. Terdapat 6 peringkat dalam proses pertanian cendawan termasuk pengkomposan, pemijahan, selongsongan, pengeraman dan penuaian. Proses-proses ini memerlukan tenaga buruh yang banyak dan sangat meletihkan. Sepanjang proses tersebut, suhu dan kelembapan rumah hijau hendaklah berada dalam keadaan yang sesuai untuk menghasilkan pertumbuhan cendawan yang maksimum. Kompos yang dibalut dengan plastik perlu menjalani proses pemanasan untuk pempasteuran. Oleh itu, sebagai sebahagian daripada pemantauan dan kawalan separa automatik, sistem berasaskan internet (IoT) akan membantu mengawal suhu dan kelembapan di dalam rumah hijau.

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I would also like to thank all my friends for their kind support, criticize and advise so that I can complete my task without any mistake and achieve my goal with flying colors. Last but not least my deeply gratitude to my family their continuous support during my training program.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	:	Internet of Things
NodeMCU	:	Node Microcontroller Unit
Wifi	:	Wireless Fidelity
Ssid	:	Service Set Identifier
API	:	Application Programming Interface
CPU	:	Central Processing Unit
RAM	:	Random Access Memory
USB	:	Universal Serial Bus
GPIO	:	General Purpose Input Output
RPM	:	Revolution Per Minute
°C	:	Degree Celsius
V	:	Volt
A	:	Ampere

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Project

This section will discuss about the overview of greenhouse monitoring and control and electrical boiler projects.

1.1.1 Greenhouse monitoring and control

There are six steps in mushroom farming which are composting, spawning, casing, pinning and cropping. During cropping process, the greenhouse needs to be at the right temperature and humidity to produce maximum crop. There are several ways to control the temperature and humidity in the greenhouse. Most of them is done manually or with the use of timer. This project will discuss on controlling and

monitoring the greenhouse temperature and humidity without the needs of worker to be present inside the greenhouse.

1.2 Problem Statement

Throughout the mushroom farming process, the temperature and humidity inside the greenhouse must be in an exact farming temperature to optimize yield of the mushroom[1]. To monitor the temperature and humidity manually, a lot of workforce is required especially in big farm[2]. Thus, high cost is required to pay the workers to make sure the temperature and humidity inside the greenhouse are monitored during the farming process.

1.3 Objectives

The main objectives for this project are:

a) To design and develop a system that can monitor and control the temperature and humidity inside a greenhouse.
b) To collect temperature and humidity data over period of time, analyze and implement the optimized control solution for the greenhouse.
c) To equip the system and get the data by using Internet of Things (IoT) by integrating with cloud.

1.4 Scope of Project

This project focus on monitoring and controlling the temperature and humidity inside a greenhouse. This project does not automate compost turning or mushroom cropping. Basically, this project only limited to provide suitable environment for the mushroom to grow. In this project, microcontroller is developed to control the output device based on the reading of the sensor. The system can be programmed by using the software available on the internet that is compatible with the selected microcontroller. For IoT function, the platform to be used as an interface is already available on the market. For greenhouse monitoring, the project covers closed space area for each sensor and control device. On-shelf module is used for microcontroller and sensors for quick development process. The final circuit & component will be encapsulated inside water-resistant casing material equivalent to IP65 standard.

1.5 Thesis Plan

This thesis consists of five chapters to elaborate about development of automated mushroom farming system which starting with Introduction, Background Study, Methodology, Result and Discussion and Conclusion and Future Works.

Chapter 1 – Introduce project. The early and basic explanations are mentioned in this chapter. Introduction discuss about the background of the project, problem statement, objectives and scope of the project.

Chapter 2 – This chapter contains the study and literature review on the theoretical concepts applied in this project. It contains the information gathering of the project in order to complete the whole project.

Chapter 3 – Methodology described about the methods or approaches used in solving the projects. Among the main content of this chapter are Method Engineering, Proposed Technique and Method, Hardware and Software Development and Application of the technique and algorithm.

Chapter 4 – Concentrates on the result and discussion of this project.

Chapter 5 – Conclusion consist the summary of the project. After the project is done, recommendations are made for the improvement of this project that might be done in the future.

CHAPTER 2

BACKGROUND STUDY

2.1 IoT application in agriculture industries

In recent years, technology has been revolutionized agriculture industries. Internet of Things (IoT) had also contribute in agriculture industry[3]. Paper [4] proposed the IoT technology in agriculture can manage the cost and maintenance also increase the monitoring performance. Without IoT technology, farmers need to do extra work or hire more workers to monitor their field continuously. Application of IoT technology in agriculture industry, the manpower cost can be reduced [5][2][6]. Monitoring performance by using IoT provide precise data, easy to operate and energy efficient [4][6][7][8]. Furthermore by implementing IoT in agriculture industries, many data can be collected at a same time with ease[8]. Paper [4] claimed use of materials such as fertilizers and pesticide in farms can be

optimized with the help of IoT technology. The right amount of fertilizers and pesticide can be obtained thus reduce the waste and cost.

2.2 Steps in mushroom farming

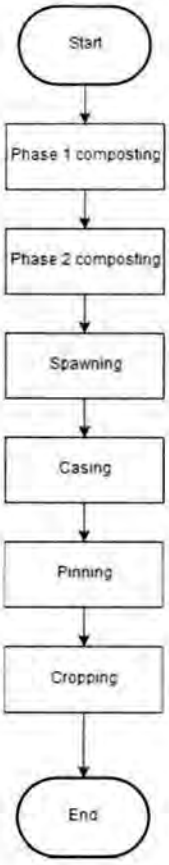

Figure 2.1: Mushroom farming flowchart

There are 6 steps in mushroom farming. These steps are Phase 1 composting, Phase 2 composting, spawning, casing, pinning, and cropping. During most of these steps, humidity and temperature need to be at exact temperature for the mushroom to grow.

Firstly, Phase 1 composting is when the mushroom compost is made. Compost provide nutrient needed for mushroom to grow. Compost need to be turned once

every 2-3 days to mix the ingredient more evenly and to relocate cooler area (outside) to warmer area (inside). During this process, paper [1] claims the compost temperature will naturally rise to 68.3°C to indicate the presence of ammonia. However, the humidity needs to be controlled by keeping the moisture content between 68 to 74 percent for the microorganism to compost the mixture.

Figure 2.2: Compost window

In Phase 2 composting, the pasteurization takes place to kill any nematodes, insects, pest fungi and other pest that may be present in the compost. Phase 2 composting is a most sensitive step in temperature and humidity controlling. Another purpose of phase 2 composting is to reduce the ammonia content that build inside the compost during Phase 1 composting. To do this, paper [1] states the temperature of the compost need to be controlled within the range from 51.6°C to 54.4°C. Between this temperature range, the de-ammonia organism will grow well. In the end of Phase 2 composting, the temperature needs to be lowered within the range from 23.9°C to 26.7°C and 68% to 72% moisture content.