THE PERFORMANCE ANALYSIS INTEGRATED URBAN FARMING USING IOT SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : The Performance Analysis Integrated Urban Farming Using IoT System

Sesi Pengajian : 2021/2022

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DEDICATION

To my beloved mother and father

ABSTRACT

Aquaponics is a system that combine hydroponic and aquaculture system and become food production method. Due to the factor of the climate change and the rising of the population, food has become one of the main issues. The aquaculture deals with the growing of fishes, hydroponic deals with the plant that grow soilless by adsorb the nutrients from the fish waste. Aquaponic is a sustainable and eco-friendly system that could grow terrestrial plants and aquatic life with minimum water usage. Since the water is continuously circulated used, a water quality monitoring system is required secure the water quality of the aquaponic system to enhance the growth of the plants and aquatic. In this project focus on developed an aquaponic with real-time monitoring. With the continuous growing of technologies, the aquaponic can be managed and controlling by integrating with the IoT (Internet of Things) technology along with pH sensors, humidity sensors and water temperatures sensors. Hence, microcontroller such as NodeMCU ESP 32 will activate the sensors operation and the reading can be obtained on Cayenne application for the water quality and at atmosphere quality for real-time monitoring. This aquaponic system can be build indoor or outdoor with minimum space required that fit in the urban farming.

ABSTRAK

Akuaponik adalah sistem yang menggabungkan sistem hidroponik dan akuakultur dan menjadi kaedah pengeluaran makanan. Disebabkan faktor perubahan iklim dan pertambahan penduduk, maka makanan telah menjadi salah satu isu utama. Sistem akuakultur adalah untuk ternakan ikan manakala hidroponik adalah penanaman tumbuhan tanpa tanah dengan menyerap nutrient yang terhasil daripada sisa-sisa ikan. Sistem akuaponik adalah sistem yang mampan dan mesra alam yang dapat menanam tumbuhan dan hidupan akuatik dengan penggunaan air yang minimum. Memandangkan air digunakan secara berterusan, sistem pemantauan kualiti air diperlukan untuk memastikan kualiti air sistem akuaponik untuk meningkatkan pertumbuhan tumbuhan dan akuatik. Dalam projek ini memberi tumpuan kepada pembangunnan akuaponik dengan pemantauan masa nyata. Dengan perkembangan teknologi yang berterusan, akuaponik boleh diurus dan dikawal dengan menyepadukan dengan teknologi IoT (*Internet of Things*) dengan menggunakan penderia pH, penderia kelembapan dan penderia suhu air. Oleh itu, mikropengawal NodeMCU ESP 32 akan mengaktifkan operasi penderia dan bacaan boleh didapati pada aplikasi Cayenne untuk kualiti air dan pada kualiti atmosfera bagi pemantauan masa nyata. Sistem akuaponik ini mampu dibina didalam atau diluar dengan ruang minimum yang diperlukan yang sesuai dalam pertanian bandar.

ACKNOWLEDGEMENTS

In completing this project report, I was in contact with many people and receive plenty of guidance. In particularly, I would like to express my special thanks of gratitude to my project supervisor TS.A.Nasoruddin Bin Mohamad for his continuous guidance throughout the whole complement of this project. This project wouldn't be the same as presented here successfully without his participation and encouragement.

Next, I would like to extend my biggest and greatest thanks to my beloved mother and father. This project would not able to complete and the report would not be exist without their endless support, patience and understandings throughout this semester.

Lastly, deepest thanks and appreciation to Universiti Teknikal Malaysia Melaka (UTeM) especially Faculty of Electronic Engineering and Computer Engineering (FKEKK) for giving me this golden opportunity to push me sharpen my skills. I am grateful to my friends for their encouragement during this period matters to me in order to complete this project.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	:	Internet of Things
pH value	:	Potential of Hydrogen
IDE	:	Integrated Development Environment
COM	:	Communication
ppm	:	Parts per million
EC	:	Electrical current
TDS	:	Total Dissolved Soluble
RH	:	Relative Humidity

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Agriculture has always been an essential part of human life and has always been one of the pillars of economic activity. The essential of the food has increase along with the growth of the population with the concern of climate change. Begin with the rise of the Earth's temperature and the lack of rain, it had caused the reduction of the water to supply to the hydroponic system. In fact, aquaponic is the junction of aquaculture and hydroponic in which plants and aquatic creature grow under a same integrated system.

Figure 1.1 Example of Aquaponic [1]

The traditional agriculture method for growing plants requires huge land space, manpower, and time. Hence, the increasing concern of the sustainable food source and safety has come up with new methods of agriculture. For as example: Singapore is a small country with highly urbanized living area, the country always concerned about their food source as they have very limited land space for the traditional agriculture. The country need supplies the food for nearly 6 million of the people but with low local food attribution. Logically, the import food from other country will need higher cost and less freshness due to the time taken for the transport.

As mentioned, the population of the global keep increasing occasionally, and the demand will be higher. Some industries using the pesticides to increase for the fast growth of the crops and it cause the damage to human health due to the harmful bio-chemical. The traditional agriculture requires manpower to manage the farm from watering, fertilizing to harvest which are using energy and time but the nutrient for the crops were un-equal and this has decreased the quality of the product. Additionally, they could not monitor the crops environment to maintain the quality.

Alternatively, the aquaponic system is the new method with higher efficient for the food sustainable. The plant and aquatic creature could grow under a single integrated system along with the monitoring by using the IoT. The purpose of this project is the

system is automatically getting monitor by using IoT domain. The sensors use to measure the surrounding temperature, humidity, pH value, total water dissolvent. Then the water pump can be either controlled or automatically turn on and off by depending on the command to do the interface with the relay. There are plenty benefits of aquaponic using IoT for the user [2]:

i. Aquaponic saving up to 90% water compared to the hydroponic or traditional agriculture.
ii. Aquaponic system can be build indoor or outdoor that require with minimum space and cost which suitable for urbanized area.
iii. The system did not used soil and chemical fertilizer or pesticides so the product fully organic and healthier.
iv. Farmer or user of the aquaponic with IoT able to monitor and analyze the water quality for the plants and aquatic life.
v. The IoT platform will constantly update the real-time data sensors reading.

1.2 Research Background

In this day and age, the world has evolved into a country with rapid urbanization and population growth and Malaysia is nonetheless. According to the world population in 2022 record has shown that the population size has been increase annually from 7.8 billion in 2021 to 8 billion as of June this year by according to the most recent statement elaborated by the Worldometer in United State[3]. Therefore, the basic essential to fulfil the world need such as food supply has become a main issue and critical path to sustain and ensure the food able to secure along with the growth of population and demand. In the cities area, the lack of agriculture activities has been down due to the space limitation that available. Therefore, it has become a problem to

enable the people to produce sufficient food for self-sufficiency and for the commercial purpose as well. Logically, the price of the essential will be higher than it should be compares to the outskirt of the cities where they have convenient space to grow crops and sustain their food for self-sufficiency.

Based on the Deputy Agriculture and Agro Based Industry Minister, Malaysia imports approximately RM3.22 billion worth of vegetables and fruits from other countries each year to meet local market demand, despite the fact that home grown supplies are self-sufficient [6]. As an example, in Singapore, urban farming has successfully provided over 25% of the country's food supply [7].

Malaysia is a country that owned advance technology and also good agriculture location but the awareness of the urban farming in this country is still low compares to the packed nations such as Taiwan and Singapore based on 2017 researchers. The 2 countries have limited space and high population to sustain the food supplies for the society. This is because the lack of knowledge of the agriculture and understanding of the technology to integrate to form a more convenient system such as aquaponic.

Furthermore, the existence of the urban farming concept able to use as an education tool for agriculture and ecological study to increase the awareness of food sustain and acknowledge the local food system. Therefore, the farmers in the urban area able to share their knowledge and experience to the community resident about the food system and current issue such as food crisis in Malaysia. Besides that, our government should organize more event, activities, and campaign more about the importance of the urban farming among the society. They also able to demonstrate the urban farming system and held festivals such as harvest dinner with the purpose to educate and simulate the

motivation of people to understand local food system nonetheless to spread the awareness of the food crisis in future.

Although aquaponic has plenty of benefits to sustain and secure the food supplies especially in future due to the increment of the population, nonetheless the system still needs regular maintenance to ensure the operation. Water quality is the most important element and it would be the critical factor either the system will collapse or vice versa. This is due to the fact that all living organisms in this system, such as fish, bacteria, and plants, require water to thrive and grow. The water quality parameters like water temperature, water dissolved and the humidity of the environment that will affect the plants growth must be monitor and maintain. Apart from that, there still have many factors are require for the maintenance such the nutrient for the aquatic and water evaporation from the tank. Thus, the maintenance approach must be chosen depending on the time spent, the effectiveness, and the tools and equipment needed.

1.3 Problem Statement

As the world population has increased drastically and the demand of the food supplies has rising as well. Study shows that world population will reach about 9 billion in 2050 compared to the latest population that record 7.8 billion by 2021. People need to find a way to produce food supplies with larger quantities and sustainable along with the population. Therefore, the aquaponic system has shown the potential with efficiency to produce larger amount of food to satisfy the demand. With the modern technique, the plant and fishes can be stacked together and develop in the same system. The traditional agriculture using chemical fertilizer that could be harmful for human health and the soil. Additionally, human labor was required for the traditional agriculture and aquaculture which are tiring and decrease the quality of the

product due to unequal and un-appropriate nutrient to the plants and aquatic creature. Furthermore, traditional farming system for aquatic creature and plants need to have wide and bigger space and it is impossible for urban living area due to the limited space and the un-able to monitor the environment. The temperature, humidity and water quality is the factor that influence plant development and the factor cannot monitor manually and without suitable equipment. To conclude, the problem statements of project is as below:

i. The constant increasing of world population requires high demand of food supplies.
ii. The ineffectiveness of manually manage the aquaculture and agriculture with human labor decrease the product quality.
iii. The ineffective and less precision of the water quality monitoring toward the traditional aquaponics system that monitored manually and without suitable equipment.

1.4 Objectives

The project main objective is to design an aquaponic with performance analysis of the water quality monitoring system that suitable for urban farming. There are three main objectives are presented to fulfil the requirement:

i. To design and develop an IoT based aquaponic system for monitoring and automation.
ii. To provide real-time data monitoring and analysis of the aquaponic parameter to enhance the aquatic and plants growth.
iii. To provide user with better experience and user-friendly system to align with the technology.