Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED SMART AGRICULTURE MONITORING SYSTEM

LIM YOU QI

Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

2021

DEVELOPMENT OF IOT BASED SMART AGRICULTURE MONITORING SYSTEM

LIM YOU QI

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Industrial Electronics) 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 : Development of IoT Based Smart Agriculture Monitoring System

Sesi Pengajian :

Saya Lim You Qi 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)

Alamat Tetap: No 151, Jalan Kelisa 10, Taman Sungai Abong Indah, 84000, Muar, Johor

(COP DAN TANDATANGAN PENYELIA)

SYED MOHAMAD SHAZALI BIN SYED ABDUL HAMID
PENSYARAH
FAKULTI TEKNOLOGI KEJURUTERAAN ELEKTRIK DAN ELEKTRONIK
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Tarikh: 5/2/2022

Tarikh: 5/2/2022

*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 IoT Based Smart Agriculture Monitoring System” 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.

Signature : ....

Student Name : LIM YOU QI

Date : 5 / 2 / 2022

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 Electronics Engineering Technology (Industrial Electronics) with Honours.

Signature :

Supervisor Name : Syed Mohamad Shazali bin Syed Abdul Hamid

Date : 5 / 2 / 2022

DEDICATION

Appreciation to my beloved parents, Lim Boon Kim and Tam Lee Lin who give me moral support and motivation when this study is being done. I would also like to dedicate my friends to help me with this project as I face trouble.

ABSTRACT

Agriculture has long been the primary occupation in our country, intending to improve rural household income, farm productivity, and local market demand. Due to people migrating from rural to urban areas, the Malaysian government proposes that agriculture can be done in a residential area without engaging big regions by combining plants and fish production in an integrated recirculating system known as aquaponics system. But there have hindrances in agriculture. As a result, the purpose of the project is to develop a smart aquaponics system in a small space and due to today's modern technology, it is necessary to include automation in aquaponics to reduce labour involvement. The objective of this project is to design and develop IoT based smart aquaponics system by using Arduino, to determine the growth effect of vegetable and fish distribution on the wastewater quality and reuse water respectively and monitor water level, water temperature, pH value, light and fish feeder automatically through a sensor that can be connected to the cloud. An Arduino Uno is utilised in this aquaponics system to regulate the system's input and output as well as a WiFi module as a transmitter to send the data and current situation to the mobile application. The system covers pH level, water temperature, water level, and light maintenance by using a pH sensor, water temperature sensor, water level sensor, and a light-dependent resistor (LDR) respectively. Moreover, it also automated a fish feeder as an additional feature. In the meanwhile, users can use the mobile application to monitor and manage smart aquaponics remotely. In contrast to the standalone recirculating aquaculture system (RAS), this project is unique, sustainable and environmentally friendly operational procedures in the aquaponics system to reduced environmental pollution and less water consumption which directly increases the profit of farmers.

ABSTRAK

Pertanian adalah pekerjaan utama di negara kita selama bertahun-tahun untuk meningkatkan pendapatan isi rumah luar bandar, produktiviti yang lebih tinggi di ladang, dan permintaan yang lebih besar di pasaran tempatan. Oleh kerana migrasi orang dari luar bandar ke bandar dari semasa ke semasa, Pemerintah Malaysia menyarankan agar pertanian dapat dilakukan di kawasan perumahan tanpa melibatkan kawasan yang luas dengan caranya kombinasi pengeluaran ikan dan tanaman dalam sistem peredaran semula bersepadu sebagai sistem akuaponik. Tetapi terdapat halangan dalam pertanian. Oleh itu, tujuan projek ini adalah untuk mengembangkan sistem akuaponik pintar di ruang terhad dan dengan teknologi canggih hari ini, automasi diperlukan dalam akuaponik untuk mengurangkan penglibatan tenaga kerja. Objektif projek ini adalah untuk merancang dan mengembangkan sistem akuaponik pintar berasaskan IoT dengan menggunakan Arduino, menentukan kesan pertumbuhan taburan sayur dan ikan terhadap kualiti air sisa dan menggunakan semula air masing-masing dan memantau nilai pH, tahap air, suhu air, nilai pH, cahaya dan pengumpan ikan secara automatik melalui sensor yang dapat disambungkan ke awan. Sistem akuaponik ini menggunakan Arduino Uno sebagai pengawal mikro untuk mengawal input dan output sistem dan modul WiFi sebagai pemancar untuk menghantar data dan keadaan semasa ke aplikasi mudah alih. Sistem ini meliputi tahap pH, suhu air, permukaan air, dan pemeliharaan cahaya dengan menggunakan sensor pH, sensor suhu air, sensor ultrasonik dan perintang bergantung cahaya (LDR) masing-masing. Selain itu, ia juga mengautomasikan pengumpan ikan sebagai ciri tambahan. Sementara itu, pengguna dapat menggunakan aplikasi mudah alih untuk memantau pengguna dapat menggunakan aplikasi mudah alih untuk memantau dan mengendalikan akuaponik pintar dari jarak jauh. Projek ini mudah digunakan dan mesra alam kerana memperkenalkan peningkatan yang lebih baik pada sistem akuaponik

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Syed Mohamad Shazali bin syed Abdul Hamid for his precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and for the financial support which enables me to accomplish the project. Not forgetting my fellow colleague, Zahritil Wadi Binti Amaruddin for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents, parent in-law, and family members for their love and prayer during the period of my study that allow me to make this project a reality.

Finally, I would like to thank all the fellow colleagues and classmates, the Faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

^oC	-	Degree Celcius
%	-	Percentage

LIST OF ABBREVIATIONS

ft	-	Feet
g	-	Gram
kg	-	Kilogram
cm	-	Centimeter
m	-	Meter
ADC	-	Analog to Digital Converter
BDP	-	Bachelor Degree Project
DWC	-	Deep Water Culture
GUI	-	Graphical User Interface
IDE	-	Integrated Development Environment
IoT	-	Internet of Things
I/O	-	Input/Output
kB	-	Kilobyte
LCD	-	Liquid Crystal Display
LDR	-	Light Dependent Resistor
LED	-	Light Emitting Diode
NC	-	Normally Closed
NO	-	Normally Open
NFT	-	Nutrient Film Technique
pH	-	Power of Hydrogen
PPFD	-	Photon Flux Density
PVC	-	Polyvinyl Chloride
RAS	-	Recirculating Aquaculture system
V	-	Voltage
VAC	-	Voltage Alternating Current
VDC	-	Voltage Direct Current
VCC	-	Voltage Common Collector
TAN	-	Total Ammonia Nitrogen
BOD	-	Biological Oxygen Demand
TP	-	Total Phosphorus
TN	-	Total Nitrogen
TOC	-	Total Organic Carbon

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Aquaponics is a term that combines the name of aquaculture and hydroponics. It's a closed recirculating multi–trophic system that incorporates aquaculture and hydroponics elements [1]. The New Alchemy Institute and the Aztec developed agricultural islands are known as chinampas, and aquaponics began in the 1970s with a couple from the institute (the earliest 1150–1350CE) [2]. Plants were raised on stationary islands in lake shallows approximately 1000 A.D where nutrient rich mud and water could be dredged from the chinampa canals to support plant growth [3]. This is a natural, environmentally friendly food-growing system that captures the best qualities without the need to discard any water or filter or add chemical fertilizer [1]. In the early 90's the hydroponics company saw the potential of aquaponic farming, a natural and sustainable method of growing fish and vegetables using a water based mineral nutrient solution without soil year-round, and embarked on a path to develop the science of aquaponics into an industry [4]. Aquaponics as an alternative has proven to be more effective than hydroponics. With a plot of land on the outskirts of Milwaukee, Will Allen's successful experiments proved the potential of aquaponics and sustainable agriculture in improving the surrounding urban community [5].

In this age of globalization, agriculture was the key development of a country and providing the primary source of food, income and employment for rural communities [6] but the global food system is starting to sag as the world population is predicted to reach 9.7 billion by 2050 [7]. In addition to population growth also increases the demand for food.

Food demand is anticipated to rise between 59% to 98% by 2050 [7] hence the planet's arable land is estimated to be half of what it was in the 1970s by that period. Land use change reflected in land cover change is the main component of global environmental change [8], affecting climate, biodiversity, and ecosystem services, affecting the land-use decision. To come up with the solution, aquaponics system is one of the techniques to replace arable land.

Aquaponics is a modern agricultural production technology that integrated hydroponics plant production into recirculating fish aquaculture system uses natural bacterial cycles to convert fish waste to plants nutrients [9]. In this context, a hydroponics system is a method of cultivating plants without soil but by using a water-based mineral nutrient solution. Hydroponics means water working or water activating [10]. On the other hand, aquaculture refers to aquafarming that controlled the process of cultivating aquatic organisms, particularly for human consumption which similar concept to agriculture by fish instead of plants or livestock [11]. In aquaponics, waste produced by the fish either by direct excretion or uneaten feed as aquaculture effluent contains many nutrients that promote plants cultured hydroponically for growth and not released to the environment. This can be more productive and economically feasible in certain situations, especially where land and water are limited on a family scale.

The Internet of Things (IoT) is an emerging paradigm that is a crucial part of our lives. The term "Internet of Things" was coined by Kevin Ashton in 1999 when he included it in the title of a presentation he made at Procter & Gamble [12]. It allows sensors and electronic devices to communicate with each other through the internet to facilitate maintenance management [13]. For example, with the implementation of smart devices, it able to automate aquaponics maintenance system. This show that IoT became essential to our life. The two important words in IoT are "internet" and "things". The internet is an electronic communications network that connected computers network and lets people share and receive information around the world. The definition of the term “things” in the dictionary is an object that eminent from a living being. Simply to said, the IoT means that a system interlinks devices, mechanical and digital equipment, objects or people to transmit data across the network without the need for human-to-human transmission [14]. General, IoT began with the best tools for communication. The devices can be monitored, operated by mobile phones or computers that connect through the Internet. Cloud serves as a great IoT partner as a forum for all sensors and it can store and access data.

Arduino is an open-source electronics based on accessible hardware and software. The Arduino project started in 2005 for students in Italy [15]. This project is launched to provide a low cost and a better way to create devices that can use sensors and actuators to communicate with their environments [16]. Arduino board can read digital inputs such as pulse on a push-button or analog input from the sensor and turn it into an output. With the development of Arduino, it has been used in a lot of different projects and applications. The Arduino software is reasonably flexible for advanced users. This is because it can run on Mac, Windows and also Linux. Arduino widely used in the education region because it is simple, clear programming environment, inexpensive and it also open-source software.

Smartphones have become a highly frequent source and primary means of communication for everyone in the world to communicate or update most of the farming community as development of technology. A smart agriculture system with IoT based system helps to monitor and maintain the optimal condition for aquaponics system. IoT based smart agriculture able to help users to control the pH value, water level, water temperature, light and fish feeder through the internet with improve services. Users allow to manually control it by using smartphone and it also can be automated by controlling the aquaponics system to reduces the manpower in process of care and planting of fish and vegetables respectively. This may seem like saving their time.

The rate of growing fish and vegetables is increasing proportionally to the good maintain of optimal condition. Smartphone development encourages users to prefer using mobile app. Growth of IoT allows the communication between the networking devices based on requirements. This mobile application develops to allow the users can check the current situation of aquaponics system whenever they are.

1.2 Problem Statement

House and townhouse gardens provide endless flexibility when it comes to garden design and style but most residential areas without involved large areas for planting especially condominiums didn't provide the land space for planting. The existing system developed was full-on manual bases which required a lot of labour in process of care and planting of vegetables and the fish feeding which constraints the time of people. Furthermore no medium provided to connect the system with the internet or data server, where it was a lack of information regarding fish health and vegetables. Ammonia is excreted from the fish via the gills [17] which toxic to aquatic life hence people always changed the water to keep it clean, which wastes the water. According to Randall and Tsui [18], acute ammonia toxicity affects the central nervous system of fish and manifests as a neurological disease. In addition, uncontrolled pH value, temperature and light intensity may result in the death of fish and deficiencies occur toward vegetables. Thus, smart agriculture system provides an intelligent solution to rear fish and plants together in limited space and controlled growing conditions to reduce the use of chemical pesticides.

1.3 Project Objective

The objectives of this project are:

a) To design and develop an IoT based smart aquaponics system by using Arduino Uno.

b) To determine the growth effect of vegetable and fish distribution on the wastewater quality and reuse water respectively.

c) To monitor water level, water temperature, pH value, light and fish feeder automatically through sensor that can be connected to the cloud.

1.4 Scope of Project

An aquaponics system is my conducted research in this proposed study. The scope of this project are as follows :

a) Using Arduino UNO microcontroller as a brain to control the components in this project.

b) WiFi module was used for communication between the Arduino UNO and the mobile application developed using the MIT App Inventer

c) Mobile application is developed to display the information received and perform monitoring toward Arduino UNO

d) To determine the growth effect of spinach and catfish distribution on the wastewater quality and reuse water respectively, a weighing scale is used.

e) pH sensor is used to detect the pH value of fish tank.

f) DS18B20 water temperature sensor is used to measuare the water temperature of fish tank to make automatic exhaust fan or white LED T5 tube light.

g) LDR sensor was used to detect light during the day and night to make automatic red LED T5 tube light by control either ON or OFF

h) A water pump cindition depending to an water level sensor either to fill the water until the desired water level or in off condition.

i) Servo motor is used to control the fish feed automatically.