



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DEVELOPMENT OF SMART AQUAPONICS SYSTEM**

**FOR AGRICULTURE INDUSTRY**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

by

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## **APPROVAL**

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours. The member of the supervisory is as follow:

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## ABSTRAK

Pada era globalisasi ini, teknologi merupakan salah satu inisiatif yang tepat untuk meningkatkan mutu dan kualiti sesuatu produk berasaskan pertanian. Kerajaan Malaysia menyarankan agar pertanian dapat dilakukan di kawasan perumahan penduduk tanpa melibatkan kawasan yang besar dimana ianya boleh dilakukan di dalam rumah sahaja. Terdapat beberapa masalah yang dihadapi dalam menguruskan sistem akuakultur dan hidroponik. Antaranya ialah sukar untuk mendapatkan kawasan pertanian yang kecil serta tumbuhan memerlukan air yang kaya dengan nutrien untuk memastikan pertumbuhan yang baik. Oleh itu, tujuan projek ini adalah untuk membangunkan sistem akuaponik pintar untuk industri pertanian. Objektif projek ini adalah untuk membangun sistem akuaponik pintar untuk industri pertanian berdasarkan mikropengawal, memantau kelembapan tanah, keamatan cahaya, memberi ikan makan dan pam air dengan menggunakan aplikasi Android dan menganalisis prestasi sistem akuaponik ke arah industri pertanian. Sistem akuaponik ini menggunakan Arduino Uno sebagai mikrokontroller untuk mengawal input dan output sistem dan Bluetooth modul sebagai pemancar untuk menghantar data ke aplikasi mudah alih. Penderia kelembapan digunakan untuk mengesan kelembapan tanah di dalam bekas tanaman manakala penderia LDR digunakan untuk mengesan keamatan cahaya. Servo motor pula digunakan untuk memberi makan kepada ikan secara automatik. Pemerhatian selama 15 hari telah dibuat untuk sistem akuaponik automatik dan sistem biasa. Ia menunjukkan bahawa tumbuhan yang ditanam berdasarkan sistem akuaponik automatik lebih sihat dari segi ketinggian berbanding dengan sistem biasa dengan perbezaan 2.1 cm. Projek ini mudah untuk digunakan dan mesra pengguna kerana ianya memperkenalkan peningkatan yang lebih baik kepada sistem akuaponik.

## ABSTRACT

In this era of globalization, technology is one of the best initiatives to improve the quality of an agricultural-based product. The Government of Malaysia suggests that agriculture can be done in residential areas without involving large areas where it can be done indoors only. There are some problems encountered in managing this aquaculture and hydroponic system. Among these problems is the difficulty of getting small-scale agricultural areas and that plants need water rich in nutrients to ensure good growth. Therefore, the purpose of the project is to develop smart aquaponics system for the agricultural industry. The objective of this project is to develop a smart aquaponics system for agriculture industry based on a microcontroller, to monitor the soil moisture, intensity, fish feeder and water pump using Android application and analyze the performance of the aquaponics system towards the agriculture industry. This aquaponics system used an Arduino Uno as a microcontroller to control input and output of the system and Bluetooth module as a transmitter to transmit the data to the mobile application, respectively. Moisture sensor is used to detect soil moisture in plant containers while LDR sensors is used to detect light intensities. Servo motor is used to feed the fish automatically. Observation for 15 days have been made for an automated aquaponics system and normal system. It shows that the plant grown based on an automated aquaponics system more healthier in terms of height compared to normal system with a difference of 2.1 cm. This project is easy to use and user-friendly as it introduced a better improvement to the aquaponics system.

## DEDICATION

Alhamdulillah,

Thank Allah because of His grace, I have been able to prepare this project successfully. Appreciation to my beloved parents, En Zamzuri Bin Zi and Pn. Salmi Binti Bi Aziz. I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. I pray and hope that you will always happy and extended lifetime, may Allah bless you. I also dedicate this report to my supervisor, Dr. Suhaila Binti Mohd Najib who always encourage and guide me until the completion of the project. Lastly, I would like to send my gratitude to any person that contributes to my final year project whether it is directly or indirectly. I would like to acknowledge their comments and suggestions, which are crucial for the successful completion of this study.

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# TABLE OF CONTENT

	<b>PAGE</b>
<b>DECLARATION</b>	iii
<b>APPROVAL</b>	iv
<b>ABSTRAK</b>	v
<b>ABSTRACT</b>	vi
<b>DEDICATION</b>	vii
<b>ACKNOWLEDGEMENTS</b>	viii
<b>TABLE OF CONTENT</b>	ix
<b>LIST OF TABLES</b>	xiii
<b>LIST OF FIGURES</b>	xiv
<b>LIST OF APPENDICES</b>	xviii
<b>LIST OF ABBREVIATIONS</b>	xix
<b>CHAPTER 1: INTRODUCTION</b>	<b>1</b>
1.0 Introduction	1
1.1 Problem Statement	2
1.2 Objective	2
1.3 Scopes	3
1.4 Project Significance	3

<b>CHAPTER 2: LITERATURE REVIEW</b>	<b>4</b>
2.1 Introduction	4
2.2 Overview of aquaponics system	4
2.3 Related Research Work	6
2.3.1 Design of a smart monitoring and control system for aquaponics based on OpenWrt	6
2.3.2 Design of aquaponics water monitoring system using arduino microcontroller	7
2.3.3 Microcontroller based automatic aquaponics system	8
2.3.4 Online monitoring and control aquaponics using lab view	9
2.3.5 Fuzzy logic controller implementation to an arduino-based solar-powered aquaponics system prototype	10
2.3.6 Automatic variation plant detector using aquaponics concept	11
2.3.7 Smart aquaponics system for urban farming	12
2.3.8 Development of aquaponics system using solar powered control pump	14
2.3.9 Environmental parameter monitoring and data acquisition for aquaponics	15
2.3.10 Automatic watering plant application based on android and web using REST Protocol	16
2.3.11 Aquaponics based farming system	18

2.3.12	Cloud-based wireless monitoring system and control of a smart solar-powered aquaponics greenhouse to promote sustainable agriculture and fishery in an arid region	19
2.4	Comparison	21
2.5	Summary	24
<b>CHAPTER 3: METHODOLOGY</b>		<b>25</b>
3.0	Introduction	25
3.1	Hardware Architectural Design	25
3.2	Hardware Development	29
3.2.1	Arduino Microcontroller Uno	29
3.2.2	High Torque Metal Gear Dual Ball Bearing Servo (MG994R)	31
3.2.3	Light Dependent Resistor (LDR)	32
3.2.4	Soil Moisture Sensor	33
3.2.5	Arduino HC-06 Serial Port Bluetooth Module	34
3.2.6	Mini Submersible Water Pump	35
3.3	Software Development	36
3.3.1	Arduino Software IDE (Integration Development Environment)	36
3.3.2	MIT App Inventor	38
3.4	MIT App Inventor 2 Development	39
3.5	Simulation Circuit	41
3.6	Simulation of LDR sensor	41

3.7	Simulation of Moisture sensor	43
3.8	Simulation of servo motor	46
3.9	Individual Hardware Testing	47
3.10	Summary	49
<b>CHAPTER 4: RESULT &amp; DISCUSSION</b>		<b>50</b>
4.0	Introduction	50
4.1	Hardware Setup	50
4.2	Project Software Layout	53
4.3	Project Analysis	56
4.4	Summary	60
<b>CHAPTER 5: CONCLUSION &amp; RECOMMENDATION</b>		<b>61</b>
5.0	Introduction	61
5.1	Conclusion	61
5.2	Recommendation	63
5.3	Project Potential	64
REFERENCES		65
APPENDIX		68

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2. 1:	Comparison between Previous Projects with Proposed Project	21
Table 3. 1:	Arduino Uno specification	30
Table 3. 2:	Servo Motor specification	32
Table 3. 3:	Moisture Sensor specification	34
Table 3. 4:	Arduino HC-6 Serial Port Bluetooth Module Specification	35
Table 3. 5:	A Mini Submersible Water Pump specification	36
Table 3. 6:	Arduino Software IDE specification	37
Table 4. 1:	Plant height vs Day using automated system	57
Table 4. 2:	Plant height vs Day using normal system	58

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 2.1	Block diagram of the hardware design of the system (Wang et al, 2015)	6
Figure 2.2	Block diagram of Aquaponics system using an Arduino microcontroller (Murad et al, 2017)	7
Figure 2.3	Block diagram of the automatic aquaponics system based on ATmega328 (Vanmore et al, 2017)	8
Figure 2.4	Block diagram of this online monitoring and control aquaponics using lab view (Jijin and Roshith, 2016)	10
Figure 2.5	Blog diagram of the arduino-based solar-powered aquaponics system prototype (Balinado, 2016)	11
Figure 2.6	Hardware design of automatic variation plant detector using aquaponics concept (Syahirah et al, 2017)	12
Figure 2.7	Block diagram of smart aquaponics system for urban farming (Kyaw and Ng, 2017)	13
Figure 2.8	Operation of aquaponics system during daylight (Mohamad et al, 2013)	14
Figure 2.9	Sensor block for aquaponics system (Nichani, 2017)	15
Figure 2.10	Server block for aquaponics system (Nichani, 2017)	16
Figure 2.11	Flow diagram of climatic variable relationship (Purwandana et al, 2017)	17

Figure 2.12	Architecture design of APA system (Purwandana et al, 2017)	17
Figure 2.13	Block diagram of Aquaponics based farming system (Ravan and Shingate, 2016)	19
Figure 2.14	Block diagram of the aquaponics greenhouse control and monitoring system (Jamisola and Nagayo, 2017)	20
Figure 3.1	Block diagram of the aquaponics system	26
Figure 3.2	Flow chart of the aquaponics system	27
Figure 3.3	Prototype design of aquaponics system	28
Figure 3.4	Prototype of aquaponics system	28
Figure 3.5	Arduino Uno microcontroller board	30
Figure 3.6	High Torque Metal Gear Dual Ball Bearing Servo (MG994R)	31
Figure 3.7	LDR structure and symbol	33
Figure 3.8	Moisture sensor	33
Figure 3.9	Arduino HC-6 Serial Port Bluetooth Module	34
Figure 3.10	Mini Submersible Water Pump	35
Figure 3.11	Arduino software IDE	37
Figure 3.12	MIT App Inventor interface	38
Figure 3.13	Interface design of mobile application	39
Figure 3.14	MIT App inventor coding block for Bluetooth connection	40
Figure 3.15	Coding block for monitor the system	40
Figure 3.16	Program code in void loop() for LDR sensor	41

Figure 3.17	Schematic diagram of LDR sensor using Proteus software	42
Figure 3.18	Run simulation circuit at value 20 lower than 300 (LED ON)	42
Figure 3.19	Run simulation circuit at value 683 higher than 300 (LED OFF)	43
Figure 3.20	Program code in void loop() for moisture sensor	44
Figure 3.21	Schematic diagram of moisture sensor using Proteus software	44
Figure 3.22	Run simulation circuit at value 512 higher than 200 (LED ON)	45
Figure 3.23	Run simulation circuit at value 82 lower than 200 (LED OFF)	45
Figure 3.24	The program code in void loop() for servo motor	46
Figure 3.25	Schematic diagram of servo motor using Proteus software	46
Figure 3.26	Schematic diagram of Aquaponics System	47
Figure 3.27	LDR sensor at value higher than 300 (Lamp OFF)	48
Figure 3.28	LDR sensor at value lower than 300 (Lamp ON)	48
Figure 3.29	Moisture sensor at value higher than 200 (Water pump ON)	49
Figure 3.30	Figure 3. 30: Moisture sensor at value lower than 200 (Water pump OFF)	49
Figure 4.1	The circuit connection of this project	51
Figure 4.2	The circuit connection setup in proper box	51
Figure 4.3	The prototype of Aquaponics system	52



Figure 4.4	The interface of mobile application	53
Figure 4.5	Selection for Bluetooth connection	54
Figure 4.6	Output value was displayed at mobile application	54
Figure 4.7	The output of LDR sensor	55
Figure 4.8	The output of moisture sensor	55
Figure 4.9	The plant using normal system	56
Figure 4.10	The plant using automated system	57
Figure 4.11	Graph Plant height vs Day using this automated system	58
Figure 4.12	Graph Plant height vs Day using this normal system	59

## LIST OF APPENDICES

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
Appendix A	Gantt Chart	68
Appendix B	Program Code	69

## LIST OF ABBREVIATIONS

LED	Light Emitting Diode
LDR	Light Dependent Resistor
GSM	Global System for Mobile Communication
IDE	Integrated Development Environment
IoT	Internet of Thing
LCD	Liquid Crystal Display
ADC	Analog to Digital Converter
Lab View	Laboratory Virtual Instrument Engineering Workbench
DC	Direct Current
AC	Alternating Current

# CHAPTER 1

## INTRODUCTION

### 1.0 Introduction

The agriculture is one of the economic profit in the country. The Malaysian government has suggested that this agriculture can be done in residential areas without involving large areas where it can be done in the yard. In this case, to produce something useful it should be based on the needs and demand of today's users. Therefore, through this project "Development of Smart Aquaponics System for Agriculture Industry" will help those in need of small-scale farming. Nowadays, many communities still do not know about this aquaponics system. This aquaponics system is a combination of aquaculture system and hydroponic system. This system is a system of hydroponics and aquaculture system which depend on each other to produce a good product and high quality.

Under natural conditions, the residual excretion of aquatic life in the tank or aquarium will cause the water containing this ammonia to turn into a high nutrient contribution to its substances and properties for hydroponic plants. This aquaponics system will flow the water containing ammonia from the aquarium to the plant and it will get the nutrients produced from the excretion of the aquatic life. After that, naturally, the plant will supply water that is clean and free of ammonia to the aquatic life. The aquatic life that lives in fresh water is best suitable for application in this aquaponics system because most of the plants require freshwater to survive. Saltwater life can also be used but the plants to be used should also correspond to the saltwater life. The advantage of this aquaponics system is to provide side income as well as to meet daily needs. Additionally, it can also be placed in limited areas like balconies or even commercially. This system facilitates the cultivation process where water control methods occur automatically.

The water conversion process does not need to be done manually because the water life can be maintained using the plants as a filtering agent in order to maintain the quality and pH of water suitable for farming. It can save our time and cost and also be handled by anyone without the need for high skills. Finally, this system will ensure that this natural cycle will continue non-stop. Water will only be increased when plants lack water due to the absorption of plants and evaporation naturally by air.

### **1.1 Problem Statement**

There are some problems encountered in managing this aquaculture and hydroponic system. Among these problems is the difficulty of getting small-scale agricultural areas. The second problem is that plants need water rich in nutrients to ensure good growth. In addition, it requires a lot of manpower in the process of care and planting of trees and the fish feeding. Furthermore, the problems encountered in the aquaculture system should always to change the water in the tank or aquarium to keep clean. In addition, the unorganized fish feeder management system is one of the problems encountered. Consumers face time constraints in managing fish feeding.

### **1.2 Objective**

There are several objectives in this project which is:

- i. To develop a smart aquaponics system for agriculture industry based on microcontroller.
- ii. To monitor the soil moisture, intensity, fish feeder and water pump using Android application.
- iii. To analyze the performance of the aquaponics system towards the agriculture industry.

### **1.3 Scopes**

The scope of this project is made to inform the features and components used and the functions of each component used in the project. Among the scope of the project is using Arduino Uno microcontroller as a brain to control the components used in this project. Additionally, bluetooth modules was used for communication between the microcontroller and mobile application developed using the MIT App Inverter. The mobile application was developed to display the information received from the microcontroller. Next, LDR sensor was used to detect light during day and night. 9V and 240V power supplies are being used in this project to be connected to Arduino Uno microcontroller and lamp, respectively. In addition, this project were used a servo motor to control the fish feed automatically. Furthermore, soil moisture sensor was used in this project to detect soil moisture in the plant container. Lastly, this project is dedicated to agriculture industry only.

### **1.4 Project Significance**

The purpose of the aquaculture system is to facilitate and assist the farmers in the residential areas without involving large areas. It also can help farmers who need small-scale farming. By using some sensors in this project, this aquaponics system can be monitored remotely because in this project it uses an android application to monitor this system. In addition, it can reduce human labor to watering a tree and converting water in tanks or aquariums that have fish waste. This water in the tank has high nutrients and is suitable for distribution for plantation. This system is a combination of hydroponics and aquaculture systems which depend on each other to produce a good product and high quality.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

In this chapter, the basic aquaponics system has been discussed. There were several aquaponics systems have been done by other researchers. Comparisons has been made towards other aquaponics system in order to provide an improvement to the existence aquaponics system.

#### 2.2 Overview of aquaponics system

This aquaponics system is a combination of aquaculture system and hydroponic system. This combination system were depend on each other to produce a good product and high quality. Aquaponics system is a system that produce plants which requires less water, less fertilizer and less space (AlShrouf, 2017). For this aquaponics systems, it is suitable for use in limited soil and water and uses only about 1% freshwater (Resh, 2013). The abundance of water can be reduced by using these hydroponic and aquaponics techniques. Water conservation is a major advantage of this modern cultivation system. The nutrients accumulated in this aquaponics system are the result of the accumulation of waste fish (Scattini and Maj, 2017). For plants growing in this aquaponics system, it requires a nutrient-rich water that is produced from raising fish to provide natural fertilizer sources. In this aquaponics system, plants can produce clean water by consuming nutrients that are present in water that is channeled from aquariums to plants. Therefore, plants and fish will be healthy because they help each other. In addition, these plants and fish can develop well by using systems such as this aquaponics system. Fish farmers having a problem to remove the waste water in the aquarium. Hydroponics farmers also have their problems to get high water nutrients to be given to the plants. Both of these problems can be solved by using this aquaponics system. In this aquaponics system, waste water in the aquarium will

be given to the plants because the plants need nutrients contained in waste water. Plants provide clean water for fish while fish waste is a source of nutrient to plants.

The agricultural sector is the sector that uses the most water compared to other sectors (The, 2012). To take care of this issue, an aquaponics system could contribute as a possible way to decrease the water utilization in agriculture. For agricultural activity, 85% of world's water consumption are used, which is a rate of 235 million liters per second while 70% of this water consumed are wasted. Good care was needed such as watering system, light, temperature, and humidity can provide good growth (Carson *et al*, 2002). Hydroponics is a system that helps to solve the problem of growing plants in terms of water and nutrients without using soil. If there is excessive water, it is not suitable for water systems and will cause the same pressure on plants such as drought (Al-Bahadly and Thompson, 2015). In addition, the roots that always moistened and aerated can help growth in this hydroponics system. In hydroponics system also gives the plants with water and nutrients are sufficient and can produce good growth.

In aquaculture, fish will be digesting their food and excreting waste in the water and makes the water as nutrients that are good for plants. Normally, the water in the fish tank will be a filtered or removed to ensure that the water in the fish tank is clean from toxic waste. By using this aquaponics system, water in the fish tank is no longer needed to be filtered or disposed of because the water in the fish tank can be used as nutrients to plants. In Indonesia, in a few years ago they have experienced a crisis of agriculture land and as much as 75% of the land in Indonesia is not fertile (Vernandhes *et al*, 2017). It has been a problem for them to do plant and fish farming because they have limited narrow land. Therefore, they need to think of other alternatives in terms of technology innovation and appropriate area selection. Aquaponics system is one of the ways to solve this problem. Agricultural cultivation technology with aquaponics system technology has provided facilities for those who do not afford or do not have land for their agricultural activities to generate income. Aquaponics systems use different agricultural techniques with conventional technique. In the analysis, this aquaponics system is an important role in the agriculture and aquaculture sectors to be used as a good food production system (Shafeena, 2016). Therefore, this system can be beneficial to the area that lacks of water.