FAKULTI KEJURUTERAAN ELEKTRIK

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PORTABLE SOLAR POWERED IRRIGATION SYSTEM

THINAGARAN A/L MAHENDRAN

Bachelor of Mechatronics Engineering

JUNE 2018

© Universiti Teknikal Malaysia Melaka

SUPERVISOR ENDORSMENT

" I hereby declare that I have read through this report entitle **"Portable Solar Powered Irrigation System**" and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Mechatronics Engineering"

Signature : .....

Supervisor's Name : Prof. Madya Dr. Mariam binti Md. Ghazaly

Date : .....

© Universiti Teknikal Malaysia Melaka

PORTABLE SOLAR POWERED IRRIGATION SYSTEM

THINAGARAN A/L MAHENDRAN

A **report submitted in partial fulfilment of the requirements for the degree**

Of Bachelor of Mechatronics Engineering

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

© Universiti Teknikal Malaysia Melaka

DECLARATION

"I declare that this report entitle" **Portable Solar Powered Irrigation System** "is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree"

Signature : .....

Name : Thinagaran A/L Mahendran

Date : .....

© Universiti Teknikal Malaysia Melaka

DEDICATION

To my beloved mother and father

© Universiti Teknikal Malaysia Melaka

ACKMOWLEDGEMENT

First and foremost, I would like to thank the God who with his willingness gave me the strength and knowledge to complete my final year project successfully without any issues. I have tried my level best and gave my full commitment to complete this project on the right time without any delays. I would like to express deepest gratitude to Prof. Madya Dr Mariam Binti Md Ghazaly, who is the supervisor for my final year project at Faculty of Electrical Engineering who have gave me all the knowledge, advice, ideas and motivation to complete this project successfully. I also like to take this opportunity to thank Universiti Teknikal Malaysia Melaka (UTeM) that gave me all the facility to do my project and experiment.

My deepest thanks and appreciation to my parents, family and special friends of mine and others who gave their cooperation, encouragement, constructive suggestion and full support directly and indirectly in completion of this report from the beginning till the end of this project. Last but not least, once again I would like to thank to all of my friends and everyone who have contributed by supporting my work and helped me during this final year project completion.

© Universiti Teknikal Malaysia Melaka

ABSTRACT

It is known that irrigation is one of the important process in agriculture. Solar power can be a solution to the decreasing availability of energy resources. The aim of this project is to develop an entirely solar powered irrigation system which is sub-irrigation system capable of performing irrigation or watering task automatically and is powered by solar photovoltaic panels (PV). A moisture sensor in the soil is used for irrigation in order to operate a DC motor powered by PV system and rechargeable battery. Arduino Uno was also applied to the project as a controller and it will control the soil moisture sensor, solenoid valve and humidity and temperature sensor to ensure the plant not have growth problems due to overwatering. In this system, the soil moisture sensor in the soil to detect the moisture content of the soil and based on these values, the motor and the solenoid valve is operated accordingly. It is the proposed solution for the energy crisis for the gardener or farmers. Then, this system conservers electricity by reducing the usage of grid power and easy to environment friendly for the irrigation. As expected that this automated solar irrigation system is will perform with the result obtained is analysed.

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Seperti diketahui bahawa pengairan adalah salah satu proses penting dalam bidang pertanian. Kuasa solar boleh menjadi penyelesaian kepada kekurangan bekalan sumber tenaga. Tujuan projek ini adalah untuk membangunkan sistem pengairan sepenuhnya tenaga solar yang merupakan sistem sub-irigasi yang mampu melaksanakan tugas pengairan atau menyiram secara automatik dan dikuasakan oleh Panel Photovoltaic (PV). Sensor kelembapan di tanah digunakan untuk pengairan untuk mengendalikan motor DC yang dikuasakan oleh sistem solar PV dan bateri boleh dicas semula. Arduino Uno juga digunakan untuk projek itu sebagai pengawal dan ia akan mengawal sensor kelembapan tanah, injap solenoid dan kelembapan dan sensor suhu untuk memastikan kilang tidak mempunyai masalah pertumbuhan disebabkan oleh terlebih menyiram. Dalam sistem ini, sensor kelembapan tanah di tanah untuk mengesan kandungan kelembapan tanah dan berdasarkan nilai-nilai ini, motor dan injap solenoid dikendalikan dengan sewajarnya. Ia adalah penyelesaian yang dicadangkan untuk krisis tenaga bagi tukang kebun atau petani. Kemudian, sistem ini menjimatkan tenaga elektrik dengan mengurangkan penggunaan kuasa grid dan mudah mesra alam untuk pengairan. Seperti yang diharapkan sistem pengairan solar automatik ini akan dilaksanakan dengan hasil yang diperoleh dianalisis.

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	ACKNOELDGEMENT	vi
	ABSTRACT	vii
	ABTRAK	viii
	TABLE OF CONTENTS	xi
	LIST OF TABLES	xiii
	LIST OF FIGURES	xv
	LIST OF SYMBOLS	xvii
	LIST OF ABBREVIATIONS	xviii
1	**INTRODUCTION**	1
	1.1 Introduction	1
	1.2 Motivation	3
	1.3 Problem Statement	4
	1.4 Objectives	5
	1.5 Scope Of Project	5
	1.6 Report Outline	6
2	**LITERATURE REVIEW**	7
	2.1 Introduction	7
	2.2 Types of irrigation system	8
	2.2.1 Application of Solar Powered Automatic Water Pumping In Turkey	11
	2.2.2 Intelligence Irrigation System Employing the Use of Solar PV	13
	2.2.3 Design and Development of a Sensor Based On Intelligent Auto irrigation System	16
		18

© Universiti Teknikal Malaysia Melaka

	2.3 Photovoltaic Panel (PV)	18
	2.3.1 Monocrystalline Silicon PV Panel	19
	2.3.2 Polycrystalline Silicon PV Panel	20
	2.3.3 Amorphous Silicon PV Panel	
	2.4 Types of the Controller	
	2.4.1 Automated Solar Based Agriculture Pumping	24
	2.4.2 Solar-Powered Automated Plant/Crop Watering System	26
	2.4.3 Smart Orchard Soil Moisture Monitoring System Based On Wireless Communication Technology	27
	2.4.4 Proposal of Solution for Automated Irrigation System	28
	2.5 Summary of the Input Source in the Previous Study	29
	2.5.1 Automated Irrigation System Using Solar Power	30 31
	2.5.2 Solar Based Plant Irrigation System	32
	2.6 Summary of the Actuators in the Previous Study	34
	2.6.1 Solar Powered Smart Irrigation System	36
	2.6.2 Solar Smart Irrigation System	37
	2.7 Summary of the Sensors in Previous Study	
	2.7.1 Solar Powered Smart Irrigation System-An Innovative Concept	39
	2.7.2 Experimental Investigation of Remote Control via Android Smart Phone of Arduino Smart Phone of Arduino-Based Automated Irrigation System Using Moisture Sensor	41 43
	2.8 The Overall Summary	
3	**METHODOLOGY**	44
	3.1 Flow Chart	45

© Universiti Teknikal Malaysia Melaka

	3.1.1 Flow Chart Of Final Year	45
	3.1.2 Flow Chart Of the Charging Battery	49
	3.1.2 Flow Chart Of the Irrigation System	50
	3.2 Gantt Chart Of The Project	51
	3.3 Overview of Solar Powered Irrigation System	53
	3.4 Hardware Part	55
	3.4.1 Arduino Uno	55
	3.4.2 Soil Moisture Sensor	58
	3.4.3 Humidity And Temperature Sensor (DHT11)	59
	3.4.4 Solar Photovoltaic Panel (PV)	61
	3.4.5 DC Water Submersible Pump	62
	3.4.6 DC Motor Driver Dual H Bridge (L293N)	64
	3.4.7 Rechargeable Battery	65
	3.4.8 Solar Charger Controller	67
	3.5 The Irrigation System Experiment Setup	69
	3.6 List of Experimental For Validating The Irrigation System	73
	3.6.1 Analysis Of Soil Moisture Sensor	73
	3.6.2 Analysis Of The Growth Plant Over Time	75
	3.6.3 Analysis Of pH Of The Soil	76
	3.6.4 Analysis Of Humidity Sensor (DHT11)	77
	3.6.5 Analysis Of Solar	78
4	**RESULTS DISCUSSION**	79
	4.1 Introduction	65
	4.2 Analysis Of Soil Moisture Sensor	80
	4.3 Analysis of the Growth Plant Over Time	84
	4.4 Analysis of pH of the Soil	87
	4.5 Analysis of Humidity Sensor (DHT11)	90
	4.6 Analysis of the Solar	92
	4.7 Discussion	95
5	**CONCLUSION AND RECOMENDATION**	96

© Universiti Teknikal Malaysia Melaka

5.1 Conclusion 96
5.2 Recommendation 97
REFERENCES 98
APPENDICES 100

© Universiti Teknikal Malaysia Melaka

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	The Types of Irrigation System	8
2.2	Advantages and Disadvantages of monocrystalline	19
2.3	Advantages and Disadvantages of polycrystalline	20
2.4	Advantages and Disadvantages of amorphous	21
2.5	The Types of Controller	22
2.6	The Summary of the Input Source	29
2.7	The Characteristics of Spin Cell	31
2.8	The Types of Actuator	33
2.9	The Sensors	37
2.10	The Advantages of the Whole System	39
3.1	Gantt chart of FYP 1	48
3.2	Gantt chart of FYP 2	49
3.3	The Description of Arduino	57
3.4	The Specification of Soil Moisture Sensor	59
3.5	The Specification of DHT11 Humidity and Temperature Sensor	60
3.6	The Specification of Dc Water Submersible Pump	63
3.7	The Features of Motor Driver	64
3.8	The Feature of the Solar Charger Controller	68
3.9	Experimental Setup	73
4.1	The Lists of Experiment	80
4.2	The Result of the Volumetric Soil Moisture Content (m^3)	82
4.3	Rate of the Growth Plant (Automatic)	85
4.4	Rate of the Growth Plant (Manual)	86
4.5	Result of pH Value with Three Different Time (Automatic)	88

© Universiti Teknikal Malaysia Melaka

4.6	Result of pH Value with Three Different Time (Manual)	89
4.7	Result of Percentages of Humidity with Different Time	91
4.8	Total Current Consumption of the System	92

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	Sprinkler System	8
2.2	Drip System	9
2.3	Sub System	10
2.4	Application of the System	11
2.5	Block Diagram of Intelligence Irrigation System	13
2.6	Flow Chart of the System	14
2.7	The Valve Is Open	14
2.8	The Valve Is Close	15
2.9	The Flow Chart of Entire System	16
2.10	The Flow System	25
2.11	The Block Diagram	26
2.12	The Block Diagram of Fuzzy Control	27
2.13	Block Diagram of Waspmote	28
2.14	The Block Diagram	30
2.15	Spin Cell	32
2.16	Block Diagram Solar Power Module	34
2.17	Block Diagram Automation of Irrigation Module	34
2.18	The Block Diagram	36
2.19	The System Design	40
2.20	The Entire System	41
3.1	Flow Chart of FYP 1	46
3.2	Flow Chart of FYP 2	47
3.3	Flow Chart of Charging the Battery	49
3.4	Flow Chart of Irrigation System	50
3.5	System Overview of Solar Powered Irrigation System	54

© Universiti Teknikal Malaysia Melaka

3.6	The Arduino Uno (Atmega328p)	56
3.7	The Description of Arduino Pin	56
3.8	The Soil Moisture Sensor Module	58
3.9	The DHT11 Sensor Module	60
3.10	The 5W Solar Panel	62
3.11	Dc Water Pump	63
3.12	The Top and Bottom of Motor Driver	65
3.13	Rechargeable Battery	66
3.14	The Solar Charger Controller	67
3.15	The Irrigation Structure	70
3.16	The Interior View of Water Tank	71
3.17	The Interior of Junction Box	71
3.18	The Irrigation Frame Designed Using Solid Work	72
3.19	Three Pot with Three Different Condition	74
3.20	The Measurement Length of the Plant	75
3.21	The Measurement pH Value From pH Meter	76
3.22	The Percentage Value of Humidity	77
4.1	The Pots with Three Type of Condition	81
4.2	The Setup of This Experiment	81
4.3	Graph of the Results of Three Condition	83
4.4	The Average of the Repeatability Test	84
4.5	Graph of Rate of the Growth Plant versus Time (Automatic)	86
4.6	Graph of Rate of the Growth Plant	87
4.7	Graph of pH Value with Three Different Time (Automatic)	89
4.8	Graph of pH Value with Three Different Time (Manual)	90
4.9	Graph of Percentages of Humidity with Different Time	91

© Universiti Teknikal Malaysia Melaka

LIST OF THE SYMBOLS

V – Voltage

m^3 - Volume

© Universiti Teknikal Malaysia Melaka

LIST OF ABBREVIATIONS

PV – Photovoltaic Panel

DC – Direct Current

AC – Alternative Current

FYP – Final Year Project

© Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.1 Introduction

A sustainable solar energy power such as solar is a best alternative to electrical power which can be used in rural areas where an electrical source is difficult to be provided. Solar is eco-friendly energy which frees from pollution where the energy usage is demanded across the world. According to the statistics published, the surface of the earth receives about 124 exa (1018) Watts or 3,850 Zetta (1024) Joules per year of solar energy [1]. It is said to be the amount generated by solar energy is the most on the earth. Photovoltaic (PV) cells are made of exceptional materials called semiconductor which is silicon. A photovoltaic (PV) module is a bundled, associated get together of various sun based cells. Fundamentally, when light strikes the cell, a specific part of it retained inside the semiconductor material. The power will be produced by the semiconductor which is called direct current (DC) and can be utilized quickly or stored in a battery [1].

The cost of solar together with batteries for capacity has kept on falling so that in numerous countries it is less expensive than common non-renewable energy source power from the power grid. This has motivated the application of solar energy in different sectors. Therefore, the application of solar can be used in agriculture for the purpose of irrigation. One of the important process in agriculture system is irrigation system which is the process controlled amounts of water to plants at needed

© Universiti Teknikal Malaysia Melaka

intervals. Irrigation helps grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of inadequate rainfall [2].

Therefore, this project is to design and construct an automatic irrigation system powered by solar photovoltaic (PV) on a small scale. The project consists of the electrical part and mechanical part. The electrical part consists of Photovoltaic panel, charge controller module, a battery which is to store the current, and other required electronic components to form the circuitry for the controller whereas the mechanical part would be a solenoid valve and water pump which enable to watering the plant.

There are a lot of type of irrigation system which is sprinkler, sub, and drip system. One of the type of irrigation system that chooses for this project is sub-irrigation system. When the plant requires water, the soil dryness level is to be implemented and it can be achieved with the use of soil moisture sensor. This project also carries the function of storing energy when not in use in the form of battery and thus saves energy. The control is made by of an Arduino Uno which is a microcontroller board based on the ATmega328P. The utilization of Automatic Solar powered water supply and irrigation system can reduce the cost of agriculture, the better alternative of energy source and solve many other problems in the field of agriculture.

© Universiti Teknikal Malaysia Melaka

1.2 Motivation

This project aims to design a solar-powered automation irrigation system to reducing the agriculture cost, provide a better alternative of energy source. It also increases the rate of the growth and optimizes the wastage water. Previously, the projects using electrical and chemical energy which powered by fuel as a power source to water the plant and it causes them cost and time-consuming. Then, it also have to monitor the productivity of the plant, soil moistening for 24 hours. The current watering system for both plants in the small scale and irrigation for large field of crops can be separated into manual and automated.

Indian economy is known as one of the biggest developing economies in the world. Whereas the largest contribution the growth of the economy has come from the agriculture sector. To reach the ultimate usage of the man power and obtain supreme profit, their several developments has been done in various engineering field. So, it is necessary to maintain a good amount of water level in the soil, in order to obtain a good harvest that could provide nutrients to us. The Indian farmers have suffered a great loss in the agriculture field due to failure in crops in the drought season. To overcome this type of situation, the usage of an automated irrigation system would be the ideal way. An automated irrigation system basically reduces the water waste, where it provides water to the plant only when it is necessary. Provided with the renewable energy fitted with it the electrical cost consuming could be reduced.

© Universiti Teknikal Malaysia Melaka

1.3 Problem Statement

Under the field of agriculture, the demand for food crops to satisfy today's population had been increasing from day to day but since both water, electricity and fuel to drive pump are costly and scarce in supply, the production or yield of crops in many countries and rural areas has been decreasing [2]. The current watering system for both plants in the small scale and irrigation for large field of crops can be separated into manual and automated. The manual system needs labor for monitoring the productivity and health crop whereas the automated system would be systems that make use of a device like a timer. As the automated system works based on timing, it can cause wastage of water and oversupply to plants. Hence the watering system that responds based on soil moisture in the soil would provide a sustainable solution. In addition, the current watering system in agriculture consumes energy based on the size of a field [3]. A renewable energy source such as solar can be an excellent alternative and development of technology based on it can be used in areas where electrical power is difficult to obtain. Thus a project that is powered by sunlight to help supply water to the desired area, only when needed through the use of a microcontroller and also at the same time stores the power in the form of storage device like a battery would greatly help the agriculture industry.

© Universiti Teknikal Malaysia Melaka

1.4 Project Objective

The objectives of the project are:

1. To design and evaluate solar powered automatic irrigation system.
2. To analyse the solar power capacity and implement automatic irrigation system.

1.5 Project Scope

The scopes of the project are:

1. Cover the studies on the principle of the solar power automatic irrigation system using Arduino for watering.
2. Arduino is used to develop a program for solar power automatic irrigation process and connect with soil moisture, temperature and humidity sensor and solenoid valve.
3. Green energy involves due to solar energy convert to electrical energy and then to mechanical energy.
4. Limitation: house garden area, small-scale garden, same type of plant

© Universiti Teknikal Malaysia Melaka

1.6 Report Outline

This report consists of 5 main chapters. Firstly, the title of the project was confirmed at the initial stage. This report starts with the chapter 1 that is an introduction. The first chapter discussed the overview of the project background, motivation, problem statement, objective, scope, and the expected outcome of the project. Then this report is continued with the second chapter literature review. Chapter 2 discussed literature review that is related to this project based articles, journal, books, and internet. In this particular chapter, it is discussed briefly the fact, technique and results about from the previous studies. Next in chapter 3 is the methodology described the planning of design structure, methods going to use, procedures of experiment going to be done throughout the project and controller such as Arduino. Chapter 4 discussed the results and analysis with construct a table. The results obtained from the project will be analysed in this chapter. Finally, chapter 5 is discussed the project achievement and future recommendation.

© Universiti Teknikal Malaysia Melaka