# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# SMART SOLAR-BASED GARDENING SYSTEM USING ARDUINO MICROCONTROLLER

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

by

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2019

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Tajuk: SMART SOLAR-BASED GARDENING SYSTEM USING ARDUINO MICROCONTROLLER

Sesi Pengajian: 2019

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## APPROVAL

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

Signature: …….

Supervisor : KAMILAH BINTI JAFFAR

## ABSTRAK

*Sistem penyiraman berasaskan tenaga solar merupakan sebuah langkah alternatif dalam bidang pertanian yang telah digunakan oleh negara-negara seperti Bangladesh, India, dan Turki. Pelaksanaan teknologi solar ke dalam sistem penyiraman automatik adalah praktikal terutamanya kerana ia memerlukan penyelenggaraan yang rendah dan mempunyai sumber yang tidak terhad. Projek ini dilakukan untuk membina sistem penyiraman yang dikuasakan oleh sistem photovoltaic (PV). Pam air dalam projek ini dikawal oleh modul geganti yang diaktifkan oleh mikrokontroler (Arduino UNO). Isyarat yang dihantar ke mikropengawal oleh sensor kelembapan tanah (FC-28) yang digunakan untuk memantau tahap kelembapan tanah dengan membandingkan nilai rintangan arus yang mengalir melalui kuar dengan nilai rujukan. Pam air akan beroperasi apabila nilai rintangan berada di bawah nilai rujukan yang membawa maksud bahawa kondisi kelembapan tanah adalah kering. Tenaga elektrik yang dihasilkan oleh panel solar Monocrystalline disimpan dalam bateri yang boleh dicas semula yang disambungkan kepada pengawal caj solar untuk mengelakkan daripada pengecasan berlebihan. Kecekapan panel solar dianalisis berdasarkan kadar voltan keluaran yang diukur.*

## ABSTRACT

*A smart solar-based watering system is an alternative step in the agriculture field that has been applied by countries like Bangladesh, India, and Turkey. The implementation of solar technology into an automatic watering system is practical especially as it requires low maintenance with unlimited sources. This project is done to build a watering system that is powered by a photovoltaic (PV) system. The water pump in this project is controlled by a relay module which is activated by a microcontroller (Arduino UNO). A signal is sent to the microcontroller by a soil moisture sensor (FC-28) which is used to monitor the moisture level of the soil by comparing the resistance value of the current flowing through the probes with a reference value. The water pump will operate when the value of resistance is below the reference value which means the soil is dry. The electrical energy produced by the Monocrystalline solar panel is stored in a rechargeable battery which is connected to a solar charge controller to avoid from overcharging. The efficiency of the solar panel is analyzed based on the measured output voltage.*

**DEDICATION**

To my beloved parents

Azizan Bin Omar

Noriah Binti Hussin

Siblings

Alya Nur Binti Azizan

Aqila Nur Binti Azizan

Supervisor

Mrs. Kamilah Binti Jaffar

Thank you very much for the unconditional guidance and encouragement

**ACKNOWLEDGEMENTS**

I would like to express my deepest gratitude to all the people whose help and support made this project possible.

First and foremost, I would like to thank my supervisor, Mrs. Kamilah Binti Jaafar, who had consistently guided me from beginning to end with a great amount of patience and knowledge. I am also very grateful for the dedication that was given and not to mentioned the time spent to thoroughly inspect every development of my project.

Moreover, I would like to express my appreciation to my family and friends for their unconditional support and understanding. I believe that this project would have not been successfully completed without any of them.

As for that, I would like to thank everyone again for being a great supporter to me throughout this whole journey.

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# LIST OF SYMBOLS

| | | |
|---|---|---|
| **EJ** | - | Exajoules |
| **W** | - | Watt |
| **V** | - | Voltage |
| **C** | - | Current |
| **EJ** | - | Exajoules |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| **PCA** | Principal Component Analysis |
| **DC** | Direct Current |
| **PV** | Photovoltaic |
| **AC** | Alternating Current |
| **Mono-si** | Monocrystalline Silicon |
| **Multi-si** | Polycrystalline Silicon |
| **TSDC** | Thin Film Solar Cell |
| **BLDC** | Brushless Direct Current Motor |
| **IDCOL** | Infrastructure Development Company LTD |
| **PVWP** | Photovoltaic Water Pump |
| **PSHs** | Peak Sun Hours |
| **VOM** | Volt-Ohm-Milliammeter |
| **Ammeter** | Ampere Meter |

# LIST OF PUBLICATIONS

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

This chapter will emphasize on the background of the irrigation system and solar power. Moreover, this chapter will also briefly explain the main parts and components used to create this solar based irrigation system with a soil moisture sensor. Besides that, this chapter will be explaining the problem statements that lead to the purposes of this project. Lastly, this chapter also will be stating the scopes of this project that allows the objectives to be successfully achieved.

## 1.2 Background

Archaeology investigations have proven that the irrigation system has existed since ancient Egyptian. The system is said to be steadily improved in conjunction with the advancement of water technology and agriculture systems. Moreover, irrigation systems prioritize the maintenance of lawns and plants with the minimum amount of water required. In Malaysia, irrigation systems are one of a major water regulation technology which helps to enhance to about 14300 farmers (Toriman and Mokhtar, 2009).

On the other hand, solar power is a type of converted renewable energy from the sun. Annually, the amount of solar energy that reaches the earth is estimated to nearly four million exajoules (1 EJ = 1018J), while 5 x 104 EJ is claimed to be easily harvestable. Apart from that, the utilization of solar energy is parallel to the current drive towards reducing global carbon emissions (Kabir et al., 2017). Unfortunately, the non-polluting

source of energy is still negligible whereas the carbon emission which leads to global warming has increased rapidly since 2017.

On the contrary, the main idea of inventing a solar based automatic irrigation system is to increase water conservation apart from providing convenience in terms of time and cost for the users. This project will be centralized in improving the irrigation system in general rather than focusing on a certain area such as farming. This is due to encouraging more people instead of agriculturalist to grow plants. Moreover, the purpose of this project is also to utilize the advancement in technologies of solar energy.

Furthermore, this project consists of two major parts, hardware development, and programming development. Basically, the solar energy is converted to electrical energy by the solar panel. Then, the generated energy will be stored in a rechargeable Direct Current (DC) battery for further implementation. However, a solar charge controller will be connected between the solar panel and the DC battery. This is due to increase the lifespan of the battery by avoiding from overcharging.

Next, the automatic parts of this project will include a soil moisture sensor and a microcontroller. The sensor is used to monitor the moisture level of the soil by comparing the amount of resistance value based on the current passing through the soil. The soil moisture sensor is occupied with a potentiometer and a comparator to allow the comparing process of the value of resistance obtained to the reference value. Then, the comparison data is sent to the microcontroller.

If the resistance value is lower than the reference value, the microcontroller will activate a relay switch that will switch ON the water pump. Thus, the water pump will operate and allow the watering process to occur on the plant. The cycle will continue as the soil moisture sensor will consistently monitors the moisture level of the soil. The

project prototype will not include any inverter since the load used belongs to DC type.

## 1.3 Problem Statement

According to the findings by Global Carbon Project, the global industrial carbon emissions of carbon dioxide are said to have risen by 2.7% in 2018. Furthermore, the non-renewable resources such as natural gas and fossil fuels which act as the main sources of energy have negatively impacted the environment over time. This unfortunate occurrence can be overcome by shifting the attention to renewable energy such as solar energy. In this case, photovoltaic system that converts sunlight directly into electricity is used as the main power supply to a watering system. Moreover, the major advantage of solar energy is the free constant supply of sunlight that could be obtained and converted into electrical energy by the smallest piece of photovoltaic (PV) cells (Shaikh, 2017).

On the other hand, the current irrigation systems that are widely used by global farmers are either manually operated or having time-based automation (Bhole and Chaudhari, 2016). An irrigation system which operated manually by humans tends to have an unsystematic operation schedule. The lack of knowledge in the agriculture field is the main factors for an unsatisfactory outcome. As an example, the limitation of a manually operated irrigation system is to determine the moisture level of soil by using human's basic senses. As for that, a smart systematic watering system which operated using a microcontroller and soil moisture sensor is developed to overcome the limitation of the previous version of irrigation system.

Lastly, there are a lot of factors affecting the efficiency of a solar panel. The factors dominating the performance of a solar panel is irradiance and temperature (Jena, S. et al. 2017). The various types of solar cells which differ in terms such as thickness,

have different merit and demerit points that should be considered to produce the most effective outcome for a photovoltaic (PV) system. Apart from that, the conversion rate of the solar cells is very important in using solar energy. Therefore, the output voltage will be measured to determine the effectiveness of the solar panel used in this project.

## 1.4 Objectives

The aim of this project is:

1. To implement a smart systematic watering system for agriculture purposes.
2. To apply a solar Photovoltaic system to power the smart systematic watering system.
3. To analyse the efficiency of solar panel as the main equipment in photovoltaic system.