AUTOMATED PLANT WATERING MACHINE BASED ON CNC

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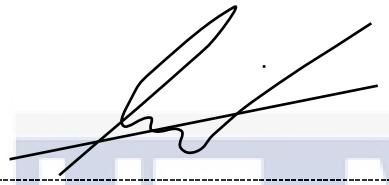
DECLARATION

I declare that this thesis entitled **AUTOMATED PLANT WATERING MACHINE BASED ON CNC** is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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APPROVAL

I hereby declare that I have checked this report entitled **AUTOMATED PLANT WATERING MACHINE BASED ON CNC** and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Electrical Engineering with Honours

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To my beloved parents, Mohd Nazaruddin Bin Mohd Nazir and Zaleha Binti Salleh, my siblings, and family. Special thanks to all my friends for the support and motivation.

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ABSTRACT

In conjuction with the progress of Industrial Revolution 4.0, every industry put their efforts in improving, innovating, and modernize the sector including agriculture. Modern agriculuture and farming sector includes the integrations of drones, robots, plant factory and Internet of Things (IOT). However, there are only few automated device for farming such as soaker hoses, drip irrigation, spray system, rotor system, and digital timer that available on the market. Besides, none of this devices can monitoring the plant. Futhermore, on average, the spray sprinkler system uses around 60.57ℓ of water in a minute. [5] According to the United Nations (UN) Sustainable Development Goals, one of the targets is to increase water use efficiency and ensure freshwater supplies. Hence, a small change or innovation needed in contributing towards the goal. Next, the objective of this project is to design using the Solidworks and develop an actual CNC based machine with 2-axis for plant watering operation. Second, to test the machine automatic and manual functionality, circuit , stepper motor movement and watering function. Third, to analyse the performance of the machine based on quantity of water use, watering operation time taken and parameter such as voltage and current. Finally, this project is built to automated the plant watering process by using soil moisture sensor to detect the soil dampness level and to reduce the usage of water during plant watering process by controlling the DC pump operation time and plant to plant watering method rather than continuous spray techniques.

ABSTRAK

Sejajar dengan perkembangan Revolusi Industri 4.0, setiap industri telah berusaha dalam meningkatkan, berinovasi dan memodenkan sektor mereka termasuklah bidang pertanian. Bidang pertanian moden meliputi integrasi menggunakan dron, robot, kilang pertanian dan "Internet of Things" (IOT). Walau bagaimanapun, hanya terdapat beberapa peranti automatik bagi pertanian di pasaran seperti "soaker hoses", "drip irrigation", "spray system", "rotor system" dan pemasa digital. Selain itu, kesemua peranti tersebut tidak berkemampuan dalam memantau tumbuhan. Tambahan pula, secara purata, "spray sprinkler" menggunakan sejumlah 60.57ℓ air dalam tempoh seminit bagi tujuan penyiraman. [5] Menurut Matlamat Pembangunan Mampan (SDG) oleh Pertubuhan Bangsa-Bangsa Bersatu (PBB), salah satu daripada objektif yang ingin dicapai ialah meningkatkan kecekapan dalam penggunaan air dan memastikan sumber air bersih. Oleh itu, sedikit perubahan atau inovasi diperlukan dalam usaha menyumbang ke arah matlamat tersebut. Seterusnya, objektif projek ini adalah untuk mereka bentuk menggunakan Solidworks dan membangunkan sebuah mesin berlandaskan konsep mesin CNC dengan 2 paksi bagi tujuan proses penyiraman tumbuhan. Kedua, untuk menguji fungsi automatik dan manual mesin, litar, pergerakan motor stepper dan fungsi penyiraman. Ketiga, untuk menganalisis prestasi mesin dengan mengambil kira kuantiti air digunakan, jumlah masa diambil bagi proses penyiraman dan parameter seperti voltan dan arus elektrik. Akhir sekali, projek ini dibina dengan fungsi untuk menyiram tumbuhan secara automatik dengan menggunakan sensor kelembapan tanah bagi mengesan tahap kelembapan tanah. Selain itu, tujuan berikutnya adalah untuk mengurangkan jumlah penggunaan air ketika proses penyiraman tumbuhan dengan mengawal waktu operasi pam DC dan menggunkan teknik penyiraman pokok ke pokok berbanding penyemburan secara berterusan.

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LIST OF SYMBOLS AND ABBREVIATIONS

Ø	-	Diameter
FYP 1	-	Final Year Project 1
FYP 2	-	Final Year Project 2
UV	-	Ultraviolet
IOT	-	Internet of Things
LED	-	Light emitting diode
CNC	-	Computer Numerical Control
DAN 2.0	-	*"Dasar Agromakanan Negara 2.0"*
V	-	Voltage
mm	-	Millimetre
DC	-	Direct Current
AC	-	Alternating Current
PWM	-	Pulse Width Modulation
A	-	Ampere
pH	-	Potential of Hydrogen
3D	-	3 Dimensional
CAD	-	Computer-aided Design
CAE	-	Computer-aided Engineering
Cm	-	Centimetre
SDGSs	-	Sustainable Development Goals
ℓ	-	Litre
LDR	-	Light Dependent Resistor
PBB	-	*"Pertubuhan Bangsa-Bangsa Bersatu"*
UN	-	United Nation
GDP	-	Gross Domestic Product

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CHAPTER 1

INTRODUCTION

1.1 Background

Agriculture is an important industry that contributes a large percentage to the world's economy. According to the Food and Agriculture Organization of United Nations, (FAO), nearly 4,725,306,611 or 60% of world's population depends on the agriculture as source of food in daily life survival. [1] As reported by the Department of Statistics Malaysia, 7.1% (RM 101.5 billion) of Malaysia's 2019 Gross Domestic Product (GDP) comes from the agriculture sector. [2] Hence, this huge numbers of statistics proved that agriculture is an important industry to be develop and maintain to sustain its existence in the future.

If agriculture is the art, then farming is one of the methods in implementing it. Since the first industrial revolution until the 20th century, farming has undergo a drastic change or evolution. From using animal as the farming power to machine such as engine powered tractor to complete farming activities. Moreover, farming is no longer an activity focusing on growing food supply alone, but also as source of income to a country's economy. With the current development of technology around the world, it creates new opportunities in creating modern farming era of 21st century. Moreover, technology such as camera, colour sensor, robots and drones will helps in monitoring and growing healthy plant. Besides that, it will cover on certain area of plant or farm that often overlooked by human as farming requires a high attention to taking care of.

As a countries that strives for modernization and innovation, Malaysia is also in race to apply and integrate technology with agriculture industry. According to Sim Tze Tzin (Former Deputy Minister of Agriculture and Food Industries of Malaysia, MAFI), "Dasar Agromakanan Negara 2.0 (DAN 2.0)" is focusing on solving the productivity issues, production cost and dependency on labor. In addition, this policy include the effort in modernize the farming sector in parallel with current technology

progress and Industrial Revolution 4.0. Besides, DAN 2.0 effort is to make sure the farming industry will be integrated with 'hi-tech' technology. The intended integration is by using robot, drone, farming data development, plant factory and Internet of Things (IoT). [3]

Figure 1.1 Article on DAN 2.0 (Berita Harian Online, November 6, 2019)

Next, for this project, the idea in develop and build the Automated Plant Watering Machine is taken based on the CNC design and mechanism concept. Computer Numerical Control machines or famously known as CNC machine is a machine that operate by following the pre-programmed software install on it. The machine is widely use in work or process involving woods, steel, aluminium or acrylic. Among the task that can be performed by the machine is grinding, cutting, carving, lathe, mills and routers. Nowadays, CNC machine is widely use in many industries as it helps a process become easier and faster. Hence, this technology is actually can be apply towards other application and industries. As an example, 3-dimensional (3D) printer use the same concept to print 3D object. Besides there are even small or mini projects of CNC for drawing shared on forums, blogs and Youtube. Thus, it is a proof that CNC machine is a basic idea and concept that can be expand towards other application.

1.2 Research Motivation

This subtopic explains the reasons on why this project is developed and at once becoming the inspiration to completed it. Besides, the objective of this project is derived based on the motivation listed.

1.2.1 Lacking Automated Farming Devices

As stated on the article shown on Figure 1.1, it is highlighted that modern farming requires the implementation of technology in farming and agriculture industry. But, based on the observation on the internet for current device or technology for farming that available on Malaysia's market, there are too few of it available. Table 1.1 below shown the devices or technology that currently available in Malaysia.

Table 1.1 Available farming devices in Malaysia

Types of Devices	Description
1. Soaker Hoses 	Water sprayed through holes along the pipes.
2. Drip Irrigation 	Pipe drip into soil to watering the plant from the roots.

3. Spray System 	Traditional method by using spray heads.
4. Rotor Sytem 	Spray water widely with spinning body system that cover large area.
5. Digital Timer 	A digital timer that connected to pipe to control the water flow on or off at any certain times set by the users.

By referring to Table 1.1, it is shown that those type of devices for farming in Malaysia is only capable to watering the plant but not in monitoring it. Hence, it is a strong point and opportunities that the agriculture industry in Malaysia in need of new technology or devices in modern farming era.

1.2.2 Sustainable Development Goals

The Sustainable Development Goals (SDGSs) or known as the Global Goals is an effort established by The United Nations (UN) in 2015. It acts as a global call to action to eradicate poverty, preserve the environment, and guarantee that by 2030, everyone lives in peace and prosperity. Together with other 192 countries, Malaysia

have adopted the 2030 SDGs Agenda in achieving 17 SDGs and 169 targets. Next, SDGs Goals 6 is to ensure availability and sustainable management of water and sanitation globally. Under this component, one of the targets under this goal is to solve water shortage and minimise the number of people affected by it. The method is by significantly enhance water-use efficiency across all sectors by 2030 and secure sustainable withdrawals and supplies of freshwater. [4]

Figure 1.2 SDGs target 6.4

On average, plant sprinkler system uses around 16 gallons or 60.57 ℓ of water in a minute. [5] The amount of water used is to cover only the radius of 15 inch or 38.1 cm.[6] Hence, a small effort in contributing towards the water sustainability and efficiency is needed.

1.3 Problem Statement

As water sprinklers and digital timer are commonly used in farming, it is unlikely that those two types of devices can be use in monitoring the plant growing. Besides, growing a healthy and high-quality plant requires high attention and continuous efforts. Although technology such as drones has been available on our local market, but the high price put on it makes it unaffordable for small or medium scale farming activity. Hence, it proves that there are not too many modern farming device or technology that can automatically watering and monitoring the plant to support the

DAN 2.0 effort. Moreover, some of the current modern machines or devices are not available locally and must be import that in result will rack up a high cost for the farmer to grab.

1.4 Objectives

This study aims to develop a unit of Automated Plant Watering Machine Based on CNC machine that can be use in farming activity. The machine is programmed to watering the plant automatically triggered by soil moisture sensor and manually by the push button. Based on the problem statement stated above, the objectives of the project have been identified as below:

a. To design using Solidworks and develop an actual CNC machine with 2-axis for plant watering operation.

b. To test the machine automatic and manual functionality, circuit, stepper motor movement and watering function.

c. To analyze the performance of the machine based on quantity of water use, watering operation time taken and parameter such as voltage and current.

1.5 Scope and Limitation

The scope of this project is to design and develop an Automated Plant Watering Machine Based on CNC. This project functionality is focus on farming activity especially watering and monitoring the soil dampness. The machine will automatically function when the soil moisture sensor detects low level of soil dampness and manually by pressing the push button. Next, the machine is control by Arduino MEGA as the main controller. Then, two NEMA 17 Stepper Motor as the drive train for the machine 2-axis movement, x-axis and y-axis. Fifth, two types of stepper motor driver have been tested, L298N Dual H-Bridge Motor Driver and DRV8825 Stepper Motor Driver. The DRV8825 is chosen to control the speed and direction of the stepper motor as the performance is better than the L298N. Next, a 12V DC pump is used to pump

water from a 3ℓ water container for watering process. In addition, a soil moisture sensor is attached to monitor the dampness of the soil and automatically triggered the machine operation when the soil is dry. Lastly, the project outer frame dimension is 900mm x 640mm and the inner frame dimension is 860mm x 600mm. Meanwhile, the watering area is 516000mm^2 or 0.516m^2. This dimension is choosing to cater few types of small size plant.

The limitation of this project is the DRV8825 motor driver have a high tendency on getting hot in just short period. To control it, the enable function is set to high when not in used to disable the driver. Besides that, two 12V DC fan and heatsink is used to reduce the heat release by both drivers. Next, due to budget constrain, the controller used for this project is Arduino MEGA instead of Raspberry PI or Programmable Logic Controller (PLC). Hence, additional function such as real time monitoring using camera or high grade and sensitivity colours sensor are limited. Lastly, this machine cannot be use for medium or high plant size as the design is suit to small size plant.

1.6 Report Structure

This report consists of 5 main chapters on the process of developing the Automated Plant Watering Machine Based on CNC. The structure of this report is arranged as below:

a. **Chapter 1**, **Introduction:** This chapter introduce the project background, research motivation, problem statement, objectives, and scope and limitation.
b. **Chapter 2**, **Literature Review:** This chapter discuss the previous project that can be related to this project and the study on the components for this project.
c. **Chapter 3, Methodology:** This chapter discuss the method approach in completing this project.
d. **Chapter 4, Result:** This chapter explain and analyze the result gain from this project.
e. **Chapter 5, Conclusion:** This chapter summarize all the outcome from this project.