AUTOMATED WATERING SYSTEM BASED ON CNC MECHANISM

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DECLARATION

I declare that this thesis entitled, 'AUTOMATED WATERING SYSTEM BASED ON CNC MECHANISM 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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Date : 4th July 2021

APPROVAL

I hereby declare that I have checked this report entitled "AUTOMATED WATERING SYSTEM BASED ON CNC MECHANISM " 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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DEDICATIONS

To my mother, Norizan binti Ibrahim and my father, Mohd Ali Jaafar bin Mohamed

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ABSTRACT

Robotics in agriculture has been slowly emerging although some improvements can be made in the technology for small farms for personal purposes. With the current rise of popularity in farming as a hobby, many people started their own urban farm, but does not have enough time to fully commit themselves in this field. Computer Numerical Control machine or CNC machine can be use to help perform simple farming tasks like watering plants. Using the already existing information known about CNC Machine, the performance of tasks such as watering plants can be improved. The CNC machine was firstly sketch for watering carrots using AutoCAD software. The machine then is developed for a 900mm x 600mm watering system.The code for the machine was then wrote in Arduino IDE software and sent to NEMA17 stepper motor using Arduino MEGA 2560. The CNC machine then can be moved in x and y axis direction. This machine can help people in urban areas to start their own small farms.

ABSTRAK

Robotik di dalam bidang pertanian telah pun meningkat. Namun begitu, beberapa perubahan boleh dibuat untuk ladang-ladang kecil yang dibuat untuk tujuan peribadi. Dengan kemeningkatan popularity dalam pertanian sebagai hobi, kebanyakkan orang memulakan ladang kecil mereka sendiri tetapi tidak mempunyai cukup masa untuk menjaganya. Mesin Computer Numerical Control ataupun mesin CNC boleh digunakan untuk membantu membuat tugasan yang mudah seperti menyiram pokok. Dengan menggunakan informasi yang telah diketahui mengenai mesin CNC, qualiti dalam tugasan seperti menyiram pokok dapat ditingkatkan. Pada mulanya, Mesin CNC itu telah di lakar untuk menyiram lobak merah menggunakan perisian AutoCAD. Mesin itu kemudian dibina untuk system penyiraman 900mm x 600mm. Kod mesin itu pula ditulis di dalam perisian Arduino IDE dan dihantar ke Stepper Motor NEMA17 menggunakan Arduino MEGA 2560. Mesin CNC itu dapat bergerak dalam arah paksi X dan Y. Mesin ini dapat membantu orang di kawasan bandar untuk memulakan tanaman berskala kecil mereka sendiri.

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CNC	Computer numerical control
NC	Numerical control
VR	Variable reluctance
PM	Permanent magnet
DC	Direct current

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CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter briefly discusses the background of Automated Watering System Based on CNC Mechanism. It is followed by an introduction of motivation, problem statements and objectives of this project. This chapter also present the scope of this project.

1.2 Motivation

Ever since human colonialization, farming has been one of the main food supplies for our society. The increasing number of human population has caused the increase number of farm food supply demand [1]. Therefore, a lot of industries in recent years uses chemical fertilizers to boost the production to produce more crops in short amount of time which poses a lot of health hazard for human [2]. These problems encourage many people to start their own small-scale farm with organic fertiliser. However, farming required huge manual effort on and off the field [3]. Because of this, many beginners in the agriculture sector had given up, but there is a way to encourage the new generation to carry out their passion in farming by using a process called CNC machining.

The term CNC stand for Computer Numerical Control. In the manufacturing sector, CNC machining is a process use to control machine tool. This process is currently used for manufacturing plastic and metal parts and was able to save a lot of energy and time as well as having good precision compared to manual machining which is perfect for the current need of big man power energy for the agriculture sector [4]. CNC machine for farming can operated in the xyz axis direction which allows the machine for tooling such as watering , and fertilizing machine tools to be position precisely on the plant and soil [5]. The CNC machine movement can be control

using an Arduino and stepper motor. Arduino is used to send the information and code from the computer to the stepper motor which allows precise movement across the track and gantry.

Using the CNC machine for farming, the new generation can carry out simple tasks like fertilizing and watering the plants without using that much man power [3]. With this application, more time can be saved from the repetitive farming tasks compared to the conventional method. Human safety can also be achieved and task can be easily performed even in complicated situation [3]. The time spent on the repetitive farming task instead can be replaced with other important purposes like restocking the supply of needs for the crops.

1.3 Problem Statement

Currently, the agriculture field plays a mandatory role in the needs of society. The rising world population and the decreasing number of workers in the agricultural, causes the demand for food suppliers to increase [1]. Because of that, a lot of people take initiative to do the farming themselves. However, with the increasing need of time and energy spend on the crops, these farmers do not have much time to themselves sector as well as much time to do other housework. This is because a lot of the time spent on the crops are to sow the seeds and water the plants. These repetitive works took a lot of time from the farmers. Because of this, a lot of young generation are discouraged to try out farming for themselves as it required a lot of energy and time to spend on repetitive tasks. Robotics in agriculture sector is a newly emerging technology but a lot of the method use to lessen the burden of the farmers still require traditional method using animals [6]. Therefore, there is not that much technology to help lessen out the burden of the farmers.

1.4 Objective

The objective of this project is as follows:

1. To design and develop a CNC machine for farming that be able to perform tasks such as watering plants.
2. To test the automated watering system in growing plants.
3. To evaluate the performance of automated watering system.

1.5 Scope

The scopes of the project are:

1. The project frame dimension is 900mm x 600mm built by using aluminium.
2. The project can move in 2 axis which is x-axis and y-axis.
3. The function for this CNC machine is to watering plants.
4. This project uses 2 NEMA 17 Stepper motor.
5. The working area can cover at least 6 plants in pot.

This project system is limited to the following scopes:

a. Can only operate for a certain task which is watering.
b. The size of the farm is fixed.

CHAPTER 2

LITERATURE REVIEW

2.1 CNC machine

Computer Numerical Control or more commonly known as CNC is a structural manufacturing process which typically utilize programmed controls. It has lingered around ever since the 1950's, being use by the US Air Force's metalworking machine [7]. Before computers were introduced to these controls, it was only called Numerical Control and only work as the basic method of controlling movement. When the computers were added to the controls in the early 1970's, they change the name to Computer Numerical Control [8]. The addition of computerized controls to NC indicates a massive advancement in the capabilities of machinery to create complex and accurate steps without any human intervention. CNC machine uses digitals information (code) from a computer to operate movement and positioning system of motors to direct shaft over raw materials [7]. A CNC machine understands and process complex information about which object should move, where it will be moving to and with how much acceleration using calculations and coordinate system. CNC machines must be able to communicate with itself to operate as its unit will need to send a position to its motor and the motor must respond back to the control that it has moved according to command correctly given the distance. Most of the CNC machine can move in three separate paths at once. These paths are called axis which is given simple names according to Cartesian coordinate system which are X- axis, Y-axis and Z-axis. The X axis move the longest distance that the machine must travel which is from front to back while the Y axis moves from left to right and the Z axis always move vertically which is usually the movement up and down. The CNC capabilities to move in three separate direction at once allows it to create any desirable patterns or shapes. CNC machines have covered every form of manufacturing process. CNC is regularly dealt with by manufacturing engineer field. Some of the early CNC machine are instructed through hard-wired controllers which make the programming unalterable. The later models of CNC machines introduced programming via mainframe cables and floppy disks which

allowed for more diversity in coding variation. In the modern day, most CNC machines use a network of computers and receive operating and instructions via a software file with the ".NC" extension. Modern CNC machines are also now capable of operating overnight without any human supervision or intervention [7].

2.2 CNC machine types

Commonly, CNC machine tools can be organized into three main types according to their structure and slider movement. [19]:

(a) Turning center.

(b) Horizontal machining center.

(c) Vertical machining center.

The different for the three types as above is the spindles position and direction of movement. This two things is to determine the work of the machine will be doing such ad milling, lathing, crashing or cutting [8].

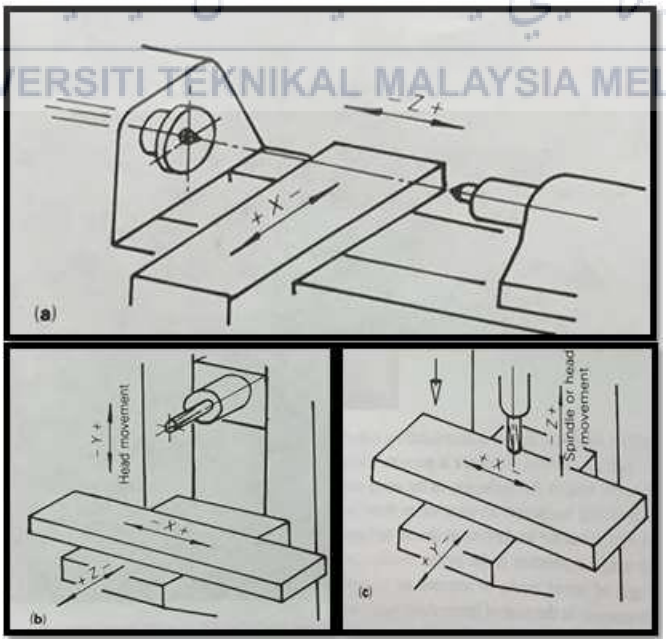

Figure 2. 1 Types of CNC machine

A. Milling, drilling, and cutting machines

Milling machines and cutting machines are usually constructed as vertical machine center structures. Due to the dynamic load and the thickness of the workpiece, the spindle axis may be deflected [19].

B. Plasma cutter

Plasma heat dissolves the dissolved material and quickly removes the liquid metal during cutting. Plasma cutting includes the use of plasma light to cut materials, such as steel and others different types of metals [8].

C. Water Jet cutter

Water planer cutting machine or also called water jet cutting machine is a machine made by cutting metal or other materials (such as rocks) with high-pressure, high-acceleration water that can exceed the speed of sound of 2000 to 3000 psi. When the sliced material is sensitive to the high temperatures generated by different strategies, water jet is the preferred technique [8].

2.3 CNC machine for farming

CNC machine tools are used as a flexible general agricultural automation basis for experimentation, prototyping and hacking. For general farming automation, the mechanical architecture has major components. The first step is making tracks which this component provides extremely high accuracy and allows repeated action of returning to the same position. [9]. The system design for CNC machine used for farming consist tracks, gantry and cross slide.

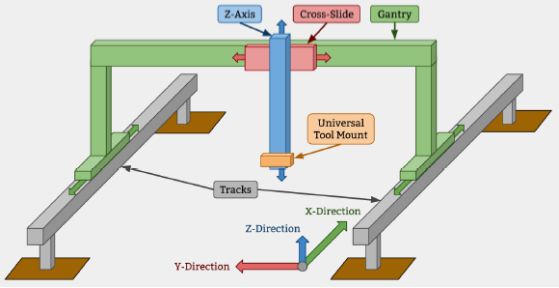

Figure 2. 2 CNC for farming design

2.3.1 Tracks

As seen in figure 2.3, tracks take the shape of rails that are partially lifted off the ground by some supports and small concrete pillars. Each rail serves as a linear reference, supplying the gantry with an interface that move along automatically. Each track has ample cross-sectional area and durability to avoid faulty during high force operation. Tracks can be used as a rail to provide the other sections with electrical power. For one gantry to move between them, the simplest system requires at least two tracks. There can be a three-track system that allows two gantries to operate on their respective lands while sharing their own intermediate tracks. There may also be more gantry frames in the fourth and fifth grade track systems. A single track allows one gantry to move, while a double track allows two gantries to share the same track as a three-track system. For smaller systems, the track can be made of T-slot aluminum profiles for easy manufacturing, flexible assembly, relatively low cost, scalability and general availability. For larger applications, customized rails may become the material of choice to reduce costs and increase strength and welding capabilities. The long and large prefabricated rails of semi-trucks can be transported to the site like railroad tracks and bolted or welded together [10].

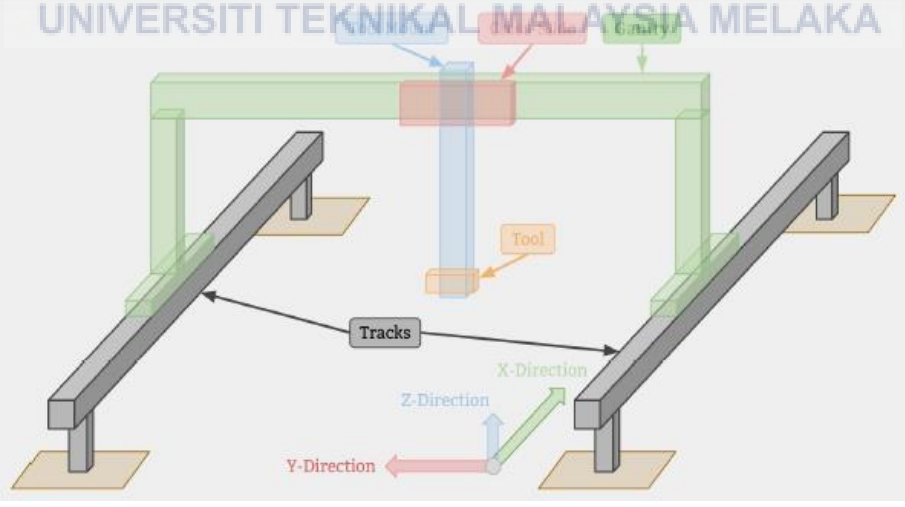

Figure 2. 3 The tracks

2.3.2 Gantry

The main structure of the gantry is an inverted of U shape like, as shown in figure 2.4. There are also linear guide systems like wheel that will across the track in the X direction which located at both end of U. The U-shaped top is used as a linear guide for bridging components and lateral sliders. The frame must be sturdy and have tight tolerance on the linear guide to avoid less precision of the tool. This is important in the operation that require high precision for example tilling which an inaccuracies less than 1 cm may damage the plants. For the gantry, T-slot aluminum profile is used for small scale application. While for large scale, it required strong material such as welded steel. [10].

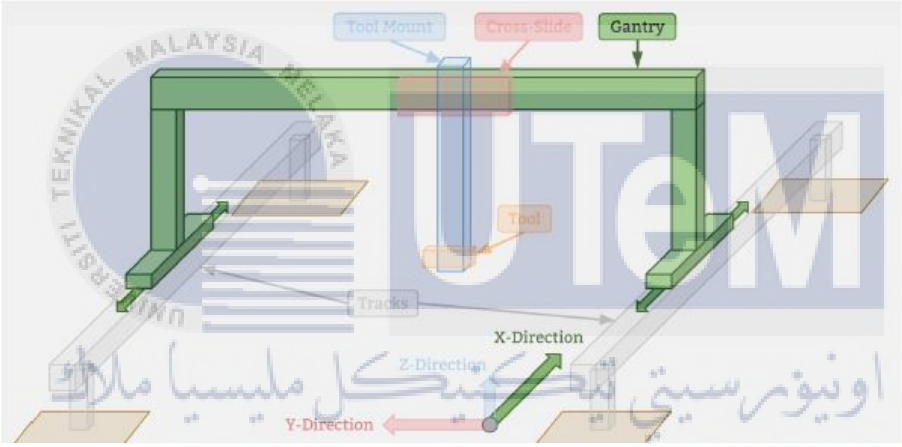

Figure 2. 4 The gantry

2.3.3 Cross-slide

As can see in figure 2.5, the cross slide is located at the gantry which moves in the Y axis direction. This movement allowed for a second major degree of freedom for the system and allows functions to be performed anywhere on the XY plan such as planting. The cross slide is used as base for tool. [10].