



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DESIGN AND DEVELOPMENT OF  
TURNTABLE FOR AUTOMATIC SORTING  
SYSTEM**

Thesis submitted in accordance with the partial requirements of the  
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Honours

By

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This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic And Automation) with Honours. The members of the supervisory committee are as follow:

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## **ABSTRACT**

Turntable is the most common automation devices that being used in industrial field for product sorting application. There are several types or model of turntable and this particular product may produced by many different company for many different usage in industries. In this project, the turntable utilizes ladder logic which is used to allow the sequences of logical action for the positioning of stop position as required from task execution. This project use Keyence KV Series PLC as a medium controller for controlling the positioning of turntable which is driven by DC stepper motor. The program is developed to control positioning and functioning switch and buttoning of turntable. This turntable are very suitable device to be used in beverage industries which is start from insert the bottle into bottle slot on turntable platform until finished the process and ready to pack in the boxes. The process that being performed on this turntable is filling the empty bottle with water, labeling the bottle, attached the cap of the bottle, monitoring the quality of the product, and some more process involved in this industry. By this device, the assembly process will successfully done during the sequences of the process. Besides, the assembly process can be smoothly and smart with existed this automatic sorting device. This is because the process is running in the sequences thus, make the process easier than used the conventional method. As additional, this device can be used to improve the productivity of the product according to their function, automatic sorting systems for the process of assembling the beverage product. In this report, it is discuss about the project of design and development of the turntable for automatic system from start until successfully finished the task.

## ABSTRAK

Didalam automasi industri, pelbagai peralatan automatik digunakan bagi memudahkan serta mempercepatkan proses pengeluaran sesuatu produk dengan sokongan teknologi moden. Melalui teknologi ini, setiap pengeluar dapat meningkatkan produktiviti pengeluaran seterusnya akan mendapatkan keuntungan yang berlipat kali ganda berbanding dengan menggunakan kaedah sebelumnya. Antara peralatan yang dapat digunakan didalam automasi industri ini adalah seperti "turntable" dimana ia digunakan untuk menyusun benda kerja ataupun produk secara automatik bagi memudahkan proses pengeluaran atau proses pencantuman produk. Sistem kawalan yang digunakan untuk mengawal pergerakan putaran "turntable" ini adalah hasil daripada bantuan sistem *programmable logic controller* (PLC) dimana sistem PLC ini menggunakan gambarajah tangga sebagai arahan untuk melaksanakan sesuatu tugas. Pada masa kini, terdapat pelbagai jenis "turntable" dalam pasaran dan telah direkabentuk untuk pelbagai tugas yang berlainan di dalam industri yang berlainan. Dalam melaksanakan projek ini, PLC daripada siri Keyence KV adalah menjadi medium pengawal bagi mengawal pergerakan motor stepper serta tempat berhenti untuk proses kerja "turntable" ini. Dengan menggunakan "turntable" ini, proses pengeluaran khususnya di dalam industri minuman, ianya akan membuatkan proses berjalan dengan lebih lancar kerana ia sangat membantu bagi mengurangkan masa untuk menghasilkan sesuatu produk. Antara kegunaan "turntable" ini di dalam industri minuman adalah untuk membolehkan proses bermula daripada mengisi botol kosong ke dalam slot botol yang disediakan di atas platform "turntable" sehinggalah proses tersebut selesai dimana bersedia untuk dipekkkan di dalam kotak. Dengan menggunakan "turntable" ini, proses pengeluaran tersebut iaitu mengisi air minuman ke dalam botol, proses perlebelan pada botol, memasang penutup botol,

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## LIST OF ABBREVIATION

PLC	-	Programmable Logic Controller
MSD	-	Musculoskeletal disorder
SME	-	Small and medium enterprise
CNC	-	Computer numerically controlled
PSD	-	Position sensitive detector
DC	-	Direct current
AC	-	Alternate current
I/O	-	Input/Output
PIC	-	Programmable integrated circuit
IC	-	Integrated Circuits
LED	-	Light emitting diode
CRT	-	Cathode-ray tube

# **CHAPTER 1**

## **INTRODUCTION**

During the past decade, global manufacturing competition has increased significantly. Consequently, the manufacturing industry around the world have been undergoing some fundamental changes, including a move to low cost, high quality systems and a shift in a focus from large business customers to diffused commodity market for all size and type of customer.

In order to satisfy today's customer, the industry needs its product to be of extremely high quality and at the same time be affordable. In order to achieve the good quality in products industries are making use of more and more automation system in manufacturing. Manufacturers use various tools to bring about the high quality products and among of them is the turntable that being used for sorting the products. While using this tool, the product will be sorted with specification required thus can ease the production process and the productivity of the production will increase.

This turntable will be controlled their rotation positioning by using the programmable logic controller (PLC). This device will act as the main controller to control the motor for the turntable to stop at the required position. This turntable also being developed with a steady base support and well function for sorting mechanism in order to enhance the performance of the turntable.

## 1.1 PROBLEM STATEMENTS

Many small companies today are still use the manual sorting process to sort the part for production process. By using the manual sorting process, it can take a long time to finish the work because human will usually feel bored and tired to do the same task repetitively. This situation will result to inefficient work condition for the worker. The repetition of these works over long period of time can expose the workers to experiencing lower back pain and in some cases of musculoskeletal disorders (MSDs). According to the serious cases, this type of injury will cause the operator to be paralyzes.

Expensive automated sorting systems that are used in large company do not suit applicable for the smaller company such as for the small and medium enterprise (SME) because of the high cost to implement. To install these systems, it will require a large space depending on the process required. The systems that first install also can't be used for other purposes of the process.

By the project of Design and Development of Turntable for Automatic Sorting System application, all problems that being mentioned earlier hope can be eliminated. With this turntable the sorting process can be done faster and perfect than before while use the manual sorting system. This is because the turntable will be doing the correct sorting process by drive from the motor that controlled by the PLC. This will result in higher material handling efficiency. Although the sorting process is also being done by this turntable, the cost of this unit is less than the available automated sorting system at market. This turntable is operating together with industrial robot to complete the task given. The industrial robot will pick and place the part to fill the holder on the turntable.

## **1.2 OBJECTIVES**

The main objective of this project is to design and development of turntable for automatic sorting system that can be used for automatic sorting in the industrial application. The application of this turntable are for sorting the selected product to turntable's platform by using the pick and place robot.

The other objective during this project is to design and develop programmable logic controller (PLC) program for the turntable to perform the automatic sorting system applications. PLC is one of control devices that frequently used in industrial field because of high quality of performance on control function.

## **1.3 SCOPE**

In order to manage the project of Design and Development of Turntable for Automatic Sorting System that will be used in the industrial application, it must have some scope to assist or as a guideline to make sure the development of the project will run smoothly. Scope of project should be identified and planned to achieve the objective of the project successfully on the time. Among the scopes that been fixed for this project are as:-

- I. To design and develop the mechanical structure for the turn-table.
- II. To design and develop PLC diagram for automatic sorting system.
- III. To integrate the PLC program for operation of the turn-table.

## **1.4 BENEFITS OF THE PROJECT**

The project of Design and Development of Turntable for Automatic Sorting System been done because want to ease the production process on the sorting system. Usually this task are been done by the human power and the achievement of productivity are

frequently not attractively because of human behaviors. The benefits out from this project are:-

- I. Eliminating the usage of human power for sorting the object in manufacturing line.
- II. Preventing injuries due to picking up things repeatable by the operators.
- III. Increasing productivity and efficiency.
- IV. The sorting process in manufacturing will be more orderly.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION TO TURNTABLE**

Turn table also known as rotary index tables, rotary tables, rotary indexer, index tables, indexing tables, rotary indexing tables, transfer tables, rotary transfer tables, dial tables and rotary dial tables are frequently used in industry as a machine tools, and assembly lines. Usually turntables consist of a circular steel plate, one or more spindles, a drive system, and pins that hold parts and components in place. [1]

Usually rotary indexing tables have either fixed or adjustable indexing angles. During each revolution, the table stops for a specified period of time so that an operation can be performed at each station. Also the bearings that support rotary indexing tables determine both the load capacity and accuracy. Angular contact bearings are more expensive than recirculating ball bearings, but provide better load capacity and axial stiffness. Cross-roller bearings are also commonly available. [1]

Rotary indexing tables are usually powered by the following mechanism:

- i. Pneumatic drives
- ii. Electrical drives
- iii. Hydraulic drives
- iv. Manual actuation
- v. Others

Drive mechanisms can be located above, below, behind, or to the side of the table surface. Pneumatic rotary indexing tables are suitable for small and medium loads. They are powered by one or more pneumatic cylinders, each of which represents an index. During the return stroke, a pawl locks the table in place. With some devices, the pawl can be adjusted to change the number of indexes. Electrically-powered tables are generally faster than pneumatic devices and can handle heavier loads. Tables that are powered by hydraulic drives use a pressurized fluid that transfers rotational kinetic energy. Manually-actuated rotary indexing tables often include a hand crank or are loosened, turned, and adjusted by hand. [2]

In order to selecting the turn-table, there are requires an analysis of specifications and features. Specifications include maximum indexing increment, work table diameter, maximum axial load, and maximum radial load. A variety of features are available. Some table surfaces can be raised or lowered at a controlled angle. Others have more than one rotating work surface. Computer numerically controlled (CNC) devices provide greater accuracy and repeatability. Position encoders are often used to relay the position of the table surface. Both four axis tables and five axis tables provide variable X, Y, and Z axis motion. Four-axis table also provide part rotation along the X axis. Five-axis tables provide part rotation along both the X axis and the Y axis. [2]

An application for rotary indexing tables includes assembly and equipment positioning, as well as various automation, inspection and machining applications. Most devices work well with machines that perform fast and simple vertical operations. Examples include industrial presses, screwdrivers, riveters, dispensers, pick-and-place units, and ultrasonic or resistance welders. Parts can be loaded and unloaded manually or automatically. [2]

The error of the rotational of turntable can be measured by using a measuring device that has been developed. That measuring devices such as a laser diode, a laser holder and a position sensitive detector (PSD) that are integrated as a simple measuring device for the

measurement of the rotary error without using a precision reference artifact also known as a cylinder or a sphere, multiple probes or error separation methods. The laser diode is assembled in the laser holder and fixed on the rotary table for measuring task. The PSD is set up above the laser holder to detect the position of an incident laser beam from the laser diode. Concept of the error measuring for rotary table is when the rotary table rotates; the rotary error changes the direction of the incident beam and also the position of the spot on the PSD. For the measurement of the angular indexing, a reflective diffraction grating and two PSDs are integrated as a high-resolution angle measuring device without using an autocollimator or a laser interferometer system. The diffraction grating is set at the center of the rotary table and reflects an incident laser beam into several diffractive rays. Two PSDs were set up for detecting the positions of  $\pm 1$ st-order diffraction rays. A simple algebraic method is used to solve the angular indexing through an optical analysis. [2]

## **2.2 TYPE OF TURNTABLE**

There are lot types of the turn-table that available at the market an also being used in the industries. The types of turn-table being classified by the driven method that use to operate the devices such as the electrical motor, pneumatic motor or actuator, hydraulic drivers, Geneva mechanism, cam indexing, and so on.

### **2.2.1 Pneumatic drives**

Pneumatic rotary indexing tables as shown in Figure 2.1 is one of the type of indexing table that suited operation for rotary-cycle operations for automatic assembly and packaging equipment, drilling and boring stations and other applications in which the workpiece or tool must rotate. [3]