"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrument & Automation)"

Signature : .....

Supervisor's Name : Mr. Mohd Ariff Bin Mat Hanafiah.

Date : 7TH MAY 2007

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

Signature : .....

Name : AZMAN BIN HAMZAH

Date : 7TH MAY 2007

Dedicate to my beloved parents, family…

My sweetheart…Siti Nurhayati Bte. Salim

ACKNOWLEDGEMENT

Firstly, I would like to thank to the almighty ALLAH S.W.T. to giving me a chance to complete this project report. Without Him, I can't even think that I could complete this Project Sarjana Muda (PSM 2) report.

In submitting this report, I would like to acknowledgment Mr. Mohd Ariff Bin Mat Hanafiah, my supervisor for Project Sarjana Muda 2 (PSM 2), for his guidance and participation in conducting my project title '**XY SERVO PALLETIZING MACHINE**' for session 2, 2006/2007. His knowledge and insights gained from over 4 years of experience with the KUTKM as a lecturer, specifically in the field of automation engineering, were invaluable in identifying the ways to solve many problems regarding to my project. The reports reflect the intelligence, dedication and fairness that Mr Mohd Ariff Bin Mat Hanafiah is known for.

ABSTRACT

This progress project report is prepared for Projek Sarjana Muda as a fulfillment of PSM 2 (BEKU 4973). This project is to design and develop a '**XY SERVO PALLETIZING** MACHINE'. This project is a combination of electrical, mechanical and electronics. This project involved a servo motor technology to make x-axis and y-axis position controls for palletizing systems. The operation 'pick and place' pallet using air gripper and can control with manual or integrating using Omron PLC (PLC-CJ1). The general objective is to introduce the student to familiar with pneumatic, positioning and servo motor on their studies. Its will give a knowledge to student before going to the industry.

In this project, a prototype was create to make sure the effectiveness of operation, the control systems which create with CX programmer connected to the instruments of palletizing prototype.

ABSTRAK

Laporan kemajuan ini dihasilkan untuk Projek Sarjana Muda sebagai syarat lulus untuk PSM 11 (BEKU 4973). Ini merupakan kajian awal berkenaan projek yang akan dihasilkan iaitu projek '**XY SERVO PALLETIZING MACHINE**'. Projek ini secara khususnya ialah menghasilkan sebuah mesin yang menggunakan servo motor yang melakukan pergerakan kerja mengangkat barang dari satu tempat ke tempat yang lain. Ia juga menggunakan pencengkam jenis angin untuk memegang barang/palet dan dikawal secara manual atau secara automatik menggunakan PLC CJ-1. Objektif umum penghasilan projek ini ialah memperkenalkan pelajar dengan aplikasi pneumatik, 'positioning' dan servo motor. Ini akan memberi pendedahan awal kepada pelajar sebelum terjun ke dalam industri.

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CHAPTER 1

INTRODUCTION

Servomotors are often use to control sensitive adjustment such as steering, remoter and also in other uses in robotic and positioning control system. Servo mechanisms have countless applications in the operation of electronic and electrical equipments. Servo systems use a weak control signal to move a large load to a desired position but with great accuracy. The most suitable key words that can define these servo mechanisms are **move** and **great accuracy**. Servos are so powerful where they can move heavy loads and be remotely controlled with great precision by synchronies devices.

The common technologies used to control the speed of servo motor are ***proportional, integral*** and ***derivative*** (**PID**) controllers. The PID controllers only able to control low torque and speed which is can be define as simple system and it using manual panel interfacing for control. PID controllers are design to eliminate the need for continues operator attention. The *integral* term is most effective at low frequencies, the *proportional* term at moderate frequencies and the *differential* term at higher frequencies. These frequencies are relative to the bandwidth of the servo or process. The primary benefit from the *Integral* term is the reduction of steady state error while the *Differential* term helps to improve the responsiveness and stability.

This project is developed to introduce how the driver control a servo motor pick and place process on X-axes and Y-axes position. The basic concept of this system is by

using software from computer or using a teach pendent/console, the Smartstep driver has ability to control speed, direction, acceleration and position of servo motor. This project is developed for palletizing the product they are use in the actual factory. It introduced the way how object can be palletized from one place to another place. Consistently, accurately and system reliability are new advantages for this system. For advancement, this systems used PLC and PC based.

1.1 PROJECT BACKGROUND

For this '**XY SERVO PALLETIZING MACHINE**' project, the aim of the project is to develop and produce the working '**XY SERVO PALLETIZING MACHINE**' that can integrate with PLC OMRON CJ 1G with complete documentation for use in the technical education. The basic concept of the project is using servo motor complete with servo driver where can be used to control the lead screw movement between X-axis and Y-axis. Also the gripper to operate on the pick and place task. This project is to create the interface between computers with servo motor drive through parallel port. Using CX-programmer as interface software to give a command to control servo motor. This project allows us to control the direction, acceleration and speed of servo motor. Other applications that use this concept are storage system, pick and place system, robotic arm and etc.

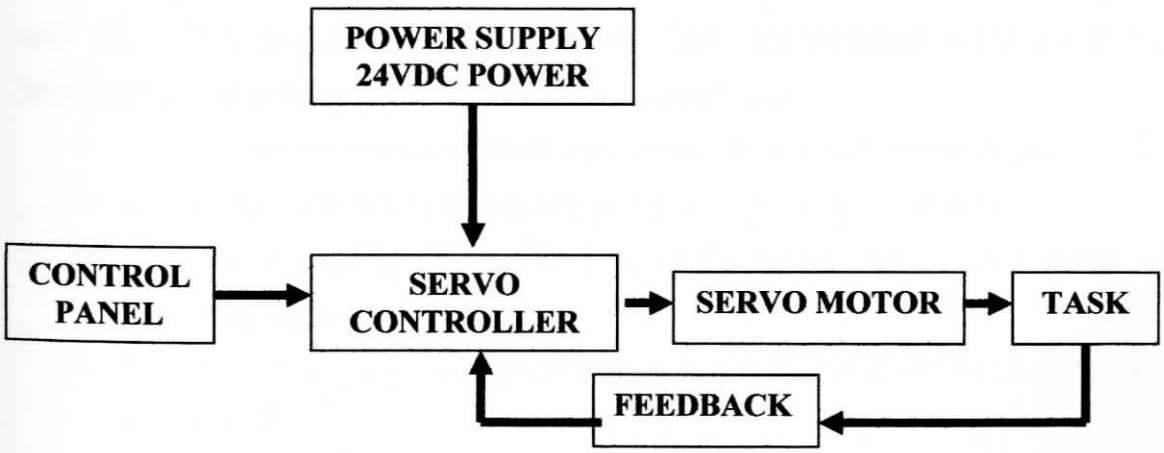

Fig 1.1: Basic Concept of Servo Controller System

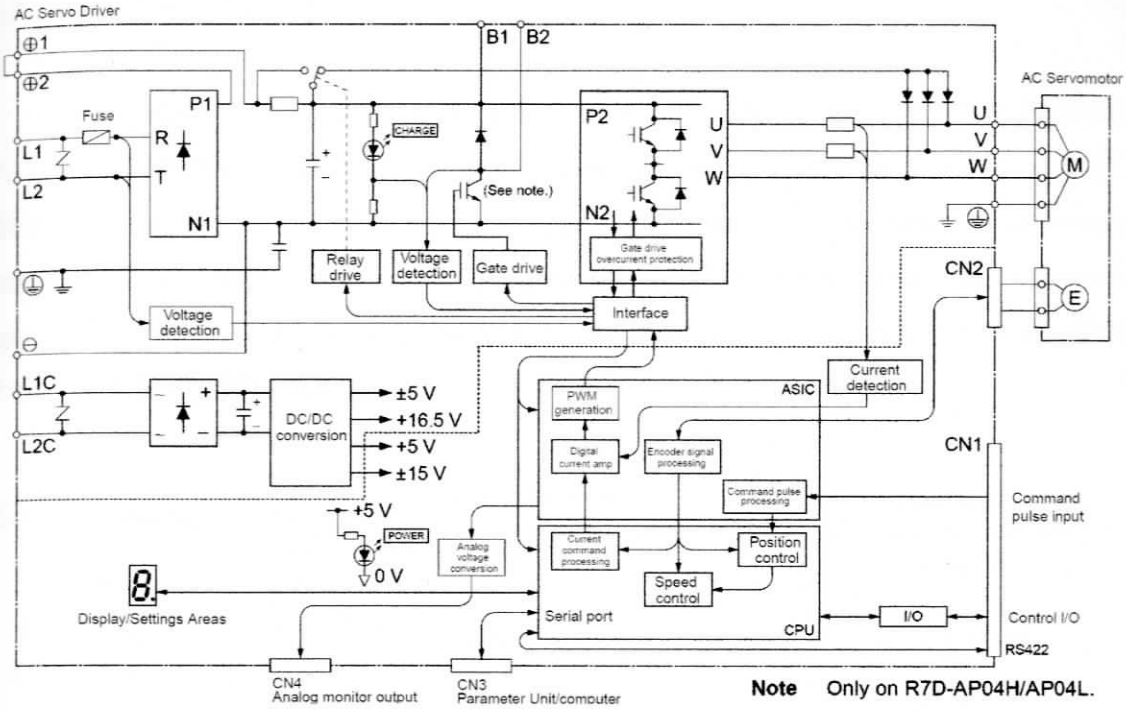

Fig 1.2: Configuration of the Servo System and Its Operation

1.2 PROJECT OBJECTIVE

The project to be developed is to fulfilled with the configuration and specification. The objectives are use for benchmark to make sure the project activities and progress will follow the requirement of the project. The '**XY SERVO PALLETIZING MACHINE**' project objective can be defined as listed below:

- ❖ To collect all information related to the project by research and readings.
- ❖ To develop and familiarize with design and construction of XY table.
- ❖ To develop and familiarize with assembly, setup and commissioning of palletizing equipment.
- ❖ To develop PLC programming and interfacing of '**XY SERVO PALLETIZING MACHINE**'.
- ❖ To understanding application of servo and drive technology.
- ❖ To produce a complete operational documentation.

1.3 PROJECT SCOPE

The scope of this project is to design and develop a prototype '**XY SERVO PALLETIZING MACHINE**' that be can interfaced using PLC Omron (CJ-1) with PC Base programmer. This project used two type of controls where manually or automatic handling. The selector switch are used to determined the manually or automatic operation. The result of this project is to produce a working '**XY SERVO PALLETIZING MACHINE**'.

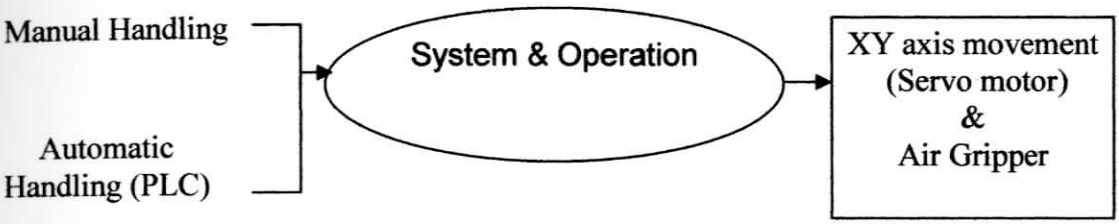

Fig 1.3: The Scope of Project

1.5. PROBLEM STATEMENT

This machine is developed for palletizing the product where been used in the actual factory. Those introduce the way how objects carry up using that system to move in one place to another place. So this machine can show the operation like as in a factory look like.

Consistently, accurately and system reliability will be a new advantages for this system. To achieve the target, many upgrading and modification is developed to intergrades using PLC programming. Therefore this can be used as introduction to student about integrating system between PLC and PC Based technology in industry.

CHAPTER 2

2.0. LITERATURE REVIEW

This chapter discussed the detail about all related equipment for the '**XY SERVO PALLETIZING MACHINE**' project. They are:

1. Servo Motor
2. Pneumatic Actuation System
3. Programmable Logic Controllers
4. Sensor and Transducers
5. Automation System
6. PID (Proportional + Integral + Derivative)

2.1. SERVO MOTOR

2.1.1 Introduction to Servo Motors.

A servo motor is a dc, ac, or brushless dc motor combined with a position sensing device (e.g. a digital decoder). In this section, the discussion will be focused on the three-wire DC servo motors that are often used for controlling surfaces on model airplanes. A three-wire DC servo motor incorporates a DC motor, a gear train; limit stops beyond which the shaft cannot turn a potentiometer for position feedback, and an integrated circuit for position control. Of the three wires protruding from the motor casing, one is for power, one is for ground, and one is a control input where a pulse-width signals to what position the motor should servo. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. As the coded signal changes, the angular position of the shaft changes.

Servos are extremely useful in robotics. The motors are small and are extremely powerful for their size. A standard servo such as the OMRON A-series has 42 oz/inches of torque, which is pretty strong for its size. It also draws power proportional to the mechanical load. A lightly loaded servo, therefore, doesn't consume much energy. The guts of a servo motor are shown in the picture below. You can see the control circuitry, the motor, a set of gears, and the case. You can also see the 3 wires that connect to the outside world. One is for power (+5volts), ground, and the white wire is the control wire.

2.1.2 HOW DOES A SERVO WORK?

The servo motor has some control circuits and a potentiometer (a variable resistor) that is connected to the output shaft. The potentiometer allows the control circuitry to monitor the current angle of the servo motor. If the shaft is at the correct angle, then the motor shuts off. If the circuit finds that the angle is not correct, it will turn the motor the correct direction until the angle is correct. The output shaft of the servo is capable of traveling somewhere around 180 degrees. Usually, it's somewhere in the 210 degree range, but it varies by manufacturer. A normal servo is used to control an angular motion of between 0 and 180 degrees. A normal servo is mechanically not capable of turning any farther due to a mechanical stop built on to the main output gear. The amount of power applied to the motor is proportional to the distance it needs to travel. So, if the shaft needs to turn a large distance, the motor will run at full speed. If it needs to turn only a small amount, the motor will run at a slower speed. This is called proportional control.

How do you communicate the angle at which the servo should turn? The control wire is used to communicate the angle. The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse Coded Modulation. The servo expects to see a pulse every 20 milliseconds (.02 seconds). The length of the pulse will determine how far the motor turns. A 1.5 millisecond pulse, for example, will make the motor turn to the 90 degree position (often called the neutral position). If the pulse is shorter than 1.5 ms, then the motor will turn the shaft to closer to 0 degrees. If the pulse is longer than 1.5ms, the shaft turns closer to 180 degrees.

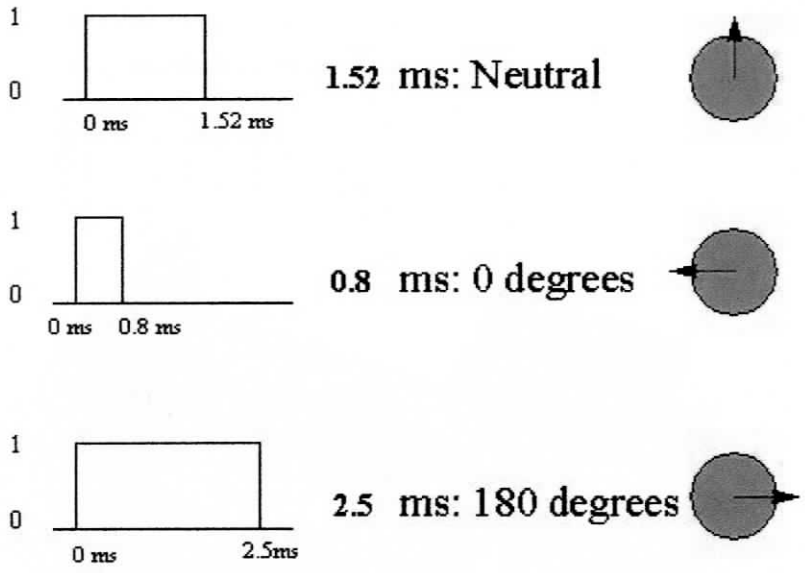

Fig 2.1: Diagram of the servo motor signal

As can be seen in the figure 2.1, the duration of the pulse dictates the angle of the output shaft (shown as the green circle with the arrow). Note that the times here are illustrative and the actual timings depend on the motor manufacturer. The principle, however, is the same.

2.1.3. Rotor Characteristics Servo Motor.

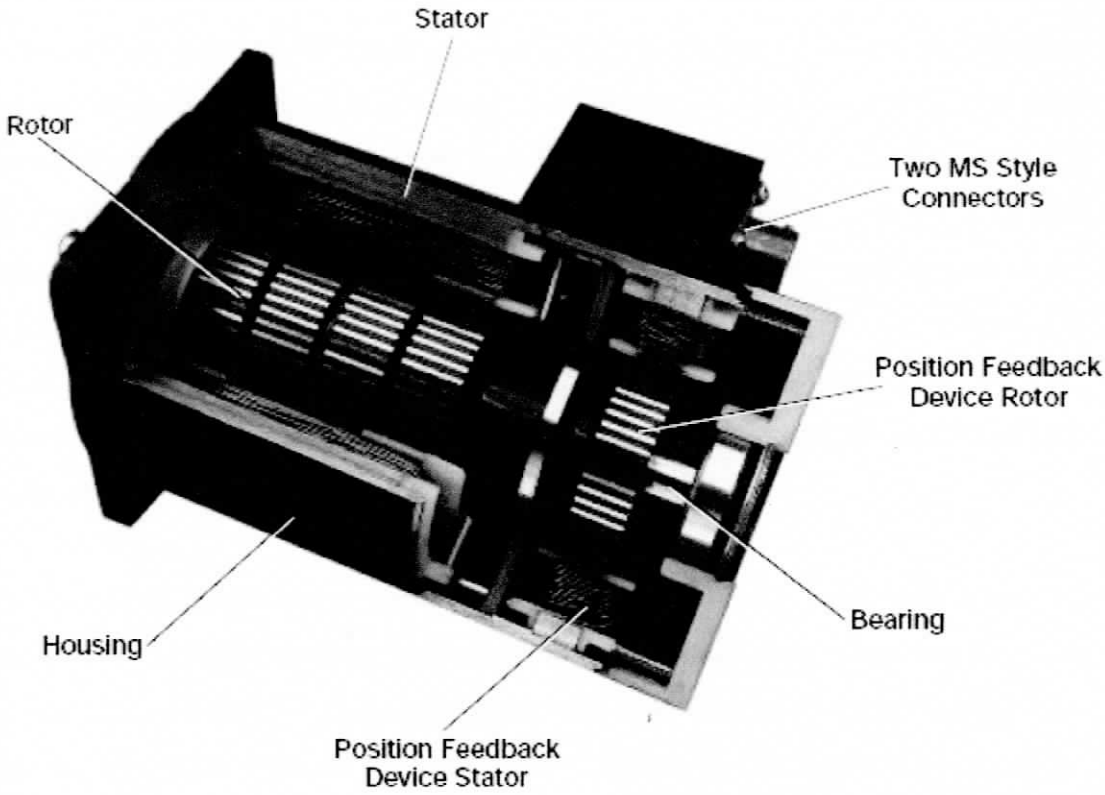

Fig 2.2: Picture of the servo motor

The present invention generally provides a compact integrated servo motor and gear reducer assembly maintained within a unitary housing. The compact integrated servo motor and gear reducer assembly can be used in applications requiring high torque output but yet with size and/or space limitations. The present servo motor and gear reducer assembly may, for example, also reduce installation and maintenance costs associated with the operation of servo motors and gear reducer assemblies. In a preferred embodiment of the invention, a servo motor and gear reducer are provided within a unitary housing. The servo motor is supported within the unitary housing at its distal end with bearings near the rear of the unitary housing. At its proximal end, the servo motor is supported with bearings and its output shaft is operatively connected directly to the gear

reducer. In a preferred embodiment of the present invention, the gear reducer is a planetary gear system.

Hence, the servo motor's output is operatively connected directly to the sun gear of the planetary gear system. In one embodiment, the servo motor rotor and the sun gear may be constructed as a unitary piece (or with the sun gear pressed onto a shaft area of a unitary piece). Furthermore, the bearings supporting the servo motor at its proximal end are contained substantially within and concentric with the planetary gear system. As a result of this configuration, the axial length of the overall assembly is reduced. In operation, the servo motor rotates the input shaft of the planetary gear reducer, specifically, the sun gear. The output from the planetary gear system is transferred to a planet carrier.

The planet carrier has a unitary design and is fully supported with a pair of bearings. As used herein, the term "fully supported" includes large diameter bearings on both sides (e.g., axially) of the planet gears. At least one prior design placed two bearings on the output shaft of the gear system. However, this leads to planet gears which are supported in a cantilevered fashion. The present invention overcomes this shortcoming by placing bearings on either of the planet/sun gear system. Also, as noted above, the sun gear bearing is placed axially within the planet carrier bearings.

Another feature of the present invention is that the bearings supporting the servo motor at its distal end are located axially within and concentric with the servo motor's windings. This feature of the present invention further contributes to the compactness of the overall assembly design. As discussed above, the present invention provides for a compact integrated servo motor and gear reducer assembly contained within a unitary housing. Hence, all of the moving components, including the servo motor, planetary gear system, and support bearings, are contained within the unitary housing. In a preferred embodiment of the present invention, input and output ports are provided to allow for lubrication. As a result of this design, the moving parts of the present invention can be lubricated with a simple low pressure oil circulation system.