"I admitted that I have read this report and in my opinion this report are fulfillment the scope and quality for the Degree of Bachelor in Electrical (Power Industry) graduation."

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DATE :.....22/11/05.....

DESIGN AND IMPLEMENTATION OF GRIPPER AND ROBOT ARM (HARDWARE DEVELOPEMENT)

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"I admitted that this project is written by me and is my own effort and that no part has been plagiarized without citations"

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For my loving parents Md Azhari and Jariah Alimun also Engku Norzatun Najhah
In appreciation of supported and understanding.

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ABSTRACT

This project explains the development of a gripper with robot arm. The main objectives of this project are to design and implement a gripper with robot arm. This project can be self-operational in controlling, starting with simple tasks such as gripping, lift, rotating and outgripping. Four servo motor was used in this project to performed four degree of freedom (4 DOF). The PIC16F877A microcontroller interfaced with robot arm and work as a brain to the gripper and robot arm. A program is written and compile with HI-TECH PICC then assembled to be converted into a hexadecimal file and downloaded into the PIC microcontroller. This project is able to analyze data from the program and drive the servo motor to create a series of motion for robot arm.

ABSTRAK

Projek ini menerangkan bagaimana pembangunan lengan robot beserta pencengkam. Objektif utama bagi projek ini adalah merekabentuk dan menghasilkan lengan robot beserta pencengkam. Projek ini beroperasi secara bersendirian bermula dengan melaksanakan tugas-tugas mudah seperti mencengkam, mengangkat, berputar dan melepas cengkaman. Empat servo motor digunakan di dalam projek ini untuk menghasilkan empat darjah kebebasan bergerak bagi lengan robot tersebut. Pengawal mikro PIC16F877A pula diantaramukakan dengan lengan robot dan bertindak sebagai otak kepada lengan robot dan pencengkam. Aturcara cara yang ditulis ditukarkan ke fail hexadecimal dengan menggunakan HI-TECH PCC dan dimuat turun ke dalam pengawal mikro PIC. Projek ini mampu menganalisa data berdasarkan program yang diberi seterusnya menggerakkan servo motor untuk menghasilkan beberapa siri pergerakkan untuk lengan robot.

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CHAPTER 1

INTRODUCTION

DESIGN AND IMPLEMENTATION OF GRIPPER AND ROBOT ARM

The last two decades have witnessed a significant advance in the field of robots application. Many more applications are expected to appear in space exploration, battlefields, and in various activities of daily life in the coming years. A robot is a mechanical device that performs automated tasks and movement, according to either pre-defined program or, a set of general guidelines and direct human supervision. These tasks either replace or enhance human work, such as in manufacturing, construction or manipulation of heavy or hazardous materials. A robot may include a feedback-driven connection between sense and action, not under direct human control. The action may take the form of electro-magnetic motors or actuators that move an arm, open and close grips, or propel the robot. The step-by-step control and feedback is provided by a computer program run on either an external or embedded computer or a microcontroller.

The robot arm system consists of the robot arm, gripper and the control program. Every robot has a unique kinematical model and this report will mainly focus on the development of that kinematical model and the development of a programming interface

to the control system. The more movement allowed randomly, that means the harder and more complicated program will get to control everything.

1.1 Objectives and Project Scope

The objective of this project is to design and implement of gripper with robot arm by using servo motor that has the capabilities to create a motion to the robot arm. Beside that, the robot also can be use as a study tools for student to learn about robotic movement and as implementation from related subjects such as robotics and mechatronics design. The design of robot is reliable and it can be used for outdoor and indoor environment.

Furthermore, the sub-objectives for this project is to write a precision program to control the dc servo motor, find and choose the good performance of the dc servo motor and create a reliable and simple movement for the robot arm and gripper.

The project scope of this project consist of designing the robot arm and gripper, which is to decide a proper programming tool or software and the exact materials to use in implementation of the gripper and robot arm which is more reliable, lightweight and easy to modify.

1.2 Report Outline

In this project report there are has 8 chapters altogether. Chapter 1 gives some introduction and the objectives about this project. Chapter 2 provides some project background for this project.

The literature review of this project is report in chapter 3. This chapter reviews the related work that been done by other people. Chapter 4 is the main part of this report. It has four main sections, which are:

a. Designing of the robotic part
b. Hardware implementation
c. Testing and analyzing

Chapter 5 brings further discussion about the project, chapter 6 and 7 the conclusion of this report. Finally, for chapter 7 and 8 consists the conclusion and the future work of this project.

CHAPTER 2

PROJECT BACKGROUND

2.1 Project Overview

This chapter provides necessary background of this project such as the controller and the programmer. A brief introduction to the concept system in this robot arm is given to provide basic understanding of the project.

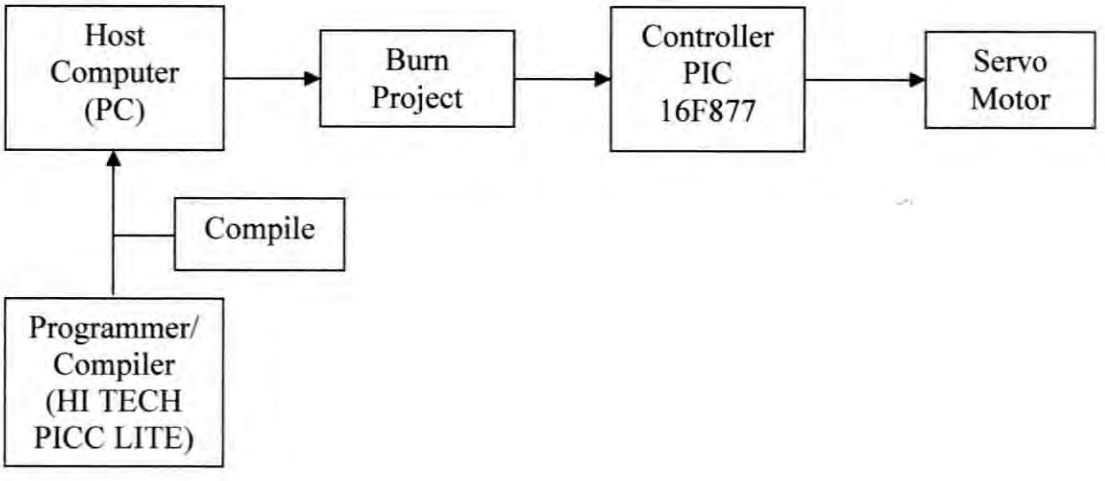

Figure 2.1: General system in robot arm application

The host computer functions as a user interface for human operator to operate the robot system. This is where normally the human creates the programming of the robot and executes or compiles the program. If there is any modification on the programming needed, all the work required is done here. All programs then will be sent to the controller.

The controller is the very important part in this project. The function of this controller is as a brain of the system. It processes all the input from the host computer and from the feed back error, and provides an appropriate output based on the sequence and programming made by the user. In the existing system, the controller parts for these systems are control by the microcontroller PIC16F877A.

The next block after controller is servo motor. In this stage, the output from the controller is fed into the 4 servo motors. All these data signals will control the motion of the servo motor, depends on the program that has created by the user.

The compiler that is used in this project is Hi Tech Picc. This compiler supports the microcontroller 16F877, 16F877A, 12F675, 12F629, 16F627, 16F627A, 16F684, 16C84, 16F84 and 16F84A devices. This compiler is chosen because it is a low cost tool for student. It is ideal as a teaching tool for an introduction into the 'C' language and embedded programming, on a Microchip device such as the microcontroller 16F877 and 16F877A.

2.2 The Original Architecture Design

This section of chapter 2 describes the overall background of the old architecture design, some of which need to be replaced and the rest is to be combined with the new parts. Figure 2.3 shows all the parts proposed in the original architecture. The controller using

microcontroller PIC16F877A work as the brain for the robot movement. All the signals to and from the microcontroller will pass through to the servo motors. Each of these servo motors is joining to the main body of the robot arm and gripper. Although using microcontroller PIC16f877A is easy to program, reliable and can found in the lab, some problem need to be consider and related with the other part of robot system. After some consideration reviews, a modification in controller section needs to be done and explained briefly in next section of this chapter.

Gripping parts for the robot arm also requires some modification and improvement. In the original architecture, the gripping element or parts for the robot arm is using injection-molded components and two HS-300 servos for open close grip and wrist movement. The jaws can open up to 1.3"(3.302 cm) and the wrist can rotates approximately 180 degrees. It needs only a screwdriver for assembly. To make gripping force more precise, a high quality sponge is stick at the front of jaws. Disadvantage of this part are it is too expensive about RM 35.00 per units and need two servo motors to operate it. Due to cost factor, considerations to replace it with other grippers are made.

Figure 2.2: Servo Gripper

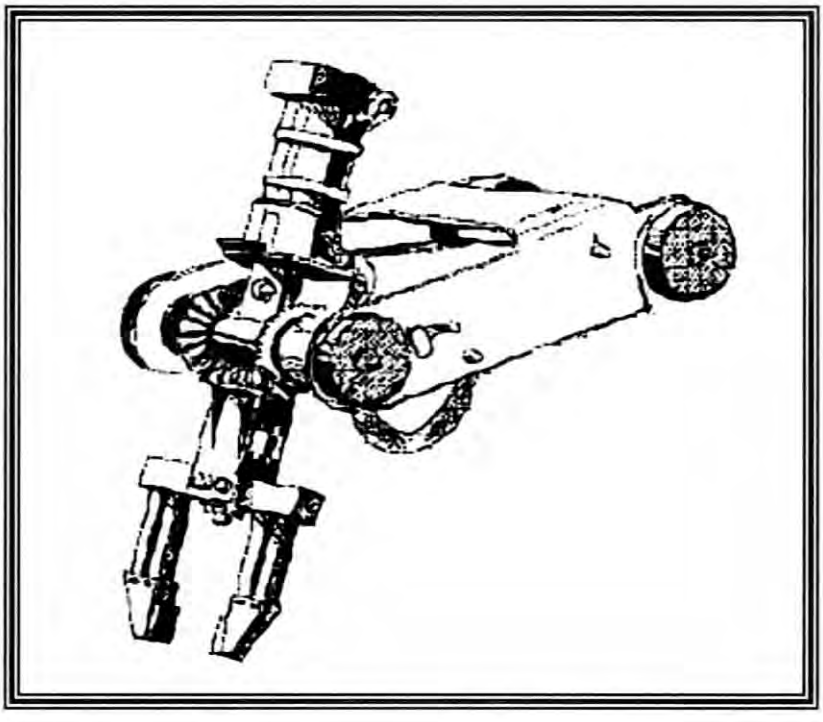

Figure 2.3: Original Architecture of Robot arm with gripper

2.3 The Modified Design

This section stated about modification on robot arm with gripper from previous proposed design. Some modification needs to be done due to problem related that can effect project flows. In this new modification design, the features of robot arm with gripper are completely different from the previous one. After all consideration on cost of part, structure and reliability again is calculated, some part needs to match required specification standard to get a good result.

Concept of movement and gripping still the same based on 3 step motions but one new part such as servo motor at the base, different types of servo motor and acrylic

structure body are introduced to make sure that this robot can achieve its objective. Selection of each part later reviewed in chapter 4.

Figure 2.4: Modified and Final Architecture of Robot Arm with Gripper

CHAPTER 3

LITERATURE REVIEW

This chapter reviews the existing project created to get an idea about this project conception, specification, design and any information that is related to improve this project.

3.1 Previous Robot Arm

Literature searched on the internet indicates, various types of robot are available included in construction, manufacturing and aerospace exploration. However, mainly the robot arm aspect or supposed to do the task of a real human arm like picking and putting the object.

Example of robot arm that more sophisticated is Robot Arm Control Exploiting Natural Dynamics. Consist of two arms with six degrees of freedom both mounted on the humanoid robot Cog.

In particular, the approach consists of using a compliant arm, which joints are control using simple non-linear oscillators. The arm has special actuators that make it robust to collisions and give it a smooth compliant motion. The actuators are use to implement low gain position control at each joint. This makes the robot link appear as a connected by springs and dampers, giving the whole arm a rich mass-spring behavior. Dynamic can be changed by altering arm posture, stiffness, damping and the manipulated object to match the passive arm dynamics with the task. Non-linear oscillators are use to inject energy and so generate the motion.

The oscillators produce rhythmic commands at the arm joints, which are excite the arm dynamics. The oscillators are adaptive, using feedback from the arm joints to alter the frequency and phase of their outputs. The oscillator behavior is to adjust the commands relative to the arm and task dynamics. The oscillator behavior can be refered to [3].

The main difference between traditional robot control and the approach taken in this project is the role of the robot dynamics. In traditional control, the robot is view as general-purpose manipulators. This is performing a task independent of the robot configuration. The tasks are specifying in terms of the desired motion (force, position, compliance) of the robot, and the robot control enforces that command. The robot dynamics are generally ignored or cancelled, and certainly do not play a part in how the task is planned. The approach taken in this project is the opposite: the robot dynamics are crucial for the performance of the task as they determine the range of possible tasks, and also how the tasks are accomplished. The robot dynamics are specify so that the task motion is a passive behavior of the system, beside the oscillators are used to inject energy into the arm and so create the motion.

A further difference in the robotic case is that the oscillator control system does not deteriorate as the speed of the task increases and the dynamics of the arm become significant. Both position and force control for robots degrade at high speeds because of disturbances from the arm dynamics. If the arm dynamics are aligned with the task, and