PROGRAMMABLE ARM ROBOT MANIPULATOR

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To my beloved mom and dad

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ABSTRACT

In the design and construction of a programmable arm robot manipulator, most of the components were taken from an old printer, thus reducing the overall cost. The robot is a spherical configuration type with two rotary joints and a gripper. This robot contains three permanent magnet stepper motor as it actuators. The method used in controlling the robot is an open-looped where no feedback is required. When one of the two sensors mounted to the robot detects an object, a PIC16F877 microcontroller is employed to generate pulses with a desired frequency to drive the motors via a driver circuit. The advantages of this design are low cost and considerably accurate. The robot can be programmed to move at any point within its working volume. For the experimental set-up, the program for the robot is written in C-language and downloaded to the microcontroller using a C compiler and a PIC16F877 programmer.

ABSTRAK

Dalam proses rekacipta dan pembinaan pemanipulasi tangan robot boleh aturcara, kebanyakan komponen diambil daripada mesin pencetak lama sekaligus mengurangkan keseluruhan kos projek ini. Robot ini adalah dari jenis konfigurasi sfera dengan dua sendi berputar dan pencengkam. Robot ini mempunyai tiga motor pelangkah magnet kekal yang bertindak sebagai penggerak kepada pergerakan robot ini. Teknik yang digunakan bagi mengawal pergerakan robot ini ialah secara lingkaran terbuka dimana tiada suapbalik diperlukan. Apabila salah satu daripada dua pengesan yang dipasang pada robot mengesan object, mikropengawal PIC 16F877 bertindak dengan menjana nadi elektrik pada frekuensi yang telah ditentukan untuk memacu motor melalui litar pemacu. Kelebihan robot ini ialah rekacipta dan pembinaanya melibatkan kos yang rendah dan pergerakanya yang agak tepat malah boleh diprogramkan untuk bergerak disepanjang kapatisi ruangan kerjanya. Untuk proses eksperimen, program untuk robot ini ditulis di dalam bahasa C dan dimuat turun ke dalam mikropengawal PIC 16F877 menggunakan pengkompilasi C dan pemprogram PIC16F877.

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CHAPTER I

INTRODUCTION

1.1 Background

The key words distinguishing robots from other machines are 'manipulator' and 'reprogrammable'. Manipulation is the act of grasping an object and changing its position and orientation in space. Humans spend a lot of their time manipulating objects: the act of lifting a pen and writing with it is a typical example. In carrying out such task the manipulator may be required to produce up to six independent motions. This is necessary since the position of an object in space is determined by its three coordinates in a fixed orthogonal frame, and by its angular rotations around each of these three axes. In practice this means that a general-purpose manipulator requires at least six actuators.

Many manipulators are anthropomorphic. As an example, they look like human arms. This is not surprising since they are often intended to replace human workers, and they have to fit the environments designed for humans. Thus, the manipulator is often referred to as the arm, the wrist and the hand of the robot, although the term 'end-effector' has been preferred to 'hand' since it encompasses tools, suction and magnetic devices as well as anthropomorphic grippers.

Therefore in this project, students will design and construct an arm robot manipulator by using PIC microcontroller unit which capable of sensing an object located in the sensor range, grab the object and put it at the assigned place. This project also requires an understanding of the concept and characteristic of the stepper motor in order to utilize it in the project. The project use stepper motor in the older model printer (dot matrix) as the actuators of the arm robot thus reducing the overall cost of this project.

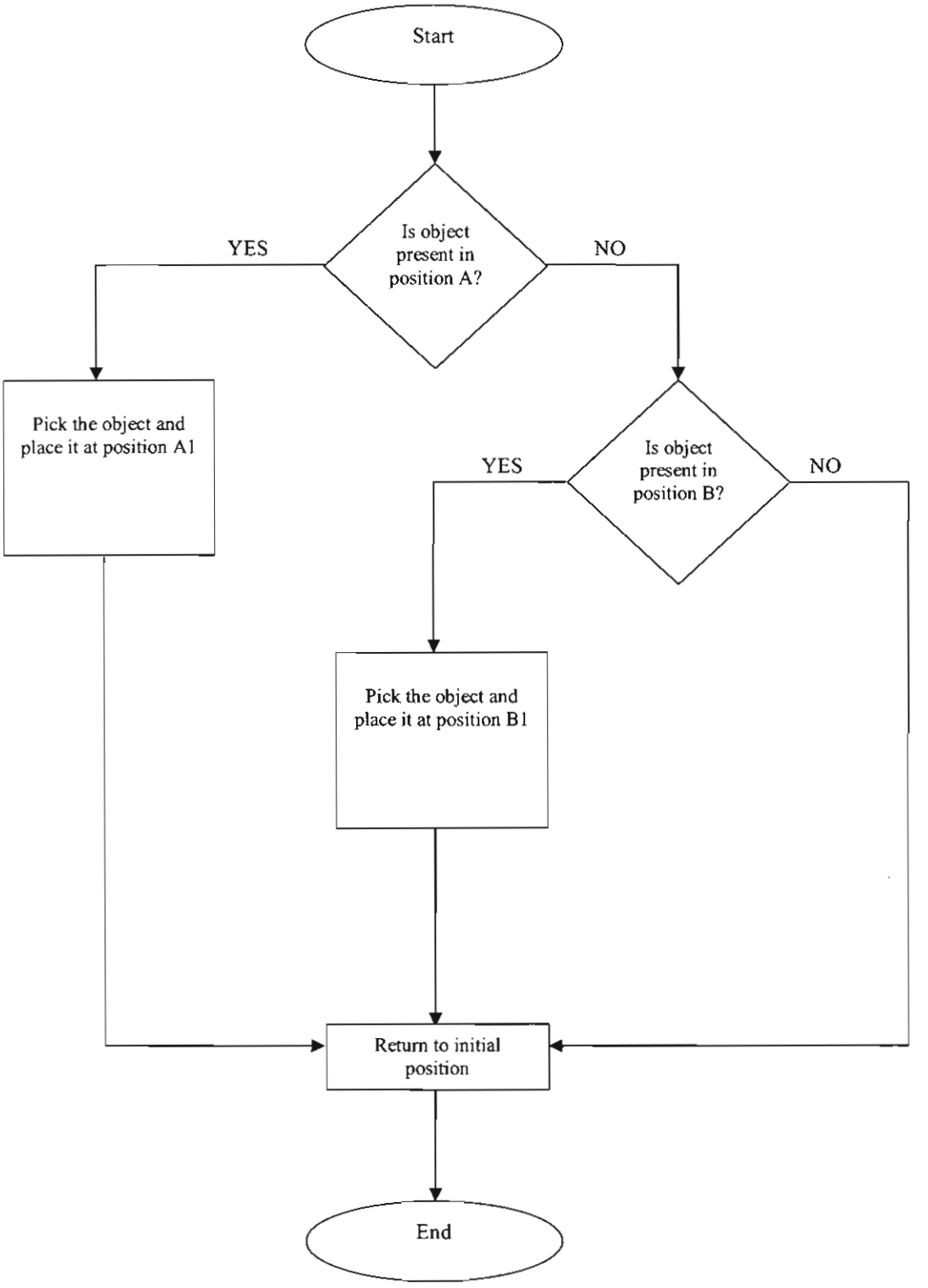

Figure 1.1 The flowchart of the robot's program

1.2 Problem Statement

Most of the robots available are expensive to build and uses controllers that are very hard to tune. Furthermore, the study of robotics demands knowledge and understanding in three major areas of engineering; electrical/electronics, mechanical and computer programming.

1.3 Objective

- To develop a simple programmable arm robot model.
- To design a considerably accurate arm robot by using stepper motor which known for its accuracy and precision as the arm robot actuators.
- To construct an arm robot model which is low-cost by using recycle material. For example, the stepper motor for this project will be using an old version printer (dot matrix).

1.4 Scope of Work

In this project, the scope of the project can be divided into two sections, which are hardware part and software part. For this project, the stepper motor was chosen for the actuators of the robot. The main reason to use stepper motor is, for a simple and small robot design, stepper motor can provide accurate positioning without the need for position feedback instruments. Therefore this will eliminate the difficulties of calibrations and positioning.

The sensors circuits are simple micro switch. If an object is placed at any of the sensor positions, the switch at the position will be off and an input will be sent to the microcontroller. Then the robot's programmed movement will start. For the software part, the language to programming the arm robot will be using assembly language.

1.5 Organization

Chapter II deals with the introduction and survey of the elements of robotics and its configurations overview such as systems overview of the robot, main components of the robot namely the stepper motor, the microcontroller, programming software and hardware. The grippers and the sensors are also explained during this chapter in term of working principles and basic constructions. In Chapter III the scope, methodology and project planning are explained.

Chapter IV explains the testing procedures of the stepper motors, the details construction mechanical and circuit design of the robot's hardware and also the programming of the robot. The results and discussion of the project are discussed in Chapter V. Finally, the conclusion and recommendations for future work are discussed in Chapter VI.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

In anthropomorphic terms, a robot system requires a brain, senses, blood supply, an arm, wrist and hand with the appropriate muscles, and possibly legs and feet. In a typical industrial robot the equivalent machine elements could be a computer, measuring devices, electrical/hydraulic/pneumatic power, a manipulator and possibly wheels.

The finite lengths of the various mechanical elements restrict a robot's end-effector to a particular working volume, and it is necessary to ensure the task to be accomplished does not call for movements beyond the boundaries of this volume. Typical working volumes are adequate for most production process, but applications such as automated warehousing make it necessary to increase the working volume by giving the robot mobility.

2.2 The Elements of a Robot

Arms, wrists, end-effectors and legs need muscles for actuation. In practice they may be driven by pneumatic, hydraulic or electric power. Pneumatic is restricted, on the whole, to pick-and-place robots where the actuators are allowed to move quickly until arrested by mechanical endstops. However, the compressibility of the air makes accurate control of speed and position extremely difficult, so that pneumatics are rarely found in most of the demanding robot system. For such systems the major contenders are hydraulic and electric drives. Hydraulic actuators are compact and capable of large forces or torques. They were the most popular form of power supply, particularly for larger robots. Eventually, electric drives took over as the main form of drive. Electrically-driven robots tend to be more accurate than their hydraulic counterparts, unlike hydraulic drives, electric motors require reduction gearboxes, and these increase the cost of the system according to McCloy and Harris [1].

Moving on to the sensing requirements of a robot, we distinguish two categories, internal and external sensing. If an end-effector is demanded to move to a particular point in space, with a particular orientation, the various mechanical elements such as trunks, arm and wrist which will have to be driven to the requisite positions. Measuring devices have to be installed at each degree of freedom so that the robot knows when it has achieved those positions. This internal sensing may be carried out by potentiometers or other position/rotation measuring devices.

External sensing, on the other hand, is the mechanism of interaction with the robot's environment. Robot vision, based on television techniques, will allow a robot to recognize a particular component, determine its position and orientation and command its actuators to drive the end-effector to that position. Robots with sense of touch, possibly derived from strain gauges, will be able to react to forces generated during automatic assembly. The brain or robot controller usually takes the form of a microprocessor or microcontroller. The controller has three main functions [1]: