DEVELOPMENT OF PING PONG BALL COLLECTOR ROBOT

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This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Industrial Electronic) with honours

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
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Dedicated to my beloved mother, father, family, Nurhasikin Mahmood and to all my friends.

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ABSTRACT

Project is required to build and designs an autonomous mobile robot that can detect ping pong ball, collect the ball, and avoid obstacles. Project required use of PIC, infra red sensor, DC Motor and Servo Motor as basic hardware. The source code was written using C language. PIC 16F877A is used as the main controller for the robot. Infra red sensor is used for object detection. DC motor is used as wheel while servo motor is used to generate gripper movement. Program is developed using C language. This kind of project is barely developed by higher institution in Malaysia as the autonomous mobile robot field is not so popular yet in Malaysia compare to other developed country which their people take it as their hobby. Actually, this project gives the opportunity to those who involve in electronic field to apply their knowledge in electronic, for example the reason of using diode in circuit. Besides that, the latest technology of sensors can be learned and applied as sensor is the most important parts in the world of autonomous mobile robot.

ABSTRAK

Objektif projek ini untuk membangunkan robot bergerak automatic-Pemungut Bola Ping Pong yang bukan hanya berupaya mengesan dan memungut bola ping pong, tetapi juga mampu mengelak halangan. Projek ini menggunakan PIC 16F877A sebagai pengawal mikro, Infra Red sebagai pengesan objek dan halangan, motor DC sebagai penggerak roda, dan motor servo untuk menjana pergerakan pengepit. Aturcara dibangunkan dengan menggunakan bahasa C. Projek seumpama ini jarang dibangunkan di institusi pengajian tinggi di Malaysia kerana bidang robot bergerak automatik masih belum mendapat tempat di kalangan rakyat Malaysia berbanding rakyat di negara-negara maju lain di dunia yang menjadikan bidang robotik ini sebagai hobi mereka di waktu lapang. Projek seperti ini sebenarnya memberi ruang kepada semua terutamanya kepada mereka yang terlibat dalam bidang elektrik dan elektronik untuk mengaplikasikan pengetahuan dalam bidang ini, sebagai contoh, apakah kegunaan diod dalam sesuatu litar. Selain itu, teknologi terkini berkaitan dengan *sensor* yang banyak diguna pakai dalam pembangunan robot-robot seperti ini dapat diaplikasikan seterusnya pengetahuan ini dapat dibawa apabila ke industri yang diketahui banyak mengaplikasikan penggunaan *sensor* .

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CHAPTER 1

INTRODUCTION

1.1 Introduction of robots

A robot is not just one thing, and study of robotics does not cover just one area of knowledge. A robot brings together systems from many different fields, and learns robotics is to learn many different technologies. Reactive robots are electronically created moving objects which respond to their environment. What classes as a robot is very hard to define. The term is generally considered as an artificial item that responds in some physical way to the environment around it.

This chapter first looks at the origin of robotics, moving through to the more specific aspects which affect the project. These include looking at existing literature on robots that collect items as well as looking into possible methods which could be used for a robot to collect ping-pong balls. As a basis for such operations, robots require means for identifying and operating on specific objects. Importantly, the robot must have knowledge of its approximate position with respect to the objects.

1.2 Existing Robot Collection

1.2.1 **A line follower robot** - Jaseung Ku (17 Dec 2005)

This is one of the example of existing collection robot is designed from Jaseung Ku. This simple a line-follower robot as Figure 1.0 is designed to be able to follow a black line on the ground without getting off the line too much. The robot has two sensors installed underneath the front part of the body, and two DC motors drive wheels moving forward.

Figure 1.0: A Line-follower Robot

A circuit inside takes the input signal from two sensors and controls the speed of wheels' rotation. The sensors used for the project are Reflective Object Sensors, 0PB710F. A light emitted from the diode is reflected off an object and back into the phototransistor, output current is produced, depending on the amount of infrared light, which triggers the base current of the phototransistor. This case, the amount of light reflected off a black line is much less than that of a white background, so detecting the black line somehow by measuring the current. (This current is converted to voltage.

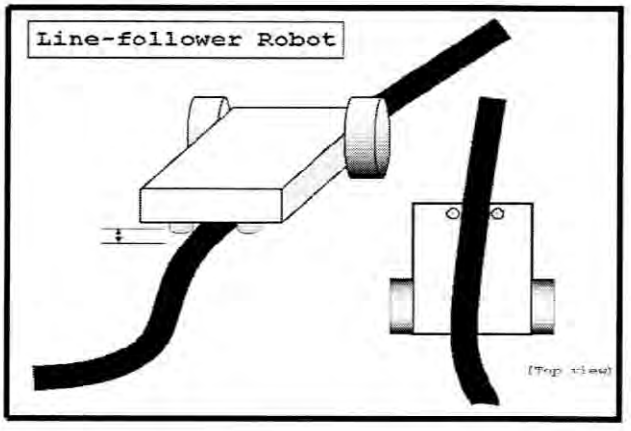

Figure 1.1: A Line-follower Robot

The control is done in such a way that when a sensor senses a black line, the motor slows down or even stops. Then the difference of rotation speed makes it possible to make turns. For instance, in the figure 1.1 on the right, if the sensor somehow senses a black line, the wheel on that side slows down and the robot will make a right turn.

1.3 Robot Details

The reactive robot that we are designed is the ping pong ball collector. This project is proposed for upgrading the Line Follower Robot. This project investigates an existing robot with the aim of designing and creating a robot that will be able to collect the ping pong balls. The designing of this robot is aim the robot to be able to perform the object detecting, obstacle avoidance, object location, object collection and returning to the base.

The designing of this robot is one of the very difficult things that we must know much more knowledge and study about each part of the robot, and also do the more research from the literatures review and internet sources for implement this ping pong ball collector robot. Refer to the figure 1.2 below, shown the basic

block diagram that are used to design the robot. The main part of this block diagram is consists the input, controller and output.

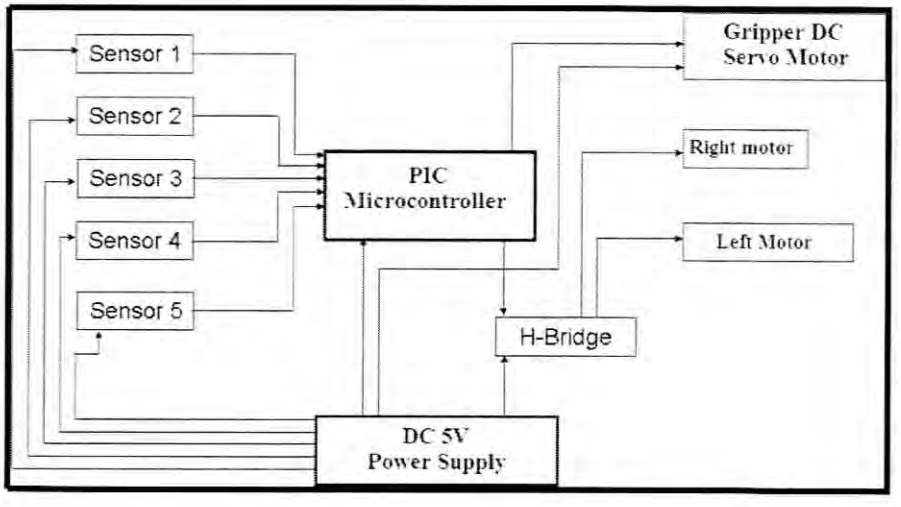

Figure 1.2: Block diagram of Ping -Pong Ball Collector Robot

The most important thing, this robot needed is sensor, which this sensor act as the input; PIC controller as the main controller and motor as the output. To collect the ping pong ball we were decided to use the gripper, which this gripper is placed in front of the robot as it will make the collection easier. The main controller of this robot is the PIC 16F877A microcontroller, which can be programmed over a serial link. In this project, the PIC controller is used to control the entire robot's system, which it's control the motion of robot, obstacle avoidance, ball collection and others.

The sensor of this robot is used to detect the ping pong ball, which is when the sensor detect the ping pong ball, it will send the signal to the PIC controller to running the process depends to the programmed in PIC and next, the PIC controller will send the signal to the output to move the motor; the wheel motor or gripper. In this project, the sensor is used to identify the objects; either the objects is the ping pong ball or not, and also to ensure the objects is the obstacle (except the ping pong ball).

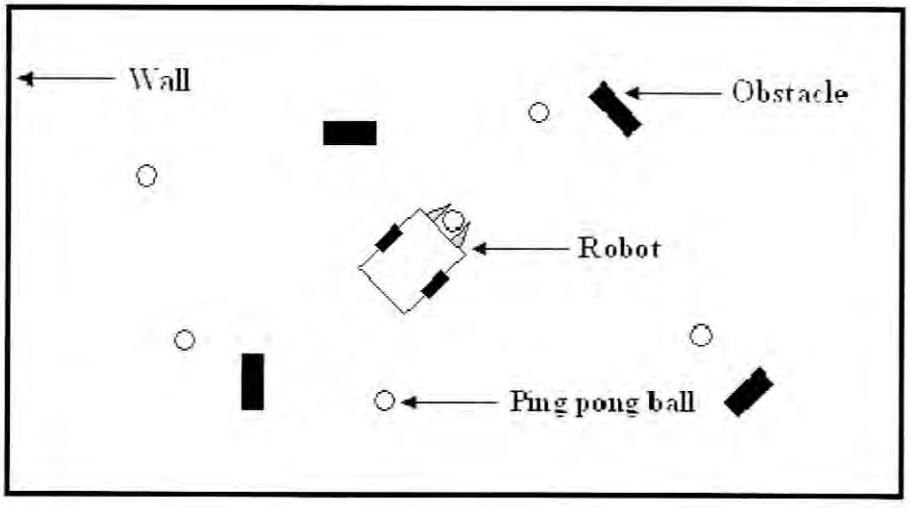

Figure 1.3: The prototype of ping-pong ball collector robot

The figure 1.3 is shown the drawing of the idea on how the robot is operation or moving. From this figure, the idea is; the robot will be placed in the limitation area, that is limit with the wall. The operation is; the robot will moving in the limitation area until the sensor detects the ping pong ball, then the PIC controller will control this robot and send the signal to motor to move to the ball, and ask the gripper to collect the ping pong ball. The collected ball is keep inside the designated pen which is on the robot's body.

1.3.1 Object detecting and object avoidance

This project considers which of the possible sensor to use to detect ping-pong balls and avoid the obstacle. The sensor that we used should be able to detect the ping pong balls and as the object avoidance. To implement this project, we are planning to use the Sharp GP2Y0A02YK infra-red distance sensor. Choosing the Sharp GP2Y0A02YK infra-red distance sensors are far more successful at detecting the balls. Therefore, the infra-red sensors will be used to perform the initial detection of the balls. To avoid the wall, two limit switches is planning to use and will be placed at the right and left bumper in front the robot.

1.3.2 Object Collection

In this project, the gripper is used to collect the ping pong ball. When the sensor is detecting the ping pong ball, the PIC controller will send the signal to move the motor, go near the ball, and move the gripper thus collect the ping pong ball. The gripper is placed in front of the robot, to make the collection easy.

1.4 Problem Statements

Nowadays, the technology in electronic field is expanding with the existing the variety of robots, which this robot helps to make the work easy for human in the world. So, more types of robot can be placed in UTeM's laboratory as teaching aided, like the Line Follower Robot. Line Follower Robot moves by following the line or track that has been setting.

From our observation and research that we have done on this robot, the main weakness that we found is the robot is unable to detect objects and avoid the obstacle. Then, to upgrade the robot, we design the robot that would be able to detect the object, to collect the object and to avoid the obstacle. The ping pong ball is used as the object set.

1.5 Project Objectives

Based on the problem statements, the project objectives of this project is to design and build a robot that be able to identify the object either the object is ping pong ball or not. This robot also should be able to avoid the obstacle and be able to collect the ping pong ball. The statement below summarized the objectives of this project;

- To design and build a robot that will be able to recognize objects;
- To design and build a robot that will be able to differentiate between ping pong ball and other objects;

- To design and build a robot that will be able to avoid obstacles;
- To design and build a robot that will be able to collect ping pong ball autonomously.

1.6 Scope of Work

To develop this project, the scope of work that we are studied includes the study and understanding of the Programmable Integrated Circuit (PIC) and its applications. We also study how to write the assembly language by using the MPLAB software. The other scope that is important is to study and do the research about the electronic circuit theory, sensor, servo motor, how to create the prototype of the robot, the idea of planning the motion of robot and design the mechanism to collect the ping pong ball. We also study the sensors which to make the sensor to be able to differ the ping pong ball and other objects.

CHAPTER 2

LITERATURE REVIEW

2.1 Actuators

2.1.1 Servo Motor

Servos are DC motors with built in gearing and feedback control loop circuitry. No motor drivers required. Servos are extremely popular with robot, RC plane, and RC boat builders. Most servo motors can rotate about 90 to 180 degrees. Some rotate through a full 360 degrees or more. However, servos are **unable to continually rotate**, meaning they can't be used for driving wheels (unless modified), but their **precision positioning** makes them ideal for robot legs and arms, rack and pinion steering, and sensor scanners to name a few. Since servos are fully self contained, the velocity and angle control loops are very easy to implement, while prices remain very affordable. Servos can operate under a range of voltages. Typical operation is from **4.8V to 6V**.

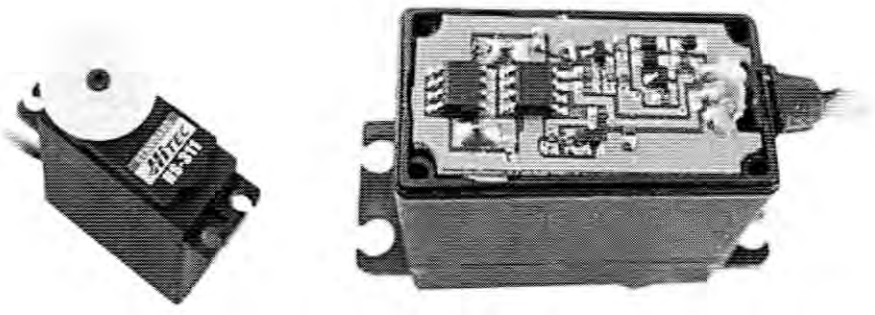

Figure 2.1: Servo motor

Due to noise and control circuitry requirements, servos are less efficient than DC motors uncontrolled. To begin with, the control circuitry typically drains 5-8mA just on idle. Secondly, noise can more than triple current draw during a holding position (not moving), and almost double current during rotation.

Noise is often a major source of servo inefficiency and therefore should be avoided. The servo motor is actually vibrated if one noticed it. This is because servo is rapidly jumping between two different angles due to interference. What causes this interference? Well the signal wire is no different than a long antenna, capable of accepting unwanted foreign signals and sending them straight to servo as a command. A common interference source is usually from other nearby servos and/or servo wiring. How to prevent this problem? Keep the signal wire short; meanings do not add say 3+ feet of extension cables to servo. If many servo wires going through one area and it aren't feasible to keep them apart, then twist them together. Supposedly this reduces cross interference [3].

2.2 Sensors

The use of sensor in the robot will be described in this chapter. Sensors are devices that can sense and measure physical properties of the environment, such as temperature, luminance, resistance to touch, weight, size, etc. They deliver low level information about the environment the robot is working in. This information is noisy

(i.e. imprecise), often contradictory and ambiguous [1]. Sensors do not produce symbols that can immediately be used by a reasoning system. If a symbolic approach is to be adopted, sensor signals need to be translated into symbols first, and it is perhaps for this reason, more than for any other, that the sub symbolic approach to robot control looks so promising. This chapter will describe the suitable sensor that can be used in this robot to date, giving examples of the kind of reading that can be obtained from them, and their most common applications. At the end of this chapter, the conclusion of which sensor that is used in this project will be stated.

2.2.1 Sensor Characteristics

All sensors are designed to sense or to measure a particular physical property, which "usually" has a meaningful relationship with a property of the environment that one "really" wants to know?

Example: a sonar range finder measures the time it takes for a sonar pulse to be heard again by a receiver placed next to the transmitter. The assumption is that the pulse was reflected by an object in front of the sensor. Using the time for the pulse to travel to the object and back, given the speed of sound, one can compute the distance to the object. So a sonar range finder does not measure range, it measures time of flight. This time of flight is in some way related to range, but the two are not identical [1].

All sensors are characterised by a number of properties that describe their capabilities [2]. The most important are:

- Sensitivity: ratio of change of output to change of input.
- Linearity: measure for the constancy of ratio of input to output.
- Measurement range: difference between minimum and maximum values measurable.
- Response time: time required for a change in input to be observable in the output.

- Accuracy: the difference between actual and measured values.
- Repeatability: the difference between successive measurements of the same entity.
- Resolution: smallest observable increment in input.
- Type of output.

2.2.2 Type of sensor

2.2.2.1 Tactile Sensors

Tactile sensors detect physical contact with an object. More precisely, they measure a physical property (like the closing of a switch), that is usually caused by physical contact with an object (but could equally well be caused by a faulty sensor, vibration, or other causes).

The simplest tactile sensors are microswitches, or whisker sensors. When a bumper is in contact with an object, a microswitch is closed and gives an electrical signal that can be sensed by the controller. Likewise, when a metal whisker is bent (see figure 3.1), it makes contact with a metal ring, closing the circuit and generating a detectable signal.

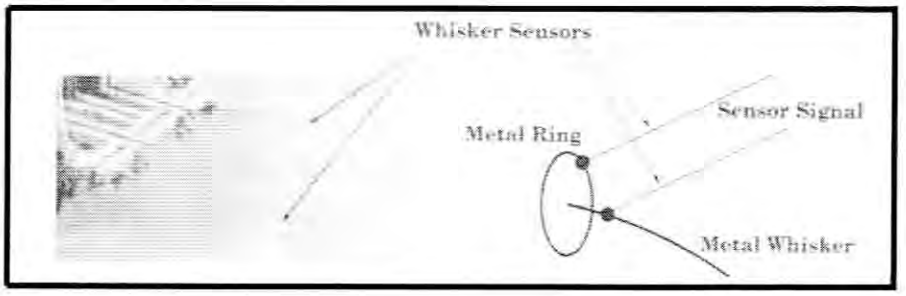

Figure 2.2: Physical implementation of whisker sensor