DEVELOPMENT OF PING PONG BALL COLLECTOR ROBOT–CMUcam2

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

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
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Dedicated to my beloved mother, father, family, Shahril Izwan Ahmad Shah and to all my friends.

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ABSTRACT

The aim of this project is to develop a ping pong ball collector robot that will be able to perform object detection, obstacle avoidance, object location and object collection. One of the parts to implement this project is concentrate more on CMUcam2. Object avoidance begins with the use of sensors to locate all of the objects around the robot. This can be done using vision non-contact sensor, which is CMUcam2 by means. PIC is used as the main controller for the robot. Program is developed using C language. Project then are produce to modify and upgrading an existing robot enabling it to collect ping pong balls. The implementation of this project is then discussed the ability of the robot produced to fulfill the specification made is tested. Further the evaluation of robot's ability to find and detect ping pong ball is performed.

ABSTRAK

Tujuan projek ini adalah untuk membangunkan robot pemungut bola ping pong yang berupaya untuk mengenalpasti objek, mengelak halangan, menentukan kedudukan objek dan pemungutan objek. Salah satu bahagian dalam melaksanakan projek ini adalah lebih tertumpu keatas CMUcam2. Pengelakan objek bermula dengan penggunaan sensor yang memberitahu kedudukan kesemua objek yang berada disekitar kawasan objek berada. Ini boleh dilakukan dengan menggunakan pengesan penglihatan tidak bersentuhan, dimana yang dimaksudkan adalah CMUcam2. PIC juga digunakan sebagai pengawal utama untuk mengawal robot ini. Aturcara dibangunkan dengan menggunakan bahasa C. Kemudian, projek yang dihasilkan adalah dengan mengubahsuai dan menaiktaraf robot yang sedia ada supaya berkeupayaan memungut bola ping pong. Perlaksanaan projek ini kemudian membincangkan tentang keupayaan robot yang telah dihasilkan agar memenuhi specifikasi yang telah dicadangkan setelah dibuat pengujian. Seterusnya, penilaian terhadap keupayaan robot ditemui dan pengesan bola ping pong dapat ditunjukkan.

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GUI	- Graphical User Interface
CMOS	- Complementary metal–oxide–semiconductor
PIC	- Programmable Integrated Circuit
IR	- Infrared

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 robots 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 1.1 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 1.1: 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.)

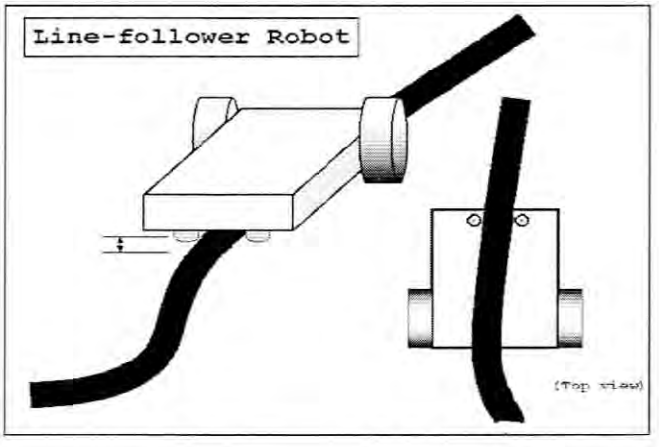

Figure 1.2: A Line-follower Robot

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 1.2 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 1.3 below, shown the basic block diagram that we are used to design the robot. The main part of this block diagram is consists the input, controller and output.

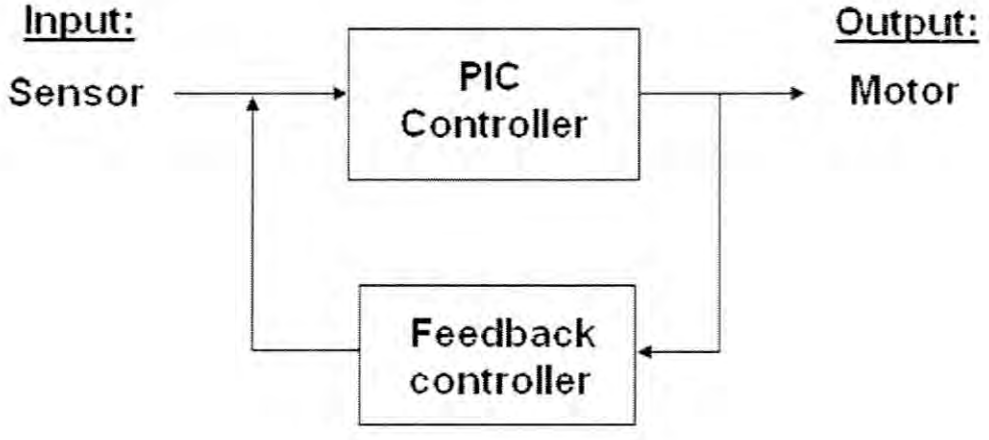

Figure 1.3: Block diagram of Ping -Pong Ball Collector Robot

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).

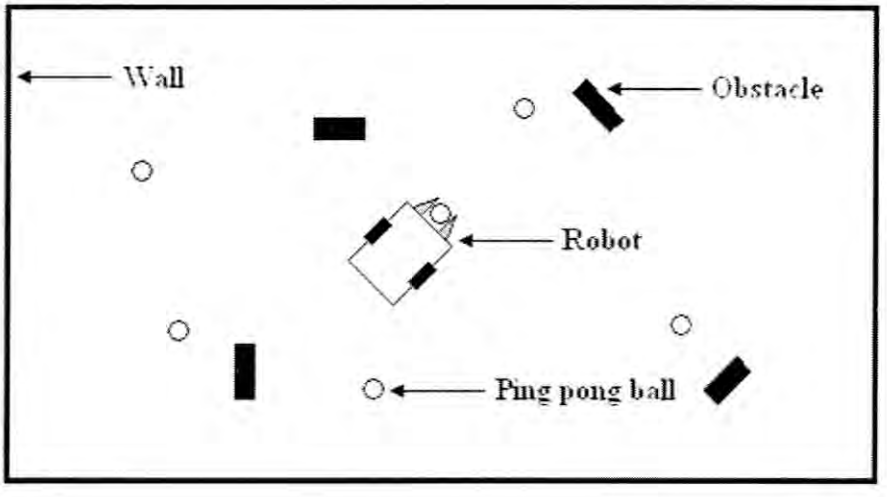

Figure 1.4: The prototype of ping-pong ball collector robot

The figure 1.4 is shown the drawing of the idea on how the robot is operation or moving. From this figure, the idea is; the robot will placed in the limitation area, that is limit with the wall, and pen is inside of the robot's body to put the collecting ball there. 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. Lastly, the robot will store the ball inside its body. Then the robot would continue searching the arena for more balls.

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.

1.3.3 Store the object

Then, the final station is store the ping pong ball. After the robot is collects the ping pong ball, the gripper of robot will grip the ball and put the ping pong ball inside robot's body.

1.4 Problems 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. By that, more types of robot are 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 I studied includes the study and understanding of the CMUcam2 Vision Sensor. The main function of CMUcam2 for this project is using to detecting the object, that is ping pong ball and also to detect the obstacle. This CMUcam2 is able to determine the color of the object and size that is needed .This CMucam2 also able to differentiate between ping pong ball and obstacle. This scope is important to study and do the research about the applications and implement of CMUcam2 as a target to detect the ping pong ball.

CHAPTER 2

LITERATURE REVIEW

2.1 CMUcam Vision Sensors

This CMUcam vision sensor is has 2 types, which are CMUcam1 and CMUcam2. To implementation this project CMUcam2 Vision Sensor is choosing because the differences of this 2 Vision Sensor. From the observation and research, the CMUcam2 is more functionality differs with CMUcam1. One of the primary uses of the CMUcam2 is to track or monitor color.

Why choose CMUcam2? The CMUcam2 includes all of the functionality of the original CMUcam (the CMUcam1) in an enhanced form and a lot of new functionality. There are two main hardware differences which are important, the CMUcam2 uses a different processor than the CMUcam1 and the CMUcam2 incorporates a frame buffer chip which the CMUcam1 does not. This allows the CMUcam2 hardware to quickly capture a single complete frame and store it the frame buffer memory. The CMUcam2 uses the SX52 processor and the CMUcam1 uses the SX28 processor, both from in the SX processor series. In both cases the processor runs at 75 Mhz so there is no difference in processor speed or computational power. The advantages of the new processor are that it has more RAM (262 vs. 136 bytes), more ROM (4096 vs. 2048 words), and more I/O pins.

More RAM and ROM meant we could write more code and more complex code which allowed us to incorporate more functionality in the CMUcam2. The larger number of I/O pins meant that we had more pins left over for other functions - like more servos, more configuration jumpers, etc[2].

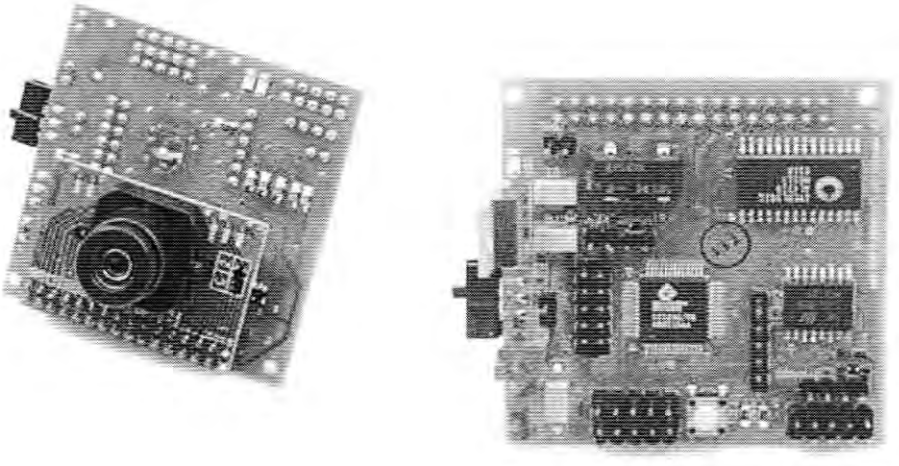

Figure 2.1: CMUcam2 Vision Sensor

The CMUcam2 as in figure 2.1 is consists of a SX52 microcontroller interfaced with an OV7620 Omnivision CMOS camera (figure 2.2) on a chip that allows high level data to be extracted from the camera's streaming video[1]. Its primary function is to track and monitor highly contrasting color regions. It can also detect motion, provide color statistics, and transmit image information to a computer for additional processing.

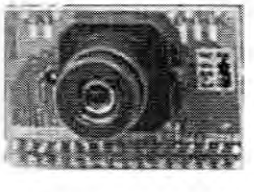

Figure 2.2: OV7620 Omnivision CMOS camera

2.2 SX52 Processor of CMUcam2

The SX52 is member of the SX family of configurable communications controllers fabricated in an advanced CMOS (Complementary metal–oxide–semiconductor) process technology. The advanced process, combined with a RISC (Reduced Instruction Set Computer)-based architecture, allows high-speed computation, flexible I/O control, and efficient data manipulation. SX Processor series runs at 75 Mhz and by optimizing the instruction set to include mostly single-cycle instructions[2]. In addition, the SX architecture is deterministic and totally reprogrammable.

The most common configuration for the CMUcam2 is to have it communicate to a master processor via a standard RS232 serial port. This "master processor" could be a computer, PIC, Basic Stamp, Handy Board, Brainstem or similar microcontroller setup. The CMUcam2 is small enough to add simple vision to embedded systems that cannot afford the size or power of a standard computer based vision system. Its communication protocol is designed to accommodate even the slowest of processors. If the device does not have a fully level shifted serial port, it can also communicate to the CMUcam2 over the TTL serial port. This is the same as a normal serial port except that the data is transmitted using non-inverted 0 to 5 volt logic[1].

The CMUcam2 supports various baud rates to accommodate slower processors. For even slower processors, the camera can operate in "poll mode". In this mode, the host processor can ask the CMUcam2 for just a single packet of data. This gives slower processors the ability to more easily stay synchronized with the data[1].