MINI OBSTACLE AVOIDANCE ROBOT USING PERIPHERAL INTERFACE CONTROLLER (PIC)

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Abstract

This paper focuses on building obstacle avoidance mechanism for mobile robot that will safely and reliably navigate in the close proximity of obstacles and in confined space, while using range sensor for real-time obstacle detection. The robot must provide a collision free movement by detecting the obstacles thus avoiding it. The movement was controlled by the microcontroller, base on information from sensors. A program using Peripheral Interface Controller (PIC) will be developed for the robot. The program will include the modeled obstacles avoidance and collision-free maneuvers when moving. The program will be implemented to the physical robot to demonstrate its efficiency. MPLAB was used to develop the software for the controller and the controller is PIC16F84A.

Keywords: Robots, Mobile Robot, Obstacle Avoidance

1.0 INTRODUCTION

Obstacle avoidance is one of the key issues to successful applications of mobile robot systems such as in personal robot assistants, surveillance robots, remote web cameras and many more. All mobile robots feature some kind of collision avoidance, ranging from primitive algorithms that detect an obstacle and stop the robot short of it in order to avoid a collision, through sophisticated algorithms, that enable the robot to detour obstacles.

In this paper, an obstacle avoidance robot was build using microcontroller PIC16F84A. The controller design, system development, control strategy and experimental results are explained in detail in the rest in this paper.

2.0 SYSTEM ARCHITECTURE

The obstacle avoidance robot consists of four major parts, which are the PIC as the microcontroller, infra-red sensors to sense obstacle, motor driver circuit to drive the motor and motor to moves the robot. Figure 2.1 shows the overall block diagram of the obstacle avoidance robot.

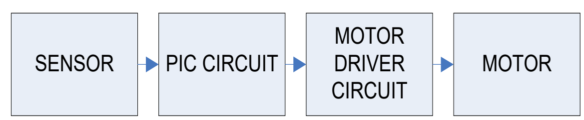

Figure 2.1: Overall Block Diagram of Obstacle Avoidance Robot

Three sensors were used to sense presence of obstacle on the front, right and left. Proximity data from the sensors, which are in digital form, was sent to PIC (Peripheral Interface Controller). The PIC then will produce an output for motor driver circuit based on input from sensors. It then will drive the motor to avoid the obstacle.

The microcontroller used was PIC16F84A. It supports 1Kx14 words of program memory, 68x8 bytes of data memory and 64x8 bytes of data EEPROM. Furthermore, the interrupt capability, 13 I/O pins and timer modules, make it an excellent fit for the application.

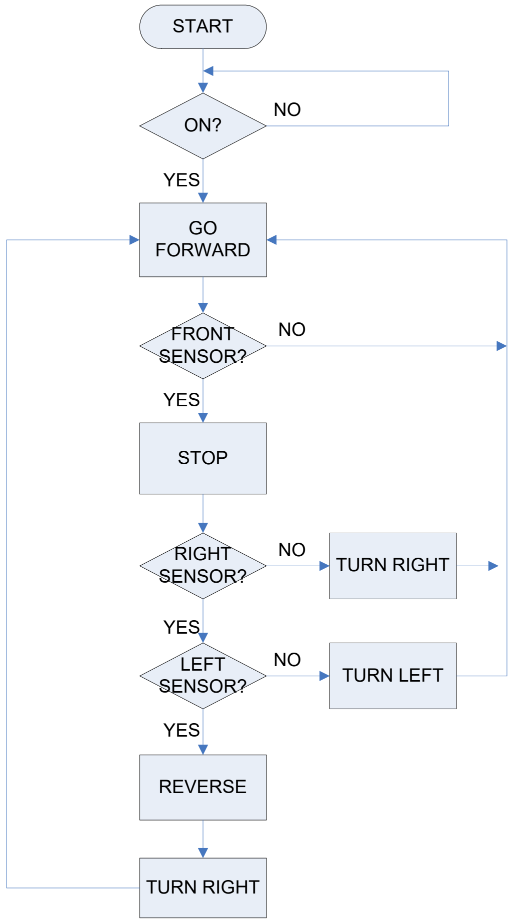

Figure 2.2: Overall System Flow Chart

3.0 HARDWARE AND SOFTWARE DEVELOPMENT

The development of obstacle avoidance robot consists of hardware and software design. This design will be highlight in this section.

3.1 HARDWARE DEVELOPMENT

The hardware consists of sensor, motor driver circuit, PIC circuit and dc motors.

3.1.1 SENSOR

There are total three sensors used in the development of the hardware. The sensor used was GP2D150A infra-red sensor by Sharp. This is a distance measuring sensor with digital output. The detection range is from 4 cm and up to 15 cm which make it suitable to be used with this robot.

Figure 3.1: Sharp GP2D150A Sensor

3.1.2 MOTOR DRIVER CIRCUIT

The motor driver circuit is based on H-Bridge connection. Figure 3.2 shows that the motor in forward direction when the upper left (A) and lower right (D) circuit is turn on while figure 3.4 shows that the motor in reverse direction when upper right (B) and lower left (C) circuit is on.

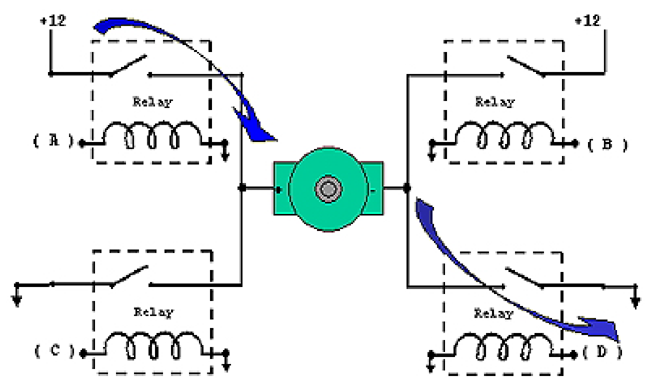

Figure 3.2: Motor in forward direction

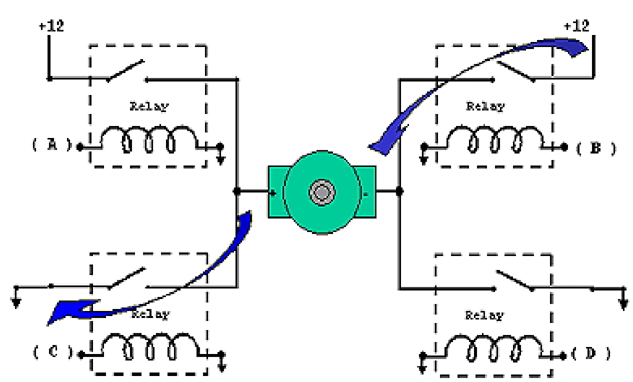

Figure 3.4: Motor in reverse direction

3.1.3 MOTORS

Tamiya's high power gearbox was used to move the robot. It comes with two gear ratios which are 41.7:1 and 64.8:1 with 250 rpm and 160 rpm respectively. This gearbox was chose because it has balance of speed and torque. It is also simple and easy to use. The output shaft can be connected directly to the tire.

Figure 3.5: Tamiya High Power Gearbox

3.2 SOFTWARE DEVELOPMENT

The program for the controller was written using MPLAB assembly language. The program flow chart was shown as in Figure 3.6.

The program was used to control the obstacle avoiding robot and was burned into the PIC. As a microcontroller, it then will be used in decision making process based on input from sensors.

The robot will move forward once the switch was turned on. Once the front sensor sense the presence of obstacle, PIC will stop both right and left motor. If right is clear to go, PIC will turn on left motor only for 5 seconds to make the robot turn right. If not, it will turn on right motor only for 5 seconds to make it turn left if the left is clear to go. If all directions (front, right and left) were blocked by obstacle, PIC will reverse both right and left motor for 5 seconds and then make it turn right.

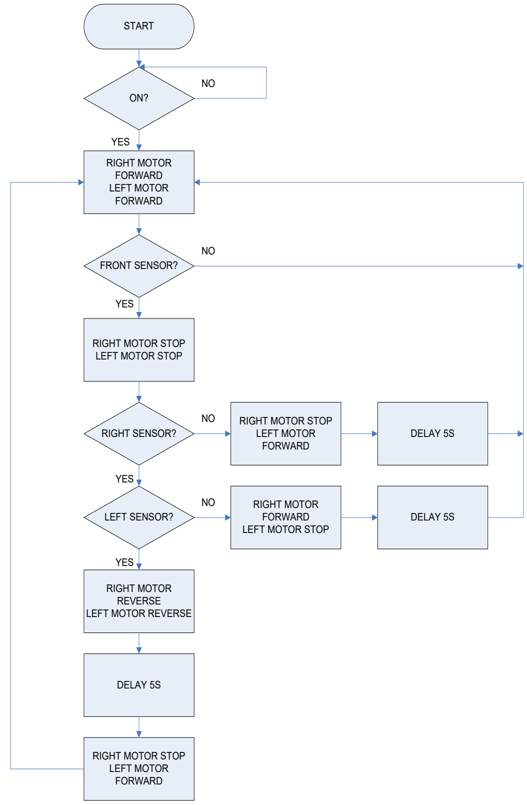

Figure 3.6: Program Flow Chart

4.0 I/O ASSIGNMENTS

Standard PIC16F84A have 18 pins with two different I/O ports: port A and port B. All I/O assignments were shown in table 4.1.

Table 4.1: I/O Assignments

I/O Assignments	
Port / (Pin Number)	Comments
A2 / (1)	Input from left sensor
A3 / (2)	Unused
A4 / (3)	Unused
MCLR / (4)	Master clear
V_{SS} / (5)	Ground
B0 / (6)	Unused
B1 / (7)	Right motor forward
B2 / (8)	Right motor reverse
B3 / (9)	Left motor forward
B4 / (10)	Left motor reverse
B5 / (11)	Unused
B6 / (12)	Unused
B7 / (13)	Unused
V_{DD} / (14)	+5V Supply
OSC2 / (15)	4 MHz resonator
OSC1 / (16)	4 MHz resonator
A0 / (17)	Input from front sensor
A1 / (18)	Input from right sensor

5.0 RESULTS AND DISCUSSION

A complete obstacle avoidance prototype robot has been developed and tested in the laboratory. The input and output signals are tested using oscilloscope.

5.1 Proximity Sensor (Distance Measuring)

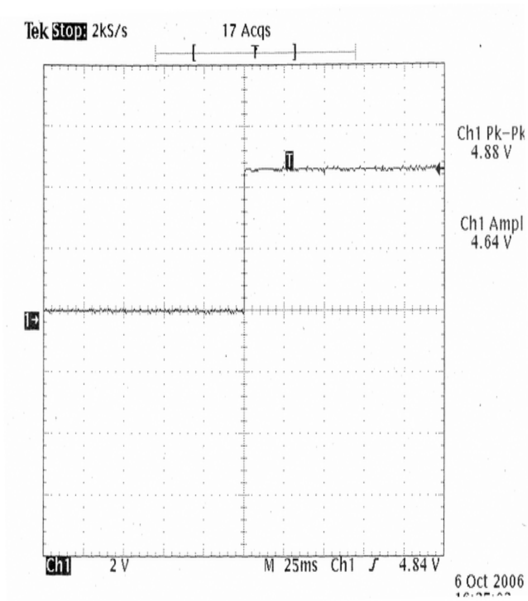

Figure 5.1: Proximity sensor output

Figure 5.1 shows the output of the proximity sensor. If the sensor senses the presence of obstacle, it will produce 4.64 V signal. This signal will be received by the PIC as HIGH state. Measuring range is from 4 to 15 cm and since this is a digital sensor, it will produce fixed output signal once obstacle is sense within the sensing range regardless the actual position of the obstacle. All three sensors will produced almost the same output signal.

5.2 Motor Driver Output

Figure 5.2 shows the output from motor driver circuit which will drive the motor. The output produced was 5.16 V. The output voltage is quite higher than motor recommended operating voltage which is between 3 and 4.5 V, because the transistors used (TIP 120 and TIP 125) need 5 V for switching.

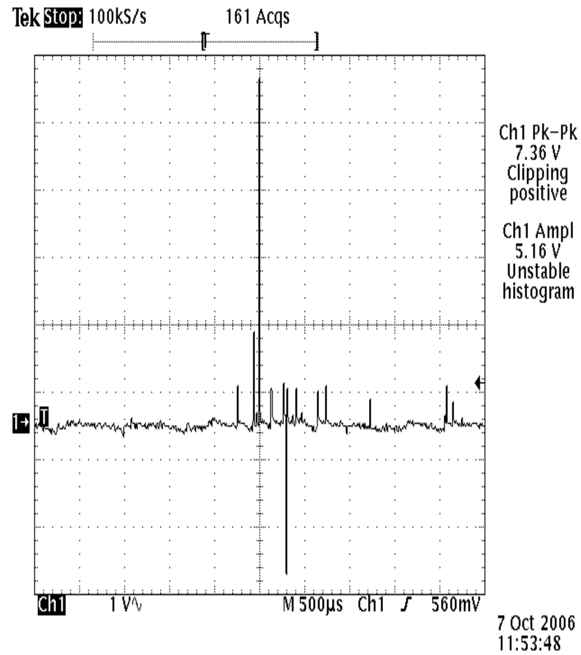

Figure 5.2: Motor driver output

6.0 CONCLUSION

In this paper, an obstacle avoidance robot has been developed and tested. From the results, it is proved that the robot can safely and reliably navigate in the close proximity of obstacles and in confined space with the use of range sensor for real-time obstacle detection. All three sensors (front, right and left) provide 180° sensing range, so that it can detect the presence of obstacle whether it is on the front, right or left, thus avoiding it.

7.0 FUTURE DEVELOPMENT

In the future, this project can be improved to make it more valuable, reliable and suitable for all kind of applications. Artificial intelligent (AI) control such as fuzzy logic and artificial neural network (ANN) can be used to replace PIC to provide intelligent decision making.

Instead of using infra-red sensors, it can be replaced with advance and complicated detection system such as image detection system together with image processing software to provide more precise input for decision making process.

8.0 ACKNOWLEDGEMENTS

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