Building Algorithm for Obstacle Detection and Avoidance System for Wheeled Mobile Robot

Dr. Chigulla Leela Kumari[1]

[1] Raipur Institute of Technology, Raipur.

Received: 14 February 2012 Accepted: 29 February 2012 Published: 15 March 2012

Abstract

Nowadays, Wheeled Mobile Robots (WMRs) are built and the control system that used to control them are made by Electronic Engineers. Depend on their desire design of WMR, Technicians made used of Microcontrollers as controlling machines and DC Motors for motion control. Autonomous robotic vehicle guidance for indoor navigation has been developed for Mobile Industrial Robot model. The resulting design will navigate the environs in a building without the need of human intervention. The guidance system consists of infrared sensors for obstacle detection, range determination and avoidance. It can detect the obstacles within the range 10 to 30 cm. This paper represents mainly on software implementation of obstacle detection and avoidance system for Wheeled Mobile Robot. This system consists of infrared sensors and microcontroller. In this system three infrared sensors are used for left, front and right. In this robot system, the input signal is received from sensor circuit and Atmega 32 microcontroller is operated according to the received sensor?s signal. The infrared sensor reading is taken and processed to avoid the obstacles. The 12V power supply is used to operate Atmega 32 board and sensor circuit board. The obstacle avoidance algorithm is simply evaluated on Atmega microcontroller based mobile robot. IR Sensors based Wheeled Mobile Robot, mainly function as an Obstacle Avoidance Vehicle. The desired goal of this system is to avoid obstacles along its path and to determine the distance.

Index terms— robotic, environs, machines, controlling

1 Introduction

OBOTS are now widely used in many industries due to the high level of performance and reliability. All mobile robots feature some kind of obstacle avoidance. Designing autonomous robot requires the integration of many sensors and actuators according to their task. Obstacle detection is primary requirement for any autonomous robot. The robot acquires information from its surrounding through sensors mounted on the robot. Various types of sensors can be used for obstacle avoiding. Methods of obstacle avoiding are distinct according to the use of sensor. Some robots use single sensing device to detect the object. But some other robots use multiple sensing devices. The common used sensing devices for obstacle avoiding are bump sensor, infrared sensor, ultrasonic sensor, laser range finder; charge-coupled device (CCD) camera web cam and so on can be used as the detection device. Among them infrared sensor is Author : M.E, Power Electronics, Raipur Institute of Technology, Raipur. E-mail : leelakumari01@yahoo.in most suitable for this obstacle avoiding robot because of its low cost and ranging capability. The IR object detection system consists of LM358N operational amplifier with a pair of infrared led and photodiode. This system is a compact, self-containedIR ranging system incorporating an IR transmitter, receiver, detection, and amplification circuitry. The unit is highly resistant to ambient light and nearly impervious to variations in the surface reflectivity of the detected object. The paper is mentioned on the basic research of "Development of an Intelligent Wheeled Mobile Robot (WMR)". This is a type of IR Sensors based Wheeled Mobile Robot and it mainly function as an Obstacle Avoidance Vehicle. It is mainly focus to software implementation of this WMR.

2 II.

3 System Overview

This mobile robot is designed to explore in the environment by detecting obstacles and avoiding collision base on the distance measurement information obtained from the infrared sensors. This robot system is obstacle avoiding robot using infrared sensors. Infrared sensor senses the obstacle along its path. In this system three infrared sensors are used for left, right and front. The Infrared sensors, used for obstacle avoidance, are connected to the processor via analog ports. The input signal is received from sensor circuit and ATMEGA32 is operated according to the received sensor's signal.

The reason to choose IR sensors as Obstacle detected device is that to determine the range of object and by this data, to control the Obstacles avoiding process. Analog to Digital Converting (ADC) process is done in ATMEGA32 by software and these data used to control the require outputs that will effect to the second Module, Navigated Control System. The basic circuit that makes these processes is shown in Figure 2. Using the input signals from sensor circuit, the navigation system determines a direction to avoid the obstacle. After turning a suitable angle, the navigation system negotiates the robot to the desired direction and check whether there is an obstacle along its way. According to the sensing information, microcontroller controls the driver unit. And then, the driver unit drives the robot's wheels individually.

4 III.

5 Infra Red Sensor

In this paper, three infrared sensors are utilized for distance measurements. The infrared sensor consists of a LED emitting the infrared light and a photo diode. This sensor enables to detect objects without any influence on the color of reflective objects, reflectivity, the lights of surroundings. Maximum range that can be detected is from 10 to 30 cm. It generates an analog voltage that is a function of range. The output voltage can be measured by an analog-to-digital ADC input line. It has three wires, positive (+5V), negative (ground), and data output.
Sensor Accuracy

Distance sensors are typically not read at a rate of more than a few samples per second, so the performance characteristics of most ADCs will be sufficient. Assuming that the noise on the Vout input signal has been kept to a minimum, the main concern is to ensure that the number of bits used for the ADC output is sufficient for the desired resolution. The change in voltage from 70 cm to 80 cm is only about 0.06 V, which corresponds to 0.006 V/cm. If the 8-bit ADC with a reference voltage of 5V is used, each bit of the ADC output represents 0.0195 V which means a one bit swing in the ADC output will result in a distance swing of about 3 cm. The maximum voltage output from a IR sensor is about 3V. If the reference voltage for the 8-bit ADC is changed to 3V, each bit of the ADC output represents 0.0117 V, which means a one bit swing in the ADC output will still result in a distance swing of about 2 cm. The resolution is better at shorter distances because there is a larger voltage change.

V.

6 Circuit Operation Of Obstacle Detection And Avoiding System

This IR range sensor produces voltage signal when the photo diode conducts due to reflection of IR rays. The emitter emits a pulse of IR light. This light travels out in the field of view and either hits an object or just keeps on going. In the case of no object, the light is never reflected and the reading shows no object. If the light reflects off an object, it turns to the detector and creates a triangle between the point of reflection, the emitter, and the detector. The angles in this triangle vary based on the distance to the object. The triangle described above. It is an analog infrared proximity sensor. It can be used to detect obstacles. This sensor has a LED that emits infrared light. Infrared light has the interesting property that it bounces on obstacles. On the front of the sensor, beside the LED that emits the infrareds, there is a photodiode that is sensible to infrared light. It will vary the output voltage based on the amount of infrared light that bounces back to the sensor. The more infrared light it sees, the closer is the object and the higher the output voltage generated by the photodiode. This sensor will provide an analog output voltage that is promotional to the distance of the object it senses. It's analog output will then be fed into the analog-to-digital converter of the microcontroller, via its pin.

If the voltage output is connected to a microcontroller with analog to digital conversion capability (such as a ATMEGA32 microcontroller), it is possible to translate this voltage to a numerical value. This value can be used to determine whether or not there are obstacles close to the sensor and how far these obstacles are. Figure 4 shows how to interface a microcontroller to a sensor.

7 Sensing Statements

The sensing in mobile industrial robot relies mostly on infra-red light (IR) detectors, either for obstacle and goal area detection, although a few robots used ultrasound distance detectors. Obstacles are detected with proximity sensors. To detect obstacles teams usually use IR sensors, although a few robots used ultrasound sensors operating as sonar's, based on pulse reflection and time of flight.

Obstacle detection is active in the sense that the robot emits IR light, and looks at the reflection received by the detectors. This allows a gross measure of the distance of a given obstacle, as the output voltage increases with the intensity of the modulated IR light (at 40KHz) received by the detector, which is inversely proportional to the distance between the robot and the obstacle. The voltage/distance relationship is approximately quadratic. Obstacle detection typically uses 3 of infrared sensors. To improve detection efficiency, the use of more than one IR LED/sensor is in order to better illuminate the detection area. In some robots the obstacle detection was also improved using more than 3 sensors. It uses the triangulation principle to compute the distance between the sensor and the obstacle being useful in the range 10-30 cm. Reliable obstacle avoidance is an essential feature. The simplest way to avoid obstacles is to use at least two noncontact (IR or ultra-sound) proximity sensors looking left and right. Detecting an object on the left side of the robot makes it turn right and vice-versa. This can be done by simple proportional control, using directly the output of the sensor, or by quantizing the sensor value in a few discrete levels (close, medium-range and far). However, most of the robots used at least 3 obstacle sensors with one facing the robot front. This improves obstacle detection area while maintaining the capability to detect obstacles in front. In this case, use of randomization can also be useful. By not turning always to the same side when facing a frontal obstacle, chances of developing vicious cyclic behaviors are reduced.

8 VII. Software Consideration Of Obstacle Detection And Avoiding System

The consideration data of IR Sensor that mentioned the graph comparing between its voltages depend on the distance of the detected object is shown in Figure **??**. For assembly software program consideration for microcontroller, the following step by step consideration should be made.

? Three inputs from three sensors are to be converted as digital data of microcontroller input.

? These data must be represented as input bits of control system that can determine which sensors are detected and which position of Robot is require rotating.

9 a) Software Consideration of Navigated Control System

The input and output consideration of this Module can be seen clearly as shown in Table **??** The system must be pre-limited for going straight distance, turning left or right and returning back straight to the starting point for no obstacles condition.

ii. Obstacle avoiding state (obstacle is detected at the front)

Table **??** Outputs from Navigation System depend on its Inputs. The system must be stop for a while. It must turn to the left and check if there is any obstacle or not in this turning state. And then it will return to right and go straight at normal line. c) Obstacle is detected at the left Stop for a while whether one or both left sensors are detected. The system must turn to right and check if there is any obstacle or not in this turning state. It must return to left and go straight at normal line. d) Obstacle is detected at the right The system must be stop for a while whether one or both right sensors are detected. It must turn to left and check if there is any obstacle or not in this turning state. And then it will return to right and go straight at normal line.

10 VIII.

11 Experimental Results

For Obstacle detection part, the result of data confirming of IR sensor is shown in

12 Acknowledgment

Firstly the author would like to thank her parents: Chigulla V.K. Rao and Chigulla Padma Vati from Raipur, C.G. for their best wishes. Ms.Dhaneshwari Sahu, her guide will also get the author's great thanks for her special guidance to pay chances. The author greatly expresses her thanks to all persons whom will concern to support in preparing this paper.

12 ACKNOWLEDGMENT

1

Figure 1: Fig. 1 :

2

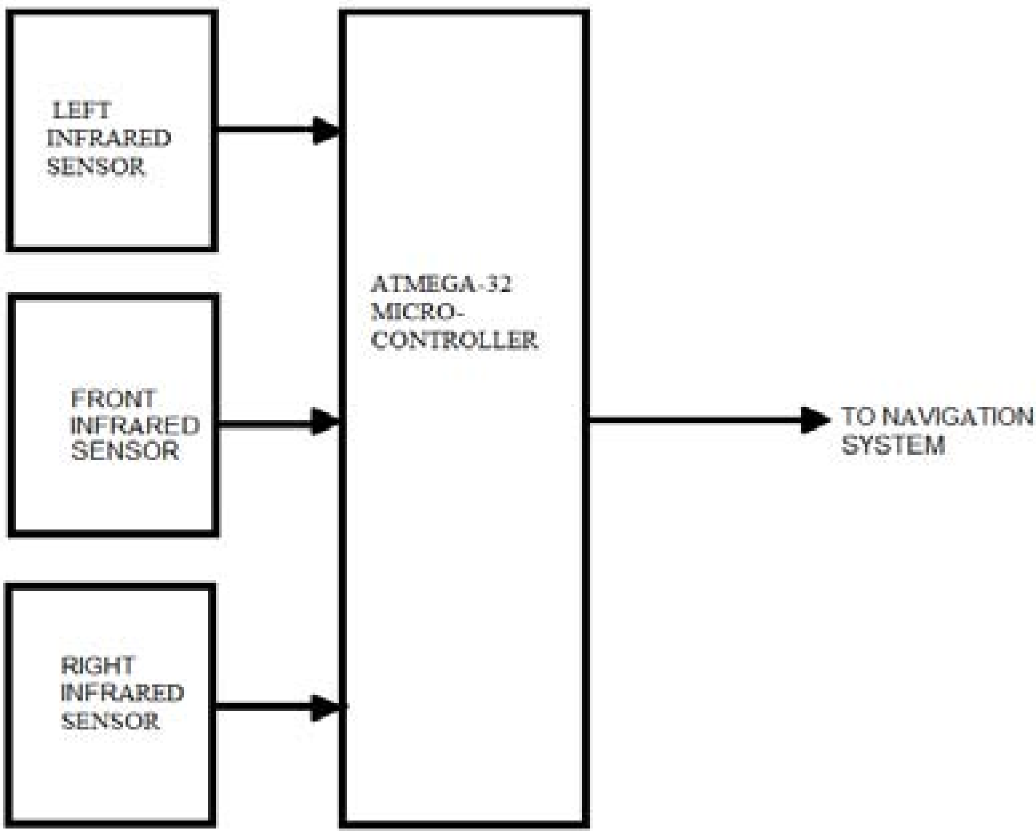
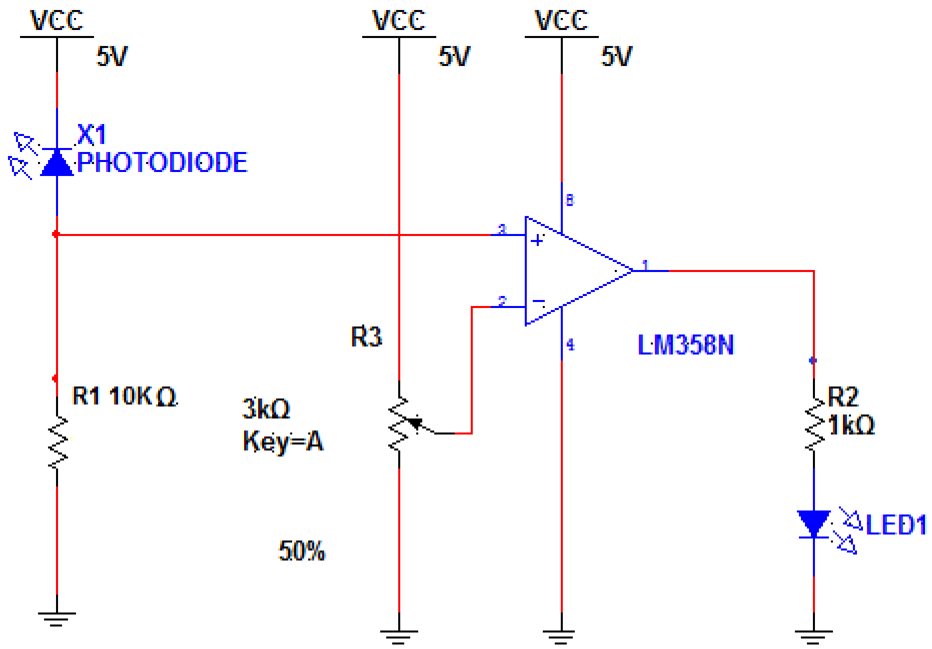


Figure 2: Fig. 2 :



3

Figure 3: Fig. 3 :

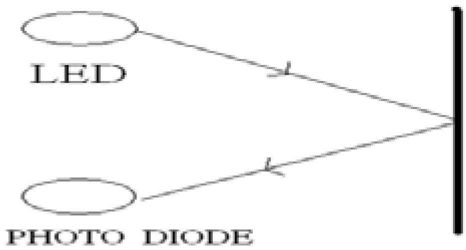
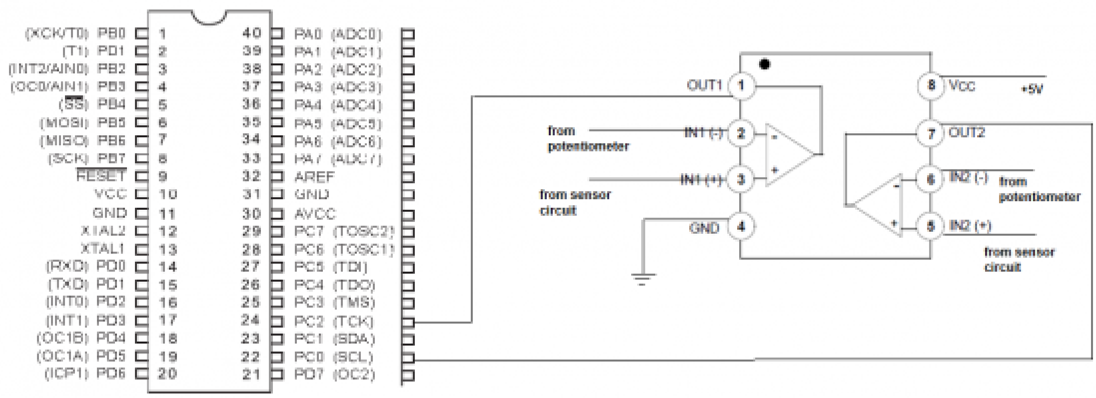


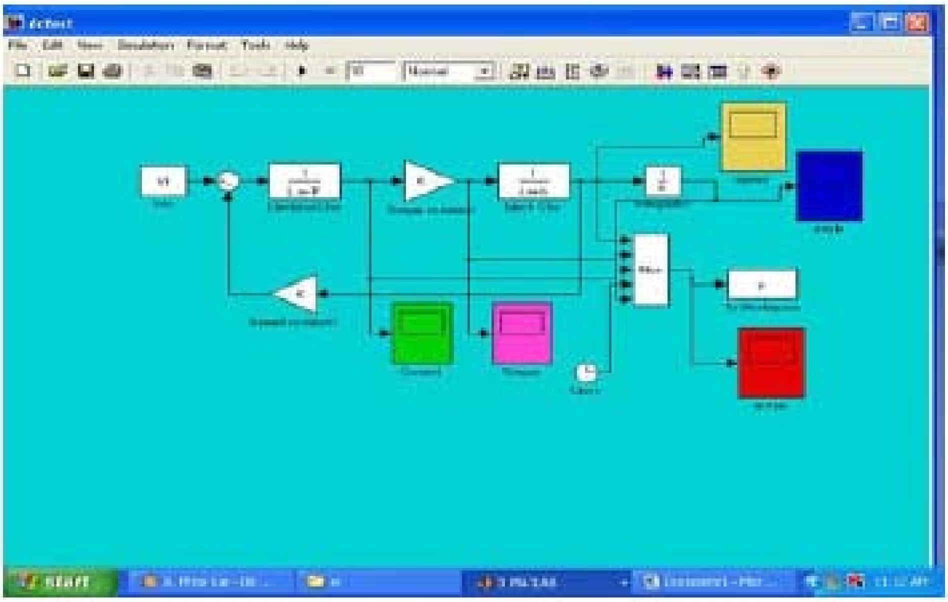
Figure 4: Building



4

Figure 5: Fig. 4 :

12 ACKNOWLEDGMENT



266

Figure 6: Figure 2 . 6 .Fig. 6 :

5

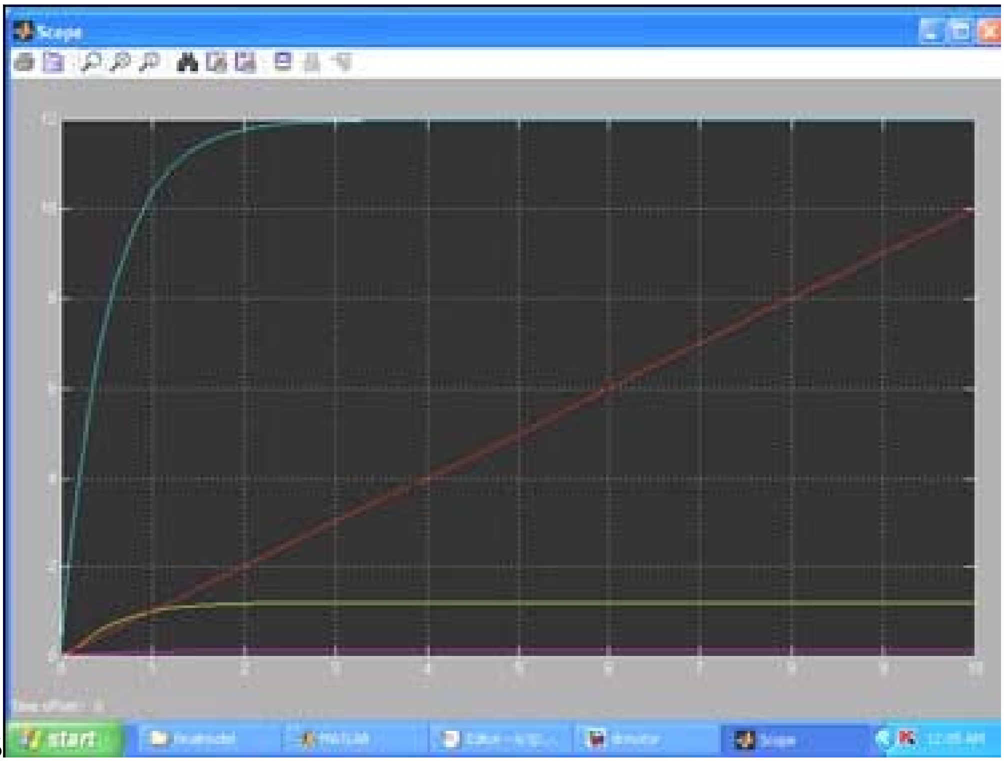


Figure 7: Fig. 5 :

STATE NUMBER	INPUT DATA	DETECTED SENSORS	DECISION TO WMR	OUTPUT DATA
1	000	NONE	straight	1001
2	001	3	Left	0001
3	010	2	Right	1000
4	011	2,3	Left	0001
5	100	1	Right	1000
6	101	1,3	straight	1001
7	110	1,2	Right	1000
8	111	1,2,3	Back	0110

Table 1

b) Consideration of Rules for Obstacle Avoiding and Navigating

i. Path predetermining state

ear 2012
Y
13
Volume XII Issue vv v v XI Version I
D D D D) F
(
Global Journal of Researches in Engineering

Figure 8:

[Ross ()] *Analog and Digital Sensors*, K Ross . 2004.

[Atmel technologies Data Sheets, of Atmega32 (Atmega16)] *Atmel technologies Data Sheets, of Atmega32*, Atmega16.

[Data Sheets for IR sensor] *Data Sheets for IR sensor*,

[James Loughnane ()] *Design and Construction of An Autonomous Mobile Security Device*, Daniel James Loughnane . 2001. University of Waikato (Thesis)

[Sabe ()] *Obstacle Avoidance and Path Planning for Humanoid Robot Using Stereo Vision*, K Sabe . 2003.

[Hoey et al.] *Obstacle Avoidance Mobile Robotic System*, Jesse Hoey , Alex Mihailids , Pantelis Elinas , Daniel Gunn , Jen Boger , James Tung . University of Toronto

[Shanmugasundaram ()] 'Simulation and optimizing the parameters'. *Control System Design for Autonomous Mobile Robot*, S K Shanmugasundaram (ed.) (India) 2000. Chapter ; Mechanical Dept., University of Cincinati (M.Sc thesis)

[Mathworks ()] *What is SIMULINK*, Mathworks . 2001. the MathWorks, Inc.