Design and Development of an Intelligent Obstacle Finder and Remover Vehicle on Predefined Street


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Abstract

The current research was to build an autonomous robot which was an obstacle remover using line tracking. The robot contains three main parts which was electronic circuit, mechanical design and programming. To build a good autonomous robot it was required that the robot would be very easily and freely controllable by the pilot to make sure that it can perform well. Commonly, this robot was used to pick and place items for some function like in factory to send the container from front of line to end of line or some other function that need to send item from one place to another place. Basically the developed robot used several sensors to follow the direction which has been lined with black tape and the robot was using several motor for the movement and obstacles removing. In the system, ATMEGA 32 was used as a controller, motor was used as a mover and remover and sensor was used as the line guider. The robot function was fully controlled by software which is programmable. WIN-AVR 2010 was used for compiler and program loader. Proteus 8.0 was used for simulating this program.

Keywords: Intelligent Vehicle, Line Follower Robot, LFR, Microcontroller, ATMEGA 32, WIN-AVR 2010, Proteus 8.0, Intelligent Obstacle Finder.

1. INTRODUCTION

By the mid of 80’s robotics got flash on track. George Devol Jr. in 1954 developed the multi jointed artificial arms which lead to the modern robots. But mechanical engineer Victor Scheinman developed the truly flexible arm known as the Programmable Universal Manipulation Arm (PUMA) [1]. Mobile Robotics moved into its own in 1983 when Odetics introduced this six-legged vehicle which was capable of climbing over objects. This robot could lift over 5.6 times its own weight parked and 2.3 times it weight while moving [2]. In 2005 the Korean Institute of Science and Technology (KIST) creates HUBO and claims it is the smartest robot in the world. This robot is linked to a computer via a high-speed wireless connection; the computer does all of the thinking for the robot [3].

A two wheels balancing robot has developed by Nor Maniha Abdul Ghani et.al which has the line following capability and for balancing it, they used infra-red distance sensor to solve the problem in inclination [4] [5]. Pakdaman M. et.al has design a small line following robot which used IR sensors to detect the line drawn on floor [6]. That system has designed for the robot competition. Colak I. et.al has design a line following robot to use in the shopping malls for entertainmentA physical robot with 50 individual controls is generated by Gomi T. et.al from which the ability and gait to lift the body can be improved. That robot can move its legs in forward motion and tested in different conditions [7]. Roman Osorio C. et.al designed an intelligent line following robot which can modify the performance of the movement with the help of different type of magnetic sensors. That robot was based on the V2X sensor which is a type of digital compass [8].
Priyank Patil has developed an AVR line following robot which can detect the line drawn on the floor with the help of sensor array. When its sensor is passing through the line drawn on the way then it reads 0 and vice versa [9]. This system is used an array of 8 IR sensors and several LEDs. M. Zafri Baharuddin et.al designed a mobile robot which can be used as the navigation purpose [10]. An intelligent robot system is designed by Bajestani S. E. M. which can give corrective feedback in different colors of light [11]. They used a comparator circuit to improve the sensitivity of the system. That comparator compares the voltage with the predetermined amounts from which a robot can move in accurate real time.

A lot of works related to line follower robot have been focused by many researchers. Researcher develops their work for different purposes. Line follower obstacle removing robot is one of them. But it is very rear in research arena. The main objective of this work is to introduce a successful obstacle removing line follower robot that can detect an obstacle and remove it from its line successfully.

2. GENERAL OVERVIEW

The line follower is a self-operating robot that detects and follows a line that is drawn on the floor. The path consists of a black line on a white surface (or it may be reverse of that). The control system used must sense a line and manoeuvre the robot to stay on course, while constantly correcting the wrong moves using feedback mechanism, thus forming a simple yet effective closed loop System. The robot is designed to follow very tight curves.

In this line follower robot system 4 pairs of IR (infra-red) emitter/sensor was used. The sensor on getting blocked or unblocked sends combination of high/low signals to ATMEGA32 microcontroller which are processed and appropriate signals are sent to L293D (motor driver chip) which switches ON/OFF the motors so as to keep the robot moving in one direction [12]. The robot was able to follow a line on the ground without getting off the line too much. The robot has sensors installed underneath the front part of the body and two Gear motors drive wheels moving forward. A microcontroller takes input signal from sensors and controls the speed of wheels' rotation. The control was 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. Fig. 1 represents the block diagram of Line Follower Robot (LFR).

![Block diagram of Line Follower Robot (LFR)](image)

3. SYSTEM DESIGN

Building a basic Line Follower Robot involves the following steps:

1. Designing the mechanical part or the body of the robot.
2. Defining the kinematics of the robots.
3. Designing the control of the robot.
3.1. Mechanical part or the body of the robot
The mechanical part or body of the robot can be designed using AutoCAD or Work-space. A basic Line follower robot can consist of a base at the two ends of which the wheels are mounted. A rectangular sheet of hard plastic can be used as the base. Further a rigid body like a cylinder can be added along with other shaped bodies inter connected with each other by joints, and each with its defined motion in particular direction. The Line follower robot can be a wheeled mobile robot with a fixed base, a legged mobile robot with multiple rigid bodies interconnected by joints.

3.2. Kinematics of the Robots
The next step involves defining the Kinematics of the robot. Kinematic analysis of the robot involves the description of its motion with respect to a fixed coordinate system. It is concerned mainly with the movement of the robot and with motion of each body in case of a legged robot. It generally involves the dynamics of the robot motion. The whole trajectory of the robot is set using the Kinematic analysis. This can be done using Workspace software.

Fig. 2: Module of line Sensing Diagram

3.3. Control of the Robot
The control of the robot is the most important aspect of its working. Here the term control refers to the robot motion control, i.e. controlling the movement of the wheels. A basic line follower robot follows certain path and the motion of the robot along this path is controlled by controlling the rotation of wheels, which are placed on the shafts of the two motors. So, the basic control is achieved by controlling the motors. The control circuitry involves the use of sensors to sense the path and the microcontroller or any other device to control the motor operation through the motor drivers, based on the sensor output [13].

3.4. Line sensing
The basic principle of the line follower robot actually almost the same as the light follower robot, but instead of tracking the light the LFR sensor is used to track the line. Therefore by differentiating the line Color and its surrounding (black over white or vice versa) any light sensitive sensor could be used to navigate the robot to follow this track [3]. The Fig. 2 represents the module of line Sensing Diagram.
4. REQUIRED COMPONENTS AND MATERIALS
The component list making the robot are as follows: (1) Two Microcontroller - ATMEGA32, (2) One 40 Pin AVR Intermediate Development Board), (3) One USB AVR Programmer, (4) One L293D Motor Drive IC, (5) Two DC Gear Motor - (60 rpm), (6) Four IR Sensor, (7) One Chassis - (light weight), (8) One Adapter - (12 V, 1 A), (9) Connecting Wire / Jumper Wire - as per require (10) Servo motor and (11) One LCD Display. Fig. 3, Fig. 4 and Fig. 5 represents some components and materials were used in the system. Fig. 6 represents the circuit diagram for L293D motor driver IC controller.

5. DEVELOPMENT PROGRAM FOR MICROCONTROLLER
In this project PIC16F84A microcontroller used as controller circuit. Windows C-compiler and IDE for Microchip microcontrollers from CCS (Custom Computer Services) was used. C level CCS's PCWH software was used as Debugger. Fig. 7 represents the flowchart of system program.

6. COMPLETE CIRCUIT DIAGRAM AND OPERATION
The Fig. 8 represents microcontroller with motor driving IC, Gear motor and Servo motor and Fig. 9 represents the microcontroller with LCD Display. Fig. 10 and Fig. 11 represent the IR sender, receiver function and robot’s path respectively.

Fig. 3: (a) L293D IC front view (b) 555 Timer IC front view (c) 7805 IC font view (d) crystal oscillator (e) ATmega32 (f) Trim pot and (g) LCD Display with pin out
IR reflective sensors have one emitter (IR led) and one receiver (photo-transistor or photo diode). If white surface is present then it reflects the light and it will sensed by the receiver, similarly if surface is black then it absorbs the light and receiver cannot sense light. From the mechanism of IR transmitter & receiver a comparator circuit gives output. When the IR receiver’s signal is high the comparator's output is low otherwise high. This output of comparator goes to microcontroller's input. These outputs go to the microcontroller's input pin. By these inputs microcontroller can decide what function have to be done & it follows the instructions given into the microcontroller. The microcontroller makes a decision and gives output as an electrical signal which is fed to motor driving IC and LCD.
Fig. 6: Circuit Diagram for l293d motor driver IC controller.

Fig. 7: Flowchart of this program.

7. RESULTS AND DISCUSSION
The Fig. 12 represents the final Line follower Robot (LFR). After building the whole system it was observed that the system was working properly as demanded. To complete the Line
follower robot many problem has been experienced. First, when program was burned in microcontroller and output is taken from PORTC then the microcontroller's output was not working as the written program. For AVR microcontroller the PORTC not acts as normal input output pin. Controlling the speed of gear motor different condition has applied but not succeeds. Firstly the delay of several ms has applied but not worked properly. Using PWM signal it has successfully worked. Interfacing LCD was another problem i.e. displaying some text from the first line, first character and to display different text for different condition on LCD was not easy. The earlier condition's text also stays on present condition. Initializing LCD after each condition it does successfully. To interface Servo motor there also have some problems to rotate the motor 180 degree and vice-versa.

Fig. 8: Microcontroller with motor driving IC, Gear motor and Servo motor.
Fig. 9: Microcontroller with LCD Display

Fig. 10: IR sender and Receiver function
8. CONCLUSION

The designed LFR using Atmega32 with obstacle detect and removing has been implemented and was working successfully. Although some problems were drawn but it was shoted as said in the discussion. This system can be considered as the improvement of the artificial intelligence of robotics so far. From the operation of the robot it was observed that when an obstacle is detected by the robot then it successfully removes it from its way as well as display the presence of obstacle with left and right indication. Instead of ATmega32 microcontroller it can be done with PIC, ATmega8 and ATmega16 microcontroller. But ATmega32 has been used because the clock speed of this chip is more preferable than others.

Fig. 11: Robot’s path.

Fig. 12: Final Line follower Robot (LFR).
ACKNOWLEDGEMENTS
The authors are thankful to Electronic Laboratory, Department of Applied Physics, Electronics & Communication Engineering, Islamic university, Bangladesh for extending experimental facilities.

REFERENCES