CONTROL SYSTEMS AND INTRODUCTION TO ROBOTICS

MAJOR PROJECT

ON

MAZE SOLVER ROBOT

Submitted By

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ABSTRACT

A Line Follower Robot, as the name suggests, is an automated guided vehicle, which follow a visual line embedded on the floor or ceiling. Usually, the visual line is the path in which the line follower robot goes and it will be a black line on a white surface but the other way is also possible. Certain advanced Line Follower Robots use invisible magnetic field as their paths.

Large line follower robots are usually used in industries for assisting the automated production process. They are also used in military applications, human assistance purpose, delivery services etc.

Line follower Robot is one of the first robots that beginners and students would get their first robotic experience with. In this project, a simple Line Follower Robot using Arduino and some other components will be designed.

Line follower robot senses black line by using sensor and then sends the signal to Arduino. Then Arduino drives the motor according to sensors output. In this project we are using two IR sensor modules namely left sensor and right sensor. When both left and right sensor senses white then robot move forward. If left sensor comes on black line then robot turn left side. If right sensor sense black line then robot turn right side until both sensor comes at white surface. When white surface comes robot starts moving on forward again. If both sensors comes on black line, robot stops.

Introduction

A maze solving robot is designed to move in a maze and escape through it by following its walls. A maze solving robot is quite similar to a line follower. Like a line follower has to follow black strip lines, a maze follower finds a wall and starts following it until it finds an escape route. But unlike a line follower which has just to follow a predetermined route, a maze follower is designed to find an escape route that is not known beforehand. However, both types of robots are designed to be autonomous, they basically perform different tasks.

The maze solving robot designed in this tutorial is built on Arduino UNO and has the maze solving algorithm implemented within the Arduino Sketch. The hardware design of the robot is quite similar that of any other typical line follower robot except that a line follower may have sensors only in the front side of the robot, the maze solving robot has sensors at left side, right side and front side of the robot. The electronic circuitry of the robot consists of the Arduino board, IR sensor array and L293D motor driver IC coupled with two geared DC motors. The robot is powered by a 12V battery and is programmed to instantly start finding an escape route once it is powered by the battery.

Components

Arduino

Geared DC motor

IR array sensor

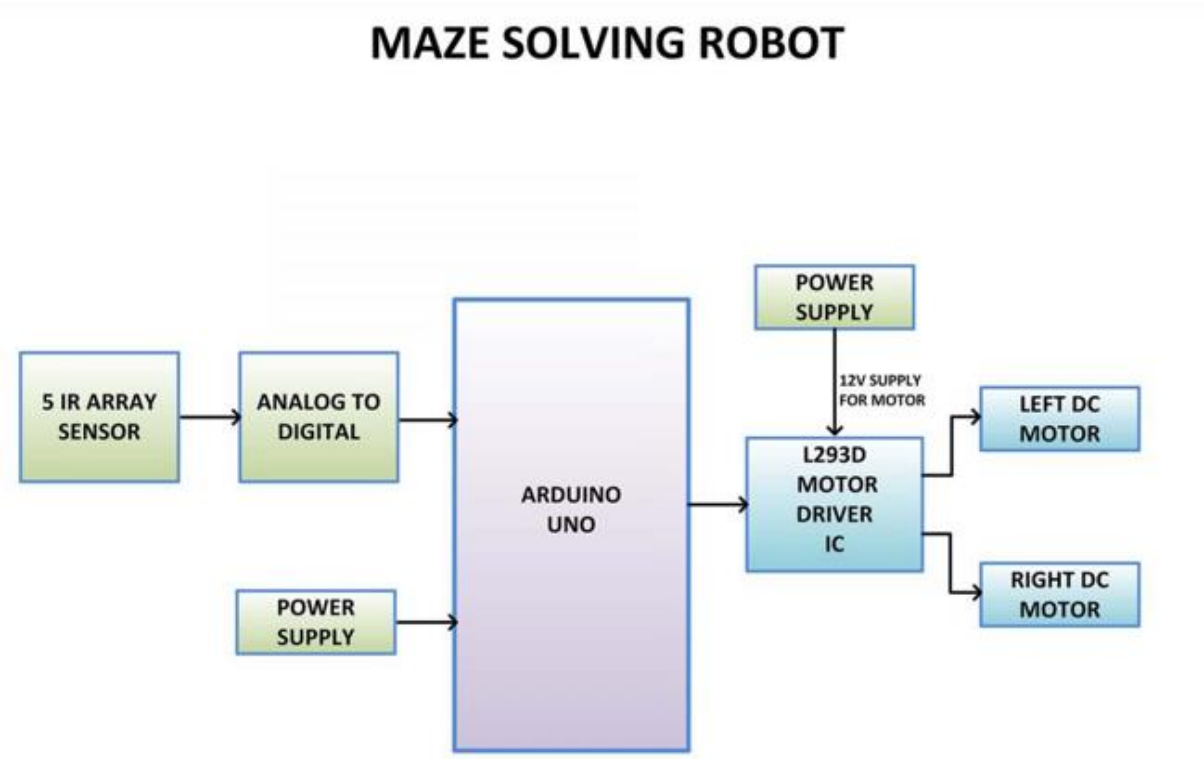
Robo Chassis

Battery

Connecting Wires

Block Diagram of the Project

The maze solver robot built in this project is divided in to 5 parts. The following image shows the block diagram for line follower robot.



Block Diagram Description

The maze solving robot has to find an escape route by following walls of the maze. For that, it is equipped with an IR sensor array and a motor driver circuit. Both the sensor circuit as well the motor driver circuit are interfaced with the Arduino board. The electronic circuit controlling the robot has the following building blocks –

Power Supply – In the circuit, Arduino board and IR sensor array need a 5V regulated DC for their operation while the motor driver IC needs 12V DC. A 12V NIMH battery is used as the primary source of power. The supply from the battery is regulated to 5V and 12V using 7805 and 7812 ICs. The pin 1 of both the voltage regulator ICs is connected to the anode of the battery and pin 2 of both ICs is connected to ground. The respective voltage outputs are drawn from pin 3 of the respective voltage regulator ICs. An LED along with a 10K Ω pull-up resistor is also connected between common ground and output pin to get a visual hint of supply continuity. Despite using 12V battery, 7812 is used to provide a regulated and stable supply to the motor driver IC. The DC motors cannot be directly connected to the battery as they can only be controlled by the motor driver IC and the motor driver IC itself need a regulated power input.

Arduino UNO – Arduino UNO is one of the most popular prototyping boards. It is used frequently in robotic applications as it is small in size and packed with rich features. The board comes with built-in Arduino boot loader. It is an Atmega 328 based controller board which has 14 GPIO pins, 6 PWM pins, 6 Analog inputs and on board UART, SPI and TWI interfaces. In this project, 5 GPIO pins of the board are utilized to connect the IR sensors and 6 GPIO pins are used to interface L293D motor driver IC.

L293D DC Motor Driver IC – The L293D is a dual H-bridge motor driver integrated circuit (IC). The Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

Geared DC Motors – In this robot, 12V geared DC motors are attached to the wheels. Geared DC motors are available with wide range of RPM and Torque, which allow a robot to move based on the control signal it receives from the motor driver IC.

IR sensor array – The maze solving robot is designed to follow walls of the robot and turn in the direction where it finds no walls. For this, a sensor which can detect the side walls is required. The IR sensors can detect the walls of the maze based on reflective/non-reflective indirect incidence. The IR LEDs emit IR radiation which in normal state gets reflected back from the white surface of the wall but can be absorbed by a black spot or surface.

IR Transmitters – The IR LEDs are used as IR transmitters in the circuit. An IR LED is a type of LED which emits light in the Infra-Red frequency range. The infra-red radiations are not visible to the human eye but can be seen by the lenses of a camera. Operationally, IR LEDs are not much different from normal LEDs. They also need a 3V DC for biasing and consume 20 mA current. They also need to be connected with pull-up resistor in a circuit. In the module, IR LEDs are connected with 470 ohm pull-up resistors.

b) IR Receivers – The photodiodes are used as IR receivers in the circuit. A photodiode is a type of diode which gets forward biased when light is incident on it. It has a high resistance when no light is falling on it. When the intensity of light incident on it increases, it starts getting forward biased and current starts flowing through it. So, when light is incident on it, its resistance decreases and there is less voltage drop across it. When light is not incident on it, its resistance increases and there is higher voltage drop across it. The photodiode looks exactly like an LED and may have a dark blue or black film on the outer casing. The photodiodes are used in reverse bias configuration in the circuit.

Working of Arduino Maze Solver Robot Robot

The maze solving robot detects the walls by using the IR sensor module and moves the robot close to the wall, until it finds a no wall region. The array of IR sensors has 2 IR sensors on the left side of the robot, two IR sensors on the right side of the robot and one IR sensor in the front of the robot. The IR sensors allow detecting side walls and obstacles in front of the robot.

When the robot finds a no wall space on left side i.e. sensors on left side of the robot detect a no wall region, it turns left and when the robot finds a no wall space on right side i.e. sensors on right side of the robot detect a no wall region, it turns right. It keeps moving along a left side wall or right side wall until it finds an obstacle in the path or find an escape route. When an obstacle is detected in front of the robot, it moves away in the opposite direction until it overcomes the obstacle. As the robot finds a path by detecting absence of a side wall, it turns in that direction moving forward to solve the maze.

The reflected radiations are detected by the photodiodes. Assuming walls to be of white colour, the IR radiations will be reflected back from the wall. But when there will be no wall, the radiations will not be reflected back. This way, an IR sensor module can detect the presence of side walls and obstacles in front of the robot. The IR sensors are available with analog output as well as digital output. In this robot, the sensor module is designed using the IR sensors having digital output.

When the IR radiation from the IR transmitter is not incident on the wall, it is gone away and no IR radiation is reflected back to the IR receiver (Photodiode).

This increases the resistance of the IR receiver, and there is more voltage drop across it. As a result, less voltage is dropped across the variable resistor and higher voltage is output by the sensor. When there is higher voltage output by the sensor module, the voltage at the inverting input is higher than the reference voltage resulting in a LOW output

Code:

```
#define l2r A4       // left sensor
#define l1r A3
#define cr A2
#define r1r A1
#define r2r A0

/*-------definning Outputs------*/
#define LM1 6       // left motor
#define LM2 7       // left motor
#define RM1 3       // right motor
#define RM2 4       // right motor
int k=400;
int d=3000;

void setup()
{
  pinMode(l2r, INPUT);
  pinMode(l1r, INPUT);
  pinMode(cr, INPUT);
  pinMode(r1r, INPUT);
  pinMode(r2r, INPUT);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
```

```
  pinMode(RM2, OUTPUT);
  Serial.begin(9600);
}
void straight(){
  digitalWrite(LM1, LOW);//straight//
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, HIGH);
  }
 void turnleft(){
    digitalWrite(LM1, LOW);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, HIGH);
 }
 void turnright(){
  digitalWrite(LM1, LOW);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, LOW);
 }
 void uturn(){
  turnright();
  turnright();
 }
void inch(){
  digitalWrite(LM1, LOW);//straight//
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, HIGH);
```

```
   delay(300);
}
void back(){
     digitalWrite(LM1, LOW);//straight//
   digitalWrite(LM2, HIGH);
   digitalWrite(RM1, LOW);
   digitalWrite(RM2, HIGH);
   delay(300);}
   int vic(int c,int l1,int l2,int r1,int r2){
     inch();
     if(c<k && l1<k &&l2<k &&r1<k&&r2<k){
     return 1;
     }
     else{
     return 0;}
   }
void loop()
{
  int l1=analogRead(l1r);
  int l2=analogRead(l2r);
  int c=analogRead(cr);
  int r2=analogRead(r2r);
  int r1=analogRead(r1r);
  Serial.println(l1);
  Serial.println(l2);
  Serial.println(c);
  Serial.println(r1);
  Serial.println(r2);
  if(c<k && l1>k && l2>k )     // Move Forward
  {
```

```
  straight();
 }
if( l1<k || l2<k){
 delay(1000);
  turnleft();
 }
 if(c>k && l1>k && l2>k &&r1>k && r2>k){
  delay(1000);
  uturn();
 }
 }
```

Note:

- In order to increase the efficiency of black line detection, number of sensors can be increased. An array of sensors will be more accurate than just two sensors.
- In this project (where two sensors are used), the positioning of the sensors is very important. The width of the black line plays a major role in the placement of the sensors.
- The sensor to detect the line can also be constructed using an LED and LDR pair.

Applications of Line Follower Robot

- Line follower Robots are commonly used for automation process in industries, military applications and consumer applications.
- They are very useful as they can work without any supervision i.e. they work as automatic guided vehicles.
- With additional features like obstacle avoidance and other security measures, line follower robots can be used in driver less cars.

Conclusion:

Even though the Maze solving Robot was successfully completed to meet its objectives of moving forward and solving a maze, detecting a black line on a white surface and the way to turn fom the sensors, and generating control commands to follow a detected black line in a way such that it can reach the output, there are opportunities available for future enhancement. The most obvious enhancement would be the improvement of the maze solving algorithm so that the Maze soviing Robot can follow more complicated courses and traverse them more quickly. Another opportunity for enhancement could involve using a simple remote control to transmit commands, such as start and stop, to the Maze Solving Robot via the infrared receiver that is installed on the SJ One Board. Proximity sensors could also be added to ensure the Line Following Robot does not collide with objects while performing its line following task.

These are the obvious future enhancements and the robot can easily solve the maze without any problems and can act as a direction finder robot. This can be further improved using in the application of driverless cars to help them turn in the right direction and not into incoming vehicles

References:

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