Sensor Guided Robotics

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SENSOR GUIDED ROBOTICS

ABSTRACT

A mobile robot control system centred on subsequent marked path can overcome numerous difficulties of the old-fashioned mobile robots. To be beneficial in an industrial atmosphere a mobile robot is essential to be low-priced, consistent and easy to acclimate to any changes in the operational environment. Old-fashioned mobile robots stereotypically based around facsimiles of the atmosphere or learning techniques, such as neural systems, are not appropriate. They include expensive sensors and significant processing possessions, which are luxurious and often conclude the design of the robot. If the atmosphere has fluctuations either the model must be substituted, necessitating considerable time and know-how, or the robot must be reinstructed, again necessitating time and know-how. Control systems grounded on marked paths do not agonize from these restrictions as badly. They can be instigated using negligible sensors and handling resources, and if the atmosphere changes the paths can basically be rehabilitated, necessitating little or no reprogramming of the automatons. The objective of this proposal is to scrutinize a simple path following robot, which is premeditated to be a malleable base for more composite robot performances.

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPANSION
PWM	Pulse Width Modulation
DC	Direct Current
LED	Light Emitting Diode
IOT	Internet of Things

CHAPTER 1

INTRODUCTION

Robotic systems have elongated been used to progress the speed and effectiveness of manufacturing responsibilities. In the automotive production robots accomplish the more monotonous tasks, such as soldering, or hypothetically dangerous responsibilities like spray painting. In the electronics business robots accomplish responsibilities necessitating high accuracy, like industrial combined circuits, or monotonous responsibilities such as accumulating circuit boards. Many added productions use robots to interchange humans in monotonous or precarious circumstances. Though, in all of these suitcases robotic systemsare castoff in small, regularly self-contained, segments of the construction lines. Humans are still mandatory to draw mechanisms from granaries and, in some circumstances, shift incompletely accumulated product segments amongst stations on the production line. These responsibilities are just as monotonous and, from time to time, perilous as the responsibilities completed by robots. Although conveyer belts can be second-hand to transportation constituents their pathways are tough to adjust if the production line fluctuations and they have need of a large quantity of floor space, predominantly if more than a few belts unite on one section of the construction line. Mobile robots, on the further hand, do not necessitate much floor space and their paths can supplementary simply be transformed if environments adjust. The main problematic thing with mobile robots is that they are luxurious to obtain and continue.

1.1 PROBLEM DESCRIPTION

In the industry carriers are required to carry products from one manufacturing plant to another which are usually in different buildings or separate blocks. Conventionally, carts or trucks were used with human drivers. Unreliability and inefficiency in this part of the assembly line formed the weakest link. The project is to automate this sector, using carts to follow a line instead of laying railway tracks which are both costly and an inconvenience.

1.2 OBJECTIVE OF THE PROJECT

The objectives of the project are:

- The robot follow a line.
- It should be able to take various degrees turns.
- The robot should not be sensitive to environmental factors .
- It must allow calibration of the line's darkness threshold.
- Scalability is the primary concern.
- It shows the distance travelled by the robot through LCD display.

1.3 SUMMARY

Line Follower is one of the most important aspects of robotics. A Line Following Robot is an autonomous robot which is able to follow either a black or white line that is drawn on the surface consisting of a contrasting colour. It is designed to move automatically and follow the plotted line. It enhances interdisciplinary approach to mechanical, electronic, electrical and programming skills. The application of the project is the automation and control aspect of large industry. Human are intelligent natural machine but it has serious limitation of efficiency and reliability. Robots are invented to replace dependency of human force. The project is somehow designed to perform the similar task.

CHAPTER 2

LITERATURE SURVEY

2.1TECHNOLOGY AND LITERATURE SURVEY

The line follower is a self-operating robot that detects and follows a line that is drawn on the floor .The line follower robot using Arduino is a self-operating system that detects and follows track drawn on the floor. The track consists of a black path drawn on white surface.

2.2BASIC OPERATION

The basic operations of line follower are as follows:

Capture line position with optical sensors mounted at front end of the robot. For this a combination of IR-LED and Photodiode called an optical sensor has been used. This make sensing process of high resolution and high robustness.

•Steer robot requires steering mechanism for tracking. Two motors governing wheel motion are used for achieving this task.

•On the detecting no black surface robot move in a circular motion until line is found.

2.3HARDWARE REQUIRED

The hardware required is divided in the following category:

2.3.1AURDINO

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world. The heart of Arduino is the microcontroller. For Arduino Uno ATmega328 is used.It has specification of 8 bit CPU, 16 MHZ clock speed, 2 KB SRAM 32 KB flash Memory, 1 KB EEPROM

Features :-

• 14 digital input output pins (3,5,6,9,10 and 11 pins are able to generate PWM).

• 6 analog input pins .

• Voltage input from the 7 – 12 V.

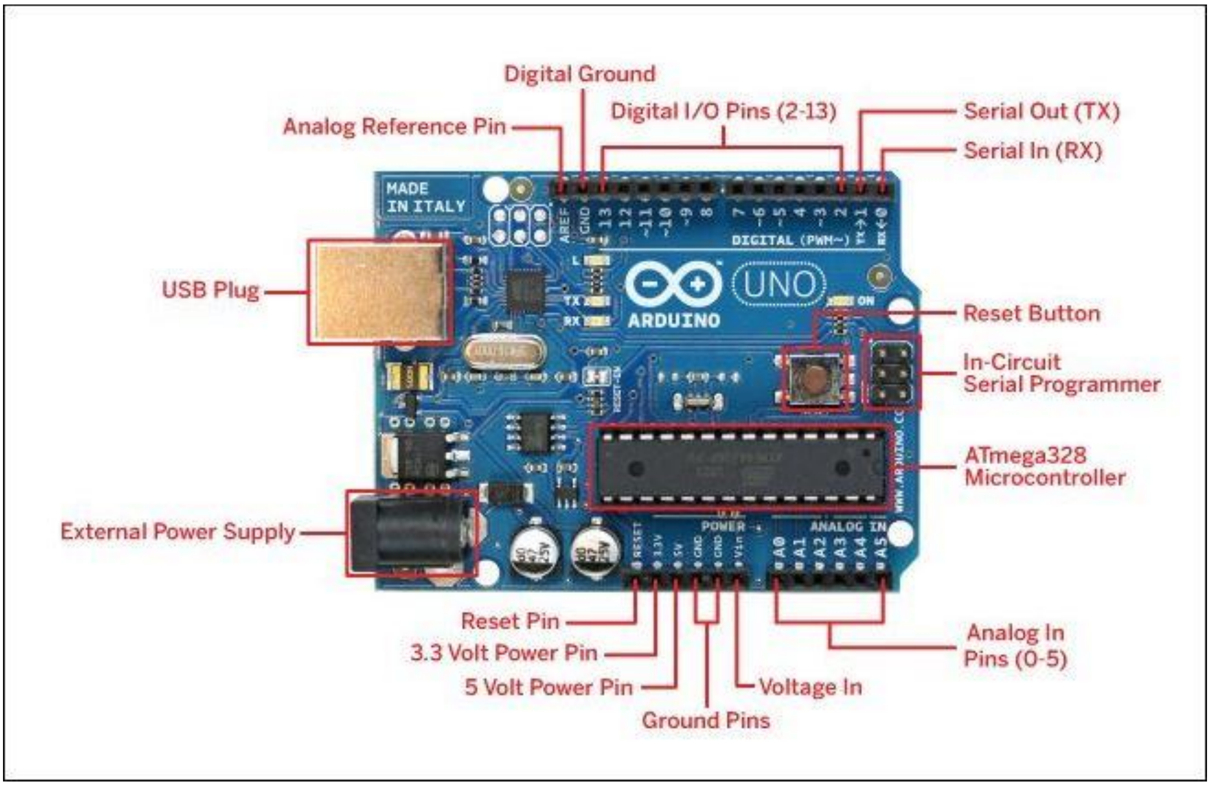


FIG 2.1 ARDUINO

2.2.1 .MOTOR DRIVER

Motor driver is a current enhancing device.It can also be act as Switching Device. Thus, after inserting motor driver among the motor and microcontroller. Motor driver taking the input signals from microcontroller and generate corresponding output for motor.

2.2.2.1IC L293D

This is a motor driver IC that can drive two motor simultaneously. Supply voltage (Vss) is the voltage at which motor drive. Generally, 6V for dc motor and 6 to 12V for gear motor are used, depending upon the rating of the motor.

Logical Supply Voltage deciding what value of input voltage should be considered as high or low .So if the logical supply voltage equals to +5V, then -0.3V to 1.5V will be considered as Input low voltage and 2.3V to 5V is taken into consider as Input High Voltage. The Enable 1 and Enable 2 are the input pin for the PWM led speed control for the motor L293D has 2 Channels .One channel is used for one motor.

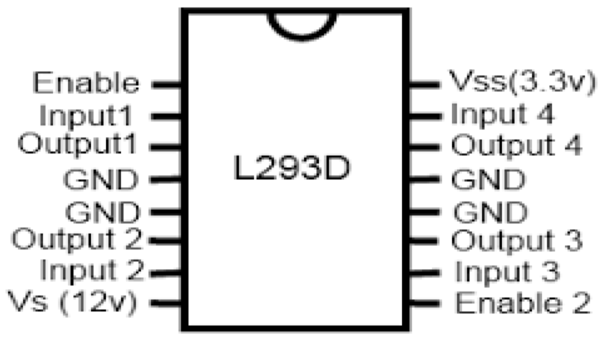


FIG 2.2 L293D

2.2.2.2 DC MOTOR

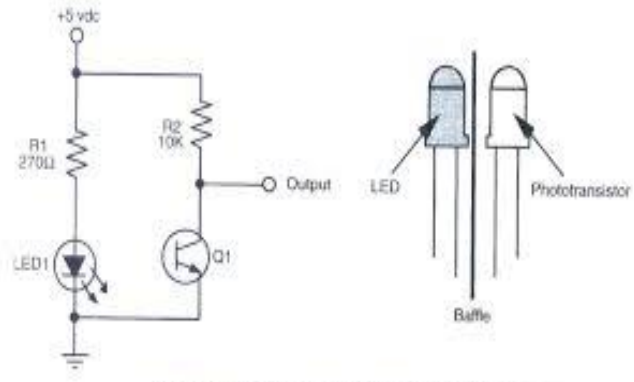
Motor is a device that converts any form of energy into mechanical energy or imparts motion. In constructing a robot, motor usually plays a crucial role by giving movement to the robot. In general, motor operating with the effect of conductor with current and therefore the permanent magnetic flux . The conductor with current usually producing magnetic flux which will react with the magnetic flux produces by the static magnet to form the motor rotate. There are generally three basic types of motor, DC motor, even servomotor and stepper motor, which are always getting used in building a robot. DC motors are most easy for controlling. One DC motor has two signals for its operation. Reversing the polarity of the facility supply across it can change the direction required. Speed are often varied by varying the voltage across motor.

FIG 2.3 DC MOTOR

DC MOTOR

2.2.2 PROXIMITY SENSOR.

The combination of IR- LED and Photodiode is employed because the reflective optical sensor. It generate interrupt when the IR-beam is break to the photodiode. To create the IR breakbeam, IR LED is used with a low value resistor so that it shines very bright. The receiver is Photodiode which biases 'on' whenever the IR LED's light is detected. A sensor are going to be placed adjacent the IR link and turned on so on generate a pulse to the Arduino. The Arduino LCD interface is employed to point out the covered distance digitally.



The basic design of the infrared proximity sensor.

FIG 2.4

PROXIMITY SENSOR

2.3.SOFTWARE USED

- Arduino.
- S4A.

CHAPTER 3

IMPLEMENTATION

3.1 SCHEMATIC:

The schematic of the “Line Following Robot” is shown within the figure. The main component is the Arduino Uno. Schematic is drawn by using Proteus. The main features incorporated into the hardware are given below:

• Arduino Uno.

• The IR-LED with IR illuminance, modified to be reflective sensor.

• The LM324 quad comparator IC.

• A potentiometer to calibrate the reference voltage.

• The H-bridge motor control IC (L293D)

• Motors, with coupled reduction gears.

• Connectors to hitch the various boards to make one functional device.

• A pair of IR-LED and Photodiode is employed as proximity sensor .

3.2 AURDINO WORKING LOGIC

Thus totally the microcontroller gets 4 inputs from the sensor circuitry, to the (A3 – A0) of Arduino to decide what to do when on the line.

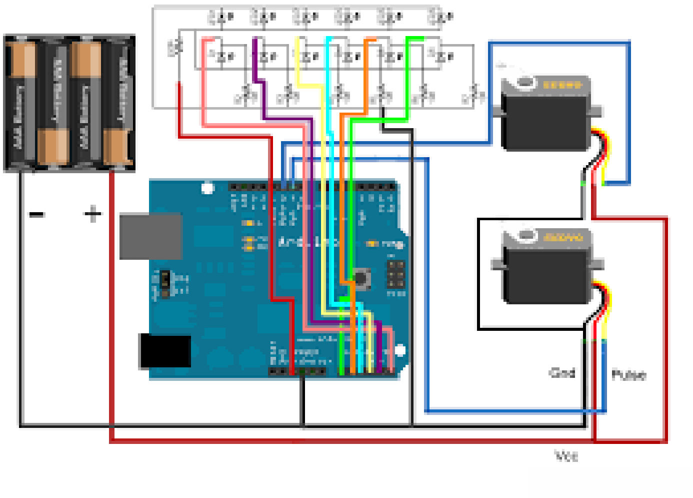


FIG 3.1

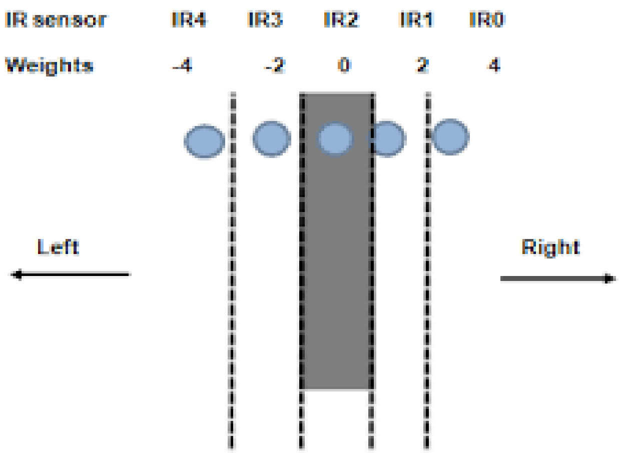


FIG 3.2

3.3 PULSE WIDTH MODULATION.

Pulse Width Modulation, or PWM, may be a technique for getting analog results with digital means. Digital control is employed to make a square wave, a sign switched between on and off. This on-off pattern can simulate voltages in between full on (5 Volts) and off (0 Volts) by changing the portion of the time the signal spends on versus the time that the signal spends off. The duration of "on time" is named the heart beat width. To get varying analog values, change or modulate that pulse width. Since, the build techometer are often used, as from the analysis the error percentage within limit, for the utmost rpm is to be measured i.e 250 rpm.

CHAPTER 4

4.1 KINEMATICS OF THE ROBOT

The backbone of our design is the differential steering system which is familiar from ordinary life because it is the arrangement used in a wheelchair. Two wheels mounted on a single axis are independently powered and controlled, thus providing both drive and steering. Additional passive wheels (usually casters) are provided for support. Most of us have an intuitive grasp of the basic behaviour of a differential steering system. If both drive wheels turn in tandem, the robot moves in a straight line. If one wheel turns faster than the other, the robot follows a curved path. If the wheels turn at equal speed, but in opposite directions, the robot pivots.

$SL = r\theta$

$SR = (r + b)\theta$

$SM = (r + b2\ )\theta$

Where SL and SR give the displacement for the left and right wheels respectively, r is the turning radius. b is the distance between wheel, and θ is the angle of turn. SM is the speed at the centre point as the main axle.

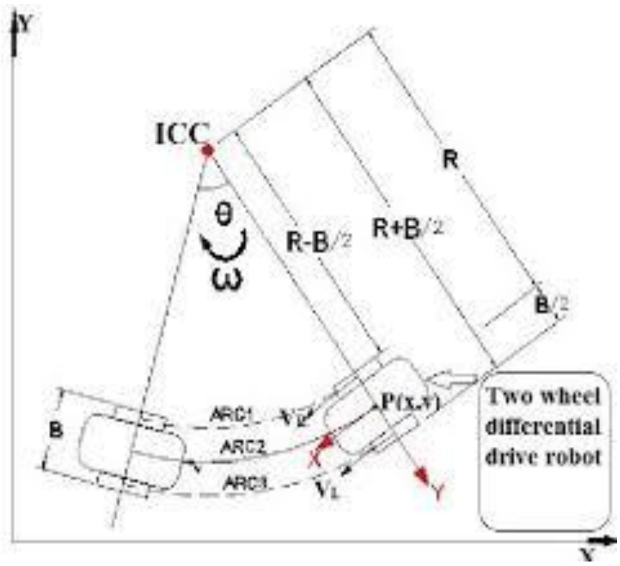


FIG 4.1

4.2 MECHANICAL DESIGN.

The chassis of the robot is made up of the acrylic glass since it can carry more load and have lighter in weight. The detail orthographic projection of the robot is drawn at the appendix.

DESIGN OF PATH

The path consists of three U-turns of different radii. Among three, the system swiftly turn two U-turn and it goes out of track in one initial U-turn and retrace it's path.

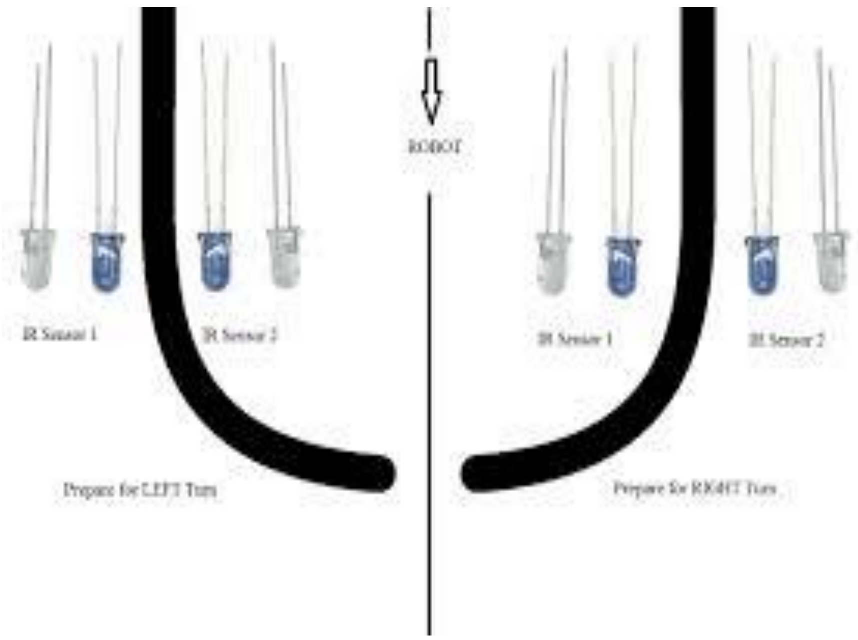


FIG 4.2 DESIGN OF PATH

4.3 TURNING RADIUS.

The turning radius of a vehicle is the radius of the smallest circular turn (i.e. U-turn) that the vehicle is capable of making. The term 'turning radius' is a technical term that is commonly used to mean the full diameter of the smallest circle, but in technical usage the turning radius still is used to denote the radius. Calculation : The total length of the robot car is 172mm (approximately 17.2mm.) the minimum turning radius that it can turn sharply.

The front wheel’s centre is P and the rear wheel’s centre is Q. Let O be the centre of the circle, along whose circumference the car moves. Let L=PQ be the length of the car and let R be the radius of the circle. Sharpest turn corresponds to smallest possible value of R. Note that PQ is a chord of the circle. Let us say that the front wheel can rotate at most by an angle w relative to the ‘straight’ position. For triangle OPQ .

u + 2v = 1800 (1)

also , w + v = 900 (2)

From, cosine rule for OPQ:

L 2 = R2 + R2 – 2R2 cos(u) (3)

From equation (1), (2) and (3) $R = L\ 2sinw$

At the maximum value of sinw i.e1 . The turning radius is found to be L/2 = 87.2mm.

Now, the velocity of the automobile is the prime factor to determine the ability to take turn smoothly or not. So we have to derive the relation between the turning radius and The velocity of the robot car.

Turning Radius(r) = 100mm.
Acceleration due to gravity(g) = 9.81m/s2 = 9.81×100 mm/s2
Velocity(v) = ?
Coefficient of friction between rubber and cardboard (μ) = 0.07 [11]
v = √μrg = √0.07 × 8.75 × 9810 = 245.20mm/s = 24.52cm/s
Which is attained at the speed of 1.4rps (or, 84 rpm)

The main criteria of the mechanical design is mainly depends upon the differential steering mechanism, turning radius. The calculation of turning radius is necessary because it finds out the mechanical limitation for the types of the curve which is avoided. The turning radius for the design is found to be 100mm . So, in case of designing path the maximum turning radius mustn’t be less than 100mm.

CHAPTER 5

5.1PROBLEMS WITH EXISTING MOBILE ROBOTS

Utmost mobile robots are premeditated by means of a five-step process:

1. Describe a problem
2. Generate a set of necessities to resolve the problem
3. Produce a problem description
4. Project a clarification to the requirement
5. Plan a robot to contrivance the explanation

While this proposal process creates robots that are respectable at resolving the problem, they are luxurious, time overwhelming to create and do not incline to be very malleable. Typical resolutions practice models of the atmosphere and the robot in mandate to achieve the anticipated task. These representations necessitate precise evidence about the format of the robot and the atmosphere and thus entail substantial dealing out resources to preserve these models. The foremost source of the expenditure of these robots is the sensors and supercomputers mandatory to apprise these models. The price of the additional resources to build the robots is not as noteworthy.

5.2 REDUCING COMPLEXITY

As the regulator system of the robot governs the sensors and dispensation properties mandatory, dropping the complication of the control system ought to condense the cost of the robot. More than a few procedures can be used to lessen the complication of the control system, nevertheless the stress-free is to shorten or eliminate one or both of therepresentations used. The prototypical of the situation can be abridged by one of numerous approaches.

5.2.1. Landmarks With Explicit Paths :

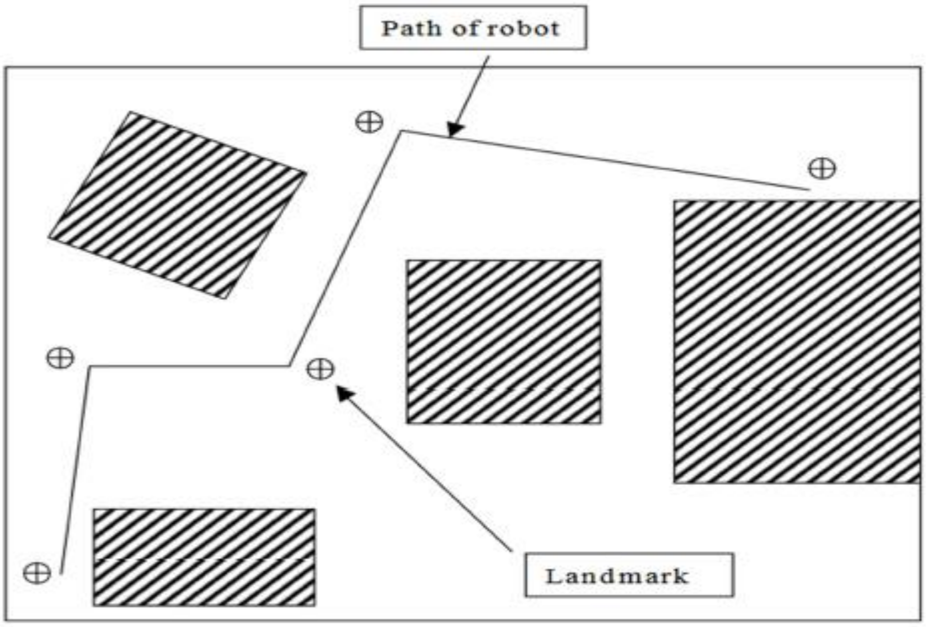


FIG 5.1 Landmark with explicit paths

Figure. 1. Landmarks with explicit paths

In this technique, the robot embraces a simple map specifying how turn in order to travel amongst uninterrupted pairs of breakthroughs. As each landmark is distinctive, the robot can prevent from spreading itself at every stage of the path. Nonetheless, if the robot slips a landmark it is incapable of recovering. If the atmosphere has deviations then it has to be reprogrammed.

5.2.2. Landmarks without Explicit Paths

Moderately than doing the software design for the robot with the track to trail amongst the landmarks, this technique basically delivers the robot with an methodical list of the landmarks to initiative to and verdures the robot to invent its own approach. While the dispensation of the situation model is at ease, this technique does necessitate that the robot can distinguish two or added landmarks at any fact on the path, demanding one or the other, that is a moral sensor system or a great amount of landmarks. As by the obvious path scheme if the amount or order of the landmarks gets some modification then the programming will need to be improved.

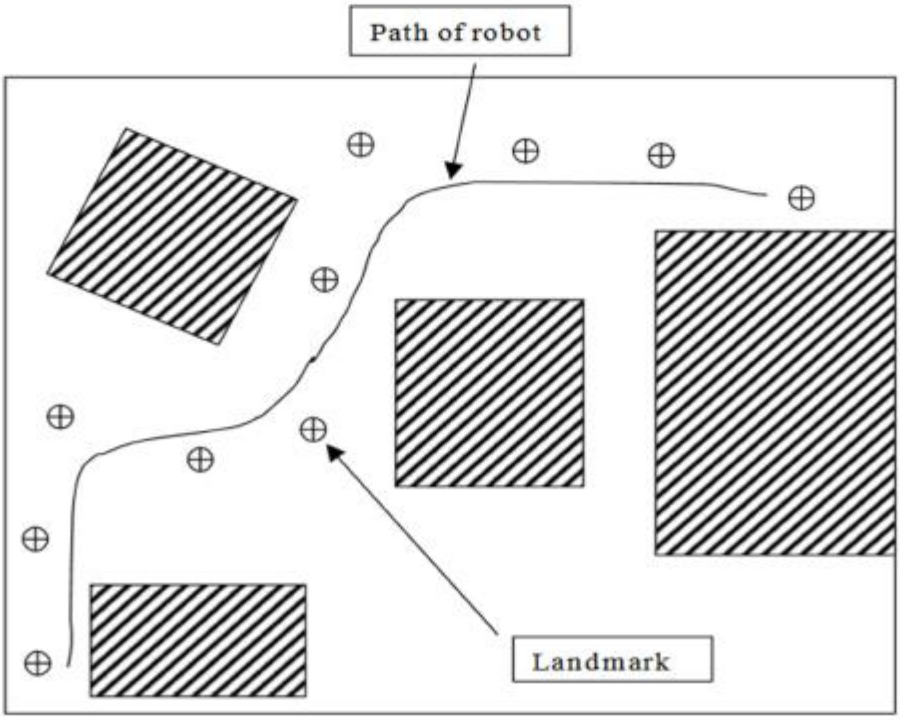


Fig 5.2. Landmarks without explicit paths

5.2.3. Marked Paths

In this technique, a line is noticeable on the floor of the work part laterally the path the robot is compulsory to proceed. The robot can formerly use a sensor to track this path, taking away all necessities for a model of the atmosphere. Alternative advantage of this tactic is that the practices established for self-governing driving can be leveraged to diminish progress time. If the robot misses the path a level-headedly modest localisation routine can permit it to make progress. The path can be with no trouble changed to replicate changes in the atmosphere deprived of requiring any variations to the robots software.

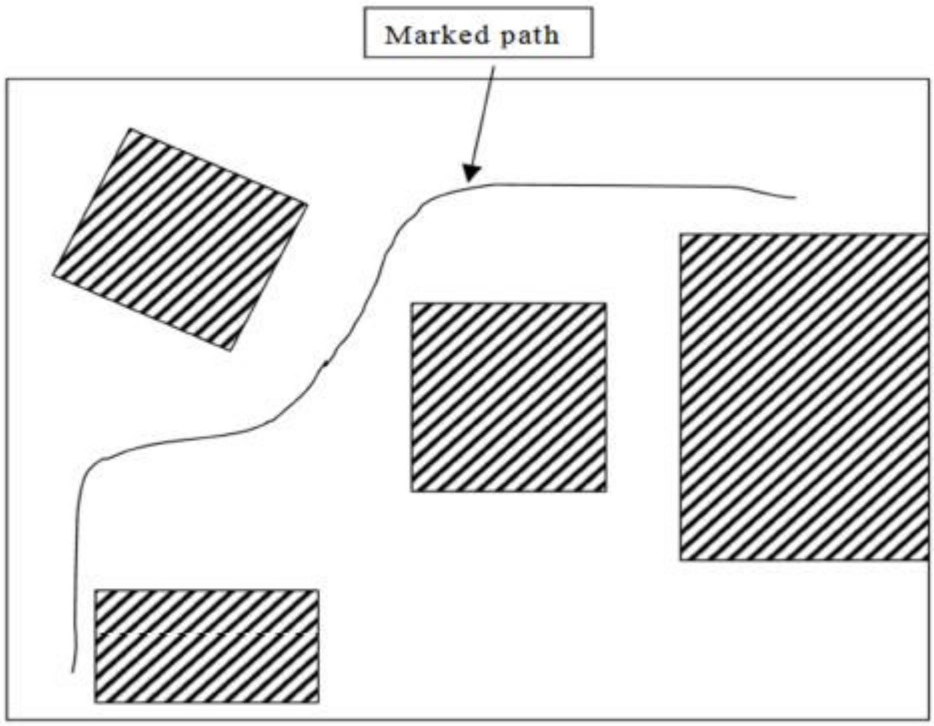


Fig 5.3. Marked paths

5.3.CONTROL ARCHITECTURE:

If the gesture control subsystem is abridged, it creates sense to abridge the complete robot control system. In an business atmosphere, a mobile robot would mostly be second-hand forconveyance of items amongst two phases in the production line. Therefore, the greatest compound robot performances are solitary used at every end of the path. Using this in mind, the control system for the robot can be divided into three subdivisions.

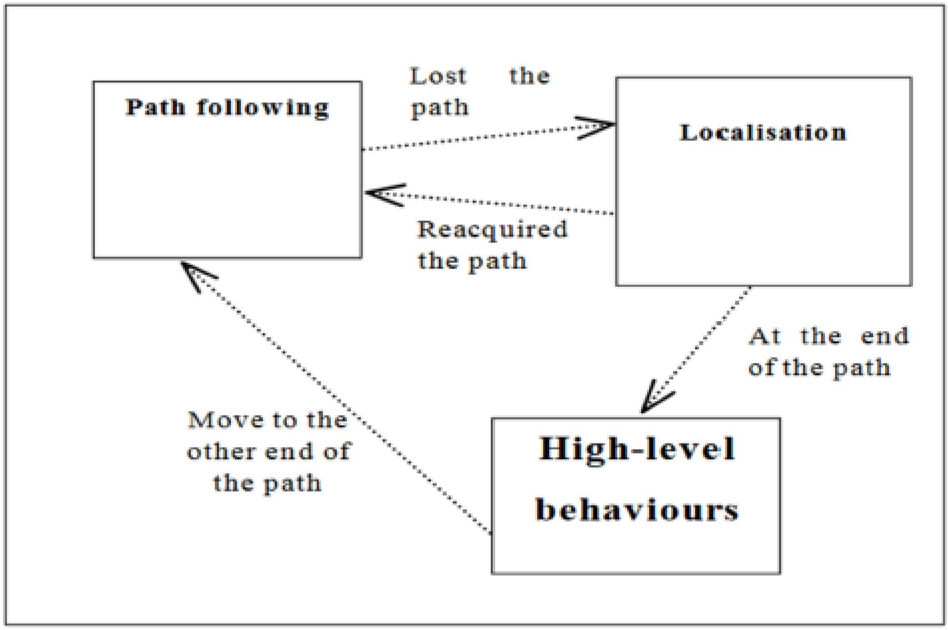


Fig 5. 4. Control architecture

5.3.1. Path following :

A scheme of paths marked on the floor of the work zone delivers the most malleable standby for a typical example of the location. The path resulting system can be completed tremendously simple, as the robot would not be obligatory to achieve multifarious errands while moving. This proposition designates one conceivable path following system.

5.3.2 Localisation:

If, for some motive, the robot loses pathway of the path specific form of localisation scheme is essential in order to reacquire it. The localisation system would also be accountable for shaping whether the robot is misplaced or it has gotten to the end of the path.

5.3.3. High-level behaviours :

The most compound robot behaviours would be second-hand at each culmination of the robots trail to freight or drop the robot or, in the situation of a warehouse robot, to recover a specific item on a ridge.

5.4LINE FOLLOWER ROBOT

A line follower robot is a robot that trails a assured path well-ordered by a feedback contrivance.

Construction of a basic Line Follower Robot comprises the subsequent steps.

- Scheming the motorized part or the figure of the robot
- Describing the kinematics of the automatons
- Planning the controller of the robot

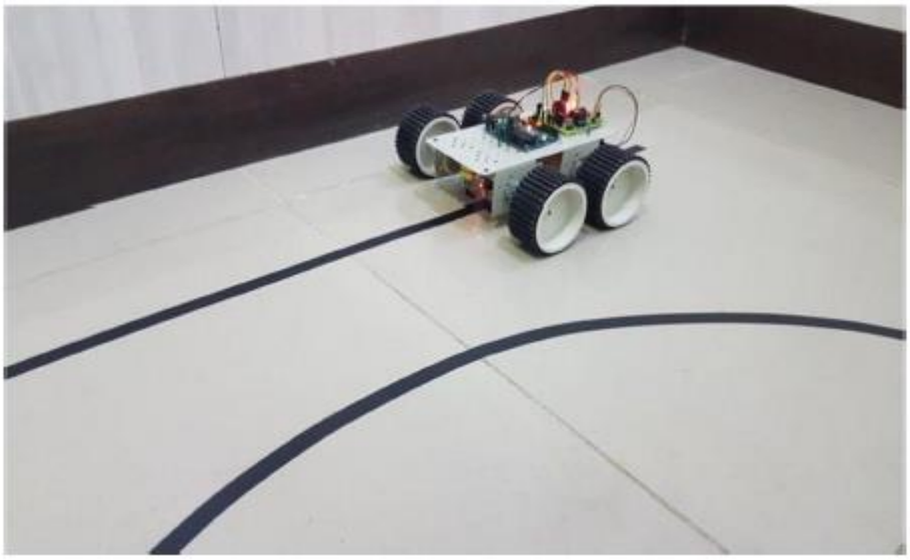


Fig 5.5. Line Follower Robot

The motorized part or body of the robot can be premeditated using AutoCAD or Workspace. A basic Line follower robot can contain of a base at the dual ends of which the wheels are attached. A four-sided sheet of firm plastic can be second-hand as the base. Additionally a rigid form like a cylinder can be supplementary alongside with extra shaped figures inter associated with each other by links, and each with its well-defined motion in certain direction. The Line follower robot can be a moved mobile robot with a fixed base, a legged mobile robot with several inflexible bodies interrelated by links.

The next phase includes outlining the Kinematics of the robot. Kinematic analysis of the robot includes the explanation of its gesture with respect to a immovable coordinate system. It is apprehensive mainly with the effort of the robot and with gesture of each body in circumstance of a legged robot. It normally comprises the undercurrents of the robot motion. The whole flight of the robot is set via the Kinematic analysis. This can be done by means of Workspace software.

The regulator of the robot is the most imperative characteristic of its working. Here the tenure control denotes to the robot motion control, i.e. governing the drive of the wheels. A rudimentary line follower robot tracks convinced path and the gesture of the robot along this path is organized by controlling the turning of wheels, which are to be found on the shafts of the two motors. So, the rudimentary control is attained by controlling the motors. The control circuitry includes the usage of sensors to intellect the path and the microcontroller or any other expedient to switch the motor action through the motor drivers, founded on the sensor output.

5.5WAYS OF CONTROLLING A LINE FOLLOWER ROBOT

5.5.1.Without using Microcontrollers

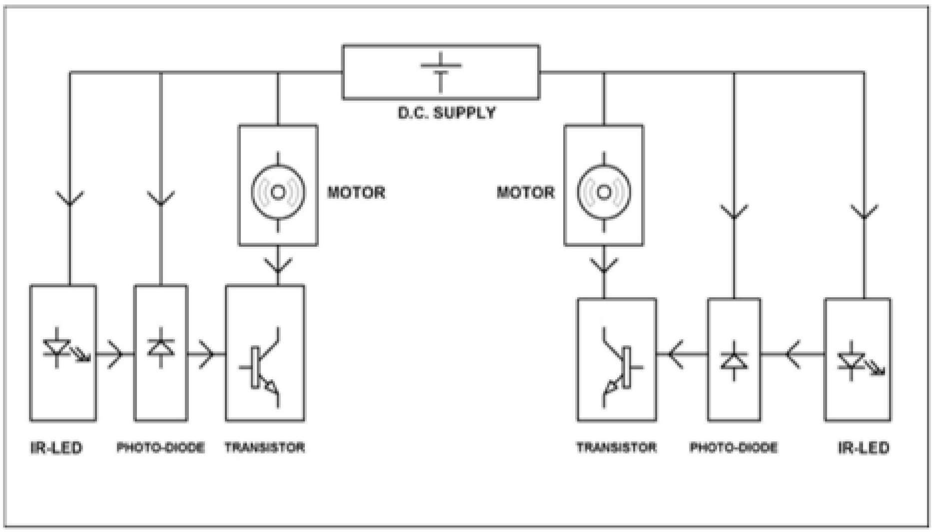


Fig 5.6. Block Diagram of the control System

It contains of an IR-LED and Photodiode organisation for each motor which is measured by the swapping on and off of the transistor. The IR LED on receiving proper biasing produces Infra red light. This IR light is reproduced in case of a white surface and the reproduced IR light is occurrence on the photodiode.

The confrontation of the photodiode declines, which are indications to an surge in current over it and thus the voltage drop transversely in it. The photodiode is linked to the base of the transistor and as a consequence of augmented voltage across the photodiode, the transistor twitches leading and thus the motor associated to the collector of the transistor gets abundant stream to start rotating. In case of a black colour on the path run into by one of the sensor procedure, the IR light is not reproduced and the photodiode proposals more confrontation, triggering the transistor to stop transmission and eventually the motor stops rotating.

Thus the whole scheme can be well-ordered by means of a simple LED-PhotodiodeTransistor organisation.

5.5.2 With using Microcontrollers.

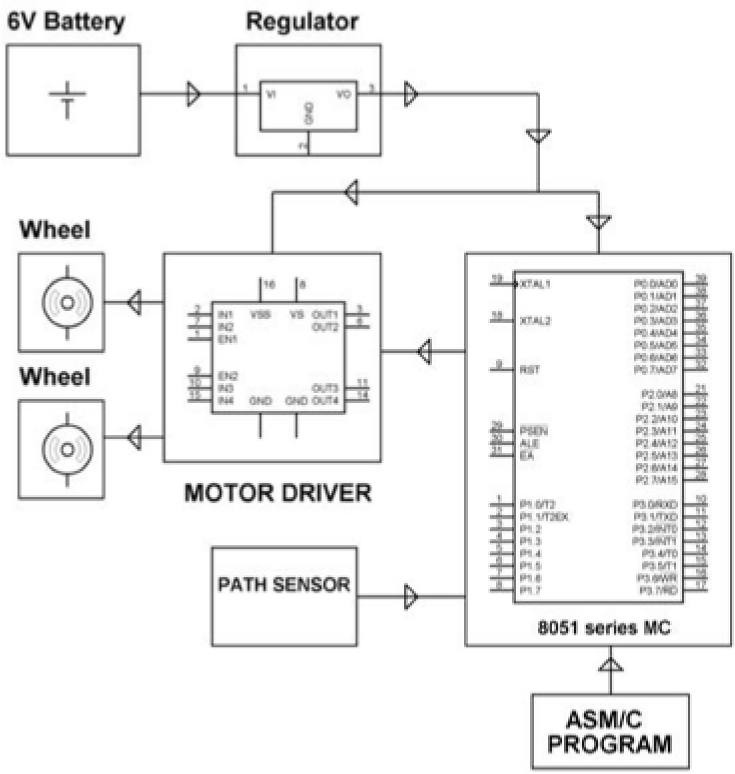


Fig 5. 7. Block Diagram of Line Following Robotic Vehicle with Microcontroller

The line following robot is one of the self-acting robots which detects and follows a line drawn on the zone. The line is designated by white line on a black surface or black line on a white surface. This scheme must be intelligence by the line. This presentation is dependent upon the sensors. Here we are using two sensors for path detection purpose. That is closeness sensor and IR sensor. The closeness sensor second-hand for path detection and IR sensor castoff for obstacle detection. These sensors attached at front end of the robot. The microcontroller is an intellectual device the complete circuit is measured by the microcontroller.

5.6.SENSOR PLACEMENT FOR TURNING

Just as a driver desires to know the minute to turn into a junction, the robot also prerequisites to know when to turn when it touches a junction point. Exact location of the sensor will guarantee a smooth changeover when turnoff into a junction. A robot will know when to turn dependent on the position of the sensors. Therefore it is very significant that the employment of the sensors resemble to the technique of turning. There are two turning approaches that were tested on as clarified in the following subdivision**.**

5.6.1One motor moving forward and the other motor stationary (Method I)

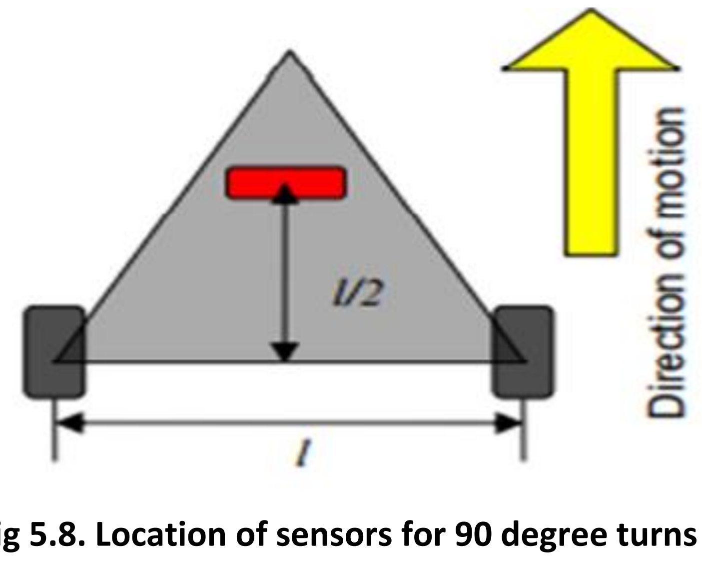


Fig 5.8. Location of sensors for 90 degree turns

Mentioning to above figure, this technique necessitates the sensors be positioned at half the distance of the distance between the left and right wheel. At this fact, when the robot turns into the junction it will go in the line exactly on the line. Henceforth the sensor array will be upright

with respect to the line after the 90-degree turn is complete. This will guarantee smooth changeover from one line to one more when turning junctions as demonstrated in figure below.
Figure

5.6.2Both motors moving in opposite directions (Method II)

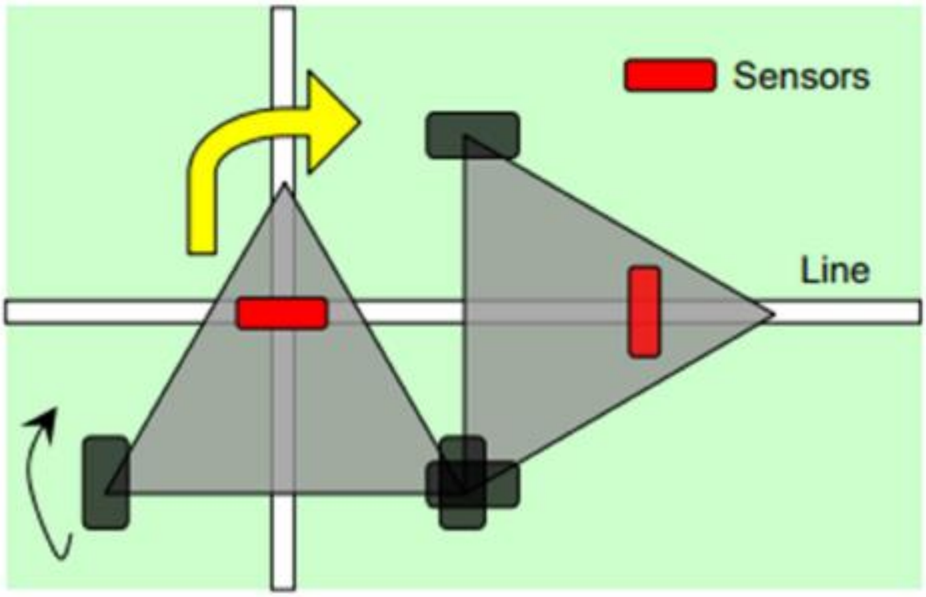


Fig 5. 9. Sensor Placement for 90 degrees turning by Method I

For Method II, the robot will have the finest turning point if its sensors notice the junction precisely in between its two wheels. Figure below indicates how the robot will turn for Method II, also entitled a point-turn.

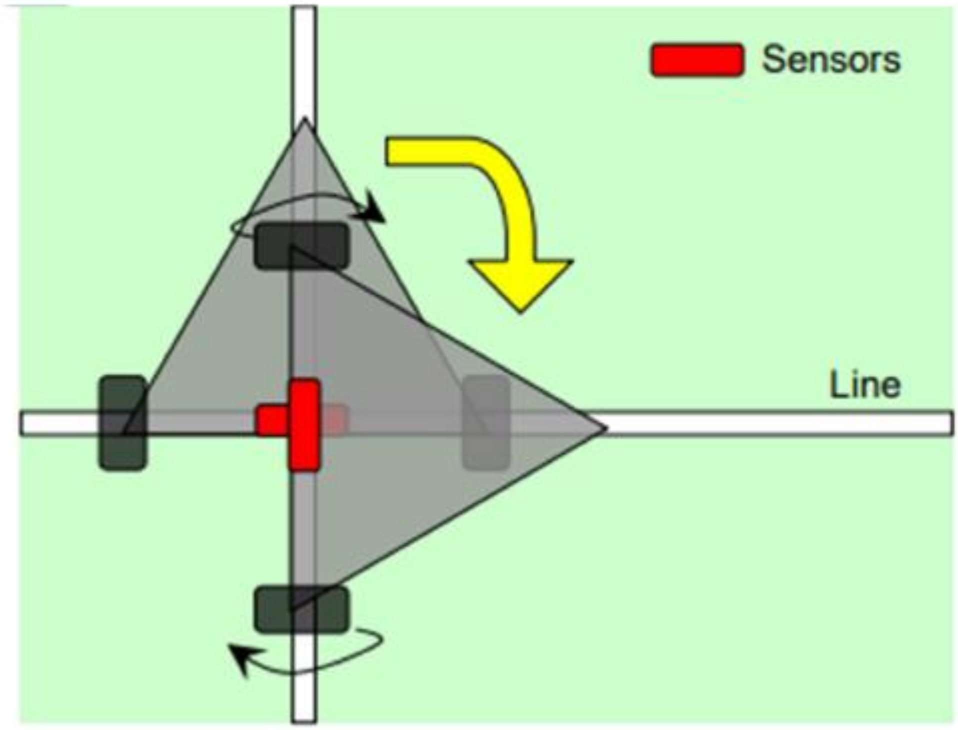


Fig 5.10. Sensor Placement for 90 degrees turning by Method II

CHAPTER 6

CONCLUSIONS AND FUTURE ENHANCEMENT

6.1 CONCLUSION

The objective of this scheme is to generate an independent robot which perceptively notices the obstacle in its path and circumnavigates rendering to the actions that we set for it. So what this scheme delivers is an alternate to the current system by substituting expert labour with robotic equipment, which in turn can handle more patients in fewer time with improved accurateness and a lesser per capita price.

6.2 FUTURE ENHANCEMENTS

In the process of development of the line follower, most of the useful feature is identified and many of them was implemented . But due to the time limitations and other factor some of these cannot be added. So the development features in brief:

- Use of colour sensor.
- Use of ccd camera for better recognition and precise tracking the path.

APPENDIX-1

SOURCE CODE:

```
void setup() {
   // put your setup code here, to run once:
  Serial.begin(9600);
  pinMode(10,OUTPUT);
  pinMode(11,OUTPUT);
  pinMode(12,OUTPUT);
  pinMode(13,OUTPUT);
  pinMode(A0,INPUT);
  pinMode(A1,INPUT);
  }
  void moveRobot(String motion)
  {
   if(motion=="forward")
   {
  digitalWrite(10,HIGH);
  digitalWrite(11,LOW);
  digitalWrite(12,HIGH);
  digitalWrite(13,LOW);
   }
   if(motion=="backward")
   {
  digitalWrite(10,LOW);
  digitalWrite(11,HIGH);
```

```
digitalWrite(12,LOW);
digitalWrite(13,HIGH);
  }
  if(motion=="right")
  {
digitalWrite(10,LOW);
digitalWrite(11,HIGH);
digitalWrite(12,HIGH);
digitalWrite(13,LOW);
  }
  if(motion=="left")
  {
digitalWrite(10,HIGH);
digitalWrite(11,LOW);
digitalWrite(12,LOW);
digitalWrite(13,HIGH);
  }
  if(motion=="stop")
  {
digitalWrite(10,LOW);
digitalWrite(11,LOW);
digitalWrite(12,LOW);
digitalWrite(13,LOW);
  }

}
```

```
void loop() {
  // put your main code here, to run repeatedly:
int right=analogRead(A0);
int left=analogRead(A1);
Serial.print("Value of right sensor is:"+String(right));
Serial.print("\t");
Serial.println("Value of left sensor is:"+String(left));
delay(1000);
if(right==0&&left==0)
{
moveRobot("stop");
}
if(right>600&&left>600)
{
moveRobot("backward");
}
if(right==0&&left>600)
{
moveRobot("left");
}
if(right>600&&left==0)
{
moveRobot("right");
}
}
```

RELATED WORKS:

A. *Obstacle Avoidance Robot*
   This project is a plan to figure an obstacle avoidance robotic vehicle by means of ultrasonic sensors. A micro-controller (AT mega 8) is used to attain the desired action.
B. *Micro-Controller Based Obstacle Avoiding Autonomous Robot*
   Robot makes use of 8051 microcontroller to travel and escape the obstacle which is coming along the path.
C. *Implementing a LineTracing Robot as an effectiveSensor and Closed Loop system*
   This learning aims to explore "the usage of computer organised line follower robots in public transportation".
D. *Design and Fabrication of Line Follower Robot*
   In this a 700gm heaviness of a WLDR sensor based line follower robot which at all times guides along the black spot on the white surface.
E. *Sensor Based BlackLine Follower Robot*
   In this robot has usages of IR sensor to monitor convinced black line.
F. *An intelligent line-following robot project for introductory robot courses*
   The line-following robot planned in this editorial for educational purposes comprises not only precise line detection procedures with analogproductions of reflective optical sensors, but likewise home-made encoders, which benefit to record all statistics about the battling track.

G. *Arduino Based Bluetooth Controlled Robot*
   This paper customs a bluetooth module alongside with arduino board for the mechanism of robot.

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