PROJECT REPORT

Line Following Robot with Obstacle Avoidance

by

BHAVISHYA KUMAR	20BCE1874
AYESHA NUMA	20BCE1290
JOSIAH JAMES	20BCE1344
SAUMYA GOEL	20BCE1574
SHREYAA RAGHAVAN	20BCE1321

A project report submitted to

Dr. RAJESH R

50999

SCOPE

In fulfillment of the requirements for the course of

Robotics and Its Applications

In

B.Tech Computer Science and Engineering

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

Vandalur – Kelambakkam Road

Chennai – 600127
Winter 2022-2023

ACKNOWLEDGEMENT

We wish to express our sincere thanks and deep sense of gratitude to our project guide, **Dr. Rajesh,** School of Computer Science and Engineering for her consistent encouragement and valuable guidance offered to us throughout the course of the project work.

We are extremely grateful to **Dr. R. Ganesan, Dean,** School of Computer Science and Engineering (SCOPE), Vellore Institute of Technology, Chennai, for extending the facilities of the School towards our project and for his unstinting support.

We express our thanks to our **Head of the Department** for his support throughout the course of this project.

We also take this opportunity to thank all the faculty of the School for their support and their wisdom imparted to us throughout the courses.

We thank our parents, family, and friends for bearing with us throughout the course of our project and for the opportunity they provided us in undergoing this course in such a prestigious institution.

TABLE OF CONTENTS

ABSTRACT

This paper shows the design and implementation of the Line Follower Robot and its ability to select and follow the desired black line along the floor. This can be combined with different colours in the future scope. Since each colour has its own distinct property, the robot can therefore easily differentiate among different colours and possess the ability to detect the presence of an obstacle and choose the other path to find its target. It is programmed in such a way that instructions are given to the robot which senses a black line and attempts to move towards the target. The robot can easily move along very congested curves as it continuously data from the sensors. This robot avoids collisions and it can detect collisions with an obstacle sensor and hence reach the target. The proposed system can be implemented in any commercial, industrial, medical and also in educational labs

INTRODUCTION

The Line Following Robot is an autonomous robot that detects a path and according to the path drawn, it follows the path with the help of an IR sensor attached to the robot. The path is a distinguishable black line drawn over a white surface thus avoiding any detection error. The robot also consists of an obstacle sensor that detects any obstacle in its path thus avoiding any unnecessary accidents. Line follower robot is designed and programmed in such a way that it does its job perfectly without any error and detects it's given path. It operates in such a way that it detects and reads the path and transmits the signal to Arduino UNO. The microcontroller decides to make any changes (if needed) in the directions or speeds of the robot according to the inputs received. Thus, it sends the control signal to the speed and directions of the line follower robot. This way the line follower robot operates without any error. To make a line follower robot with object detection ability it is attached with an ultrasonic sensor, which is a device that can measure the distance between an object and robot by using sound waves. It calculates the distance between itself and the object obstructing it by sending a sound wave of a specific frequency and detecting the bounced sound wave at the receiver.

It is important to understand that some objects might not be detected by ultrasonic sensors. This can be applied for military purposes, delivery services, transportation systems, blind assisting applications

LITERATURE REVIEW

1. **A new approach for line following robot using radius of path curvature and differential drive kinematics**

Authors:
Jitendra Singh; Prashant Singh Chouhan

Description:
The paper describes in detail an idea using geometry to determine the radius of path curvature and based on it the desired difference between angular velocity of two wheels is calculated using Differential drive Kinematics. This robot uses an array of IR reflective sensors to find out the degree to which a circular arc deviates from a straight line. In this scheme a single PID controller is used to control the desired angular velocity for both wheels. To maintain the circular path of desired radius with constant linear velocity, the output of the same PID controller is added in the left wheel actuator and subtracted from right wheel actuator. Therefore the desired Radius of circular arc is followed by robot.

Citation:
J. Singh and P. S. Chouhan, "A new approach for line following robot using radius of path curvature and differential drive kinematics," 2017 6th International Conference on Computer Applications In Electrical

Engineering-Recent Advances (CERA), Roorkee, India, 2017, pp. 497-502, doi: 10.1109/CERA.2017.8343380.

2. **Line Following Autonomous Driving Robot using Deep Learning**

Authors:

Reza Javanmard; Amir Hossein Zabbah; Mohammad Karimi; Kossar Jeddisaravi

Description:

In this paper, they have proposed a deep neural network for the learning of an autonomous line following robot. In this way, the robot can autonomously drive and follow the line painted on the ground. First of all, a sufficient amount of data was collected for training the network with images and videos. Consequently, CNN and RNN models were applied to learn and classify the robot states. Experimental results in a simulator show the efficiency of the proposed approach.

Citation:

R. Javanmard, A. H. Zabbah, M. Karimi and K. Jeddisaravi, "Line Following Autonomous Driving Robot using Deep Learning," 2020 6th Iranian Conference on Signal Processing and Intelligent Systems (ICSPIS), Mashhad, Iran, 2020, pp. 1-5, doi: 10.1109/ICSPIS51611.2020.9349547.

3. **Two Wheels Line Following Balancing Robot Control using Fuzzy Logic and PID on Sloping Surface**

Authors:

Nurul Hasanah; Ali Husein Alasiry; Bambang Sumantri

Description:

The robot proposed in this paper is a robot that can follow the line and also be balanced on the sloping area while moving only by two wheels on the right and left side of the robot. Distance controller is used for the movement of the robot that uses rotary encoder sensor to calculate its traveled distance and uses Proportional Integrated Derivative controller to convert it to angle. That angle will change the center of gravity of the robot to make the robot keep moving forward on the flat or sloping area. The balancing control used in this robot is Fuzzy Logic to maintain the robot stable on the set point position. An angle error for Fuzzy Logic input combines the tilt feedback from IMU and the output of the distance controller. To be able to follow the line, the robot uses a Proportional Derivative controller. The output of line following control will be combined with the output of balancing control to make the robot balanced while following the line. By combining the three controllers above, the robot is able to balance not only on the flat area but also on the sloping area while moving to follow the line.

Citation:

N. Hasanah, A. H. Alasiry and B. Sumantri, "Two Wheels Line Following Balancing Robot Control using Fuzzy Logic and PID on Sloping Surface," 2018 International Electronics Symposium on Engineering Technology and Applications (IES-ETA), Bali, Indonesia, 2018, pp. 210-215, doi: 10.1109/ELECSYM.2018.8615483.

4. Design & implementation of a line following robot for irrigation based application

Authors:

Rabiul Hossen Rafi; Shuva Das; Nawsher Ahmed; Iftekhar Hossain; S. M. Taslim Reza

Description:

The agriculture sector is the backbone of an economy which provides the basic ingredients to mankind and raw materials for industrialization. With the increasing number of the population over the world, the demand for agricultural products has also increased. In order to increase the production rate, irrigation techniques should be more efficient. The irrigation techniques used till date are not in satisfactory level, especially in a developing country like Bangladesh. This paper has proposed a line follower robot for irrigation based application which may be considered as a cost-effective solution by minimizing water loss as well as an efficient system for irrigation purposes. This proposed system does not require an operator to accomplish its task. This gardening robot is completely portable and is equipped with a microcontroller, an on-board water reservoir, and an attached water pump. The area to be watered by the robot can be any field with plants, placed in a predefined path. It is capable of comparing movable objects and stationary plants to minimize water loss and finally watering them autonomously without any human intervention. The designed robot was tested and it performed nicely.

Citation:

R. H. Rafi, S. Das, N. Ahmed, I. Hossain and S. M. Taslim Reza, "Design & implementation of a line following robot for irrigation based application," 2016 19th International Conference on Computer and Information Technology (ICCIT), Dhaka, Bangladesh, 2016, pp. 480-483, doi: 10.1109/ICCITECHN.2016.7860245.

5. **Sensor based autonomous color line follower robot with obstacle avoidance**

Authors:

Kazi Mahmud Hasan; Abdullah Al-Nahid; K. J. Reza; S. Khatun; M. R. Basar

Description:

This paper introduces the multiple source Multiple Destination Robot (MDR-1) having the ability to choose a desired line among multiple lines autonomously. Every line has different colors as their identities. The robot can differentiate among various colors and choose a desired one to find its target. Unlike any other simple line follower robot, this robot can be considered as a true autonomous line follower robot having the ability to detect the presence of obstacles on its path. A powerful close loop control system is used in the robot. The robot senses a line and endeavors itself accordingly towards the desired target by correcting the wrong moves using a simple feedback mechanism but yet a very effective closed loop system. The robot is capable of following very congested curves as it receives the continuous data from the sensors.

Citation:

K. M. Hasan, A. Al-Nahid, K. J. Reza, S. Khatun and M. R. Basar, "Sensor based autonomous color line follower robot with obstacle avoidance," 2013 IEEE Business Engineering and Industrial Applications Colloquium (BEIAC), Langkawi, Malaysia, 2013, pp. 598-603, doi: 10.1109/BEIAC.2013.6560199.

6. Vision-Based Line Following Robot in Webots

Authors:

Alfian Ma'arif; Aninditya Anggari Nuryono; Iswanto

Description:

Line following robot is one of the popular robots commonly used for educational purposes. The most widely used sensors for the robots are photoelectric sensors. However, it is irrelevant, along with the development of autonomous vehicles and robotic vision. Robotic vision is a robot that can obtain information through image processing by the camera. The camera installed on the line following the robot aims to detect image-based lines and to navigate the robot to follow the path. This paper proposed a method of image preprocessing along with its robot action for line-following robots. This includes image preprocessing such as dilation, erosion, Gaussian filtering, contour search, and centerline definition to detect path lines and to determine the proper robot action. The implementation of the robot is

simulated using Webots simulator. OpenCV and Python are utilized to design line detection systems and robot movements. The simulation result shows that the method is implemented properly, and the robot can follow a different type of path lines such as zigzag, dotted, and curved lines. The resolution of the cropped-image frame is the fundamental parameter in detecting path lines.

Citation:

A. Ma'arif, A. A. Nuryono and Iswanto, "Vision-Based Line Following Robot in Webots," 2020 FORTEI-International Conference on Electrical Engineering (FORTEI-ICEE), Bandung, Indonesia, 2020, pp. 24-28, doi: 10.1109/FORTEI-ICEE50915.2020.9249943.

7. A line follower robot from design to implementation: Technical issues and problems

Authors:

Pakdaman, Mehran & Sanaatiyan, Mohammad Mehdi & Rezaei, Mahdi

Description:

The Line follower robot is a mobile machine that can detect and follow a line drawn on the floor. It is designed and tested to attend the Tabrize line follower robots competition, but it has encountered technical and mechanical problems. This Paper illustrates the process of design, implementation and testing TABAR, a small line follower robot designed for the competition, and investigates the technical and mechanical issues and problems.

Citation:

Pakdaman, Mehran & Sanaatiyan, Mohammad Mehdi & Rezaei, Mahdi. (2010). A line follower robot from design to implementation: Technical issues and problems. 5 - 9. 10.1109/ICCAE.2010.5451881.

8. **Development and Applications of Line Following Robot Based Health Care Management System**

Authors:

Punetha, Deepak & Kumar, Neeraj & Mehta, Vartika

Description:

This paper report describes the techniques for analyzing, designing, controlling and improving the health care management system. It focuses on the delivery of safe, timely, efficient, effective, patient-centered and equitable health care. A Line follower robot is an electronic system that can detect and follow the line drawn on the floor. Light dependent resistor sensor has been attached with the robot, which varies with light intensity. A switch with IR sensor has been fitted near the patient, and a flag bit set in the microcontroller allows the robot to follow the line and provide the medicine to the patient with the help of dc motor. A proximity sensor also has been attached to the robot so that it can detect any obstacle on their ways and can alarm.

Citation:

Punetha, Deepak & Kumar, Neeraj & Mehta, Vartika. (2013). Development and Applications of Line Following Robot Based Health Care Management System. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET_. 2. 2446-2450)

9. Line Follower Using Arduino And Its Applications

Authors:

Md Younus, Pooja Gadekar, Adhiraj Walse

Description:

This paper builds a Line following Robot using IR sensor to follow a designated path and run over it. It will move in a particular direction specified by the user to navigate the robot through a black line marked on the white surface. Automatic parking technology can complete parking operations safely and quickly without a driver, improving driving comfort and reducing the probability of accidents.

10. Line following robot for library inventory management system

Authors:

J. Thirumurugan; M. Vinoth; G. Kartheeswaran; M. Vishwanathan

Description:

This paper demonstrates the application of Line Following Robot (LFR) for library inventory management system (LIMS). A line following robot is designed using sensor operated motors to keep track the line path predetermined for library book shelf arrangements. The robot carries a barcode reader which collects the barcode data from the books arranged in a vertical manner and compares the decoded barcode data with the search input. If the robot reaches the book which is to be found out, then the robot gives location of the book to the librarian or the person visiting the library, in which the robot is used for searching purpose. In case of any hindrance faced by the robot when it does the searching process, the robot halts and sends an alarm. Misplaced books can be rearranged using the pre-programmed data in the robot which helps to maintain the books in an order. This helps and simplifies the job of arranging the books and also reduces the manual routine work done by the library staff.

Citation:

Rushad Mehta, Abhay Sahu, "Autonomous Robot for Inventory Management in Libraries", 2020 IEEE International Students' Conference on Electrical,Electronics and Computer Science (SCEECS), pp.1-6, 2020.

11. Design and implementation of an outdoor line follower robot for RoboCup search and rescue league

Authors:

Mustafa Burak Dılaver; Erkan Uslu; Furkan Çakmak; Nihal Altuntas; M. Fatih Amasyali; Sırma Yavuz

Description:

RoboCup is the most prestigious robotics contest in the world, with increasing popularity among robot communities and new contests. In this study, design and implementation of a line follower robot for outdoor categories which have been recently added to RoboCup Search and Rescue League is emphasized. In this category, a 100m long colored rope is placed in a field whose floor is made of sand, concrete and laminate and the competing robots are ranked according to the maximum trajectory distance that they cover in 20 minutes. The track is made of right and acute angle parts for the robot which is expected to follow the line including also 15° ramps. The robot which is implemented on ROS (The Robot Operating System) follows the line with the camera sensor above it.

Citation:

Meer Shadman Shafkat Tanjim, Mahedi Islam Rizvi, Ashrafun Nushra Oishi, "Impact Analysis of Body Materials for Robo-Res 2.0 & 3.0: Part of Humanoid Rescue Robot", 2021 IEEE International Conference on Robotics, Automation, Artificial-Intelligence and Internet-of-Things (RAAICON), pp.94-97, 2021.

12. Design and implementation of static and dynamic objects store systems using line follower robots

Authors:

Fatima R. Ali; Abdulmuttalib T. Rashid

Description:

This paper introduces static and dynamic methods for objects store system using the line follower robot. The static means the robot moves on static lines to reach to any store location while the dynamic means that the arranged of the following lines is changed according to the location of the storage box. The static objects store system is represented by the Digital differential algorithm DDA and the dynamic objects store system is represented by the Bezier curve algorithm. In both environments the propose store system consists of several boxes that arranged in several columns. These boxes can be used to store and return small objects like mobile phones according to a secret code that entered from a user interface unit. The principle of store and restore of these objects is dependent on using line follower mobile robots. Both the methods are designed and software implemented in an environment with thirty boxes arranged in four columns. The comparisons between these algorithms are shown with respect to the length of the paths and time of arrival.

Citation:

Hanan M. Hameed, Abdulmuttalib Turky Rashid, Khairia A. Al Amry, "Automatic Storage and Retrieval System using a Single Mobile Robot", 2020 International Conference on Electrical, Communication, and Computer Engineering (ICECCE), pp.1-6, 2020.

13. Straight-line path following in cleaning robots using lateral ultrasonic sensors

Authors:

J. Palacin; X. Lasa; S. Marco

Description:

Floor cleaning is a typical mobile robot application. In general, the cleaning operation requires an algorithm for real-time path generation for complete floor coverage, however, a mobile robot has many problems to follow a given path because on the on board sensors error. In this paper, a procedure for straight-line parallel path following using lateral ultrasonic measurements is introduced. The procedure does not require the use of specific landmarks and is based on the creation of a reference lateral distance vector that can be used during the cleaning procedure to align the robot in consecutive parallel paths.

Citation:

Jieru Chi, Guowei Yang, Jie Yang, "The on-line coverage algorithm and localization technique of the intelligent cleaning robot", 2008 IEEE International Conference on Networking, Sensing and Control, pp.943-948, 2008.

14. Design Implementation of High-Performance Line Following Robot

Authors:

Milan Shah; Viraj Rawal; Jay Dalwadi

Description:

Nowadays, in hospitals, in medical centers, in farming, in the military, on factory floors, in each and every field application of robotics is increasing day by day. Line following robot is one of the widely used robots. Basically, line following robot is an autonomous mobile system which follows the line which has a different color from the background. So the performance of these line following robots heavily depends upon its efficiency in differentiating the line from the background. Many robotic events based on the line following robot are organized at college as well as industry level all across the world. In this paper, we have described various problems we faced while designing the line following system for the robot for ROBOCON 2016 (International robotics event), how we overcome them and how we designed the most optimized, efficient and high-performance line following system.

Citation:

Sudha Ellison Mathe, Ashok Chakravarthy Pamarthy, Hari Kishan Kondaveeti, Suseela Vappangi, "A Review on Raspberry Pi and its Robotic Applications", 2022 2nd International Conference on Artificial Intelligence and Signal Processing (AISP), pp.1-6, 2022.

15. Vision-based system for line following mobile robot

Authors:

A. H. Ismail; H. R. Ramli; M. H. Ahmad; M. H. Marhaban

Description:

A vision based application is proposed for a line following mobile robot. A low-cost webcam is used as the sensor and the image buffers are processed via a customized image segregation method to output necessary information for the mobile robot's controller under uncontrollable lighting condition. The task is to allow the mobile robot to navigate through a predefined path marked by a white line on a dark green floor surface. Experimental results shows that the mobile robot successfully able to navigate throughout the provided path. This technique is robust, reliable and easily modified for used in any other applications, such in industrial applications where costly sensors and transducers are normally used.

Citation:

Ata Jahangir Moshayedi, S. Mohammadali Zanjani, Dangling Xu, Xi Chen, Guijiang Wang, Shuxin Yang, "Fusion BASED AGV Robot Navigation Solution Comparative Analysis and Vrep Simulation", 2022 8th Iranian Conference on Signal Processing and Intelligent Systems (ICSPIS), pp.1-11, 2022.

EXISTING WORK

In robotics there are many systems invented which have different applications in different fields. Robotics is a very popular field for research and manufacturing. Pakdaman M. et.al has designed a small line following robot which uses IR sensors to detect the line drawn on the floor . Priyank Patil has developed an AVR line following robot which can detect the line drawn on the floor with the help of a sensor array. When its sensor is passing through the line drawn on the way then it reads 0 and vice versa . That system was designed for the robot competition. Colak I. et.al has designed a line following robot to use in the shopping malls for entertainment. That system used a 4.8 cm wide black line to carry a maximum load of 400 kg. Two wheel balancing robot has been developed by Nor Maniha Abdul Ghani et.al, which has the line following capability and for balancing it, they used infrared distance sensor to solve the problem in inclination , They also used a manual control with the help of a remote controller.

A 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 is tested in different conditions. 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 [14]. This system uses an array of 8 IR sensors and several LEDs.

M. Zafri Baharuddin et.al designed a mobile robot which can be used for navigation purposes. An intelligent robot system is designed by Bajestani S. E. M.

which can give corrective feedback in different colours of light. 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. Kazi Mahmud Hasan et.al designed a sensor based autonomous color line following robot with obstacle avoidance, this robot can follow not only black and white colors but also some other different colors. This robot includes electronic logic gates as a brain instead of a microcontroller.

RESEARCH GAP

Some of the existing solutions to avoid obstacles and line following robots are presented here along with their drawbacks that calls for the necessity of our proposed project.

One of the proposed solutions to avoid obstacles is Moving obstacle avoidance of a mobile robot using a single camera. Some of the components involved in this report are the mobile robot and the camera.. This system is designed to avoid collisions between a mobile robot and dynamic obstacles. The authors used the Block-based motion estimation method to avoid collisions of robots. This robot can detect approaching obstacles such as walking humans, but sometimes it did not detect the object due to the colour of the object and the reflected light.

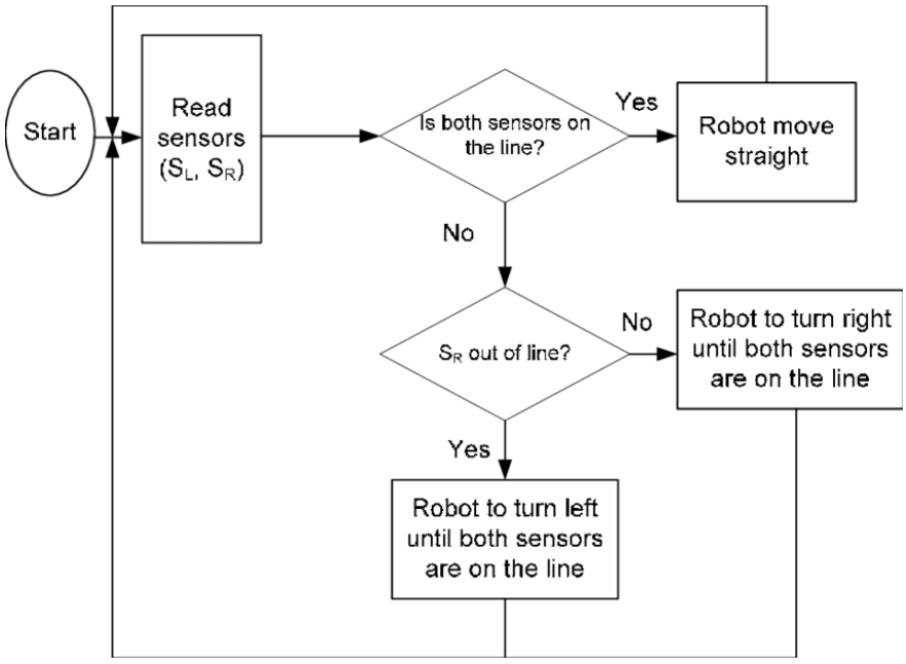
An already existing proposal that is used for obstacle avoidance is An IoT Based Obstacle Avoidance Robot Using Ultrasonic Sensor and Arduino. Some of the components involved in this report are Arduino UNO, Ultrasonic Sensor, and DC motor. This system detects obstacles using an ultrasonic sensor. The Ultrasonic sensors work on ultrasonic sound waves. An ultrasonic wave is transmitted, it hits an object and returns. The time consumed until the wave returns to the origin is used to calculate the distance. But there may be some problems if there are sound absorbs with the object or if an echo is produced due to multiple sound waves returning to the origin at the same time, which is a major drawback of this robot.

Another proposal that is used for the path following is Vision-Based LineFollowing Control of a Two-Wheel Self-Balancing Robot. Some of the components involved in this report are an IP Camera, Arduino Mega 2560, Control

board, Motor driver, DC motor, HC-05 Bluetooth, MPU 6050, and Motor encoder. This system can trace the black line on the map, and the robot follows the black line as its path. An IP camera is a particular kind of digital video camera that communicates with an IP network to receive control data and transmit picture data. They are frequently employed for surveillance, but unlike analog closed-circuit television (CCTV) cameras, only a local area network is used. IP Cameras are generally used to monitor a fixed area.It is fixed on the top of the robot. IP cameras are quite expensive than traditional cameras.

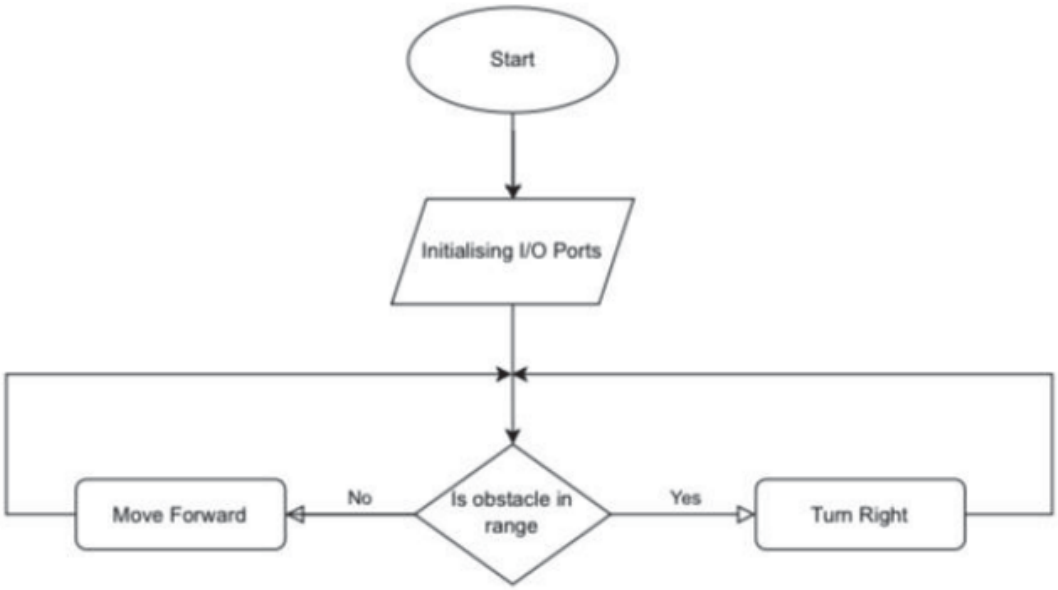
FLOW IDEA

The flow-chart shown below describes the robot that follows the line. Initially the robot will start by getting readings from the sensor, and sees whether the robot is on the predefined path or not. If the robot is in the predefined path, then it moves in a given path. When the robot is not on a predefined path then the robot stops and remains there until it is able to detect black line in its vicinity again.



The flowchart following this description shows the control algorithm of an obstacle avoidance robot. Initially when the robot is activated, it reads the signal from the ultrasonic sensor to check whether any obstacle is present. If the obstacle is detected then the robot is made to stop and move to the right, and again check for the obstacle presence signal. If the obstacle is not found, then the robot moves to the right. The robot moves to the right and checks for the signal until it finds a path

without any obstacles. In such cases the robot proceeds to move along the path until the next obstacle is detected.



ARCHITECTURE PROPOSED

The architecture of the robot proposed can be divided into several parts as follows:

- Arduino UNO
- L293D (Motor Driver)
- HC-SR04 (Ultrasonic Sensor)
- IR Sensor
- Jumper Wires
- IC 7805
- Chassis
- Castor Wheel
- Batteries

Arduino UNO

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller.

L293D (Motor Driver)

The L293 and L293D devices are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V.

HC-SR04 (Ultrasonic Sensor)

The HC-SR04 ultrasonic sensor uses SONAR to determine the distance of an object just like the bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package from 2 cm to 400 cm or 1" to 13 feet.

IR Sensor

The Infrared (IR) sensors consist of Infrared (IR) LED and Infrared (IR) photodiodes. The IR LED is called a photoemitter and the IR photodiode is called a receiver. The IR light emitted by the LED strikes the surface and gets reflected back to the photodiode. Then the photodiode gives an output voltage which is proportional to the reflectance of the surface which will be high for a light surface and low for dark surface. Light coloured objects reflect more IR light and dark coloured objects reflect less IR light

Jumper Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed

IC 7805

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It converts a positive voltage (7-29V) to +5 volts.

Chassis

Basic chassis for building your own Arduino robot car etc. The acrylic base is pre-drilled & routed to mount the gear motor/Tire assemblies, a 4 “AA” cell battery holder and a small caster for the rear wheel. Motors: 5-10 VDC with Tach disks.

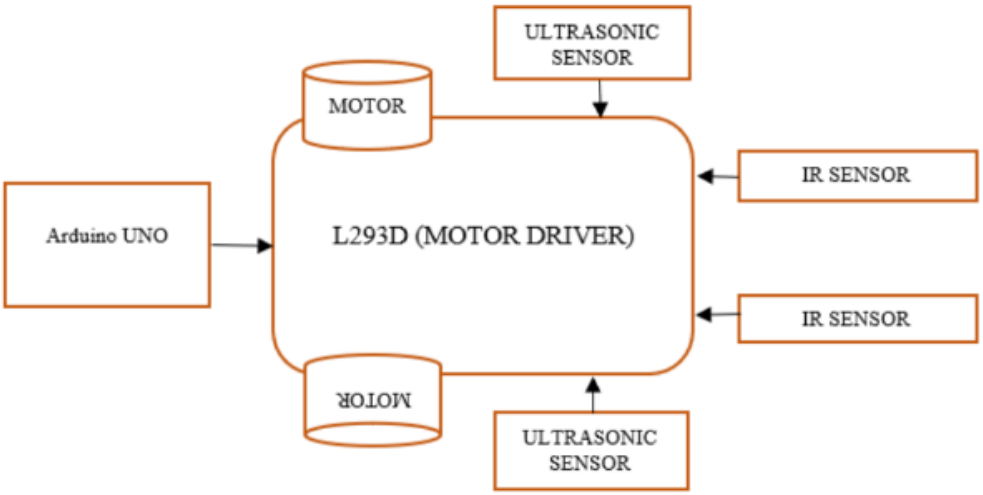
Castor Wheel

A caster (or castor) is an undriven, single, double, or compound wheel that is designed to be mounted to the bottom of a larger object (the "vehicle") to enable that object to be easily moved. They are available in various sizes and are commonly made of rubber, plastic, nylon, aluminium, or stainless steel.

Batteries

A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, mobile phones, and electric cars.

The architecture of the robot is such that the Arduino UNO microcontroller sends a set of signals to the L293D and uses the Motor Shield L293D. All kinds of processing take place in the Arduino UNO microcontroller. Two Dc Motors are connected with the motor shield as well as Two IR sensors and two Ultrasonic Sensors are connected to the motor shield. They send signals through the L293D to the Arduino. The 11v Lithium Polymer battery powers the whole system.



The connections are as follows-

Connection between Motor Driver and Arduino:

Motor Driver	Arduino
N 1	10
IN 2	9
IN 3	6
IN 4	5
VCC/12V	Vin/5V
GND	GND
5V	5V

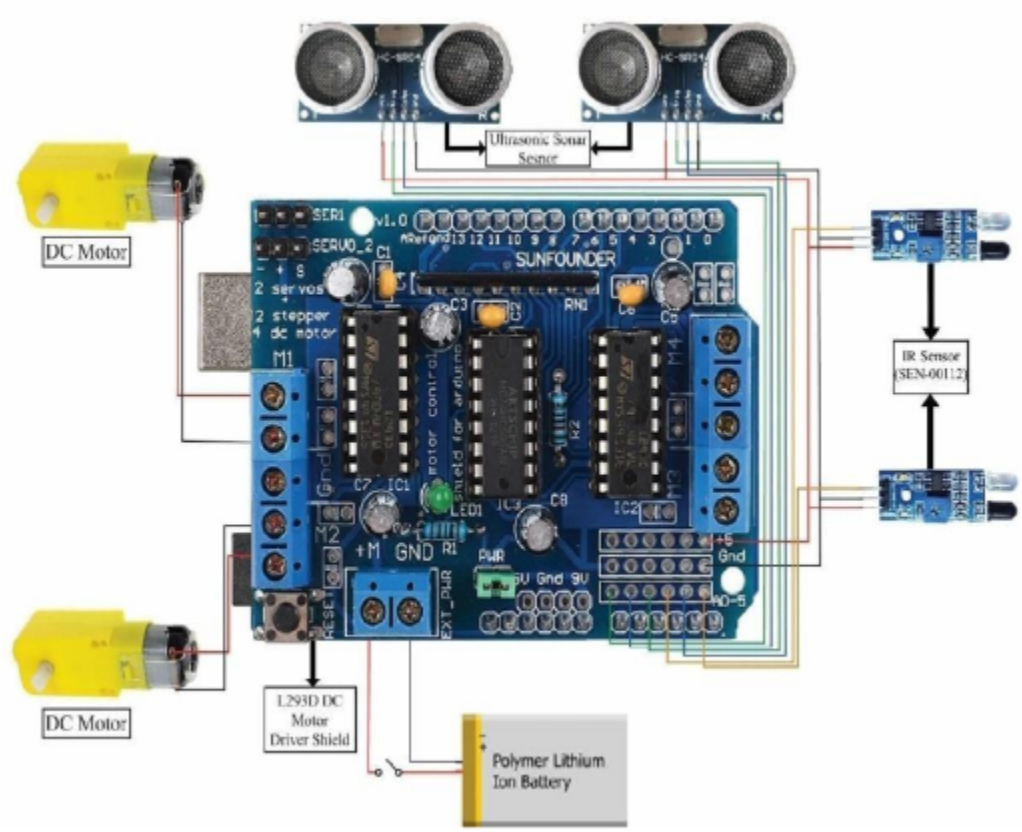
Connection between IR Sensor and Arduino:

Sensor 1	
IR Sensor	**Arduino**
VCC	VCC
GND	GND
OUT	A0
Sensor 2	
IR Sensor	**Arduino**
VCC	VCC
GND	GND
OUT	A1

Connection between Ultrasonic Sensor and Arduino:

Ultrasonic Sensor	**Arduino**
GND	GND
ECHO	A3
TRIG	A5
VCC	VCC

System Architecture:



CODES

```
#include <NewPing.h>
#include <Servo.h>
#include <AFMotor.h>

//hc-sr04 sensor
#define TRIGGER_PIN A2
#define ECHO_PIN A3
#define max_distance 50

//ir sensor
#define irLeft A0
```

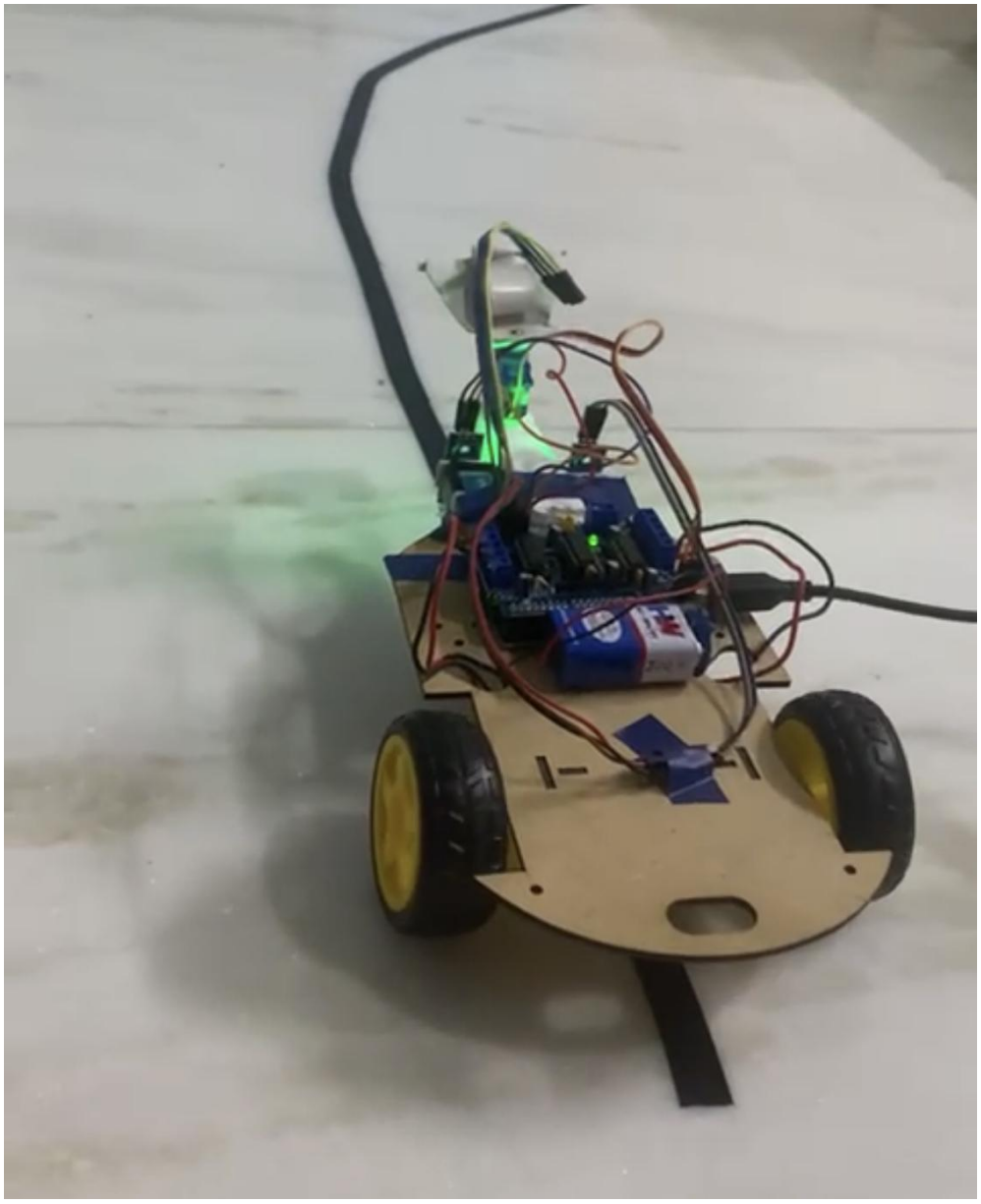
```
#define irRight A1

//motor
#define MAX_SPEED 200
#define MAX_SPEED_OFFSET 20

Servo servo;

NewPing sonar(TRIGGER_PIN, ECHO_PIN, max_distance);

AF_DCMotor motor1(1, MOTOR12_1KHZ);
AF_DCMotor motor2(2, MOTOR12_1KHZ);
AF_DCMotor motor3(3, MOTOR34_1KHZ);
AF_DCMotor motor4(4, MOTOR34_1KHZ);

int distance = 0;
int leftDistance;
int rightDistance;
boolean object;

void setup() {
 Serial.begin(9600);
 pinMode(irLeft, INPUT);
 pinMode(irRight, INPUT);
 servo.attach(10);
 servo.write(90);

 motor1.setSpeed(220);
 motor2.setSpeed(220);
 motor3.setSpeed(220);
 motor4.setSpeed(220);
}

void loop() {
 if (digitalRead(irLeft) == 0 && digitalRead(irRight) == 0 ) {
   objectAvoid();
   //forword
 }
 else if (digitalRead(irLeft) == 0 && digitalRead(irRight) == 1 ) {
   objectAvoid();
   Serial.println("TL");
   //leftturn
   moveLeft();
 }
 else if (digitalRead(irLeft) == 1 && digitalRead(irRight) == 0 ) {
   objectAvoid();
   Serial.println("TR");
   //rightturn
   moveRight();
 }
 else if (digitalRead(irLeft) == 1 && digitalRead(irRight) == 1 ) {
   //Stop
   Stop();
```

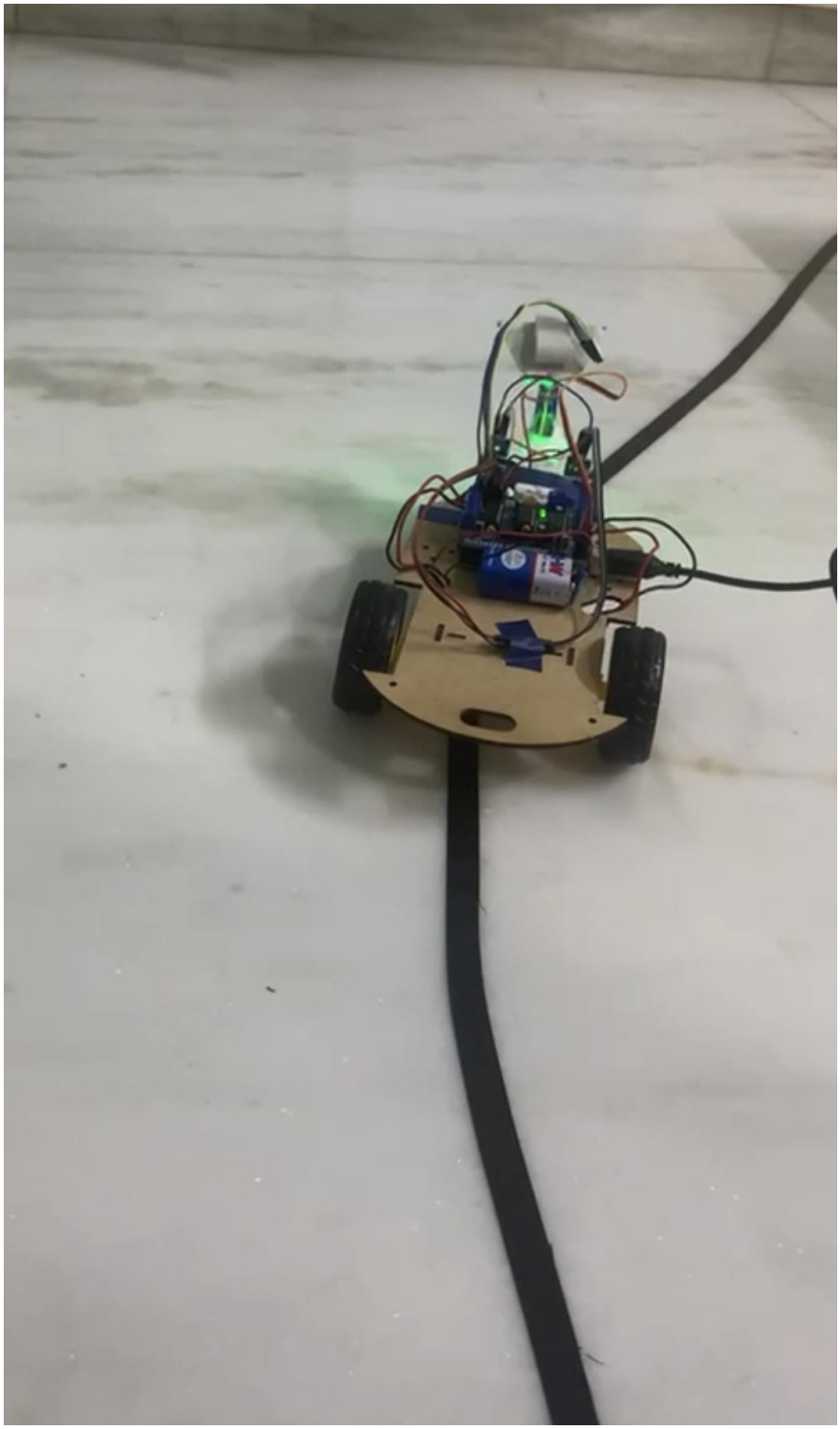
```
 }
}

void objectAvoid() {
 distance = getDistance();
 if (distance <= 15) {
   //stop
   Stop();
   Serial.println("Stop");

   lookLeft();
   lookRight();
   delay(100);
   if (rightDistance <= leftDistance) {
     //left
     object = true;
     turn();
     Serial.println("moveLeft");
   } else {
     //right
     object = false;
     turn();
     Serial.println("moveRight");
   }
   delay(100);
 }
 else {
   //forword
   Serial.println("moveforword");
   moveForward();
 }
}

int getDistance() {
 delay(50);
 int cm = sonar.ping_cm();
 if (cm == 0) {
   cm = 100;
 }
 // Serial.println(cm);
 return cm;
}

int lookLeft () {
 //lock left
 servo.write(150);
 delay(500);
 leftDistance = getDistance();
 delay(100);
 servo.write(90);
 Serial.print("Left:");
 Serial.print(leftDistance);
 return leftDistance;
```

```
 delay(100);
}

int lookRight() {
 //lock right
 servo.write(30);
 delay(500);
 rightDistance = getDistance();
 delay(100);
 servo.write(90);
 Serial.print("   ");
 Serial.print("Right:");
 Serial.println(rightDistance);
 return rightDistance;
 delay(100);
}
void Stop() {
 motor1.run(RELEASE);
 motor2.run(RELEASE);
 motor3.run(RELEASE);
 motor4.run(RELEASE);
}
void moveBackward() {
 motor1.run(FORWARD);
 motor2.run(FORWARD);
 motor3.run(FORWARD);
 motor4.run(FORWARD);
}
void moveForward() {
 motor1.run(BACKWARD);
 motor2.run(BACKWARD);
 motor3.run(BACKWARD);
 motor4.run(BACKWARD);

}
void turn() {
 if (object == false) {
   Serial.println("turn Right");
   moveLeft();
   delay(700);
   moveForward();
   delay(800);
   moveRight();
   delay(900);
   if (digitalRead(irRight) == 1) {
     loop();
   } else {
     moveForward();
   }
 }
 else {
   Serial.println("turn left");
   moveRight();
```

```
    delay(700);
    moveForward();
    delay(800);
    moveLeft();
    delay(900);
    if (digitalRead(irLeft) == 1) {
      loop();
    } else {
      moveForward();
    }
  }
}
void moveRight() {
 motor1.run(BACKWARD);
 motor2.run(BACKWARD);
 motor3.run(FORWARD);
 motor4.run(FORWARD);
}
void moveLeft() {
 motor1.run(FORWARD);
 motor2.run(FORWARD);
 motor3.run(BACKWARD);
 motor4.run(BACKWARD);
}
```

SCREENSHOTS





CONCLUSION

The line following and obstacle avoidance robot project aimed to create a robot that can follow a line and avoid obstacles. While the line following part of the project worked well, the robot faced issues with obstacle avoidance. This is a complex problem that requires sophisticated sensors and algorithms. Despite the challenges faced, the project provided valuable experience in designing, building, and programming a robot, and highlighted the importance of testing and iteration to improve performance. Overall, this project is a great example of the potential of robotics to solve real-world problems with further development and refinement.

To improve the robot's obstacle avoidance capability, it may be necessary to explore more advanced sensor technologies such as LIDAR, ultrasonic sensors or depth cameras, which can provide more accurate and reliable obstacle detection. Additionally, optimising the robot's path planning algorithm and its movement control can improve its ability to navigate around obstacles in a timely and efficient manner. These are important considerations for future iterations of the line following and obstacle avoidance robot project.

REFERENCE

[1]. Pakdaman,M.Sanaatiyan,M.M.,"Design and Implemen tation of Line Follower Robot,", Second International Conference on Computer and Electrical Engineering TCCEE '09, vol.2, pp.585-590,Dec.2009.

[2]. PriyankPatil,"AVR Line Following Robot," Department of Information Technology K. 1. Somaiya College of Engineering Mumbai, India. Mar 5, 2010.

[3]. Dean A. Pomerleau; Jay Gowdy; Charles E. Thorpe, "Combining Artificial Neural Networks and Symbolic Processing for Autonomous Robot Guidance," Engng Applic. Artif. Intell. Vol. 4, No. 4, pp. 279-285, 1991.

[4]. L1U Shi-Cai,L1U Guang-Jun, "Formation Control of Mobile Robots with Active ObstacleAvoidance," Acta Automatica Sinica, Vol. 33, No. 5, 2007.

[5]. YANG Tian-Tian; L1U Zhi-Yuan; CHEN Hong; PEl Run, "Formation Control and Obstacle Avoidance for Multiple Mobile Robots," Acta Automatica Sinica, Vol. 34, No. 5, 2008.

[6]. Sandhana, Lakshmi (2002-09-05), "A Theory of Evolution for Robots, "Wired Magazine ... Retrieved 2007- 10-28.

[7]. J.Kramer and M. Scheutz, "Development environments for autonomous mobile robots: A survey, "Autonomous Robots, vol. 22.

[8]. Floreano, D.,Mondada F.,"Evolutionary neurocontrollers for autonomous mobile robots," Neural Networks 11, pp. 1461-1478, 1998.

[9]. Hagras,H., Pounds-cornish, A., Colley, M., Callaghan, V.,Clarke,G.: Evolving Spiking Neural Network Controllers for Autonomous Robots. Proceedings of the 2004 IEEE International Conference on Robotics and Automation , pp. 4620-4626., 2004

[10]. Charles A. Schuler, Willam L. McNamee, "Industrial Electronics and Robotics," McGraw-Hill International Edition, Industrial Electronics Series 2003.

[11]. Nor Maniha Abdul Ghani, FaradilaNaim, Tan Pi own yon, "Two Wheels Balancing Robot with Line Following Capability ".

[12]. Colak, I., Yildirim, D.,"Evolving a Line Following Robot to use in shopping centers for entertainment", Industrial Electronics, 2009. IECON '09. 35th Annual Conference of IEEE, pp.3803 - 3807, 3-5 Nov. 2009.

[13]. T. Gomi, K. Ide, "Evolution of gaits of a legged robot", IEEE International Conference on Fuzzy Systems 06/1998; DOI:10.1109/FUZZY.1998.687476 ISBN: 0-7803-4863-X In proceeding of: Fuzzy Systems Proceedings, 1998.

[14]. Román Osorio," Intelligent Line Follower Mini-Robot System", International Journal of Computers, Communications & Control Vol. I, No.2, pp.73-83, 2006.

[15]. M. Zafri Baharuddin, Izham Z. Abidin, S. Suleiman Kaja Mohideen, Yap Keem Siah, Jeffrey Tan Too Chuan,"Analysis of Line Sensor Configuration for the Advanced Line Follower Robot", University Tenaga Nasional.