SMART FACTORY NAVIGATION USING AUTONOMOUS GUIDED VEHICLES (AGVs)

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Abstract—

Line follower is a smart autonomous robot that detects or follows a visible line embedded in the ground. The trail is predetermined and can be selected with a high contrast color or with a black line visible on the trail surface. Infrared sensors are used to detect these lines. Typically speaking, the area unit of the infrared sensors is used to locate the path that the robot has to follow. The robot movement is automatic and can be used for applications of long distances. It is the fundamental line follower robot's function. The device proposed for commercial, medical, rescue and military operations are extremely useful. In particular, these past constraints are no longer necessary with recent technological advances in computing. The production of tracking systems can now be made more capable of reliably estimating the target location behind the obstacle. The benefit of these technologies consists in the possibility of using an ultrasonic method for measurement without direct contact with a target. Different models and systems for indoor and outdoor object detection have been described in the literature. Using optical, heat base, infrared and ultrasonic approaches, object localization techniques were introduced. Indoor positioning systems monitor and locate objects and enclose environments inside buildings. Wireless methods, optical tracking, and ultrasonic techniques are used for object position detection systems. The goal of this study is to develop a monitoring system that follows certain paths and can detect objects and edges using ultrasonic frequencies. If some object is put, a regular line follower will try to move and smash the obstacle. This prototype of line follower robot tries to push the limit little to overcome this issue. It has been built in a way that any obstacle in front of it can be identified. It will stop and will not pass until the barrier remains. Also, it is able to identify every front edge and comply similarly.

Keywords: Line Following Robot, Arduno uno, Servo motor

INTRODUCTION

LINE FOLLOWING ROBOT

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. Autonomous robot are robots that can perform with a high degree of autonomy, which is particularly desirable in fields such as space exploration, cleaning floors, mowing lawn, and waste water treatment. Some modern factory robots are "autonomous" within the strict confines of their direct environment. It may not be that every degree of freedom exists in their surrounding environment, but the factory robot's workplace is challenging and can often contain chaotic, unpredictable variables. The exact orientation and position of the next object of work and even the type of object and the required task must be determined. This can vary unpredictably. One important area of robotics research is to enable robot to cope with its environment whether this be on land, underwater, in the air, underground, or in space.

The project is designed to develop a robotic vehicle that follows a specific pathA pair of photo sensors comprising IR transmitter and photo diode is interfaced to the controller to detect the specified path for its movement.Line follower robot is a useful robot that is used in ware houses, industries, and stores etc, where it follows a dedicated path. This proposed system of a line following robot fulfils the desired functionality and demonstrates the working of it. It uses a pair of photo sensors, comprising of one IR transmitter and a photo diode in each. It guides the robot to follow a specified path by giving appropriate signal to the microcontroller. Two DC motors are used interfaced to the microcontroller through a motor driver IC. Input signals given to the microcontroller from the sensors and then the controller takes the appropriate action according to the program written in it and drives motors as desired.Further the project can be enhanced by adding more advanced sensors to it. This will add more features to the existing project. For example, we can use ultrasonic sensors for detect any obstacle in front of the robot and to take appropriate action.

MOTIVATION

In time of automation advances to reduce human efforts, it is necessary to develop colour line following robot, this robot can be used in airports to carry equipment and baggage from one place to another place, and it can be used for home automation, in restaurant it is used as robotic waiter like in Robot Restaurant in Porur, Chennai. It was opened in November 2017. Advantage of such robots is that they can operate efficiently for 6-7 long hours with a single charge. Thus, it is profitable for the business itself. Therefore, for a large country like India, it is necessary to use the line following robots in restaurants, industries etc. Such Robots come into play when large and heavy machineries are to be transferred from one place to another within industries. This technology can be implemented in running buses or other mass transit systems.

A Robot is a machine which is completely automatic, i.e. it starts on its own, decides its own way of work and stops on its own. Robotics has greatly advanced in the developed countries. High performance, high accuracy, lower labor cost and the ability to work in hazardous places have put robotics in an advantageous position over many other such technologies but as for developing countries like Bangladesh it is still quite out of reach. But it is one of the most

fascinating and interesting aspects to the new generations and a lot of development in robotics has been done in last couple of years. Robots have several useful applications in our daily. It is actually a replica of human being, which has been designed to ease human burden. It can be controlled pneumatically or using hydraulic ways or using the simple electronic control ways.

OBJECTIVES

The main aim of this project is to design and develop an autonomous line tracking robot. This is achieved through these objectives.

- The robot must be capable of following a line.
- It should be capable of taking various degrees of turns.
- The robot must be insensitive to environmental factors such as lighting and noise.
- It must allow calibration of the line's darkness threshold.
- Scalability must be a primary concern in the design.
- The objective of the project is paper the multiple source Multiple Destination Robot (MDR- l) having the ability to choose a desired line among multiple lines autonomously. Every line has different colours as their identities. The robot can differentiate among various colours 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 presence of obstacle on its path. A powerful close loop control system is used in the robot. The robot senses a line and endeavours itself accordingly towards the desired target by correcting the wrong moves using a simple feedback mechanism but yet very effective closed loop system. The robot is capable of following very congested curves as it receives the continuous data from the sensors

2. LITERATURE SURVEY

Design of autonomous line follower robot with obstacle avoidance

by Kumar Rishabh (2021). This paper shows design and implementation of the Line Follower Robot and its ability to select the desired line among black and white line. This can be combined with different colours. Since each colour has its own distinct property, 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 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 collision and it can detect collision with an obstacle sensor and hence reaching the target. The proposed system can be implemented in any commercial, industrial, medical and also in educational labs.

Design and implementation of line follower and obstacle detection robot

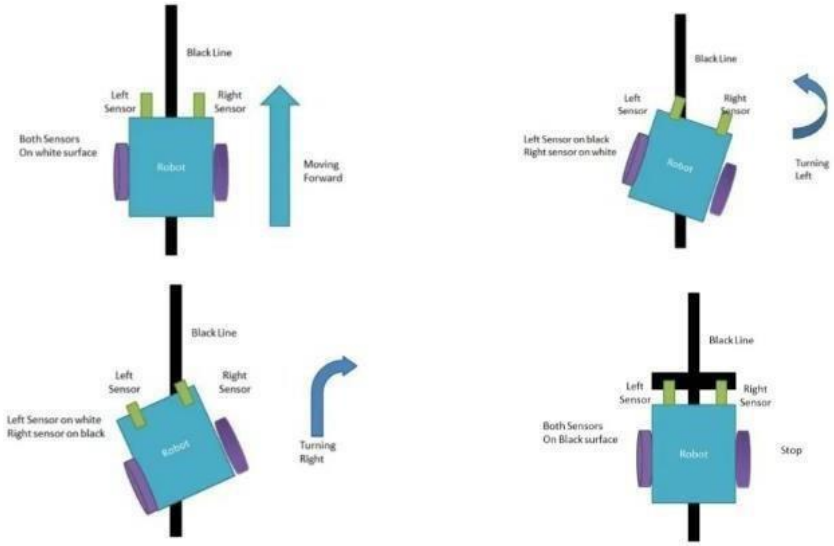
by Ayob Amrani(2020). In this paper, we propose a method for a line follower robot based on the instantaneous computation of the radius of curvature of this line, using infrared line sensors. The number and layout of its sensors, as well as the method chosen, play an important role in the robot's response to the line, with the desired accuracy and speed. In addition, the robot must be equipped with an anti-collision system, using an ultrasonic distance sensor, to detect and avoid obstacles in several situations, especially at line crossovers, when other robots share a common

complex line.

Punetha, Deepak, Neeraj Kumar, and Vartika Mehta (2018). "Development and applications of line following robot based health care management system. The methodologies for assessing, planning, administering, and enhancing the health care management system are outlined in this paper report.

3. METHODOLOGY

Principle of Line follower robot



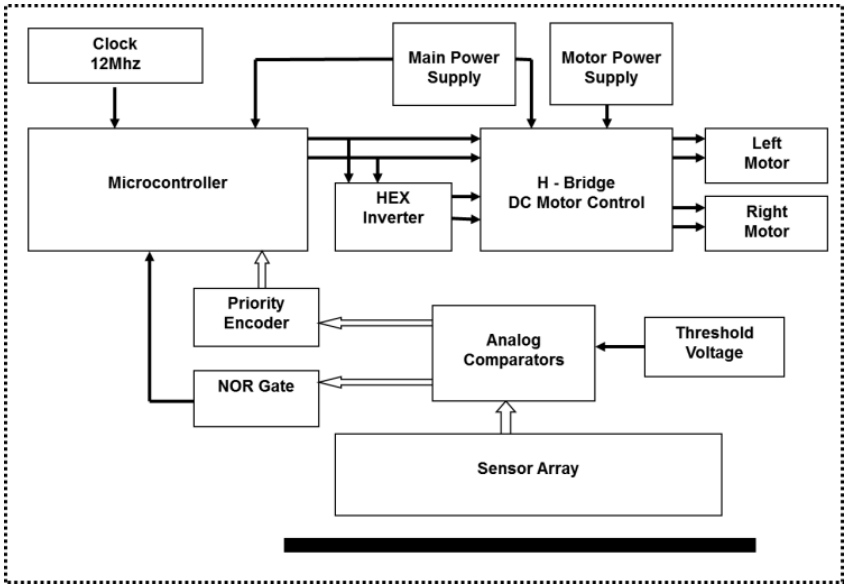
Principle of Line Follower

Line follower is an intelligent robot which detects a visual line embedded on the floor and follows it. The path is predefined and can be either visible like a black line on a white surface with a high contrasted color or the path can be a complex such as magnetic markers or laser guide markers. In order to detect these lines various sensors can be employed. Generally, infrared Sensors are used to detect the line which the robot has to follow. The robot movement is automatic and can be used for long distance application. Line follower can be modified by giving obstacle detection capability to it. If any object is placed on the path then a normal line follower will try to push the obstacle and hence it gets damaged. By using ultrasonic sensor, the line follower can detect an obstacle and can stop till the obstacle is removed. This type of robots can perform lot of tasks in industries, like material handling. These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts. They also have domestic application and one of the interesting application of this line follower robot is in health care management. As this smart line follower robot has obstacle detection capability it will not be damaged easily as it stops it motion till the obstacle is removed or till the path is changed. This ability of the robot increases it application especially in industries because obstacles are common in any workplace and if the robot is not able to detect the obstruction it will get damaged so this gives an added advantage wherever this intelligent line follower is used.

By using ultrasonic sensor, the line follower can detect an obstacle and can stop till the obstacle is removed. This type of robots can perform lot of tasks in industries, like material handling. These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts. Line follower robot can be used in many industrial purposes. It can be used in carrying heavy and risky products. Radioactive products transportation inside a factory is very much risky for human life. A line follower robot can help in that section.The Line Follower Robot consists of two IR sensors and an Ultrasonic sensor attached to it. When the left sensor comes on the black line, then the robot turns the left side in the black line and if the right sensor senses a black line, then the robot turns the right side until both the left and right sensor senses white then only the robot moves forward . If robot comes across a path where there is another black strip lying perpendicular to the path then the robot stops at that instant .

If one of the infrared sensors (on the left) identifies a dark path while the other (on the right) detects a white path, the robot will also turn left. The robot turns left because the left engine remains upright while the right engine spins according to the clock.Generate the left engine rotate clockwise while the right engine rotates counterclockwise to make a steep right bend.To make a sharp left turn, rotate the right engine clockwise while rotating the left engine counterclockwise. When the ultrasonic sensor in front of the robot detects any interruption (at a predetermined distance), the motors stop rotating and the robot comes to a halt. As soon as the block is removed, the robot starts moving.

Block diagrom of Line following robot

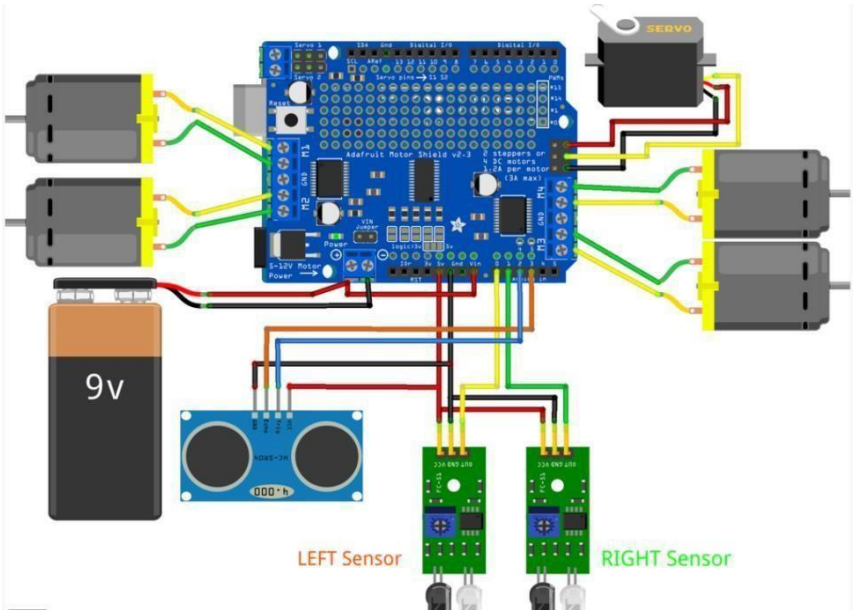


Block Diagram

According to the above , we notice that a microcontroller (Atmega328p) is used to communicate with the whole system for processing the robotics functions. First, we need to connect both Vcc and ground pins of the Arduino Nano with a 9V power supply. As we know this is the main source for operating the whole system.After connecting the above connection, let's connect the L293D motor driver shield onto the Arduino UNO. Four geared motors are connected to the outer terminal of the motor driver as shown in the circuit diagram. This is a powerful motor driver that can drive four 6V motors easily.

Sensors,These are the components that detect the line and obstacles. Commonly used sensors include infrared sensors, ultrasonic sensors, and camera-based vision sensors.Microcontroller, The microcontroller is the brain of the robot. It receives input from the sensors, processes it, and sends commands to the motors to control the movement of the robot.Motor driver,This component is responsible for controlling the speed and direction of the motors that drive the robot. The motor driver receives commands from the microcontroller and converts them into signals that can be used to control the motors.Power supply, The power supply provides the necessary voltage and current to power the components of the robot, including the microcontroller, sensors, and motor driver.Wheels, The wheels are responsible for moving the robot. The wheels can be controlled independently to allow the robot to turn and maneuver around obstacles. Obstacle avoidance module,This module is responsible for detecting obstacles in the path of the robot and taking evasive action to avoid them. It can use sensors such as ultrasonic or infrared sensors to detect obstacles and then send signals to the microcontroller to take evasive action.

The block diagram shows how these components are connected and how they work together to enable the robot to follow a line while avoiding obstacles. The sensors detect the line and obstacles, and the microcontroller processes this information and sends commands to the motor driver to control the movement of the robot. The power supply provides power to the components, while the wheels move the robot. The obstacle avoidance module detects obstacles and takes evasive action to avoid them, ensuring that the robot can navigate around obstacles while following the line.

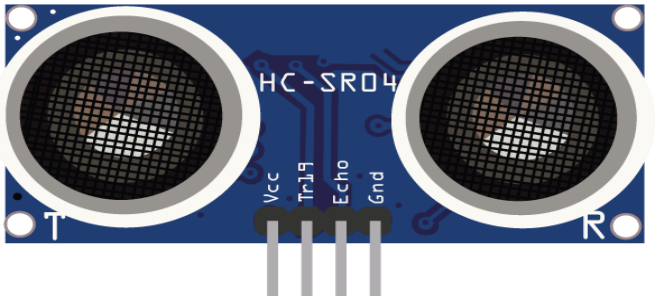


Circuit Diagram

Components Used

a) *HC-SR04(Ultrasonic sensor)*

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns.To make a line follower robot with obstacle detection ability, it is attached with an ultrasonic sensor, which is a device that can measure the distance between an object and a robot sensor by using ultrasonic waves.

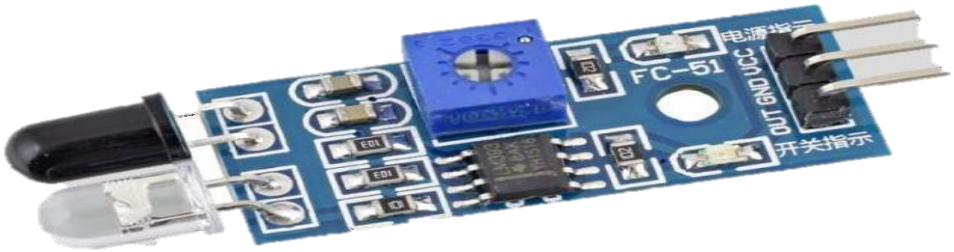


Ultrasonic Sensor

An ultrasonic distance sensor consists of two ultrasonic transducers; one acts as a transmitter with 40Khz frequency, and the other one acts as a receiver and listens to the reflected received pulses. The sensor produces an output pulse that is proportional to the distance of the object in front of the sensor. By reading the pulse width with a microcontroller, one can determine the distance of the object the sensor has an operating voltage of 5 volts and can provide excellent non-contact range detection between 2cm to 400cm.

b) *IR-Sensor*

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, which can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode that is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received

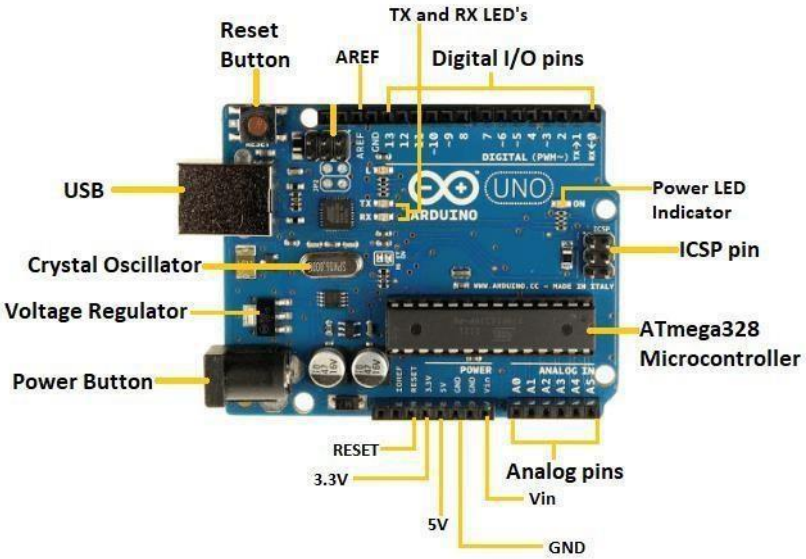


The working principle of an infrared sensor is similar to the object detection sensor. This sensor includes an IR LED & an IR Photodiode, so by combining these two can be formed as a photo-coupler otherwise optocoupler. The physics laws used in this sensor are planks radiation, Stephan Boltzmann & weins displacement.IR LED is one kind of transmitter that emits IR radiations. This LED looks similar to a standard LED and the radiation which is generated by this is not visible to the human eye.

Arduino Uno

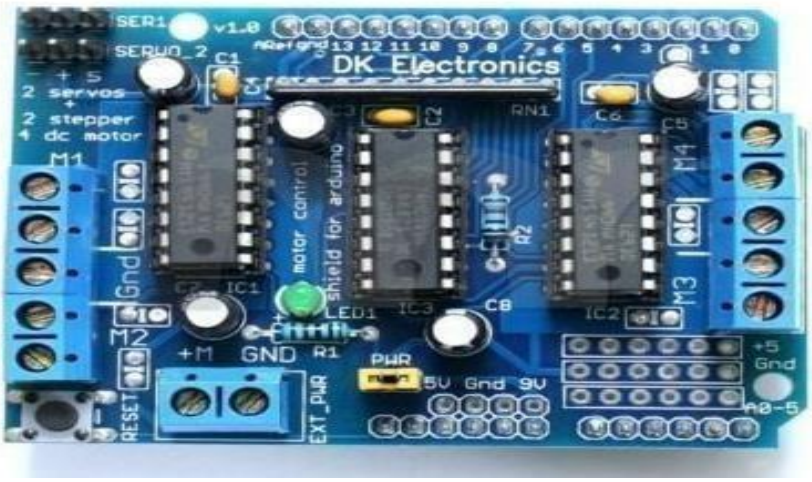
The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board.

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits.



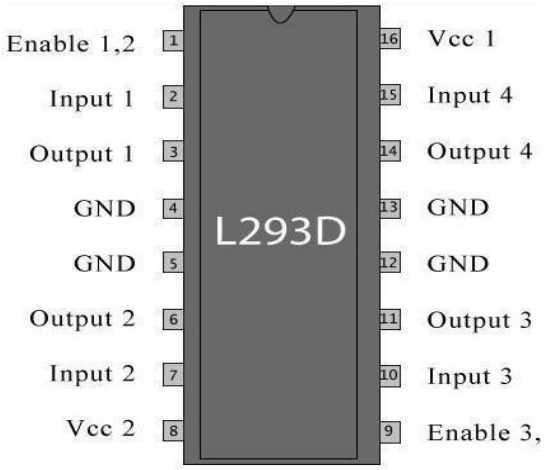
L293D Motor Driver

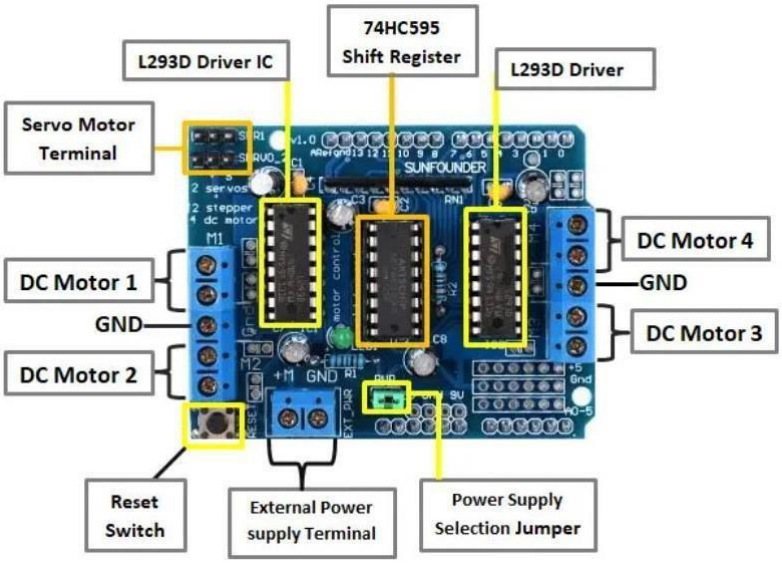
A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between Arduino and the motors . The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. We will be referring the motor driver IC as L293D only. L293D has 16 pins.The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.



c) *Fig:3.7 L293D Motor Driver*

The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high- current/high-voltage loads in positive-supply applications.Now that we have completely understood how the L293D motor driver IC works we can connect all the required wires to the L293d Arduino, and we can write some code to rotate the motor and control the speed of the motor.





L293D Motor Driver pins function

d) *Bo Motor*

BO Motor is known as Battery Operated motor. These motors are commonly used in hobby-grade projects where the user requires a small DC motor as a simple actuator. The DC motor is considered the simplest motor with continuous angular rotation, which has various applications ranging from households to industries. Examples include an electric window in cars, machine tools, printers, electric vehicles etc.

BO motor

The rotation of DC Motor can be controlled, which makes it ideal for Motor use in different categories. The operation of most of the DC motors depends on the magnetic field forces.BO series linear motor provides good torque and rpm at lower operating voltages. The BO motors are available in single Shaft, Dual Shaft, and DC Plastic Gear BO. These motors consume low current. In this project, we have used four single shaft BO motors.

This single shaft plastic geared motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors. Small shaft with matching wheels give optimized design for your application or robot. Mounting holes on the body & light weight makes it suitable for in-circuit placement. This motor is a perfect choice for light weight robots.

Specifications:

Voltage	2V to 12V
RPM	150 rpm
Gear	Plastic
Motor Type	Straight
Torque	4 kg-cm
Connector Type	2 pin Relimate Connector

Lithium-Ion Battery

A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry. During a discharge cycle, lithium atoms in the anode are ionized and separated from their electrons. The lithium ions move from the anode and pass through the electrolyte until they reach the cathode, where they recombine with their electrons and electrically neutralize. The lithium ions are small enough to be able to move through a micro-permeable separator between the anode and cathode.

In part because of lithium's small size (third only to hydrogen and helium), Li- ion batteries are capable of having a very high voltage and charge storage per unit mass and unit volume. Compared to the other high-quality rechargeable battery technologies (nickel-cadmium or nickel-metal-hydride), Li-ion batteries have a number of advantages. They have one of the highest energy densities of any battery technology today (100-265 Wh/kg or 250-670 Wh/L). In addition, Li-ion battery cells can deliver up to 3.6 Volts, 3 times higher than technologies such as Ni-Cd or Ni-MH. This means that they can deliver large amounts of current for high- power applications, which has Li-ion batteries are also comparatively low maintenance, and do not require scheduled cycling to maintain their battery life. Li- ion batteries have no memory effect, a detrimental process where repeated partial discharge/charge cycles can cause a battery to 'remember' a lower capacity.

Li-Ion battery

Generally, the negative electrode of a conventional lithium-ion cell is graphite made from carbon. The positive electrode is typically a metal oxide. The electrolyte is a lithium salt in an organic solvent. The anode (negative electrode) and cathode (positive electrode) are prevented from shorting by a separator.[10] The anode and cathode are separated from external electronics with a piece of metal called a current collector. The electrochemical roles of the electrodes reverse between anode and cathode, depending on the direction of current flow through the cell.

The most common commercially used anode is graphite, which in its fully lithiated state of LiC6 correlates to a maximal capacity of 1339 C/g (372 mAh/g). The cathode is generally one of three materials: a layered oxide (such as lithium cobalt oxide), a polyanion (such as lithium iron phosphate) or a spinel (such as lithium manganese oxide). More experimental materials include graphene-containing electrodes, although these remain far from commercially viable due to their high cost.

Lithium reacts vigorously with water to form lithium hydroxide (LiOH) and hydrogen gas. Thus, a non-aqueous electrolyte is typically used, and a sealed container rigidly excludes moisture from the battery pack. The non-aqueous electrolyte is typically a mixture of organic carbonates such as ethylene carbonate and propylene carbonate containing complexes of lithium ions.Ethylene carbonate is essential for making solid electrolyte interphase on the carbon anode, but since it is solid at room temperature, a propylene carbonate solvent is added.

Servo Motor

A servo motor **is** a type of motor that can rotate with great precision. Normally

this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a **servo** mechanism. If motor is powered by a DC power supply then it is called DC servo motor,

Switch

In electrical engineering, a switch is an electrical component that can "make" or "break" an electrical circuit, interrupting the current or diverting it from one conductor to another The mechanism of a switch removes or restores the conducting path in a circuit when it is operated. It may be operated manually, for example, a light switch or a keyboard button, may be operated by a moving object such as a door.

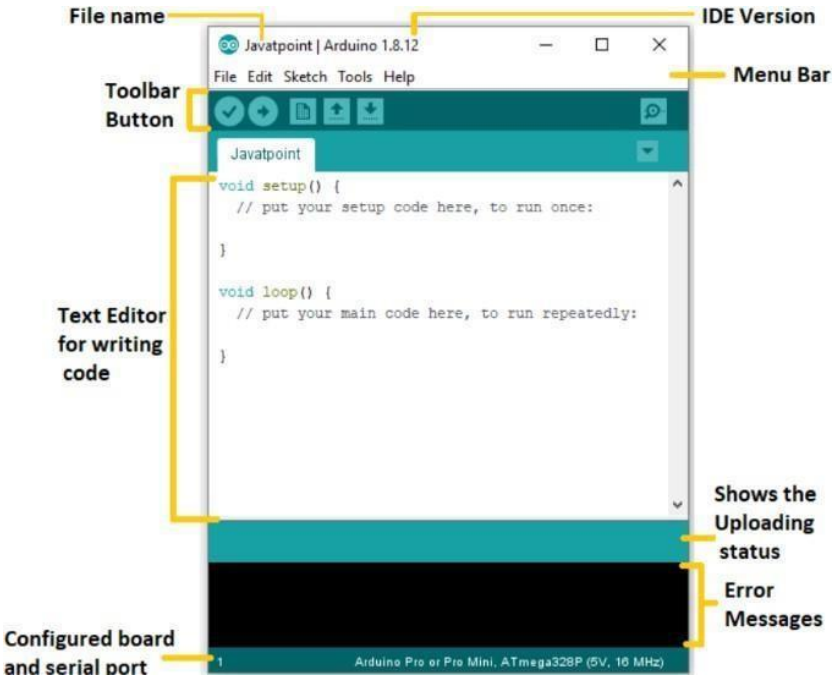
Jumper wires

Most, if not all, electronics suppliers stock jumper wire in various lengths and assortments. These wires are commonly used with breadboards and other prototyping tools like Arduino.Jumper wires make changing circuits as simple as possible. A jumper wire may appear uncomplicated, and it doesn't get much more basic than other wires or cables. But there are tiny details you need to pay attention to.Generally, jumpers are tiny metal connectors used to close or open a circuit part. They have two or more connection points, which regulate an electrical circuit board.Their function is to configure the settings for computer peripherals, like the motherboard. Suppose your motherboard supported intrusion detection. A jumper can

Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The Arduino IDE will appear as:



RESULTS AND DISCUSSIONS:

Hardware Implementation

A microcontroller is the brain of the robot, which controls all its functions. It receives input signals from the sensors and generates output signals to the motor driver circuit. Some popular microcontrollers used for line follower robots are Arduino, Raspberry Pi, and PIC. A motor driver is an electronic circuit that controls the speed and direction of the motors. Line follower robots usually have two or more DC motors, and the motor driver circuit is responsible for controlling their movements. The most commonly used motor driver is the L293D, which is compatible with many microcontrollers. Line follower robots use various sensors to detect the line and obstacles. The most commonly used sensors are infrared (IR) sensors, which emit and receive IR radiation. The sensors are placed on the underside of the robot, and they detect the contrast between the line and the surface. To detect obstacles, ultrasonic sensors or IR distance sensors can be used.

A power source is required to power the microcontroller, motor driver, and sensors. The power source can be a battery or a power supply, depending on the requirements of the robot. The chassis is the physical structure of the robot, which holds all the components together. It can be made of plastic or metal, and its shape and size depend on the design requirements. The wheels are attached to the DC motors and enable the robot to move forward and backward. The size and type of wheels depend on the surface on which the robot will be operated. Other components such as LEDs, buzzers, and switches can also be included in the robot to enhance its functionality.

First, attach a motor driver shield to the arduino. Now connect the bo motors to the l293d motor driver shield.Motor 1 to motor driver M1,Motor 2 to motor driver M2,Motor 3 to motor driver M3,Motor 4 to motor driver M4,connect the IR sensor to motor driver.IR sensor OUT pin is connected to motor driver A0 pin.IR sensor GND pin is

Model of the Robot

If any object is placed on the path then a normal line follower will try to push the obstacle and hence it gets damaged. By using ultrasonic sensor, the line follower can detect an obstacle and can stop till the obstacle is removed. This type of robots can perform lot of tasks in industries, like material handling**.**Once the robot is convinced that a certain direction is clear of any obstacles, it will turn the robot in that particular direction and then move in a straight line along that direction till the next obstacle is found. If there is no way to go ahead the robot executes a full 180° turn.

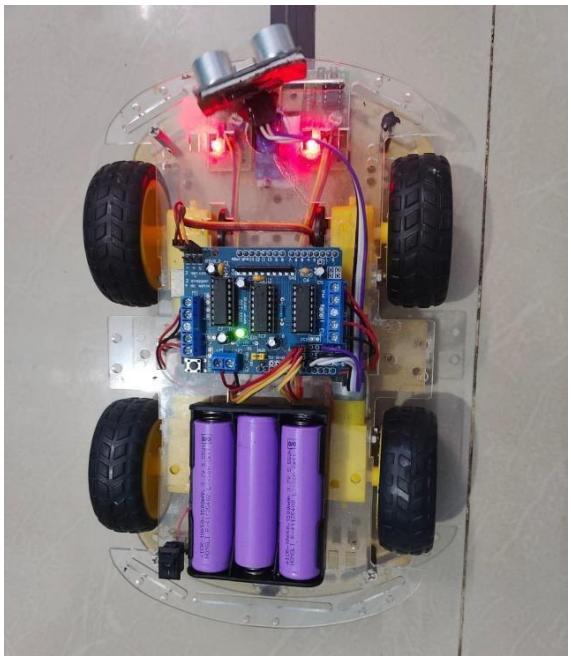


Fig:4.1Structure Of Line Follower Robot

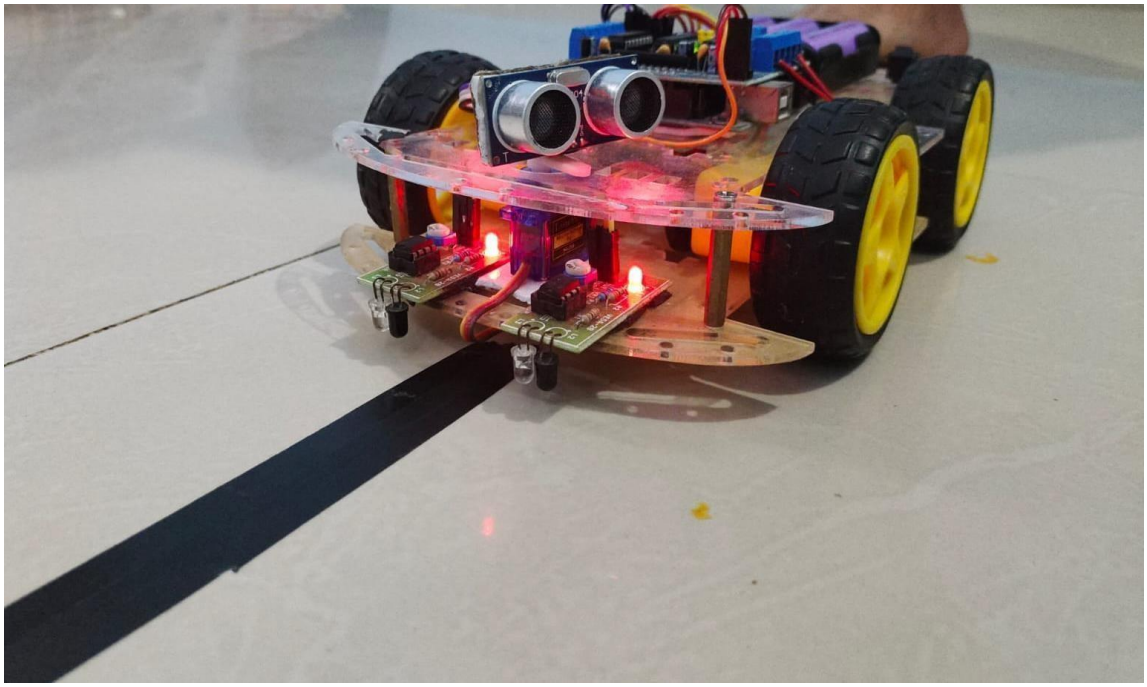


Fig:4.2 Working of Sensors

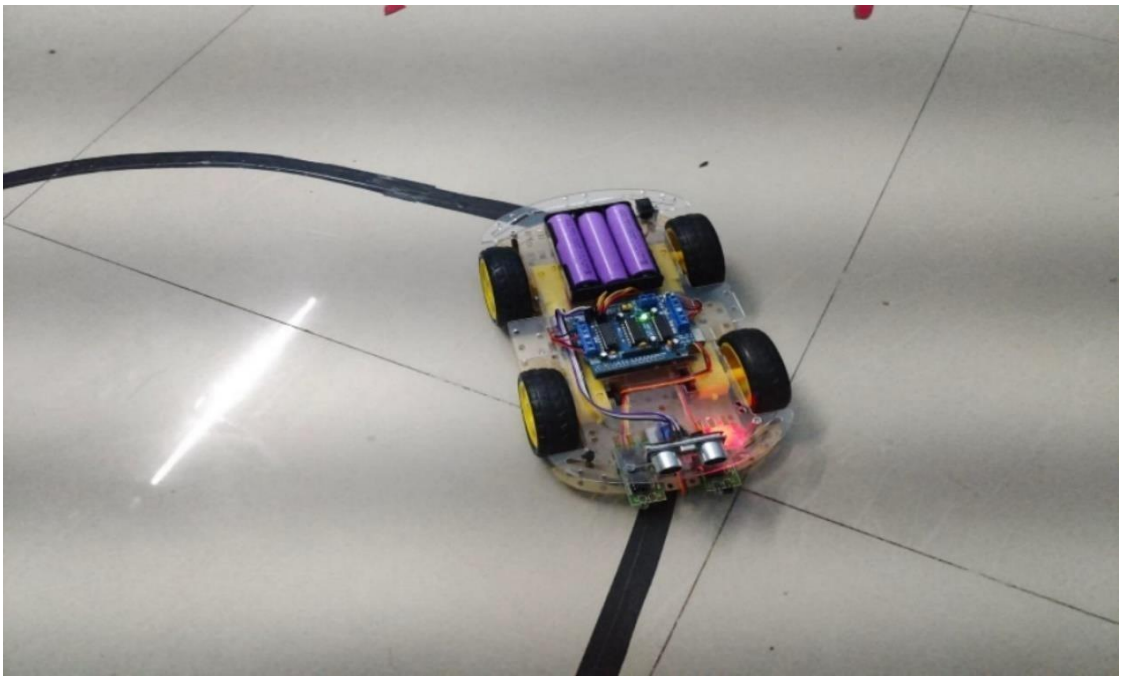
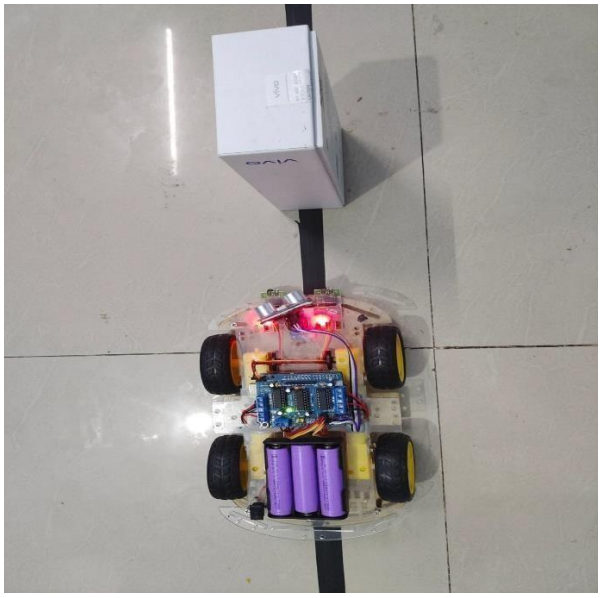


Fig:4.3 Robot Following The path



a) *Fig:4.4 Robot Detecting the obstacle* *Fig:4.5 Robot Overcoming the Obstacle*

The Line follower robot is a mobile machine that can detect and follow the line drawn on the floor. Generally, the path is predefined and can be either visible like a black line on a white surface with a high contrasted color or it

can be invisible like a magnetic field. This robotic system can provide an alternative to the existing system by replacing skilled labor, which in turn can perform better tasks with accuracy and lower per capita cost. Line follower robots with obstacle detection have a wide range of potential future works. Here are some possible directions for future research and development Improved obstacle detection: Currently, most line follower robots use simple sensors to detect obstacles, such as infrared sensors or ultrasonic sensors. Future work could explore more advanced sensing technologies, such as LIDAR or computer vision, to improve obstacle detection accuracy and reliability.Autonomous navigation: Most line follower robots require a pre-determined path to follow.

CONCLUSION AND FUTURE WORKS

Robots play a vital role in the global economy and in everyday life. Also of concern for robotic research is the competitiveness and design of patents in the world's industries according to their type of applications. The need for robotic technology is growing in a wide variety of human applications and applications, especially in the manufacturing, medical, service, defence and consumer industries. This linear robot is an example of an industrial robot. By studying this one can create a linear robot for use in industry. Performance can be improved by using good materials and hearing aids. improves motor movement. The cost of setting up a linear robot depends largely on the costly machinery, land, construction and watchmaking equipment to maintain and operate such equipment.

Another way to improve the current system is to replace trained workers with robotic robots. This robot will be able to manage a large number of assets in a manufacturing system in a shorter amount of time, with higher precision and cheaper cost per unit.The applications of the line follower are limited because it cannot be controlled. The only way to control the line follower is to change the path. Using WIFI module to control the line follower robot will not be helpful because more power will be consumed, so the battery will drain out quickly. Apart from these limitations smart and intelligent line follower robot can be used for long distance applications with a predefined path. This smart and intelligent robot has more benefits because it doesn’t consume much power.

This robotic system can provide an alternative to the existing system by replacing skilled labor, which in turn can perform better tasks with accuracy and lower per capita cost. Line follower robots with obstacle detection have a wide range of potential future works. Here are some possible directions for future research and development Improved obstacle detection: Currently, most line follower robots use simple sensors to detect obstacles, such as infrared sensors or ultrasonic sensors. Future work could explore more advanced sensing technologies, such as LIDAR or computer vision, to improve obstacle detection accuracy and reliability.Autonomous navigation: Most line follower robots require a pre-determined path to follow.

Future work could focus on developing algorithms that enable robots to autonomously navigate to a given destination without a pre-determined path. This could involve using machine learning algorithms to teach the robot to recognize and avoid obstacles.Multi-agent coordination: Line follower robots could be deployed in groups to perform complex tasks. Future work could explore ways to coordinate the actions of multiple robots to achieve a common goal, such as collectively transporting an object from one location to another.Integration with other technologies: Line follower robots with obstacle detection could be integrated with other technologies to enable them to perform more complex tasks. For example, they could be integrated with drones to perform aerial surveys or with 3D printers to create complex structures.Real- world applications: There are many potential real-world applications for line follower robots with obstacle detection, such as search and rescue operations or inspection of hazardous environments. Future work could focus on developing robots that are optimized for specific applications,

such as robots that are designed to navigate through tight spaces or robots that are designed to operate in extreme temperatures.

The line follower developed is also sensing any type of obstacle in its way and can also control speed with the help of speed regulator. Further improvement can be done in the robot by using more number of IR sensors or an array or IR sensors.This robot is able to produce the basic walking movements using two gear motors. They developed the robot with a very good intelligence which is easily capable to sense the obstacle and by processing the signal coming from the sensor it is perfectly avoiding the obstacle coming in the path.

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