NAVIBOT

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Under Guidance

of

Internal Guide

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Changa

Acknowledgement

Knowledge in itself is a continuous process. At this moment of our substantial enhancement, We rarely find words to express our gratitude towards those who were constantly involved with us.

The completion of any inter disciplinary project depends upon coordination, cooperation and combined efforts of several resources of knowledge, creativity, skill, energy and time. The work being accomplished now, we feel our sincerest urge to recall and knowledge through these lines, trying our best to give full credit wherever it deserves.

We would like to thank our project guide **Dr. Shailesh Khant** and I/C Principal **Dr. Dharmendra Patel** & I/C Dean **Dr**. **Sanskruti Patel** who advised and gave us moral support through the duration of our project. Without their constant encouragement we could not have been able to achieve what we have.

It's our good fortune that we had support and well wishes of many. We are thankful to all and those names which have been forgotten to acknowledge here but contributions have not gone unnoticed.

With Sincere Regards,

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Table of Contents

Table of Figures

PROJECT PROFILE

❖ Project Profile

Project Name:	NAVIBOT
Type of Application:	Embedded Application
Project Description:	Navibot is a multi-functional robot. This robot is designed to execute four distinct tasks: line following, human following, path memorization, and obstacle avoidance. The robot is built in such a way that all four functions can be carried out with a single device. This robot is commonly used in manufacturing industries to automate the transportation of goods and materials from one location to another, security and surveillance applications to track a person's movement and ensure their safety. It is also used in autonomous vehicles and drones to avoid collisions.
Team Size:	3
Front End:	Arduino, L298N Motor Driver, IR Sensors, Servo Motor, Ultrasonic Sensor, IR Receiver, IR Remote, Bluetooth Module
Back End:	Embedded C
Tools used:	Arduino IDE

INTRODUCTION

TO

TOOLS

❖ Introduction to Tools

Software –

1)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, Arduino and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

2) Embedded C

Embedded C is an extension of C language and it is used to develop micro-controller based applications. The extensions in the Embedded C language from normal C Programming Language is the I/O Hardware Addressing, fixed-point arithmetic operations, accessing address spaces, etc.

In every embedded system based projects, Embedded C programming plays a key role to make the microcontroller run & perform the preferred actions. At present, we normally utilize several electronic devices like mobile phones, washing machines, security systems, refrigerators, digital cameras, etc. The controlling of these embedded devices can be done with the help of an embedded C program.

Hardware –

1) Arduino mega

The Arduino Mega is based on ATmega2560 Microcontroller. The ATmega2560 is an 8-bit microcontroller. We need a simple USB cable to connect to the computer and the AC to DC adapter or battery to get started with it.

The Arduino Mega is organized using the Arduino (IDE), which can run on various platforms.

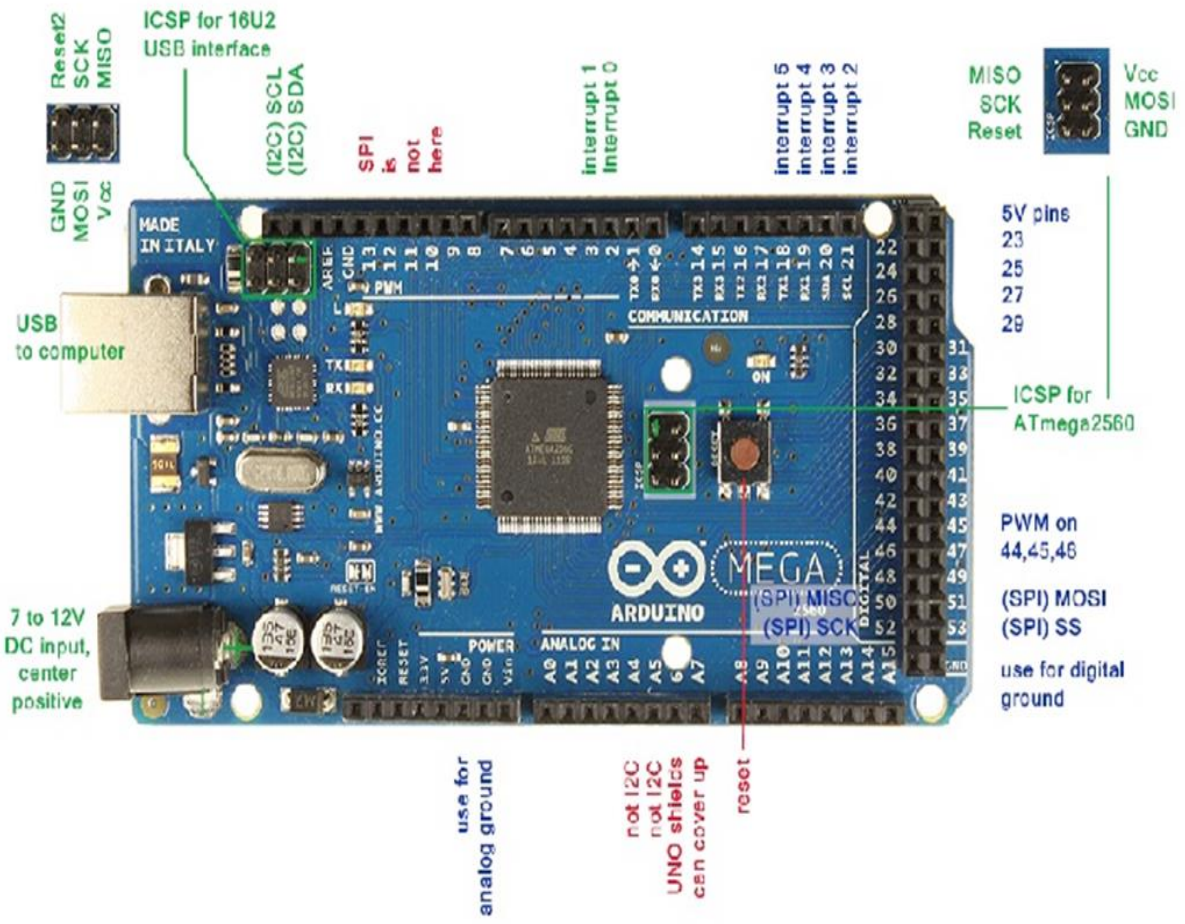

Figure 2.1

Arduino Mega Specifications

The specifications of Arduino Mega include the following.

- The ATmega2560 is a Microcontroller
- The operating voltage of this microcontroller is 5volts
- The recommended Input Voltage will range from 7volts to 12volts
- The input voltage will range from 6volts to 20volts
- The digital input/output pins are 54 where 15 of these pins will supply PWM o/p.
- Analog Input Pins are 16
- DC Current for each input/output pin is 40 mA
- DC Current used for 3.3V Pin is 50 mA
- Flash Memory like 256 KB where 8 KB of flash memory is used with the help of bootloader
- The static random-access memory (SRAM) is 8 KB
- The electrically erasable programmable read-only memory (EEPROM) is 4 KB
- The clock (CLK) speed is 16 MHz
- The USB host chip used in this is MAX3421E
- The length of this board is 101.52 mm
- The width of this board is 53.3 mm

2) L298N Motor Driver

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.

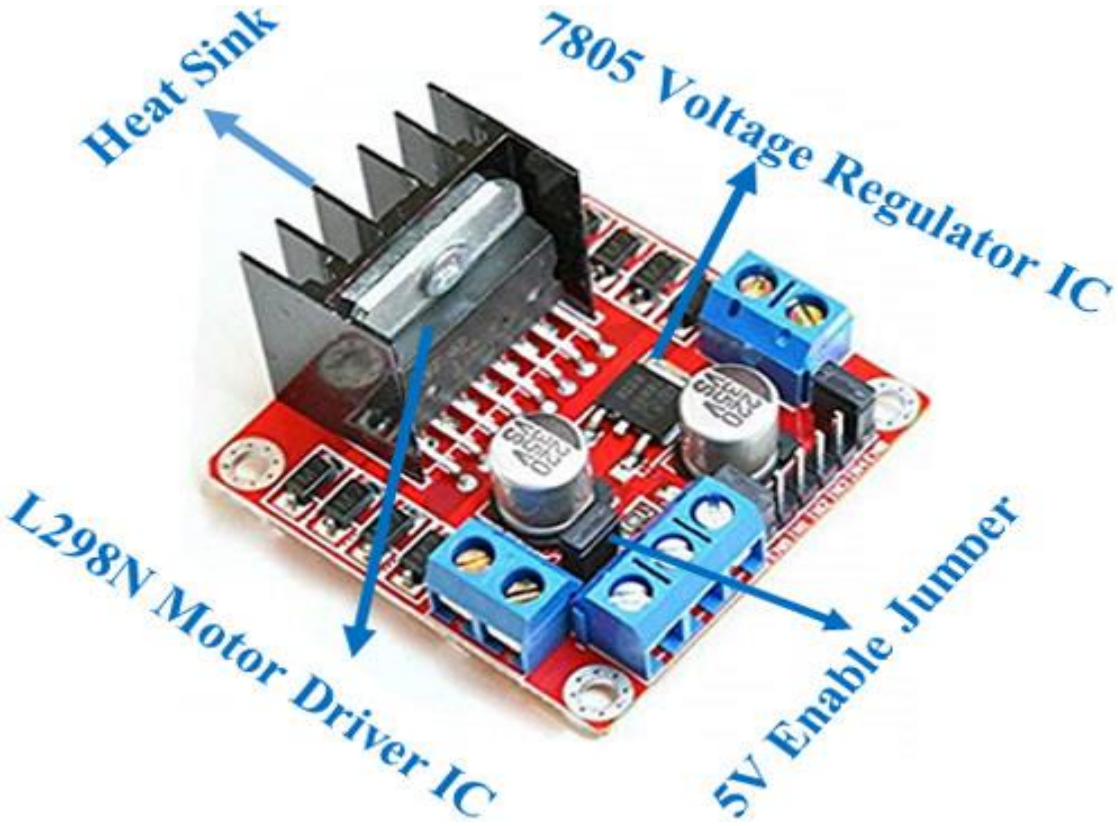

Figure 2.2

Specifications:

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

3) IR Sensor

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

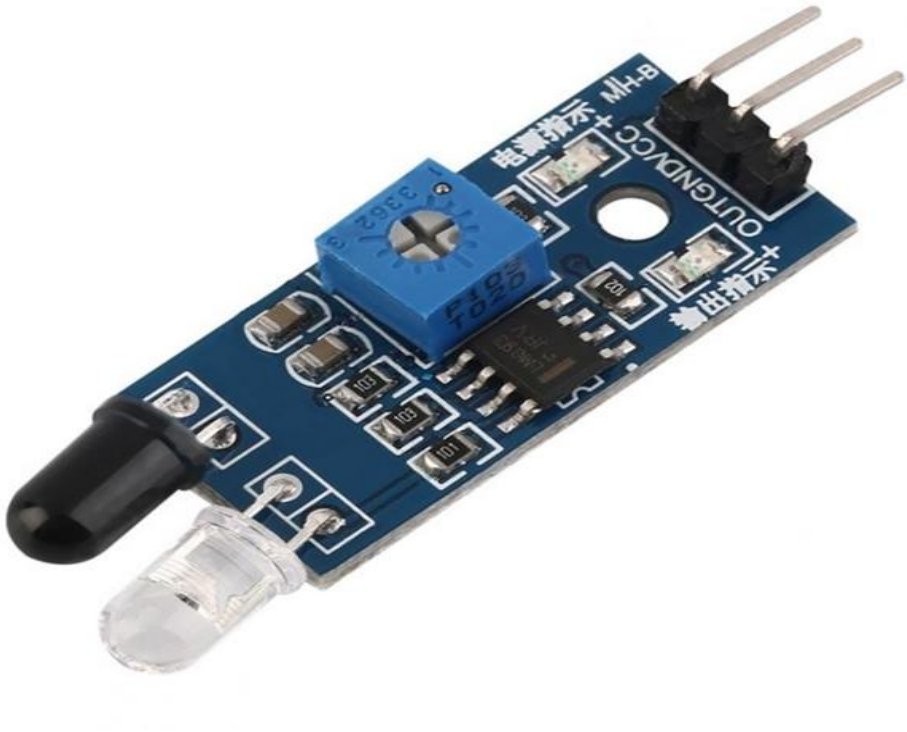

Figure 2.3

Specifications :

- The operating voltage is 5VDC
- I/O pins – 3.3V & 5V
- Mounting hole
- The range is up to 20 centimeters
- The supply current is 20mA
- The range of sensing is adjustable
- Fixed ambient light sensor

4) IR Receiver

An infrared receiver, or IR receiver, is hardware that sends information from an infrared remote control to another device by receiving and decoding signals. In general, the receiver outputs a code to uniquely identify the infrared signal that it receives. This code is then used in order to convert signals from the remote control into a format that can be understood by the other device. It is the part of a device that receives infrared commands from a remote control.

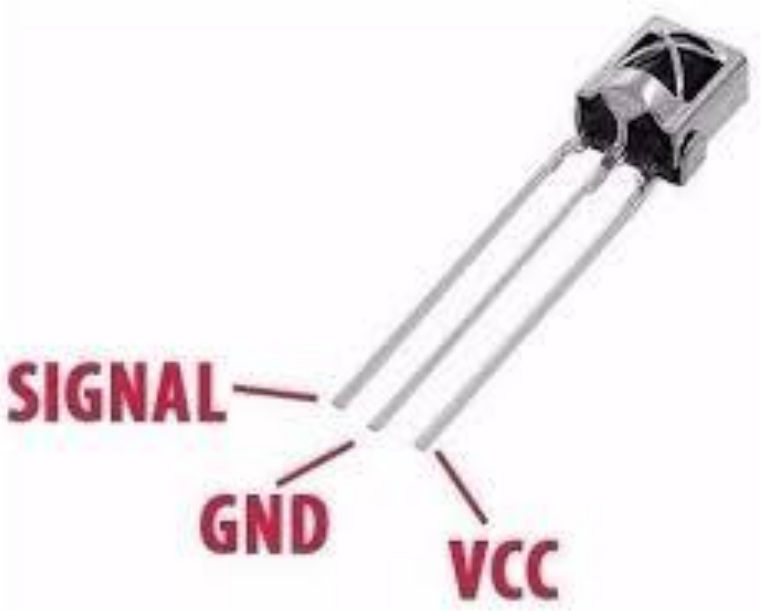

Figure 2.4

Specifications:

• Very low supply current

• Photo detector and preamplifier in one package

• Internal filter for PCM frequency

• Supply voltage: 2.5 V to 5.5 V

5) Ultrasonic sensor

An ultrasonic sensor is a device that detects an object and measures the distance to it. It measures the distance by emitting ultrasound and receiving the wave that the object reflects.

Ultrasonic sound vibrates at a frequency above the range of human hearing. Transducers are the microphones used to receive and send ultrasonic sound. HC-SR04 and like other ultrasonic sensor module use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to the target by measuring time lapse between sending and receiving of the ultrasonic pulses.

Figure 2.5

Specifications:

- Power Supply: 3.3V – 5V.
- Operating Current: 8mA.
- Working Frequency: 40Hz.
- Ranging Distance : 3cm – 350cm/3.5m.
- Resolution : 1 cm.
- Measuring Angle: 15 degree.
- Trigger Input Pulse width: 10uS TTL.
- Dimension: 50mm x 25mm x 16mm.

6) 18650 Li-ion Rechargeable Battery (1800 mAh)

18650 battery is a Li-ion rechargeable battery with an 1800 mAh Battery Capacity. This is not a standard AA or AAA battery but is very useful for applications that require continuous high current or high current in short bursts like in cameras, DVD players, iPod, etc. An 18650 cell can be charged and discharged up to 1000 cycles without much loss in battery capacity. They are safe to use, environment friendly and have long battery life. It comes with high energy density and provides excellent continuous power sources to your device. It should be used with a protection circuit board that guards the battery against over-charge, over-discharge of the pack, and avoid over-current drawn.

Figure 2.6

Specifications:

- Voltage: 3.7 Volts
- Capacity: 1800 mAh
- Rechargeable: Yes
- Battery Size: Diameter- 18mm x Length- 67mm
- Charging Method CC-CV

7) 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. Fairly simple. In fact, it doesn't get much more basic than jumper wires.

Jumper wires typically come in three versions: male-to-male, male-to-female and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into. Male-to-male jumper wires are the most common and what you likely will use most often. When connecting two ports on a breadboard, a male-to-male wire is what you'll need.

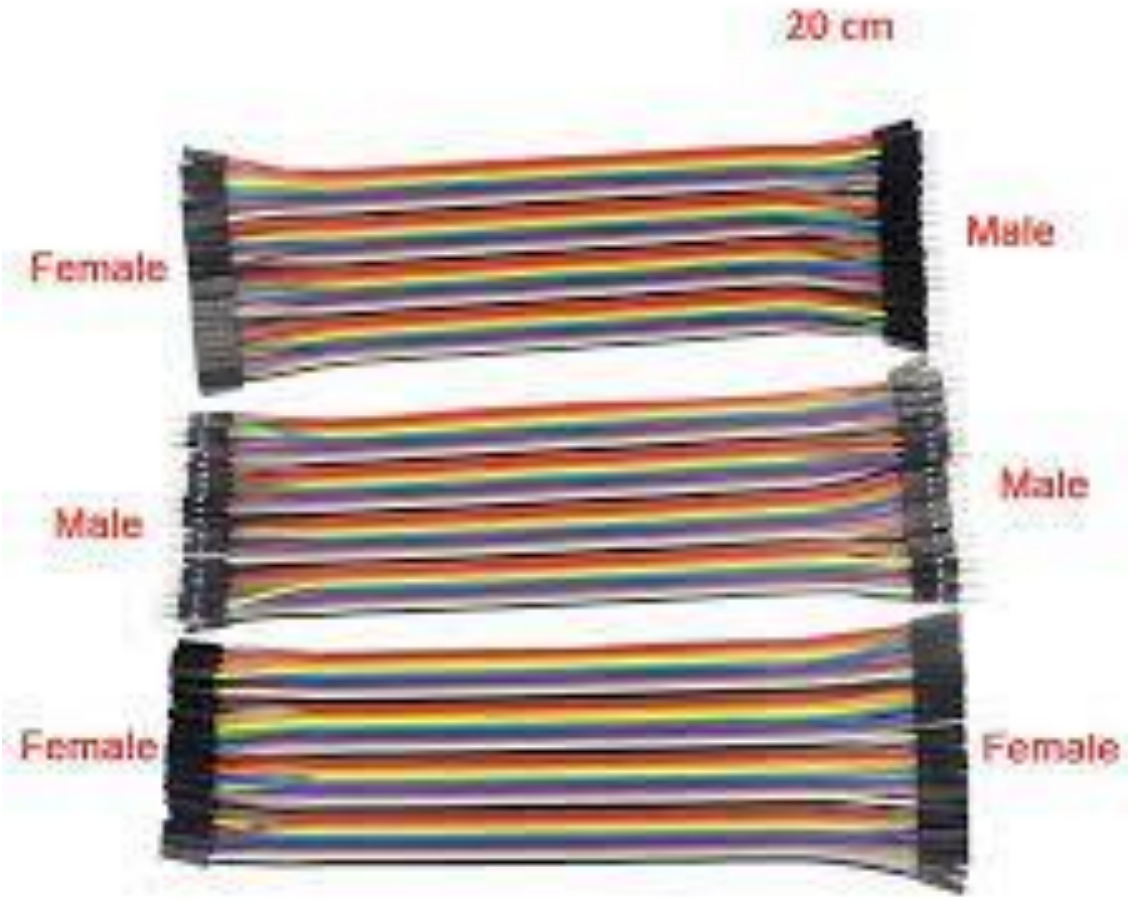

Figure 2.7

8) Chassis board, DC Motor an wheels

A chassis is the load-bearing framework of an artificial object, which structurally supports the object in its construction and function.

A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current, and convert this energy into mechanical rotation.

DC motors use magnetic fields that occur from the electrical currents generated, which powers the movement of a rotor fixed within the output shaft. The output torque and speed depends upon both the electrical input and the design of the motor.

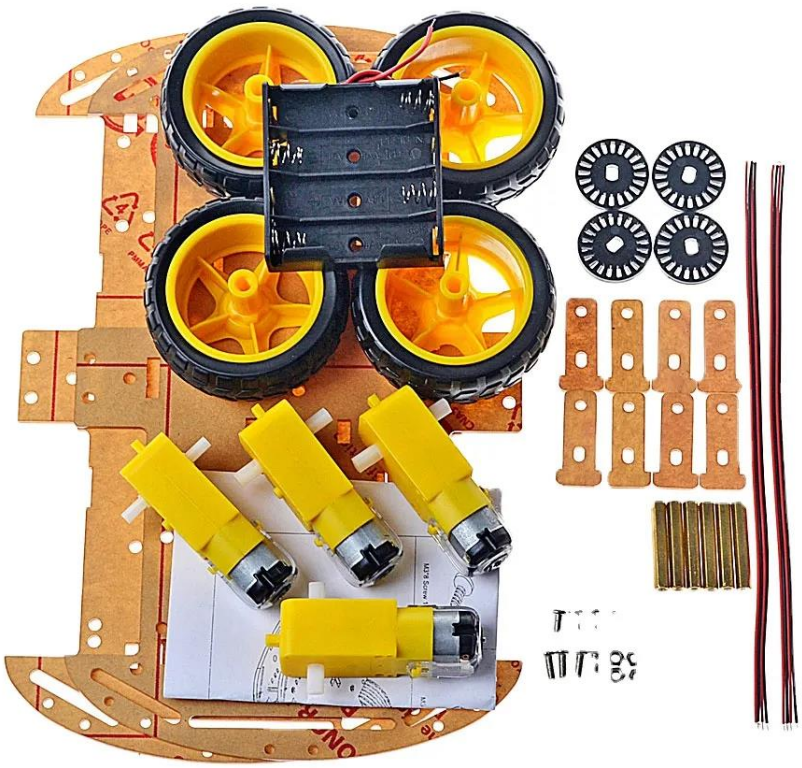

Figure 2.8

9) Servo motor

A servo motor is a self-contained electrical device, that rotate parts of a machine with high efficiency and with great precision.

The output shaft of this motor can be moved to a particular angle, position and velocity that a regular motor does not have. The Servo Motor utilizes a regular motor and couples it with a sensor for positional feedback.

Figure 2.9

Specifications:

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Gear Type: Plastic
- Rotation : 0°-180°
- Weight of motor : 9gm
- Package includes gear horns and screws

10) HC-05 Bluetooth Module

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration. It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard, and many more consumer applications. It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.

Figure 2.10

Specification of HC-05 Bluetooth Module

- Bluetooth version: 2.0 + EDR (Enhanced Data Rate)
- Frequency: 2.4 GHz ISM band
- Modulation: GFSK (Gaussian Frequency Shift Keying)
- Transmit power: Class 2 (up to 4 dBm)
- Sensitivity: -80 dBm typical
- Range: approximately 10 meters (or 33 feet) in open air
- Profiles supported: SPP (Serial Port Profile), HID (Human Interface Device) and others
- Operating voltage: 3.3V to 5V DC
- Operating current: less than 50mA
- Standby current: less than 2.5mA
- Sleep current: less than 1mA
- Interface: UART (Universal Asynchronous Receiver/Transmitter)

11) Rocker Switch

A rocker switch definition is; an ON/OFF switch that trips once pressed on one side which means one side of the switch is raised while another side is depressed. There are two symbols on this switch where one is a circle symbol which indicates ON & the side is a line or horizontal dash which indicates OFF. Sometimes, these types of switches are known as see-saw switches. These switches are mainly used in display monitors, surge protectors, power supplies for computers, and many more.

Figure 2.11

Pin1 (Power): This is a power pin, where the switch gets power from the power source.

Pin2 (ACC): This pin is connected to the load in the circuit. Once the rocker switch is turned ON, the load will be turned ON.

Pin3 (GND): This pin is connected to the GND of the circuit

- Tools Needed

Some tools names are given below:

1) Soldering Iron
2) Glue gun
3) Cutter
4) Knife
5) Screwdriver
6) Wire Strippers
7) Double sided tape

SYSTEM STUDY

1] Existing system

Existing systems or equipment are built in such a way that they cannot function independently and must be overseen by people. Many businesses rely on labor to carry items, which is a time-consuming operation. Moving to some dangerous areas puts people's lives at jeopardy.

Vehicles are useful and assist in lowering the workload for humans; nonetheless, these machines are continually dependent on human supervision to function. These vehicles operate on the basis of relative skills and techniques. Automobiles right now are powered by either fuel or electricity.

Vehicle demand has grown due to the world's fast population development, producing greater traffic congestion and road accidents. Driver weariness, excessive speeding, and other factors can all contribute to a road accident. Also risk of goods getting damaged is high. Moreover, there aren't many tools that can be useful to disabled persons.

2] Proposed System

To achieve the drawbacks or the disadvantages in the existing system, we proposed the Navibot. The Navibot is a multi-functional robot that can execute four specific operations simultaneously.

The four operations include:

A. Following a marked line
B. Memorizing a path
C. Avoiding obstacles in the route
D. Following a human

This handy project aims to follow the proper person or barrier. In this robot, infrared sensors are utilized to move the robot in both directions, and ultrasonic sensors are used in three directions. The Arduino Mega microcontroller served as the project's brain. This robot is powered by four dc motors and is controlled by L298N motor driver.

Many corporations are spending much in the development of algorithms in order to make driving easier and safer. The study is concerned with the same concept of increasing robot efficiency for remembering places and paths taken during manual control mode using a feedback-based control system. Path memorizing feature that is build included in this robot can be particularly beneficial in the time-consuming task of carrying raw materials from one location to another in an industry since they can remember the path and independently transport the item to the destination as many times as needed. It may also be utilized to move timber from the forest to the industry without the usage of human labor.

With the assistance of a human following function, our system is capable of assisting or guiding disabled people both indoors and outside.

3] Scope of the proposed system

Navigation is a very important aspect for mobile robots. A robot that can navigate its own path autonomously will always be desired. New and employable technologies pertaining to navigation is the need of the hour.

Obstacle avoiding robots can be used in almost all mobile robot navigation systems.

- They can also be used in dangerous environments, where human penetration could be fatal.
- They can be used for household work like automatic vacuum cleaning.
- Can follow a particular vehicle.
- Can follow a particular path.
- Can service people at shopping centers or public areas.
- Can assist elderly people, special children and babies.

4] Aim and Objective of the Proposed System

Our attempt to solve some aspects of the existing system is to build a robot car with advanced features that can be of help for the human race.

Objectives:

- To detect obstacles accurately and automatically.
- To help people with disabilities in managing their day-to-day life.
- To help people guide the way in public places such as museums.
- To use in households for cleaning purpose.
- Build robot that can reach the places where human cannot enter.
- To build driver less cars.
- To reduce human labor in industries by carrying the goods from one place to another.

5] Feasibility study

A feasibility study evaluates a project's or system's practicality. As part of a feasibility study, the objective and rational analysis of a potential business or venture is conducted to determine its strengths and weaknesses, potential opportunities and threats, resources required to carry out, and ultimate success prospects. Below are a few reasons feasibility studies are important:

- Identifies valid reasons to advance or veto a project idea
- Improves the focus of the project team
- Provides useful information for the next steps after the study
- Narrows potential business alternatives
- Evaluates current and needed resources and technology
- Enhances the success or failure rate of the project by assessing all variables
- Estimates the return on investment

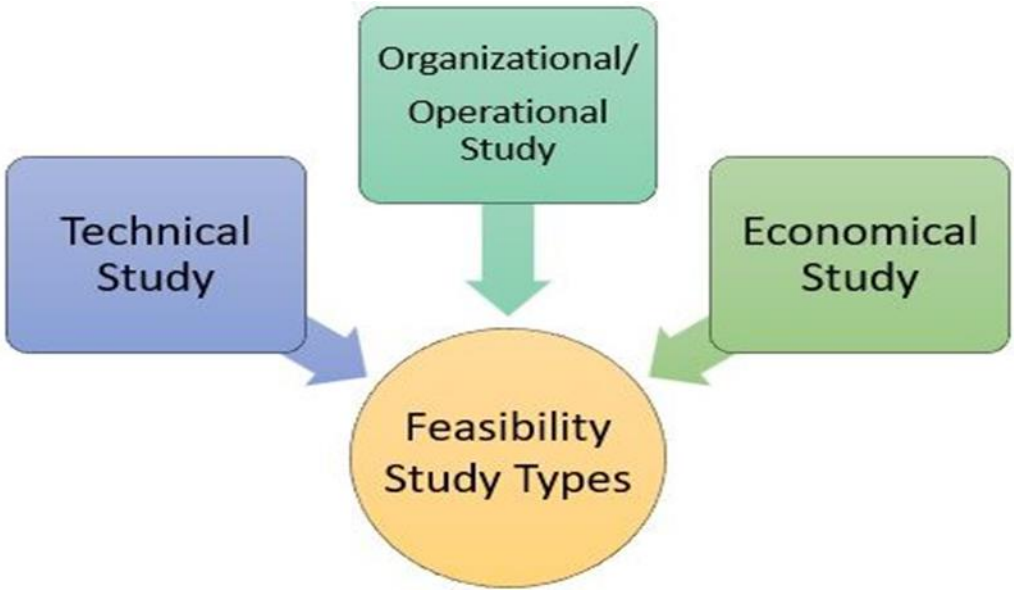

Figure 3.1

Operational feasibility

Operational feasibility is the measure of how well a proposed system solves the problems and takes advantages of the opportunities identified during scope definition and how it satisfies the requirements identified in the requirement phase of system development.

The operational feasibility performs the following tasks:

•The operational feasibility aids in deciding whether or not the solution proposed by the software development team is acceptable.

•Operational feasibility also aids in establishing if the issues foreseen in the user requirements are a high priority.

•It determines whether the program is user-friendly or not

•Its interface should be simple enough that everyone can utilize it.

•Assists in determining if the organization is pleased with the alternative options presented by the software development team members.

The operational feasibility of the robot depends on following factors:

1) Accuracy and precision:

The robot's accuracy in executing the user's commands depends on the sensors used, the programming of the Arduino board, and the memory module. Whether a robot needs to memorize a complex path with many curves, or follow a straight line or a human, accurate sensors and programming are required for the robot to perform its function properly.

2) Environment

The complexity of the terrain can affect the robot's ability to memorize paths. In cluttered or obstacle-filled surroundings, the robot's sensors may not be able to detect its position accurately, resulting in path memorizing errors.

3) Reliability

Robots must be designed to operate reliably and avoid obstacles without getting stuck or damaged. The robot must be programmed to properly calibrate its sensors and react appropriately to various obstacles. The robot should be designed to follow the human reliably, without losing track or colliding with obstacles. The sensors should be calibrated properly, and the robot should be programmed to react appropriately to the human's movements.

4) Ease of use

Robots should be user-friendly, with simple controls and intuitive programming. The Arduino code should be well documented and easy to understand, and the robot hardware should be easy to assemble and use.

5) Power consumption

Robot power consumption must also be considered. Robots must be able to operate long enough without the need for frequent battery changes or recharging.

6) Durability

A robot must be able to withstand the environmental conditions in which it will be used. If the robot will be used outdoors or in harsh conditions, it must be designed to withstand water, dust and extreme temperatures.

7) Maintenance requirements

Robots should be designed to be serviceable, with components that can be easily replaced or repaired as needed. Sensors must be protected from damage and robots must be designed to minimize component wear.

8) Security Considerations

Robots must be designed for safe operation and contain safety precautions to prevent accidents. For example, robots should be designed to shut down when encountering obstacles that they cannot avoid, and should be designed to avoid collisions with people or other objects.

Overall, a robot using Arduino can be designed to be operationally feasible with proper attention to these factors. It is important to thoroughly test the robot and ensure that it operates reliably and safely before deploying it in any critical application.

Technical feasibility

Technical feasibility aids in gaining access to existing resources as well as technology essential for completing the user's needs in the software within the budget and schedule constraints.

In the technical feasibility, the following tasks are done:

•Assists in assessing the stability of the technology employed.

•Is the required technology available?

•Or are the proposed functionalities viable to integrate with current/available technology?

•Examine the technical talents and talents of software development team members.

The technical feasibility of the robot depends on following factors:

1) Arduino board

The heart of this project is an Arduino board that acts as a microcontroller that processes input from sensors and controls motors. The Arduino board should have enough pins to support the required number of sensors and motors.

2) Sensor

A robot needs sensors to detect obstacles in its path. Common sensors used for obstacle avoidance include ultrasonic sensors, infrared sensors, and LIDAR sensors. We need to connect the sensor to the Arduino board and program it to send data to the microcontroller. In accordance to the path memorization function accurate sensor integration is essential for robots to perceive their surroundings and pinpoint their location. Different types of sensors can be used to achieve this, such as ultrasonic sensors, infrared sensors, encoders, etc. These sensors must be properly integrated into the Arduino board and process the sensor data correctly so that the robot can accurately determine its position.

3) Programming

Programming is essential for robot operation. The robot's movements are controlled by programming the Arduino board. A robot must be programmed to navigate its environment and remember the path taken. The various conditions and obstacles the robot may encounter along the way. The programming language used is usually embedded C. Code must be written to receive input from sensors, process data, and control motors to avoid obstacles. The programming of the robot to recognize and follow humans requires complex algorithms and decision-making processes. Robots must process data from sensors and interpret that data to determine how to coordinate their movements to keep up with humans.

4) Motors

Robots need motors to move and avoid obstacles. Depending on the design, robots can use wheels or other locomotion mechanisms. The motor should be compatible with his Arduino board and wired to a microcontroller.

5) Memory management

Robots need a reliable memory management system that stores path data accurately and allows robots to retrieve data quickly when needed. Data can be stored using EEPROM or SD card. Programming must ensure that data is organized and accessible.

6) Power supply

Robots need a reliable power source to keep them moving. Depending on the robot design, this could be a rechargeable battery or a wired power supply.

7) Mechanical design

The robot's mechanical design must be able to follow the human it follows, including any necessary adjustments in speed and direction. This requires careful selection of engines, wheels and other mechanical parts.

Overall, technical feasibility of building a robot using Arduino is achievable. With the right selection and integration of sensors, programming, power management, motor control, and memory management, a robot can be built that works according to the commands of the user.

Economic Feasibility

Economic feasibility determines if the necessary software has the ability to provide financial rewards for a company.

This sort of research includes the cost of the software development team, the cost of the study involved in completing a feasibility study, and the expected cost of software and hardware.

Only if system focuses on the concerns described below can it be regarded viable:

•The expense of training, development team, software, and hardware.

•The cost of undertaking software research activities such as requirements analysis and requirements elicitation.

•The cost of developing software to provide long-term benefits for a company.

•It is also studied if the program can be produced within the financial constraints.

•Because some clients demand a lot of functionality in their program but are unwilling to spend the appropriate money.

The economic feasibility of the robot depends on following factors:

1) Cost of components

The cost of the components needed to build the robot will depend on the specific requirements of the project. Typically, Arduino boards and sensors are relatively affordable, but the cost of the motor, power supply, and memory module can vary widely depending on the specs.

2) Assembly and testing

Assembly and testing costs can also affect the economic viability of the project. If the design is simple and the assembly is simple, the cost can be minimal. However, if the design is complex or requires specialized tools, costs can add up.

3) Labor cost

The cost of labor required to build and program the robot will depend on the complexity of the project and the skill level of the people involved. For example, building a simple robot that memorizes the path may require basic programming and assembly skills, while a more complex robot may require advanced programming and engineering expertise.

4) Potential benefits

The potential profit of a robot can affect its economic viability. For example, a path-remembering robot could be used for surveillance and security purposes, reducing the need for human patrols and potentially saving labor costs. In addition, it can be used for mapping and exploration, providing data that can be used to optimize industrial processes or improve urban planning.

5) Maintenance cost:

The maintenance cost of the robot should also be taken into account when assessing its economic feasibility. Components such as sensors and motors may require periodic maintenance or replacement, and these costs should be factored into the total cost of ownership.

Overall, the economic feasibility of the robot using Arduino will depend on the specific requirements of the project, the potential benefits, and the costs of components and labor. If the benefits outweigh the costs, the project could be economically feasible, but if the costs are too high or the benefits too limited, the project may not be financially viable. With careful planning and budgeting, the project can be completed on a budget.

SYSTEM ANALYSIS

Requirement specification

A requirement specification is a detailed description of the functional and non-functional requirements of a system or product. It outlines what the system or product must do and how it should perform.

The requirement specification for the proposed Navibot are as follows:

Functional requirements

- The robot should be able to memorize the path according to the user's commands.
- It should be able to store the data related to path memorization.
- It should be able to detect the obstacle precisely.
- It must follow the marked path accurately.

Non-functional requirements

- The robot should be able robust enough to survive in severe environment.
- It should be user-friendly.
- It should be cost-effective.
- It must be interoperable so that it can communicate with other devices and systems.

System module

1] Line following

The line following robot is one among the self-operating robots. That detects and follows a line drawn on the surface. The line is indicated by reference white line on a black surface or black line on a white surface. This system must be sense by the line. This application is depending upon the sensors.

The applications of the line following robot are:

- Industrial automation:

This robot can be used in factories and warehouses to transport goods and materials along a predetermined path.

Once the instructions are programmed, then it will follow the same instructions all the time

- Logistics:

Line robots can be used in logistics and distribution centers to transport packages and goods along a predefined route.

- Education:

It can be used in educational settings to teach students about robotics, programming, and sensors.

- Entertainment:

It can be used in amusement parks or other entertainment venues as a fun and interactive attraction.

2] Path memorization

A path memorization robot is a robot designed to follow a predetermined path and record that path for future reference. It is based on the Arduino microcontroller board, an inexpensive and easy-to-use platform for building digital devices and interactive objects.

The applications of the path memorizing robot are:

- Educational purpose:

Robots can be used as an educational tool to introduce students to concepts of robotics, programming, and control systems.

- Security and surveillance:

Robots can be used to patrol a certain area and remember the route traveled. This can be useful for surveillance and security purposes in places like museums, airports, and public buildings.

- Indoor navigation:

Robots can be used to navigate indoor environments and remember the route to a particular destination. This can be especially helpful for people with visual impairments.

3] Obstacle avoidance

An obstacle avoidance robot is a type of autonomous robot that is designed to navigate through an environment while avoiding obstacles in its path. This robot using Arduino has the potential to be a versatile and useful technology with a wide range of applications.

The applications of an obstacle avoidance robot are wide-ranging.

- Industrial automation:

  Obstacle avoidance robots can be used in factories and warehouses to transport goods and materials without human intervention.

- Search and rescue:

  Obstacle avoidance robots can be used in search and rescue operations to navigate through hazardous environments and locate survivors.

- Agriculture:

  Obstacle avoidance robots can be used in agriculture to navigate through fields and spray crops with pesticides or fertilizers.

- Cleaning:

  Obstacle avoidance robots can be used in homes or offices to clean floors or other surfaces without bumping into furniture or other objects.

4] Human following

Human-following robot is an automotive system that has the ability to recognize obstacles, move and change the position of the robot with respect to the subject in the best way to go in the right direction.

A human-following robot using Arduino has several potential uses and applications.

- Protect:

Human tracking robots can be used in security applications to track and monitor the movements of suspicious individuals.

- Hospitality:

Robots that follow humans could be used in hotels or resorts to carry luggage or guide guests to their rooms.

- Personal assistant:

A human tracking robot can be programmed to help people with disabilities or mobility impairments by following them and carrying their belongings.

Block diagram

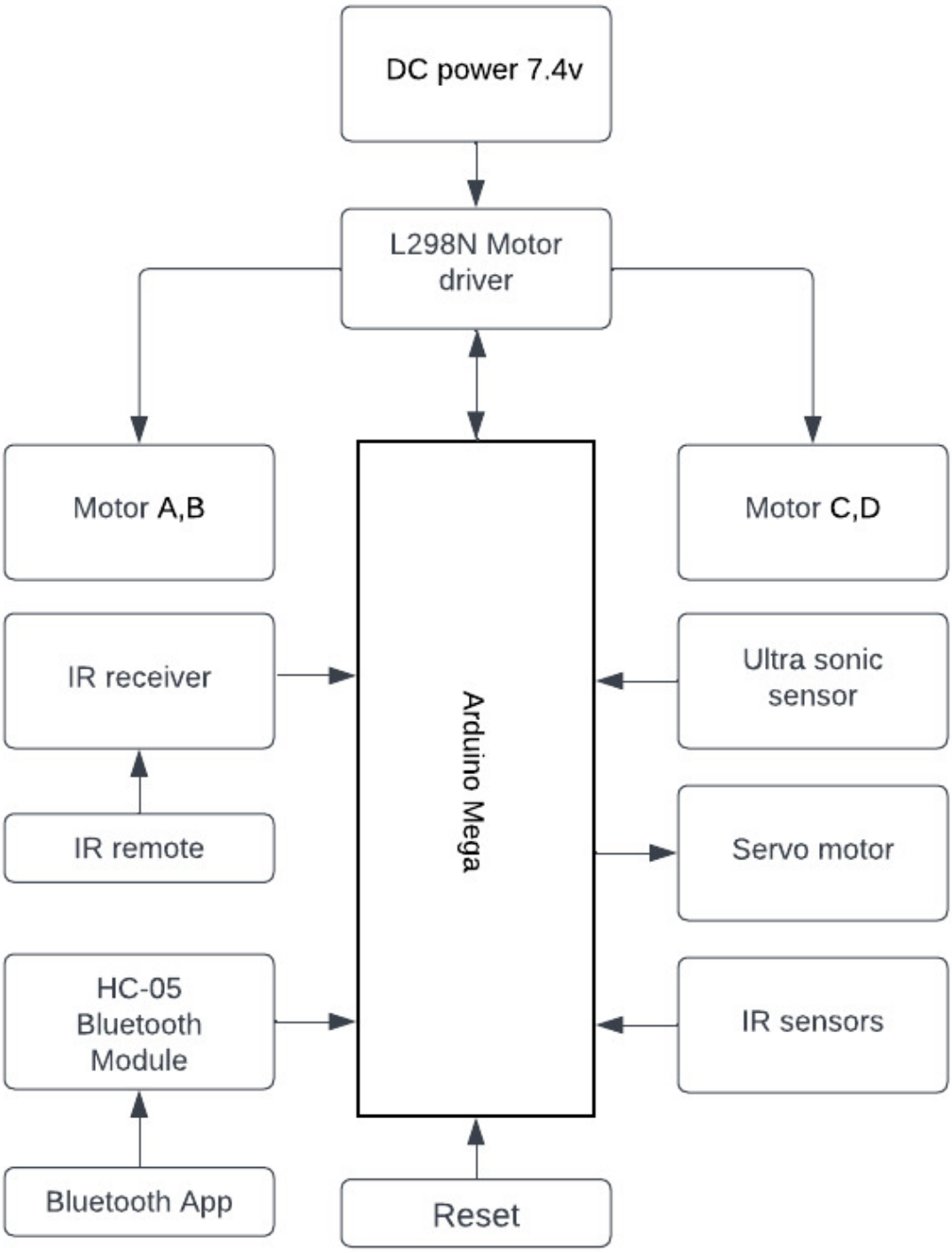

Figure 4.1

Flowchart – Line Following

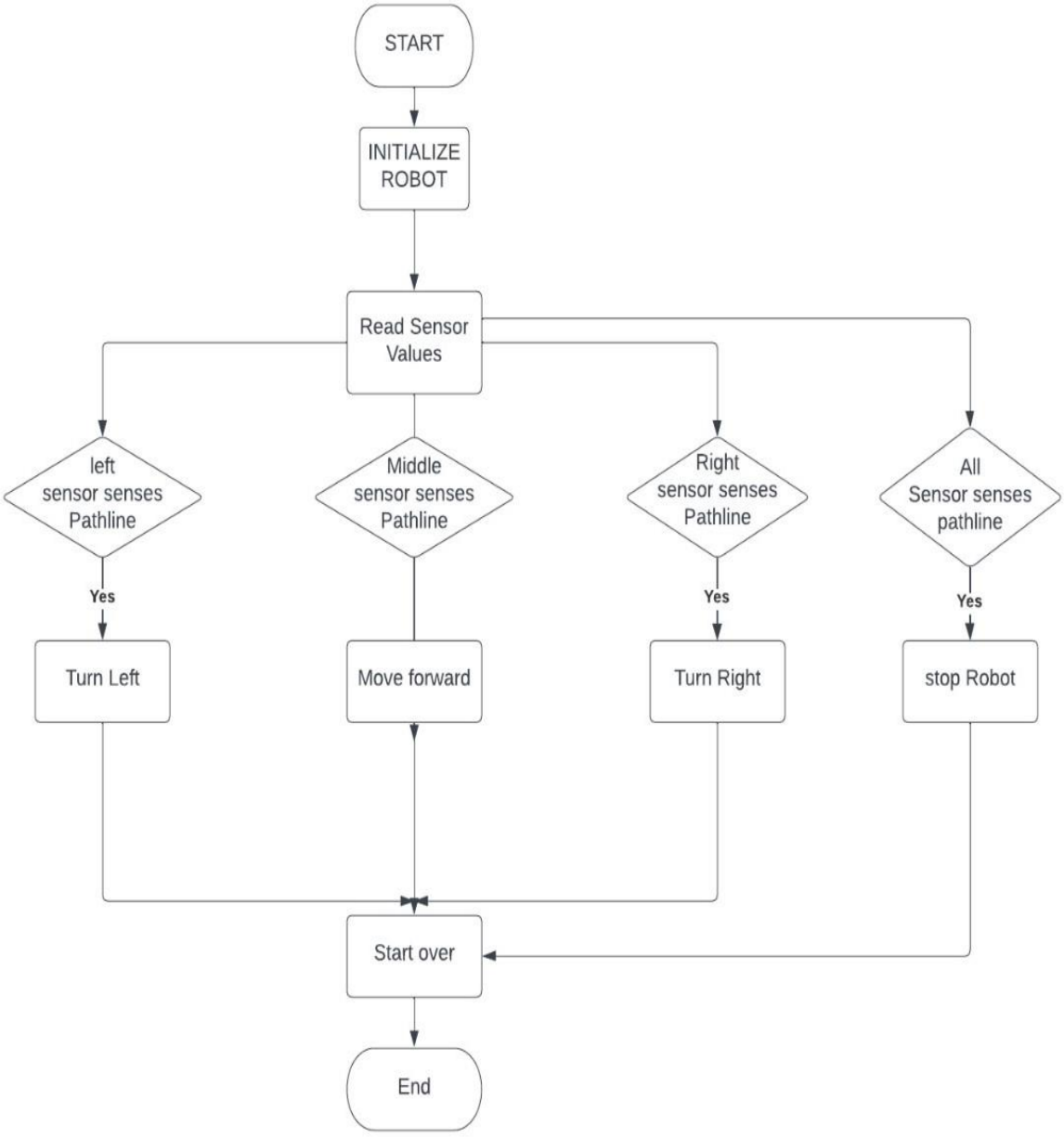

Figure 4.2

Flowchart – Obstacle Avoidance

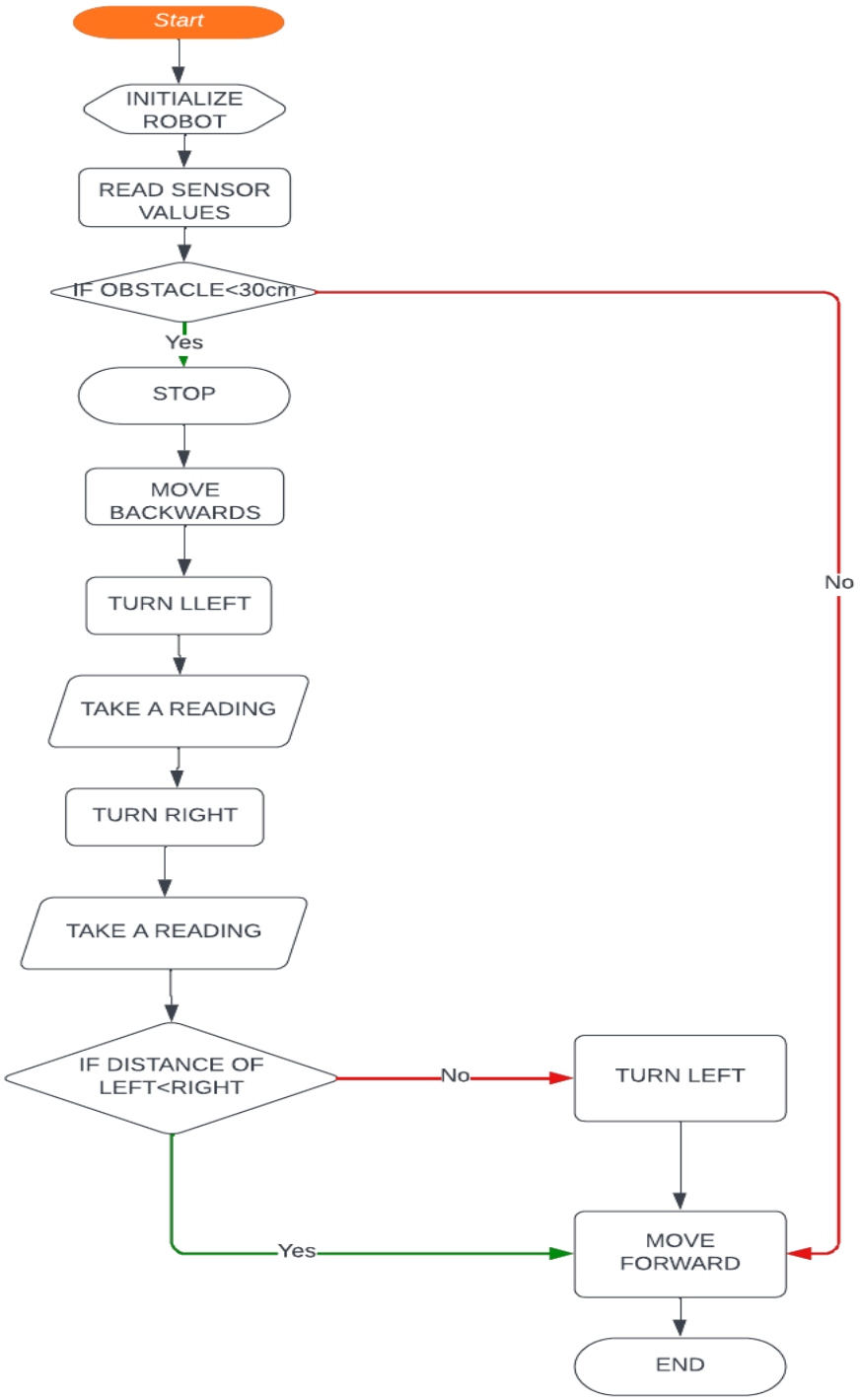

Figure 4.3

Flowchart – Human Following

Figure 4.4

Flowchart – Path Memorization

A] Learning mode

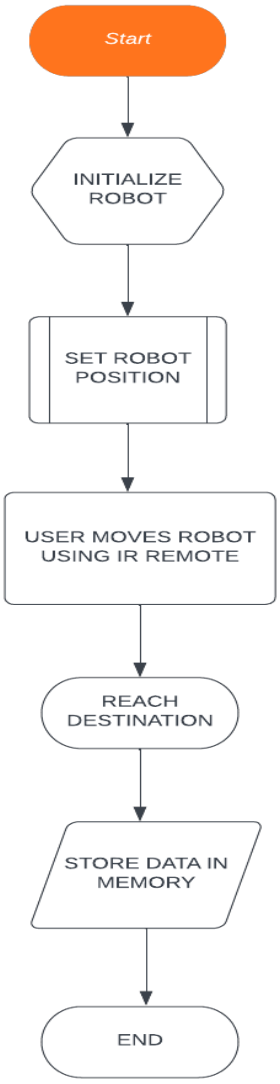

Figure 4.5

Flowchart – Path Memorization

B] Play mode

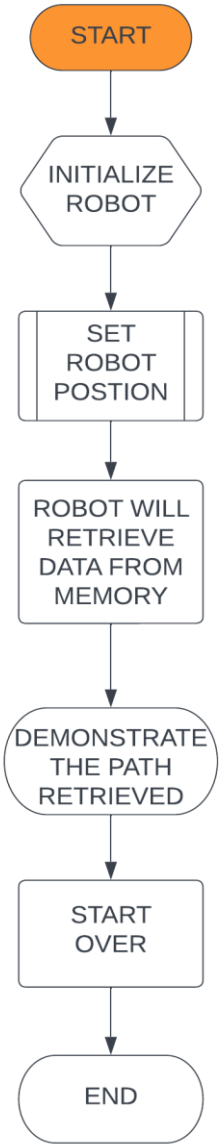

Figure 4.6

Functional decomposition diagram

Functional decomposition is a method of analysis that dissects a complex process in order to examine its individual elements. A function, in this context, is a task in a larger process whereby decomposition breaks down that process into smaller, easier to comprehend units.

The individual elements of the process and their hierarchical relationship to each other are commonly displayed in a diagram called a functional decomposition diagram. The diagram is shown in a top-down format illustrating a process. A functional decomposition diagram contains the overall function or task as well as the necessary sub-functions or tasks needed to achieve the overall objective.

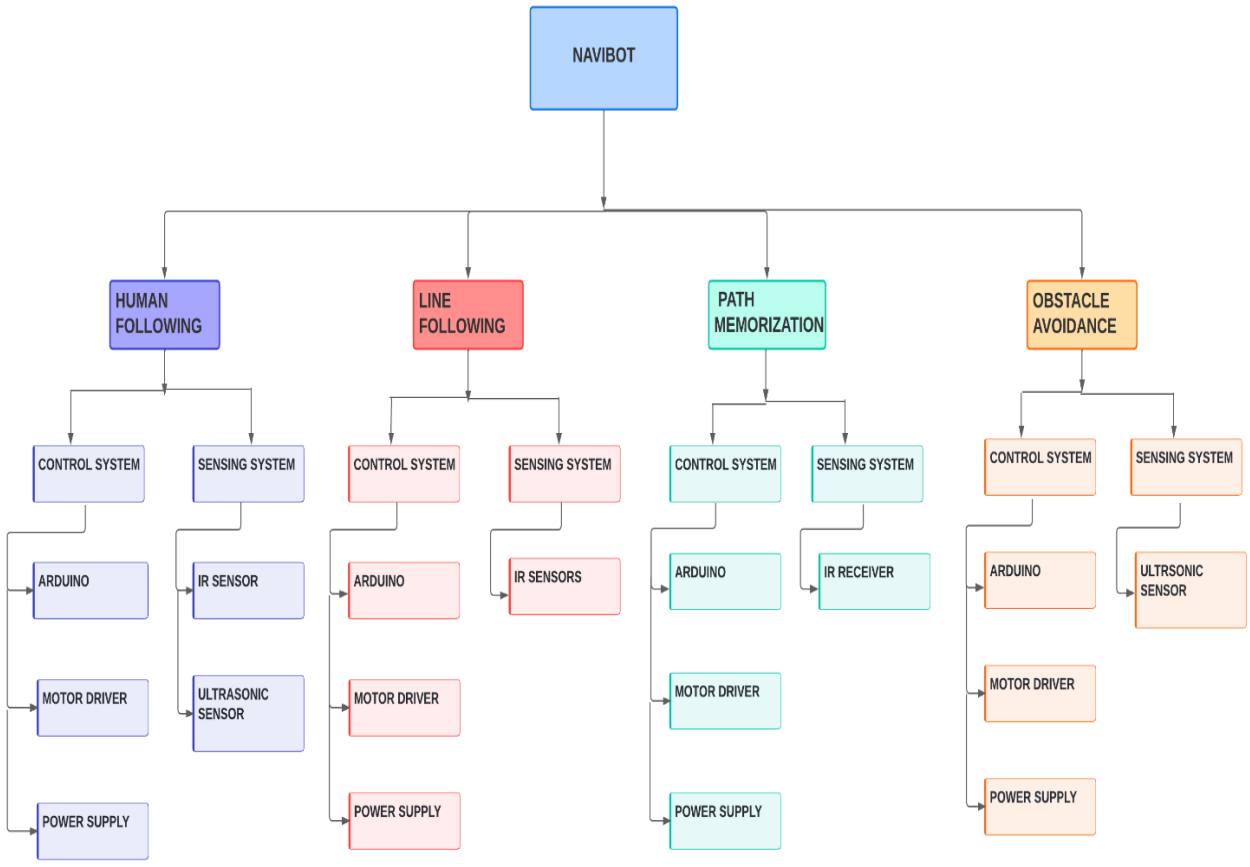

Figure 4.7

SYSTEM DESIGN

Screen layouts

System circuit design

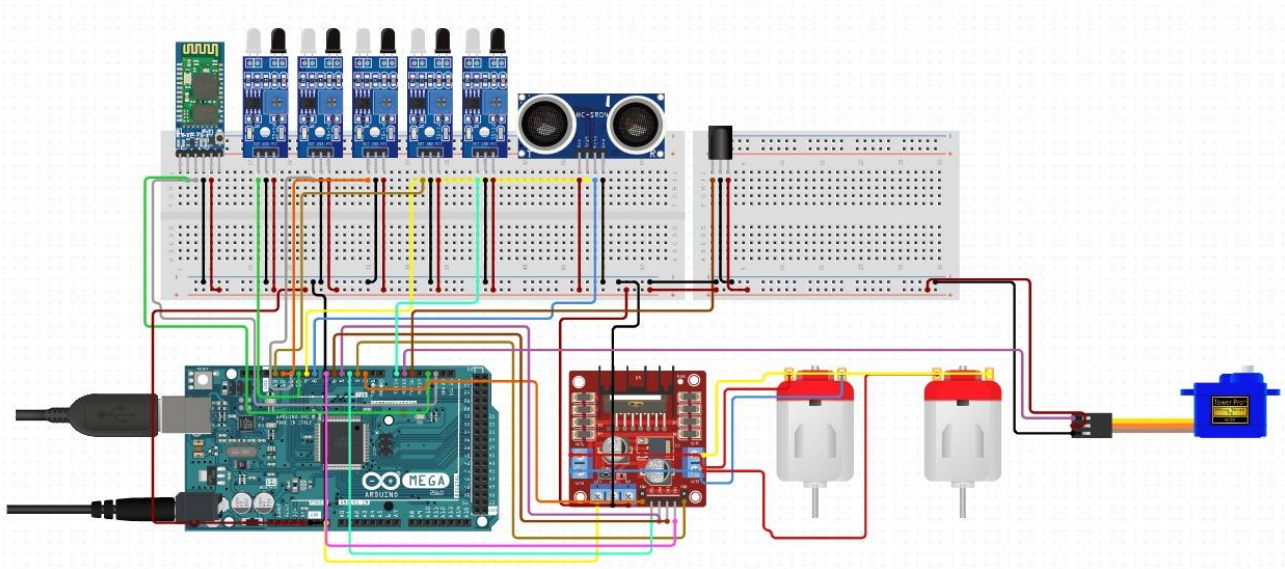

Figure 5.1

Path memorization

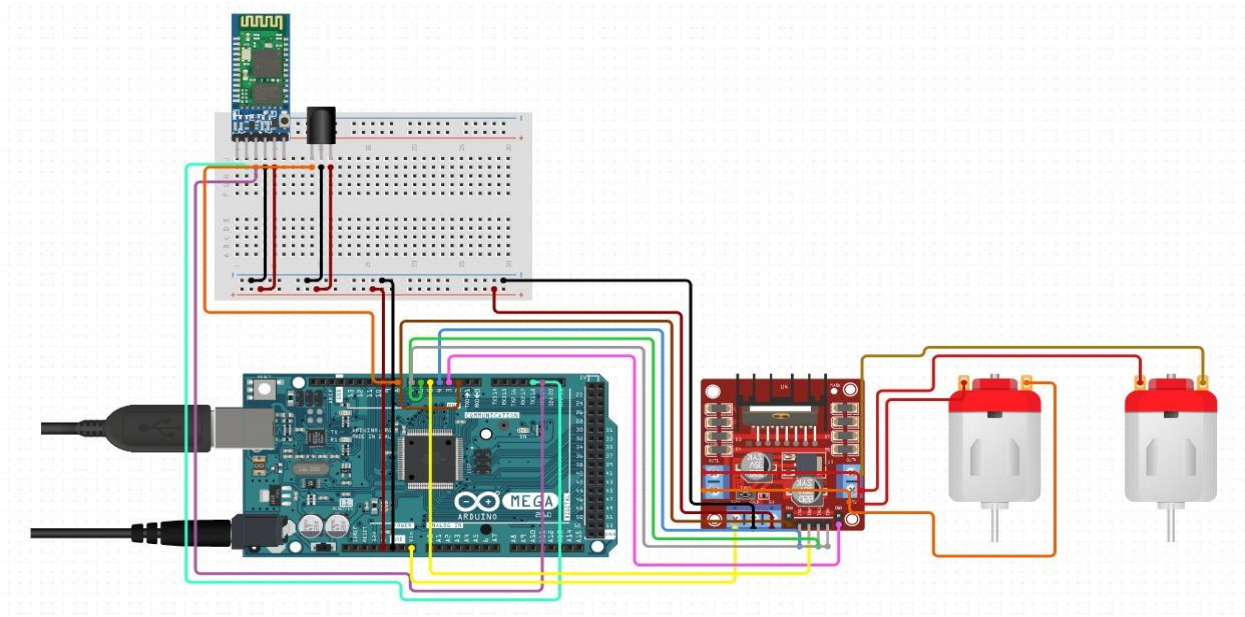

Figure 5.2

Line following

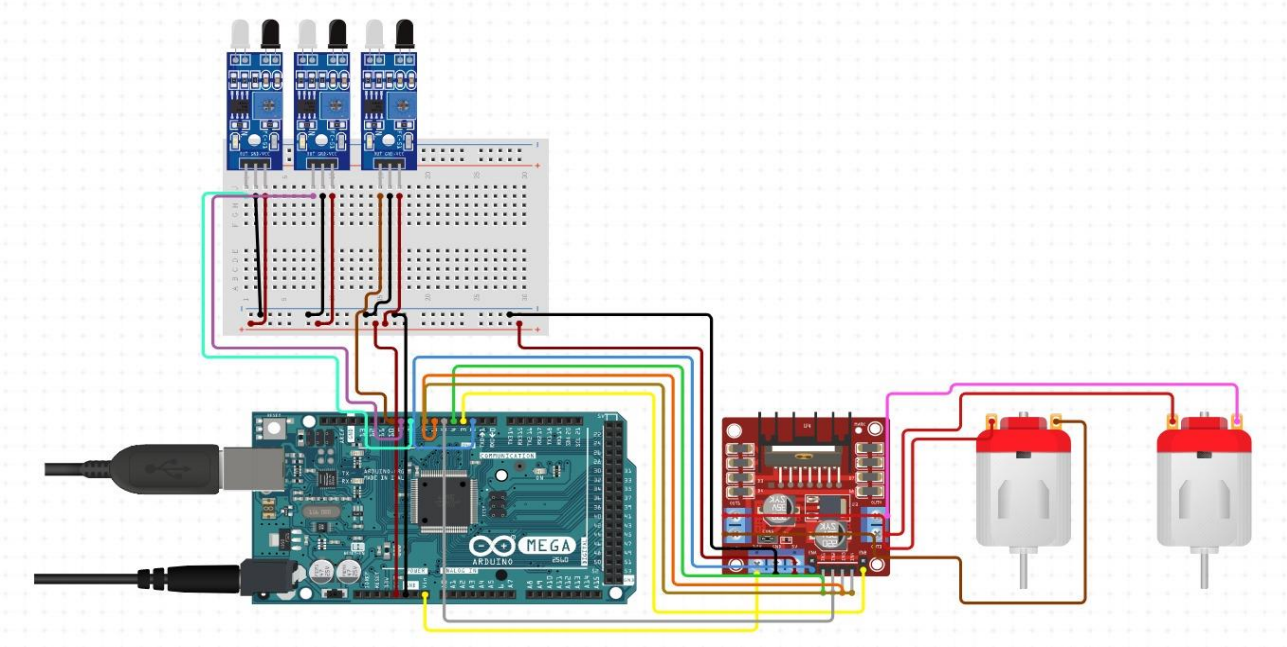

Figure 5.3

Human following

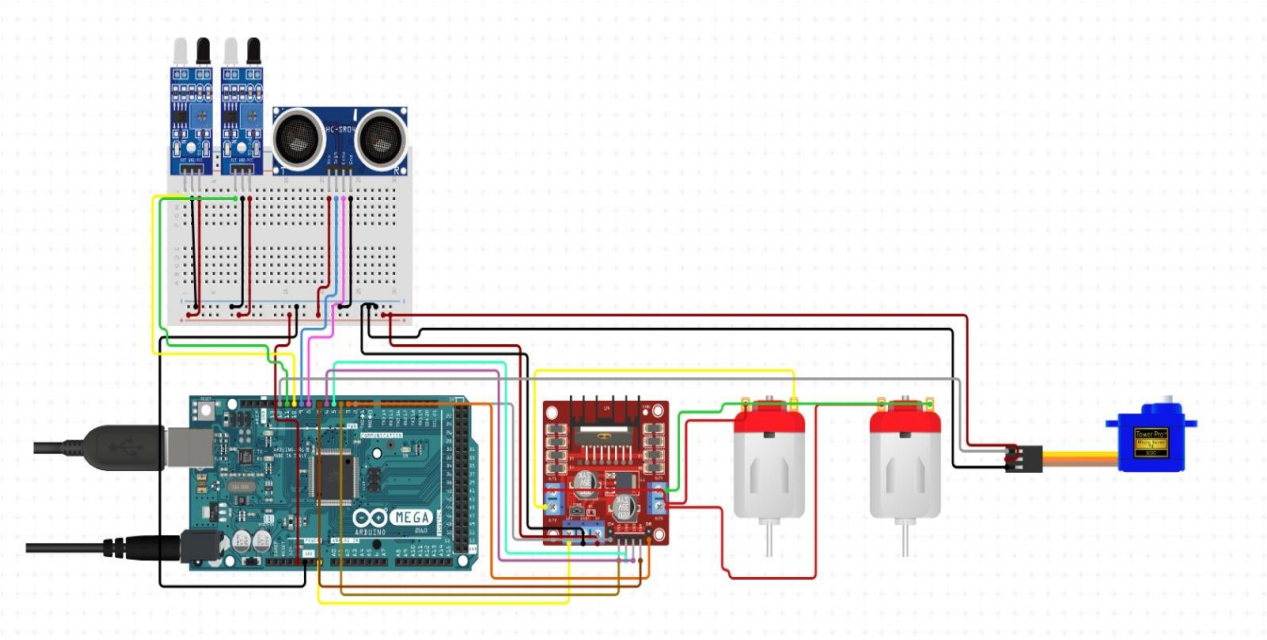

Figure 5.4

Obstacle avoidance

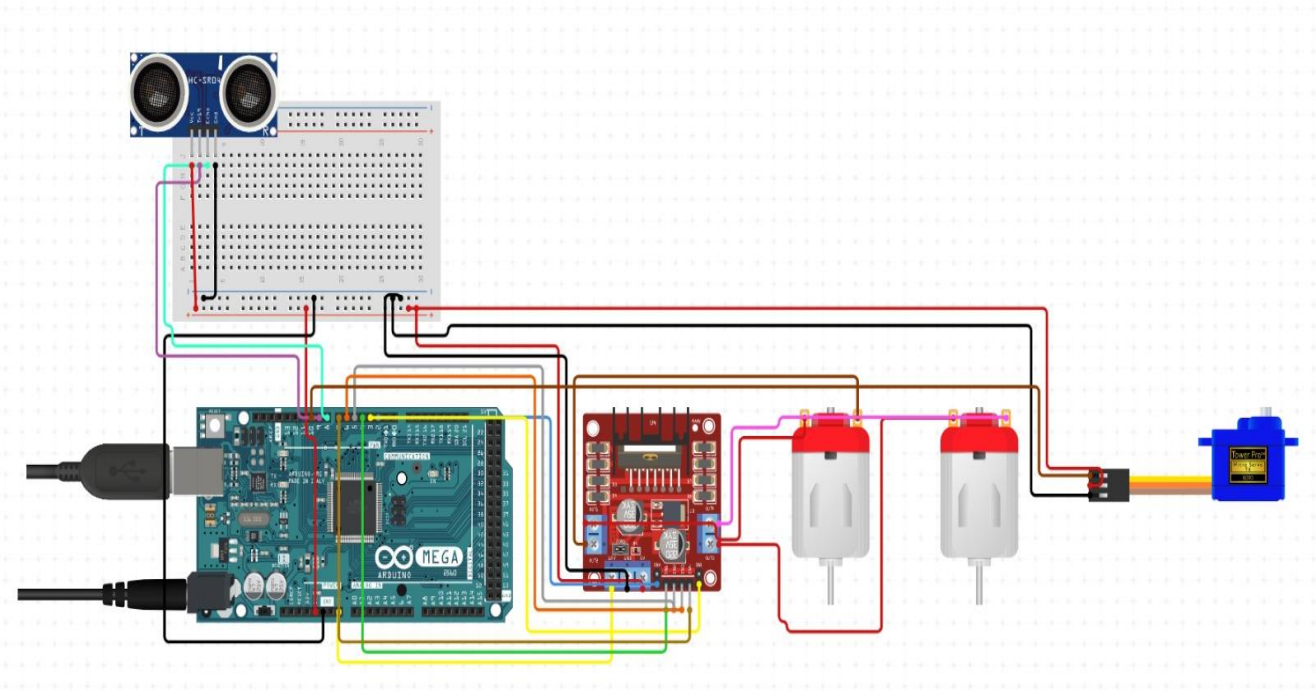

Figure 5.5

SYSTEM TESTING

Testing strategies

1] Unit testing

This includes testing individual components of the robot's hardware and software to ensure that they work as expected. For example, you can test your Arduino board's inputs and outputs, line sensors, motor control, and line tracking algorithms.

2] Integration testing

Test how the various components of the robot work together to achieve the desired functionality. For example, you can test how the sensors and motor controllers work together to make the robot follow the line accurately or test how motor controller work to move the robot along a memorized path.

3] System testing

The robot is tested as a whole to ensure it meets the overall system requirements. For example, testing a robot's ability to navigate a complex environment with various obstacles, or its ability to precisely follow a saved path while avoiding obstacles and stopping at specific waypoints.

4] Acceptance testing

This includes testing the robots against customer requirements to ensure that they meet their expectations. For example, you can test a robot's ability to follow a specific human and keep a safe distance.

5] Regression testing

Robot functionality is tested after hardware or software changes. For example, testing the robot after updating the path memory algorithm or adding a new sensor, or testing the robot after updating the obstacle avoidance algorithm or changing the calibration settings of the distance sensor.

FUTURE ENHANCEMENT

There are many interesting applications of this research in different fields whether military or medical, 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 color sensor.

•Further the robot can be programmed with fuzzy logic to find its own path among given set of paths from source to destination which will be shortest of all. The controller should be capable of re- planning the new optimum collision-free path

•A wireless communication functionality can be added in the robot to make it more versatile and control it from a large distance.

•We can also add some modifications in the algorithm and the structure as well to fit it for any other purpose. E-g a vehicle follower.

•Adding night vision camera

•Use of lidar sensor for precise measurement of variable distance and range detection.

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