A Novel Prototype of a Multi-Functional Robot based on Path Memorizing Algorithm

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***Abstract*— Navibot is a path memorizing multi-functional robot. Navibot is an acronym for navigation robot. Arduino serves as a controller of the robot, and the program developed in it provides the necessary logic to drive the Motors. We have used L298N Motor driver to supply enough current to the DC motors. Power supply is provided through rechargeable batteries. It is important to thoroughly test the robot and ensure that it operates reliably and safely before deploying it in any critical application. Sensors such as IR sensor and ultrasonic sensor are used to perform functions namely line following, obstacle avoidance and human following. Apart from these functions, the robot is capable of executing a crucial task that is path memorizing. To control all these functions easily, we have two ways, one is through an IR remote and another is by using an application, which can connect to the Bluetooth module attached to the robot. The device is tested though various testing strategies for better and efficient user experience.**

Keywords*— *Arduino, L298N Motor Driver, Bluetooth module

I. INTRODUCTION

Robots have been assisting humans to achieve various tasks since many years. Every few days, technology in the field of robots gets enhanced. Robots with new and more efficient features are the need of the hour .

A robot that can assist us in various domains, such as transporting objects, operates with more precision and in less time in all types of job. A robot that can assist us at a hospital or carry medical supplies in an emergency will be more useful to a doctor. This sort of robot has several advantages and will be useful in the future. In this paper we are introducing a navigation robot named as Navibot which can contribute in making human life better. This electronic device can execute various functions according to the needs of the user. It can move on a track paved by the user, avoid an object or obstacle and follow a human diligently. The unique selling proposition of our robot is path memorization. Path memorization feature allows the user to operate the robot in such a way that it can follow a particular trail, remember it by storing the path in its memory and demonstrate it as and when required by the user.

II. SYSTEM ANALYSIS

The block diagram of the proposed system is shown in Figure 1. The system is made in such a way that it can execute commands according to the requirements of the user. 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 is programmed to control the robot's movements. Data can be saved on an EEPROM or an SD card. Connecting the sensor to the Arduino board and programming it to deliver data to the microcontroller are the next steps. Accurate sensor integration is required for robots to comprehend their surroundings and locate their location, according to the path memorization function. This device can be used to fulfill various purpose such as in security applications to track and monitor the movements of suspicious individuals.

It can be also used logistics and distribution centers to transport packages and goods along a predefined route. A crucial purpose of this device is that it 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.

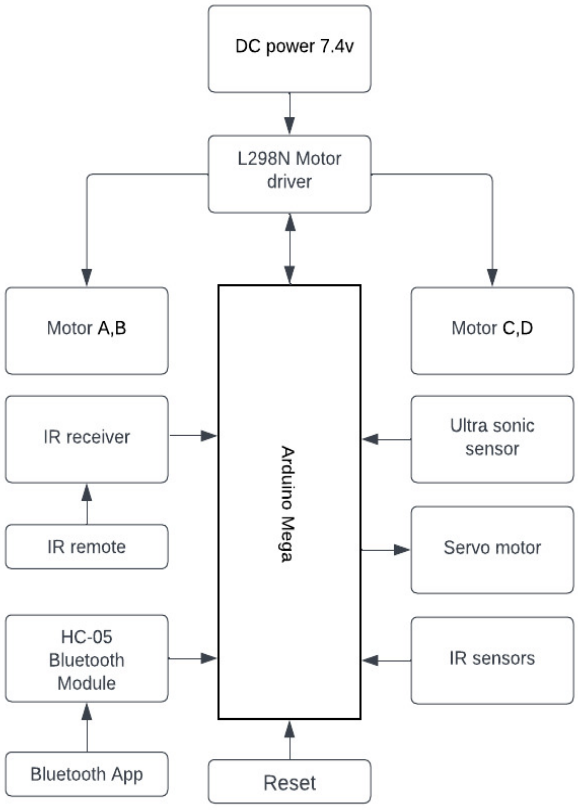

Figure 1: Block diagram of Proposed System

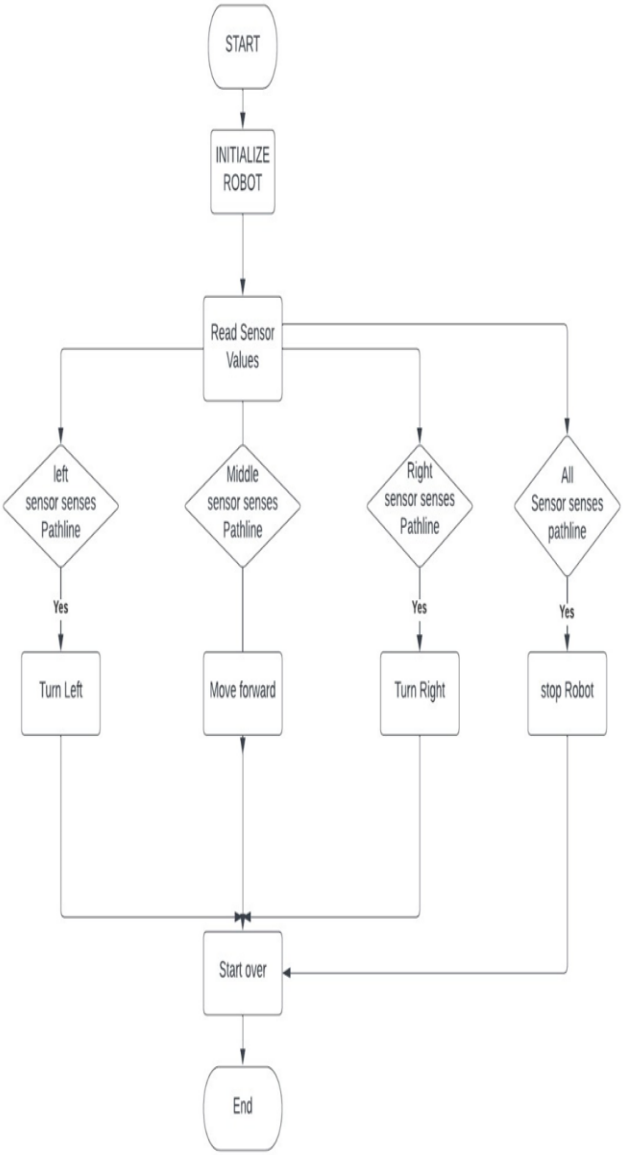

Figure 2: Flow Chart of Line Following

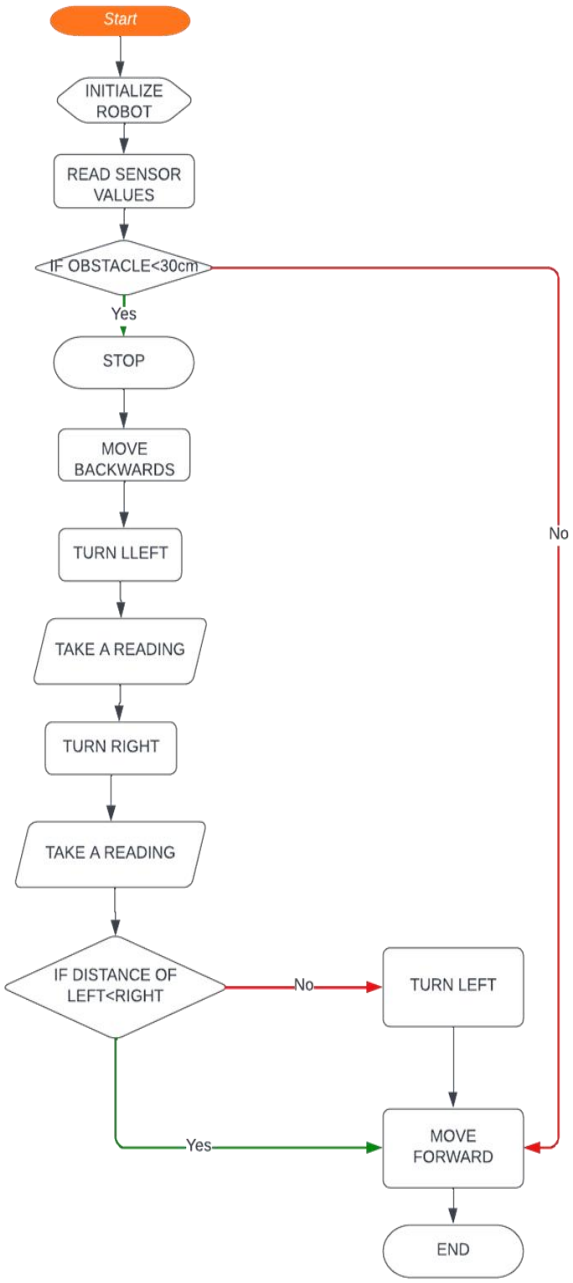

Figure 3: Flow Chart of Obstacle Avoidance

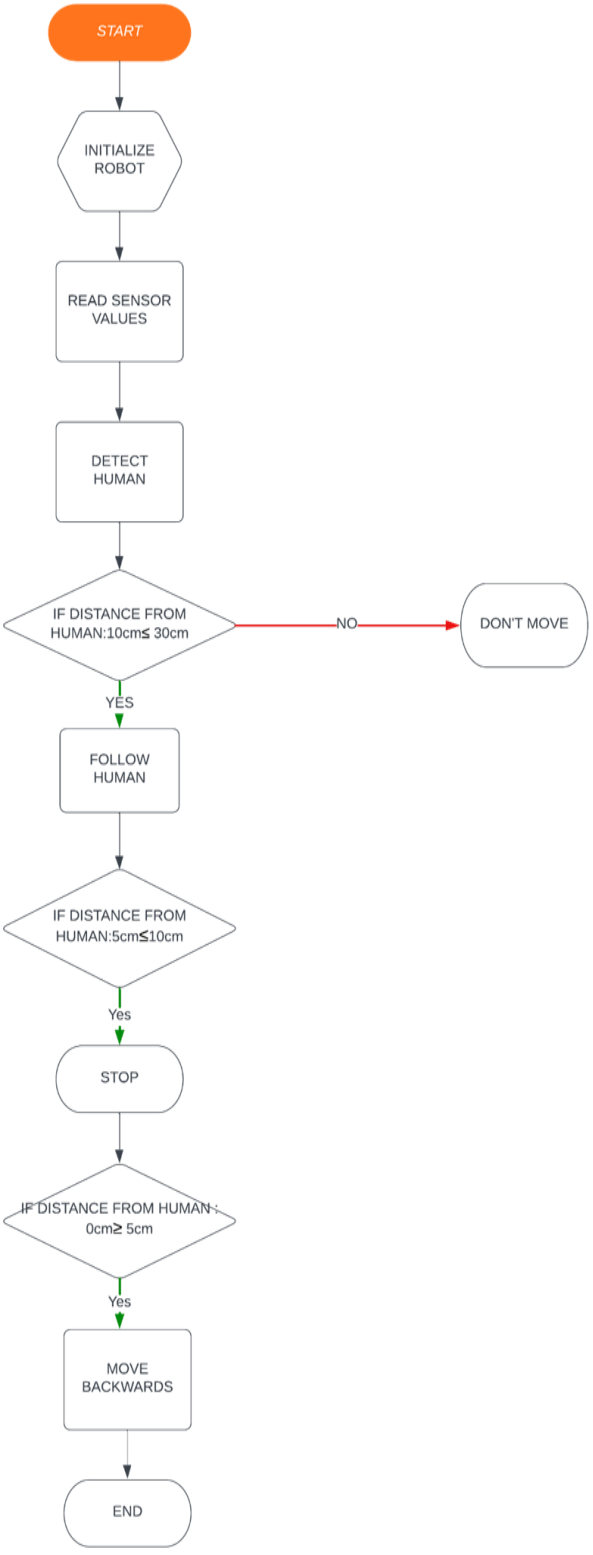

Figure 4: Flow Chart of Human Following

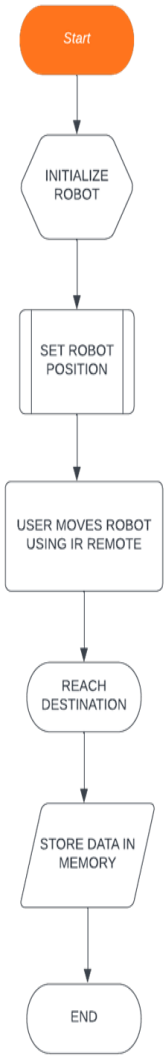

Figure 5: Flow Chart of Path Memorization
[A] Learning mode

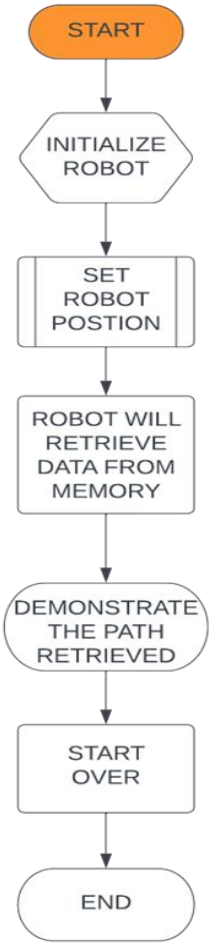

Figure 6: Flow Chart of Path Memorization

[B] Playing mode

The flowchart shown in figure 2 explains the flow of line following feature. To understand the operations of the robot, refer to figure 3 for obstacle avoidance function, figure 4 for human following function. Path memorization functionality has two modes namely learning mode shown in figure 5 and second is playing mode shown in figure 6. Firstly, the robot is turned on by using a switch. After initialization, the robot performs tasks according to the needs of the user. The user can choose any function from the menu on the given application.

If the user wants the robot to move on a particular track, then he/she has to select line following option in the menu. In the same way, for the robot to follow a human press human following button, for avoiding an object click on obstacle avoidance. Furthermore, if the user wishes for the robot to remember a path, he/she has to first move the robot on that path and then save the path in the robot's memory by using the application.

III. WORDS FROM LITERATURE

Syeda Ramisa Masum et. al (2021) from Bangladesh have created "Bachao" device which is used for safety of children and women. According to them safety of children and women is major challenge. Their system involves Arduino Uno as controller and with it they have developed android based mobile application [1].

Utsav Rai, et al (2018) have developed safety device for women and children. They have used Raspberry Pi, GPS module as main hardware components and AWS cloud, API for google map and code in python, PHP and android studio as main software components. Whenever user of this device press a button his or her location will be sent to mobile app. [2]

Divya Chitkara et al. (2016) used the concept of Walton ladder network, Fly back driver, Fly back transformer and MOSFET as main components to develop safety device. The design didn't involve any programming components. It was in the shape of gloves which develops an electric shock waves when someone attacks. [3]

Dr. S. Pravinth Raja et al. (2021) have created smart shoes for safety of children and women. The foot-ware is equipped with IoT facility and includes other components like GSM and GPS. A button is pressed whenever someone is in trouble. Just by pressing a button a message will be sent to guardian's or parents phone. [4]

Priyanka S et al. (2018) have designed and implemented a device named SALVUS for women safety. The device is equipped with GSM module, ARM 7 Microcontroller, GPS module, LCD display, RFID module, emergency switch and vibrator. RFID reader will find out the details of the victim. [5]

Luo Hongqi et al (2021) designed alarm system and safety device for motor vehicles. The device is used here to detect the fault of brakelight of the vehicle and reminds with alarm in any abnormal scenario. The device uses triode, potentiometer and Operation amplifier. Programming component is not involved here. [6]

Satyam Tayal et al. (2021) have implemented hardware-based device for women safety. The device uses nodeMCU as main controller to support IoT facility. Other components used here are IoT module, Vibration module, GSM module, GPS module and camera module. Buzzer will make an enormous sound so that other people will get the information that someone is in trouble. [7]

V. Hyndavi et al. (2020) have developed wearable device using IoT for safety of the women and children. An emergency alert system is developed here which send message to relatives and police station that someone is in trouble. Various devices used to develop the system are pressure sensor, GSM, GPS and temperature sensor. [8]

Priya C. et al. (2022) developed safety device for women using IoT technology. They have developed all in one safe guard system. The system includes Arduino microcontroller, GPAS and GSM module, Bluetooth module. In danger situation system will send message to guardian. [9]

II. HARDWARE AND SOFTWARE USED

Software of the proposed system comprises of:

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.

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 project, 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.

3) MIT App Inventor

It is an intuitive, visual programming environment that allows everyone – even children – to build fully functional apps for Android phones, iPhones, and Android/iOS tablets.

Following hardware components are used to design proposed system.

1. Arduino Mega
2. L298N Motor Driver
3. Ultrasonic sensor
4. IR Sensor
5. IR Receiver
6. Bluetooth module
7. Servo motor
8. Switch

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. Here, IDE stands for Integrated Development Environment. The functioning of the Arduino Mega is similar to other Arduino Boards. We need not require extra components for its working. The ATmega2560 Microcontroller is consistent with most of the shields of Arduino UNO.

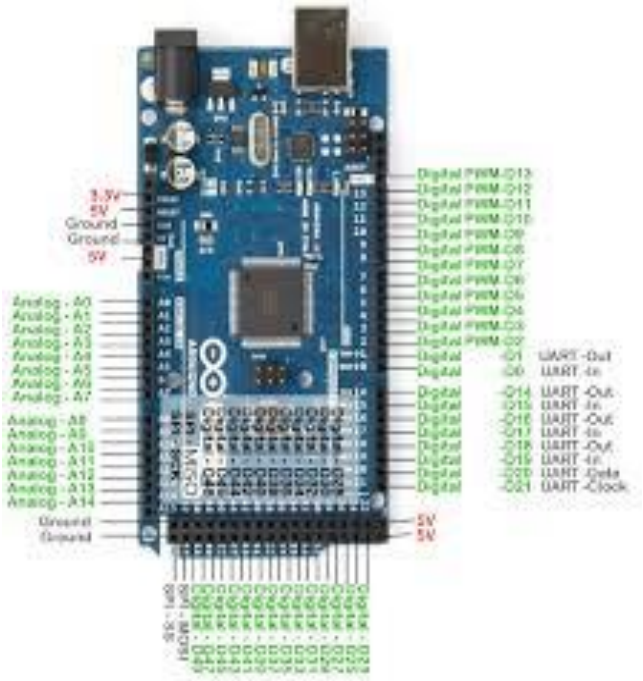

Figure 7: Arduino Mega

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. 78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.

ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

Figure 8: L298N Motor Driver

Ultrasonic sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e., the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

Figure 9: Ultrasonic sensor

IR Sensor

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. Infrared radiation was accidentally discovered by an astronomer named William Herchel in 1800. While measuring the temperature of each color of light (separated by a prism), he noticed that the temperature just beyond the red light was highest.

IR is invisible to the human eye, as its wavelength is longer than that of visible light (though it is still on the same electromagnetic spectrum). Anything that emits heat (everything that has a temperature above around five degrees Kelvin) gives off infrared radiation.

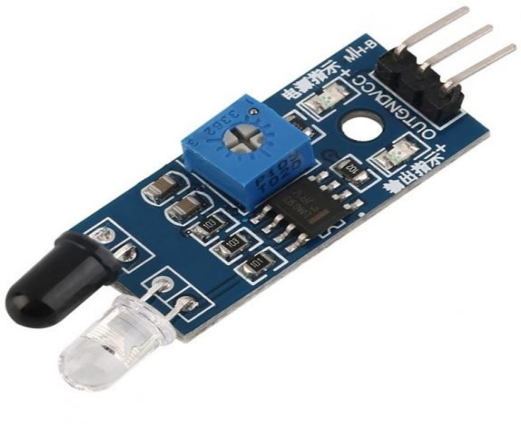

Figure 10: IR sensor

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 11: IR Receiver

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. HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner.

When it gets connected to any other Bluetooth device, its blinking slows down to two seconds. This module works on 3.3V. We can connect 5V supply voltage as well

since the module has on board 5 to 3.3 V regulator. As HC-05 Bluetooth module has 3.3V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module

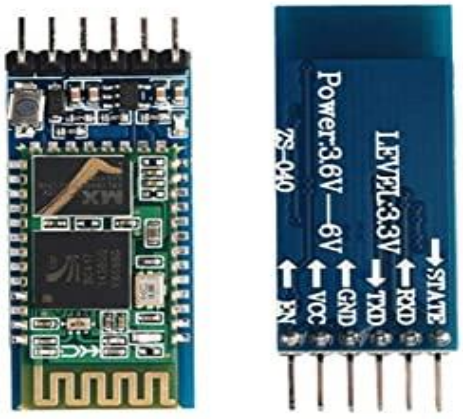

Figure 12: Bluetooth Module

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 13: Servo Motor

III. CIRCUIT DIAGRAM

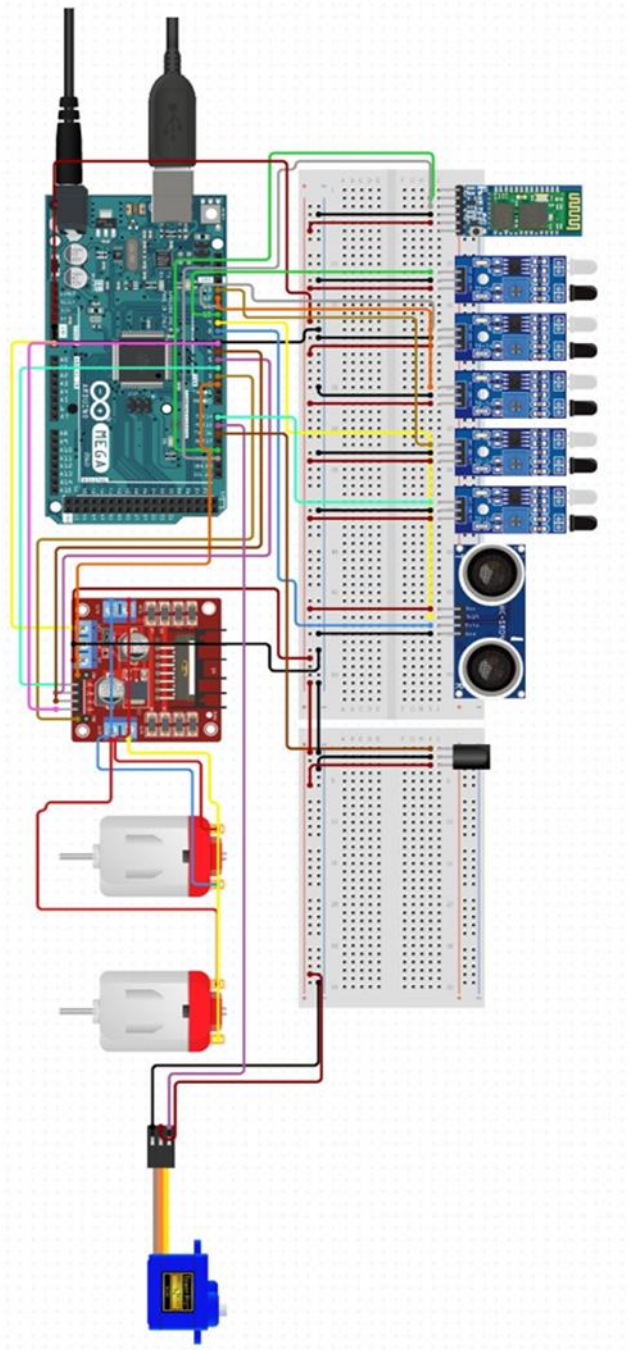

Figure 14: System Circuit Diagram

IV. IMPLEMENTATION

As shown in figure 14, assemble all the components on the chassis board and connect them appropriately. The robot is first turned-on by pressing the switch as shown in figure 15. After its initialization, the user can operate the robot according to his/her needs. A menu is displayed on the application, through which the user can choose which action he/she wants the robot to perform.

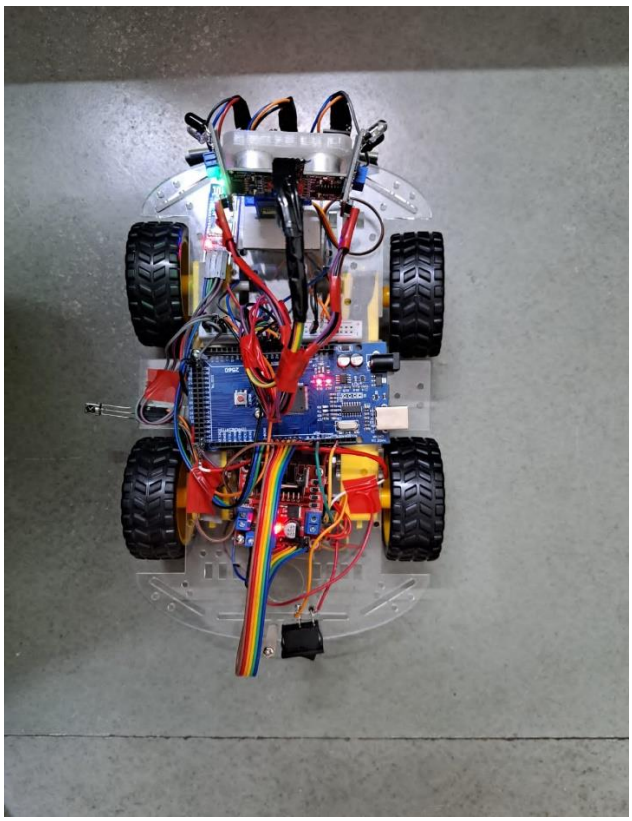

Figure 15: NAVIBOT

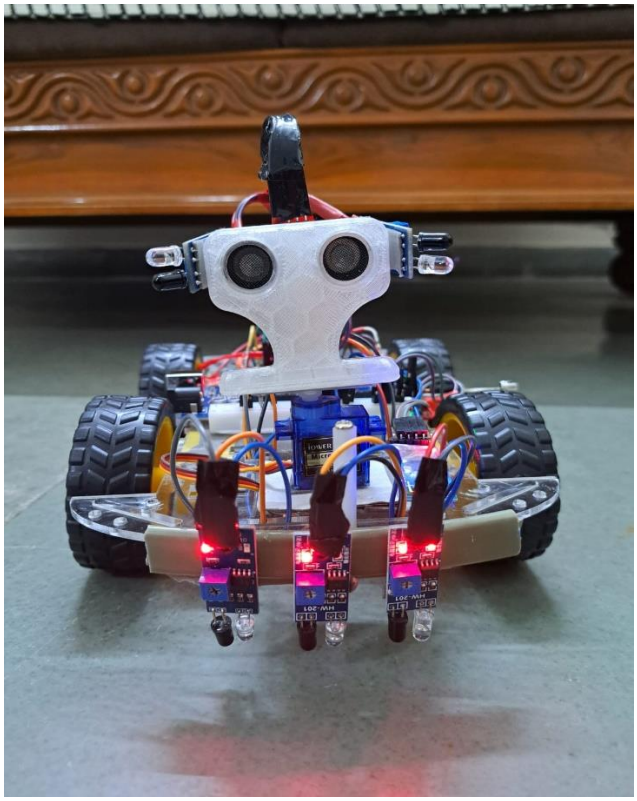

Figure 16: Front view of NaviBot

IV. CONCLUSION AND FUTURE SCOPE

This paper sheds light on an innovative method for assisting persons with disabilities in managing their daily lives, guiding people in public venues such as museums, and in residences for cleaning purposes. This research has numerous fascinating applications in many domains, whether military or medical, and the majority of the relevant features have been recognized and realized. However, due to time constraints and other factors, some of these cannot be included. The robot may be designed using fuzzy logic to discover the shortest path from source to destination among a given collection of pathways. The controller should be able to re-plan the new best collision-free path. We can add wireless communication features to the robot to make it more adaptable and controllable from a distance; we can also make changes to the algorithm and structure to fit it for any other use. As an example, consider a vehicle follower.

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