SENSOR BASED SOCIO-ECONOMICAL LOW-COST AUTONOMOUS GROUNG WIPER ROBOT FOR CLEANING

Prof. (Dr.) Manisha Rajesh Mhetre, Bhargav Chaudhari,
Samarth Bhalake, Prabhat Bhasme, Bhagyashri Joshi.

**Department of Instrumentation and Control Engineering,
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra,
India**

Abstract *- It takes a lot of time and effort to clean the floor; periodically, we send staff to the job and pay them. However, as technology advances, homes are getting more intelligent and automated, which is convenient for the general public. Although there are several different types of vacuum cleaners on the market, none of them offer wet cleaning and all operate manually. In order to make cleaning considerably easier, the primary goal of our project is designing an autonomous floor-cleaning Robot that integrates wet and dry cleaning into a single design. The Motor Shield L298, an Arduino uno CPU, a Servo, a Dc motor with an Ultrasonic sensor, and other parts make up the full ground cleaning robot. The Arduino Uno Microcontroller employs The Ultrasonic Sensor as a robotic driver and a DC Motor as a distance detector. The Motor Shield L298 pushes the DC motor through the Arduino Uno.*

Keywords *— Arduino uno, Motor driver shield, Servo motor, cleaner, robot.*

I. INTRODUCTION

In recent years, the advancement of robot's technology has led to the emergence of various innovative robots that have made our lives easier and more convenient. One such robot is the floor wiper robot, which can be used to clean floors without any human intervention. The floor wiper robot is an autonomous robot that uses motors and sensors to move around and clean floors. In this research paper, we will discuss the implementation and design of a floor wiper robot using Arduino-Uno. Arduino-Uno is a microcontroller board that is open-source which is widely used in the field of robotics and automation. The use of Arduino-Uno in this project makes the development of the floor wiper robot more accessible and affordable. The paper will begin with a brief overview of the existing literature on floor wiper robots and their applications. This will be followed by an in-depth description of the design and components of the floor wiper robot, including the mechanical design, electronics, and software development. The results of the experiments conducted to test the performance of the floor wiper robot will also be presented.

Finally, we will discuss the limitations of the current design and the scope for future research in the field of floor wiper robots. This research paper will be a valuable resource for researchers and engineers interested in the development of floor wiper robots using Arduino-Uno

II. LITERATURE REVIEW

Here are some papers surveyed for literature review purposes.

1. Shubham Tiwari, Prof. Sangeeta Kotecha, Gaurav Rasal, Pramod Shukla, Ajinkya Mandavkar contributed to "Arduino Based Cleaner Robot", published in 2017, that describes that image illustrates the innovation that proposed deploying a robot to clean floors. The automation and intelligence of modern homes are expanding [1]. Automation in Home system improves people's convenience and frees up time. The use of domestic robots in homes and in daily life is growing, although the market is still in its early stages. Yet, a surge in their use is projected, and it is evolving. This project's goal is to create and develop a vacuum robot for autonomous dry and wet cleaning applications using a mop. Robot vacuum cleaners are designed to make cleaning simpler than using a manual vacuum. Using an Arduino Uno, a motor, an ultrasonic sensor, and an infrared sensor, the primary aim of this project involves designing. and constructing a vacuum robot prototype.
The 12V battery powers the whole circuitry. Vacuum Robot will adhere to a variety of usability standards. [2]

2. Dadasaheb Shaik. contributed to "Arduino Based Floor Cleaning Robot Using Ultrasonic Sensor", published in 2021, concentrates on the usage of the

Motor Shield L298 together with the servo, dc motor, and Arduino Uno microcontroller with an ultrasonic sensor. The ultrasonic sensor is utilised by the Arduino Uno microcontroller. [2] as a robotic driver and a DC motor as a distance gauge. The motor shield L298 pushes the DC motor through the Arduino Uno. When a barrier just before the ground-cleaning robot is detected by an ultrasonic sensor the robot will automatically search for a direction that isn't a barrier. The distance fee at the sensor has been set when the distance recorded through the ultrasonic sensor is less than 15 cm. The outcomes of testing the ultrasonic sensor distance fee revealed peculiar events that take place. The results of experimenting with the ultrasonic sensor distance fee identified unusual circumstances that occur. The prototype cleaning robot is placed in the proper position to clean the street surface at a distance of more than 15 cm. [2]

3.Bokam divakar, dr. R.S.R. Krishnam naidu, kayala avinash, potnuru anji, sumanth maharana, kodigudla dinesh, p. B. N. V. Sai pavan, salapu sravanthi, talari chandini, “Arduino Based Floor Cleaning Robot”, published in 2019, demonstrates how the model finds dust-producing objects and collects the dust. As a result, finding things close to the garbage can requires some sensor effort. Cleaning jobs involving dust may take some time, therefore occasionally other tasks are overlooked. We are thus developing a smart, dust-clearing floor cleaning robot. [3]

4.Mohd. Shahbaz Khan, Nagageetha, M. Gurunadha Babu, “Bluetooth Control Cleaning Robot using Arduino”, published in 2019, shows that we designed the robot to make the process simpler, and that it is made in a way that allows it to clean streets, houses, offices, apartments, and even apartments. The person watching the robot from a distance away from the cleaning area. This concept incorporates DC motors, servo motor brushes, a water pump, an Arduino, a tub, a scrub brush, an LED light, a battery, and a mobile phone.[4]

5.Ms. Sahana H. P. , Mr. Vinod kumar M. S. , Mr. Nagesh M. S. , Dr. C. Mallikarjuna , Dr. R. Suresh, “Multipurpose Cleaning Robot”published in 2019, proposed work can be employed for scheduled floor cleaning of large flooring surfaces in homes and offices. The Robot should be as little as feasible while still being able to reach nearly every corner of any area. A Bluetooth-enabled Android phone is employed to operate the robot. At the heart of the robot's construction is an Ardunio microprocessor. In order for the microcontroller to work properly, it is supplemented by marketing communication modules like Bluetooth, motor, and brushes. The power source is a 12V standard rechargeable battery. The floor is continuously scrubbed with a cleaning brush to achieve the cleaning objective, and mopping is done concurrently as the robot begins cleaning the floor.[5]

6.Goon, Li Hung, et al. contributed to “Development of Simple Automatic Floor Polisher Robot using Arduino”, published in 2019, that describes an affordable and user-friendly floor polishing robot that operates autonomously. By utilizing the Arduino microcontroller as the central control unit, the authors successfully integrated various hardware components such as motors, sensors, and actuators into the robot's structure. They explain the assembly process, electrical connections, and software architecture, which involved the development of algorithms for navigation, obstacle detection, and efficient polishing. The experimental results demonstrate the robot's satisfactory performance and highlight its potential for further enhancements in future iterations. This research contributes to the field of robotics and automation, specifically in the area of automated floor cleaning systems, by providing a cost-effective solution that can effectively perform polishing tasks while reducing human effort.[6]

7.Kaur, Manreet, and Preeti Abrol. contributed to “Design and development of floor cleaner robot (automatic and manual)", published in 2014, that describes the need for an efficient and versatile floor cleaning system that can adapt to different cleaning requirements. They proposed a robot that can function autonomously in automatic mode or be manually controlled by a user when needed. The paper provides a detailed description of the hardware components used in the robot's construction, including motors, wheels, sensors, and cleaning mechanisms. The authors explain the assembly process and how these components are integrated into the robot's body. The robot's software architecture and control system are also discussed in the paper. The authors outline the algorithms and logic used to enable the robot's autonomous navigation and cleaning functions. They also describe the manual control interface for user interaction. The experimental results demonstrate the effectiveness of the developed floor cleaner robot in both automatic and manual modes. The authors highlight the robot's ability to navigate different types of surfaces, detect obstacles, and perform efficient cleaning tasks.[7]

8.Irawan, Yuda, et al. contributed to "Automatic floor cleaning robot using arduino and ultrasonic sensor", published in 2021, that describes the need for automated cleaning systems and propose a robot that effectively detects obstacles and navigates using the ultrasonic sensor. The hardware components, including motors and wheels, are integrated into the robot's structure, while the software architecture based on Arduino programming enables autonomous cleaning operations. Experimental results demonstrate the robot's efficient obstacle avoidance and floor cleaning capabilities. This research contributes to the field of robotics and automation, offering a cost-effective solution for automated floor cleaning tasks, with potential for further advancements. The software architecture of the robot, based on the Arduino programming language, is presented, highlighting the algorithms and logic utilized for autonomous cleaning operations. The ultrasonic sensor plays a crucial role in detecting obstacles and enabling the robot to navigate the floor effectively. In conclusion, the paper presents a practical approach to the development of an automatic floor cleaning robot using Arduino and ultrasonic sensor technology. The research contributes to the field of robotics and automation by providing a cost-effective solution for automated cleaning tasks. The developed robot demonstrates satisfactory performance in terms of obstacle detection, navigation, and cleaning efficiency, and offers potential for further advancements in the field. [8]

9.Zhang, Lei, et al. contributed to “A new compact stair-cleaning robot ", published in 2016, that describes the robot's mechanical structure and algorithms enable it to effectively clean stairs by detecting their dimensions accordingly. Experimental results confirm the robot's successful performance in navigating various staircases and achieving efficient cleaning. This research contributes to the field of robotics and automation by providing a practical solution for addressing the specific cleaning needs of stairs, with potential applications in residential, commercial, and industrial settings. The navigation system of the robot is also discussed, outlining the use of sensors and algorithms to detect stairs, determine their dimensions, and enable the robot to move or control and object and clean them efficiently. The experimental results demonstrate the effectiveness of the compact stair-cleaning robot in terms of its ability to navigate different types of stairs and perform effective cleaning. The authors also discuss potential improvements and future directions for the robot's development.[9]

10.Gargava, Parth, Karan Sindwani, and Sumit Soman contributed to "Controlling an arduino robot using Brain Computer Interface.”, published in 2014,that describes
the application of a Brain Computer Interface (BCI) to control an Arduino-based robot. A BCI is a technology that enables communication between the human brain and an external device without using conventional motor pathways. It allows individuals to interact with the external world by translating brain signals into commands that can be understood by machines. The paper presents a system that combines a Brain Computer Interface with an Arduino-based robot, enabling users to control the robot's actions through their brain signals. The authors demonstrate the feasibility and effectiveness of their approach through experimental results, suggesting potential applications in fields such as assistive technology, rehabilitation, and human-robot interaction.[10]

11.Patil, Dhiraj Arun, et al. contributed to "Multi robot communication and target tracking system with controller design and implementation of swarm robot using arduino.",published in 2015,that describes the development of a multi-robot communication and target tracking system using Arduino. The authors propose a swarm robotics approach where multiple robots work together to track and pursue a target. The robots communicate with each other to share information and coordinate their actions. the paper presents a multi-robot communication and target tracking system based on Arduino. The authors emphasize the importance of swarm robotics for achieving coordinated behaviors among multiple robots. They provide insights into the design, implementation, and control strategies employed in their system, highlighting the potential applications of such technologies in areas like surveillance, exploration, and distributed sensing.[11]

12.Irawan, Yuda, Yunior Fernando, and Refni Wahyuni contributed to "Detecting Heart Rate Using Pulse Sensor As Alternative Knowing Heart Condition.",published in 2019,that describes the application of a pulse sensor as an alternative method for detecting heart rate and monitoring heart conditions. The authors propose using a pulse sensor, a non-invasive device that measures the pulsations of blood vessels, to obtain heart rate data. The authors conduct experiments to evaluate the performance of their proposed method. They compare the heart rate measurements obtained from the pulse sensor with those obtained from a standard electrocardiogram

(ECG) device, which is considered the gold standard for heart rate monitoring. The results of the experiments are discussed, providing insights into the accuracy and reliability of the pulse sensor in detecting heart rate.[12]

13.Muthiah, M., K. Nirmal, and Rk Sathiendran contributed to "Low cost radio frequency controlled robot for environmental cleaning.",published in 2015,that describes the development of a low-cost robot controlled via radio frequency for environmental cleaning purposes. The authors propose a robot system that can be operated remotely using radio frequency signals.They describe the hardware components of their robot, including motors, sensors, and a microcontroller. They explain the design and integration of these components to create a functional cleaning robot. Additionally, they discuss the radio frequency control mechanism that allows the robot to receive commands wirelessly from a remote control unit. The presented robot offers a cost-effective solution for remote-controlled cleaning operations, potentially reducing human effort and improving efficiency in environmental cleaning tasks.[13]

14.Muhardi, Muhardi, et al. contributed to "Design of web based LMS (learning management system) in SMAN 1 Kampar Kiri Hilir.", published in 2020,that describes the design and implementation of a web-based Learning Management System (LMS) specifically tailored for SMAN 1 Kampar Kiri Hilir, an educational institution. The authors propose the use of an LMS to enhance the learning and teaching experience by providing an online platform for course management, content delivery, and interaction between teachers and students.The authors describe the design and development process of the web-based LMS. They discuss the features and functionalities incorporated into the system, such as user authentication, course management, resource sharing, online assessments, and communication tools. The paper highlights the benefits of using a web-based LMS, including improved access to learning materials, enhanced collaboration, and increased flexibility in learning. The paper contributes to the advancement of educational technology by showcasing a practical application of a web-based LMS in a specific school context.[14]

15.The paper "Design of web-based LMS (learning management system) in SMAN 1 Kampar Kiri Hilir" published in the Journal of Applied Engineering and Technological Science (JAETS) in 2020 presents the design and development of a web-based Learning Management System (LMS) for SMAN 1 Kampar Kiri Hilir, a high school in Indonesia. The LMS is designed to improve the learning process and facilitate communication between teachers and students. The paper provides a detailed description of the LMS design, including its architecture, database design, and user interface. The LMS features modules for managing courses, assignments, quizzes, and grades, as well as a messaging system and a dashboard for monitoring student progress. The authors conducted a usability test with a group of teachers and students to evaluate the effectiveness of the LMS design. The results of the test show that the LMS is user-friendly and has a positive impact on the learning process. Overall, the paper presents a useful case study of LMS development for a high school in Indonesia, with insights into the design process and the benefits of using an LMS for education [14].

16.The paper "Low cost radio frequency controlled robot for environmental cleaning" presented at the 2015 International Conference on Circuits, Power and Computing Technologies (ICCPCT-2015) describes the design and development of a low-cost radio frequency controlled robot for environmental cleaning. The authors present the hardware and software design of the robot, which includes a microcontroller-based control system, a radio frequency (RF) transmitter and receiver, and a cleaning mechanism consisting of a brush and a dustbin. The robot is designed to navigate and clean floors autonomously, while being controlled remotely by an operator using an RF transmitter. The paper also describes the testing and evaluation of the robot, which includes assessing its performance in terms of cleaning efficiency, battery life, and range of operation. The results show that the robot is effective in cleaning floors and has a battery life of around 2 hours, with a range of operation of up to 10 meters. Overall, the paper presents an innovative approach to environmental cleaning using a low-cost robot controlled by radio frequency, which has the potential to improve cleaning efficiency and reduce manual labour. The paper could be useful for researchers and engineers interested in the development of low-cost robotic systems for environmental applications.[15]

III.MATERIALS AND METHODS

1] *System Overview*

This smart helmet consists of several components, including sensors, a microcontroller, a

wireless communication module, a power source, and an implementing cooling system. The sensors are responsible for collecting data on the gestures for automated control, and they are mounted on different parts of the helmet, such as at the top of the helmet. The microcontroller processes the data received from the sensors and runs the algorithms that analyze and interpret the data to extract essential information about the surroundings or gestures we make with our hands and heads. The gesture helps the wearer control their helmet in an automated and easy way.

2] Hardware & Helmet Prototype

Components and parts-

Moving parts

So our robot consists of 4-12 volt dc motor that are well movable part of this cleaning robot. These motors provide speed for wheels that are attached to the motor. The wheels are made up of plastic and rubber. We have use motor driver that is connected to dc motor for controlling its direction and speed. Using motor driver as the main part of the robot that is connected with the Arduino-uno. It helps our robot to move in desired direction for cleaning purpose. We have use another dc motor for cleaning purpose that is attached with sponge cleaner.

Microcontroller board

When we need to choose microcontroller we had many options to choose from but Arduino uno is the best suit for our floor wiper bot. It is also a good option for motor driver. Arduino uno is 8 bit microcontroller with 32kb flash memory. Its instruction rate is 20mps.

Figure 1. Shows *Microcontroller Board*

The floor wiper robots' main goal is to detect directions and move it in a right direction for cleaning. So, we must use an ultrasonic sensor to detect the obstacle and prevent a collision. The robot's built-in sensor can detect obstacles by measuring their distance from the machine and transmitting an instruction to the microcontroller. So according to the distance measured it will travel in direction which doesn't have any obstacles. The ultrasonic sensor has 2 things transmitter and receiver it emits the sound of frequency of 41khzs the main characteristics of the ultrasonic sensor. So, this sensor was the best option available to us for this project.

Figure 2. Shows *Ultrasonic Sensor*

The transmitter and receiver emit and reflects sound that is reflected back from the obstacles. So it will measure the distance according to speed and time taken by sound wave. After that according to ultrasonic sensors output dc motor will rotate in desired direction.

Motors-

Different types of motor are available in market but the Arduino L293D Motor driver shield is best for controlling dc motors. Also, we used 4 dc motors that are connected to motor driver shield for controlling dc motor.

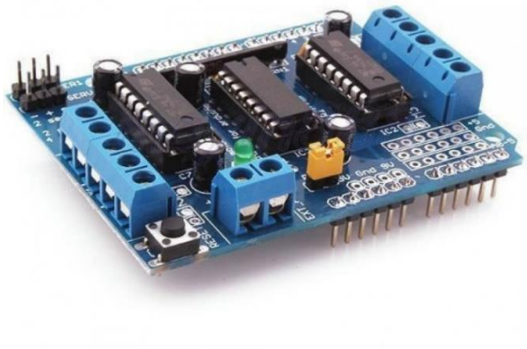

Figure 3. Shows *Motor driver*

Also, servo motor is used for rotation of ultrasonic sensor in 180 degrees for sensing direction.

Chassis selection and other components

Chassis is the important part of handling the Components and electronic circuit. We have given support of 2 cardboard for entire circuit, also 1motor,1 scrubber and 1 pipe for vacuum purpose. Operation The main part of ultrasonic sensor which is placed on top of the servo motor is Configured with ninety degrees of the middle position. The ultrasonic sensor continued to check the distance with the delay provided in the code. When the sensors detect the presence of obstacles, the robot calculates the distance (in centimeters) between itself and the detected obstacles. Then after comparing the measured distance with the given distance that is 20cmOur robot will move to the right or to the left depending on whether an obstacle is present or not. Additionally, a 5th DC motor located at the rear of the enclosure will use the scrubbing disc to clean the floor after vacuuming up tiny dust particles

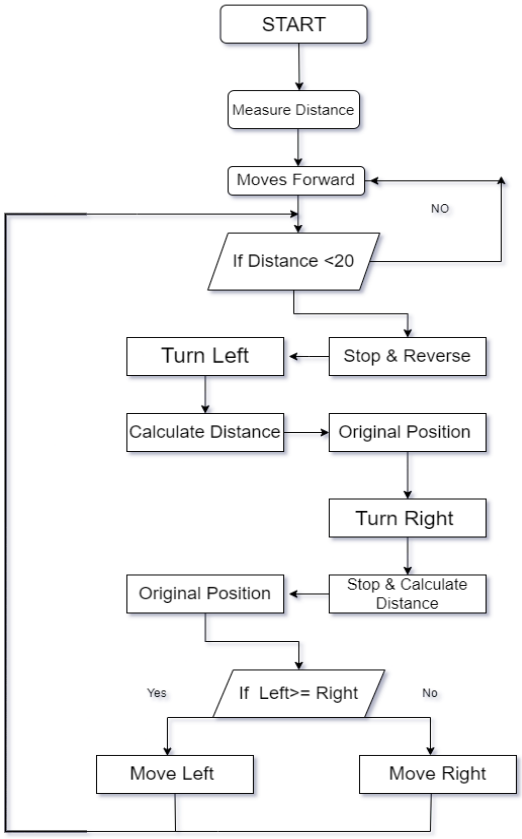

Figure 4. Shows *Working Of Floor Cleaner Robot*

Fig.04 demonstrates the suggested model's flowchart. The distance is measured and moved forward at this location after the automobile has been started. The prototype travels where the distance is higher and turns left and right, respectively, if the distance is less than 20 cm. Repeating the same procedure.

IV.METHODS (implementation)

The Autonomous Ground Wiper Robot for Cleaning project is designed to clean the floor autonomously without human intervention. The robot uses an Arduino-uno board, ultrasonic sensors, a servo motor, DC motor drivers, and a vacuum pump to clean the floor. The robot's main component is the motor driver shield, which is integrated with the Arduino-uno board. The DC motor drivers are also integrated with the motor driver shield, which controls the DC motor. The robot's main component is the motor driver shield, which is integrated with the Arduino-uno board. The DC motor drivers are also integrated with the motor driver shield, which controls the DC motor. The items are sensed using the ultrasonic sensor on the floor and direct the DC motor through the motor driver shield for forward, backward, right, and left direction movements. The entire circuit and components are mounted on a cardboard chassis, making it lightweight and easy to maneuver.

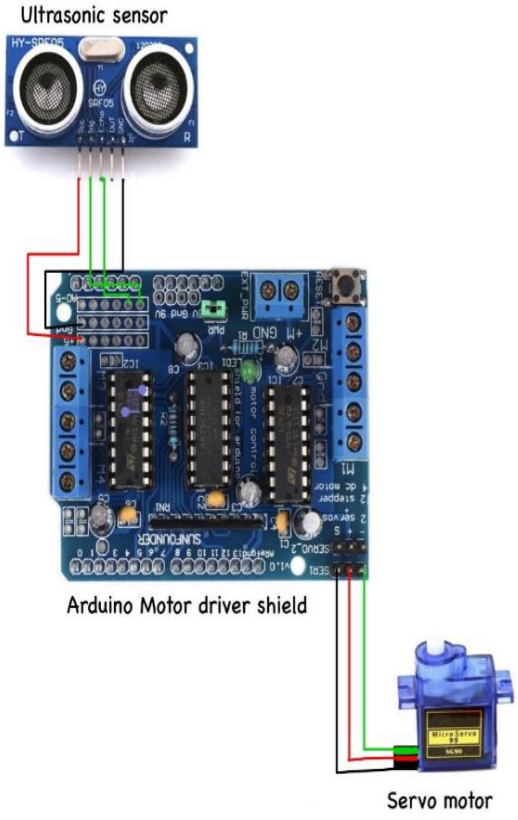

Figure 5. Shows *Interface of Ultrasonic Sensor and Servo Motor*

The 12v battery is connected to power the entire circuit autonomously, using the ultrasonic sensor to Identify obstacles and navigate around them. The DC motor drives the wheels, allowing the robot to move in different directions and cover large areas of the floor. The vacuum pump sucks up the dirt and debris from the floor and stores it in a container for later disposal. All the circuits and components are embedded on a chassis which is made up of cardboard. When the ultrasonic sensor senses the object, it directs the dc motor through motor driver shield for forward, backward, right and left direction. We connected a 12v battery with the circuit which provides power to the entire circuit. Also, another 9v battery we have connected to the vacuum pump for dc motor functionality.

The Robot and cleaner will each receive a 9V power, and once the cleaner is running, it uses an ultrasonic sensor to calculate the distance between obstacles and the vehicle before moving ahead in accordance with the code in the Arduino IDE. If the distance is less than 20 cm, the floor cleaner stops, briefly reverses, then travels to the left side to measure the distance once again before returning to its original location. It then makes a quick right turn, pauses for a while, and then resumes its previous position [15]. To avoid hitting any obstacles, the automobile moves in the direction of the bigger distance after assessing the two distances while the vacuum pump uses a separate 9v battery. The robot moves around the floor .

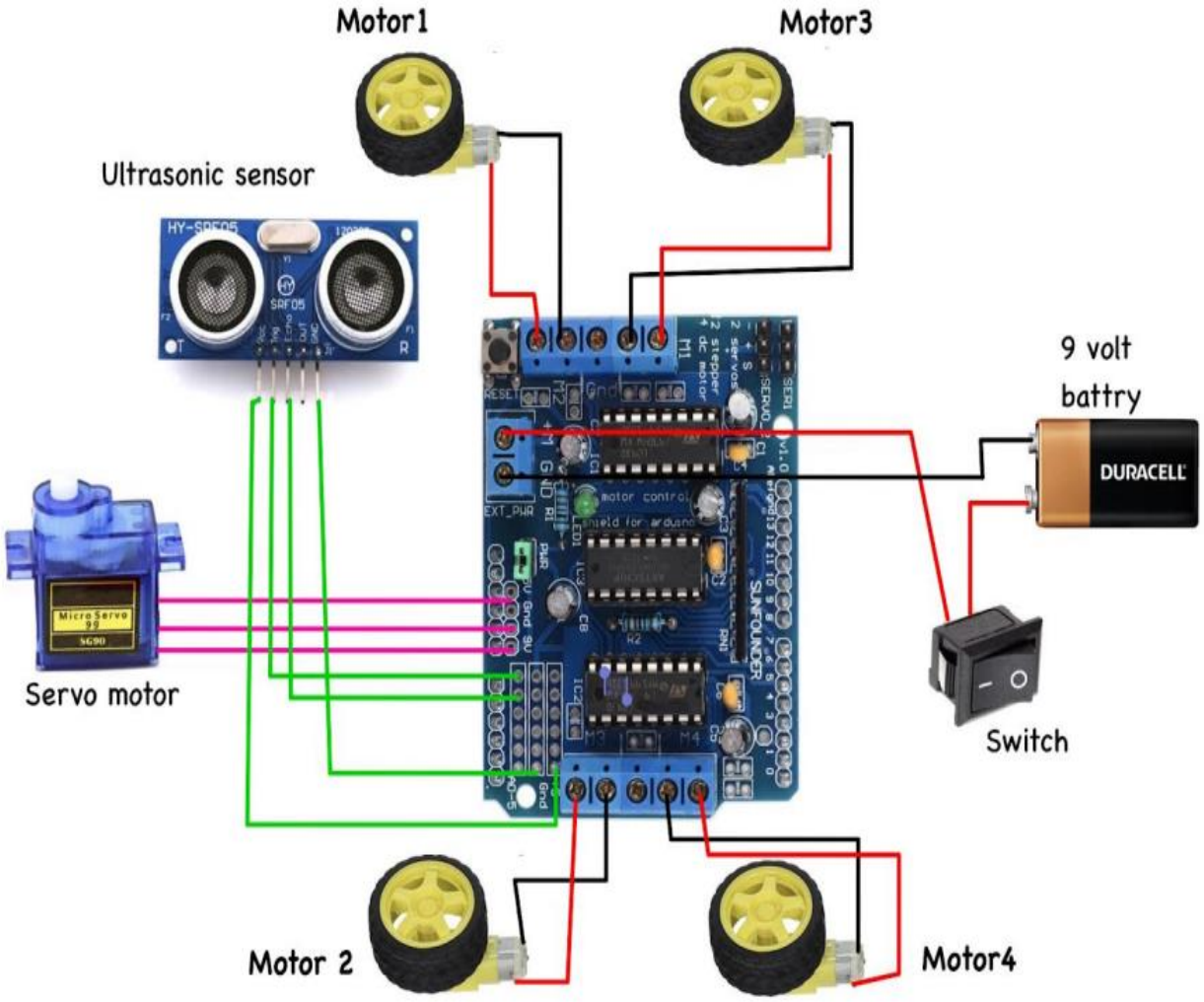

Figure 6. Shows *Interfacing of Floor Cleaner Robot.*

V. RESULT AND DISCUSSION

In this we created a self-cleaning bot with Arduino-uno which can partially do water cleaning and a manual vacuum cleaner with two separate batteries one for all the control for bot and one separate for vacuum cleaner bot. Our floor cleaner can operate without incident since the servo motor and ultrasonic sensors in this system offer it the ideal cleaning direction. As an ultrasonic sensor offers information about impending impediments, it aids the cleaning accuracy of the robot. Also, we attached one dc motor in back of the vacuum cleaner for cleaning purpose. The combination of the front and back cleaners can clean both wet and dry floors since the motor at the back can clean the wet floor [14]. There are various benefits to designing the floor wiper robot with Arduino-Uno technology, including cost-effectiveness, user-friendliness, and customization options. The robot can be used in various settings and can clean different types of floors autonomously, saving time and effort [15]. The use of sensors and motors in the robot makes it an efficient and eco-friendly solution for floor cleaning, reducing the use of cleaning chemicals and water. Overall, the floor wiper robot with Arduino-Uno technology is an innovative and practical solution for floor cleaning.

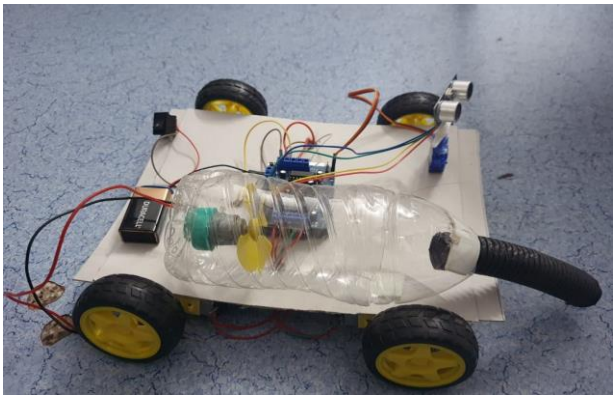

Figure 7. Shows *prototype of Floor Cleaner*

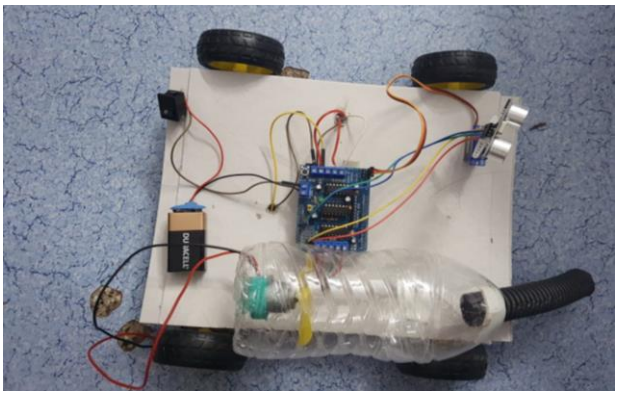

Figure 8. Shows *Implementation of Floor Cleaner.*

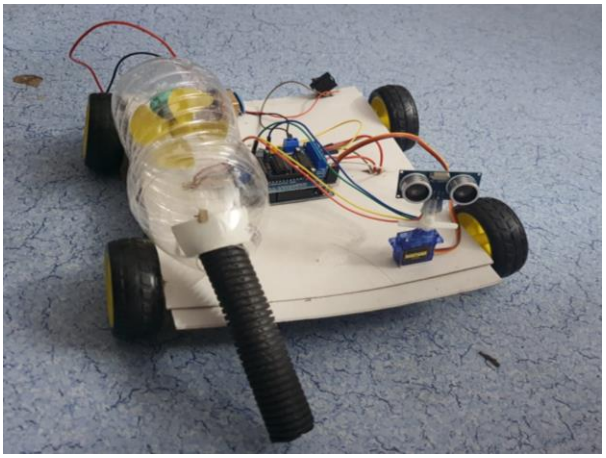

Figure 9. Shows *Implementation of Floor Cleaner*

Ultrasonic sensor is connected with the Arduino, which is giving our robot a sense of direction. \

The formula of ultrasonic sensor is-

$$\text{Distance} = \frac{\text{Echo pulse time} * \text{Sound velocity(340m/s)}}{2}$$

we can also write this as distance =echo pulse*0.017. As there are two ways sending and receiving so we divide it my 2 and converting it to centimeters. The output produced is the distance of object. The use of dc motor and Arduino in the design of the floor cleaning robot generates vibration that affects the overall stability of the robot, especially when a vacuum cleaner is attached to it. The robot also produces noise that can be a problem in quiet environments. Navigation can be difficult in complex environments, and limited battery life can require frequent recharging or battery replacement [18]. However, the robot has good accuracy in direction sensing and can clean both wet and dry floors efficiently.

VI. CONCLUSION

In conclusion, the floor wiper robot using Arduino-Uno is an innovative solution for floor cleaning. The use of Arduino-Uno in the development of the robot makes it a cost-effective, user-friendly, customizable, and versatile solution for individuals and industries. The robot is efficient, time-saving, and eco-friendly, making it an attractive solution for floor cleaning. The robot vacuum designed and implemented using the Arduino-Uno featured in this research paper is an invaluable resource for researchers and engineers interested in developing autonomous robots for a variety of

applications. The experiments conducted and demonstrated, the effectiveness of the design. However, there are limitations to the current design, such as the limited battery life and the need for additional sensors for more efficient cleaning. Future research could focus on improving the design by addressing these limitations and developing more advanced features, such as obstacle avoidance and mapping capabilities.

In summary, the floor wiper robot using Arduino-Uno is a promising solution for floor cleaning that can save time, effort, and resources. The study that is described in this publication adds to the advancement of robotics technology and provides a foundation for further research in the field.

VII. REFRENCES

[1] Sandeep, P., et al. "Arduino based Economical Floor Cleaning Robot." 2022 International Mobile and Embedded Technology Conference (MECON). IEEE, 2022.

[2] Shaik, Dadasaheb. "ARDUINO BASED FLOOR CLEANING ROBOT USING ULTRASONIC SENSOR." Irawan, Yuda, et al. "Automatic floor cleaning robot using arduino and ultrasonic sensor." Journal of Robotics and Control (JRC) 2.4 (2021): 240-243.

[3] Khan, Mohd Shahbaz, and M. Gurunadha Babu. "Bluetooth Control Cleaning Robot using Arduino [J]." International Journal of Innovative Technology and Exploring Engineering (IJITEE) 8.11s2 (2019).

[4] Sivanantham, Vinu, et al. "Adaptive Floor Cleaning Strategy by Human Density Surveillance Mapping with a Reconfigurable Multi-Purpose Service Robot." Sensors 21.9 (2021): 2965.

[5] Junizan, Nur Afiqah, et al. "Design and implementation of automatic room temperature controlled fan using Arduino Uno and LM35 heat sensor." International Journal of Engineering Creativity & Innovation 1.2 (2019): 8-14.

[6] Goon, Li Hung, et al. "Development of Simple Automatic Floor Polisher Robot using Arduino." International Journal of Engineering Creativity & Innovation 1.1 (2019): 17-23.

[7] Kaur, Manreet, and Preeti Abrol. "Design and development of floor cleaner robot (automatic and manual)." International Journal of Computer Applications 97.19 (2014).

[8] Irawan, Yuda, et al. "Automatic floor cleaning robot using arduino and ultrasonic sensor." Journal of Robotics and Control (JRC) 2.4 (2021): 240-243.

[9] Zhang, Lei, et al. "A new compact stair-cleaning robot." Journal of Mechanisms and Robotics 8.4 (2016).

[10] Liu, Chao-Chung, Yu-Ping Kang, and Sun-Nien Yu. "Hardware and software integration for domestic stairs cleaning robot." SICE Annual Conference 2011. IEEE, 2011.

[11] Juang, Hau-Shiue, and Kai-Yew Lum. "Design and control of a two-wheel self-balancing robot using the arduino microcontroller board." 2013 10th IEEE International Conference on Control and Automation (ICCA). IEEE, 2013.

[12] Al-Busaidi, Asiya M. "Development of an educational environment for online control of a biped robot using MATLAB and Arduino." 2012 9th France-Japan & 7th Europe-Asia Congress on Mechatronics (MECATRONICS)/13th Int'l Workshop on Research and Education in Mechatronics (REM). IEEE, 2012.

[13] Araújo, André, et al. "Integrating Arduino-based educational mobile robots in ROS." Journal of Intelligent & Robotic Systems 77 (2015): 281-298.

[14] Gargava, Parth, Karan Sindwani, and Sumit Soman. "Controlling an arduino robot using Brain Computer Interface." Proceedings of 3rd International Conference on Reliability, Infocom Technologies and Optimization. IEEE, 2014.

[15] Patil, Dhiraj Arun, et al. "Multi robot communication and target tracking system with controller design and implementation of swarm robot using arduino." 2015 International Conference on Industrial Instrumentation and Control (ICIC). IEEE, 2015.

[16] Irawan, Yuda, Yunior Fernando, and Refni Wahyuni. "Detecting Heart Rate Using Pulse Sensor As Alternative Knowing Heart Condition." Journal of Applied Engineering and Technological Science (JAETS) 1.1 (2019): 30-42.

[17] Muthiah, M., K. Nirmal, and Rk Sathiendran. "Low cost radio frequency controlled robot for environmental cleaning." 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015]. IEEE, 2015.

[18] Muhardi, Muhardi, et al. "Design of web based LMS (learning management system) in SMAN 1 Kampar Kiri Hilir." Journal of Applied Engineering and Technological Science (JAETS) 1.2 (2020): 70-76.