

SMART FLOOR CLEANER

**Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering**

By

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

CATEGORY-1 UNIVERSITY BY UGC

Accredited with Grade “A++” by NAAC | 12B status by UGC | Approved by AICTE

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CHENNAI – 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **NIVASH S (40130157)**, **SRINIVAS A (40130225)** who carried out the Project entitled **SMART FLOOR CLEANER** under my supervision from NOVEMBER 2023 to APRIL 2024.

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DECLARATION

We **S. NIVASH (40130157), A. SRINIVAS (40130225)** hereby declare that the Project Report entitled “**SMART FLOOR CLEANER**” done by us under the guidance of **DR. V. BALAMURUGAN, M.Tech., Ph.D.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in **DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING.**

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I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Electronics and Communication Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

The "Smart Floor Cleaner" project integrates cutting-edge technology to revolutionize the cleaning process for both wet and dry surfaces. By combining a mopping system with a vacuum cleaner, our device offers comprehensive cleaning capabilities, ensuring thorough cleanliness in any environment. Additionally, the incorporation of a camera enables remote monitoring and control via smartphone application, utilizing Bluetooth technology for seamless connectivity.

Efficient and smooth movements are key aspects of our design, achieved through the implementation of wheels that facilitate agile navigation across various surfaces. This ensures optimal coverage and thorough cleaning, enhancing the overall effectiveness of the Smart Floor Cleaner. This innovative solution aims to address the needs of elderly individuals and those in their golden years, providing them with an efficient and user-friendly cleaning tool that enhances their quality of life. Through intuitive design and advanced features, the Smart Floor Cleaner offers convenience, accessibility, and improved hygiene, ultimately contributing to a safer and more comfortable living environment for all users.

In this report, the Smart Floor Cleaner project provides an in-depth exploration of the development process, technical specifications, and functionalities of the innovative cleaning solution. Highlighting its potential impact on the cleaning industry and its significance in addressing the evolving needs of an aging population, the report also discusses future enhancements and potential applications, showcasing the scalability and adaptability of the solution across different cleaning challenges and settings.

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LIST OF ABBREVIATIONS

IEEE	-	INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS
IOT	-	INTERNET OF THINGS
RC	-	REMOTE CONTROL
SMPS	-	SWITCHED-MODE POWER SUPPLY
AC	-	ALTERNATING CURRENT
DC	-	DIRECT CURRENT
RPM	-	REVOLUTIONS PER MINUTE
BLE	-	BLUETOOTH LOW ENERGY
ICSP	-	IN-CIRCUIT SERIAL PROGRAMMING
USART	-	UNIVERSAL SYNCHRONOUS/ASYNCHRONOUS RECEIVER/TRANSMITTER

CHAPTER 1

INTRODUCTION

In an era marked by technological advancements and an aging population, the need for innovative solutions to address everyday challenges has never been more pronounced. The "Smart Floor Cleaner" project emerges as a response to this imperative, aiming to revolutionize the cleaning experience for individuals, particularly the elderly and those with mobility limitations. Traditional cleaning methods often pose difficulties for individuals with restricted mobility or advancing age. Tasks such as mopping and vacuuming can be physically demanding and time-consuming, leading to increased strain and potential safety hazards. Recognizing these challenges, our project seeks to integrate state of the art technology to create a user-friendly and efficient cleaning solution. The Smart Floor Cleaner is designed to offer versatility and convenience by combining both mopping and vacuuming functionalities in a single device. This comprehensive approach ensures thorough cleaning of both wet and dry surfaces, eliminating the need for separate tools or manual intervention. Moreover, the incorporation of advanced sensors and navigation systems allows for precise movement and coverage, optimizing cleaning performance across diverse floor types and configurations. Central to the design philosophy of the Smart Floor Cleaner is accessibility. By leveraging Bluetooth technology and a smartphone application, users can effortlessly monitor and control the device remotely, providing greater flexibility and autonomy in their cleaning routines. Additionally, the inclusion of features such as efficient wheel mechanisms ensures smooth and agile movement, further enhancing user experience and operational efficiency. This project not only addresses practical cleaning needs but also underscores the broader societal significance of leveraging technology to enhance the quality of life for aging populations. By empowering individuals to maintain a clean and safe living environment independently, the Smart Floor Cleaner promotes dignity, autonomy, and well-being. In this report, we provide a comprehensive overview of the Smart Floor Cleaner project, detailing its development process, technical specifications, and functionalities. Furthermore, we explore potential applications, future enhancements, and the broader implications of our innovation in meeting the evolving needs of an aging society.

CHAPTER 2

LITERATURE SURVEY

1.1 LITERATURE SURVEY

1. Cleaning Robot with Android Application Controller

Authors: Devabalan Sinnapatchai, Ellysa Muizz Zaini, Syahira Salleh, Mohamad Md Som.

Publication: Multidisciplinary Applied Research and Innovation, Volume 3, Issue 2, 2022.

Abstract: This paper presents the development of an interactive robotic vacuum cleaner utilizing the 802.11b wireless transport protocol for user control via a PC interface. The research aims to create an intelligent and practical cleaning solution, introducing innovative cost reduction strategies alongside the incorporation of a vacuum cleaner component.

2. Floor Cleaning Robot

Authors: Rushi Nagargoje, Deep Thakare, Aditya Bhosale, Prof. Tushar K. Zombade.

Publication: International Research Journal of Modernization in Engineering Technology and Science, Volume 05, Issue 02, February 2023.

Abstract: This paper presents the development of an interactive robotic vacuum cleaner utilizing the 802.11b wireless transport protocol for user control via a PC interface. The research aims to create an intelligent and practical cleaning solution, introducing innovative cost reduction strategies alongside the incorporation of a vacuum cleaner component.

3. Smart Multifunction Floor Cleaning Robot

Authors: Prof. Vaishnavi Dhole, Palash Lakhe, Vinod Lanjewar, Mayur Bowade, Mayuri Jaypurkar.

Publication: International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 10, Issue III, March 2022.

Abstract: This study presents a solar-powered mobile-operated floor cleaning robot designed as a cost-effective and user-friendly alternative to conventional machines. Finite element analysis ensured its structural integrity, showing stress levels within safe limits, promising practical viability in various commercial settings.

4. Design & Fabrication of Bluetooth Controlled Robotic Floor Cleaning Machine

Authors: Shreyash J. Sagaonkar, Aishwarya V. Patil, Shreyash R. Mulik, Sushrut H. Wagh, Swapnil H. Patil.

Publication: International Research Journal of Engineering and Technology (IRJET)
Volume: 07 Issue: 05 | May 2020 .

Abstract: The project focuses on manufacturing a Bluetooth-controlled floor cleaning machine for wet and dry surfaces, simplifying floor cleaning efforts significantly. It comprises sponge mop, swiping brushes, and a fan to enhance cleaning efficiency, catering to health and hygiene concerns. With a simple design and low cost, this machine offers easy operation, making it accessible for anyone. Addressing the growing demand for efficient floor cleaning in India, it presents a practical solution to large-scale cleaning needs.

5. Design of Autonomous Mobile Robot for Cleaning in the Environment with Obstacles

Authors: A. Joon, W. Kowalczyk.

Publication: Applied Sciences, November 2021, 8076.

Abstract: This paper details the design and development of a cleaning robot using adaptive manufacturing technology and a stability-proven control algorithm. Its goal is to merge theory with practical implementation using cost-effective components. The robot features a four-wheel-drive platform, a four-degrees-of-freedom robotic arm, and a vacuum system, enhancing flexibility in cleaning uneven areas. Equipped with a LIDAR sensor and web camera, it employs a low-level PID speed controller and a high-level

controller to avoid collisions with obstacles. The Robot Operating System (ROS) facilitates communication between controllers for efficient operation.

6. Design and Implementation of Smart Floor Cleaning Robot using Android App

Authors: S Monika, K Aruna Manjusha, S V S Prasad, B. Naresh.

Publication: International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-8, Issue-4S2, March 2019.

Abstract: This paper introduces a smart floor cleaning robot operated via a wireless robotic cleaning system. Controlled through an Android mobile app, the robot integrates an Arduino UNO controller, a robotic arm with a cleaning pad, and a water sprayer for efficient cleaning. Commands from the app are transmitted via Bluetooth to the Arduino UNO, enabling motor control for navigation. An IR sensor detects obstacles, providing feedback through a buzzer for obstacle detection.

7. Floor Cleaner using Arduino and Bluetooth

Authors: Rucha Dilip Dasalkar, Amruta Ganjewar, Samiksha Ahire.

Publication: International Journal of Creative Research Thoughts (IJCRT), Volume 11, Issue 4, April 2023.

Abstract: This project presents an autonomous floor cleaning robot utilizing IoT and Arduino Nano programming, with an ultrasonic sensor for obstacle detection. It aims to enhance household automation and convenience, integrating a Vacuum Robot with both autonomous and manual control via a Blynk phone application. The prototype aims to simplify floor cleaning processes by offering wet cleaning alongside traditional vacuuming, leveraging Arduino Nano, motor driver, and ultrasonic sensor technologies.

8. Automatic Smart Floor Cleaning Robot Using Arduino – UNO

Authors: Dr. Akash Rathee, Ishant Jalan, Lakshita Nandwani, Tanya Sharma.

Publication: 2020 International Journal for Research in Engineering Application & Management (IJREAM).

Abstract: This paper presents a smart floor cleaning robot designed to execute user-provided instructions, enhancing cleaning efficiency. Operated wirelessly via a Bluetooth module embedded within, the robot receives commands from a smartphone. Functions include movement in various directions and mopping the floor. The system offers cost-effectiveness, low maintenance, and reduced human effort, ensuring reliability.

9. Design and Development of an Automated Floor Cleaning Robot for Domestic Application

Authors: Raveena Ishalavath M, Sandhyashree N, Rakshitha R, Arpitha Shankar.

Publication: 2020 International Journal of Engineering Research & Technology (IJERT).

Abstract: This project focuses on creating a Remote Controlled Autonomous Floor Cleaning Robot using IEEE Standards. It utilizes Bluetooth control for mobile operation and incorporates obstacle detection to avoid collisions during motion. Raspberry Pi3 serves as the primary control component, managing the robot's functions. An ultrasonic sensor detects obstacles, transmitting and receiving ultrasonic waves, with its output processed by Raspberry Pi3. The robot features a servomotor-controlled ultrasonic sensor for rotation and mopping brush activation via a DC motor. The Pi3 halts the robot upon obstacle detection and triggers a buzzer.

10. Automatic Floor Cleaning Robot Using Arduino and Ultrasonic Sensor

Authors: Yuda Irawan, Muhardi , Rian Ordila, Roni Diandra.

Publication: 2021 - Journal of Robotics and Control (JRC), Vol. 2, No. 4.

Abstract: This project employs an Arduino Uno microcontroller, Ultrasonic Sensor, Motor Shield L298, Servo, and DC Motor to create an automatic floor cleaning robot. The microcontroller processes data from the ultrasonic sensor to detect obstacles, directing the robot's movement using the DC motor controlled by Motor Shield L298. When obstacles are detected within a threshold distance (<15 cm), the robot alters its direction to continue cleaning. Testing reveals successful navigation and obstacle avoidance capabilities of the robot.

1.2 PROBLEM STATEMENT

The growing demographic of aging individuals faces significant challenges in maintaining cleanliness and safety within their living spaces. Traditional cleaning methods, such as mopping and vacuuming, often pose physical strain and safety hazards, particularly for those with limited mobility or age-related impairments. Existing cleaning devices lack the versatility and accessibility necessary to meet the diverse needs of this demographic effectively. Therefore, there is a pressing need for a technologically advanced cleaning solution that caters specifically to the requirements of elderly individuals and those with mobility limitations.

In modern households, the task of floor cleaning often poses challenges, especially for individuals with mobility limitations or busy schedules. Traditional cleaning methods involving manual mopping and vacuuming are time-consuming, labor-intensive, and sometimes ineffective at achieving thorough cleanliness. Moreover, the elderly and individuals with physical disabilities may struggle with the physical exertion required for these tasks, leading to concerns about safety and independence.

To address these challenges, our project aims to develop a Smart Floor Cleaner that revolutionizes the way we approach home cleaning. By integrating advanced technologies such as robotics, wireless connectivity, and intelligent control systems, our solution offers a comprehensive and efficient approach to floor cleaning, catering to the diverse needs of modern households.

The key objectives of our project include:

Efficiency: Our Smart Floor Cleaner will feature both mopping and vacuuming functions, allowing for comprehensive cleaning of various floor surfaces, including hardwood, tile, and carpet. This dual functionality ensures efficient removal of dust, dirt, and stains, resulting in pristine floors with minimal effort.

Accessibility: Designed with accessibility in mind, our solution will be user-friendly and easy to operate for individuals of all ages and abilities. Wireless control via smartphone

application enables remote operation and monitoring, ensuring convenience and flexibility for users.

Safety: Safety is paramount in our design. We prioritize the implementation of collision avoidance and obstacle detection mechanisms to prevent accidents and ensure the safety of both users and household objects. Additionally, our Smart Floor Cleaner will feature non-slip wheels and a stable chassis design for enhanced stability during operation.

Affordability: We recognize the importance of affordability in making our solution accessible to a wide range of users. By utilizing cost-effective components and open-source technologies, we aim to develop a Smart Floor Cleaner that is both effective and budget-friendly, offering a compelling alternative to expensive commercial cleaning solutions.

Through our project, we envision empowering individuals to maintain a clean and hygienic living environment effortlessly, promoting comfort, safety, and independence in their daily lives. By harnessing the power of innovation and technology, we strive to revolutionize home cleaning practices and set new standards for efficiency and convenience in household chores.

1.3 EXISTING METHODS AND THEIR LIMITATIONS

Currently available cleaning devices offer various features and functionalities, but they often fall short in addressing the specific needs and challenges faced by elderly individuals and those with mobility limitations. A comparative analysis of existing models highlights several limitations and areas for improvement:

➤ Traditional Vacuum Cleaners



Fig 2.1 Vacuum cleaner

- While traditional vacuum cleaners are effective for dry surface cleaning, they may lack versatility in handling wet surfaces.
- Many models require manual operation, which can be challenging for elderly users with limited strength or dexterity.
- Accessibility features such as easy-to-use controls and ergonomic design may be lacking in some models, making them less suitable for elderly users.

➤ Mop and Bucket Systems:



Fig 2.2 Traditional Mopping system

- Mop and bucket systems are effective for wet surface cleaning but may require significant physical effort and repetitive motions, which can be taxing for elderly individuals.
- Using a mop and bucket can be hard, especially for people who have trouble moving around easily. It can also be risky because it might cause accidents like slipping and falling.

➤ **Current Floor Cleaners in market**



Fig 2.3 Floor cleaner device using smartphone

- In the current market landscape, there exists a robot vacuum cleaner priced at 50,000, renowned for its multi functionality in vacuuming, mopping, and drying. However, while it offers comprehensive cleaning solutions, its hefty price tag may weigh down on potential consumers, especially those seeking cost-effective options.
- Despite its advanced features, its high cost limits accessibility and fails to address the needs of price-conscious individuals.

CHAPTER 3

AIM AND PROPOSED MODEL

3.1 AIM AND SCOPE

The aim of this project is to address these challenges by developing a Smart Floor Cleaner—a technologically advanced cleaning solution tailored to the needs of elderly individuals and those with mobility limitations. The primary objective is to create a device that combines the functionalities of both a mop and a vacuum cleaner, capable of efficiently cleaning both wet and dry surfaces. By integrating advanced sensors, navigation systems, and remote control capabilities, the Smart Floor Cleaner seeks to provide a user-friendly and autonomous cleaning experience.

The scope of our project encompasses the following key aspects:

1. Hardware Development:

We will focus on designing and assembling the necessary hardware components required for the floor cleaning system. This includes motors, sensors, actuators, and a control unit, all of which will be carefully selected and integrated to ensure optimal performance and functionality.

2. Smart Control Mechanism:

We aim to implement a sophisticated control mechanism that enables users to remotely operate and monitor the floor cleaning system using a smartphone application. This control interface will provide intuitive features for commanding movement, activating cleaning functions, adjusting settings, and receiving real-time feedback.

3. Multi-functional Cleaning Capabilities:

Our system will be designed to offer multi-functional cleaning capabilities, including vacuuming, mopping, and wet mopping. This versatility will allow users to effectively clean various floor surfaces, including hardwood, tile, carpet, and linoleum, with minimal manual effort.

4. User Experience and Accessibility:

We prioritize user experience and accessibility in our project, aiming to develop a user-friendly interface that caters to users of all demographics and technical proficiency levels. The system will be designed with ergonomic considerations to ensure ease of use and convenience for a wide range of users.

5. Cost-Effectiveness and Sustainability:

While incorporating advanced technology, we will strive to maintain cost-effectiveness and sustainability in our design. This includes selecting energy-efficient components, optimizing resource usage, and minimizing maintenance requirements to ensure long-term viability and affordability of the floor cleaning system.

3.2 OBJECTIVE

Efficient Cleaning: Develop a Smart Floor Cleaner capable of efficiently mopping and vacuuming both wet and dry surfaces, ensuring comprehensive cleaning coverage across various floor types and configurations.

User-Friendly Design: Design intuitive controls and interfaces to facilitate ease of operation, making the Smart Floor Cleaner accessible to users of all technological proficiency levels, including elderly individuals.

Enhanced Safety: Implement advanced sensors and navigation systems to promote safe operation and minimize the risk of slips, falls, or overexertion during cleaning tasks, thereby creating a safer living environment for elderly users.

Remote Monitoring and Control: Integrate Bluetooth technology and smartphone connectivity to enable remote monitoring and control of the Smart Floor Cleaner, allowing users to manage cleaning tasks conveniently from their smartphones.

3.3 PROPOSED MODEL

The Bluetooth application serves as the cornerstone for the design and control of our floor cleaning equipment, working in tandem with a sophisticated charging unit. The meticulously crafted chassis frame, constructed from durable materials such as plywood and reinforced with two sturdy plastic boxes, provides a stable foundation for the intricate system. Within this framework, we've seamlessly integrated a host of components, including the versatile Arduino Uno microcontroller, high-performance DC motors, robust wheels for mobility, and a reliable battery system to power the entire apparatus. The inclusion of a Bluetooth unit further enhances the machine's functionality, allowing for seamless communication and control from our smartphones or tablets. Beyond the core components, our design incorporates additional features to elevate the user experience and cleaning efficiency. The integration of an ESP-32 Cam enables real-time monitoring of the machine's movements, providing users with invaluable insights and control over the cleaning process. Moreover, the inclusion of essential accessories such as brushes, a water tank, a fan, and a cleaning sponge ensures thorough and effective cleaning across various floor surfaces. Despite its compact size, our floor cleaning machine boasts a sleek and visually appealing design that belies its robust construction and functionality. The welded chassis, composed of one-inch mild steel square bars, provides structural integrity and stability, ensuring reliable performance even in demanding cleaning environments. Powering the machine's DC motors is a sophisticated SMPS unit, capable of converting AC supply into a steady 12V DC output, thereby optimizing energy efficiency and performance.

The diagram illustrates the seamless control of our floor cleaning machine using a mobile device via Bluetooth connectivity. At the center of the diagram is our innovative floor cleaning machine, depicted with its sleek design and advanced components. Surrounding the machine are symbols representing the smartphone and Bluetooth connectivity, symbolizing the interface through which users can remotely control and monitor the cleaning process. Through the dedicated smartphone application, users can effortlessly command the floor cleaning machine, adjusting settings, initiating cleaning cycles, and monitoring progress in real-time. This intuitive control mechanism offers unparalleled

convenience and flexibility, allowing users to optimize cleaning operations with ease from the palm of their hand. With just a few taps on their mobile device, users can enjoy a cleaner and more hygienic living environment, all thanks to the seamless integration of technology and innovation.

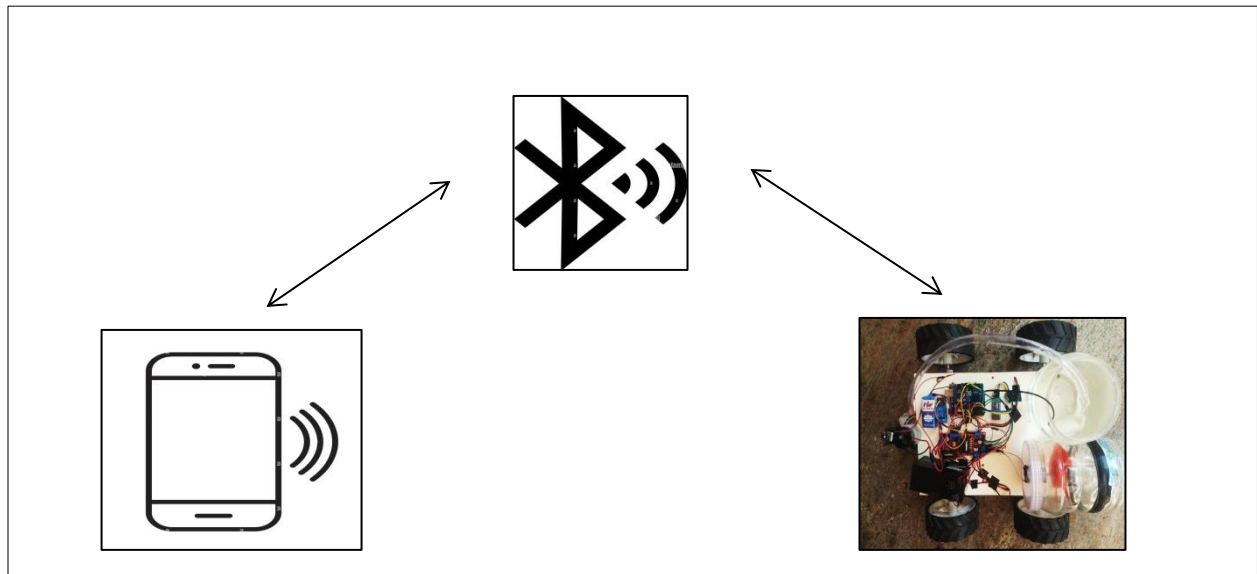


Fig 3.1 Proposed model

One of the defining aspects of our project is its commitment to affordability and accessibility. Recognizing the exorbitant costs associated with existing cleaning products on the market, we set out to design a solution that is not only cost-effective but also accessible to individuals from all walks of life. By leveraging Arduino IDE, we've implemented intricate algorithms and logic to govern the machine's operation, enabling seamless integration and coordination of its various components. Furthermore, our decision to utilize an RC controller application for Bluetooth connectivity ensures intuitive and user-friendly control over the floor cleaning machine, empowering users to achieve immaculate cleaning results with minimal effort and time investment.

3.4 STANDARDS

The Smart Floor Cleaner project upholds rigorous standards across various domains to ensure its efficacy, safety, and accessibility. Adhering to industry-established cleaning practices guarantees thorough cleanliness on wet and dry surfaces, promoting a safe and healthy living environment through compliance with hygiene standards. Technological integration follows stringent industry protocols, ensuring reliability, compatibility, and safety, particularly in the utilization of Bluetooth technology for seamless connectivity. In consideration of accessibility, the design caters to the needs of elderly individuals and those with mobility issues, incorporating intuitive controls and ergonomic features to enhance usability. Moreover, a paramount focus on safety is evident through the integration of obstacle detection and emergency stop mechanisms, aligning with established safety standards to mitigate potential accidents or injuries during operation. Through steadfast adherence to these standards, the Smart Floor Cleaner project aims to deliver a cutting-edge cleaning solution that not only meets industry benchmarks but also prioritizes user satisfaction and well-being.

3.5 CONSTRAINTS

1. **Cost:** The project must operate within a predefined budget, necessitating careful consideration of material costs, manufacturing expenses, and technological investments to ensure affordability without compromising quality.
2. **Size and Weight:** The Smart Floor Cleaner must be compact and lightweight to facilitate ease of use and storage. This constraint requires efficient design and component selection to achieve the desired balance between functionality and portability.
3. **Power Consumption:** Efficiency in power consumption is essential to prolong battery life and reduce operating costs. The project must optimize energy usage through intelligent system design and power management techniques.
4. **Durability:** The device must withstand regular use and environmental conditions, requiring robust construction and quality materials to ensure longevity and reliability.

3.6 TRADE OFFS

1. **Functionality vs Complexity:** Balancing advanced features with user-friendliness is crucial. While additional functionalities enhance the device's capabilities, overly complex operations may detract from usability. Trade-offs between sophistication and simplicity are carefully evaluated to optimize user experience.
2. **Performance vs Cost:** Incorporating high-performance components may enhance cleaning efficiency but can also increase manufacturing costs. Trade-offs between performance and cost-effectiveness are considered to deliver a competitive product without sacrificing functionality.
3. **Connectivity vs Security:** Seamless connectivity via Bluetooth enables remote monitoring and control, but it also introduces security risks. Trade-offs between connectivity and security measures are managed to ensure data protection and user privacy.
4. **Agility vs Stability:** Agile navigation across surfaces enhances cleaning coverage but may compromise stability. Trade-offs between agility and stability are addressed through the design of adaptive control algorithms and responsive sensor systems.

CHAPTER 4

EXPERIMENTAL DESIGN AND METHODS

4.1 HARDWARE REQUIREMENTS

4.1.1 ARDUINO UNO

The Arduino Uno is a versatile and widely-used microcontroller board that serves as the heart of countless electronic projects and prototypes. Developed by Arduino LLC, it features an Atmega328P microcontroller chip and provides a user-friendly interface for programming and interfacing with various sensors, actuators, and other electronic components.

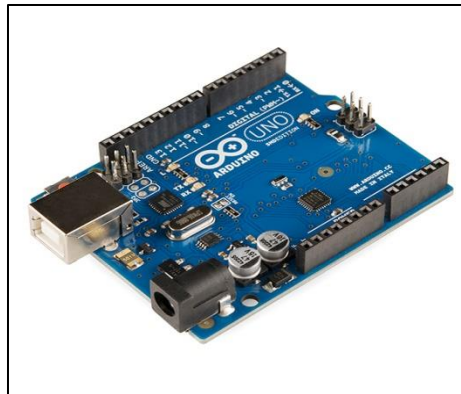


Fig 4.1 Arduino UNO

The Arduino Uno is a versatile microcontroller board renowned for its wide array of features and ease of use. Powered by the Atmega328P microcontroller chip, it offers 14 digital input/output pins, 6 of which support PWM output, along with 6 analog input pins, providing ample connectivity options for external devices and sensors. Its integrated USB interface facilitates seamless communication with a computer for programming and debugging tasks. With a clock speed of 16 MHz and 32 KB of flash memory, the Arduino Uno delivers fast and efficient performance, capable of executing complex algorithms and logic. Additionally, its onboard voltage regulator ensures stable operation across a wide range of input voltages (7V to 20V), while the inclusion of 1 KB of EEPROM enables the storage of non-volatile data. Compatible with a multitude of shields and expansion

modules, this open-source platform fosters collaboration and innovation within the maker community. Affordable, accessible, and supported by a user-friendly Integrated Development Environment (IDE), the Arduino Uno is an ideal choice for learners, hobbyists, and professionals alike, seeking to explore the world of embedded systems and electronics.

Digital Pins (0-13):

- These pins can be used for both input and output operations.
- They operate at 5 volts.
- Digital pins 0 and 1 are also used for serial communication (RX and TX respectively).

Analog Pins (A0-A5):

- These pins can read analog voltage levels (0-5V) using the analog-to-digital converter (ADC).
- Can also be used as digital pins (14-19).

Power Pins:

- 5V: Provides a regulated 5V output to power external components.
- 3.3V: Provides a regulated 3.3V output to power external components.
- Vin: Input voltage to the Arduino board when using an external power source (e.g., from a battery or DC power adapter).

GND (Ground): Ground pins for connecting to the ground of external components.

PWM Pins (Digital Pins marked with ~):

- Pulse Width Modulation (PWM) pins allow for simulating analog output using digital pins.
- They provide a pseudo-analog output by rapidly switching the output voltage between HIGH and LOW states.

Reset Pin: Allows resetting the microcontroller.

Communication Pins:

- **RX (pin 0):** Receive pin for serial communication.
- **TX (pin 1):** Transmit pin for serial communication.
- **SCL (A5):** I2C clock pin for I2C communication.
- **SDA (A4):** I2C data pin for I2C communication.

AREF Pin: Analog Reference pin: It can be used to set the external reference voltage for the analog inputs.

These are the basic pin descriptions for an Arduino Uno. Other Arduino boards may have different pin configurations and capabilities, but the basic concepts remain similar. Always refer to the specific documentation for the Arduino board you are using for detailed information.

4.1.2 BLUETOOTH MODULE (HC-05)

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. It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air. It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

The HC-05 module typically features six pins, which are as follows:

- **VCC:** Power supply pin, typically connected to a 5V power source.
- **GND:** Ground pin, connected to the ground terminal of the power supply.
- **TXD:** Transmit data pin, used for transmitting data from the module to another device.
- **RXD:** Receive data pin, used for receiving data from another device.

- **STATE:** Status pin, used to indicate the current state of the module (e.g., whether it is in pairing mode or connected).
- **EN (or KEY):** Enable pin, used for configuring the module (e.g., switching between AT command mode and data transmission mode).

Enables wireless communication between devices over short distances (typically up to 10 meters indoors). It supports serial communication (UART) for transferring data between devices. Operates on Bluetooth version 2.0, providing reliable and stable communication. It supports the Serial Port Profile, allowing for easy integration into serial-based applications. Master/Slave Mode: Can be configured to operate as either a master or slave device, offering flexibility in network configurations.

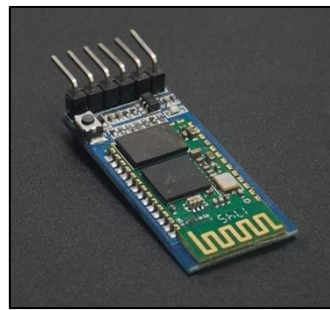


Fig 4.2 Bluetooth module

4.1.3 MOTOR DRIVER

A motor driver, also known as a control motor, is an electronic device or module that controls and manages the operation of an electric motor. It serves as an interface between a microcontroller or other control system and the motor itself, enabling precise control of the motor's speed, direction, and other parameters. Motor drivers are commonly used in various applications, including robotics, automation, automotive systems, and industrial machinery.

The L298N motor driver module typically features the following pins:

- **IN1 and IN2:** These pins control the direction of Motor A. IN1 is used to control the motor's rotation direction (clockwise or counterclockwise), while IN2 is often used in conjunction with IN1 to set the motor's direction.
- **IN3 and IN4:** Similarly, these pins control the direction of Motor B. IN3 is used to set the motor's rotation direction, while IN4 works in conjunction with IN3 to determine the direction.
- **ENA (Enable A) and ENB (Enable B):** These pins are used to control the speed of Motor A and Motor B, respectively. By varying the voltage supplied to these pins using PWM (Pulse Width Modulation) signals, you can adjust the speed of the motors.
- **VCC (12v):** This pin is connected to the external power supply, providing power to the motor driver module and the motors connected to it.
- **GND:** This pin is connected to the ground (0V) of the power supply, completing the circuit.
- **OUT1, OUT2, OUT3, and OUT4:** These pins are the output pins that connect to the terminals of the motors. The polarity of the connections depends on the direction set by the input pins (IN1, IN2, IN3, and IN4).
- **+5V:** This pin provides a regulated 5V output that can be used to power external components or devices.

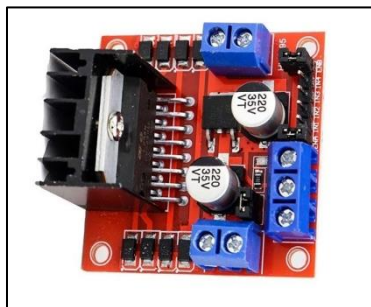


Fig 4.3 Motor driver

4.1.4 DC MOTOR

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. Most often, this type of motor relies

on forces that magnetic fields produce. Regardless of the type, DC motors have some kind of internal mechanism, which is electronic or electromechanical. In both cases, the direction of current flow in part of the motor is changed periodically. This 12V DC Motor has an RPM of 1000.

Rotor: This is the moving part of the motor responsible for turning the shaft to deliver mechanical power. It usually contains conductors that carry currents, interacting with the magnetic field of the stator to generate the forces that rotate the shaft. Alternatively, some rotors carry permanent magnets, while the stator holds the conductors.

Bearings: The rotor is supported by bearings, which allow it to turn on its axis. Bearings are, in turn, supported by the motor housing. The motor shaft extends through the bearings to the outside of the motor, where the load is applied.

Stator: The stator is the stationary part of the motor's electromagnetic circuit, typically consisting of windings or permanent magnets. The stator core is made up of thin metal sheets called laminations, which help reduce energy losses.



Fig 4.4 DC motor (12v)

Air Gap: This is the space between the rotor and stator. It's critical for motor performance, with smaller gaps generally being preferable to larger ones, as larger gaps can negatively impact performance.

Windings: These are wires laid in coils, usually wrapped around a laminated soft iron magnetic core to form magnetic poles when energized with current. There are different winding configurations depending on the type of motor.

Commutator: This is a mechanism used to switch the input of most DC machines and certain AC machines. It consists of insulated slip-ring segments connected to the armature current supply through stationary brushes in contact with the rotating commutator. This arrangement causes the required current reversal and applies power to the machine in an optimal manner as the rotor rotates.

Motor Supply and Control: DC motors are typically supplied through slip-ring commutators. AC motors can have different commutation methods, fixed or variable speed control, and can be synchronous or asynchronous. Various control technologies like power inverters, variable-frequency drives, or electronic commutators are used for controlling motor speed and operation.

4.1.5 WATER PUMP

The Micro DC 3-9V Micro Submersible Pump is a versatile and efficient solution for small-scale water circulation projects, offering a range of features to enhance its usability. Its compact size and low power consumption make it ideal for applications such as fountain gardens, mini aquariums, hydroponic systems, and more. Despite its small footprint, it boasts a maximum flow rate of up to 120 liters per hour while consuming a mere 220mA of current, ensuring both impressive performance and energy efficiency. With a wide voltage range of 3 to 9 volts, it accommodates various power sources, including batteries, solar panels, or DC adapters, providing users with flexibility in powering their projects. Its submersible design allows for easy integration into water environments, and simple installation involves connecting a tube pipe to the motor outlet and submerging it in water. Additionally, it features durable construction materials, ensuring reliable operation over time even in demanding conditions. Its quiet operation adds to its appeal, creating a serene ambiance for indoor and outdoor applications without causing disturbances. Overall, the Micro DC 3-9V Micro Submersible Pump combines performance, efficiency,

and convenience, making it an excellent choice for DIY enthusiasts, hobbyists, and educational projects alike.

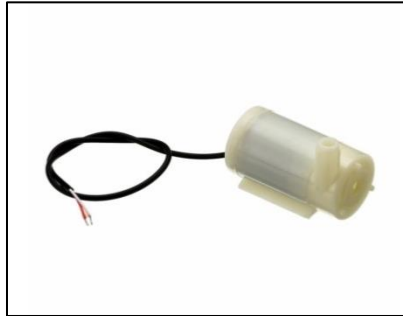


Fig 4.5 Water pump

4.1.6 ESP32 CAMERA

ESP32-CAM is a low-cost ESP32-based development board with onboard camera, small in size. It is an ideal solution for IOT application, prototypes constructions and DIY projects. The board integrates Wifi, traditional Bluetooth and low power BLE, with 2 high performance 32-bit LX6 CPUs. It adopts 7-stage pipeline architecture, on-chip sensor, Hall sensor, temperature sensor and so on, and its main frequency adjustment ranges from 80MHz to 240MHz. Fully compliant with Wifi 802.11b/g/n/e/i and Bluetooth 4.2 standards, it can be used as a master mode to build an independent network controller, or as a slave to other host MCUs to add networking capabilities to existing devices.

- **3.3V and GND:** Power supply pins for providing regulated 3.3V and ground connections, respectively.
- **GPIO Pins:** The ESP32-CAM features several GPIO pins that can be used for general-purpose input/output, including GPIO0, GPIO2, GPIO4, GPIO5, GPIO12, GPIO13, GPIO14, GPIO15, GPIO16, and more.
- **UART Pins:** RX and TX pins for serial communication.
- **SD Card Slot:** Slot for inserting a microSD card, allowing for local storage of images and videos captured by the camera.
- **Reset Button:** Button used to reset the module.

- **Flash Button:** Button used for entering programming mode or flashing firmware onto the module.

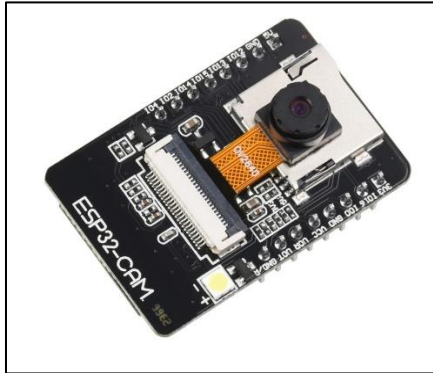


Fig 4.6 ESP32-CAM

4.1.7 RELAY

A relay is an electrically operated device. It has a control system and (also called input circuit or input contactor) and controlled system (also called output circuit or output contactor). It is frequently used in automatic control circuit. To put it simply, it is an automatic switch to controlling a high-current circuit with a low-current signal. The advantages of a relay lie in its lower inertia of the moving, stability, long-term reliability and small volume. It is widely adopted in devices of power protection, automation technology, sport, remote control, reconnaissance and communication, as well as in devices of electromechanics and power electronics. Generally speaking, a relay contains an induction part which can reflect input variable like current, voltage, power, resistance, frequency, temperature, pressure, speed and light etc. It also contains an actuator module (output) which can energize or de-energize the connection of controlled circuit. There is an intermediary part between input part and output part that is used to coupling and isolate input current, as well as actuate the output. When the rated value of input (voltage, current and temperature etc.) is above the critical value, the controlled output circuit of relay will be energized or de-energized.

FEATURES

- In power system and high voltage system, the lower current can control the higher one.
- Channel high voltage system output, meeting the needs of single channel control.
- Wide range of controllable voltage.
- Being able to control high load current, which can reach 240V, 10A.
- With a normally-open (NO) contact and a normally-closed (NC) contacts



Fig 4.7 Relay

PINS

1. Control Pins:

- **Signal Input Pin:** This pin connects to a digital output pin on the microcontroller (such as an Arduino) to control the relay. When the digital pin goes HIGH, it activates the relay, and when it goes LOW, it deactivates the relay. Usually labeled as "IN" or "SIG".
- **VCC or JD-VCC:** This pin connects to the power supply voltage of the microcontroller (typically 5V for Arduino) to power the relay's internal circuitry. If there are separate power supplies for the relay and the microcontroller, there might be two pins labeled JD-VCC (for the relay's internal circuitry) and VCC (for the relay's switching mechanism). It's essential to provide the correct voltage to these pins to avoid damaging the relay module.

2. Switching Pins:

- **Normally Open (NO):** This pin is connected to one end of the relay's internal switch. When the relay is activated, it connects this pin to the Common (COM) pin.

- **Normally Closed (NC):** This pin is connected to the other end of the relay's internal switch. When the relay is deactivated, it connects this pin to the Common (COM) pin.
- **Common (COM):** This pin is common to both the Normally Open (NO) and Normally Closed (NC) pins. Depending on whether the relay is activated or deactivated, it connects to one of these pins.

3. Optional Pins:

- **Ground (GND):** This pin connects to the ground of the microcontroller to complete the circuit. It's essential to have a common ground when using external devices with a microcontroller.
- **Additional Control Pins:** Some relay modules may have additional pins for more advanced control features, such as opto-isolation, status indicators, or compatibility with specific microcontrollers.

4.1.8 BATTERY

A 12-volt battery is a type of battery that is commonly used in automobiles, boats, and other vehicles. It is a rechargeable battery that provides electrical power to the vehicle's engine and other electrical components ¹. There are different types of 12-volt batteries available in the market, including lead-acid batteries, lithium-ion batteries, and alkaline batteries ¹. The capacity of a 12-volt battery can vary depending on the type and model. For example, some 12-volt batteries have a capacity of 3 Ah, while others can have a capacity of up to 65 Ah ¹.

TYPES OF 12-V BATTERIES

Lead-Acid Batteries: Traditional lead-acid batteries have been a staple in the automotive industry for decades. Renowned for their robustness and affordability, these batteries utilize lead plates submerged in sulfuric acid electrolyte to generate electrical power. They are well-suited for starting engines due to their high cranking power.



Fig 4.8 Lead Acid Battery

Lithium-Ion Batteries: In recent years, lithium-ion batteries have gained popularity for their superior energy density and lighter weight compared to lead-acid counterparts. These batteries offer extended lifespan and enhanced performance, making them ideal for applications where weight and space are critical factors, such as in electric vehicles (EVs) and hybrid vehicles.



Fig 4.9 Lithium-ion Battery

Alkaline Batteries: While less common in automotive applications, alkaline batteries find widespread use in smaller electronic devices such as flashlights, remote controls, and portable gadgets. Known for their long shelf life and stable voltage output, alkaline batteries are valued for their reliability in low-power applications.



Fig 4.10 Alkaline Battery

Capacity and Variability:

The capacity of a 12-volt battery varies greatly depending on factors such as battery chemistry, design, and intended application. Manufacturers offer a diverse range of capacities to accommodate the varying power demands of different vehicles and systems. Some batteries may have a modest capacity of 3 Ah, suitable for light-duty applications or as auxiliary power sources. In contrast, high-capacity batteries boasting up to 65 Ah are favored for heavy-duty vehicles and demanding electrical systems, providing ample power reserves for sustained operation.

Applications and Usage:

Beyond the automotive sector, 12-volt batteries find utility in an array of applications, including recreational vehicles (RVs), motorcycles, golf carts, and off-grid power systems. In marine environments, specialized marine batteries are employed to withstand harsh conditions such as constant vibration and exposure to moisture. Additionally, 12-volt

batteries serve as backup power sources in emergency lighting systems, telecommunications infrastructure, and renewable energy installations.

Technological Advancements:

Advancements in battery technology continue to drive innovation in the 12-volt battery market. Research efforts focus on enhancing energy density, improving charging efficiency, and extending battery lifespan. Emerging technologies such as solid-state batteries and graphene-based electrodes hold promise for revolutionizing the performance and durability of future 12-volt battery systems.

4.2 SOFTWARE REQUIREMENTS

4.2.1 ARDUINO IDE

The Arduino IDE (Integrated Development Environment) is a software platform used for programming and developing projects with Arduino-compatible microcontroller boards. It provides a user-friendly interface for writing, compiling, and uploading code to Arduino boards. The IDE is open-source and supports a simplified version of the C++ programming language, making it accessible to beginners and experienced developers alike. Key features include a text editor with syntax highlighting, a serial monitor for debugging and communication, and a library manager for easy access to pre-written code modules. The Arduino IDE also supports a wide range of Arduino-compatible boards and shields, allowing for flexibility in project design. Additionally, it is compatible with Windows, macOS, and Linux operating systems, making it widely accessible to users across different platforms.

BUTTON BARS

- The check mark is used to verify your code. Click this once you have written your code.
- The arrow uploads your code to the Arduino to run.
- The dotted paper will create a new file.

- The upward arrow is used to open an existing Arduino iproject.
- The downward arrow is used to save the Current file.
- The far-right Button is a serial monitor, which is useful for sending data from the Arduino to the PC for debugging purposes.



Fig 4.11 Arduino IDE

4.2.2 RC CONTROLLER APPLICATION

A Bluetooth RC (Remote Control) controller application allows users to remotely control devices such as robots, drones, cars, or any other electronic system equipped with Bluetooth connectivity. Users can typically control these devices using their smartphones or tablets, leveraging the Bluetooth connection to send commands and receive feedback in real-time. The application interface often includes directional controls, buttons for various actions, sliders for speed or other parameters, and sometimes even gyroscopic controls for more intuitive operation. These applications are popular among hobbyists, educators, and professionals for prototyping, experimentation, and entertainment purposes. Bluetooth RC controller applications provide users with a convenient and versatile means to remotely control a wide range of electronic devices equipped with Bluetooth connectivity. Whether it's navigating a robot through obstacles, piloting a drone for aerial photography, or controlling the speed and direction of a remote-controlled car, these applications offer intuitive interfaces and real-time feedback for seamless operation.

Popular among hobbyists, educators, and professionals alike, they serve as valuable tools for prototyping, experimentation, and entertainment, showcasing the power of wireless communication and mobile technology in modern-day electronics. With their ease of use and extensive functionality, Bluetooth RC controller applications continue to drive innovation and creativity in various fields, enabling users to bring their ideas to life with just a tap on their smartphone or tablet.

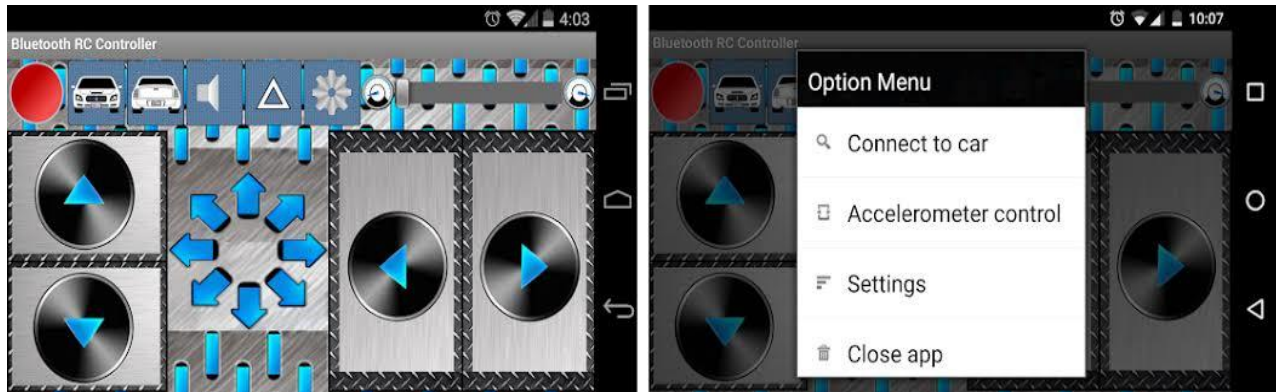


Fig 4.12 RC Controller Application

COMMANDS AND CONTROL

F -> FORWARD

B -> BACKWARD

L -> LEFT

R -> RIGHT

G -> FORWARD LEFT

I -> FORWARD RIGHT

H -> BACKLEFT

J -> BACKRIGHT

W -> MOPPING ON

V -> WATER PUMP ON

X -> VACUUM ON

4.3 BLOCK DIAGRAM

Our floor cleaning system integrates several essential components, each playing a crucial role in its functionality and effectiveness. Below is a concise overview of each block depicted in the block diagram:

The mopping system includes a water tank for wet mopping, ensuring thorough cleaning and sanitization of floor surfaces. It utilizes a pump controlled by a relay to regulate the flow of water onto the mopping mechanism, providing efficient cleaning action. The vacuum cleaner component effectively removes dust, debris, and other particles from both carpeted and hard floor surfaces. It enhances the overall cleaning performance by capturing fine particles that may be missed by traditional sweeping or mopping methods. The built-in camera provides real-time monitoring of the cleaning process, enabling users to remotely supervise and control the system via a smartphone application. It offers visual feedback, allowing users to assess the cleaning progress and make adjustments as needed. The Bluetooth module facilitates seamless communication between the floor cleaning system and the user's smartphone. It enables remote control and monitoring, allowing users to initiate cleaning cycles, adjust settings, and receive status updates conveniently from their mobile devices. The motor driver controls the movement of the cleaning system across various floor surfaces, ensuring efficient coverage and navigation. It also regulates the operation of the mopping and vacuum motors, facilitating synchronized cleaning actions based on user commands. A rechargeable battery powers the system, providing mobility and autonomy during cleaning operations. It ensures uninterrupted performance and allows for flexibility in cleaning tasks, eliminating the need for constant tethering to power sources.

Each block in the block diagram contributes to the overall functionality and performance of our floor cleaning system, offering users a comprehensive and efficient solution for maintaining clean and hygienic living spaces.

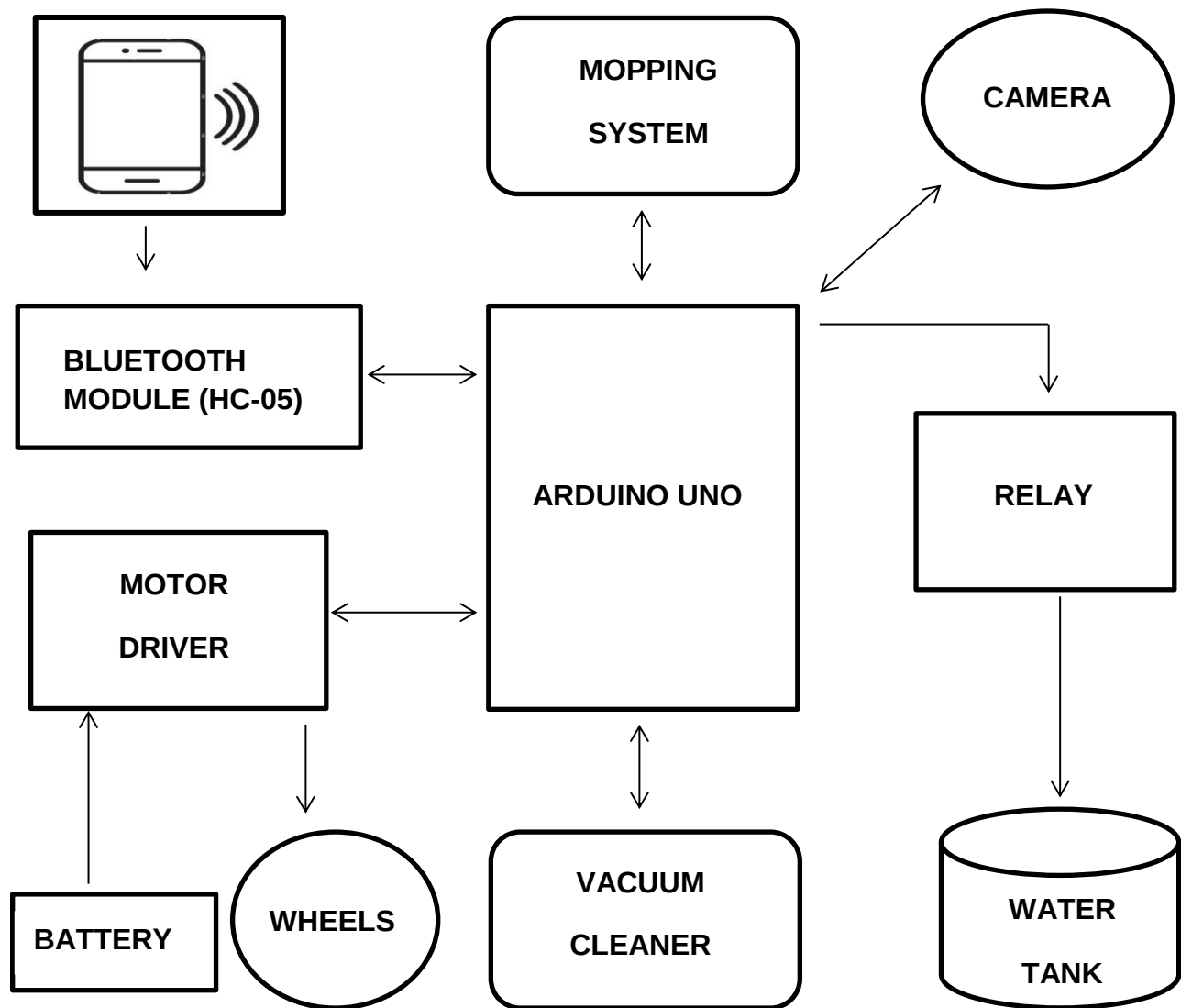


Fig 4.13 Block Diagram

4.4 CIRCUIT DIAGRAM

The circuit connections for our floor cleaning system are integral to its smooth operation and efficient functionality. Beginning with the L298N motor driver module, its pins in1 through in4 are meticulously linked to digital pins 8, 9, 10, and 11 on the Arduino Uno, respectively, controlling the direction and speed of the DC motors responsible for the system's movement. When a command is received from the smartphone application via the Bluetooth module, the Arduino Uno processes the instruction and triggers the appropriate motor driver pins to activate the corresponding DC motors. For instance, forward movement is achieved by activating pins in1 and in3, while reverse movement activates pins in2 and in4. Turning left or right is accomplished by activating specific combinations of pins to drive the motors accordingly. The mopping motor and vacuum motor, connected to digital pins 12 ('mopMotor') and 4 ('vacMotor'), respectively, are controlled in a similar fashion based on user commands received via the Bluetooth module. Additionally, the water pump motor, crucial for wet mopping operations, is activated or deactivated through digital pin 13 ('waterMotor') in response to user input. Meanwhile, the LED indicator connected to digital pin 13 ('LED') provides real-time feedback on the system's status, illuminating to indicate when the system is operational. Powered by a 12V power supply, this meticulously arranged circuit ensures that our floor cleaning system operates flawlessly, enhancing user experience and maintaining optimal cleanliness with ease.

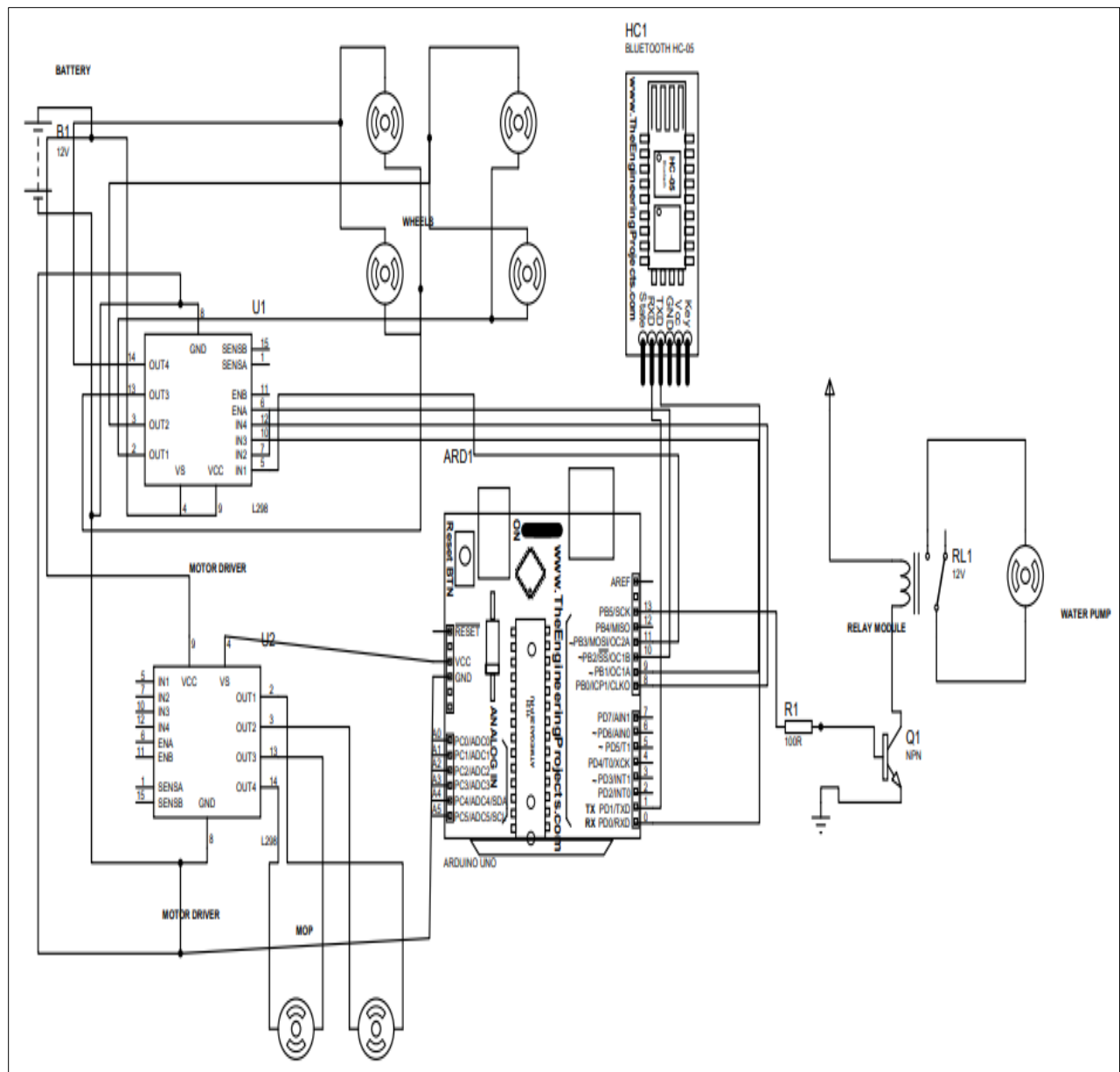


Fig 4.14 Circuit diagram

4.5 FLOW CHART

A flowchart is a graphical representation of a process or algorithm, illustrating the sequence of steps involved and the decision points along the way. Flowcharts are commonly used in various fields such as software development, engineering, business management, and education to visually communicate complex procedures and workflows in a clear and structured manner.

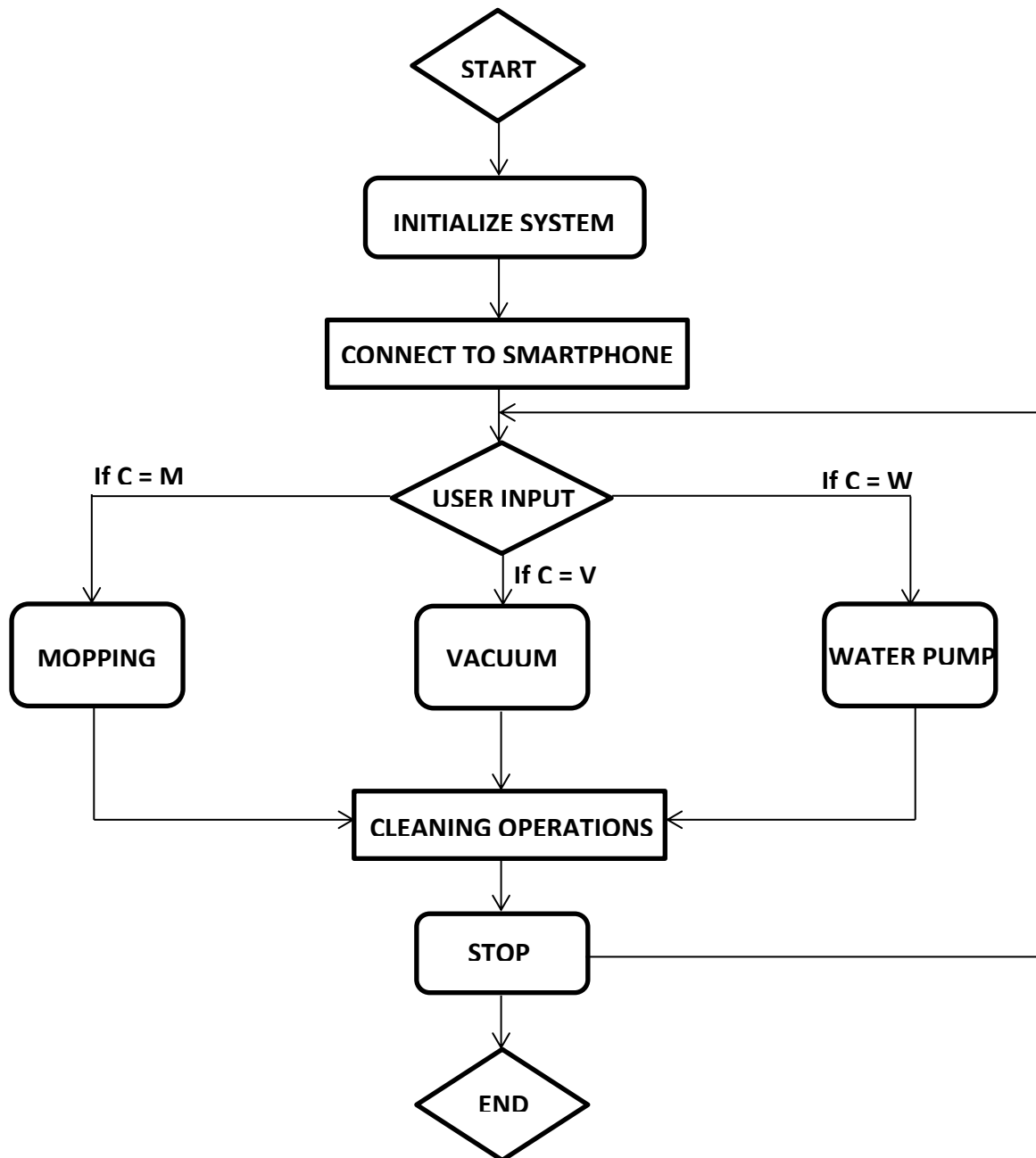


Fig 4.15 Flow chart

1. **Start:** Begin the flowchart.
2. **Initialize System:** Initialize the Smart Floor Cleaner system, including powering on the Arduino Uno, Bluetooth module, motor driver, and other necessary components.
3. **Connect to Smartphone:** Establish a Bluetooth connection between the Smart Floor Cleaner and the user's smartphone or tablet using the RC controller application.
4. **User Input:** Receive user input via the smartphone application, allowing the user to control the movement and operation of the Smart Floor Cleaner.
5. **Process User Commands:**
 - Interpret the user's commands received via Bluetooth.
 - Determine the desired action, such as moving forward, backward, turning, or activating the cleaning functions (mopping or vacuuming).
6. **Execute Commands:**
 - Based on the user's commands, activate the appropriate motors and actuators to perform the specified actions.
 - Control the speed and direction of movement using PWM signals to the motor driver.
7. **Monitor Sensors:**
 - Continuously monitor sensors for detecting obstacles, collisions, or changes in cleaning mode.
 - If obstacles are detected, adjust the Smart Floor Cleaner's path or activate collision avoidance mechanisms.
8. **Cleaning Operations:**
 - Execute the cleaning operations, including mopping and vacuuming, as per the user's commands.
 - Ensure thorough coverage of the floor surface while avoiding areas with obstacles.
9. **End of Operation:** Once the cleaning task is complete or the user terminates the operation, proceed to the end of the flowchart.
10. **Stop Motors and Shutdown:**
 - Stop the motors using the same button.
 - Shutdown the Smart Floor Cleaner system and prepare for the next operation.
11. **End:** End the flowchart.

4.6 TECHNICAL SPECIFICATIONS

The floor cleaning system operates at a voltage of 12 volts, ensuring reliable performance while being controlled through an intuitive smartphone application. Weighing approximately 4000 grams (4 kg), the system strikes a balance between portability and stability, making it easy to maneuver yet stable during cleaning tasks. With a battery life of 60 minutes, users can enjoy extended cleaning sessions without frequent recharging, while the system efficiently cleans an area of 500 square meters in approximately 25 to 30 minutes, delivering rapid and thorough results. Equipped with a 1-liter capacity water tank, the system minimizes the need for frequent refills during cleaning sessions. With an estimated cost of around 6000 rupees, it offers an affordable and accessible solution for automated floor cleaning, catering to a wide range of user's needs.

Table 4.1 Technical Specifications

Operating voltage	12v
Control Type	App Control
Weight	4000grams (4Kg)
Battery life	60 minutes
Time Taken for Cleaning (500 Square meter)	Around 25 to 30 minutes
Capacity	1Litre
Cost Estimation	Around 6000 rupees

CHAPTER 5

RESULT

5.1 DEVELOPED PROTOTYPE

The attached prototype image showcases our innovative solution for floor cleaning automation, combining advanced technologies to enhance efficiency and convenience. At the heart of our prototype lies a compact yet powerful floor cleaning machine, equipped with both vacuuming and mopping capabilities to tackle a variety of cleaning tasks. The machine's design, featuring a sturdy chassis frame and durable components, ensures reliable performance and longevity.



Fig 5.1 Developed prototype

Overall, our prototype represents a significant advancement in floor cleaning automation, leveraging cutting-edge technologies to deliver a solution that is efficient, user-friendly, and accessible to all. With its versatile functionality and intelligent design, our prototype promises to revolutionize the way we approach household cleaning tasks, offering a glimpse into the future of smart home appliances.

5.2 PROTOTYPE RESULTS

After months of hard work and thorough testing, our floor cleaning machine project has proven to be a success. Our system, which includes an Arduino Uno microcontroller, DC motors, Bluetooth module, and cleaning mechanism, effectively simplifies floor cleaning tasks. With just a few taps on our companion smartphone app, users can effortlessly control the machine's movements and activate the cleaning function.

Our tests have shown that the machine efficiently cleans both wet and dry surfaces, leaving them thoroughly clean. Its navigation algorithms smoothly guide it across different floor types while cleverly avoiding obstacles. We've also put the machine through extensive usage tests, and it has shown impressive durability, standing up well to everyday wear and tear.

During usability testing, participants praised the system for its user-friendly design. They found the setup process intuitive and the operation straightforward. Users particularly appreciated the convenience of being able to control the machine remotely via the smartphone app, making the cleaning process a breeze. Additionally, our focus on keeping costs low has made the machine accessible to a wide range of users, addressing the affordability concerns often associated with similar products.

CHAPTER 6

CONCLUSION AND FUTURE DEVELOPMENT

6.1 CONCLUSION

In conclusion, the development and implementation of floor cleaning robots offer significant advancements in the field of household and commercial cleaning technologies. Through the integration of various technologies such as Arduino controllers, Android applications, ultrasonic sensors, and Bluetooth communication, these robots provide efficient and user-friendly solutions for floor cleaning tasks. The studies reviewed have demonstrated the feasibility and effectiveness of different approaches in designing and fabricating floor cleaning robots, catering to various requirements and environments.

6.2 FUTURE DEVELOPMENT

Furthermore, the research conducted in this domain showcases the potential for further enhancements and innovations. Future developments may focus on improving the autonomy, navigation, and obstacle detection capabilities of cleaning robots to ensure robust performance in real-world scenarios. Additionally, efforts towards cost optimization, energy efficiency, and sustainability can contribute to making these technologies more accessible and environmentally friendly.

Overall, the integration of smart technologies in floor cleaning robots represents a promising avenue for addressing the evolving needs of modern households and commercial spaces. With ongoing research and advancements, these robots have the potential to revolutionize the cleaning industry, offering convenient, effective, and intelligent solutions for maintaining cleanliness and hygiene in various environments.

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APPENDICES SOURCE CODE

```
#define in1 8 // L298n Motor Driver pins.
#define in2 9
#define in3 10
#define in4 11
#define mopMotor 12
#define waterMotor 13
#define vacMotor 4
#define LED 13

int command; // Int to store app command state.
int Speed = 204; // 0 - 255.
int waterSpeed = 20;
int Speedsec;
int buttonState = 0;
int lastButtonState = 0;
int Turnradius = 0; // Set the radius of a turn, 0 - 255 Note:the robot will malfunction if this
is higher than int Speed.
int brakeTime = 45;
int brkonoff = 1; // 1 for the electronic braking system, 0 for normal.
void setup() {
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);
  pinMode(mopMotor, OUTPUT); // Set the mopping motor pin.
  pinMode(vacMotor, OUTPUT); // -----
  pinMode(waterMotor, OUTPUT);
  pinMode(LED, OUTPUT); // Set the LED pin.
  Serial.begin(9600); // Set the baud rate to your Bluetooth module.
```

```
}
```

```
void loop() {  
  if (Serial.available() > 0) {  
    command = Serial.read();  
    Stop(); // Initialize with motors stopped.  
    switch (command) {  
      case 'F':  
        forward();  
        break;  
      case 'B':  
        back();  
        break;  
      case 'L':  
        left();  
        break;  
      case 'R':  
        right();  
        break;  
      case 'G':  
        forwardleft();  
        break;  
      case 'I':  
        forwardright();  
        break;  
      case 'H':  
        backleft();  
        break;  
      case 'J':  
        backright();  
        break;  
    }  
  }  
}
```

```
case 'W':  
    waterpumpon();  
    break;  
case 'w':  
    waterpumpoff();  
    break;  
case 'V':  
    mopOn(); // Turn on the mopping motor.  
    break;  
case 'v':  
    mopOff(); // Turn off the mopping motor.  
    break;  
case 'X':  
    vacOn();  
    break;  
case 'x':  
    vacOff();  
    break;  
case '0':  
    Speed = 100;  
    break;  
case '1':  
    Speed = 140;  
    break;  
case '2':  
    Speed = 153;  
    break;  
case '3':  
    Speed = 165;  
    break;  
case '4':
```

```

    Speed = 178;
    break;
case '5':
    Speed = 191;
    break;
case '6':
    Speed = 204;
    break;
case '7':
    Speed = 216;
    break;
case '8':
    Speed = 229;
    break;
case '9':
    Speed = 242;
    break;
case 'q':
    Speed = 255;
    break;
}
Speedsec = Turnradius;
if (brkonoff == 1) {
    brakeOn();
} else {
    brakeOff();
}
}
}

void forward() {

```

```
    analogWrite(in1, Speed);  
    analogWrite(in3, Speed);  
}
```

```
void back() {  
    analogWrite(in2, Speed);  
    analogWrite(in4, Speed);  
}
```

```
void left() {  
    analogWrite(in3, Speed);  
    analogWrite(in2, Speed);  
}
```

```
void right() {  
    analogWrite(in4, Speed);  
    analogWrite(in1, Speed);  
}
```

```
void forwardleft() {  
    analogWrite(in1, Speedsec);  
    analogWrite(in3, Speed);  
}
```

```
void forwardright() {  
    analogWrite(in1, Speed);  
    analogWrite(in3, Speedsec);  
}
```

```
void backright() {  
    analogWrite(in2, Speed);  
    analogWrite(in4, Speedsec);  
}
```

```
}
```

```
void backleft() {  
    analogWrite(in2, Speedsec);  
    analogWrite(in4, Speed);  
}
```

```
void Stop() {  
    analogWrite(in1, 0);  
    analogWrite(in2, 0);  
    analogWrite(in3, 0);  
    analogWrite(in4, 0);  
}
```

```
void brakeOn() {  
    // Here's the future use: an electronic braking system!  
    // Read the pushbutton input pin:  
    buttonState = command;  
    // Compare the buttonState to its previous state  
    if (buttonState != lastButtonState) {  
        // If the state has changed, increment the counter  
        if (buttonState == 'S') {  
            if (lastButtonState != buttonState) {  
                digitalWrite(in1, HIGH);  
                digitalWrite(in2, HIGH);  
                digitalWrite(in3, HIGH);  
                digitalWrite(in4, HIGH);  
                delay(brakeTime);  
                Stop();  
            }  
        }  
    }  
}
```

```

    // Save the current state as the last state,
    // for next time through the loop
    lastButtonState = buttonState;
}
}

void brakeOff() {
    // Implement this function if needed.
}

void mopOn() {
    digitalWrite(mopMotor, HIGH); // Turn on the mopping motor.
}

void mopOff() {
    digitalWrite(mopMotor, LOW); // Turn off the mopping motor.
}

void vacOn() {
    digitalWrite(vacMotor, HIGH);
}

void vacOff() {
    digitalWrite(vacMotor, LOW);
}

void waterpumpon(){
    digitalWrite(waterMotor, HIGH);
}

void waterpumpoff()

```

```
{  
  digitalWrite(waterMotor, LOW);  
}
```