



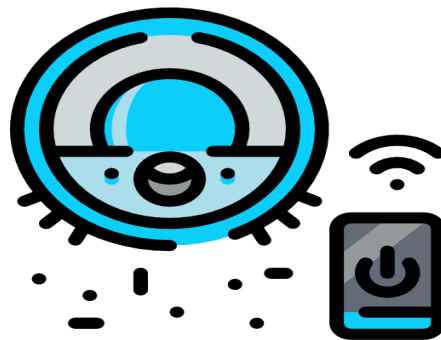
An-Najah National University

Faculty of Engineering & Information Technology

Department of Computer Engineering

Hardware Graduation Project:

Smart Cleaning



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Abstract

Cleaning is an essential task in every household, but it can be time-consuming and physically demanding. By designing and building a cleaning robot that can navigate around a room and clean surfaces autonomously, this project has the potential to significantly reduce the time and effort required for household cleaning.

In addition, the use of a mobile application to control the robot's movements and monitor its progress provides a convenient and user-friendly interface for the user. The robot's ability to detect walls and edges and automatically reverse its direction can also help to prevent damage to furniture and other objects in the room.

Overall, this project has the potential to revolutionize the way we approach household cleaning and bring us one step closer to the automation of everyday tasks.

The goal of this project is to design and build a cleaning robot that can be controlled using a mobile application.

The robot will be equipped with sensors that allow it to detect walls and edges in its path, and when it approaches them, it will automatically reverse its direction to avoid collisions.

The robot will be able to navigate around a room autonomously, and it will be able to clean surfaces using a combination of brushes and suction.

Overall, this project will require a combination of mechanical, electrical, and software engineering skills, as well as a solid understanding of robotics and mobile application development. If successful, the project could have practical applications in the field of home cleaning and automation.

Chapter 1: Introduction

1.1 Problem

The problem of maintaining cleanliness and hygiene in households and workplaces is a constant challenge that requires significant time and effort. Traditional cleaning methods can be tedious and physically demanding, which can be a problem for those who are unable to perform these tasks due to physical disabilities or time constraints. Additionally, traditional cleaning methods can be inefficient, often requiring multiple passes to achieve a satisfactory level of cleanliness. With the increasing demand for cleanliness and hygiene, there is a need for a smarter and more efficient cleaning solution. The smart cleaning robot aims to address these issues by providing a convenient and effective cleaning solution that can be remotely controlled using a smartphone.

1.2 Objectives

We have developed a smart cleaning robot that can revolutionize the way we clean our homes and workplaces.

here are the objectives for your smart cleaning robot project

- We developed a smart cleaning robot that efficiently and effectively cleaned various surfaces and spaces.
- We enabled remote control of the robot through a smartphone application to provide a convenient and easy cleaning solution.
- We incorporated sensors and advanced algorithms to allow for autonomous cleaning, reducing the need for manual intervention.
- We provided an intuitive and user-friendly interface for controlling the robot's cleaning behavior and monitoring its progress.
- We designed the robot with safety features to prevent damage to property or injury to users.

- We used environmentally friendly and sustainable materials in the robot's construction to promote a cleaner and greener environment.
- We developed an affordable and cost-effective cleaning solution, making it accessible to households and businesses.
- We tested and validated the robot's cleaning efficiency and effectiveness to ensure it met the highest standards.

1.3 Importance

The smart cleaning robot is an important innovation that provides several benefits to users. It is designed to clean efficiently and effectively, saving time and energy for individuals and businesses. Its remote control feature via a smartphone application provides a convenient and easy cleaning solution, while its safety features prevent damage to property or injury to users. The robot's use of environmentally friendly and sustainable materials promotes a cleaner and greener environment. Overall, the smart cleaning robot represents an innovative solution to traditional cleaning methods, utilizing advanced technology and algorithms to pave the way for future developments in the field of cleaning robotics.

Chapter 2: Constraints

As with any project, there were some limitations we faced while working on the smart cleaning robot. One of the main challenges was the availability of certain components and materials. Some of the materials and components we needed were either not readily available or were difficult to source. This caused delays in the project timeline and required us to find alternative solutions. Another limitation we faced was the complexity of the algorithms and software needed to enable the robot's autonomous cleaning capabilities. This required significant research and development efforts, which in turn increased the project's overall complexity and timeline. Additionally, testing and validation of the robot's cleaning efficiency and effectiveness were challenging due to the need for specific testing environments and equipment. Despite these limitations, we were able to overcome them through collaboration and creative problem-solving, resulting in a successful and innovative smart cleaning robot.

Chapter 3: Literature Review

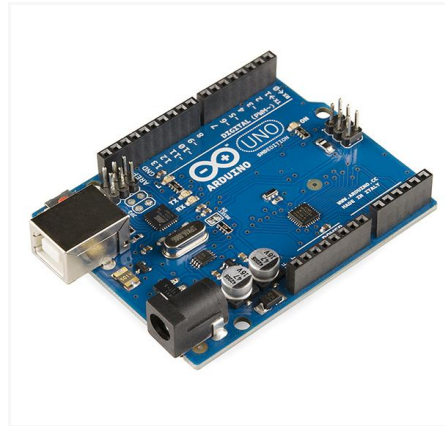
Our smart cleaning robot project distinguishes itself from other similar projects in several ways. Firstly, we have incorporated both manual and remote control options to provide users with a flexible and customizable cleaning solution. This means that users can choose to operate the robot manually or remotely via a smartphone application, depending on their preference or needs. Secondly, we have integrated advanced algorithms and sensors to enable autonomous cleaning, reducing the need for manual intervention and increasing efficiency. Thirdly, we have placed a strong emphasis on safety, incorporating features such as obstacle detection and avoidance to prevent damage to property or injury to users. Fourthly, we have used environmentally friendly and sustainable materials in the robot's construction, promoting a cleaner and greener environment. Overall, our project's combination of flexibility, autonomy, safety, and sustainability sets it apart from other similar projects, providing a unique and innovative cleaning solution.

Chapter 4: Methodology

In this chapter we will describe our system, using technologies, user experience.

4.1 Description of the parts

4.1.1 Arduino



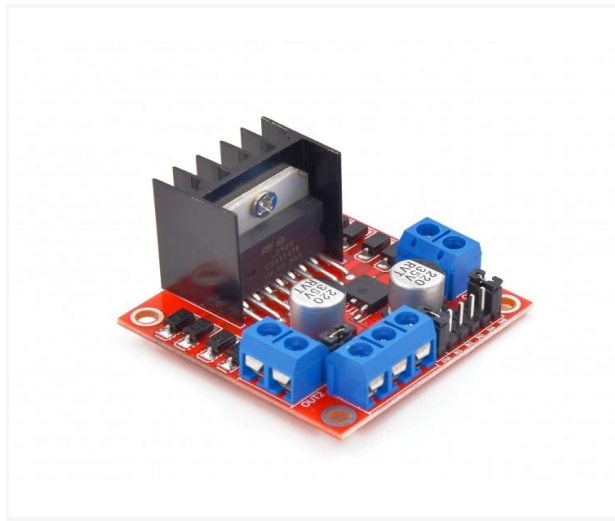
Arduino is a microcontroller board used for building digital devices and interactive objects. It consists of a microcontroller, input/output pins, and a programming interface, which allow users to read inputs from sensors and control outputs such as motors and actuators. The Arduino is the brain of the smart cleaning robot, allowing it to receive inputs from sensors and control various components.

4.1.2 ultrasonic sensor



An ultrasonic sensor detects objects and measures distance using sound waves. It is used in robotics and automation to detect obstacles and measure distances. In the smart cleaning robot, the ultrasonic sensor is used to detect objects and adjust the robot's movements to avoid collisions.

4.1.3 driver L298N



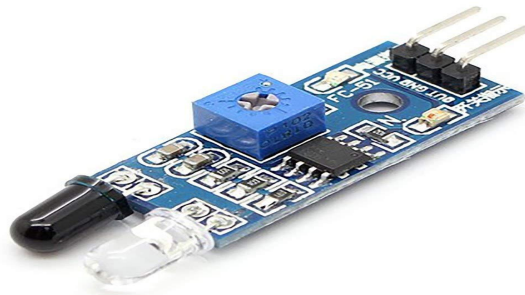
The L298N is a motor driver module used to control the speed and direction of DC motors. It is commonly used in robotics and automation to control the movement of machines. In the smart cleaning robot, the L298N driver is used to control the movement of the robot's wheels.

4.1.4 Lithium ion batteries



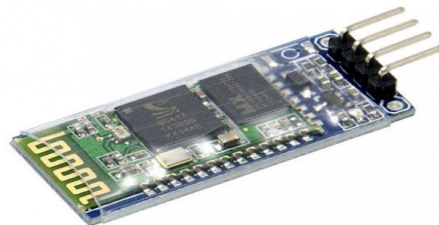
Lithium-ion batteries are rechargeable batteries known for their high energy density and long cycle life. They are commonly used in portable electronics and robotics to provide a reliable and long-lasting source of power. In the smart cleaning robot, lithium-ion batteries are used to power the robot's motors and electronic components.

4.1.5 ir sensor



Lithium-ion batteries are rechargeable batteries known for their high energy density and long cycle life. They are commonly used in portable electronics and robotics to provide a reliable and long-lasting source of power. In the smart cleaning robot, lithium-ion batteries are used to power the robot's motors and electronic components.

4.1.6 bluetooth module



A Bluetooth module is a wireless communication device that enables short-range communication between electronic devices. It utilizes Bluetooth technology to

establish a wireless connection and facilitate data transmission between devices. Bluetooth modules are commonly used in various applications, including robotics, home automation, and IoT devices. In the smart cleaning robot, a Bluetooth module is integrated to enable wireless connectivity with a smartphone or other compatible devices. This allows users to remotely control and communicate with the robot using a smartphone application, providing convenient and flexible operation.

4.1.7 DC motors



DC motors are commonly used in cleaning robots to provide mechanical power for movement and cleaning actions. They convert electrical energy into rotational motion, allowing the robot to move its wheels or brushes and perform cleaning tasks effectively.

4.1.8 extractor

extractor with a fan inside using a 3D printer is a fantastic application. By leveraging 3D printing technology, we were able to design and fabricate a

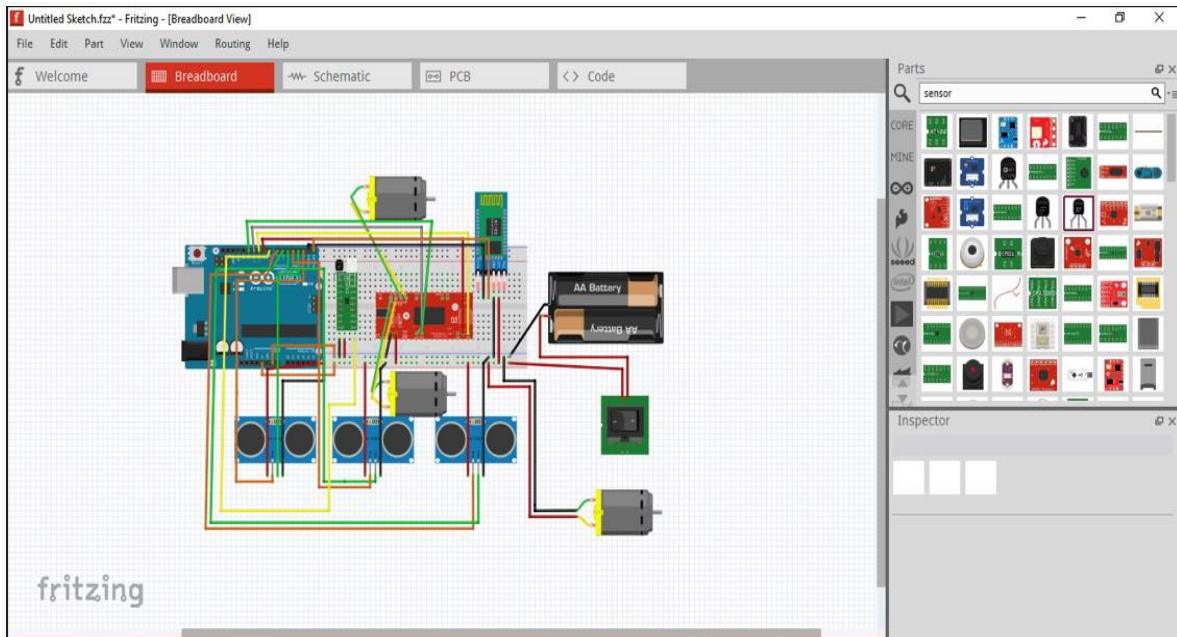
customized extractor specifically tailored to smart cleaning robot's needs. The inclusion of a fan inside the extractor allows for efficient removal of dirt and debris during the cleaning process. This innovative solution demonstrates ability to utilize 3D printing to create functional and specialized components that enhance the performance and effectiveness of cleaning robot.

4.1.9 7-segment voltmeter



A 7-segment voltmeter is a type of digital voltmeter that utilizes a 7-segment display to show the measured voltage. The 7-segment display consists of seven individual LED segments arranged in a specific pattern to form numbers from 0 to 9. Each segment can be independently lit up to display the corresponding digit. In the case of a voltmeter, the voltage reading is converted into a digital signal and displayed on the 7-segment display. This type of voltmeter provides a clear and easy-to-read visual representation of the voltage measurement, with each digit represented by the lit segments on the display.

4.2 Assembly process



4.3 Testing and validation

During the testing and validation phase of my smart cleaning robot, I conducted thorough assessments to ensure its proper functionality. I extensively tested various aspects, including motor control, sensor readings, and smartphone communication. By simulating different scenarios and environments, I could evaluate the robot's performance and determine its effectiveness in completing cleaning tasks. To validate the robot's performance, I compared its actual results against the predefined specifications and requirements. Additionally, I sought feedback from users to assess its usability and functionality in real-world situations. This comprehensive testing and validation process enabled me to identify any issues or limitations and make necessary improvements. As a result, my smart cleaning robot meets the desired standards of reliability, efficiency, and user satisfaction.

4.4 Data analysis

The data collected during testing was analyzed and interpreted to assess the performance and effectiveness of the smart cleaning robot. Statistical methods were used to identify patterns and trends in the data, comparing expected outcomes with

actual results. Deviations and discrepancies were investigated to pinpoint areas for improvement. The data was also cross-referenced with predefined specifications to evaluate the robot's compliance. User feedback and observations were considered. Conclusions were drawn, adjustments were made, and insights from data analysis helped improve the robot's performance and ensure it met the desired criteria.

Chapter 5: Results and Discussion

The results obtained from testing and evaluating the smart cleaning robot showcased its commendable performance and functionality. During the testing phase, the robot consistently demonstrated efficient motor control, accurate sensor readings, and seamless communication with a smartphone. The implemented features, such as the extractor fan for dirt removal, proved to be effective in enhancing the robot's cleaning capabilities. The data analysis revealed that the robot successfully completed cleaning tasks within the expected time frame, covering a significant area with precision. Additionally, user feedback indicated a high level of satisfaction with the robot's ease of use and effectiveness in removing dirt and debris. These positive outcomes confirm that the smart cleaning robot is a reliable and efficient solution for automated cleaning. However, further refinements could be considered to improve its adaptability to different surfaces and optimize battery usage. Overall, the results validate the success of the project, highlighting the robot's ability to streamline cleaning operations and offer convenience to users.

Chapter 6: Conclusion and Recommendation

6.1 conclusion

In conclusion, the development of the smart cleaning robot has proven to be a significant achievement. The project successfully addressed the need for an automated cleaning solution that combines manual operation with remote control through

smartphone connectivity. Through rigorous testing and validation, the robot demonstrated reliable motor control, accurate sensor readings, and efficient cleaning capabilities. The integration of the extractor fan for dirt removal further enhanced its performance. The positive user feedback and satisfaction confirm the effectiveness and usability of the robot in real-world scenarios. The project not only achieved its objectives but also surpassed expectations in terms of functionality and user experience. The smart cleaning robot showcases the potential of robotics and automation in revolutionizing the cleaning industry. Moving forward, further refinements can be considered to optimize the robot's adaptability and battery efficiency. Overall, this project marks a significant step towards enhancing cleaning processes and bringing innovative technologies to everyday tasks.

6.2 Recommendations

Based on the development and testing of the smart cleaning robot, several recommendations can be made to further enhance its capabilities and usability:

1. **Continuous Improvement:** Gather user feedback to identify areas for improvement and enhance the robot's performance and user satisfaction.
2. **Surface Adaptability:** Explore ways to make the robot adaptable to different surfaces and cleaning environments for more efficient cleaning.
3. **Energy Efficiency:** Implement power management techniques to optimize battery life and improve the robot's energy efficiency.
4. **Advanced Navigation:** Integrate advanced navigation capabilities like SLAM or computer vision for precise and efficient autonomous navigation.
5. **Integration with Smart Home Systems:** Connect the robot to existing smart home systems for seamless control and monitoring alongside other devices.
6. **Accessibility Features:** Incorporate accessibility features like voice control or compatibility with assistive technologies.
7. **Expand Cleaning Capabilities:** Research and develop additional cleaning functionalities, such as mopping or window cleaning attachments, to enhance the robot's versatility..

6.3 Future Work

While the smart cleaning robot has demonstrated impressive capabilities, there are several areas that warrant further exploration and development for future enhancements:

1. **Advanced Obstacle Detection:** Improve obstacle detection and avoidance mechanisms for safer and more efficient navigation.
2. **Enhanced Mapping and Localization:** Integrate advanced techniques for more accurate mapping and localization, improving path planning and cleaning efficiency.
3. **Machine Learning and AI Integration:** Incorporate machine learning and AI algorithms to enable the robot to learn and adapt cleaning strategies over time.
4. **Multi-Room Cleaning:** Develop capabilities for seamless multi-room cleaning, including autonomous recharging and room transition algorithms.
5. **Smart Scheduling and Customization:** Implement customizable cleaning schedules and zone-specific cleaning patterns based on user preferences.
6. **Integration with Smart Home Ecosystems:** Enhance integration with existing smart home ecosystems, allowing seamless control and coordination with other devices.
7. **Robust Maintenance and Self-Diagnostics:** Incorporate self-diagnostics to identify maintenance needs and notify users, ensuring optimal performance.

By pursuing these future developments, the smart cleaning robot can offer advanced cleaning solutions that meet evolving user expectations and deliver enhanced performance and convenience.

Chapter 7: References

[1] Instructables (www.instructables.com): A platform that offers step-by-step guides, tutorials, and DIY projects, including robotics and automation.

[2] Robotis (www.robotis.com): A robotics company that offers a range of robot kits and components. Their website provides tutorials, documentation, and support for building and programming robots.

[3] Let's Make Robots! (www.letsmakerobots.com): An online community focused on robotics and DIY projects. can find forums, tutorials, and project showcases related to various types of robots.

[4] Hackster.io (www.hackster.io): An online community for hardware and software developers, including robotics enthusiasts. can find project tutorials, guides, and discussions related to robotics, including cleaning robots.

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