IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

Smart Sweep Cleaning Rover

Arpita Teli[1], Ashwini Umap[2], Bhagyashri Salve[3] , Prof. A. R. Landge[4]
[4]Asst. Prof. and [1,2,3]Students of Department of Electronics and Telecommunications,
Dr. Vithalrao Vikhe Patil College of Engineering, Ahilyanagar, Maharashtra
Savitribai Phule Pune University, Pune

Abstract: *Automation in cleaning systems has become essential for improving efficiency and reducing human effort. This paper presents a Smart Sweep Cleaning Rover designed for autonomous floor cleaning in indoor and semi-outdoor environments. The system integrates sweeping and vacuum mechanisms with intelligent navigation using ultrasonic and infrared sensors for obstacle and edge detection. The rover is capable of real-time path adjustment to ensure effective coverage and collision avoidance. An IoT-based module is incorporated to enable remote monitoring and control through a mobile interface, enhancing usability and flexibility. The proposed system is compact, energy-efficient, and cost-effective, making it suitable for residential, commercial, and industrial applications. Experimental analysis shows that the rover performs efficient cleaning with stable navigation and low power consumption. This system demonstrates a practical approach toward smart cleaning automation and robotic assistance in daily life.*

Keywords: Web Content Acquisition, Business News Aggregation, NLP Chatbot, Sentiment Analysis, Content-Based Filtering, Java Web Application, etc

I. INTRODUCTION

In recent years, rapid advancements in robotics and automation have significantly transformed everyday tasks, including cleaning and maintenance. With increasing urbanization and busy lifestyles, there is a growing need for smart and efficient cleaning solutions that reduce human effort while maintaining high standards of hygiene. Traditional cleaning methods are time-consuming, labor - intensive, and often inefficient in covering large or hard-to-reach areas. This has led to the development of autonomous cleaning systems that can perform tasks with minimal human intervention. A Smart Sweep Cleaning Rover is an innovative robotic system designed to automate the process of floor cleaning. It combines sweeping and vacuum mechanisms with intelligent navigation capabilities to ensure effective cleaning performance. The system uses sensors such as ultrasonic sensors for obstacle detection and infrared sensors for edge and dirt detection, enabling the rover to move safely and efficiently within its environment. These features allow the robot to avoid collisions, detect boundaries, and adapt its path in real time. Furthermore, the integration of Internet of Things (IoT) technology enhances the functionality of the system by allowing users to monitor and control the rover remotely through a mobile application. This not only improves convenience but also increases operational flexibility. The compact design and energy-efficient operation make the system suitable for various applications, including homes, offices, hospitals, and industrial spaces.

The objective of this paper is to design and develop a cost-effective and intelligent cleaning rover that can operate autonomously while delivering reliable performance. The proposed system aims to contribute to the field of smart robotics by providing an efficient solution for automated cleaning tasks

II. PROBLEM STATEMENT

Traditional cleaning methods are time-consuming, labor-intensive, and often inefficient in large or hard-to-reach areas. Existing robotic cleaning systems are expensive and lack affordability and customization. Therefore, there is a need to develop a cost-effective Smart Sweep Cleaning Rover that can perform autonomous cleaning using sensor-based navigation and IoT technology, reducing human effort while improving efficiency.

DOI: 10.48175/IJARSCT-34335

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III. LITERATURE SURVEY

Several researchers have contributed to the development of autonomous cleaning robots aimed at reducing human effort and improving efficiency. S. K. Shah et al. proposed an autonomous floor cleaning robot using Arduino and ultrasonic sensors, demonstrating effective obstacle detection and navigation in indoor environments. Their work highlights the feasibility of low-cost robotic cleaning solutions.

A. Pandey and R. Singh focused on designing an affordable cleaning robot with simple navigation techniques, emphasizing energy efficiency and cost-effectiveness. Their system demonstrated that basic sensor integration can achieve satisfactory cleaning performance without the need for complex algorithms.

In another study, M. R. Islam et al. developed a multifunctional cleaning robot capable of both dry and wet cleaning. Their work improved cleaning efficiency by combining sweeping and mopping mechanisms, making the system suitable for various applications.

Recent advancements have incorporated intelligent technologies into cleaning systems. J. Lee et al. proposed an AI-powered cleaning robot with optimized path planning and mobile-based control, enhancing performance and user convenience. Similarly, K. Verma et al. reviewed modern cleaning robots and highlighted the importance of advanced sensors and IoT integration for real-time monitoring and control.

Despite these developments, most existing systems are either costly or lack user-friendly features and efficient navigation. Therefore, there is a need for a cost-effective Smart Sweep Cleaning Rover that integrates sensor-based navigation with IoT capabilities.

IV. SYSTEM OVERVIEW

The Smart Sweep Cleaning Rover is an autonomous robotic system designed to perform efficient floor cleaning with minimal human intervention. The system integrates mechanical cleaning components with electronic control and intelligent navigation to achieve effective performance in indoor and semi-outdoor environments.

The rover consists of a microcontroller unit that acts as the brain of the system, controlling all operations. It is equipped with ultrasonic sensors for obstacle detection and infrared sensors for edge detection, allowing safe and smooth navigation. The cleaning mechanism includes a rotating brush for sweeping dust and a vacuum unit for collecting debris into a storage container.

The rover operates on a motor-driven wheel system, enabling movement in multiple directions. Based on sensor inputs, the microcontroller processes real-time data and adjusts the rover's path to avoid collisions and ensure maximum area coverage. Additionally, an IoT module is integrated to provide remote monitoring and control through a mobile application, enhancing user convenience.

Overall, the system is designed to be cost-effective, energy-efficient, and compact, making it suitable for various applications such as homes, offices, and industrial spaces.

V. PROPOSED SYSTEM

The proposed Smart Sweep Cleaning Rover is an autonomous robotic system designed to perform efficient floor cleaning by integrating sweeping and vacuum mechanisms with intelligent navigation. The system is built around a microcontroller (such as Arduino UNO), which controls all operations and processes data received from various sensors.

The rover is equipped with ultrasonic sensors for obstacle detection and infrared sensors for edge or cliff detection, ensuring safe and smooth movement. A dust sensor may also be used to identify dirty areas for targeted cleaning. Based on sensor inputs, the microcontroller directs the motor driver (L298N) to control the movement of DC motors, enabling the rover to navigate and avoid obstacles in real time.

The cleaning mechanism consists of a rotating brush that sweeps dust and debris toward a vacuum unit, which then collects it into a dustbin. An IoT module (such as ESP8266) is integrated to allow users to monitor and control the rover through a mobile application, providing real-time status updates and remote accessibility.

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The system operates on a rechargeable battery, making it portable and energy-efficient. Overall, the proposed system is designed to be cost-effective, compact, and suitable for applications in homes, offices, hospitals, and industrial environments.

The proposed smart sweep cleaning rover is an autonomous system designed to perform efficient floor cleaning using integrated sensing, processing, and actuation modules. The rover utilizes sensors such as ultrasonic, IR, and dust sensors to detect obstacles and assess surface cleanliness. The collected data is processed by a central microcontroller, which performs decision-making and path planning for optimized navigation. Based on these decisions, the actuation system controls the drive motors, brush mechanism, vacuum unit, and water spray system to ensure effective cleaning. Additionally, a wireless communication module enables remote monitoring and control through a mobile or web interface. The system is powered by a rechargeable battery with proper power management to ensure reliable and continuous operation. Based on the processed data, the controller generates control signals for the actuation module, which includes drive motors for movement and dedicated motors for cleaning operations such as brushing, vacuuming, and optional water spraying. This enables the rover to effectively remove dust and debris from various types of surfaces.

Furthermore, an efficient power management unit, comprising a rechargeable battery, battery management system (BMS), and voltage regulators, ensures stable power distribution to all components and supports prolonged operation. Auxiliary components such as LED indicators and buzzers are included to provide system status and alerts. Overall, the proposed system offers a cost-effective, scalable, and smart solution for automated cleaning applications in both domestic and industrial environments.

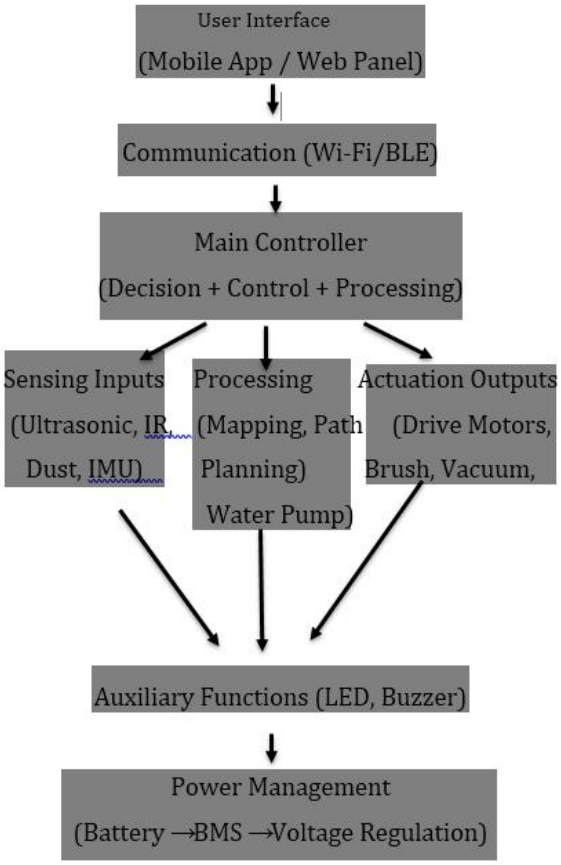

Fig.1: System Architecture Design

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VI. CONCLUSON

The Smart Sweep Cleaning Rover presented in this paper provides an efficient and cost-effective solution for automated cleaning. By integrating sensor-based navigation with sweeping and vacuum mechanisms, the system is capable of performing autonomous cleaning with minimal human intervention. The use of ultrasonic and infrared sensors ensures safe movement through obstacle and edge detection, while the IoT module enhances user convenience through remote monitoring and control.

The proposed system demonstrates reliable performance, energy efficiency, and adaptability for various environments such as homes, offices, and industrial spaces. Overall, this project highlights the potential of combining robotics and IoT technologies to develop smart cleaning solutions that improve productivity and maintain hygiene standards.

ACKNOWLEGEMENT

The authors would like to express their sincere gratitude to their project supervisor for invaluable guidance, continuous support, and constructive suggestions throughout the course of this work. The authors also acknowledge the support provided by the Department of Electronics and Telecommunication Engineering for offering the necessary facilities and resources required for the successful completion of this project.

The authors are thankful to all faculty members and colleagues for their encouragement and cooperation. Finally, the authors extend their appreciation to their families for their constant support and motivation.

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