

Smart Floor Cleaner

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Peer Review Information	Abstract
Type: Article Received: 12 February 2026 Revised: 10 March 2026 Accepted: 22 April 2026 Published: 23 May 2026	This paper presents the design of a Smart Floor Cleaner using ESP 32 for automated household cleaning. The system integrates sensors for obstacle and edge detection, motor control for movement and cleaning mechanisms, and optional IoT features for remote monitoring. ESP 32 serves as the central controller, enabling efficient navigation and real-time decision-making. Keywords: Smart Floor Cleaner; ESP32; IoT; Motor Driver; DC Gear Motor; Relay Module; Automation; Embedded System; Wireless Control.

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Introduction

Automation in household chores is becoming increasingly important due to busy lifestyles and the need for efficiency. Floor cleaning is a routine task that requires significant time and effort, and traditional methods are often labor-intensive. While robotic cleaners are available in the market, they are generally expensive and may have limited functionality. To address this, a Smart Floor Cleaner has been designed to provide an autonomous and efficient solution for cleaning floors. The system is built around the proposed solution provides a cost-effective and energy-efficient alternative to conventional robotic vacuum cleaners.

Literature Review

Shripad Malavadikar et al. [1] designed an Automatic Cleaner Robot that focuses on autonomous navigation and basic cleaning operations. Their work highlighted the integration of sensors for obstacle detection and movement control in robotic floor cleaners. Pooja D. Rathod et al. [2] proposed a multipurpose smart floor cleaning system using Android devices, which enables remote control and scheduling through mobile applications. This work demonstrated the advantages of IoT integration in smart cleaning systems, improving accessibility and user convenience.

ESP32, which acts as the central controller for decision-making. Ultrasonic and infrared sensors are used to detect obstacles and prevent the device from falling off edges. Motor drivers control the movement of the device as well as the cleaning mechanism. Optional IoT connectivity allows users to monitor and control the cleaner remotely. This approach ensures systematic navigation and effective cleaning with minimal human intervention. Overall, the project presents a cost-effective, energy-efficient, and user-friendly solution for modern households

H.G.T. Milinda [3] studied mud and dirt separation methods for floor cleaning machines, emphasizing the mechanical and functional aspects of cleaning efficiency. The methods discussed provided insight into optimizing the separation of debris from the surface during robotic cleaning. Jens-Steffen Gutmann et al. [4] explored the social impact of systematic floor cleaners, evaluating how domestic robots interact with human users in household environments. Their study underscored the importance of designing robots that are not only efficient but also socially acceptable.

Evolution Robotics Inc. [5] introduced Mint, one of the early commercial floor-cleaning robots. The Mint robot highlighted the transition from research prototypes to market-ready smart cleaners, combining navigation technology with practical usability.

J.-S. Gutmann et al. [6] presented Vector Field SLAM, a technique for autonomous navigation and mapping in cleaning robots. This research contributed to advancements in simultaneous localization and mapping (SLAM), which is crucial for efficient floor coverage and obstacle avoidance.

J.-Y. Sung et al. [7] examined domestic robot technologies from a social perspective, particularly focusing on housewives' interaction with robotic cleaners. Their study provided insights into user acceptance, interaction design, and the role of robots in daily domestic routines.

Overall, the literature shows a trend toward integrating autonomous navigation, IoT connectivity, user-friendly interfaces, and social acceptability in smart floor cleaning systems. These developments are essential for creating efficient, reliable, and widely adopted robotic cleaners.

Methodology

The smart floor cleaner is designed to autonomously clean floors with minimal human intervention, using sensors, a microcontroller (Raspberry Pi), and a motor-driven cleaning mechanism. The methodology can be divided into the following steps:

System Design:

The hardware consists of an ESP 32, motor driver, wheels, cleaning brush/roller, and power supply. Navigation and Obstacle Avoidance:

The ultrasonic sensors detect obstacles, allowing the cleaner to change direction and avoid collisions. The ultrasonic sensors detect obstacles, allowing the cleaner to change direction and avoid collisions. IR sensors prevent the robot from falling off edges like stairs. Algorithms such as Random Walk, Wall Following, or SLAM (Simultaneous Localization and Mapping) are implemented for systematic cleaning.

Cleaning Mechanism:

The floor cleaning unit consists of a rotating brush or mop driven by DC motors. Suction or a wet-dry mop mechanism can be integrated depending on the design. Control System: The ESP 32 processes sensor inputs and controls motors via a motor driver module. The system can be programmed to follow predefined cleaning patterns or adjust routes dynamically based on sensor feedback. User Interface: A mobile application or web interface can allow the user to start, stop, or schedule cleaning. Optional features include voice control or integration with smart home assistants. Power Management: The robot uses a rechargeable Li-ion battery, and the system monitors battery levels to return to the charging dock automatically. Testing and Optimization: The robot is tested on different floor types (tiles, wood, carpet) to optimize speed, cleaning efficiency, and obstacle handling.

Software and technologies used

- Microcontroller / Processor ESP32 for control and processing.
- Programming Languages Python – for image processing, control logic, and AI C/C++ – for embedded system programming.
- Sensor Technologies Ultrasonic Sensors – for obstacle detection. IR Sensors – for edge/cliff detection. LiDAR / Camera – for mapping and navigation.
- Wireless Communication Wi-Fi / Bluetooth – for app-based control. IoT Platforms (MQTT, Blynk, Firebase, etc.) – for remote monitoring.
- Mobile Application / User Interface Android/iOS Apps – for scheduling, control, and monitoring.
- Motor Control Technology Motor Driver Modules (L293D, L298N, etc.) – to control wheels and brushes.
- Power Management Rechargeable Li-ion Battery & Charging Dock – for autonomous recharging.

Hardware and technologies used

Processing Unit ESP32 for controlling the system, Wheels Mechanical component Enables movement and stability, Actuators & Motors, DC Motors – for wheel movement, Servo Motors – for brush/mop mechanism. Suction Motor / Vacuum Pump – for dust collection, Cleaning Mechanism Rotating Brushes / Rollers. Mop Pads / Wet Cleaning Unit Suction Chamber with Dustbin. Power Supply Rechargeable Li-ion Battery. Charging Dock with Auto- Return Feature.

Features

Autonomous Navigation: Uses sensors and mapping algorithms to move around without human guidance. Obstacle Detection and Avoidance: Equipped with ultrasonic, infrared, or LiDAR sensors to detect and avoid furniture, walls, and other obstacles. Edge and Cliff Detection: Prevents the robot from falling off stairs or edges using ultrasonic sensor. Multiple Cleaning Modes: Supports vacuuming, sweeping, and mopping depending on floor type and user preference. Smart Scheduling: Allows users to set cleaning times through a mobile app or web interface.

Result

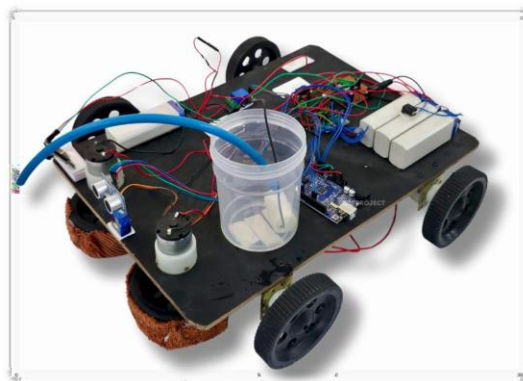


Fig 1: *Arduino-Based Autonomous Floor Cleaning Robot*

A four-wheel autonomous cleaning robot prototype built using an Arduino microcontroller. The robot is equipped with rotating cleaning brushes, a water container with hose pipe for wet cleaning, DC motors for movement, and various sensors/modules connected through wiring. It is designed for automated floor sweeping and mopping applications.

Conclusion

Smart floor cleaners represent a significant advancement in home and commercial cleaning technology. By integrating sensors, autonomous navigation, and smart control systems, these devices reduce human effort, save time, and ensure efficient cleaning across different floor types. They offer convenience through scheduling, remote control, and automatic charging while adapting to obstacles and home layouts. However, limitations such as high initial cost, maintenance requirements, and reduced effectiveness on heavily soiled areas highlight that they complement rather than fully replace manual cleaning. Overall, smart floor cleaners are a practical, time-saving solution that enhances cleanliness and convenience, reflecting the growing role of robotics and IoT in daily life.

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