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Robovac Floor Cleaner Using IOT

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ABSTRACT :

The development of a Smart Autonomous Floor-Cleaning Robot addresses the growing demand for intelligent, efficient, and user-friendly cleaning solutions in modern households. Traditional cleaning methods and existing robotic vacuum systems often fall short in providing complete floor coverage, especially when it comes to edge cleaning, mopping, and user-level customization. This project presents a low-cost, multi-functional robot equipped with vacuuming, mopping, and wall-edge cleaning capabilities, designed to enhance the overall cleaning process and reduce manual effort. The core of the system is an ESP32 micro controller, which enables real-time sensor-based obstacle detection and IoT-based remote control through a web interface. The robot uses ultrasonic sensors to detect obstacles and dynamically adjust its path while performing cleaning tasks. Users can control and monitor the robot remotely via a smartphone or browser, turning individual cleaning functions on or off as required. The integration of these technologies allows for flexible operation, efficient energy usage, and a more complete cleaning experience. The robot was tested in various indoor environments to evaluate its navigation accuracy, cleaning effectiveness, and user interface responsiveness. Results demonstrated that the robot could successfully avoid obstacles, cover edge areas, and respond to user commands through the web application. Its modular design allows easy upgrades such as AI-based navigation and auto-charging, making it a scalable prototype for future smart home robotics. The proposed system thus offers a practical and affordable approach to intelligent floor maintenance..

INTRODUCTION :

The Smart Autonomous Floor-Cleaning Robot is designed to address the limitations of traditional and semi-automated floor-cleaning methods commonly used in homes and small offices. Manual cleaning processes are time-consuming, physically demanding, and often inconsistent, while many existing robotic cleaners are restricted to basic vacuuming with limited navigation intelligence and little user interaction. This project aims to bridge that gap by developing a cost-effective, multi-functional cleaning robot that integrates key features such as vacuuming, mopping, wall-edge brushing, and IoT-based control. The robot is powered by an ESP32 microcontroller, which manages sensor inputs, motor outputs, and wireless communication. Ultrasonic sensors are used for obstacle detection, allowing the robot to navigate autonomously and avoid collisions with furniture or walls. The user interface is accessible via any device connected to the same Wi-Fi network, offering remote control of cleaning functions, obstacle monitoring, and real-time status updates. This makes the robot adaptable, interactive, and user-friendly in day-to-day applications. The primary goal of the project is to offer an efficient, modular solution for autonomous cleaning that can be easily enhanced with advanced features in the future. The system architecture and control logic are designed to be scalable, enabling potential integration with AI-based navigation systems, camera modules, or automatic charging docks. With a focus on automation, flexibility, and user convenience, this project represents a significant step toward smart home.

LITERATURE SURVEY :

The advancement of autonomous cleaning robots has been driven by the need to improve household efficiency, reduce manual labor, and provide smart solutions for daily maintenance. Early designs were limited to basic vacuuming functions using random navigation and rudimentary bump sensors, which often led to incomplete cleaning and inefficient battery usage. Researchers identified these limitations and began introducing ultrasonic, infrared, and optical sensors to improve obstacle detection and environmental awareness. Literature from multiple studies shows that the implementation of such sensors enables robots to make real-time navigation decisions, avoiding collisions and adapting to various room layouts. Furthermore, the addition of mopping systems and side brushes addressed the issue of limited coverage in wall edges and corners, enhancing the overall cleaning quality. With the rapid growth of the Internet of Things (IoT), there has been a noticeable shift in floor-cleaning systems from standalone automation to connected, remotely controllable platforms. Studies indicate that microcontrollers like the ESP32, with built-in Wi-Fi, Bluetooth, and extensive GPIO options, have become a popular choice in academic and industrial projects aiming to combine control logic with web-based or app-based interfaces. This shift not only improves the user experience but also opens the door for features like real-time monitoring, remote operation, and scheduled cleaning cycles. Recent academic work also explores modular designs that allow the integration of cameras for visual feedback and AI-based algorithms for intelligent path planning and area mapping, enhancing adaptability and autonomy. In particular, researchers emphasize the importance of scalability and ease of customization in robotic systems for practical deployment. Overall, the literature provides clear evidence that the future of floor-cleaning robots lies in systems that are multifunctional, sensor-rich, remotely accessible, and easily upgradeable, supporting the relevance and importance of the model proposed in this project, which integrates vacuuming, mopping, obstacle detection, and IoT-based control into a compact and affordable robotic system.

RESEARCH METHOD :

The development of the Smart Autonomous Floor-Cleaning Robot followed a structured and iterative engineering approach, beginning with requirement analysis and culminating in hardware-software integration and real-time testing. The focus was on designing a multifunctional cleaning system that could operate autonomously and be controlled remotely via IoT. The selected components had to be low-cost, energy-efficient, and compact enough to fit into a mobile platform. The ESP32 microcontroller served as the heart of the system, coordinating all sensor inputs, actuator outputs, and Wi-Fi-based communication. Key considerations included obstacle avoidance, simultaneous control of multiple cleaning functions, and user-friendly remote access. The following steps summarize the methodology adopted in this project:

Requirement Analysis and Objective Definition:

Identified the need for a compact, autonomous robot capable of vacuuming, mopping, and wall-edge brushing, all remotely controllable via a web interface. The target environment included domestic settings with varied floor types and obstacles.

Microcontroller Selection and Control Architecture:

Selected the ESP32 for its integrated Wi-Fi, low cost, and processing efficiency. It handled real-time data processing from sensors and controlled cleaning motors via GPIO outputs.

Sensor and Obstacle Detection System:

Implemented ultrasonic sensors to detect objects and walls, allowing the robot to dynamically avoid obstacles. The sensor provided real-time distance feedback to the controller.

Motor Control and Cleaning Mechanism:

Used three separate DC motors for vacuuming, mopping, and wall-edge brushing. Each motor was independently controlled via motor drivers using PWM signals, ensuring flexible and targeted cleaning.

Web-Based User Interface Development:

Designed a lightweight HTML interface hosted on the ESP32, accessible via Wi-Fi. The user could control cleaning functions and view sensor data remotely through any web browser.

Chassis and Mechanical Assembly:

Built a balanced chassis that housed all components—motors, sensors, controller, and cleaning modules—ensuring stability, ease of movement, and effective floor contact.

Programming and Integration:

Developed firmware in Arduino IDE to integrate sensor input, motor control logic, and web interface responses. The code enabled smooth operation and modular upgrades.

Testing and Calibration:

Conducted indoor testing to validate cleaning performance, obstacle avoidance, and remote control functionality. Calibrated motor speeds, ultrasonic range, and response times based on observed performance.

APPLICATIONS :

The development of autonomous systems has seen significant advancements in recent years, especially in the domain of household and industrial robots. With the growing need for automation in daily tasks, such as floor cleaning, robots equipped with intelligent features can greatly enhance convenience, efficiency, and cleanliness. This smart autonomous floor-cleaning robot, incorporating advanced sensors, obstacle detection, and IoT integration, stands out as a promising solution for various real-world applications:

1. **Domestic Use:**The robot can be used in homes to automate floor cleaning, reducing manual effort and ensuring a consistently clean environment. Features like obstacle detection and mopping make it suitable for different floor types.

2. **Commercial Use:** In offices, hotels, or large commercial spaces, the robot can save time and labor costs. It can be integrated with IoT for remote control and scheduling, making it ideal for busy environments.

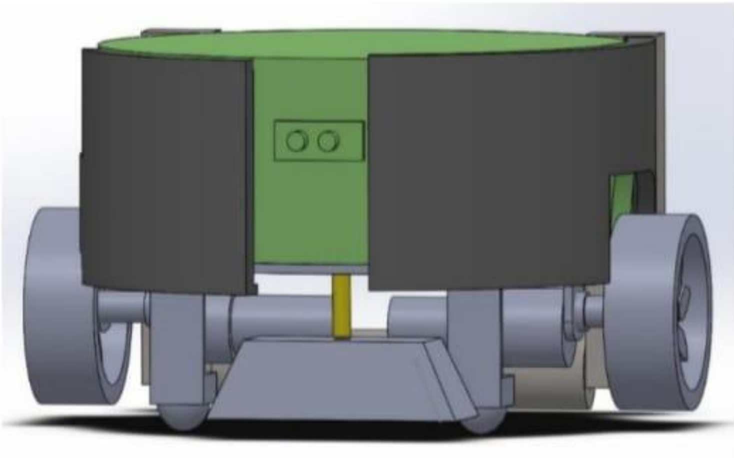
3. **Healthcare Facilities:** Hospitals and clinics require constant cleaning to maintain hygiene. The robot can assist in these environments, ensuring that floors remain clean and safe for patients and staff.

4. **Industrial Use:** In factories and warehouses, the robot can be programmed to clean large areas, helping to maintain cleanliness in environments with heavy foot traffic.

5. **Smart Home Integration:** The IoT-enabled feature allows the robot to be integrated into a smart home ecosystem, enabling users to control and monitor the cleaning process remotely via a mobile application.

6. **Environmentally Friendly Cleaning:** The mopping function, coupled with the vacuum cleaner, ensures that the robot uses minimal water and cleaning agents, making it an eco-friendly solution.

DESIGN



CONCLUSION :

The Smart Autonomous Floor-Cleaning Robot effectively demonstrates the application of IoT and embedded systems in home automation. With its multi-functionality and real-time user interface, the robot offers a practical solution for floor maintenance in both residential and institutional settings. The ESP32 serves as an efficient control hub, handling multiple peripherals and wireless communication. While the robot currently requires manual charging and basic sensor-based navigation, it serves as a scalable prototype with potential for enhancements such as autonomous docking, advanced path planning, and AI-powered vision systems. This project contributes to the growing field of low-cost, user-friendly smart home robotics.

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