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"Automop: Autonomous Voice-Enabled Floor Cleaner with Smart Navigation"

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ABSTRACT :

This paper presents Automop, an autonomous, voice-enabled floor cleaning robot designed to meet the growing demand for intelligent and energy-efficient cleaning systems.

The robot integrates smart navigation with obstacle avoidance, remote control functionality, and voice-based operation to provide an efficient cleaning solution for residential and industrial environments. The system combines sensors, microcontrollers, and real-time control mechanisms to navigate autonomously and respond to user commands. In addition to enhancing cleaning efficiency, Automop aims to reduce human labor and operational costs. Its modular and scalable design, paired with intuitive control options, makes it a versatile toolfor modern smart spaces.

Keywords: Autonomous Robot, Smart Navigation, Voice Control, Ultrasonic Sensor, Floor Cleaning System, IoT

1. Introduction

With the evolution of home automation and smart technologies, autonomous systems are increasingly being deployed to ease human efforts. Cleaning, an essential daily task, often consumes substantial time and physical labor, especially in homes, industries, and commercial spaces. Automating this task not only enhances efficiency but also reduces manual effort. The Automop robot is an autonomous floor cleaning robot designed to support both voice-controlled and manual operation. It utilizes ultrasonic sensors for obstacle detection, Bluetooth for manual control, and Arduino as its central processing unit. The robot is compact, energy- efficient, and capable of cleaning various floor types with minimal supervision. By integrating both hardware and software components seamlessly, Automop can operate in automatic mode using pre-programmed logic or be remotely controlled via a mobile app, making it a practical solution for modern cleaning requirements.

2. Literature Review

Over the years, researchers have explored various implementations of autonomous and semi-autonomous cleaning robots. Manreet Kaur and Preeti Abrol designed a dual-mode floor cleaning robot that uses RF modules for communication and supports manual keypad control. Jens Steffen Gutmann et al. introduced a robot that uses systematic mapping for cleaning, exploring the social implications of robotic cleaning aids. Other studies have developed
semi-automatic robots with obstacle avoidance and wet cleaning capabilities, emphasizing user convenience and cost efficiency. Despite technological advancements, issues like limited self-charging and navigation in complex indoor environments persist, justifying further innovation like Automop.

3. Methodology

The development of the Automop robot followed a structured methodology to ensure effective cleaning and reliable performance in both autonomous and manual modes.

- Requirement Analysis – Identified user needs and core functionalities such as obstacle avoidance, cleaning mechanism, voice commands, and mode switching.
- Component Selection – Chose components including Arduino Uno, ultrasonic sensors, Bluetooth module (HC-05), L298N motor driver, vacuum suction unit, and chassis.
- Hardware Integration – Assembled the robot by mounting sensors, motors, vacuum units, and other electronics onto the chassis. Connected all components to the Arduino controller.
- Software Development – Programmed the Arduino to execute autonomous navigation and receive Bluetooth commands from a mobile app. Voice

control was implemented using a voice recognition module.

• Testing and Optimization – Performed unit and integration tests, refined navigation logic, and ensured robust performance in different cleaning scenarios.

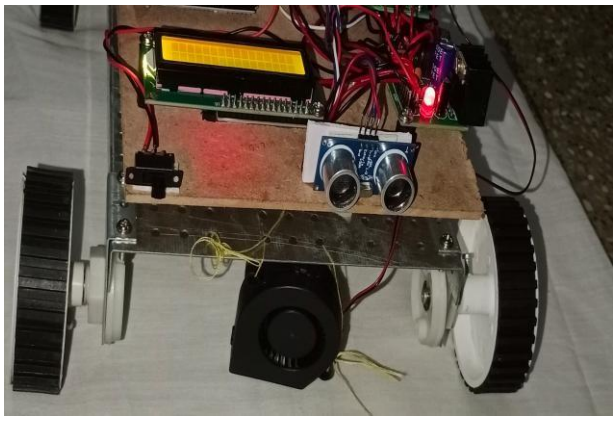

Fig 1: showing the initial hardware setup, including the ultrasonic sensor, Arduino, andother components.

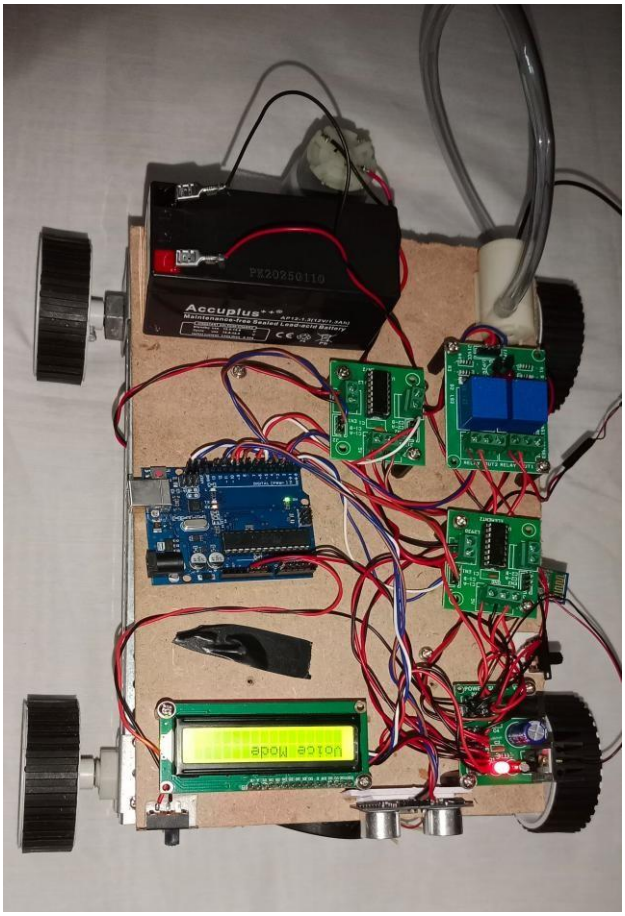

Fig 2: showing a more detailed view with additional components like the vacuum suctionunit, motor driver, and power supply.

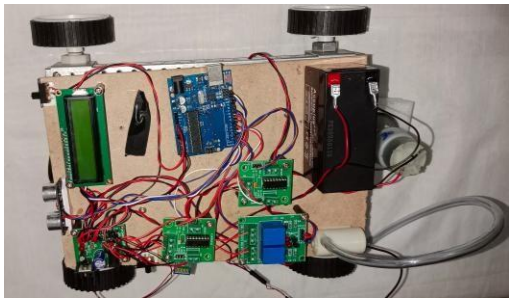

Fig 3: providing another perspective of the robotwith the integrated components, demonstrating the overall configuration.

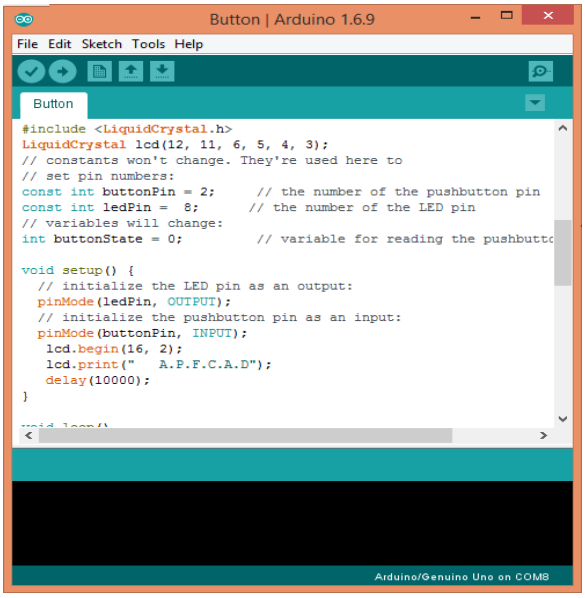

Fig 4: The main programming window of theArduino IDE.

Fig 5: Startup/Loading Screen of theAutomation App

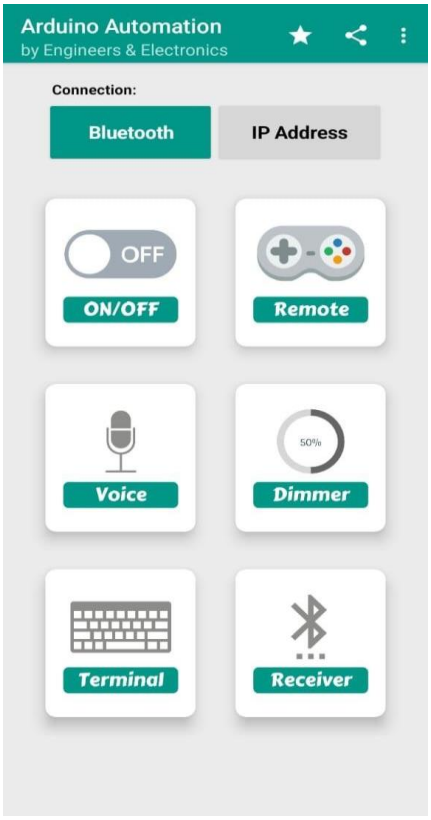

Fig 6: Home Interface of Automation Appshowing Multiple Control Options

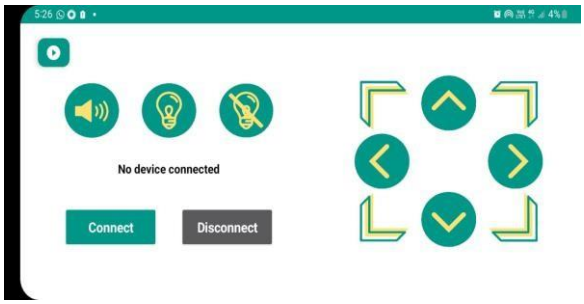

Fig 7: Remote Control Interface of AutomationApp (Device Control Panel with Navigation Buttons)

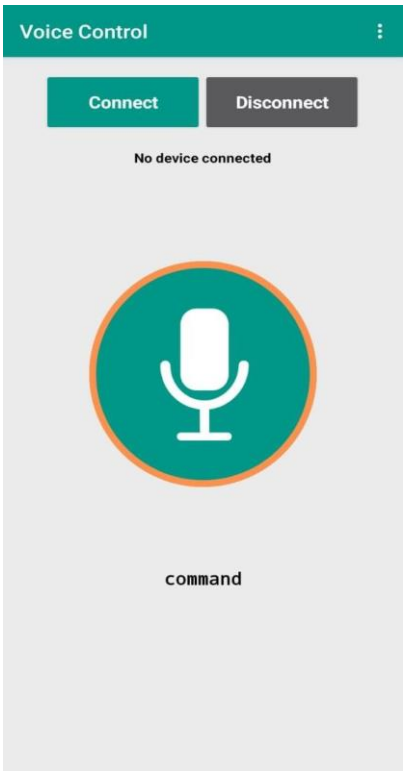

Fig 8: Voice Control Interface of AutomationApp (Microphone Command Mode)

Results and Discussion

The Automop robot was tested under multiple scenarios, including residential and semi- industrial settings. In manual mode, users successfully controlled the robot using a mobile app via Bluetooth. Switching to autonomous mode, the robot navigated in a preprogrammed S-pattern, avoiding obstacles using ultrasonic sensors. Both dry vacuuming and wet mopping functions were validated. The robot achieved an average cleaning efficiency of approximately 80%, which can be improved further with advanced mapping and suction mechanisms.

4. Advantages and Applications

- Autonomous and voice-based cleaning forhands-free operation.
- Dual-mode control increases flexibility andusability.
- Reduces manual labor in homes, offices, andindustries.
- Compact design allows cleaning underfurniture and tight spaces.
- Energy-efficient operation with minimalmaintenance.

5. Conclusion

The Automop project demonstrates a practical and affordable solution to automated floor cleaning. With dual cleaning modes, voice recognition, and effective navigation, it serves both domestic and light industrial purposes. The robot's compact form factor and ease of use make it suitable for various users. Further improvements can include AI-based navigation, self-charging capabilities, and multi-surface

adaptability, extending its scope andfunctionality.

6. Future Scope

Future iterations of Automop can benefit from integrating features such as AI-powered navigation, obstacle learning, and environment mapping. Additional modules like UV sterilization, GSM-based remote control, and solar charging can enhance the robot's utility. With such advancements, Automop could become a standard tool in automated facility management systems.

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