Floor Cleaning Robot with Android-Based Voice Command

S VAIRAPRAKASH
Associate Professor
Department of ECE
Ramco Institute of Technology
Rajapalayam, Tamil Nadu, India

MIDHUN V S
Department of ECE
Ramco Institute of Technology
Rajapalayam, Tamil Nadu, India
midhun890390@gmail.com

PONDURAI M
Department of ECE
Ramco Institute of Technology
Rajapalayam, Tamil Nadu, India
prenesh2304@gmail.com

Abstract— **The Voice-Controlled Floor Cleaning Robot with Android Application Integration introduces a novel solution for household cleaning tasks. Leveraging voice command technology and mobile connectivity, the work aims to transform floor cleaning in modern homes. Users can remotely control the robot via a dedicated Android application, eliminating manual intervention and saving time. Voice commands issued through the app are transmitted to the robot's microcontroller, enabling seamless execution of predefined functions. Equipped with sensors and navigation systems, the robot autonomously navigates, avoids obstacles, and optimizes cleaning patterns. This cutting-edge integration of voice command and mobile technology offers a streamlined and efficient solution for floor cleaning, setting new standards for smart home cleaning systems and enhancing user convenience and efficiency.**

Keywords— Floor Cleaning Robot, Voice-controlled, Android application, Obstacle avoidance, Remote access, Mobile connectivity, Cleaning functions, ESP32, WiFi

I. INTRODUCTION

In the era of smart technologies and automation, integrating robotics into household chores has become a focal point for innovation. This paper introduces a cutting-edge work: the Voice-Controlled Floor Cleaning Robot with Android Application Integration. Aimed at revolutionising the conventional approach to floor cleaning, this work leverages voice command technology and mobile connectivity to create a seamless and efficient cleaning experience for users. Traditional floor cleaning methods often demand considerable time and effort from individuals. The advent of robotics in this domain seeks to alleviate these challenges. Our work introduces a novel floor-cleaning robot that not only autonomously performs cleaning tasks but also responds to voice commands issued through a dedicated Android application. This integration of voice control technology enhances the user experience and introduces a level of remote accessibility that transcends the limitations of conventional cleaning methods. The core functionality of the robot is centred around a microcontroller unit, where received voice commands are interpreted as inbuilt functions. By allowing users to control the robot from their current location, we aim to eliminate the need for manual intervention and, consequently, redefine the concept of time spent on household chores. The system is designed to cater to diverse cleaning needs, incorporating sweeping, mopping, and vacuuming functions for various floor surfaces. This work represents a significant stride towards creating smart homes where automation and user-friendly interfaces converge. By integrating sensors and navigation systems, the robot ensures efficient movement and obstacle avoidance, promising both cleanliness and adaptability to different home environments. The subsequent sections of this paper will delve into the technical aspects, design considerations, and performance evaluations of this innovative Voice-Controlled Floor-Cleaning robot with Android Application Integration.

II. LITERATURE REVIEW

The Voice Controlled Robot (VCR) utilises voice commands received through a microphone, processed by a voice module, and transmitted via Zigbee to an ATmega 2560 development board. Servo motors execute actions based on recognised commands. The robot features a camera for live transmission and recording. The speech recognition circuit operates independently, preserving the main CPU's processing power. Software development is in Arduino IDE using Embedded C [1].

A floor cleaning robot was designed for autonomous and manual cleaning using a mobile application that was connected to Bluetooth of the robot's microcontroller. The movement input was given by the buttons that were pressed in the mobile application. When the forward button is pressed then the information is shared using Bluetooth technology to the microcontroller of the robot. According to the input, the floor cleaning robot works. For autonomous mode, there is a switch in the robot, which should be turned on manually [2].

A voice-controlled personal assistant robot that performs various tasks and communicates through speech output. It operates in real-time, using an offline server, and is built on a microcontroller platform. The robot's capabilities include movement, object relocation, and conversation with humans, showing promising results for applications in homes, hospitals, cars, and industries [3].

A goods-lifting robot for academic use, specifically for transporting books or files. The robot, controlled via smartphone, can lift up to 5 kg and navigate to specified locations. The control system, based on Arduino allows for voice commands and basic movements like forward, backward, left, and right turns [5].

A system for controlling a robot using human voice commands implemented through an Android app and a microcontroller. The system aims to enable basic robot movements through voice control, using an Arduino board and Bluetooth technology [6].

A vacuum cleaning cost-efficient robot that was designed to suck all waste and dust materials from the floor. The system consists of a circular robotic vacuum cleaner with ultrasonic sensors for navigation, controlled by a Raspberry Pi. It has manual control via a smartphone application and

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autonomous cleaning modes like random walk and snake algorithms for efficient room coverage [7].

III. PROPOSED SOLUTION

The purpose of this work is to build a cleaning robot that can be controlled using voice commands. Generally, these kinds of systems are known as Speech Controlled Automation Systems (SCAS). Our system will be a prototype of the same. We are not aiming to build a robot that can recognize a lot of words. A crucial aspect of the work is integrating voice command technology into the robot's control system. This involves implementing speech recognition algorithms and software that can accurately interpret and respond to user commands issued through the Android application as depicted in Fig 1. Another key component of the task is the development of the Android application that serves as the interface for controlling the robot. This involves designing and coding the application to facilitate communication between the user's smartphone or tablet and the robot's microcontroller unit.

The "voice command" feature integrated into the work is the primary method for users to interact with the floor-cleaning robot. Utilizing this feature, users can issue commands to the robot simply by speaking into the microphone of a connected Android application. These voice commands are then processed and interpreted by the robot's microcontroller unit, which subsequently triggers the corresponding predefined functions within the robot's programming. The implementation of voice command functionality adds a layer of convenience and accessibility to the cleaning process, allowing users to control the robot autonomously from their current location. Through the Android application, users can initiate cleaning tasks, pause or resume operations, adjust cleaning settings, and direct the robot to specific areas for targeted cleaning, all with simple voice commands.

To ensure accuracy and responsiveness, the voice command system incorporates advanced speech recognition technology, enabling the robot to interpret a wide range of voice inputs accurately. Additionally, the system may include natural language processing algorithms to enhance its ability to understand and respond to user commands conversationally. Overall, the voice command feature enhances the user experience by eliminating the need for manual intervention and providing a seamless and intuitive method for controlling the floor-cleaning robot. With this feature, users can effortlessly manage their cleaning tasks with minimal effort, ultimately saving time and enhancing the efficiency of their household cleaning routines. The block diagram of our design is displayed in Fig 2.

Several software and hardware implementation techniques were used to design and develop the system. Fig.3 shows the block diagram of the system. We used a 12VDC motor, L293D IC, Different Sensors, Real Time Clock, mobbing mechanism and ESP32 to develop our system. The user can activate the robot from wherever he\she is present at the current time. The robot can detect the obstacle in its path and change its direction with respect to the direction of the obstacle. The user can give a single command like ‘start’ so that the robot can clean the entire room by itself automatically and ‘stop’ to terminate the current task.

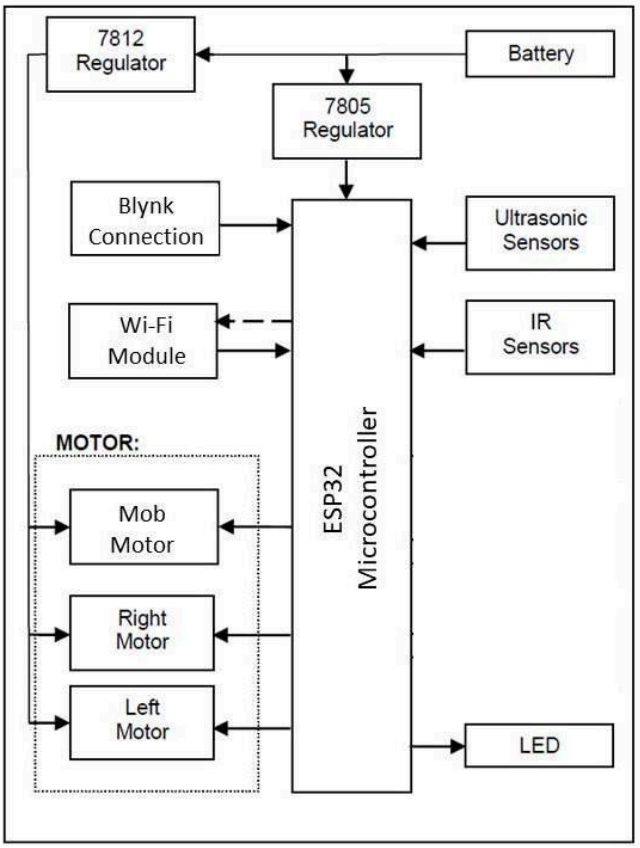

Fig 2: Block Diagram

The robot uses an ESP32 as the main controller, and a Blynk app to send commands to the robot via the Blynk cloud. The robot has two motors, one for each wheel, and a servo motor to rotate the Mob. ESP32 is the main controller for the robot. It runs the Blynk app and sends commands to the motor driver and servo motor. Blynk app is the smartphone app that you use to control the robot. It sends commands to the Blynk cloud, which then forwards them to the ESP32. Blynk Cloud is a cloud-based service that allows the Blynk app to communicate with the ESP32. A motor driver is an integrated circuit that controls the two motors of the robot. It takes signals from the ESP32 and uses them to control the speed and direction of the motors. A Servo motor is a motor that can rotate its output shaft to a specific position. It is used to rotate the "Mob" of the robot. 9V battery provides power to the ESP32 and the servo motor. The motor driver has its own separate power supply. The circuit diagram also shows a few other components, such as resistors, capacitors, and LEDs. These components are used to protect the circuit and provide feedback to the ESP32. Ultrasonic Sensor emits high-frequency sound waves and measure the time taken for their echo to return, thereby calculating the distance to nearby obstacles. This information is sent to the ESP32.

Overall, this circuit diagram shows a relatively simple robot that can be controlled by a smartphone app. With some additional programming, you could add more features to the robot, such as energy-efficient, outdoor spaces.

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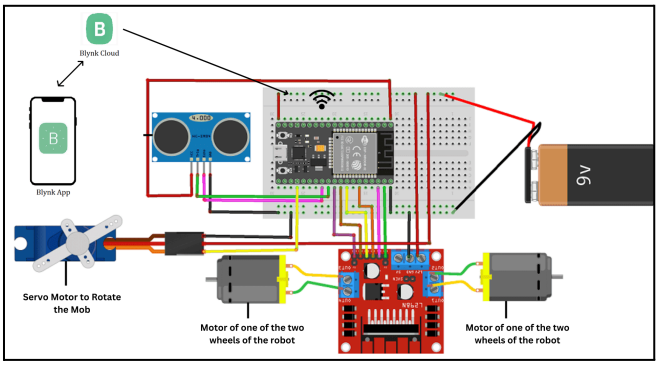

Fig 3: Circuit Diagram

The use of the house cleaning robot in this work is intended to streamline and simplify the process of floor cleaning in domestic environments. By incorporating advanced robotics technology and integrating voice command functionality via an Android application, the house cleaning robot offers numerous benefits and advantages to users:

1. **Efficiency:** The house cleaning robot automates the floor cleaning process, allowing users to achieve cleaner floors with minimal effort and time investment. By autonomously navigating through the cleaning area and performing designated cleaning tasks, the robot significantly reduces the time and energy required for manual cleaning.

2. **Convenience:** With the integration of voice command technology, users can control the house cleaning robot remotely from their smartphones or tablets using simple voice commands. This eliminates the need for direct physical interaction with the robot, providing users with greater convenience and flexibility in managing their cleaning tasks.

3. **Accessibility:** The use of voice commands makes the house-cleaning robot accessible to a wide range of users, including those with physical disabilities or mobility limitations. By offering a hands-free control interface, the robot ensures that individuals with diverse needs can easily and effectively utilise its cleaning capabilities.

4. **Versatility:** The house cleaning robot is designed to clean various types of floor surfaces, including hardwood, tile, laminate, and carpet. Equipped with advanced sensors and cleaning mechanisms, the robot can adapt to different environments and effectively remove dust, dirt, and debris from floors throughout the home.

5. **Maintenance:** Beyond cleaning, the house cleaning robot may also offer features for maintenance and monitoring. Users can receive notifications and alerts regarding the robot's battery status, cleaning progress, and any potential issues or errors, allowing for timely intervention and troubleshooting.

IV. RESULTS

The successful development and implementation of an autonomous floor-cleaning robot. This robot effectively reduces the time required for cleaning, alleviating the burden of physical labour, particularly for working mothers. Autonomously cleaning the entire area until instructed otherwise ensures thorough cleaning and allows users to focus on other tasks. Additionally, the robot's capability to clean various surfaces such as tiles and hardwood enhances its versatility and utility in different household settings. Overall, the implementation of the floor cleaning robot achieves its objectives of efficiency, convenience, and improved work-life balance for users, marking a significant advancement in home cleaning technology. The implementation of hardware is in progress, and the mobile application controls the robot using voice commands. The commands are shown in Table 1.

Input (Application)	Output (Robot)
Forward	Moves Forward
Back	Moves Backward
Right	Turns Right
Left	Turns Left
Clean	Rotates the Mob
Spray	Spray's Water
Start	Autonomous Cleaning
Stop	Ends the Current Task

Table 1: Voice Commands

The application features a single image button, depicting a microphone symbol, which serves as the gateway for users to interact with the robot using their voice. Upon pressing the microphone button within the application, the device's microphone is activated, allowing users to speak commands directly into their smartphone or tablet. The application leverages advanced speech recognition technology to transcribe the user's voice accurately commands into text format. Once the speech recognition process is completed, the text-based commands are securely transmitted to a cloud-based server for further processing. The robot is shown in Fig 4.

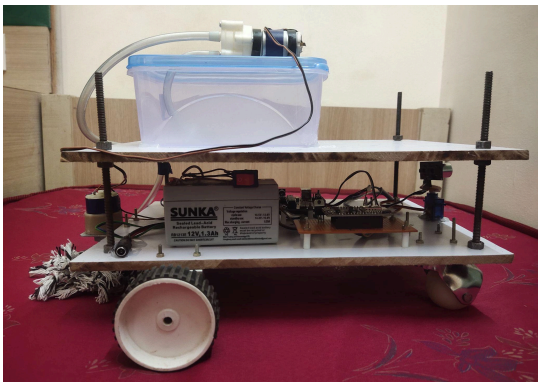

Fig 4: Cleaning Robot

The cloud server is the intermediary between the Android application and the floor-cleaning robot, facilitating real-time communication and command execution. By utilising cloud-based processing, the application ensures rapid response times and seamless connectivity between the user's device and the robot. This cloud-based approach also offers scalability and flexibility, allowing for future enhancements and updates to be easily implemented without requiring modifications to the application itself.

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Overall, the Floor Cleaning Robot with Android-Based Voice Command application provides users with a user-friendly and intuitive interface for controlling the robot using voice commands. By simplifying the command input process and leveraging cloud-based technology, the application enhances the overall user experience and efficiency of the floor cleaning robot, paving the way for a smarter and more convenient cleaning solution in modern households. The Android application is shown in Fig 5.

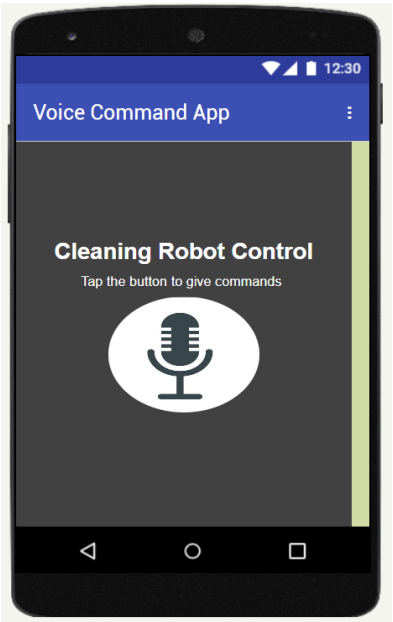

Fig 5: Android Application

V. CONCLUSION

The Voice-Controlled Floor Cleaning Robot with Android Application Integration represents a significant advancement in smart home cleaning technology. As we conclude this project, several avenues for future research and development present themselves, paving the way for even more efficient and versatile cleaning solutions.

1. Integration of advanced sensors, such as lidar or depth cameras, to improve obstacle detection and navigation in complex environments.

2. Development of self-diagnostic and maintenance features to detect and address issues autonomously, ensuring the robot's continued performance and longevity.

3. Research into developing robots capable of cleaning outdoor spaces, such as patios or driveways, by addressing challenges like uneven terrain and weather conditions.

4. Focus on designing energy-efficient cleaning robots with longer battery life or the ability to recharge, allowing for extended cleaning sessions without interruption autonomously.

In conclusion, the Voice-Controlled Floor Cleaning Robot with Android Application Integration represents a significant step forward in the realm of smart home cleaning technology. By combining voice command functionality with mobile connectivity, this project has demonstrated the potential to revolutionize the way floors are cleaned in modern homes. The seamless interaction between users and the robot enabled through the Android application, offers unprecedented convenience and efficiency, eliminating the need for manual intervention and saving valuable time.

Looking ahead, several exciting avenues for future research and development could further enhance the capabilities and utility of the robot. Integration of advanced sensors, such as LiDAR or depth cameras, holds promise for improving obstacle detection and navigation in complex environments, while the development of self-diagnostic and maintenance features could ensure the robot's continued performance and longevity with minimal user intervention.

Furthermore, expanding the robot's cleaning capabilities to include outdoor spaces presents an intriguing opportunity to address new challenges and cater to a wider range of cleaning needs. Research into energy efficiency and battery life optimization will also be crucial for extending the robot's operational duration and minimizing interruptions during cleaning sessions.

Ultimately, the ongoing evolution of the Voice-Controlled Floor Cleaning Robot promises to redefine the standards of cleanliness and convenience in modern households. By embracing innovation and exploring new possibilities, future iterations of the robot will continue to enhance the quality of life for users, making household cleaning tasks simpler, faster, and more enjoyable.

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