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Mechano Smart Floor Cleaning Robot

Akshay S. Dandwate, Nishant G. Dighe, Madhavi D. Dahiphale, Sagar P. Gunjal Prof.Takle V.B

Department of Electronic & Telecommunication Engineering, JSPM's Bhivrabai Sawant Polytechnic Wagholi,
Maharashtra, India

ABSTRACT: The Mechano Smart Floor Cleaning Robot is a low-cost autonomous indoor robotic system designed for dry dust collection and obstacle-aware navigation. The system integrates Arduino UNO Rev3 as the central controller, HC-SR04 for distance measurement, and L293D for bidirectional DC motor control. A rotating brush mechanism enables mechanical dust collection while the robot navigates.

The robot operates in two modes: automatic navigation using real-time obstacle detection and manual control via Bluetooth communication. The proposed system demonstrates practical implementation of embedded systems, sensor interfacing, motor driving techniques, and autonomous decision-making. Experimental evaluation confirms reliable obstacle detection, stable mobility, and effective cleaning performance on flat indoor surfaces.

KEYWORDS: Autonomous Robot, Embedded System, Floor Cleaning, Motor Driver, Obstacle Avoidance.

I. INTRODUCTION

Automation has significantly influenced domestic and industrial environments. Autonomous mobile robots are increasingly used in repetitive tasks such as surveillance, material handling, and cleaning. Floor cleaning is labor-intensive and time-consuming when performed manually.

Commercial robotic vacuum cleaners are available but often costly. Therefore, this project aims to design a cost-effective and educational prototype of a smart cleaning robot using embedded system principles.

The key objectives of this work are:

- Develop a low-cost cleaning robot
- Implement real-time obstacle detection
- Provide dual operation modes (Automatic & Manual)
- Demonstrate motor control using H-bridge driver
- Integrate mechanical dust collection mechanism

II. LITERATURE SURVEY

Autonomous floor cleaning robots have been extensively studied in the field of robotics and embedded systems. In earlier designs, cleaning robots operated using simple collision-based navigation methods, where the robot changed its direction after physically hitting an obstacle. Although these systems were economical and simple to design, they lacked intelligent path planning and resulted in inefficient cleaning coverage.

With advancements in sensor technology, researchers introduced sensor-based obstacle detection methods using ultrasonic and infrared sensors. Among these, ultrasonic sensors gained popularity due to their low cost, ease of interfacing with microcontrollers, and reliable short-distance measurement capability. These sensors enable robots to detect obstacles without physical contact, improving navigation safety and efficiency.

Microcontroller-based control systems, particularly using Arduino platforms, have been widely adopted in academic and prototype-level robotic applications. Motor driver ICs such as the L293D are commonly used to control DC motors in such systems. The L293D provides dual H-bridge functionality, allowing bidirectional control of motors along with speed regulation using PWM signals.

Recent research in robotic cleaning systems includes advanced navigation techniques such as SLAM (Simultaneous Localization and Mapping), vision-based detection, and LiDAR-based mapping. While these methods provide improved navigation accuracy, they significantly increase system cost and design complexity.

Based on the review of existing technologies, it is observed that there is a requirement for a simple, low-cost, and reliable cleaning robot suitable for educational and small-scale applications. The proposed Mechano Smart Floor Cleaning Robot addresses this requirement by implementing ultrasonic-based obstacle detection and embedded motor control to achieve efficient indoor cleaning with minimal complexity.

III. METHODOLOGY

The methodology adopted for the development of the mechano smart floor cleaning robot is based on the integration of sensing, control, and actuation mechanisms to achieve autonomous navigation and cleaning. The system is designed using a modular approach consisting of a sensing unit, processing unit, motor driving unit, and cleaning mechanism.

Initially, the ultrasonic sensor is interfaced with the arduino microcontroller to measure the distance between the robot and surrounding obstacles. The sensor operates on the echo time principle, where a sound pulse is transmitted and the reflected signal is received back. The microcontroller calculates the distance based on the time interval between transmission and reception of the echo signal. This measured distance is continuously monitored to ensure real-time obstacle detection.

The control algorithm is implemented within the arduino program. A predefined threshold distance is set to determine obstacle presence. When the measured distance is greater than the threshold value, the robot moves forward. If the detected distance is less than or equal to the threshold, the robot stops and changes its direction to avoid collision. This logic ensures safe and smooth navigation in indoor environments.

For motor control, the dc motors are interfaced through the l293d motor driver ic. The motor driver acts as an interface between the low-power control signals from the microcontroller and the higher current requirements of the motors. Direction control is achieved using digital logic signals, while speed control is implemented using pulse width modulation (pwm) technique.

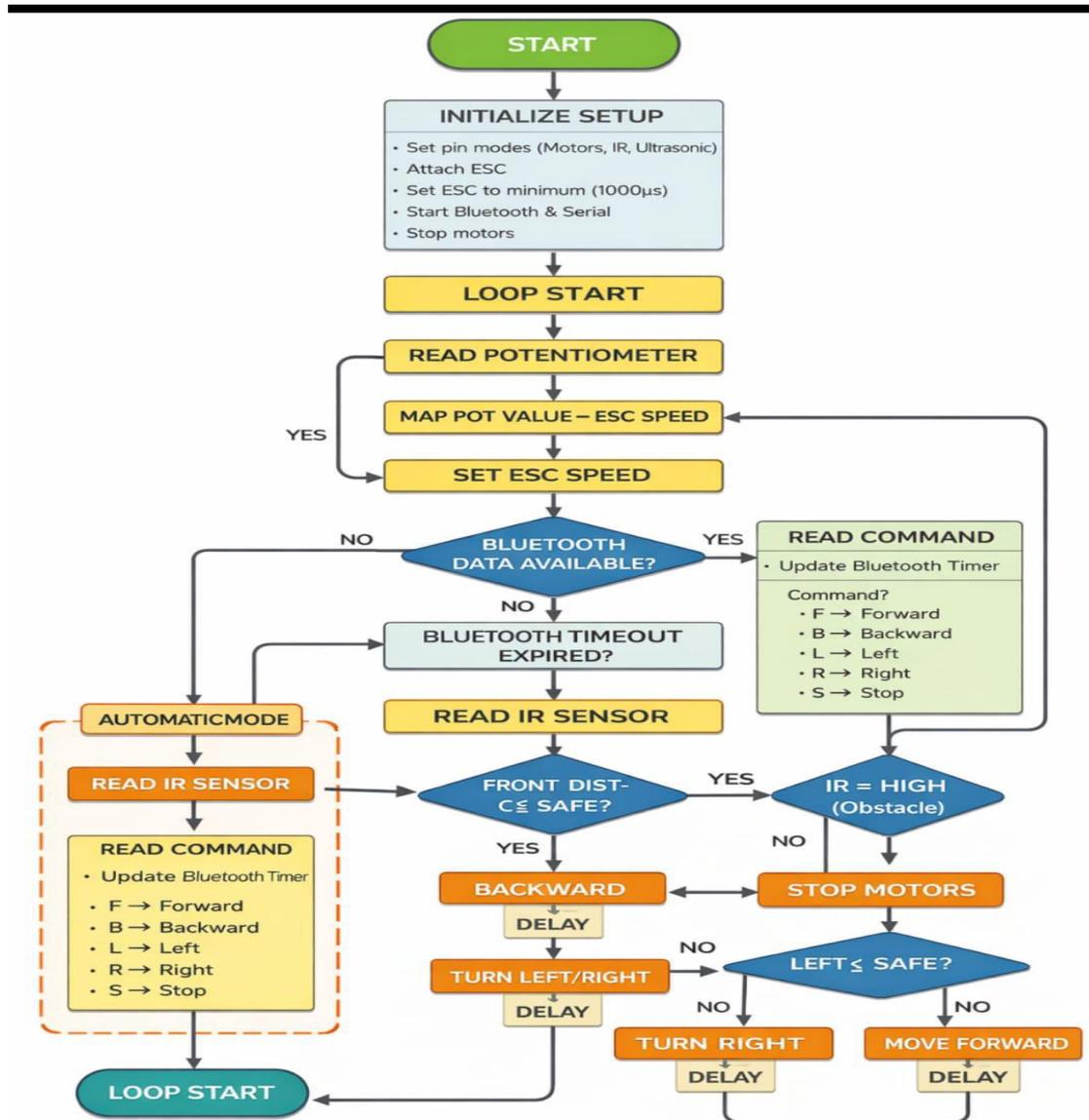
In addition to navigation, a rotating brush mechanism is installed at the base of the robot to collect dry dust and small particles. The brush motor operates continuously when the robot is in motion, ensuring simultaneous cleaning and movement.

The system also supports manual control mode using bluetooth communication. In this mode, directional commands are transmitted from a mobile device to the microcontroller, allowing the user to control the robot's movement directly. The entire methodology ensures a balance between simplicity, cost-effectiveness, and functional performance, making the proposed system suitable for academic and small-scale indoor cleaning applications.

BLOCK DIAGRAM



FLOW CHART



IV. EXPERIMENTAL RESULTS

The experimental testing of the Mechano Smart Floor Cleaning Robot was conducted in an indoor environment to evaluate its navigation and cleaning performance. The robot successfully detected obstacles and changed direction without collision. The motor driver L293D provided smooth motor control, and the cleaning mechanism effectively collected dry dust particles. The Bluetooth mode also worked properly within a short range.

Figure 1 shows the prototype model of the developed Smart Floor Cleaning Robot used during experimental testing.



Figure 1: Prototype of Mechano Smart Floor Cleaning Robot.

V. CONCLUSION

We have successfully designed and implemented the Mechano Smart Floor Cleaning Robot for autonomous indoor cleaning applications. Our system integrates ultrasonic sensing, microcontroller-based control logic, and motor driving mechanisms to achieve obstacle avoidance and efficient navigation. The robot successfully detects obstacles in real time and changes its direction automatically without collision. The DC motors are controlled effectively using the L293D, ensuring smooth movement and proper speed regulation.

We have tested the proposed system in different indoor environments and observed that it performs reliable obstacle detection and basic dry dust cleaning. The experimental results show that the robot operates efficiently in mixed indoor conditions consisting of furniture and other obstacles. Overall, the developed prototype demonstrates that a low-cost and compact smart cleaning robot can be successfully implemented using simple hardware components and embedded system techniques.

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