Automatic Floor Cleaner

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Abstract:

This research paper explores the creation of an Automatic Floor Cleaner designed to enhance cleanliness in both residential and commercial settings. Ensuring hygiene and safety in these spaces is critical, and this project introduces a robotic device to automate floor cleaning tasks. It is intended for both domestic and industrial use, cleaning surfaces autonomously once activated. The device consists of DC motors housed in a wheeled plastic container, equipped with a cleaning solution on top and a scrubber attached underneath, powered by one of the motors. The machine is user-friendly and easy to operate, utilizing a controller to drive the motors and sensors to avoid obstacles. Notable innovations include an energy-efficient pathfinding algorithm and a surface-adaptive cleaning mechanism suitable for various flooring types. This automated cleaner significantly reduces the need for manual labor, making it a practical solution for everyday cleaning needs.

Keywords: Automation, Floor Cleaning, Controllers, Sensors.

1. Introduction:

Technological advancements have revolutionized many aspects of daily life, including household chores. One significant development in this area is the introduction of robotic floor cleaners, which automate cleaning processes, providing users with convenience and efficiency. The proposed floor cleaner integrates ultrasonic and infrared sensors to detect and navigate around obstacles, ensuring comprehensive coverage of different floor types. Powered by a rechargeable battery, the device features a compact, modular design that allows for easy maintenance and operation in confined spaces. Key innovations include an optimized pathfinding algorithm to reduce energy consumption and a cleaning mechanism adaptable to various floor surfaces.

1.1 Need of Project:

The development of an Automatic Floor Cleaner is driven by the need for efficient, consistent cleaning solutions in both residential and commercial settings. Traditional cleaning methods can be labor-intensive and time-consuming, often yielding inconsistent results. With the growing emphasis on hygiene, particularly in response to global health concerns, there is an increasing demand for automated cleaning systems that can uphold high cleanliness standards with minimal human intervention. This project aims to create a robotic floor cleaner capable of navigating diverse surfaces, reducing the workload of cleaning personnel, and ensuring regular, reliable cleaning. As urbanization and busy lifestyles continue to rise, automated cleaning solutions are becoming essential for maintaining healthy living and working environments.

1.2 Objective:

The goal of the Automatic Floor Cleaner project is to design and develop a robotic cleaning device that can autonomously navigate and clean various floor surfaces with high efficiency and reliability. The system will incorporate advanced sensors and algorithms for obstacle detection, surface adaptability, and optimized pathfinding to ensure thorough and consistent cleaning. Additionally, the project seeks to minimize energy consumption and maintenance requirements, while providing a user-friendly interface for easy operation. The ultimate objective is to create a cost-effective and scalable solution that enhances cleanliness in residential, commercial, and public spaces, reducing the dependence on manual cleaning.

1.3 Scope of the project:

The scope of the Automatic Floor Cleaner project encompasses the design, development, and testing of a robotic cleaning device that autonomously navigates and cleans various floor surfaces. The project will involve selecting suitable components, programming navigation and obstacle detection algorithms, and optimizing cleaning efficiency. Testing will assess the device's performance on different surfaces and in diverse environments. The goal is to create a user-friendly, scalable, and cost-effective solution for both residential and commercial applications, with potential future enhancements such as remote control and smart home integration.

2. System Architecture:

2.1 Block diagram:

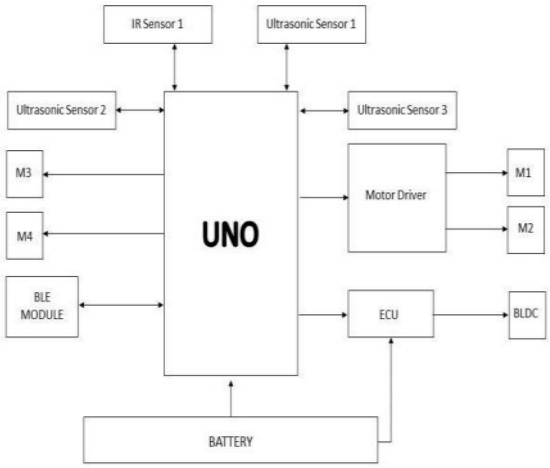

Fig. 1 - Block diagram

2.2 Hardware used:

- Arduino UNO
- HC-SR04 Ultrasonic Sensor
- L293D Motor Driver Board
- Geared Motors
- HC-05 Bluetooth Module

Arduino UNO:

The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller. It features digital and analog input/output (I/O) pins for interfacing with various expansion boards and circuits. The board includes 14 digital I/O pins (six with PWM output), six analog I/O pins, and is programmable via the Arduino IDE using a type B USB cable. It can be powered through a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a 9-volt battery. Unlike previous models, the Uno uses the Atmega8U2 microcontroller programmed as a USB-to-serial converter instead of the FTDI USB-to-serial driver chip.

Fig. 2 - Arduino UNO

HC-SR04 Ultrasonic Sensor:

The Ultrasonic Sensor is used to measure distance with high accuracy and stable readings, capable of measuring distances from 2cm to 400cm (1 inch to 13 feet). It emits an ultrasound wave at a frequency of 40KHz, which bounces back to the sensor if it encounters an object. The HC-SR04 utilizes non-contact ultrasound sonar for distance measurement, consisting of two ultrasonic transmitters, a receiver, and a control circuit. The sensor calculates the distance based on the time taken for the ultrasound wave to hit the object and return.

Fig. 3 - HC-SR04 Ultrasonic Sensor

L293D motor driver board:

The L293D motor driver simplifies interfacing for embedded applications, mounted on a quality, single-sided PCB. The IC's pins are connected to accessible connectors, providing easy access to its functions. The L293D is a Dual Full Bridge driver capable of driving up to 1 Amp per bridge, with a supply voltage of up to 24V. It can control two DC motors, relays, solenoids, and more, with the option to connect two H-bridges in parallel to increase its current capacity to 2 Amps.

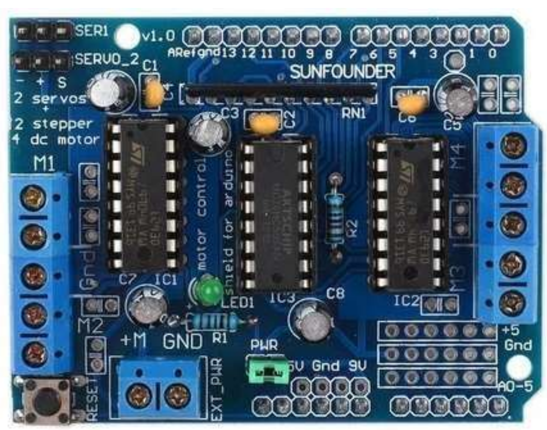

Fig. 4 - L293D motor driver board

Geared Motors:

A battery-operated DC gear motor is a compact electric motor combined with a gearbox, designed for portable applications. Powered by batteries, it offers flexibility and mobility, making it ideal for robotics, toys, and other portable devices.

Key components include a DC motor and a gearbox. The gearbox reduces motor speed while increasing torque. DC motors convert electrical energy into mechanical energy. This lightweight motor delivers substantial torque and speed at lower voltages, making it suitable for battery-powered robots. It can operate at approximately 200 RPM on a single Li-ion cell and can be reversed for bidirectional movement.

Fig. 5 – Battery operated DC motor

HC-05 Bluetooth Module:

The HC-05 Bluetooth Module facilitates wireless communication between devices, using the UART/TTL interface. It supports both master and slave modes, enabling secure and efficient data transfer with a range of up to 30 meters, making it ideal for wireless control in robotic applications.

Fig. 6 – HC-05 Bluetooth module

3. Methodology:

3.1 Design and Development:

This autonomous floor cleaner is a smartphone-controlled robot designed to efficiently scrub your floors. Equipped with rotating mops and a foam roller, the cleaner effectively removes dirt and grime. A built-in water pump and reservoir allow for damp mopping when needed, while the movable foam roller provides flexibility. Adjustable speed controls optimize cleaning performance.

The robot operates via Bluetooth communication with an Arduino UNO microcontroller. Powered by a 12V lead-acid battery, it utilizes 100rpm driver motors and 75rpm mop motors configured in a parallel, counter-rotating setup. For secure connections, heat shrink tubing is used to protect soldered motor wires to the transistor circuit. The water pump is wired similarly. The 12V battery directly supplies power to the transistor circuit, Arduino, and motor driver. Transistor control for mops and pump is linked to Arduino pins D5 and D4 respectively. All motor grounds connect to Arduino ground.

An L293D driver with H-bridge configuration enables omnidirectional movement. Ultrasonic sensors (HC-SR04) provide obstacle detection and drop prevention, enhancing safety and navigation. This cost-effective, eco-friendly robot offers convenience and time-saving benefits.

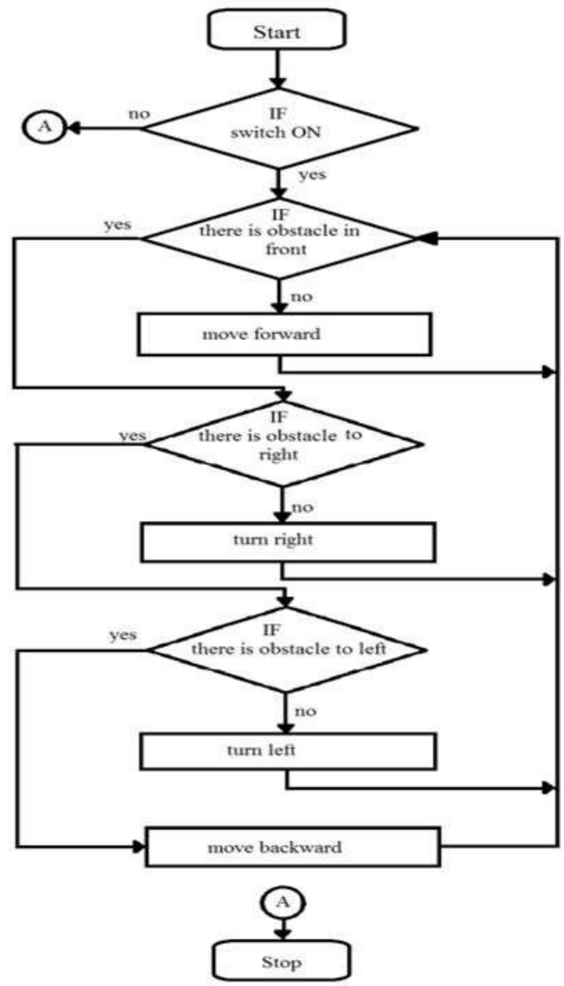

Fig. 7 – Flow Chart

3.2 Software and Algorithm:

The Arduino software (IDE) is used to program the Arduino boards. This open-source environment supports C/C++ programming and is compatible with Windows, Linux, and Mac OS X. The code written in the IDE is processed and compiled to machine language, allowing the Arduino to execute instructions and interact with connected devices.

4. Impact on Users and Society:

The integration of robotic floor cleaners into households is reflective of a broader trend towards home automation. As homes become smarter, the convenience offered by these devices is increasingly valued by users. For many, particularly those with busy schedules, robotic floor cleaners provide a way to maintain cleanliness without dedicating time to manual cleaning.

Moreover, the adoption of these devices is gradually changing attitudes towards home maintenance. Users are becoming more accustomed to the idea of systematic cleaning managed by a robot, which in turn is influencing lifestyle patterns. The presence of a robotic cleaner allows users to allocate their time to other activities, potentially improving their quality of life. Despite being a relatively new market, the growth and adoption of domestic robots are predicted to increase, signaling a shift in how households approach cleaning.

5. Conclusion:

Robotic floor cleaners represent a significant step towards automating household chores, offering both convenience and efficiency. The evolution of these devices, from simple vacuuming robots to more sophisticated systems capable of mopping and disinfecting, highlights the potential of this technology to transform home environments. As the market matures, further advancements are expected to address current limitations, making robotic floor cleaners an integral part of modern households. The ongoing adoption of these devices will likely continue to shape user lifestyles and attitudes toward home maintenance.

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