

Robotic Vacuum Cleaner using Arduino Microcontroller based System

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Abstract— In the current hectic schedule, cleaning houses and surrounding environment is more arduous. At present, there are vacuum cleaners which require humans to handle it. Manual work is taken over the robot technology and many of the related robot appliances are being used extensively also. Here represents the technology that proposed the working of robot for Floor cleaning. Thus, there is a dire need to implement vacuum cleaner which works without human intervention. An efficient method to clean the desired area has been implemented through this project. In a present-day situation, people are so occupied with their work that they often lack the capacity to properly clean their homes. The solution to this problem is a home vacuum cleaner robot, such as iRobot Roomba, which can clean the house with the press of a button. However, commercial products often share a common issue, which is cost. Today, a team has decided to create a simple floor cleaner robot. The new Arduino Vacuum Cleaner that we will create is expected to be cost-effective and practical. The advancement of robotics and automation has revolutionized various aspects of everyday life, including household chores. One such innovation is the development of a robotic vacuum cleaner, which autonomously navigates through indoor spaces, detecting and cleaning dirt and debris. This project focuses on designing and implementing a robotic vacuum cleaner using Arduino microcontroller technology. This project aims to demonstrate the feasibility of building an affordable robotic vacuum cleaner using readily available components and Arduino programming. The outcomes include a functional prototype capable of autonomously cleaning floors, contributing to the advancement of home automation technologies.

Index Terms— Arduino microcontroller, Robotic vacuum cleaner, Home automation, Obstacle detection, Path planning, Autonomous navigation, Sensors, Actuators, Cost-effective solution, Smart home technology, Wireless control, Machine learning, Cleaning efficiency, Microcontroller-based system, Robotics and automation

I. INTRODUCTION

For many people, returning home after a stressful day at work to a relaxing evening can be a major relief. However,

the realization that they have chores to do, such as cleaning, can be daunting. Cleaning is a necessary requirement for personal hygiene, especially for those with dust allergies and illnesses like asthma. In recent years, the field of robotics has witnessed remarkable advancements, leading to the development of autonomous systems that can perform tasks traditionally handled by humans. One prominent example is the robotic vacuum cleaner, which exemplifies the integration of robotics and home automation technology. These devices have gained popularity for their ability to autonomously navigate indoor spaces, detect obstacles, and clean floors without human intervention.

The robotic vacuum cleaner operates by incorporating various sensors for environmental perception, such as ultrasonic sensors for detecting obstacles and edge sensors to prevent falls. These sensors enable the robot to navigate intelligently around furniture and other obstacles, ensuring efficient cleaning coverage. The software architecture of the system includes algorithms for path planning, obstacle avoidance, and cleaning pattern optimization. These algorithms are crucial for enabling the robot to navigate smoothly through complex environments and ensure thorough cleaning of the designated area.

D.C. Patel et.al., [15] In this paper the Indigenous vacuum tunnel made with 18,000 rpm DC motor is sufficient to vacuum small objects for commercial cleaning purpose. The indigenous wiper system made with Teflon bevel gears is strong enough to wipe the floor. The indigenous Arduino logic programme for working of limit switch, infrared sensor and drive motors is sufficient to turn smart vacuum cleaner in commercial floor by developing arbitrary path and cover all the floor area. The developed AI vacuum cleaner is highly cost effective compared to commercially available smart vacuum cleaners.

Pawan kumar Ramkisoon et.al., [2] In this journal, the design and implementation of a smart, autonomous cleaning and mopping robot is presented. The system is powered by a rechargeable dc Lithium Polymer battery of 12 V. The Arduino Mega board is used in this project due to its large number of GPIO pins and a better flash memory storage of 256 kB, compared to other Arduino based microcontrollers. The range of the wireless control is 10 meters. It is observed that the system performs the desired task successfully and works both on an autonomous mode or application-controlled mode.

S Yatmono et.al., [11] The hardware for a floor cleaning robot is made up of several mechanical and robot control parts, and Android application software serves as the robot motion controller. The hardware for controlling the robot is divided into two master and slave subsystems, each of which has an Arduino control module, input sensors, and motor drivers. The master block controls the motor wheel, and the slave block controls the cleaning and polishing motor. The performance of Android as a manual robot controller can work in accordance with the buttons. The ultrasonic sensor robot can avoid obstacles with an object distance of less than 15 cm when operating in automatic mode. Floor cleaning performance for various types of dusty dirt, fine sand, pieces of paper and fur carpet shows that the remaining less than 20% of the dirt on the floor.

II. PROBLEM DEFINITION AND REQUIREMENTS GATHERING

Define the scope and objectives of the project, including the desired functionalities and performance metrics (e.g., cleaning efficiency, navigation accuracy) & gather requirements based on user needs and environmental considerations (e.g., size of the robot, types of surfaces to clean) [1].

III. HARDWARE SELECTION AND DESIGN

Choose appropriate hardware components, focusing on compatibility with Arduino microcontrollers. This includes:

Arduino board (e.g., Arduino Uno, Arduino Mega) for central control.

Sensors such as ultrasonic sensors (for obstacle detection), edge sensors (for detecting stairs).

Power supply (battery or external power source).

IV. SOFTWARE DEVELOPMENT

Develop the firmware and software for the Arduino microcontroller

Implement control algorithms for motor speed and direction (for movement and steering).

Write code for sensor data acquisition and processing (e.g., obstacle detection, edge detection).

Implement safety features to prevent collisions and falls (e.g., emergency stop mechanism).

V. INTEGRATION AND ASSEMBLY

Assemble the hardware components into a functional robotic vacuum cleaner prototype.

Connect sensors, actuators, and other modules to the Arduino microcontroller.
Ensure proper wiring and connections to facilitate communication and control between components.

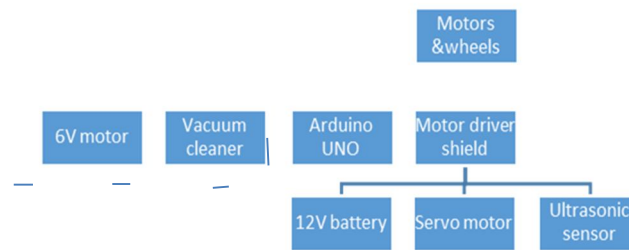


Fig. 1: Overall block diagram of the proposed system

(Hardware/software) – Arduino UNO, Arduino motor shield, gear motor, wheels, lithium ion battery, 6V motor, ultrasonic sensor, servomotor, fan [2].

VI. HARDWARE

Here, we describe the complete hardware of the system [3].

VII. ARDUINO UNO

Arduino UNO serves as the main controller of the robotic vacuum cleaner. It coordinates all the activities of the robot, including sensor data processing, decision-making algorithms, and motor control [4].

VIII. ARDUINO MOTOR SHIELD

It drives the DC motor after the Arduino Uno microcontroller processes the ultrasonic sensor as a distance detector and a DC motor as a robot driver [5].

IX. ULTRASONIC SENSOR

To recognize the obstructions, we are utilizing the famous HC-SR04 ultrasonic distance sensor or we can call it the hindrance evasion sensors [6].

X. SERVO MOTOR

Servo motors can be used to control the steering mechanism of the robotic vacuum cleaner. By attaching a servo motor to the front wheels or a swivel caster, the robot can adjust its direction to navigate around obstacles and follow cleaning paths more accurately [7].

XI. LITHIUM ION BATTERY

Li-ion batteries are well-suited for powering robotic vacuum cleaners using Arduino due to their high energy density, long cycle life, fast charging capability, compact size, and safety features. These characteristics contribute to the efficient and reliable operation of the robotic vacuum cleaner in a variety of indoor environments [8].

XII. SOFTWARE

Here, we describe the complete software of the system [9].

XIII. ARDUINO IDE

Arduino IDE serves as a comprehensive development environment for creating, testing, and deploying the firmware that controls the behavior of a robotic vacuum cleaner using Arduino. Its simplicity, extensive library support, debugging tools, and community engagement make it an invaluable tool in the development toolkit for robotics enthusiasts and professionals alike. The Fig. 2 gives the flow-chart for the proposed system, whereas the Fig. 1 gives the overall block-diagram of the proposed system [10].

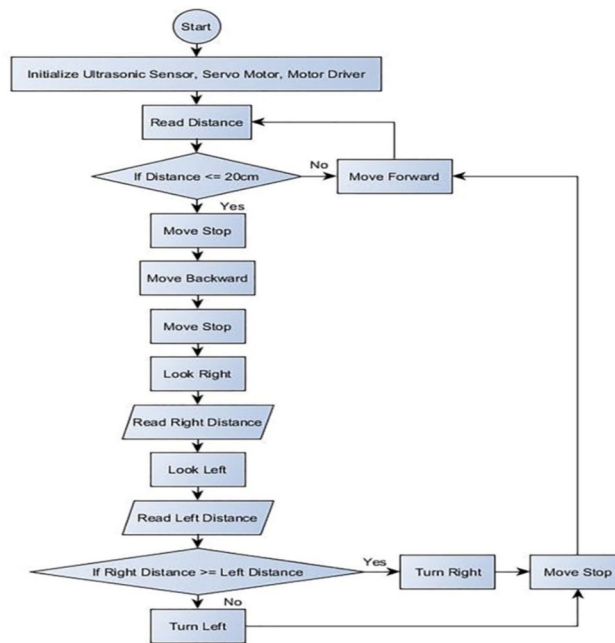


Fig. 2 : Flow-chart of the proposed system

The outcome of developing a robotic vacuum cleaner using Arduino are

XIV. FUNCTIONAL PROTOTYPE [11]-[15]

The primary outcome is a fully functional robotic vacuum cleaner prototype capable of autonomously navigating indoor environments, detecting obstacles, and efficiently cleaning floors.

XV. EFFICIENT CLEANING PERFORMANCE [15]-[20]

The robotic vacuum cleaner prototype showcases effective cleaning performance through optimized cleaning patterns and thorough coverage of designated areas. It demonstrates the capability to adapt to different floor types and navigate around furniture and obstacle.

XVI. USER INTERACTION AND INTERFACE [21]-[24]

The outcome includes a user-friendly interface that allows for easy monitoring of the cleaning process, manual control options, and possibly scheduling features. This enhances user experience and accessibility, making the robotic vacuum cleaner practical for everyday use in household settings.

XVII. INNOVATION AND CUSTOMIZATION [25]-[30]

The project outcome encourages innovation and customization. Builders can experiment with different sensors, algorithms, and hardware configurations to improve performance, add new features (e.g., WiFi connectivity, voice control), or adapt the design to specific user preferences or environmental challenges.

XVIII. APPLICATIONS [31]-[34]

Cleaning the dry floors

A floor cleaning assistant at home and offices

Can clean the inaccessible areas like underneath of sofas bed and table.

Small particles and can be picked up efficiently.

XIX. ADVANTAGES [35]-[38]

- *Cost-effective*: Arduino-based smart vacuum cleaners are relatively inexpensive compared to commercially available vacuum cleaners, making it a cost-effective option for those on a budget.
- *Customizable*: Arduino provides a platform for developers to customize their smart vacuum cleaner, allowing them to add features that meet their specific needs.

- *User-friendly*: Arduino's programming environment is user-friendly, making it easier for non-programmers to create their own smart vacuum cleaner.
- *Scalability*: The modular design of Arduino boards allows users to easily upgrade or add new features to their smart vacuum cleaner as needed.
- *Flexibility*: With an Arduino-based smart vacuum cleaner, users can choose to use different sensors, motors, and other components, allowing for greater flexibility in terms of design and functionality.
- *Real-time monitoring*: The smart vacuum cleaner can be equipped with sensors to monitor its environment in real-time, providing data on the level of dirt and dust in the environment.
- *Efficient cleaning*: An Arduino-based smart vacuum cleaner can be programmed to optimize its cleaning patterns, making it more efficient in terms of cleaning time and energy consumption.

XX. CONCLUSIONS

The project on the development of a Robotic Vacuum Cleaner using an Arduino Microcontroller Based System successfully demonstrates the integration of robotics and automation to create an efficient, cost-effective solution for home cleaning. The design leverages the versatility of the Arduino platform, coupled with various sensors and actuators, to navigate and clean an area autonomously. The implemented algorithms for obstacle detection, path planning, and cleaning efficiency have proven to be effective in achieving the desired functionality. This project not only highlights the potential of microcontroller-based systems in everyday applications but also opens avenues for further enhancements such as incorporating advanced features like wireless control, machine learning for better navigation, and improved suction mechanisms. The robotic vacuum cleaner thus represents a significant step towards smart home automation, offering convenience and ease of use for users.

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