Volume 10, Issue 7, July – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul791

Smart Vacuum Cleaner Using Arduino

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Publication Date: 2025/07/19

Abstract: The increasing demand for automated cleaning solutions has led to the development of smart vacuum systems that can operate autonomously in indoor environments. This paper presents the design and implementation of a cost-effective smart vacuum cleaner powered by non-rechargeable batteries, controlled by an Arduino-based microcontroller system. The primary aim is to demonstrate an efficient cleaning mechanism suitable for small-scale applications, such as domestic or academic use, without the added complexity of rechargeable battery management.

The proposed system integrates key components such as DC motors for mobility and suction, ultrasonic sensors for obstacle detection, and an Arduino Uno for centralized control. A motor driver module enables precise control of the drive motors, allowing the robot to navigate and clean autonomously within a defined area. The vacuum's behavior is guided by a programmed pathfinding and collision-avoidance algorithm, making it capable of operating with minimal human intervention.

Although the use of non-rechargeable power sources limits long-term deployment, this design offers significant advantages in terms of simplicity, cost, and ease of implementation. The system is particularly well-suited for educational demonstrations, prototype development, and disposable-use scenarios where short-duration operation is sufficient. The project illustrates the potential for creating low-cost, intelligent cleaning robots using open-source electronics and accessible components.

How to Cite: Uzma Satteekar; Malikanaaz Kolhar; Suhana Begum Togari; Sneha Chavan (2025) Smart Vacuum Cleaner Using Arduino. *International Journal of Innovative Science and Research Technology,* 10(7), 1217-1219. https://doi.org/10.38124/ijisrt/25jul791

I. INTRODUCTION

With the rise of smart homes and autonomous systems, robotic vacuum cleaners have become a popular household appliance. However, many of these systems involve complex circuitry, high costs, and require rechargeable power sources. This project explores a simplified version of the robotic vacuum cleaner using non-rechargeable batteries and an Arduino microcontroller. The goal is to design a low-cost, portable, and functional cleaning system suitable for short-term or demonstration purposes, especially in academic or rural settings with limited access to advanced electronics.

II. OBJECTIVES

- To develop a smart vacuum cleaner that uses non-rechargeable batteries for power.
- To control the system using an Arduino Uno microcontroller.
- To integrate obstacle detection using ultrasonic or IR sensors.
- To implement autonomous navigation and cleaning logic.
- To provide a low-cost prototype suitable for educational or experimental use

III. COMPONENTS REQUIRED

Table 1 Components Required

Component	Specification
Arduino Uno	ATmega328P microcontroller
DC Motors	6V geared motors for wheels
Motor Driver Module	L298N or similar
Vacuum Fan Motor	6V or 12V mini blower
Ultrasonic Sensor	HC-SR04

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Component	Specification
Wheels and Chassis	2-wheel robot base
Battery Pack	AA/9V non-rechargeable batteries
Jumper Wires	Male-to-male, male-to-female
Switch	ON/OFF toggle switch
Breadboard	Mini-size

IV. METHODOLOGY

The design involves assembling a two-wheeled robot with a suction fan. The Arduino Uno acts as the control unit. Two DC motors provide movement, while an additional motor powers the suction fan. Ultrasonic sensors are mounted at the front to detect obstacles. The motor driver receives commands from the Arduino to control both driving and fan motors. A simple logic is programmed to allow the robot to move forward, stop when obstacles are detected, reverse, and turn to find a new direction.

V. WORKING PRINCIPLE

- The system is powered by non-rechargeable batteries connected through a switch.
- When turned on, the Arduino continuously receives data from the ultrasonic sensor.
- If no obstacle is detected within a certain distance, the vacuum moves forward.
- If an obstacle is detected, it stops, reverses briefly, and changes direction.
- The fan motor runs continuously while the system is powered, collecting dust through a suction pipe or hole at the bottom.

VI. CIRCUIT DIAGRAM

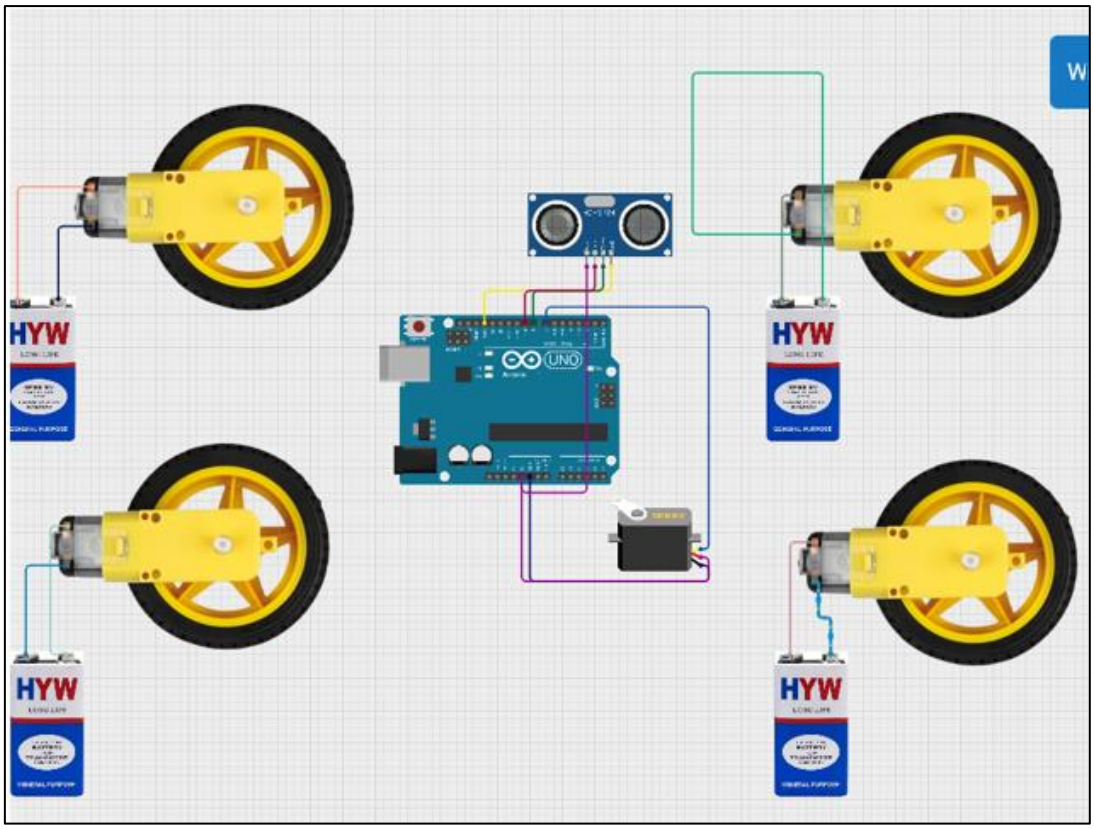

Fig 1 Circuit Diagram

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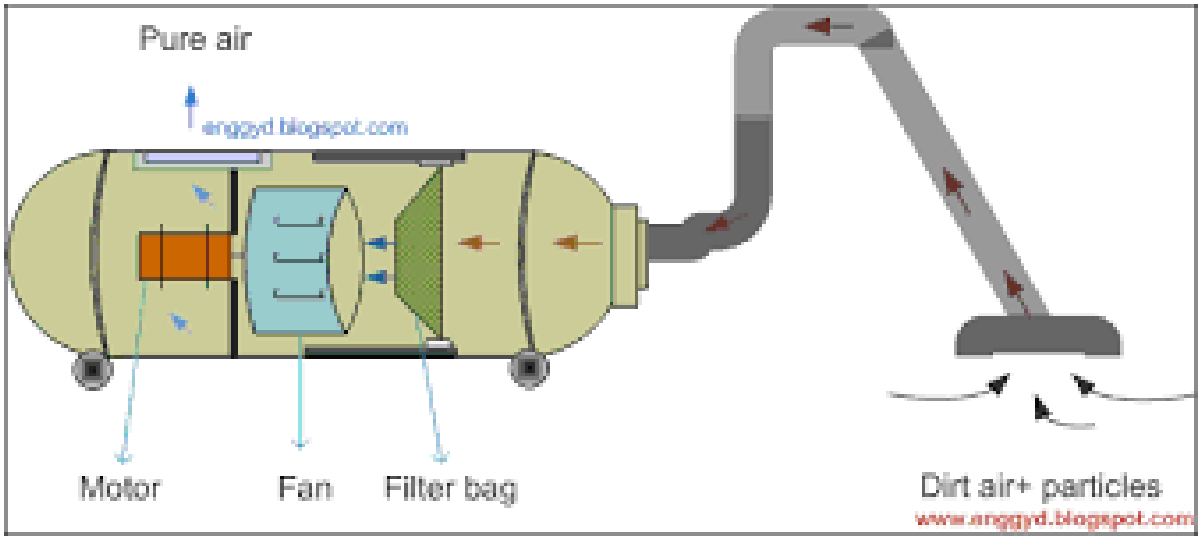

Fig 2 Vacuum Cleaner Circuit

VII. ADVANTAGES

- Low cost and easy to build
- Ideal for educational use and demonstrations
- Simple design and lightweight
- Can be deployed in remote areas without access to charging facilities

VIII. LIMITATIONS

- Short operational time due to non-rechargeable batteries
- Limited suction power
- Lacks advanced mapping or path optimization
- Not suitable for continuous or large-scale cleaning

IX. APPLICATIONS

- Educational robotics and embedded system training
- Demonstration of autonomous cleaning concepts
- Use in temporary or emergency cleaning situations
- Disposable-use systems in restricted environments

X. CONCLUSION

The proposed smart vacuum cleaner demonstrates a simplified and cost-effective approach to autonomous cleaning using readily available components and non-rechargeable power sources. While it does not replace commercial robotic cleaners, it serves as an excellent platform for learning and prototyping in low-resource settings. Future work could involve replacing the power source with solar cells or hybrid systems and adding Bluetooth or Wi-Fi for remote control.

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