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# Design and Development of a Solar-Powered Vacuum and Wet Cleaning Robot using Arduino UNO

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**ABSTRACT**

In today's day and time, it is difficult to find the time to clean our homes by ourselves. It is even more difficult to do so with conventional cleaning methods. This is where vacuum cleaners come to our aid to provide an efficient way to keep our surroundings clean, with the help of motors and filters that can pull up any kind of dirt and dust. In this paper, we present the design and implementation of a dual-function cleaning robot, which functions both as a vacuum cleaner and a wet floor cleaner. The robot is powered by a solar panel and is equipped with an Arduino UNO, a motor driver shield, and DC motors. An ultrasonic sensor was also integrated for obstacle detection. The vacuum function employs suction to remove dust and debris from floors, while the wet floor cleaning function uses wipers and a small pump to dispense water and clean the surface. This paper outlines the components, design considerations, and testing results for this innovative and eco-friendly cleaning solution.

**Keywords:** Solar panel, vacuum and wet cleaner, sensor, obstacle detection, eco-friendly.

## 1. INTRODUCTION

As technology advances, there has been a growing interest in developing environmentally friendly and autonomous cleaning solutions. This has led to the development of cleaning robots, which have become increasingly popular in recent years. The aim of this project is to design and implement a dual-function cleaning robot that combines the functions of a vacuum cleaner and a wet floor cleaner, powered by solar energy. However, most of these robots rely on battery power and need to be charged frequently, which can be inconvenient for users. This thesis explores the design and development of a solar-powered vacuum and wet cleaning robot that utilizes solar energy as its primary power source.

The use of solar energy as a power source for robots has been a topic of research for several decades. However, most of the existing research has focused on outdoor robots and solar-powered vehicles. The idea of using solar energy to power household cleaning robots is relatively new. By utilizing solar power, the robot can be more environmentally friendly and reduce the need for frequent charging. In this project, the following components have been used to design the robot.

- Arduino UNO Microcontroller: The Arduino UNO microcontroller is a versatile and programmable device that serves as the brain of the robot. It controls all the other components, including the DC motors and the ultrasonic sensor.
- Motor Driver Shield: The motor driver shield is an electronic device that provides an interface between the microcontroller and the DC motors. It allows the microcontroller to control the speed and direction of the motors.

- DC Motors: The DC motors are responsible for driving the movement of the robot and the cleaning functions. The vacuum function is driven by a DC motor that powers the suction, while the wet floor cleaning function is driven by DC motors that control the wipers and the water pump.
- Ultrasonic Sensor: The ultrasonic sensor is used for obstacle detection, allowing the robot to navigate around obstacles and avoid collisions.
- Solar Panel: The solar panel provides the power for the robot, eliminating the need for a power outlet or battery. This makes the robot environmentally friendly and cost-effective.

### 1.1 Methodology

The design of the solar-powered vacuum and wet cleaning robot was based on a commercially available vacuum cleaning robot. The robot was equipped with a solar panel and a battery system to store the energy generated by the solar panel. The robot was also equipped with a water tank and a spray nozzle to allow for wet cleaning capabilities. The battery system has been given an external port for recharging in the absence of solar energy.

In designing the dual-function cleaning robot, several considerations were taken into account, including the power consumption of the components, the weight of the robot, and the size of the cleaning head. The design was optimized for efficiency and ease of use, with a focus on achieving maximum cleaning performance.

## 2. WORKING PRINCIPLE

Vacuum Cleaners work using the Bernoulli's principle – as the speed of air increases, the pressure decreases. To try to balance out the pressure, the air always moves from high pressure area to low pressure area. The vacuum cleaner consists of two ports – the intake port and the exhaust port. The fan inside the vacuum cleaner pushes the air towards the exhaust port at very high speeds, lowering the pressure. This creates suction inside the vacuum cleaner as the air from outside rushes in to balance out the low pressure inside, bringing in dirt and dust with it.

The Arduino UNO is a microcontroller-based development board that works on the principle of digital and analog input/output (I/O) operations. It is based on the ATmega328P microcontroller, which is a low-power 8-bit microcontroller from Atmel (now owned by Microchip Technology). The working of Arduino UNO is discussed below.

- The Arduino UNO board contains a number of input/output (I/O) pins, which can be programmed to interact with various electronic components, such as sensors, actuators, and other devices.
- The microcontroller on the board is programmed using a computer, through the Arduino Integrated Development Environment (IDE). The user writes the code in a high-level language (such as C or C++), which is then compiled and uploaded to the microcontroller on the board.
- The microcontroller then executes the code, which determines how it interacts with the external components connected to the I/O pins.
- The microcontroller performs various operations, such as reading sensor data, controlling actuators, and processing data, based on the code it has been programmed with.
- The microcontroller can communicate with the computer or other devices through various communication protocols, such as USB, I2C, or SPI, allowing it to exchange data and commands.
- The microcontroller can also perform analog-to-digital conversions, which allows it to read and process analog signals from sensors. Similarly, it can perform digital-to-analog conversions, allowing it to control analog devices, such as motors or lights.

In summary, the working principle of the Arduino UNO is based on the interaction between the microcontroller, the code that has been programmed into it, and the external components connected to the I/O pins. The microcontroller processes the code, performs operations, and interacts with the external components to control and monitor various devices and systems.

### 2.1 Block diagram

The block diagram shown in Figure 1 is used to build solar powered vacuum and wet cleaning robot. The main component used in the project is the Arduino Uno microcontroller which is used to give commands to the rest of the structure such as moving, vacuuming, dispensing of water, etc.

As shown in the block diagram (Figure 1), the microcontroller is attached to an RC car which is fitted with wheels running on DC motors. A mop constructed with a wiper attached to a servo motor for rotatory functions and fitted with a water tank and a pump to dispense water is connected to the Arduino Uno microcontroller [3]. A vacuum cleaner is connected to the Arduino board to achieve the vacuuming function [1]. A GSM module is attached to the microcontroller to get updates on the status of the robot such as battery level, etc.

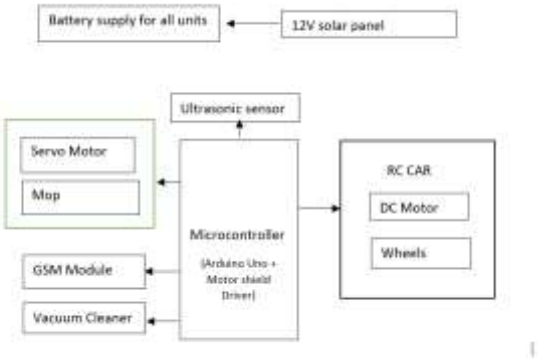



**Figure 1:** Block diagram for solar powered vacuum cleaner and floor cleaner Robot.

### 2.2 Hardware and Software

The hardware and software used in this project include an Arduino UNO, batteries, vacuum cleaner, DC motors, motor driver shield, ultrasonic sensor, wheels, diode, servo motor, GSM module, and the software Arduino IDE [2], [4]. These components work together to create a robotic vacuum cleaner that can navigate its environment and clean surfaces using its vacuum mechanism.

- Arduino UNO:

The Arduino UNO is a microcontroller board that serves as the brain of the robotic vacuum cleaner. It is responsible for controlling the other components and processing the data received from sensors. The Arduino UNO is programmed using the Arduino IDE software.

- Solar panel

The solar panel is used to convert solar energy into DC electricity which is then fed to the battery using a solar regulator. The purpose of the solar regulator is to make sure that the battery is not damaged and is charging properly. An inverter is used to convert the DC electricity into AC current of 240 volts.

- Batteries

Batteries provide the necessary power to run the robotic vacuum cleaner. They can be rechargeable or disposable, depending on the design. In this project, the batteries are used to power the DC motors and the servo motor.

- Vacuum cleaner

The vacuum cleaner is the primary cleaning mechanism of the robotic vacuum cleaner. It uses suction to pick up dust and debris from surfaces. In this project, the vacuum cleaner is attached to the robot and powered by a DC motor.

- DC motors

DC motors are used to power the wheels and the vacuum cleaner. They are controlled by the motor driver shield and receive commands from the Arduino UNO. The DC motors are responsible for the movement and cleaning actions of the robotic vacuum cleaner.

- Motor driver shield

The motor driver shield is an add-on board that is placed on top of the Arduino UNO. It provides the necessary circuitry to control the DC motors and protects the microcontroller from damage. The motor driver shield receives commands from the Arduino UNO and translates them into actions for the motors.

- Ultrasonic sensor

The ultrasonic sensor is used to detect obstacles in the environment. It sends out high-frequency sound waves and measures the time it takes for the waves to bounce back. The ultrasonic sensor is used by the robotic vacuum cleaner to avoid collisions and navigate around obstacles.

- Wheels

The wheels provide the necessary mobility for the robotic vacuum cleaner. They are powered by the DC motors and allow the robot to move in any direction. The wheels are attached to the chassis of the robot and provide traction for movement on various surfaces.

- Diode

A diode is a type of electronic component that allows electrical current to flow in only one direction. In this project, diodes are used to protect the electronic components from damage due to reverse voltage. They help ensure that the electronic components are protected from electrical damage during operation.

- Servo motor:

The servo motor is used to control the wiper in the wet cleaner. It is a type of motor that can rotate to a specific position and hold that position. The servo motor receives commands from the Arduino UNO and rotates the wiper accordingly.

- GSM module

The GSM module is a type of communication module that allows the robotic vacuum cleaner to communicate with the outside world using a cellular network. It can be used to send and receive text messages and make voice calls. In this project, the GSM module is used to remotely control the robotic vacuum cleaner and receive status updates.

- Arduino IDE

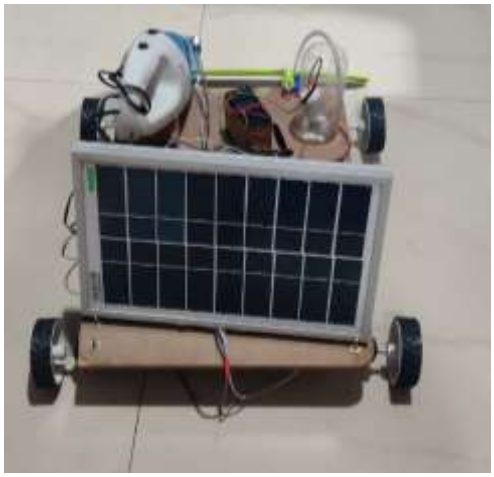
The Arduino Integrated Development Environment (IDE) is a software program used to write and upload code to the Arduino UNO. It provides a user-friendly interface for writing code and debugging, and allows the user to upload the code to the microcontroller board with a few clicks.

## 3. RESULTS AND DISCUSSIONS

The solar-powered vacuum and wet cleaning robot was able to navigate around the house to perform cleaning tasks. The solar panel was able to generate enough energy to power the robot for a few hours of cleaning. The water tank and spray nozzle are used to effectively clean surfaces. The dual-function cleaning robot was tested for its cleaning performance and obstacle detection capabilities. The performance of the working Robot used for both vacuum and wet floor cleaning functions is shown in figure 2 (a), (b) & (c). The ultrasonic sensor proved to be reliable in detecting obstacles, allowing the robot to navigate around them.

(a)

(b)



(c)

**Figure 2**: Prototype of Solar Powered vacuum cleaner and wet cleaner robot.

## 4. CONCLUSIONS

The solar-powered vacuum and wet cleaning robot is an innovative solution that utilizes solar energy as its primary power source. It has the potential to be more environmentally friendly and reduce the need for frequent charging. Further research and development are needed to improve the robot's efficiency and functionality. However, this thesis demonstrates the feasibility of using solar energy to power a household cleaning robot. In conclusion, the dual-function cleaning robot is a practical and innovative solution that combines the functions of a vacuum cleaner and a wet floor cleaner in a single device. By using solar power, the robot is environmentally friendly and cost-effective, making it an attractive option for cleaning homes and offices. Further development and testing are needed to refine the design and improve the performance of the robot.

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