AUTOMATIC VACCUM CLEANER WITH AIR QUALITY MONITORING

Submitted to

RCS Sastra

Submitted by

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PROBLEM STATEMENT:

In urban environments, indoor air quality can significantly impact the health and well-being of occupants. Traditional vacuum cleaners often contribute to indoor air pollution by stirring up dust and allergens during cleaning operations. Additionally, without real-time monitoring, occupants may be unaware of deteriorating air quality levels caused by dust and particulate matter accumulation.

To address these challenges, there is a need for an Automatic Vacuum Cleaner equipped with advanced sensors capable of not only efficiently cleaning indoor spaces but also monitoring air quality in real-time. Such a system would provide occupants with a healthier living environment by minimizing indoor air pollution and alerting them to potential air quality issues.

The key objectives of this project are:

- Designing and implementing an Automatic Vacuum Cleaner capable of autonomously cleaning indoor spaces.
- Integrating air quality monitoring sensors into the vacuum cleaner to measure particulate matter levels and other pollutants.
- Developing algorithms to analyze sensor data and provide real-time feedback on air quality status.

REAL LIFE APPLICATIONS:

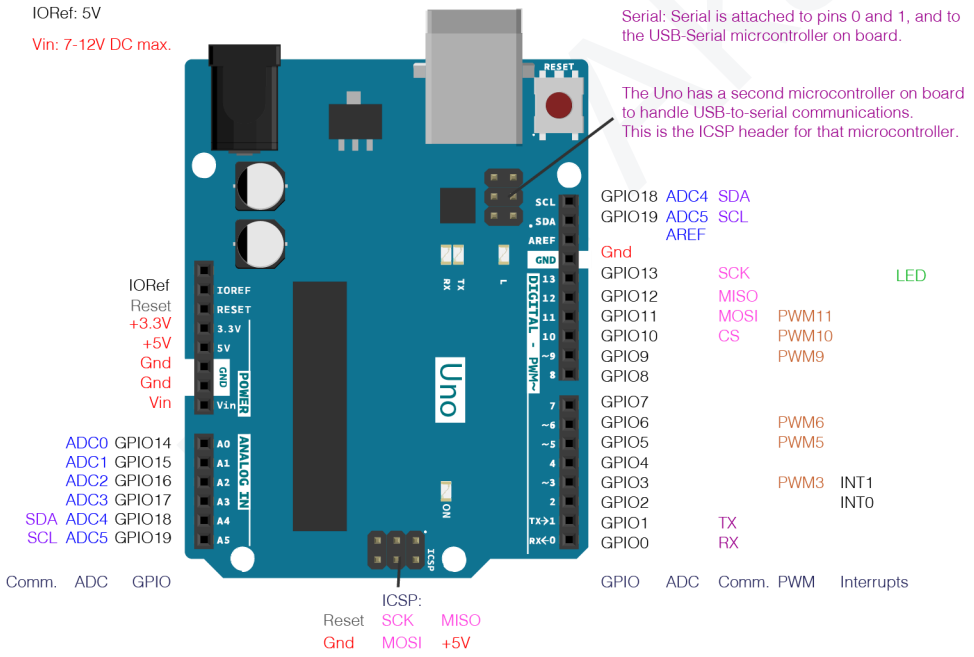
The Automatic Vacuum Cleaner with Air Quality Monitoring is applicable in homes, offices, schools, healthcare facilities, hospital venues, and commercial spaces. By combining cleaning efficiency with real-time air quality monitoring, it enhances indoor environments, improves occupant well-being, and ensures safety and satisfaction across diverse settings.

COMPONENTS REQUIRED:

Sno	Component	Quantity
1	Arduino Uno	1
2	Gear Motors	2
3	L293D Motor Driver	1
4	DC Motor	1
5	Ultrasonic Sensor	1
6	LCD Display	1
7	Dust Sensor(DSM501A)	1
8	Switch	1
9	330 ohm resistor	1
10	4.7 kiloohm resistor	1
11	250 ohm potentiometer	1
12	Connecting wires	As Required

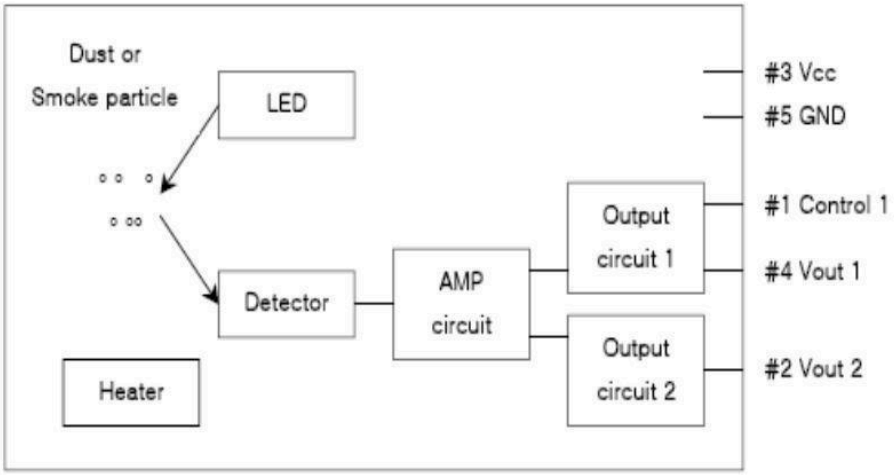
PIN DESCRIPTION OF THE COMPONENTS:

Arduino Uno:

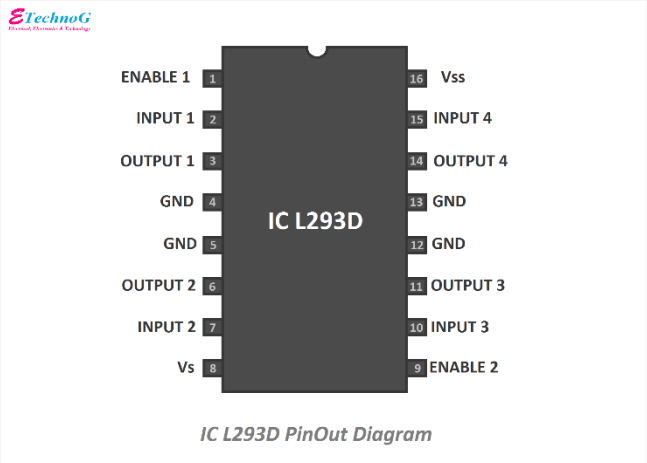


Ultrasonic Sensor:

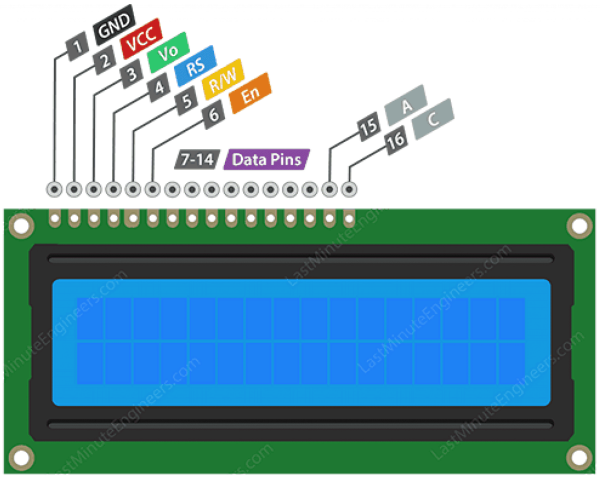
Dust Sensor(dsm501a):



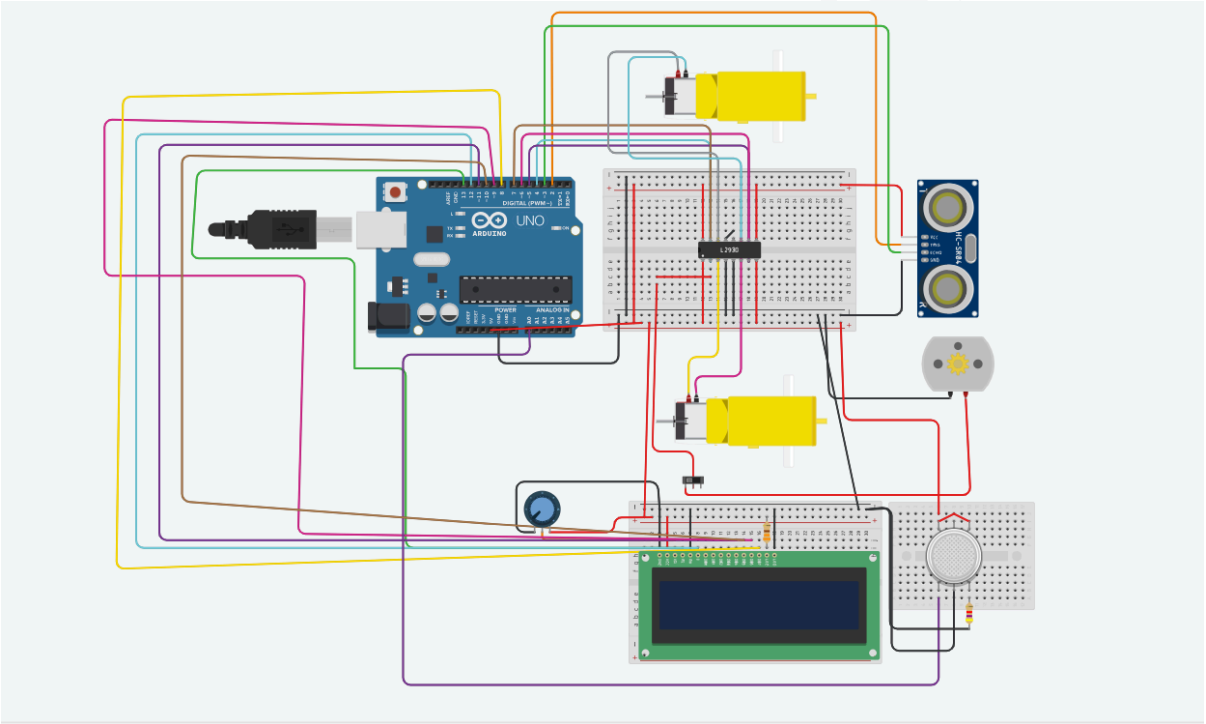
Motor Driver(L293D):



LCD Display:



CIRCUIT DIAGRAM:



Note:

- ✔ Due to the unavailability of DSM501A(Dust sensor) in tinkercad instead I have placed a Gas sensor in place of DSM501A.
- ✔ For DSM501A pinouts

DSM501A	Arduino Uno

PIN 3	VCC
PIN 4	A0
PIN 5	GND

WORKING:

Initialization:

- Upon startup, the vacuum cleaner initializes its sensors, motors, and display.

Sensors Activation:

- The ultrasonic sensor continuously measures the distance to objects in front of the vacuum cleaner.
- The dust sensor periodically samples the air quality to detect dust levels.

Obstacle Avoidance:

- If the ultrasonic sensor detects an obstacle within 10cm, the vacuum cleaner activates its obstacle avoidance routine.
- The vacuum cleaner stops its forward motion, rotates to the left or right to avoid the obstacle, and then continues moving forward once the obstacle is cleared.

Air Quality Monitoring:

- The dust sensor measures the concentration of dust particles in the air.
- If the dust level falls below a certain threshold, indicating relatively clean air, the vacuum cleaner stops its cleaning operation to conserve power and prevent unnecessary cleaning.
- The current air quality reading is displayed on the LCD display for user monitoring.

Cleaning Operation:

- While the dust level is above the threshold, indicating the need for cleaning, the vacuum cleaner continues its cleaning operation.
- The DC motor responsible for suction is activated to suck up dust and garbage from the floor.
- The vacuum cleaner moves forward in its cleaning path using its gear motors for propulsion.

Continuous Monitoring:

- Throughout the cleaning process, the vacuum cleaner continuously monitors the environment using its sensors.
- It dynamically adjusts its cleaning behavior based on real-time feedback from the ultrasonic sensor and dust sensor.

Completion and Shutdown:

- Once the cleaning operation is complete or if the dust level falls below the threshold for an extended period, indicating a clean environment, the vacuum cleaner stops its cleaning operation.

- The vacuum cleaner shuts down its motors and sensors.

PURPOSE OF THE COMPONENTS:

- Arduino Uno: The Arduino Uno serves as the main microcontroller unit, responsible for controlling the operation of the vacuum cleaner, reading sensor data, and controlling motor movements based on input from sensors.
- Two Gear Motors: These motors are used to drive the wheels of the vacuum cleaner. They provide the necessary propulsion for the vacuum cleaner to move around and clean the designated area.

- L293D Motor Driver: The L293D motor driver is used to control the speed and direction of the gear motors. It takes input signals from the Arduino and provides the necessary power and control signals to the motors.
- DC Motor: The DC motor is used for suction purposes. It creates the vacuum necessary to collect dust and debris from the floor.
- Ultrasonic Sensor: The ultrasonic sensor is used for obstacle detection. It emits ultrasonic waves and measures the time taken for the waves to bounce back. By calculating the distance to obstacles, the vacuum cleaner can avoid collisions.
- LCD Display: The LCD display provides visual feedback to the user. It can display information such as the current air quality level and cleaning status for user interaction.
- Dust Sensor: The dust sensor is used for air quality monitoring. It detects the concentration of dust particles in the air. By periodically sampling the air, the vacuum cleaner can determine when cleaning is required based on the detected dust levels.
- Switch: The switch serves as a user input device. It can be used to turn the vacuum cleaner on/off or to trigger specific actions, such as initiating a cleaning cycle or resetting the system.

CODE:

```
#include "LiquidCrystal.h"
LiquidCrystal lcd(13,12,11,10,9,8);
int GAS_VAL = 0;
long readUltrasonicDistance(int triggerPin, int echoPin) {
pinMode(triggerPin, OUTPUT);
digitalWrite(triggerPin, LOW);
delayMicroseconds(2);
```

```
digitalWrite(triggerPin, HIGH);
delayMicroseconds(10);
digitalWrite(triggerPin, LOW);
pinMode(echoPin, INPUT);
return pulseIn(echoPin, HIGH);
}
void setup()
{
pinMode(4, OUTPUT);
pinMode(5, OUTPUT);
pinMode(6, OUTPUT);
pinMode(7, OUTPUT);
pinMode(A0, INPUT);
Serial.begin(9600);
lcd.begin(16,2);
lcd.setCursor(0,0);
lcd.print("   AIR QUALITY  ");
}
void loop()
{
GAS_VAL = analogRead(A0);
Serial.println(GAS_VAL);
lcd.setCursor(7,8);
lcd.print(GAS_VAL);
if(GAS_VAL>310)
 {
```

```
  if (0.01723 * readUltrasonicDistance(2, 3) < 10) {
digitalWrite(4, LOW);
digitalWrite(5, HIGH);
digitalWrite(6, LOW);
digitalWrite(7, HIGH);
}
else {
digitalWrite(4, HIGH);
digitalWrite(5, LOW);
digitalWrite(6, LOW);
digitalWrite(7, HIGH);
}
 delay(10);
 }
  else
  {
digitalWrite(4, LOW);
digitalWrite(5, LOW);
digitalWrite(6, LOW);
digitalWrite(7, LOW);
 }
}
```

CONCLUSION:

In conclusion, the Automatic Vacuum Cleaner designed with an Arduino Uno, gear motors, L293D motor driver, DC motor, ultrasonic sensor, LCD display, dust sensor, and a switch offers a comprehensive solution for efficient cleaning and air quality monitoring. By leveraging these components, the vacuum cleaner can navigate obstacles, detect dust levels, and provide real-time feedback to users. This versatile and intelligent system enhances indoor air quality, promotes cleanliness, and contributes to a healthier living environment.

REFERENCES:

Ultrasonic sensor: Getting Started with the HC-SR04 Ultrasonic sensor | Arduino Project Hub

Dust Sensor: Dust Sensor DSM501A with Arduino, PM10 & PM2.5 Air Quality Monitoring, Arduino Project (youtube.com)

LCD Display: Liquid Crystal Displays (LCD) with Arduino | Arduino Documentation

L293D: Obstacle Avoiding Robot Circuit Tinkercad 1 (youtube.com)

Tinkercad Link: Circuit design Automatic vaccum cleaner - Tinkercad

ADDITIONAL:

- Incorporate a Wi-Fi module (e.g., ESP8266) to enable remote monitoring and control of the vacuum cleaner via a smartphone app or web interface.