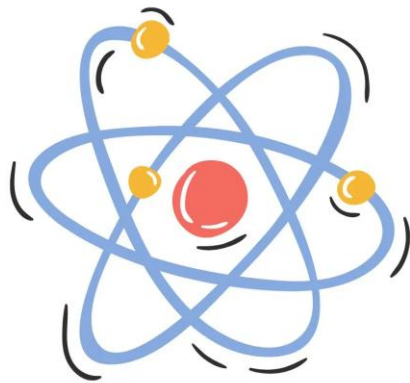




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Abstract: A solar-powered air purifier with an integrated air quality monitoring system aims to provide an eco-friendly solution for improving the air quality. It involves incorporating solar panels, a power storage system, an efficient air purifier unit, and a real-time air quality sensing system. The goal is to create a self-sustaining system capable of enhancing the surrounding air quality while monitoring and responding accordingly to the changes in air quality. The solar-powered air purifier with air quality monitoring system is designed to address the growing concerns for cleaning air. The innovative system utilizes solar panels to harness renewable energy, making it both sustainable and independent of external power sources. The solar energy is stored in a power storage system, ensuring uninterrupted operation even during periods of low sunlight. An efficient air purifier unit is incorporated to filter pollutants and particulate matters from the air, contributing to an improved breathing environment.

Keyword: Solar Panel, Activated Carbon, BLDC, HEPA, Particulate Matter, Air Purifier, Air Pollutants.

1. INTRODUCTION

As we know, air pollution levels in cities are increasing rapidly day by day. Most of the pollution is due to the by-products from vehicle's exhaust, waste gases from industries and dust from construction sites. These include gases like methane, carbon dioxide, nitrogen dioxide, dust etc. This results in health issues like asthma, lung infections, heart disease, pregnancy failing etc.



Fig 1 Pollution in atmosphere

These air purifiers can respond to the change in the air quality on their own,

aiming to remove some of the harmful air pollutants from the air and improve the quality of breathable air for humans all around the world. This purifier use solar energy and fight against air pollution in an environmentally friendly way. It's advanced filtration technology includes the combination of HEPA filter with activated carbon filter, which eliminate particulate matter, organic compound and pollutants in the atmosphere, leading to better air quality overall.

The integration of solar power with the Air purifier system will help in making it independent and rely less on traditional energy resources and also, it fits well with the world's global sustainable development push.



Fig 2. Sources of PM 2.5 and PM 10

This air purifier draws air from the environment, passes it from the filters combination, purifies it and releases it from the other side. There are two sensors which continuously monitor the air quality before and after filtration. Also, the purifier will turn on and off automatically with the change in air quality.

The HEPA filter captures the particulate matter of size as small as 0.3 microns, dust while Active carbon filter removes the odour and volatile compounds from the air.

2. METHODOLOGY

- The solar panel of 20 watt is used which captures the sunlight and converts it to electricity, which is then stored in the battery.
- The rating of the battery used is 12v and 7.5 amps. Here the battery is connected to the L298N Motor drive, which converts 12 V supply into 5v for

Arduino uno board and other components.

- The Fan is connected to the motor drive, which acts as a switch and provides 12v supply to the fan.

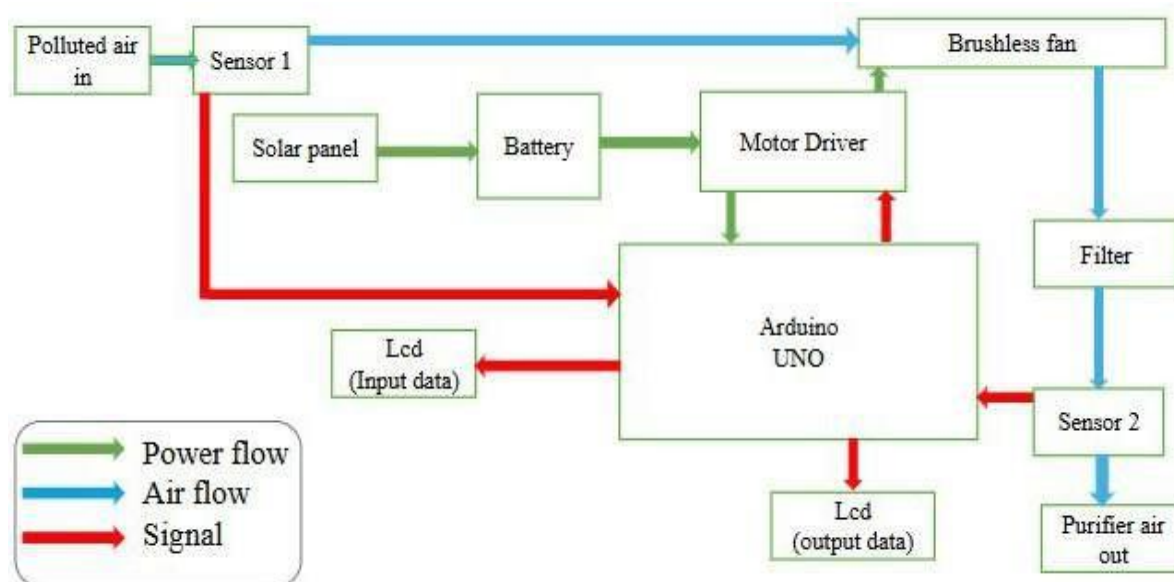


Fig 3. Block Diagram of Air Purifier

- The MQ135 Sensors are placed before and after the filters which are connected to Arduino which provides the real-time Air Quality before and after filtering.
- The arduino then analyzes the data and sends a signal to the L298N drive to turn on and off the fan based on the data.
- The Air passes through the filters which removes the pollutants from the air.
- Fan is used to maintain the air flow through the filters.
- The real-time data of both the sensors is shown on the LCD Displays.

Table: Break points for comparing AQI, India

AQI Category (Range)	NO ₂ 24-hr	O ₃ 8-hr	CO 8-hr (mg/m ³)	SO ₂ 24-hr	NH ₃ 24-hr	Pb 24-hr
Good (0-50)	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	41-80	51-100	1.1-2.0	41-80	201-400	0.5 –1.0
Moderately	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0

polluted (101-200)						
Poor (201-300)	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	400+	748+*	34+	1600+	1800+	3.5+

3. COMPONENTS

- **MQ135 Sensor**

This is a gas sensor which is used to detect the harmful gases like carbon dioxide(CO₂), Carbon Monoxide(CO), Ammonia, smoke etc, and the signals to the arduino uno. There are two such sensors in this prototype.



- **Arduino UNO**

Arduino Uno is a microcontroller board based on the ATmega328P. It plays a crucial role in collecting, analyzing Data and controlling the air purifier accordingly. It is also responsible for showing the real-time data on the LCD displays.



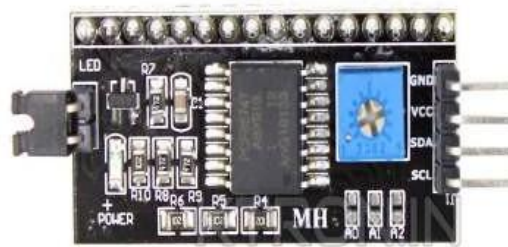
- **LCD Display**

Liquid crystalline display is used to display the real-time data of the sensors for before and after filtering. We are using two 16x2 LCD displays in it.



- **I2C Module**

I2C(Inter Integrated Circuit) Module is a Display driver which is used to control the LCD Display through a two-wire interface: Serial Data Line(SDA) and Serial Clock Line(SCL).This reduces the number of pins required on microcontrollers like Arduino which also simplifies connections.



- **BLDC Fan**

A brushless DC fan employs brushless DC motors (BLDC motors) featuring a configuration of four permanent magnets arranged in a cross pattern on the rotor's sides. Unlike brushed DC motors, BLDC motors operate without the need for a commutator or brushes. The brushless DC fan consists of a robust BLDC motor, shaft, and fan blades.



BLDC (BrushLess Direct Current) Fan is used to maintain the air flow through the filters. The Fan will be automatically turned on and off based on the readings of the sensor (placed before filter).

- **L298N Module**

The L298N is a motor driver module designed to control the speed and direction of DC motors and stepper motors. This module supports Pulse Width Modulation (PWM) for speed control, enabling precise adjustments of the motor speed.

This module is commonly used in automation projects due to its ability to handle high voltage and high current. It also converts the 12V DC to 5V DC which can be used to supply Arduino UNO.



- **Solar Panel**

Solar Panel is a device which captures the sunlight and converts it to electrical energy. It is the collection of photovoltaic cells which generates electricity through the photovoltaic effect. Here, we are using a 20W capacity panel.



- **Solar charger and controller**

It is an essential component in the solar power management which manages and controls the flow of energy from the solar panel to the battery and load. It regulates the voltage and current from solar panels to ensure that the battery is charged efficiently and safely, while protecting system components from damage.



- **Filters**

Filters are very essential components of an air purifier. Without filters, it is not possible to filter out the pollutants from the air. There are two types of filters used in this prototype:-

- **HEPA Filter** - High Efficiency Particulate Air (HEPA) Filter captures the particulate matter of size as small as 0.3 microns. It removes Dust, smoke, etc. particles from the air. Its efficiency is 99.97% for cleaning minor particles
- **Activated-Carbon Filter** - Activated-carbon filter contains the activated carbon particles, which traps the volatile compounds, odour, etc in it.



- **Battery**

This prototype includes Lead-acid batteries in it. It is a mature and cost- effective technology which uses chemical reactions between lead, lead dioxide, and sulfuric acid to store and release electricity. They are widely used in various applications, including automotive, industrial, and backup power systems. We are using a 12V, 7.5A rating battery in this prototype.



4. RESULTS

Location	Before Filtering	After Filtering
Location 1	140	87
Location 2	125	96
Location 3	113	73
Location 4	91	40



5. CONCLUSION

The Solar Air Purifier design fulfills its intended objective, which is a user friendly, low cost, portable, environment friendly device. This Solar Based Air Purifier is more efficient than the other types of devices available in the market. It provides clean air by responding according to the real-time situation of the air.

Clean air is essential for every human being for breathing, supporting the proper functioning of body organs, and preventing respiratory & heart diseases as well as overall well being.

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