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Air Purification Using Water Filtration And Hepa Filter

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Abstract: Against the background of growing indoor air pollution concerns, this study introduces the design and implementation of an air cleaning system that incorporates HEPA filtration, water purification, and instant air quality monitoring. The system features a two-stage cleansing mechanism: a HEPA filter filters airborne particulates, while a water vortex treatment mechanism cleanses the air additionally and ensures ideal humidity levels. CO_2 and CO concentrations are monitored in real time with MQ series gas sensors. When pollutant concentrations surpass set limits, the system will trigger a relay module to shut off high-energy appliances, minimizing emissions and heat production. Sensor data processing and control operations are carried out by the Arduino Nano microcontroller for a fast and energy-efficient indoor space.

Keywords **– Air Purification, Water Filtration, Indoor air Quality, Automation, Water-Based Indoor Quality System**

1. INTRODUCTION

Indoor air quality (IAQ) has considerable impacts on human health and comfort. Increased concentrations of particulate matter (PM), carbon dioxide (CO_2), and carbon monoxide (CO) are linked with several health problems, such as respiratory diseases and cardiovascular conditions. Conventional air cleaners mostly depend on HEPA filters, which, although good, involve frequent cleaning and generate environmental waste. This research suggests the integration of HEPA filtration and water-based cleansing with state-of-the-art air quality monitoring in order to provide IAQ enhancement sustainably and effectively.

2. EXISTING SYSTYEM VS PROPOSED SYSTEM

2.1 Existing System

Modern air cleansing technologies make major use of HEPA filters and water-based methods to clean the indoor air from particulate contaminants. HEPA filters work but need frequent upkeep because performance dwindles with build-up. Water-based cleaners using water vortex technology have been constructed to optimize the efficiency of capturing particles and limit maintenance requirements. For example, research has established that water vortex air cleaners work at optimal rates even after accumulating large amounts of particulate pollutants.

2.2 Proposed system

The proposed air purification system incorporates high-tech filtration and real-time monitoring technologies to purify indoor air. It utilizes a HEPA filter and water vortex purification step, trapping a wide range of airborne particles and ensuring optimal humidity. Real-time CO_2 and CO concentration monitoring is done using MQ series gas sensors. When levels surpass specified limits, the system triggers a relay module to shut

off high-energy appliances, including heaters or air conditioners, lowering emissions and heat production. The Arduino Nano microcontroller oversees sensor data processing and control operations, maintaining an energy-efficient and responsive indoor climate.

This device is an improvement over current air purifiers as it combines water vortex technology with HEPA filtration, providing a multi-stage cleaning process that is efficient in trapping different particle sizes. Continuous measurement of particulate matter and gas concentrations enables dynamic control of air purification and device operation, enhancing energy efficiency while ensuring a healthy indoor climate. By automating the management of high-energy devices based on real-time air quality data, the system not only improves air quality, but also saves energy and enhances user comfort.

3. SYSTEM DESIGN AND DEVELOPMENT

3.1 System Overview

The constructed air cleaning system combines several stages of filtration along with real-time monitoring in order to achieve the highest quality indoor air. It consists of a HEPA filter and a water vortex purification chamber that can remove particulate matter efficiently, with MQ series gas sensors (in this case, MQ-7 for CO_2 measurement) tracking gas concentrations. The Arduino Nano microcontroller handles sensor information and system operations, such as turning a relay module on to operate high-energy appliances like air conditioners and heaters according to predetermined air quality levels.

3.2 Development Process

- Prototyping: Each of the individual parts, such as the HEPA filter, water vortex chamber, gas sensors, and Arduino Nano, were individually assembled and tested to ensure compatibility and functionality.
- Integration: All the components were connected to allow for easy communication between the microcontroller, actuators, and sensors.
- Programming: The Arduino Nano was written to perform data acquisition from the sensors, process it, and implement control logic for relay triggering and device management.
- Testing and Calibration: The system was tested iteratively to calibrate sensors, optimize control algorithms, and confirm performance under different conditions.
- Optimization: Adjustments were made based on test results to improve system responsiveness, accuracy, and energy efficiency.

4.WORKING OF THE SYSTEM

1. Air Intake: Indoor air is suctioned by a pump into the purification system.

2. First Stage Purification (HEPA Filtration): The air is filtered through a HEPA filter, which traps at least 99.97% of particles in the air that are as small as 0.3 microns.

3. Second Stage Purification (Water Vortex): The air subsequently passes into a water vortex chamber, in which a rotating impeller forms a vortex to effectively trap particles of different sizes. Centrifugal force forces particles to accumulate at the bottom, with high purification efficiency still being maintained after extended use.

4. Humidity Maintenance: The air, when passing through the water vortex, picks up moisture, ensuring optimum humidity levels and increased comfort.

5. Air Quality Monitoring: The MQ series gas sensors continuously monitor CO_2 and CO concentrations. When the concentration exceeds predefined values, the system sends out an alert.

6. Device Control: When high pollutant levels are detected, the Arduino Nano controls the relay module to shut off high-energy devices like heaters or air conditioners, lowering emissions and heat production.

7. Air Circulation: The humidified and cleaned air is then blown into the room by a blower fan, providing even distribution and constant air quality enhancement

5. BASIC BLOCK DIAGRAM

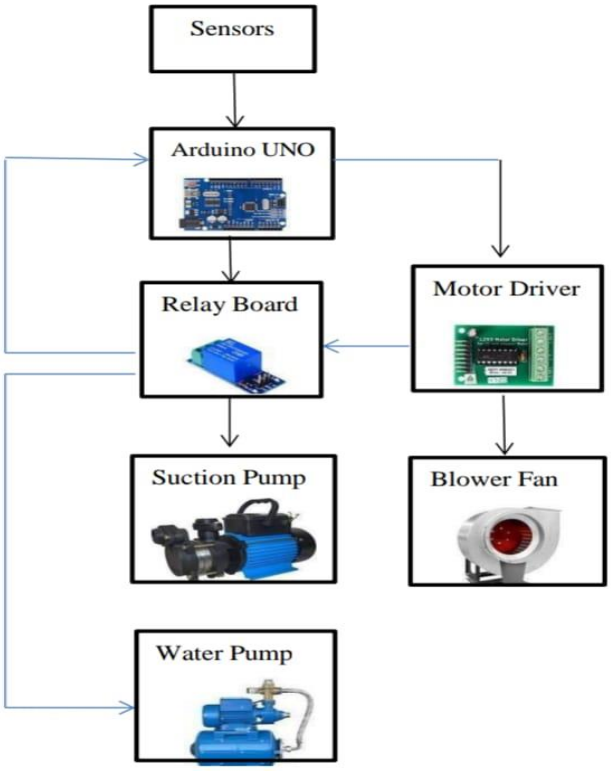

Fig.1. Basic Block Diagram

6. RESULT AND DISCUSSION

6.1 APPLICATIONS

1. Indoor Air Quality Improvement: This system can be used in homes. offices, and commercial spaces to maintain a healthy indoor environment, especially for people with respiratory conditions or allergies.

2. Healthcare Environments: Hospitals, clinics, and medical centers can utilize the system to reduce airborne contaminants and ensure clean air for patients. and staff.

3. Industrial and Manufacturing Facilities: In environments with dust, smoke, or chemical pollutants, this air purification system can help reduce health risks associated with poor air quality.

4. Smart Home Integration: When integrated into smart home systems, the purification system can automatically adjust based on real-time air quality data, creating a responsive and optimized environment.

5. Public Spaces: In places like schools, gyms, or waiting rooms, the system can contribute to better air quality for large groups of people.

6.2 ADVANTAGES

1. Two-Stage Filtration: Combining HEPA filtration and water filtration enhances the purification process,

2. Real-Time Monitoring: Sensors monitor CO2 levels, oxygen concentration. and air quality index (AQI).

3. Automation: With the integration of the Arduino ESP8266 microcontroller. the system can automatically control airflow, activate ventilation, and sound alarms when air quality falls below set thresholds.

4. Health Benefits: The system helps reduce airborne allergens, pollutants, and particulate matter, improving overall indoor air quality and reducing health.

5. Energy Efficiency: By using sensors to monitor air quality and adjusting ventilation and filtration accordingly, the system operates efficiently and reduces energy consumption when air quality is optimal.

6.3 DISADVANTAGES

1. Complexity in Maintenance: Regular maintenance is required for both the HEPA filter and water filtration system. The water filter must be cleaned or replaced periodically to ensure proper functioning.

2. Initial Cost: The integration of advanced components such as sensors, pumps. and microcontrollers may result in a higher initial cost compared to simpler air purifiers.

3. Dependence on Water Supply: The water filtration stage requires a continuous water supply. In areas with limited or no access to clean water, this system may not be feasible.

4. Noise Generation: The operation of components like the blower fan and pumps may generate noise, which could be disruptive in quiet environments.

5. Energy Consumption: While the system is energy-efficient, continuous operation of pumps, sensors, and fans may contribute to an increase in energy usage over time.

6.4 FUTURE SCOPE

1. Integration with Smart Home Systems
2. AI and Machine Learning Integration
3. Advanced Filtration Technologies
4. Wireless Communication and IoT
5. Energy Harvesting Capabilities
6. Self-Cleaning Mechanisms
7. Mobile Application Development
8. Indoor Plant Integration

7. CONCLUSION

In conclusion, this air purification system combines HEPA filtration and water filtration to clean the air in two stages, ensuring that it is free from particulate matter, allergens, and pollutants. Real-time sensor monitoring tracks the CO2 levels, oxygen concentration, and Air Quality Index (AQI), while the MQ-15 gas sensor detects dangerous gases like carbon monoxide (CO). If harmful CO levels are detected, the system alerts the user to turn off gas-producing devices, ensuring safety. Simultaneously, the system manages oxygen levels to maintain a comfortable and breathable environment. The system ensures that the purified air is circulated effectively, and users are constantly informed of any unsafe conditions through alerts and notifications, promoting a safe, healthy, and comfortable indoor environment.

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