**Indoor Air Quality Monitoring (IAQ) for Home Capstone Project**

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**General Block Diagram**

A screenshot of a black screen

Description automatically generated

1. **The Problem (need) and Solution**

The main problem is that most Indoor Air Quality monitoring devices do not provide direct solution in cleaning the air. The solution to alert the user if the air quality pollution exceeds the threshold and to integrate the IAQ device to other air cleaning solutions such as air purifiers and humidifiers.

1. **User Stories**

As an allergy sufferer, I want the IAQ monitoring device to alert me promptly when air quality exceeds safe thresholds, so that I can take necessary actions such as opening air purifier, opening air humidifier or close windows. I want the IAQ device to provide real-time data on temperature, humidity, and particulate levels, helping me make informed decisions about my indoor environment. It is also nice to have if the device can control an air purifier automatically based on the results generated so that I don’t have to worry about manually activating the air purifying appliances.

1. **Stakeholders**

**Users**

Individuals concerned about indoor air quality, including homeowners, allergy sufferers, and other indoor occupants.

**Manufacturers**

Companies producing IAQ monitoring devices, air purifiers, and humidifiers.

**Health Professionals**

Experts who can provide guidance on safe air quality levels.

**Service Providers**

Entities responsible for maintaining and servicing IAQ systems.

1. **Scope Statement**

The project scope includes integrating temperature, humidity and particulate sensor for IAQ monitoring that:

* Provides real-time alerts to users when air quality exceeds acceptable thresholds.
* Ensures user-friendly operation and maintenance.
* Integrates seamlessly with existing air-cleaning solutions.

1. **Functional Requirements**

This project involves utilizing three sensors, temperature, humidity and particulate sensor to determine the indoor air quality. The device will gather the data from the sensors and then use Arduino IoT cloud to create a dashboard and display a real time result.

1. Temperature Sensor:

* **Function:** Measure ambient temperature.
* **Inputs:** Environmental temperature.
* **Behaviors:** Continuously monitor temperature.
* **Outputs:** Temperature data sent to ESP32.

1. Particulate Sensor:

* **Function:** Detect allergens, pollen, dust mites, pet dander, and smoke.
* **Inputs:** Airborne particles.
* **Behaviors:** Sample air quality and identify particulates.
* **Outputs:** Detection data transmitted to ESP32.

1. Humidity Sensor:

* **Function:** Measure ambient humidity levels.
* **Inputs:** Air humidity.
* **Behaviors:** Monitor humidity variations.
* **Outputs:** Humidity data provided to ESP32.

1. ESP32:

* **Function:** Process sensor data and make informed decisions.
* **Inputs:** Data from Temperature Sensor, Particulate Sensor, and Humidity Sensor.
* **Behaviors:** Analyze data, trigger actions (e.g., display results, activate appliances).
* **Outputs:** Processed data sent to Arduino IoT.

1. Arduino IoT:

* **Function:** Receive processed data from ESP32 and respond accordingly.
* Inputs: Processed data.
* **Behaviors:** Display environmental conditions (e.g., on LCD/phone) or activate Relay Switch.
* **Outputs:** Displayed information or appliance control signals.

1. Relay Switch (Optional):

* **Function:** Control AC/DC appliances (e.g., air purifiers, humidifiers) based on sensor readings.
* **Inputs:** Signals from Arduino IoT.
* **Behaviors:** Turn appliances on/off as needed.
* **Outputs:** Appliance status (activated/deactivated).

**Non-Functional Requirements**

* **Accessibility**

The display should be accessible by people with or without color-blindness

* **Availability**

The device should be working 24/7. If it is battery operated, it should display battery percentage.

* **Maintainability**

The device should be easy to clean except for the products that are integrated with it that cleans the air. For example, change the air purifier’s HEPA filter and clean the water bin of the air humidifier.

* **Upgradability and Modularity**

The device should be integrated to air purifying products and sensors can be added to it based on the user’s requirements.

1. **Technical Requirements**
2. **Sensor Integration:**

* The particulate, temperature, and humidity sensors should be seamlessly integrated into the Indoor Air Quality (IAQ) monitoring device.
* Ensure compatibility and communication protocols between the sensors and the monitoring device.

1. **Data Accuracy and Precision:**

* The sensors should provide accurate and precise measurements of particulate levels, temperature, and humidity.

1. **Real-time Monitoring:**

* Enable real-time monitoring of indoor air quality parameters, including particulate levels, temperature, and humidity.

1. **Threshold Alerts:**

* Set customizable threshold levels for particulate pollution, temperature, and humidity.
* Trigger alerts to the user when air quality parameters exceed preset thresholds.

1. **User Interface:**

* Design an intuitive and user-friendly interface for the IAQ monitoring device.
* Display real-time data in a clear and understandable format for the user.

1. **Connectivity Options:**

* Provide multiple connectivity options, such as Wi-Fi or Bluetooth, for data transmission to external devices or cloud platforms.

1. **Compatibility with Air Cleaning Solutions:**

* Ensure compatibility with various air purifiers and humidifiers for seamless integration and automation of air cleaning processes.
* Enable communication protocols to synchronize operation between the IAQ monitoring device and connected air cleaning solutions.

1. **Specify Technical Performance needed to solve the "problem.”**

The project should:

* Promptly alert users when air quality exceeds safe thresholds. The accuracy of sensors should remain stable over time.
* Ensure reliable data transmission between sensors, microcontrollers, and display interfaces.
* Minimize power consumption to ensure prolonged operation without excessive energy usage.