Product Design Specification (PDS) — Team 8

Project Title: Smart Air Quality Monitoring System

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Short Descriptive Name

- **Smart Air Quality Meter** — a compact, multi-sensor device that continuously measures indoor environmental conditions and displays real-time air quality levels.

Executive Summary with Concept of Operations

- This project focuses on developing a portable indoor air quality monitor capable of measuring particulate matter (PM2.5), carbon dioxide (CO_2), volatile organic compounds (VOC), ozone (O_3), temperature, and humidity. The system uses an array of sensors interfaced with a microcontroller to collect, process, and display environmental data in real time.
- Users can place the device in homes, classrooms, or offices to instantly assess air quality. Measurements are visualized through a color TFT display, where key pollutant values and comfort indicators are clearly presented. The system aims to raise awareness about indoor pollution and help users maintain healthier living environments.
- Data acquisition is handled by digital and analog sensors, with periodic sampling and signal averaging for stability. Power is supplied through a DC adapter, making it suitable for long-term operation.

Brief "Market" Analysis

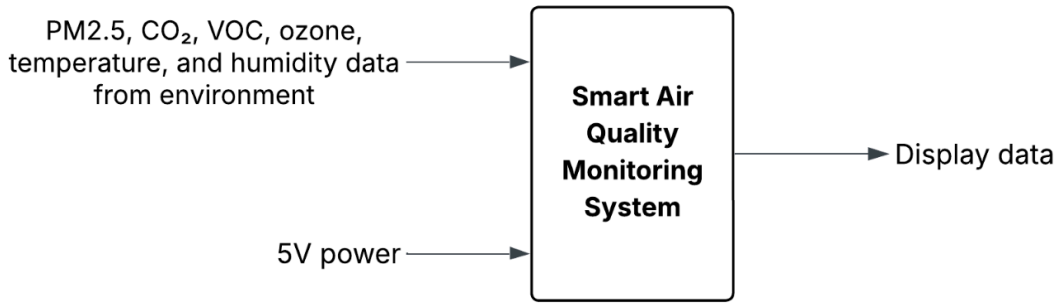
- **Target Users:** The intended users include homeowners, educators, and environmental enthusiasts seeking affordable, accurate indoor air-quality feedback. It's also suitable for schools or labs aiming to demonstrate environmental sensing principles.
- **Competition and Uniqueness:** Commercial air-quality monitors often provide limited sensor coverage or high cost. Our system integrates multiple sensors in one device—PM2.5, CO_2, VOC, ozone, temperature, and humidity—while keeping costs low and size compact.
- **Estimated Cost:** Approximate material cost is **$60–$90** based on sensor and display components. This price point makes it more affordable than typical commercial equivalents ($150+).
  (Note: Detailed bill of materials not yet generated.)

Requirements

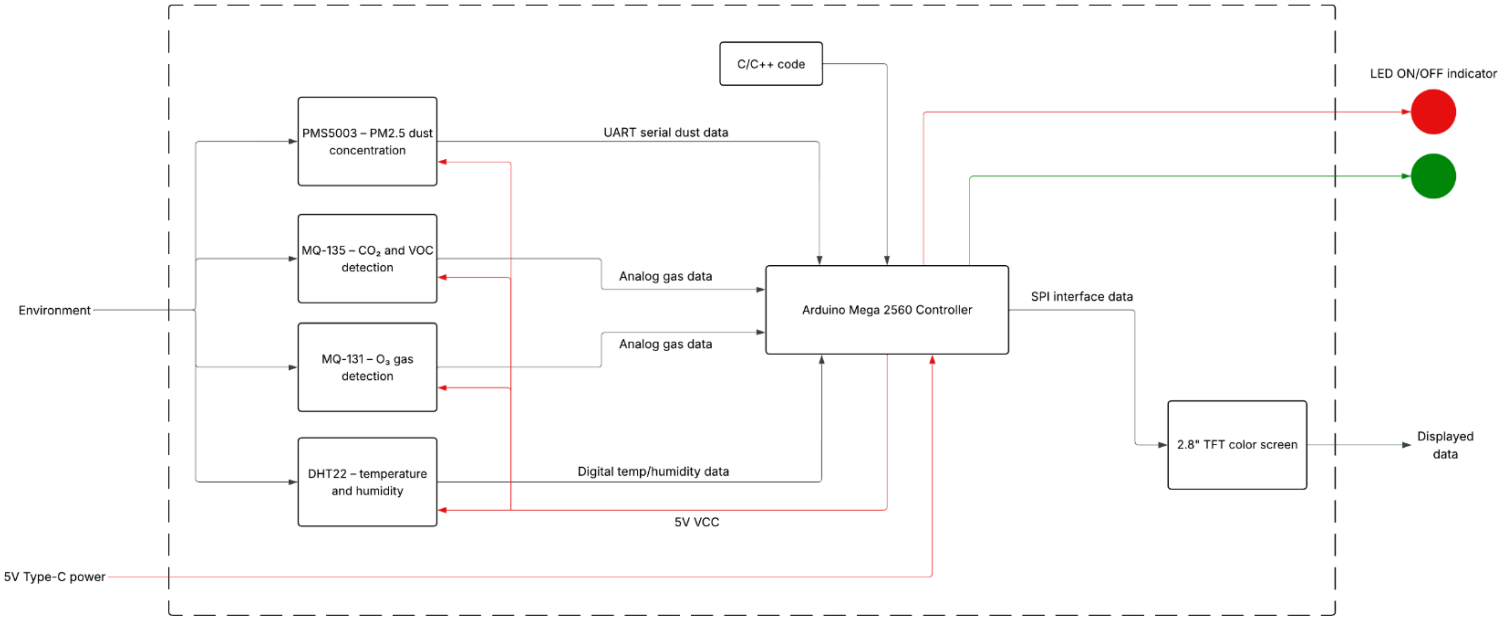
Category	Description
Functionality	Must measure PM2.5, CO_2, VOC, ozone, temperature, and humidity accurately.
Display	Must show live readings and air quality indicators on a color TFT screen.
Portability	Should be compact and lightweight for tabletop use.
Power	Must operate from standard 5 V DC supply or USB input.
Data Refresh	Should update all readings at least once every few seconds.
Accuracy	Must maintain ±5% or better for temperature/humidity and consistent pollutant data within sensor tolerance.
Safety	Must not overheat or exceed rated voltage; components housed securely.
Durability	Should withstand continuous operation without sensor drift over short intervals.
User Interface	Should provide readable data and optional air-quality color codes.
Maintenance	May require sensor recalibration periodically (as specified in datasheets).

System Architecture

LEVEL 0 DIAGRAM



LEVEL 1 DIAGRAM



Design Specification

- **Controller:** Arduino Mega 2560 (chosen for multiple I/O pins and memory).
- **Sensors:**
    i. PMS5003 – PM2.5 dust concentration
    ii. MQ-135 – CO_2 and VOC detection
    iii. MQ-131 – O_3 gas detection
    iv. DHT22 – temperature and humidity
- **Display:** 2.8" TFT color screen (SPI interface).
- **Power Source:** 5 V DC adapter or USB supply.
- **Communication:** UART (PM2.5), SPI (TFT), analog (gas sensors), digital (DHT22).
- **Firmware:** Arduino IDE-based C/C++ code handling sensor data acquisition, filtering, and real-time display update.
- **Enclosure:** Plastic or 3D-printed casing with air vents for proper airflow.
- **Development Environment:** Arduino IDE, open-source libraries for sensor drivers and graphics.
- **Optional Features (Future Add-ons):**
    v. SD card logging
    vi. Wi-Fi/Bluetooth for data upload
    vii. LED indicator for air quality warning