PM2.5 dust sensor simulation and data analaysis

Tran Duc Binh, Nguyen Tuan Duc   
School of Mechanical Engineering  
Hanoi University of Science and TechnologyHanoi, Vietnam  
binh.td207146@sis.hust.edu.vn

*Abstract*—The simulation of a PM2.5 dust sensor is essential for studying and understanding the measurement of fine particulate matter in environmental monitoring. This paper presents a program developed in C language that simulates a PM2.5 dust sensor, focusing on the measurement of dust particle concentrations below 2.5 microns in ambient air. The program is designed with appropriate functions and data structures to accurately replicate the behavior of the sensor.

The development of this program facilitates the understanding of PM2.5 dust sensor operation, empowers students to explore the world of environmental monitoring, and encourages their engagement in addressing air quality challenges for a healthier and sustainable future.

Keywords—PM2.5 dust sensor, simulation, C programming, environmental monitoring, fine particulate matter, measurement range, resolution.

# Introduction

In recent years, the measurement and monitoring of fine particulate matter (PM2.5) have become crucial in environmental studies and public health research due to their adverse effects on human health and the environment. To facilitate a deeper understanding of PM2.5 measurement techniques, students often undertake projects that involve simulating the behavior of PM2.5 dust sensors. These simulations enable students to gain hands-on experience in programming, algorithm design, and data manipulation while exploring the principles and challenges associated with monitoring airborne particulate matter.

This paper focuses on the development of a program in C language that simulates a PM2.5 dust sensor, specifically targeting the concentration of dust particles with sizes below 2.5 microns in ambient air. The main sensor specifications considered in this simulation include a measurement range of 0 to 1000 μg/m³ and a resolution of 0.1 μg/m³. The program aims to accurately replicate the behavior of a real PM2.5 dust sensor by utilizing appropriate functions and data structures.

By implementing the program, students can generate simulated data representing dust particle concentrations within the specified measurement range. The program incorporates algorithms and techniques to generate random or user-defined data, allowing students to simulate various scenarios and observe the resulting concentration levels. Suitable data structures are employed to store and manipulate the simulated data, facilitating statistical calculations such as average concentration, maximum and minimum values, and other relevant metrics.

The development of this simulation program serves as a valuable educational tool. By simulating the operation of a PM2.5 dust sensor, students also develop insights into the challenges associated with monitoring fine particulate matter in ambient air.

# Background and Technologies Used

## Programming language (C language)

The C programming language is a general-purpose programming language developed in the early 1970s by Dennis Ritchie. It was designed to provide low-level access to the computer's memory and to facilitate efficient programming for system software, such as operating systems and compilers. C is known for its simplicity, efficiency, and flexibility, making it widely used in various domains, including embedded systems, device drivers, game development, and application programming.

C is a structured programming language that allows developers to break down complex problems into smaller, manageable modules through the use of functions. It provides a rich set of data types, operators, control structures, and libraries, which enables developers to write efficient and portable code. The language has a relatively small and standardized syntax, making it easy to learn and understand.

## Visual Code Studio.

Visual Studio Code (VS Code) is a free and open-source source code editor developed by Microsoft. It has gained significant popularity among developers due to its lightweight and customizable nature. VS Code is designed to be a versatile tool that supports a wide range of programming languages and development workflows.

VS Code was designed to provide a cross-platform development environment that can be used on Windows, macOS, and Linux operating systems. It is built using web technologies such as HTML, CSS, and JavaScript, utilizing the Electron framework, which allows it to run as a desktop application.

One of the key features of VS Code is its rich extension ecosystem. It supports a wide range of extensions contributed by both Microsoft and the community, enabling developers to enhance their workflows and customize the editor to their specific needs. These extensions provide additional functionalities, such as language support, linters, debugging tools, version control integration, and productivity enhancements.

# Program design

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*a**b* 

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