

A Portable PM_{2.5} Sensor Device for Exposure, Indoor and Outdoor Air Quality Research

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Will Air pollutants be detected by your lung or by AS-LUNG?

AS-LUNG, short for Academia Sinica-Lung (the organ affected by air pollutants), has integrated PM_{2.5}, CO₂, temperature, relative humidity, Global Positioning System (GPS), and motion sensors in one package. Real-time environmental data can be transmitted by WIFI or GSM to the Cloud database and a built-in SD storage system is available to avoid data loss. All monitoring data and location information can be transmitted at interval choices from 15 seconds to 5 minutes. From now on, your lung is only for breathing air. To Detect air pollutants can totally rely on AS-LUNG (fig.1).

Portable type

AS-LUNG-portable can be carried by subjects or citizens to assess personal exposure levels. The portable one can record every location where the carrier go through based on the built-in Global Positioning System (GPS) as well as the real-time resolution of PM_{2.5} and CO₂ data. This portable sensor helps scientists and citizens to realize air-pollutant exposure of their activities.



Portable AS-LUNG



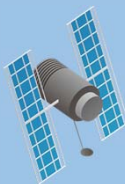
Cloud database



Wireless transmission



Outdoor AS-LUNG



GPS

Figure 1 the schematic diagram of AS-LUNG dataflow

Outdoor type

AS-LUNG-outdoor is a sensor device with multiple power supply choices. Users can install outdoor AS-LUNG at the points of interest based on municipal electric systems or solar power. A solar energy module is optional for users to set up and connects to a series of rechargeable batteries to ensure stable power supply. Weatherproof construction of outdoor AS-LUNG protects sensors from harsh weathers, especially in Taiwan where typhoons hit and hot ambient temperature up to 37 °C (99°F).

Validation of AS-LUNG

AS-LUNG have been evaluated in the laboratory and in the field. PM_{2.5} readings were compared to the observations of GRIMM instruments side-by-side. The operation conditions in different concentration ranges from low (3-100 µg/m³) to high (100-500 µg/m³) concentration both performed very well and R² were at 0.93-0.99 (table 1). All measured data was transmitted back to a cloud database for further analysis.

Table 1 the results of regression between AS-LUNG (portable and outdoor) and GRIMM in lab tests

Instrument No.	Type	Test1(R ²)	Test2(R ²)
AS-LUNG 008	Portable	0.98	0.95
AS-LUNG 009	Portable	0.99	0.95
AS-LUNG 010	Portable	0.99	0.94
AS-LUNG 012	Portable	0.99	0.94
AS-LUNG 014	Portable	0.99	0.96
AS-LUNG 015	Portable	0.93	0.96
AS-LUNG 017	Portable	0.90	0.94
AS-LUNG 018	Portable	0.99	0.93
AS-LUNG 036	Outdoor	0.99	0.98
AS-LUNG 037	Outdoor	0.97	0.99
AS-LUNG 039	Outdoor	0.95	0.96
AS-LUNG 040	Outdoor	0.98	0.97
AS-LUNG 041	Outdoor	0.96	0.98
AS-LUNG 042	Outdoor	0.98	0.98

R²: the coefficient of determination

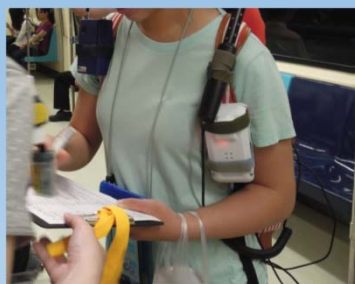


Figure 2 personal exposure monitored by portable AS-LUNG in MRT

The real-time resolution of personal exposure levels

The portable AS-LUNG is very suitable for monitoring personal daily exposure and recording exposure locations. In the example of observations in the mass rapid transit system (MRT) in Taiwan, commuters might experience levels close to 50 µg/m³ of PM_{2.5} and more than 2500 ppm of CO₂ (fig.2 and fig.3).

This AS-LUNG device could be applied in aerosol science. Every scientist/citizen can install his/her own AS-LUNG and estimate the exposure levels of their interested time-periods. Our working group has created a cloud database to collect monitoring data from users' AS-LUNG (you can determine whether your data being transmitted to Cloud or not). Data can be used for epidemiological investigations, health risk assessments, and pollution control strategies to protect public health.

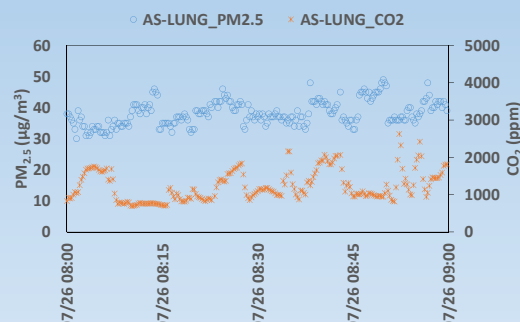


Figure 3 the variations of PM_{2.5} and CO₂ concentrations per 15 seconds in MRT

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