"Your Sneeze, My Mask": Crowdsourcing Hyper-Local Pollen Data via a Wearable Detector

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Abstract*—This paper proposes a prototype of a portable pollen detection device born from a personal mission to reclaim daily comfort from the "invisible enemy" of pollen. While broad forecasts exist, they fail to reflect the immediate, local reality of the user's environment. By integrating M5Stack with high-precision sensors, this device provides real-time, hyper-local data and actionable advice. My goal is to transform passive suffering into proactive self-defense, leveraging technology to ensure that hay fever no longer dictates a person's productivity or quality of life.

I. Introduction / Background

Hay fever is a serious issue that significantly reduces people's productivity and well-being. Not only in Japan but worldwide, people suffer from various types of pollen, making accurate pollen avoidance crucial for maintaining health. Currently, daily pollen dispersion levels can be easily checked via TV or smartphone apps, but these remain broad regional forecasts. There are scarce means for users to pinpoint the dispersion status of the exact location they are in "right now," and this low resolution of information makes it difficult to take appropriate self-defense measures when going out. To solve this problem, this project proposes a wearable pollen detection device (Fig. 1).

This device pursues thorough portability; measured values are instantly transferred to a smartphone to notify the user of pollen danger levels. Furthermore, by making the dispersion information shareable online, users can complement each other's data, accelerating the "pollen visualization" of society as a whole and creating an experience that users will naturally want to share.

II. Related Work

Traditional methods like the Durham method[1] provide scientific accuracy in identifying pollen types but rely on manual, analog sampling, lacking the immediacy required for daily decision-making. To overcome this limitation, modern automated systems predominantly employ electrical measurement techniques based on optical (laser) scattering[2].

As illustrated in Fig. 2, this method works by drawing air into a chamber using a small fan. A laser beam illuminates the airborne particles, and a photodiode captures the scattered light. This allows for the real-time counting and estimation of particle sizes, including pollen.

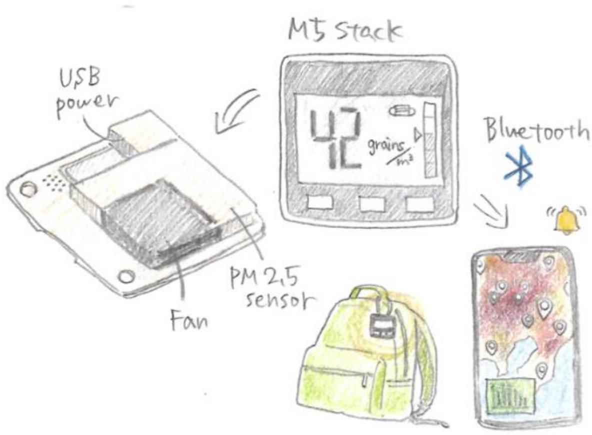

Fig. 1. System Architecture and Data Ecosystem.

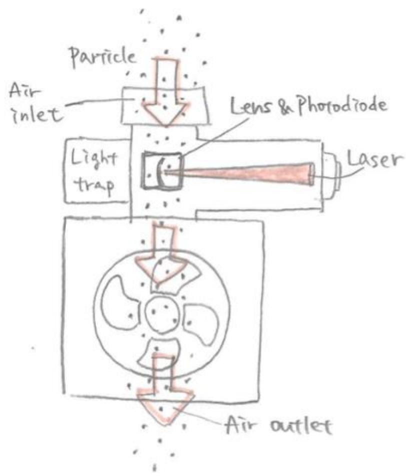

Fig. 2. Schematic of a typical laser scattering sensor. Air is drawn in by a fan, and a laser illuminates the particles. A photodiode detect the scattered light to count and measure the particles in real-time.

While existing stationary automated systems (such as Shinyei's PS2[3] or Weathernews' Pollen Robo[4]) utilize this scattering principle to offer high-quality, real-time data, they are confined to fixed locations. This proposal fills the void by miniaturizing this optical scattering technology, prioritizing portability and real-time personal context, and thereby transforming a stationary measurement into a wearable experience.

III. Imagined or existing prototype sketches/drawings/photos

A. Hardware design and core components

M5Stack was selected for its integrated architecture—combining a display, battery, and ESP32 microcontroller into one module—which enables rapid prototyping of the wearable concept without custom circuit design.

- Core Unit: M5Stack Basic/Core2.
- Sensor: PM2.5 Sensor Unit using laser scattering.
- Power: Built-in Lithium-ion battery for portability.

B. Software integration and user interface

To optimize the user experience, the following two features are implemented:

- Intuitive Alert Display: Rather than just displaying numerical values, it suggests specific actions according to the dispersion level, such as "Mask Recommended," "Glasses Recommended," or "Refrain from Going Out".
- Smartphone Integration: Data is sent to an app via Bluetooth, and by linking with GPS, the dispersion status is recorded and visualized on a map.

C. Usage scenario

Attached to a bag as a keychain, users can check the pollen dispersion level on their smartphone or the device's built-in monitor whenever they are concerned about the pollen amount.

To illustrate the practical value of this ecosystem, consider two common daily scenarios:

Daily Commute: Before leaving the house, a user can instantly check the device or their smartphone. Instead of relying on a broad, city-wide forecast, they receive accurate, real-time data for their immediate neighborhood, allowing them to make a confident decision on whether to wear a mask that morning.

Weekend Planning: When preparing to visit an unfamiliar location for the weekend, the user can consult the cloud-based "Pollen Map" on the app. By accessing crowdsourced data gathered by other users who have already been to that area, they can proactively prepare (e.g., taking medication or bringing protective glasses) before even arriving.

IV. Responsible innovation

This research aims to contribute not only to the promotion of individual health but also to the reduction of environmental impact. Specifically, an IoT integration could be considered where indoor smart air purifiers are activated only when this device detects pollen dispersion. This could prevent unnecessary continuous operation, potentially realizing energy savings.

Furthermore, as this system involves location-based data sharing, I am committed to ensuring strict data privacy. All GPS-linked dispersion data will be fully anonymized before being uploaded to the cloud, ensuring that personal privacy is protected while contributing to the collective good.

V. Future Work

Through this project, I have identified two primary areas for future development:

Substance Identification via AI and Collective Data: Current PM2.5 sensors estimate particle quantity based on light scattering, but they cannot inherently distinguish between substances of the same size, such as pollen and dust. To address this, I plan to explore the use of AI algorithms and crowdsourced data. By analyzing environmental patterns from multiple users simultaneously, it may be possible to distinguish pollen signatures from other microparticles, significantly improving detection accuracy.

Hardware Optimization for Scalability: While M5Stack is an excellent platform for rapid prototyping, its unit cost is high for mass production. In the next phase, I aim to transition to a more cost-effective hardware design using discrete ESP32 modules and custom PCBs. This will make the device more affordable and accessible to a wider range of users, fulfilling the goal of large-scale "pollen visualization."

VI. Author bio(s) / experiences

I am currently a third-year high school student at Shoei Girls' Senior High School. Having dealt with pollen allergies for many years, I have often looked for practical ways to manage my symptoms more effectively in daily life. This personal experience sparked my interest in design engineering—the idea of using technology to solve common, everyday problems. While I am still early in my journey as a maker, I am eager to use this Lancaster Summer School as an opportunity to challenge myself and transform a personal frustration into a functional, helpful solution.

VII. Acknowledgements

I would like to express my deep gratitude to my family, who provided tremendous support and meaningful advice in conceiving this project.

VIII. References

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