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DRAPER LABORATORY

TECHNICAL CHALLENGE COMPETITION

for

NSBE STUDENTS

CHALLENGE

Detect Allergens: The release of harmful gases into the environment, intentional or otherwise, remains a constant threat to one's personal safety. Airborne allergens, food allergens, and other contagions can be harmful and some cases deadly. Peanut allergies and its adverse reaction is a growing concern and highlight the need for better personal awareness of these contagions. In recent years, we have seen the proliferation of warning labels on food packaging in cafeterias and in restaurants. The wide use of cell phones can offer a level of safety to better deal with these threats. Discuss how cell phone technology coupled with smart-phone applications and mobile sensing can be applied to provide a level of personal safety from these threats.

Section 1: Introduction

Due to a relatively long history of industrialization, the effects of seasonal changes and the modern forms of food processing, we now live in a society where the occasional development of allergic ailments has become the norm. The modern day smart phone has introduced a variety of functions that are readily accessible to a large user base. Coupled with its processing power, I propose a compact 2-in-1 air/food allergen testing device that works in conjunction with a smartphone application via bluetooth technology. It is important to note that an external device is most feasible considering that very few smartphone manufacturers will be willing to take on the additional cost burden of adding any facet of the technology to be discussed. Furthermore, by cutting out some of the "hardware fat" such as the LCD display present on most of the existing models of similar ilk, a size efficient device is born.

Section 2: Preliminary Design

1. Detecting Air Allergens (Airborne Optical Particle Counter)

The most efficient technology in small particle counting is in the realm of the detection of laser light scattering due to the interference of said particle in question. In order to heighten the accuracy of this section of our device, a total of 6 semiconductor lasers (a variety of green, blue and red) with their corresponding photo detectors will be placed in staggered form in a non-volumetric chamber. This will prove to be a more elaborate/effective detection system because of the different laser frequencies and their positions, therefore increasing air test quality. In addition, each laser will have special optical masks to refine the incident light by solely exposing the more intense areas at the laser's center. A high flow rate coupled with a diffuser

setup and a relatively small axial fan will be able to test a larger air sample. A pulse height analyzer acting as an A-D converter amplifies the minute electrical signal spikes unique to each laser over the air test period. Finally, the data obtained during this timeline will be wirelessly transferred to the phone in real time for analysis.

2. Detecting Food Allergens (Raman Spectroscopy)

Also a scattering based technology, the incident light (usually in the ultra-violet range for better resolution) is shone on the test subject where it notes the relatively small percentage of dispersed light that undergoes a phase shift. The phase shifts in question occurs when the incident UV laser comes in contact with the molecular vibrating energy levels distinct to each test sample. The plotting of these phase shifts brings about the Raman Spectra. Like a finger print, all food stuffs possess their very own Raman Spectra and its equivalent spectroscopy is known to yield some of the most accurate results. In addition, a green laser that is closely parallel to the invisible UV ray is simultaneously activated once food testing has begun to indicate the initialization and continuation of the test process. This laser also provides a reference for the 1 inch maximum distance the device has to be from said test sample to be most effective. The data collected is live streamed to the phone wirelessly for analysis.

3. Smartphone Application

Smartphones have far more powerful processors when compared to other devices with a similar mono-functionality such as that of the allergen detectors previously described. This gives them a greater ability to process the data obtained via bluetooth, then run a background check against a far more extensive allergen list (perhaps by means of an online source) than that installed on a standalone device. The added feature of being able to keep track

of numerous tests and the availability of a smarter, more interactive and more comprehensive display unit makes it an invaluable asset.

Section 3: Conclusion

This product is most feasible in that it has the potential to work on all smartphone software platforms without tampering with each phone's designed hardware. It is important to note that this device will be rechargeable. The proposed device will be capable of running at different test time modes for varying levels of effectiveness. Also, multiple testing should be conducted for the best results, especially when the food test subject is macro-heterogeneous (e.g. salad). In addition, a library of all allergens in existence can be constantly refined and details concerning each allergen will also be provided on the application. A dual functioning, compact, and portable air/food allergen detector with wireless technology in conjunction with a smartphone application will serve as protection against potential allergens.

References

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- **Raman Tutorial** - https://depts.washington.edu/ntuf/facility/docs/NTUF-Raman-Tutorial.pdf
- **What is Raman Spectroscopy?** - http://www.inphotonics.com/raman.htm