Development of a low-cost environmental sensor with remote real-time monitoring of indoor particulate, temperature and relative humidity.

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INTRODUCTION

Particles suspended in the air and inhaled influence symptoms, lung function and exacerbations in many pulmonary diseases, particularly among morbid and susceptible populations. For the first time, recent technological advancements make low-cost, direct-reading telemetric instrumentation for exposure estimation a possibility for industrial hygienists and exposure scientists.

The objective of this study is to develop such an instrument and validate it against industrial hygiene standards facilitating the conversion of particle counts into exposure estimates.

METHODS

Engineers retrofitted Dylos 1100 Pro Particle sensors with a Beagle Bone Black (Linux-Based computer), a temperature & relative humidity sensor (SHT21), Wi-Fi adapter, a higher resolution RGB color display, and software modifications to permit remote data logging, web and mobile application interfaces. Industrial Hygienists compared the modified Dylos units to Dylos units against primary and secondary sampling systems in a test chamber using known aerosols. Comparators were: A Grimm No. 1.109 Aerosol Spectrometer and traditional gravimetric impactor samplers (SKC PM2.5).

RESULTS

• Successfully retrofitted Dylos 1100 Pro units with additional components and software installed is shown in Figure 2.
• Graphical representation of the performance of 3 Dylos units estimating PM2.5 while operating simultaneously in the test chamber with uniform aerosol challenge (Figure 3).
• Figure 4 demonstrates the relationship in particulate counts in the range of 0.5 - 2.5 µm (an approximation of PM2.5) for an average of the three randomly chosen modified Dylos units and a Grimm 1.109.
• Figure 5 shows the particulate count graphs as they can be reported on the web interface. This graph also contains the user-supplied notations accompanying high particulate count events. These are updated in real time.
• Figure 6 displays a portion of the smartphone app interface reporting the user tagging of particulate excursions. This permits researchers to identify activities that lead to elevated particulate in homes.

CONCLUSION: The performance and features of the modified Dylos combined with its low cost vastly increases the quantitative and observational capability of exposure/health research where indoor airborne particulates are of concern. Our current efforts are to complete a comprehensive statistical validation of the modified Dylos for operation in indoor home environments.

FUTURE WORK

• Integration of low cost real time monitoring devices like this into studies to investigate the developmental origins of health and disease (DOHAD).
• Miniaturization of the instrumentation to allow wearability for personal monitoring and individualized exposure assessment.
• Upgrade the analytical engine to enhance reporting and become predictive of potential exposures permitting behavior changes to limit personal exposures and/or health exacerbation related to exposures.

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