Tech Brief on Malodar Alert by COTS Sensors Integration

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A Malodor Alert by COTS Sensors Integration

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Deliverable 4. Gap analysis and recommendations on next steps

Introduction

Malodors in and around toilets, and released during fecal sludge management activities remain an important risk factor for adoption of sanitation products and technologies. One critical need is to develop the ability to monitor odor, even crudely, to provide feedback in the event a significant malfunction. The purpose of this study was to explore the technical possibility to accomplish this using low costs gas sensors.

Project outcomes

Low-cost gas sensors were screened for their ability to respond to exposure to fecal odors. The gas sensors selection was expanded to 12 sensors from 4 different vendors from the original 3 from one vendor and resulted in original and promising results. The project established early on a collaboration with Prof Marc Deshusses and his student to leverage his expertise and capabilities in gas sensing and olfactometry.

A small and mobile test platform that includes odorous air generation and metering was developed and constructed. The system can be connected to an exhaust or ambient air for field testing. For laboratory experiments, an attachment enables generation of fecal odor air streams from both fresh feces and thermal processing of feces. The system allows simultaneous testing of 16 different gas sensors connected to a data logging system. The system allows for odorant dilution to measure dose response (figure 1).

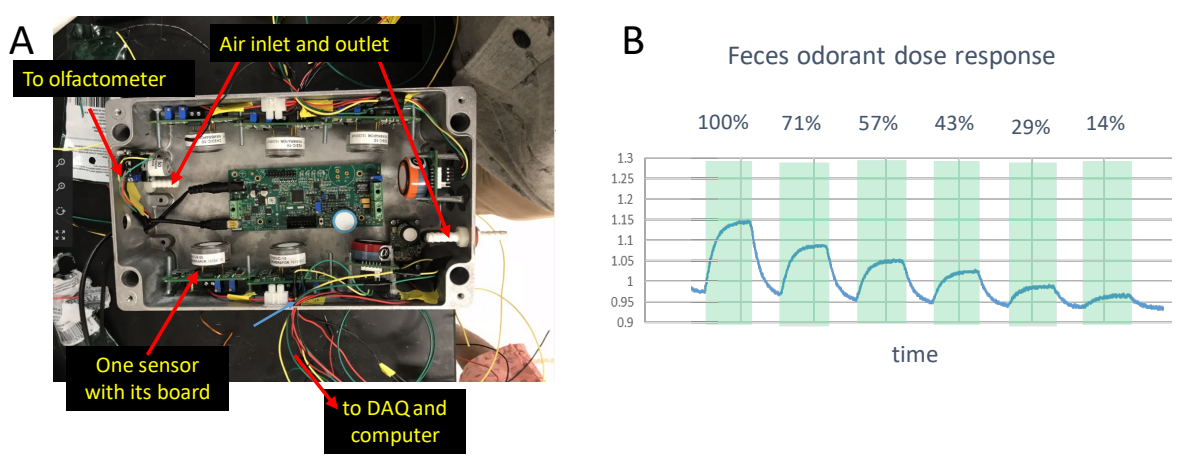

Figure 1. A picture of the odorant exposure testbed with 12 sensors. B example of a dose response to feces odor by one low-cost gas sensor.

In parallel, olfactometry was conducted on the air undergoing testing, so that chemical sensor responses could be correlated to olfactometric data (D/T dilution to threshold measurements).

A major finding of this project was that several of the electrochemical sensors (H2S, NH3 and THT) selected for this project did respond to fecal odors and mostly with a linear dose response. An unexpected and exciting finding is that, the most sensitive gas sensors to malodor is Formaldehyde (CH2O) from the vendor Membrapor. The sensor response were correlated with olfactometry D/T with typical values ranging from 208 down to as little as 10.

These findings demonstrate that this approach holds promise for the realization of a low-cost malodor sensor for sanitation systems.

The study produced a large dataset and s collaboration was established with the computational research group of Krish Chakrabarty from Duke ECE to support analytics toward the development of an alert algorithm.

Gap analysis

This effort identified also engineering gaps that can be addressed with additional funding. The false positive response of the sensors was explored by exposing them to pleasant odors. The test revealed that the system specificity could be improved and in particular that environmental humidity is a powerful interferents that should be accounted for.

The study was also focused on fecal specimen, however urine malodor (and as well as urine/feces mixture) is a major challenge at the user interface and it was not investigated.

Recommendations

In view of the promising results obtained, the recommendation is to further develop the evaluation of this approach and to conduct additional data collection and analytics development.

The goal of the continuation of this effort is to further refine the design of a robust hardware and software solution .amenable of integration with a third party sensor field testing platform.

The recommendation includes further specimen data collection in order to establish robust specificity. These would require the addition of a high quality humidity sensor and systematic evaluation of interferents and urine/feces mixtures. The study may also include assessment of chemical odor modulation in the context of assessment and improvement of sensor specificity.

The preliminary data analytics approach should be developed to define specificity with proper correction for interferents.

The final objective of this effort is to position this technology to be picked up for product development by a different funding source or a commercial entity.