Bin-ary: Detecting the State of Organic Trash to Prevent Insalubrity

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Abstract
Bin-ary is a self-contained gas detector that analyzes organic trash odor compounds and releases subtle burst of scent when bad odor is detected. The prototype is meant to be used as a plugin to make trash bins and dumpsters smarter and prevent insalubrity in cities and villages.

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Intelligent Environments; Sensors; Sustainability; Internet of Things; Olfaction.

ACM Classification Keywords
H.5.m. Information interfaces and presentation: Miscellaneous; H.5.2. User Interfaces: Prototyping.

Introduction
We generate 21.5 million tons of food waste each year [1]. The average person generates over four pounds of trash every day and about 1.5 tons of solid waste per year [2]. This causes unsanitary conditions and poorly maintained dumpsters, bad odors, rats and cockroaches. What if we could monitor this situation by designing smarter garbage systems for our homes, cities and villages?

While a lot of research and commercial products are putting efforts on transmission and reproduction of smell, there is still a lot to do regarding the sensing part of digital scent technology. Researchers have being trying to overcome the limitations and challenges of smell-based technology by using olfactometers and building electric noses. However, in order to reach sensing capabilities similar to the human olfactory system, we still require significant advances and experimentation with chemical sensors.

With *Bin-ary* we explore how to maximize the possibilities of current off the shelf gas sensors to detect chemical odors that are released by aged food. We focus on three main chemical compounds, rather than building an electric nose for multiple case scenarios. We created a prototype that senses rotten food gas compounds and transmits a nice fragrance when a non-pleasant smell is detected. It also allows the user to better understand what the state of the food is through a simple user interface.

In this paper, we present a prototypical implementation of a sensing and smell-composing device designed to detect food in bad state and obfuscate resultant bad odors by exuding masking smells. The data detected can be sent via Wi-Fi to your computer and smartphone device. The system is portable and can be embedded in dumpsters and trash bins to make them smarter (Figure 1).

Related Work

The history of olfactory research can be first dated to the late 50's, when scents were released during the viewing of a film, so that the viewer could associate certain smells with scenes of the movie (*Smell-O-Vision* and *AromaRama*). More recently commercial inventions are *Smelling Screen* [3] or *OPhone* [4], that allow odors to be produced by a digital display screen. For the last decade, researchers and product developers have created a variety of items that enable scent to become part of digital communication. Projects like *Scentee* [5], which emits a fragrance when a notification is received in your smartphone or Ranasinghe et al. [6] that enables sharing fragrances over the Internet.

Other researchers have explored how smell can trigger certain memories or longings [7]. Brewster et al. [8] developed a smell-based photo-tagging tool to elicit memories though smell. *clayodor* [9] triggers certain scents through user manipulation of clay material.

Figure 1. The prototype can be placed inside a trash bin or placed in between the trash can and the plastic bag.

Implementation

The prototype (Figure 2) consists of a smell dispenser (A)(B) to release the fragrance, and a compact case for the odor sensing part (C).

Actuation and smell release

When a scent liquid or oil is placed in the dispenser (B), it is spread through the nozzle (A) in form of vaporized fragrance. Like a regular ultrasound atomizer, when a high frequency is applied to a piezo transducer (placed in the nozzle), the conversion is returned as vibration that turns the liquid to vapor. In order to properly vibrate the piezo transducer, a frequency of 100KHz and 10V AC was applied.

Detection of odor compounds
In order to detect the state of organic trash we primarily focused on the chemical compounds that are produced when food starts to rotten or ripen: Hydrogen Sulfide (H2S), Ethylene (C2H4) and Carbon Dioxide (CO2). H2S is a gas with the characteristic foul odor of rotten eggs that it is heavier than air. Fermentation produces CO2 and C2H4 is emitted when fruit starts to ripen. Without a particular scent and invisible to the eye, ethylene gas (C2H4) in fruits is a naturally occurring process resulting from the ripening of the fruit. Hydrogen (H) and Carbon Monoxide (CO) levels were also tracked to maximize the accuracy and experiment with the data obtained.

Our prototype consists of a Microcontroller, a Bluetooth radio and five gas sensors (C2H4, CO2, CO, H2S and H). The data obtained by the sensors gives different voltage outputs depending on the intensity of the odor compound. This data is processed and analyzed (Figure 3). The output is mapped with 4 different LED colors that indicate the state of the food (Figure 2, bottom image).

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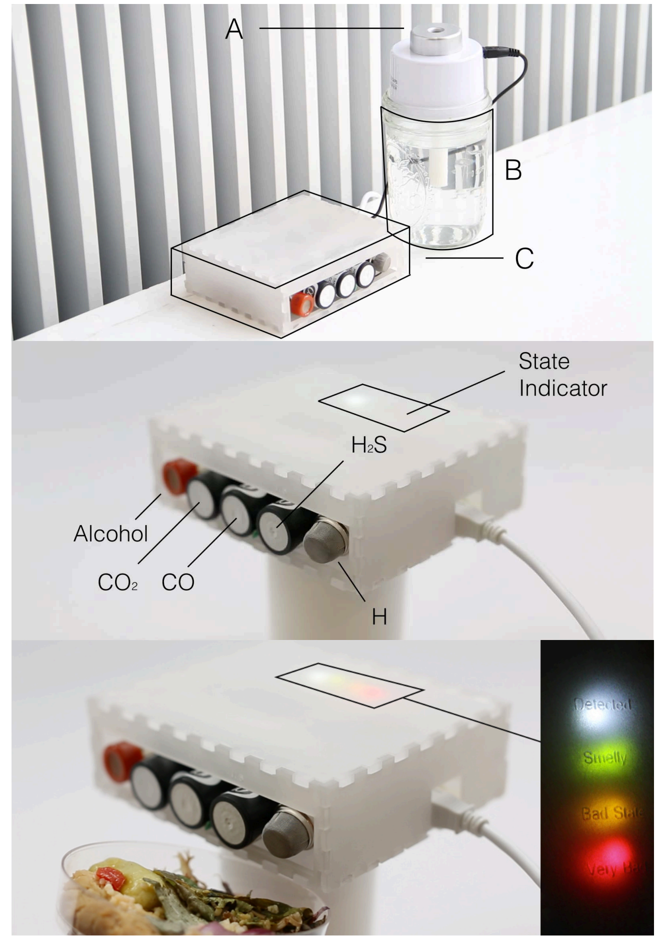

Figure 2. On the top: (A) Subtle burst of smell will be triggered. (B) Smell dispenser. (C) Laser-cut case, contains a compact version of the gas sensors and electronics. It analyzes and sends the gas sensor data. The visual feedback is a state indicator (middle and bottom image): white color when an odor is “Detected”, green when it is “Smelly”, orange for “Bad State” food, and red for “Very bad” state.

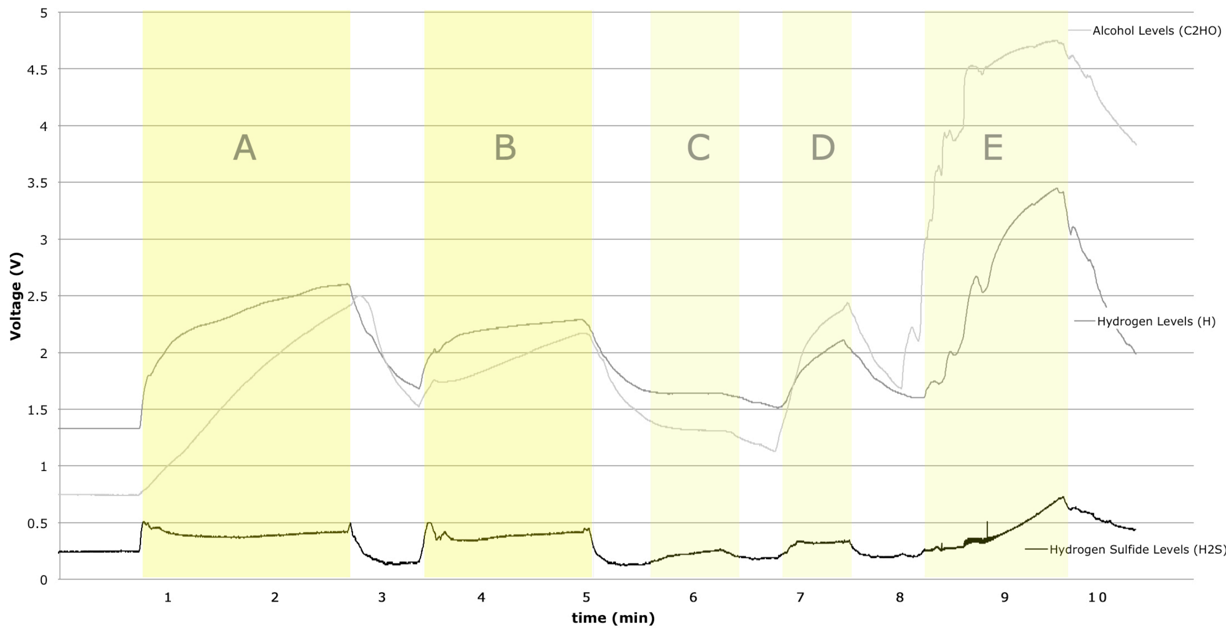

Figure 3: In the graph we can see how the output voltage for each one of the sensors varies in relation to the state of the food. Old leftovers: (A) 5 days old. (B) 7 days old. (C) Newly opened honey, (D) 7 days rotten fruit, (E) alcoholic beverage. The average values of the H2S, H and C2HO gas sensors outputs, make possible to successfully differentiate between food that is in good or bad conditions.

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