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Detecting the Food Spoilage in Refrigerator using Food Sensor

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Abstract-Refrigerator is an essential food storage technique that lowers the reproduction rate of bacteria. But in certain situations we may fail to notice the food items that are unused in long-term storage inside it. This paper is developed to meet this problem of food spoilage, with the use a sensor which is a small chip used to detect the spoilage of the food items by sensing it continuously. Here the sensor continuously monitors the growth of yeasts and microbes from the spoiled food placed in the refrigerator. This will detect the freshness of the food items placed on the tray and shows the signal based on the freshness of the food through light and alarm. Using this alarm, it will be possible to control the food quality throughout the consumption chain. This wireless sensor is passive and simple in design, making it an inexpensive, battery-less option for remote monitoring of food freshness during its shelf life.

Keywords- food quality monitoring, gas absorption sensor

I.INTRODUCTION

Food freshness is a key public health issue for both the consumer and food processing industry. Food borne pathogens are a major cause of illness resulting in 3,000 deaths and 128,000 hospitalizations occurring in the United States annually. Therefore, monitoring food quality is important in order to manage the safety of food [1], [2]. During the food spoilage process, growth of yeasts and microbes result in organic acids, and volatile acidic and basic gases. These by-products can lower or raise the pH of the environment within and surrounding the food [3]. For example, milk spoilage produces lactic acid [3]. Fish spoilage produces acetate, ammonia and CO_2 [4], [5]. In this paper we present a sensor that detects the presence of acidic and basic volatiles through the absorption of these volatiles into a volume of hydrogel from the gas space surrounding the food. The sensor allows remote detection of the acidic and basic volatiles. It does not require any direct contact with the fluid surrounding the food, and thus avoids the problems with detection in dry foods, electrode fouling, and food contamination.

Chemical sensing is of critical importance to human health, safety, and security, yet it is not broadly implemented because existing sensors often require trained personnel, expensive and bulky equipment, and have large power requirements. A study reports the development of a smartphone-based sensing strategy that employs chemiresponsive nanomaterials integrated into the circuitry of commercial near-field communication tags to achieve non-line-of-sight, portable, and inexpensive detection and discrimination of gas-phase chemicals (e.g., ammonia, hydrogen peroxide, cyclohexanone, and water) at part-per-thousand and part-per-million concentrations.

II.EXISTING SYSTEM

A.*Electronic Nose*:

In the existing systems an electronic nose(2004) is used to sense the decay of the food that is unused for a long period of time. Electronic Nose Working Principle: The electronic nose was developed in order to mimic human olfaction whose functions are non separate mechanism, i.e. the smell or flavour is perceived as a global finger print. The electronic nose consists of three major parts which are detecting system, computing system, sample delivery system. The proposed electronic nose system was tested with the smells of three fruits namely, leman, banana, litchi. The smells were prepared by placing a sample of fruits in the breakers sealed with a cover. The 8051 was set in to testing or training mode. If the system is in training mode, sensor value

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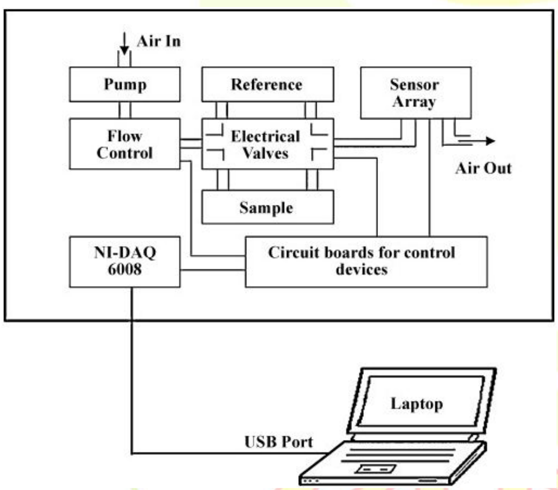
is shown on the LCD. If the system is in testing mode, classification result of the target fruit is shown on the LCD. The sensor array gets the gas through Valve1, which is normally closed. The vacuum pump is turned on for 20 sec to pump the gas out of the sensor array.The value1 was closed and the sensor resistance was given 60 sec to reach a study state mode. The classification result of sensors characteristic value appeared on the LCD. The sensor array chamber was disconnected from the fruit sample breaker and the valve1 was opened to turn fresh air, the valve 2 was opened so that the smells were pumped out. The chamber was aired out with fresh air for two minutes.



B. ***Versatile Gas Detector:***

Chemists at MIT have been working on a wireless, inexpensive sensor that, among other things, identifies spoiled food early by detecting gases in the air. The new sensors are modified near-field communication (NFC) tags, which are often used as proximity sensors. The team punched a whole in the tag's electronic circuit and then replaced the missing link with carbon nanotubes designed to detect particular gases. The nanotubes were drawn on using mechanical pencils, which were also developed in Swager's lab back in 2012. These sensors require little power, which comes courtesy of short pulses of magnetic fields emitted by the smart phone used to read them. Normally, these pulses induce an electric current in the tag's circuit that keeps it running. But in the modified tags, once the carbon nanotubes smell a targeted gas in the air the radio frequencies at which it receives these pulses is shifted. The sensor will only respond to the reading smartphone if the frequencies are unchanged, therefore indicating whether or not a targeted gas is present. The chemicals successfully sniffed out in testing include gaseous ammonia, hydrogen peroxide and cyclohexanone. While revealing rotting food is one potential use for the sensors, the minimal amount of energy required could see them deployed just about anywhere, possibly detecting everything from explosives to environmental pollutants to dangerous gas levels in manufacturing plants.

We have seen other devices emerge recently that are aimed at letting you know when food is unsafe to eat, such Peres and color-coded smart tags, though they don't quite promise the same versatility as MIT's newest creation. The researchers have filed a patent for the technology and are now further exploring its potential applications. They are also seeking to integrate Bluetooth technology to expand its range beyond 5 cm (2 in).

III.PROPOSED WORK

A. ***Food quality monitoring***

In this proposed system, the sensor senses the state of freshness of the food and alerts the user.The sensor monitors the growth of yeasts and microbes from the spoilage of food placed in the fridge. The information given by the sensor is transmitted from the device and signals the alarm-LED setup accordingly. Food Spoilage detector detects the following changes:

1.Appearance:Microbial growth mycelia or colonies visible on surface of food, development of cloudiness in liquids
Changes in food color due to heme or chlorophyll breakdown in pigments, growth of mycelia, etc.

2.Textural changes (feel): Slime formation due primarily to surface accumulation of microbial cellsn also be a manifestation of tissue degradation

3.Changes in taste and odor
Development of nitrogenous compounds (ammonia, amines, etc.) ,sulphides, organic acids

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B. ***Sensor operation and description***

Asensor is placed on the top of each tray in a fridge. When the moment a food item is placed, the sensor starts sensing it continuously for detecting gases that starts emitting when any decay found in it. As soon as the sensor detects any gas indicating the spoilage of food item, it automatically triggers the alarm in the system and the led glows in that particular tray. However this type of sensing is not possible when tight container is used to store the food item, since there is no chance of gas emitted from it. In order to solve this problem, sensor can be placed in the headspace of that container. The sensor consists of a hydrogel coated electrode pair is connected to a varactor based LC resonator circuit as shown in Fig. 1. A spiral inductor is used as the near-field coil. The potential difference between the electrodes acts as a biasing voltage to the voltage dependent capacitor (varactor). In Fig. 1, LS is the inductance of the spiral inductor, C(VC) is the capacitance of the voltage sensing circuit and VpH is the potential difference developed across the electrodes when coated with the thin layer of amorphous hydrogel. As acidic and basic volatiles are absorbed in the hydrogel, the pH of the hydrogel changes, varying VpH. The capacitance, C(VpH), changes in response to the low frequency change of the biasing voltage, VpH. The spiral inductor and capacitor form a resonant circuit with a resonant frequency, f0=1/2π((LsC(VpH)). An interrogator coil is inductively coupled to the sensor inductor and used to track the resonant frequency, which is directly related to the acidic or basic volatile absorbed by the hydrogel.

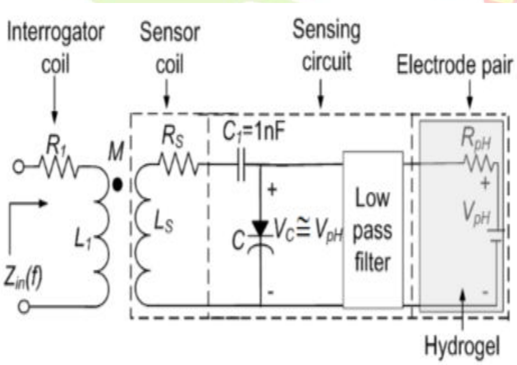

Fig. 1. Circuit diagram of volatile absorption sensor.

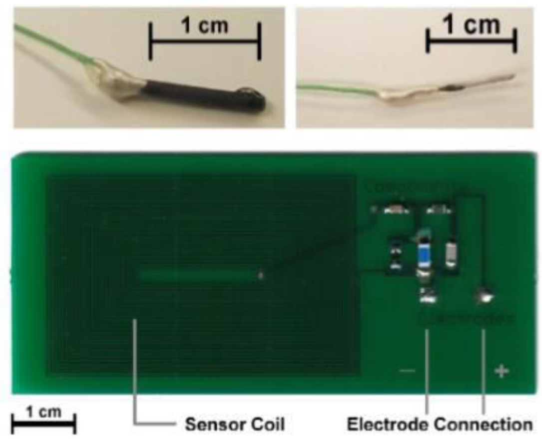

Fig. 2. Prototype volatile absorption sensor.

As in Fig. 2, a mixed metal oxide (MMO) electrode is used as the pH-sensitive electrode, and a silver/silver chloride electrode as the reference electrode. The sensor was designed for a resonant frequency, f0, near 6 MHz. The prototype sensor was fabricated on a 8 cm x 3.5 cm FR4 printed circuit board. The interrogator coil was constructed of 5 turns of insulated copper wire with a self-resonant frequency, fres=28.32 MHz. The sensor's resonant frequency was determined by measuring the real part of the impedance of the interrogator coil when coupled to the sensor coil using an impedance analyzer.

IV.EXPERIMENT

A. ***Acidic/Basic Volatile Absorption Test***

The assumption of acidic or basicvolatile absorption into hydrogel was tested using different concentrations of acetic acid (source of acidic volatile) and ammonium hydroxide (source of basic volatile) via ordinary evaporation at room temperature. The mean temperature, while not controlled, was 24.3° C (σ=0.7 °C) throughout all experiments. The MMO/AgAgCl electrode pair was coated with the a thin layer of amorphous hydrogel. The electrode pair was placed inside a large (1 L) beaker containing a smaller (50 mL) beaker. Experiments involved into two phases. In phase (i), 40 mL of deionized water was dispensed into the small beaker and the large beaker was sealed to create a closed environment. In phase (ii) the contents of the small beaker was replaced with 40 mL of different concentrations of acetic acid or ammonium

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hydroxide. The potential difference across the hydrogel coated electrodes, VpH, was measured using a high impedance voltmeter for each concentration of acetic acid or ammonium hydroxide and is shown in Fig. 4. The electrode potential, VpH, is dependent on the concentration of acetic acid or ammonium hydroxide and stabilized within a few hours. These results demonstrate that the sensor is capable of detecting acidic/basic volatiles in vapor to concentrations less than 0.04 M.

B. *Wireless monitoring of volatiles*

For wireless monitoring, the hydrogel coated electrodes were connected to the LC resonator circuit, as shown in Fig. 2. A two phase experiment, similar to the test described in the acidic/basic volatile absorption test section was performed. Here in phase (ii) 0.87 M acetic acid was used as an acidic volatile source. The resonantfrequency of the sensor was tracked by measuring the impedance at the interrogator coil. Fig. 5 shows the wirelessly monitored resonant frequency tracks the directly measured electrode potential response (Fig. 4) demonstrating that wireless monitoring of the resonant frequency of the sensor can be used to detect the presence of the acidic volatile.

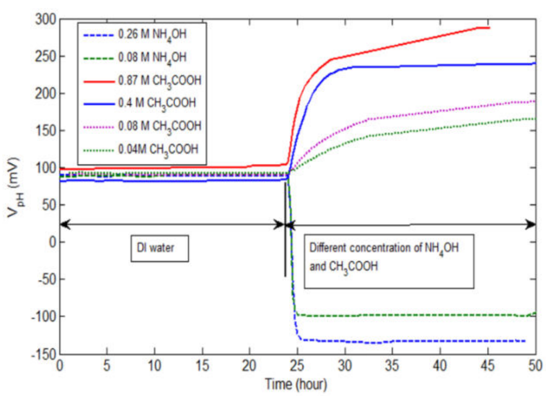

Fig. 4. Change of voltage across the pH-sensitive electrode pair in response to acidic/basic volatile absorption.

V.CONCLUSION

The results presented here demonstrate that the hydrogel coated electrode based sensor can wirelessly sense the change in concentration of acidic and basic volatiles. As the sensor is passive, it can be placed at top of the tracks inside a refrigerator and used to sense the food continuously for detecting spoilage.

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