

Request For Approval

ECE 445
Senior Design Laboratory
Team 25

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Problem

Maintaining the freshness of produce in household refrigerators is a common challenge. Spoiled fruits and vegetables not only lead to food waste but also produce unpleasant odors and can compromise the quality of other items stored nearby. Identifying and removing spoiled produce in time requires regular monitoring, which is often inconvenient for many people. There is a growing need for an automated system that can detect spoilage and provide timely alerts, thereby reducing food waste and helping users maintain a fresh fridge environment.

Solution

Our project aims to develop a monitoring device that can detect when produce inside a refrigerator is going bad. The system will utilize sensors to monitor humidity and detect ethylene gas, which is emitted by spoiling fruits and vegetables. Once spoilage is detected, the system will alert the user via wireless communication to an external LED indicator, which will be magnetically attached to the refrigerator's exterior. This solution will automate the process of monitoring produce freshness, allowing households to take timely action and reduce food waste, while also maintaining food quality and saving costs.

Solution Components

Sensor Subsystem

The sensor subsystem will be placed inside the refrigerator's designated produce drawer. This area is ideal for monitoring the freshness of fruits and vegetables since it is where most perishable items are stored. The following sensors will be used:

- **Humidity Sensor:** Monitors the humidity levels in the produce drawer. Elevated humidity can indicate a higher likelihood of spoilage.
 - DHT11 Humidity & Temperature Sensor
- **Ethylene Gas Sensor:** Detects the presence of ethylene gas, which is released by spoiling produce, which will be the key indicator of spoilage.
 - The 110-65x family Ethylene sensors are small and low-profile

These sensors will be connected to the microcontroller and will trigger hardware interrupts, allowing for real-time monitoring of the conditions within the produce drawer.

Microcontroller Subsystem

The microcontroller (ESP32 or equivalent) will collect data from the sensors, process it, and manage wireless communication with the external alert system. The microcontroller will be housed inside the refrigerator alongside the sensor subsystem. The processing of sensor data will trigger the alert system once predefined spoilage thresholds are met. It will use wireless communication protocols like Bluetooth or WiFi to send a signal to the LED alert on the fridge's exterior.

- **Microcontroller (ESP32 or similar):** Handles sensor data processing and wireless communication. It is capable of low-energy Bluetooth for continuous monitoring with minimal power consumption.

Wireless Alert Subsystem

The alert subsystem consists of an LED housed in a magnetic casing that can be attached to the refrigerator's exterior. This LED will blink or change colors based on the level of spoilage detected inside the produce drawer.

- **LED Indicator:** Provides a visible alert to users outside the fridge. The LED will be wirelessly controlled by the microcontroller to blink or change color based on the severity of spoilage.
- **Magnetic Housing:** Allows the LED alert system to be easily attached to the outside of the refrigerator.
- **BLE Receiver/Transmitter:** Leverage the microcontroller's BLE communication system that will also support our need for low power consumption.

Power Subsystem

The power subsystem will consist of a battery that powers the sensors, microcontroller, and wireless communication system. The device will be designed to minimize energy consumption, with long battery life being a priority.

- **Battery:** A battery that provides power to all components. It will be chosen to ensure that the device can operate for extended periods without frequent recharging.
- **Low-Power Design:** The device will be optimized to consume as little power as possible, with sleep modes when no spoilage is detected.

Criterion for Success

- **Accuracy:** The sensors must reliably detect humidity levels and ethylene gas concentrations, triggering alerts only when spoilage is likely.
- **Wireless Communication:** The microcontroller must effectively communicate with the external LED, ensuring timely alerts are provided.
- **User-Friendly Design:** The magnetic LED indicator should be easy to install and visible enough to catch the user's attention.
- **Battery Life:** The device should operate for several months on a single charge, minimizing the need for maintenance.

Alternatives

Traditional methods of detecting spoiled produce rely on manual observation or expiration date tracking, both of which can be imprecise or inconvenient. Our solution provides real-time, automated monitoring that removes the guesswork from identifying spoiled produce. Additionally, while some refrigerators come with built-in freshness monitors, they are often expensive and limited to high-end models. Our device offers an affordable and easy-to-install alternative that can work with any refrigerator.