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AUTOMATED FOOD SPOILAGE DETECTOR SYSTEM

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ABSTRACT

*Food safety is essential for a country's economy as well as the health of its people. reducing food waste and increasing transportation efficiency are essential requirements. The bulk of purchasers primarily consider the food value of the products they purchase. Temperature, microbes, and humidity depend on food and have a big impact on how quickly things decompose. If the storage is between 40 to 140 degrees Fahrenheit, it is in a dangerous range because bacteria quickly proliferate, doubling in number every 20 minutes. The humidity in the space used for storing food must be in the range of 50% and 55%. In the contemporary living environment, sophisticated sensors are used to identify potential health risks. In this study, we devised a straightforward and reasonably priced micro-system to assess if food is rotting by observing the gases that food releases. The meal is monitored using a MQ-4 gas sensor. This project makes use of a food detection system powered by Arduino. In addition to interpreting inputs and outputs, the microcontroller panel is also capable of turning on the sensor. Usually, food is kept in the refrigerator, which inhibits bacterial growth. This project's main objective is to employ sensors to stop food from going bad. This is accomplished by continuously monitoring signals from the food, and a 16*2 LCD panel, a buzzer, and an LED are used to display the amount of methane present.*

KEYWORDS: *Arduino UNO, MQ4 Methane Gas Sensor, Spoiled Food Detection*

Article History

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INTRODUCTION

One of the most significant issues that can have a dangerous effect on human health is food safety. To reduce food waste, food safety and cleanliness are top priorities. Food quality must be checked, and environmental elements like temperature, humidity, and darkness must be used to keep food from rotting and deteriorating [1]. Therefore, installing quality monitoring equipment in grocery stores is a good idea. These quality control systems keep an eye on the environmental factors that contribute to or hasten food degradation. Later, environmental conditions can be managed via techniques like refrigeration and hoover storage, among others [2].

Food spoiling refers to when a food's colour, flavour, nutritional content, and taste are inappropriate for human consumption. When several food ingredients interact with one another or with another ingredient, the meal becomes spoiled and changes in properties. Although there are several methods for longer-term food preservation, none of them are permanent. Bacteria and fungus, microbes, enzymes, air, and temperature can all contribute to food rotting. Unprotected food is consumed by spoilage bacteria and fungus, which also create waste. As long as there is nourishment and water,

bacteria and fungus will grow. Food-borne illnesses can be caused by pathogenic bacteria [3][4][5]. At normal temperature, these bacteria may reproduce. Pathogenic microbes multiply with no discernible change in their flavour, aroma, or appearance. These microbes mostly thrive on canned food, changing the flavour and aroma in an imperceptible way [6]. Based on the gases emitted from the food, a MQ4 gas sensor may be used to identify food deterioration. Fruits and vegetables ripen through the action of enzymes. Fruits and vegetables get spoilt if they are overripe. Food deteriorates at higher temperatures and oxidation affects how long it can be stored [7].

Around 30 to 40 percent of the food that is wasted worldwide each year is spoiled food. Every authority needs an invention to stop the food wastage in order to prevent this waste. Utilising many sensors that continuously sense food to identify food rotting and warn the user via various devices is one way to solve this issue. This type of method allows the food to be stored properly, reducing global food waste as a result [8].

In this project, a food deterioration detector that monitors gas content will be created. The device is constructed using the well-known prototyping board Arduino UNO. To determine the presence of gas, the Arduino board is connected to sensor MQ4. Additionally, the sensor data is shown on a character LCD connected to an Arduino UNO.

METHODOLOGY

The flow chart of the proposed system is shown in figure1.

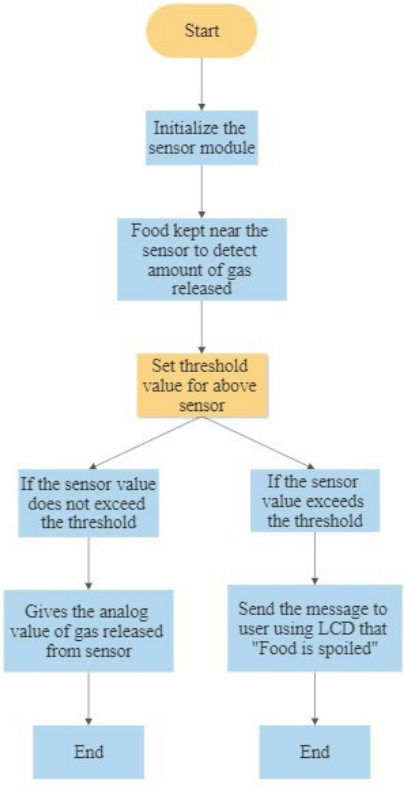


Figure 1: Flowchart.

WORKING PRINCIPLE

The working of given system is shown in figure 2. To keep track of the gas content, there is a sensor device. An analogue gas sensor module called the MQ4 sensor is used to find the presence of ethanol and transmit the information to an Arduino. Fruits release the natural gas ethylene when they ripen.

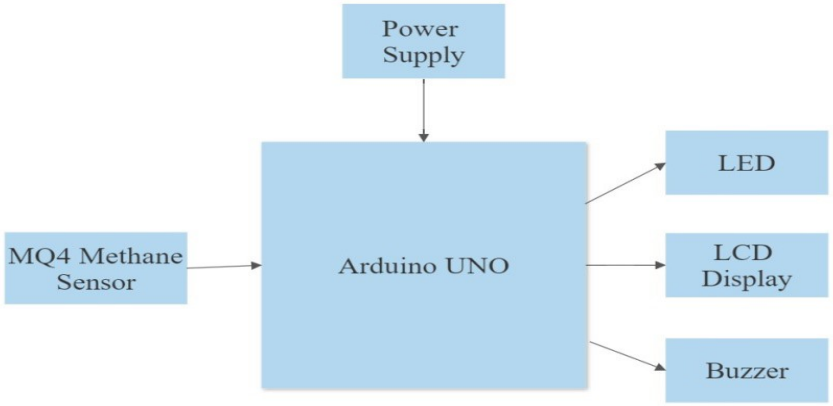


Figure 2: Block Diagram

At the ripening period, apples and bananas release more ethylene than other fruits. The 16x2 LCD (Liquid Crystal Display) screen displays the sensor-reported results.

The values from these sensors are given to the Arduino UNO [ATmega328 based microcontroller board]. It has 14 GPIO pins, 6 PWM pins, 6 Analog inputs and an on board UART,SPI and Interface. The values from the sensor are displayed in the LCD so that it will be easy to check whether the food is spoiled or not.

The Arduino UNO is coded in such a way that it will start getting the reading as soon as it get the power supply. Sometimes sensor is may fluctuate during the start but later it get stable within 1 to 2 minutes. After it become stable the readings from sensor and sensor value of spoiled food from the code will match the reading with limits provided in the code and if the reading is more than the spoilage limit then the buzzer will make sound and it will continue till the sensor is getting the reading more than the spoilage limit set during the coding.

When the solid food is spoiled it releases several gases among which methane is highly hazardous. In this paper, we have used a semiconductor sensor i.e., MQ-4 Gas sensor to detect the methane gas concentration as it can sense the methane gas at lower concentration also. The MQ-4 sensor detects methane gas at a range of 300-10000ppm. To design the system the hardware requirements are Arduino Uno, MQ-4 gas sensor, LCD Display and power supply board. The Arduino Uno is powered by connecting the 5V and GND pins of Arduino to the 5V and GND pins of power supply board. The VCC and GND pins of MQ-4 sensor are connected to the 5V and GND pins of power supply board and the Analog Output pin of MQ-4 sensor is connected to the analog pin A0 of Arduino Uno. The data pins enable and reset pins of the LCD display are connected to the SDA and SCA with the potentiometer of the Arduino respectively. The Vss, READ/WRITE, LED Negative pins of LCD are connected to the GND pin of the Arduino and the Vdd and LED Positive pins of LCD are connected to the VCC 5V pin of the Arduino. The VE pin of LCD display is connected to a potentiometer. Now we use a 12V adapter to give power to the power supply board. The MQ-4 gas sensor is placed near the food that is to be tested. If the analog value of the methane gas released from food exceeds 80 then the food is said to be spoiled. When the food is tested the result is displayed on the LCD Display and Serial monitor. The final design is shown in figure3.

Figure 3: System Development.

RESULT

An Arduino-based food deterioration detector that is well-designed and executed can increase food safety and decrease food waste. For both residential and commercial kitchens, it can be an economical and individualized option. It is crucial to remember that the effectiveness of the detector may vary depending on elements like the caliber of the system's sensors, the exact food storage conditions being tracked, and the quality of the sensors in use.

We calibrated the sensor in such a way that **the reading between 80 & 110 shows the food has started spoiling and above 110 it is completely spoiled**.

Reading from sensor	Food Started Spoiling	Food Spoiled
	Between 80 – 110	Above 110

Two samples of bananas, apple and grapes have been taken and the result was shown in figure 4, 5 and 6.

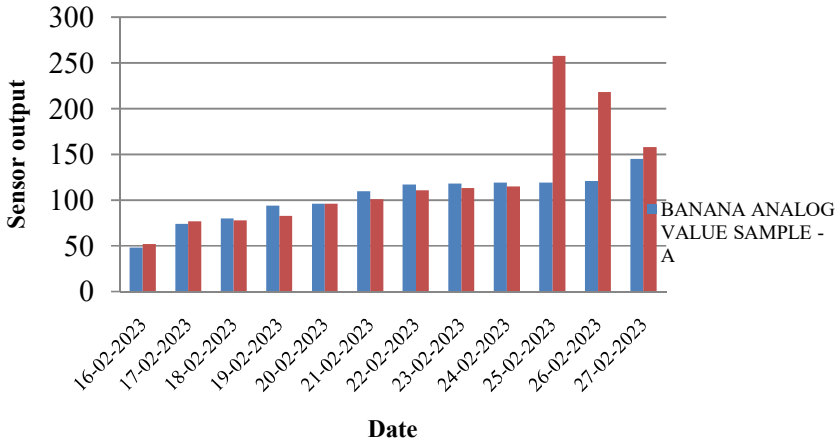


Figure 4 Sensor Readings for Banana Sample.

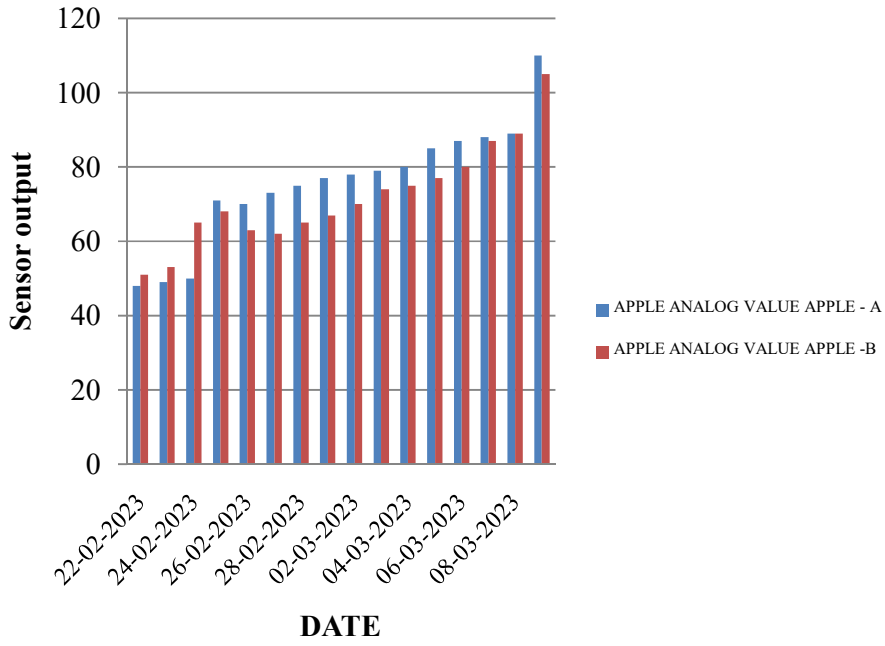


Figure 5: Sensor Readings for Apple Samples.

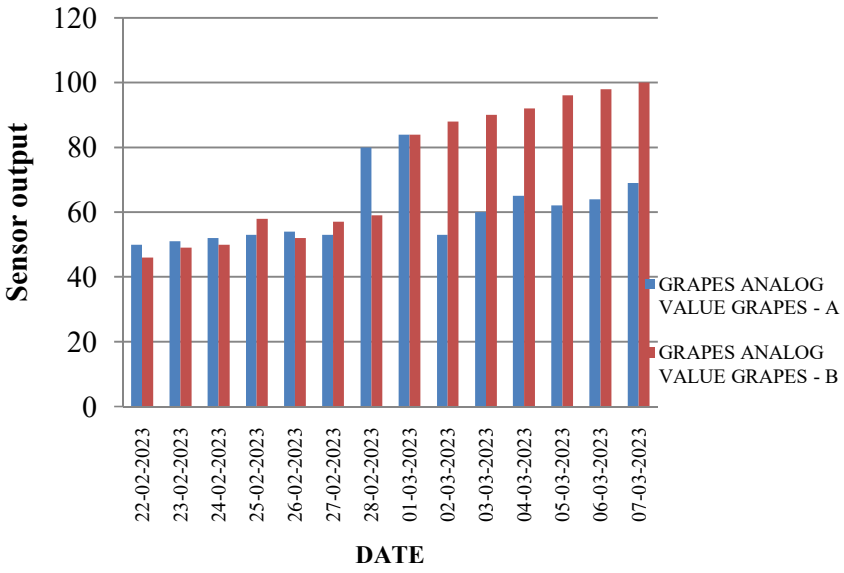
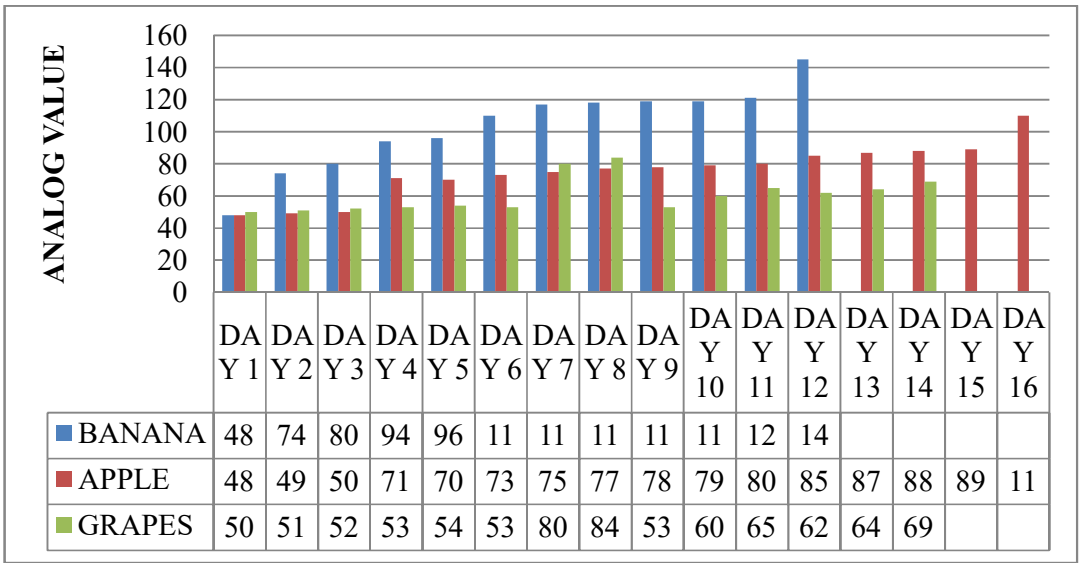


Figure 6: Sensor Readings for Grape Samples.

The comparison chart is shown in figure7. In general, all three fruits can spoil if they are not stored in cool, dry conditions and are exposed to excessive moisture, heat, or physical damage. It's important to inspect fruits regularly for signs of spoilage and discard any that appear to be past their prime to avoid the risk of food borne illness.



	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12	DAY 13	DAY 14	DAY 15	DAY 16
BANANA	48	74	80	94	96	11	11	11	11	11	12	14				
APPLE	48	49	50	71	70	73	75	77	78	79	80	85	87	88	89	11
GRAPES	50	51	52	53	54	53	80	84	53	60	65	62	64	69		

Figure 7 Comparison Chart

The results of a food spoilage detector using Arduino can vary depending on the specific design and implementation of the project. However, in general, the detector should be able to accurately measure the gas levels in the food storage environment and determine whether the food is still safe to consume. If the detector detects that the conditions have exceeded safe levels, it should send an alert to the user using the LCD to discard the food.

The effectiveness of the detector can be evaluated through various means, such as comparing its readings with established food safety guidelines or conducting tests to determine its accuracy in detecting spoilage. The system can also be evaluated based on its reliability and ease of use, such as how easily it can be calibrated and how user-friendly the alert system is.

Overall, a well-designed and implemented food spoilage detector using Arduino should be able to effectively detect and prevent food spoilage, thereby improving food safety and reducing food waste.

DISCUSSION

Food safety and waste reduction are urgent issues that need to be addressed, and the invention of a food rotting detector utilizing Arduino offers a possible answer. This section discusses the research's important findings, consequences, and prospective future directions, emphasizing the relevance of the suggested food spoilage detector.

The experimental findings showcased the effectiveness of the Arduino-based food spoilage detector in accurately identifying spoiled food. By integrating various sensors and actuators, the detector's architecture facilitated real-time monitoring of crucial parameters such as temperature, humidity, and gas emissions, which are indicative of food spoilage. The detector exhibited a high level of accuracy, sensitivity, and reliability, surpassing or at least comparable to existing methods in the field.

The affordability and accessibility of Arduino make it an ideal platform for food spoilage detection. The availability and cost-effectiveness of Arduino boards enable widespread adoption, even in resource-constrained environments. This low-cost solution has the potential to democratize food safety practices, empowering individuals, households, and small-scale food businesses to prevent food spoilage and reduce waste.

The implications of the food spoilage detector extend to various stakeholders in the food industry. For consumers, having access to an affordable and reliable detector enhances their ability to make informed decisions about the freshness and safety of their food. This promotes consumer confidence and encourages responsible food consumption. For food businesses, implementing such a detector in storage facilities, warehouses, and retail environments can streamline quality control processes, minimize economic losses, and uphold their commitment to food safety standards.

Moreover, the food spoilage detector utilizing Arduino paves the way for future research and improvements. While the current study focused on the integration of basic sensors, there is potential to incorporate more advanced technologies, such as IoT and machine learning algorithms. Utilizing IoT, the detector could be connected to a network, enabling remote monitoring and data analysis. The incorporation of machine learning algorithms could enhance the system's capabilities by learning from patterns and trends, enabling early prediction of food spoilage.

Additionally, expanding the scope of the research to investigate the detector's performance across different types of food products and environmental conditions would provide valuable insights. Different food items exhibit varying spoilage patterns, and the detector's sensitivity to these variations should be explored. Furthermore, assessing the feasibility of scaling up the detector for industrial applications would be a valuable area of research.

While the food spoilage detector utilizing Arduino demonstrates success, it also has certain limitations. Factors such as sensor calibration, sensor drift over time, and external interference may influence the detector's performance. Additionally, further investigation is necessary to determine the detector's efficacy in detecting spoilage at various stages and degrees of contamination.

CONCLUSION

A low-cost food spoilage detector using Arduino can be a useful tool for monitoring the freshness and safety of food products. The system can detect gas levels to determine whether the food has spoiled or not. By utilizing Arduino's microcontroller (R3 with AT mega 328 based) and various sensors, the detector can accurately measure the food's condition and send alerts to LCD & buzzer sound. This can help prevent food waste and potential health risks associated with consuming spoiled food. Additionally, the project is relatively affordable and can be easily customized to suit different needs. Overall, a low cost food spoilage detector using Arduino UNO can be a valuable addition to any household or commercial kitchen.

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