Spoiled Fruit and Vegetables Detection System

Project Exhibition Report

Submitted in partial fulfillment for the award of the degree of

Bachelor of Technology

In

Electronics and Communication (Specialization in AI & Cybernetics)

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

Submitted to
VIT BHOPAL UNIVERSITY (M. P)

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OCTOBER – 2023

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CANDIDATES' DECLARATION

We hereby declare that the Dissertation entitled "**Spoiled Fruit and Vegetables Detection System**" is our own work conducted under the supervision of **Dr. Deep Chandra Upadhyay**, Assistant Professor, School of Electrical and Electronics Engineering **(SEEE)** at VIT University, Bhopal.

We further declare that to the best of our knowledge this report does not contain any part of work that has been submitted for the award of any degree either in this university or in other university / Deemed University without proper citation.

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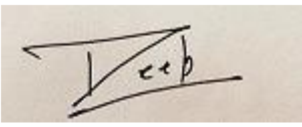

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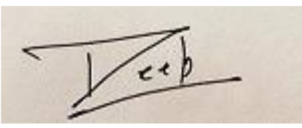
CERTIFICATE

This is to certify that the work embodied in this project report entitled **"Spoiled Fruit and Vegetables Detection System"** has been satisfactorily completed by **Mr. Saaransh Gupta (22BAC10027), Mr. Nishant Kumar (22BAC10047) & Mr. Sourabh Shrivastava (22BAC10026)** in the School of Electrical & Electronics Engineering at VIT Bhopal University, Bhopal. This work is a bonafide piece of work, carried out under my/our guidance in the School of Electrical and Electronics Engineering for the partial fulfilment of the degree of Bachelor of Technology.



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Acknowledgement

In the first place we would like to record our gratitude to "**Dr. Deep Chandra Upadhyay"** for his supervision, advice, and guidance from the very early stage of this thesis work as well as giving us extraordinary experiences throughout the work. Above all and the most needed, he provided us unflinching encouragement and support in various ways. His words have always inspired us to work in an efficient and comprehensive way. We would like to thank him for his constant encouragement that enabled us to grow as people. His presence has improved us as better human beings.

We thank our Program Chair **"Dr. Soumitra K Nayak**" who was always available to motivate and give suggestions and opinions during the periodic reviews of the Project that was conducted in the University.

We express our gratitude towards "**Dr. Debashis Adhikari",** Professor and Dean of School of Electrical and Electronics Engineering Department, VIT Bhopal University, Bhopal, for providing us all the help and permitted us to work with complete enthusiasm,

We shall remain indebted to "**Dr. Senthil Kumar Arumugam",** Vice Chancellor, VIT Bhopal University, for providing us institutional and administrative facilities during our project work at VIT.

Saaransh Gupta

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Executive Summary

Imagine a world where the freshness of your favorite fruits is guaranteed with a single glance. That's the promise of our innovative fruit ripe and rotten detection system. Harnessing the power of advanced sensors and cutting-edge technology, this project ensures that every banana and apple you pick is at its peak of ripeness. Picture a seamless process guided by ultrasonic precision for perfect fruit placement, a gas sensor sniffing out the ideal methane levels to distinguish ripe from rotten, and a user-friendly potentiometer allowing you to customize your selection effortlessly. With the Arduino Uno at the helm, this system not only detects the perfect moment of ripeness but also alerts you with a gentle buzz if a rogue rotten fruit tries to sneak in. It's not just a project; it's a flavorful revolution in fruit quality control.

In a world striving for sustainable practices, this project stands as a beacon of efficiency in agriculture and food distribution. The real-time feedback displayed on the serial monitor adds a layer of transparency to the process, ensuring that only the freshest fruits make their way to your table. But it doesn't stop there—imagine the potential impact on global food waste, as our system minimizes the chances of distributing overripe or spoiled produce. The adaptability of technology opens doors to a future where smart agricultural practices are the norm, and every fruit you savor is a testament to precision and innovation.

Step into a future where your fruit bowl becomes a testament to technological elegance. This project is not just about detecting ripeness; it's a symphony of sensors and a melody of microcontrollers working in harmony to redefine the way we experience the freshness of nature's bounty. With an eye on the future, this system is not merely a solution; it's a glimpse into a world where technology meets taste, ensuring that every bite is a celebration of perfect ripeness. Welcome to the future of fruit quality control—where innovation meets flavor, and freshness is always in season.

List of Figures

List of tables

List of Symbols & Abbreviations

Symbols:

VCC: Voltage Common Collector

GND: Ground

Trig: Trigger (Ultrasonic Sensor)

Echo: Echo (Ultrasonic Sensor)

Signal: Signal Output (MQ2 Gas Sensor)

Abbreviations:

MQ2: Methane Gas Sensor

IoT: Internet of Things

AI: Artificial Intelligence

LCD: Liquid Crystal Display

RFID: Radio-Frequency Identification

ML: Machine Learning

GUI: Graphical User Interface

LED: Light Emitting Diode

USB: Universal Serial Bus

API: Application Programming Interface

Table of Contents

CHAPTER 1: INTROUDCTION

1.1 MOTIVATION

The driving force behind this project is the desire to empower consumers with a tool that ensures they consistently enjoy the freshest and highest-quality fruits. In a world where visual assessments often fall short, the motivation is to introduce a reliable, technology-driven solution that transcends appearances, enabling users to make informed decisions based on real-time, sensor-derived data. Additionally, the project is fueled by a commitment to address the pressing issue of food waste by providing a practical means to identify and discard rotten fruits, contributing to more sustainable consumption practices.

1.2 INTRODUCTION

The food we take can affect any form of impurity that may happen due to storage or chemical changes within the food. In some countries, the majority of people struggle on a daily basis for food, due to preservation of foods and use of chemicals to artificially increase the time span of food causes people illness. It is mandatory to grow a system that can assist people to identify the elegance of food or quality of food items. The quality of the food should check to prevent it from spoiling under different environmental conditions like temperature, humidity, vegetable/fruit characteristics, which will be helpful to check quality through different techniques. The sensor senses the food quality through change in its colour. There are various signal processing and pattern recognition techniques to detect food intake time through sensors. The rotted or not fit for usage food causes a major food related illness called food poisoning, this is one of the diseases along with various other such diseases related to spoiled food.

1.3 OBJECTIVE

- **Enhance Food Quality Assurance:** Improve overall food quality by preventing the consumption of spoiled or potentially harmful produce, thereby reducing foodborne illnesses and waste.
- **Cost-Effective Solution:** Strive to create an affordable solution that can be implemented by farmers, distributors, and retailers without significant financial burden.
- **Regulatory Compliance:** Ensure that the system complies with relevant food safety and quality regulations and standards, facilitating its adoption by businesses operating in the food industry.

- **Real-time Detection Capability:** Implement a real-time detection mechanism to identify deteriorating produce as soon as possible, allowing for timely removal and replacement.

1.4 METHODOLOGY – BASIC OVERVIEW

The methodology used for a Spoiled Food Detection System Project typically involves several stages, including research, development, testing, and evaluation. Below is a high-level overview of the methodology commonly used for such a project:

1.Project Initiation
2.Research and Data Collection
3. Sensor Selection and Integration
4. Data Preprocessing
5. Machine Learning Model Development
6.Real-Time Monitoring System
7.User Interface Design
8.Testing and Validation

CHAPTER 2: LITERATURE SURVEY

Paper name -

- Global Methane Initiative. Global Methane Emissions and Mitigation Opportunities. 2011.
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- methane. Proc. Nat. Acad. Sci. USA 2019, 116, 2805–2813. [Google Scholar]
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CHAPTER 3: PROBLEM FORMULATION AND DETAILED METHODOLOGY

3.1 PROBLEM FORMULATION

Problem Formulation:

In the agricultural and food distribution industry, ensuring the timely identification of fruit ripeness is a critical challenge. The absence of a reliable, automated system for differentiating between ripe and rotten fruits poses a significant obstacle to maintaining quality standards. Traditional methods lack efficiency and are prone to human error, leading to increased instances of suboptimal fruit distribution and substantial food wastage.

Key Issues:

- **Inconsistent Quality Assessment:** Existing methods for assessing fruit ripeness lack consistency and are heavily reliant on subjective human judgment, resulting in a lack of precision and reliability.
- **Delayed Detection of Rotten Fruits:** The current delay in identifying rotten fruits in distribution chains contributes to the spread of spoilage and increases the risk of delivering subpar products to consumers.
- **Limited Adaptability to Different Fruit Types:** The absence of a versatile system that can adapt to the unique ripening characteristics of various fruits hampers the efficiency of quality control processes.

3.2 LIST OF COMPONENTS USED

Software Modules and Hardware Components used in the Project were:

- Arduino libraries
- Ultrasonic Distance Sensor HC-SR04
- Arduino UNO
- MQ2 Methane Gas Sensor
- 16x2 LCD Display
- Buzzer
- Potentiometer
- Jumper Wires
- Breadboard

3.3 DETAILED METHODOLOGY

1. System Setup:
Assemble the hardware components, including Arduino Uno, Ultrasonic Sensor, MQ2 Gas Sensor, Potentiometer, and Buzzer.

Connect the components according to the specified connections, ensuring proper wiring and adherence to voltage requirements.

2. Arduino Code Initialization:

Write an Arduino sketch to initialize and configure the pins for each component.

Include necessary libraries for sensor readings and communication.

3. Ultrasonic Sensor Calibration:

Implement a function to calibrate the Ultrasonic Sensor for accurate distance measurements.

Set a threshold distance for proper fruit placement.

4. MQ2 Gas Sensor Calibration:

Develop a calibration routine for the MQ2 Gas Sensor to establish baseline methane levels for both ripe and rotten fruits. Determine methane concentration thresholds for ripeness and rot.

5. Potentiometer Integration:

Incorporate the potentiometer readings into the system, allowing users to select the type of fruit being examined. Map potentiometer values specific fruit types for adaptability.

6. Main Loop Implementation:

Create the main loop to continuously monitor the sensors and make decisions based on sensor readings. Use the Ultrasonic Sensor to verify proper fruit placement. Read methane levels with the MQ2 Gas Sensor and compare them to predefined thresholds for ripeness and rottenness.

7. Decision Making:

Implement decision-making logic to determine whether the fruit is ripe or rotten based on sensor readings. Activate the Buzzer if a rotten fruit is detected.

8. Serial Monitor Output:

Display the results on the serial monitor, providing real-time feedback on fruit ripeness. Include clear messages indicating whether the fruit is ripe or rotten.

9. User Interaction:

Develop user prompts on the serial monitor to guide users through the proper use of the system. Ensure that users are informed about the selection process and receive alerts for rotten fruits.

10. Testing and Calibration:

Conduct thorough testing of the system with different fruits to ensure accurate and consistent results. Fine-tune calibration parameters as needed for optimal performance.

11. User Documentation:

Create comprehensive user documentation explaining the system setup, operation, and troubleshooting steps.

Include information on interpreting sensor readings and adjusting settings.

CIRCUIT DIAGRAM

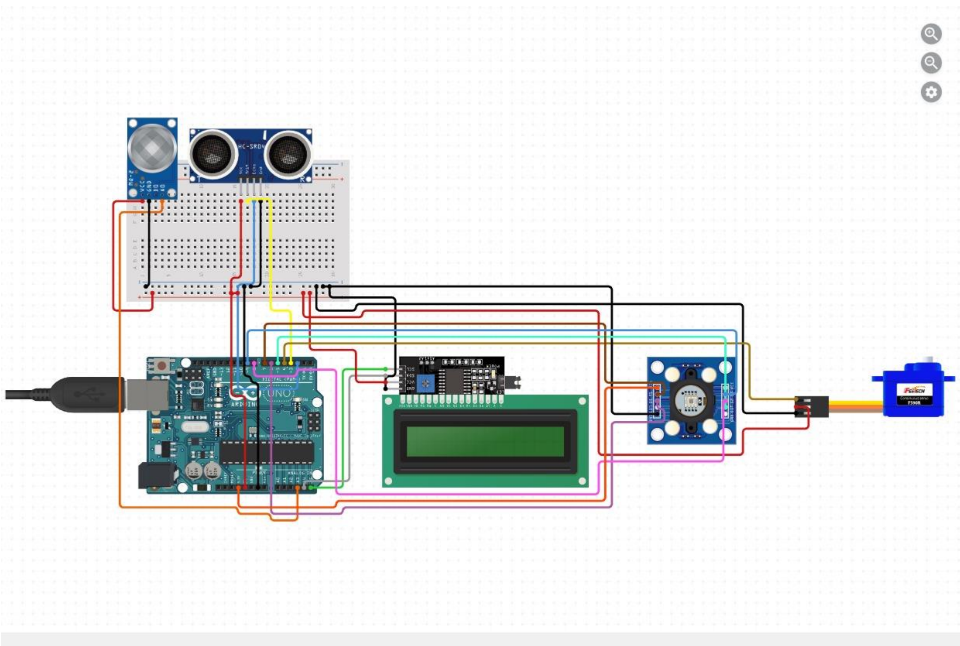

Fig. 1 Circuit Diagram

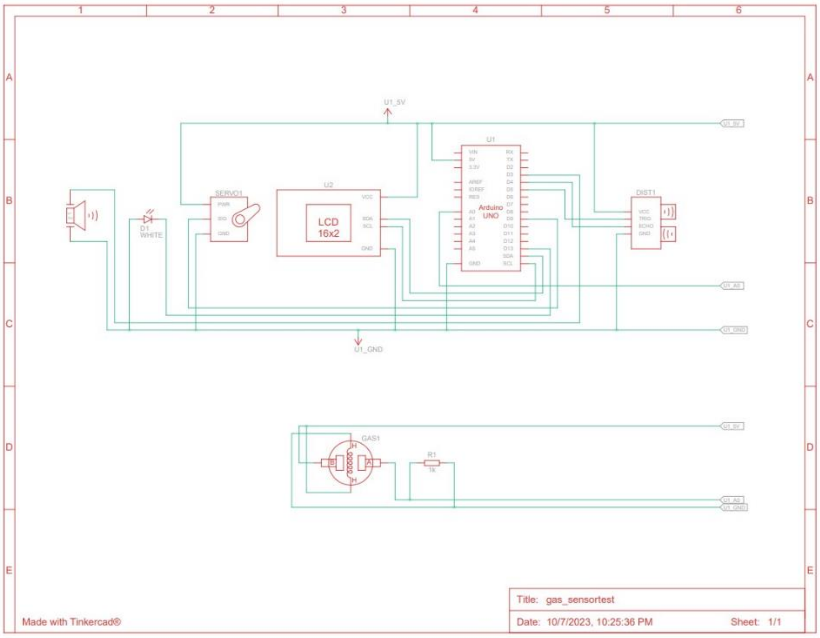

Fig. 2 Block Diagram

FLOWCHART

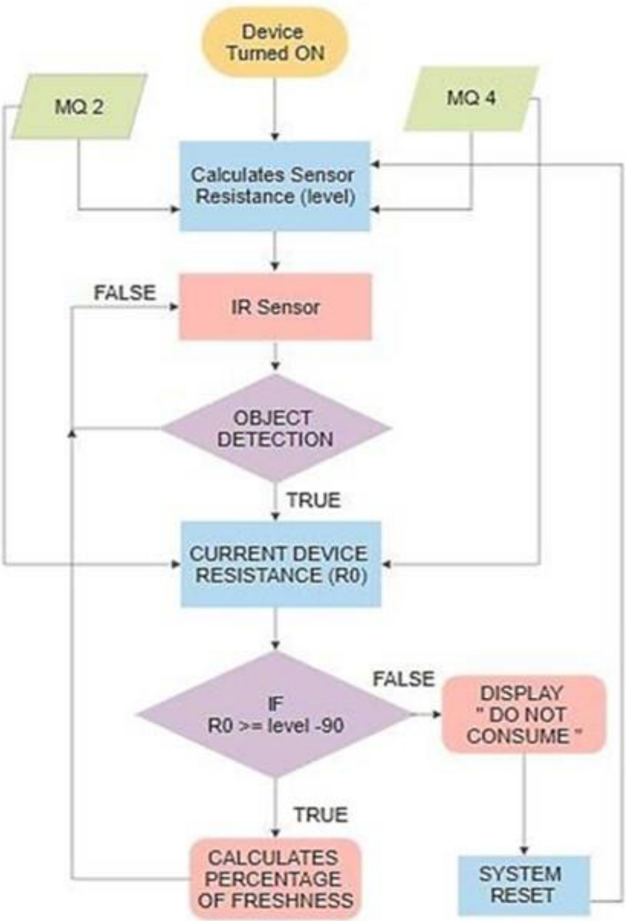

Fig. 3 Flowchart

GRAPH

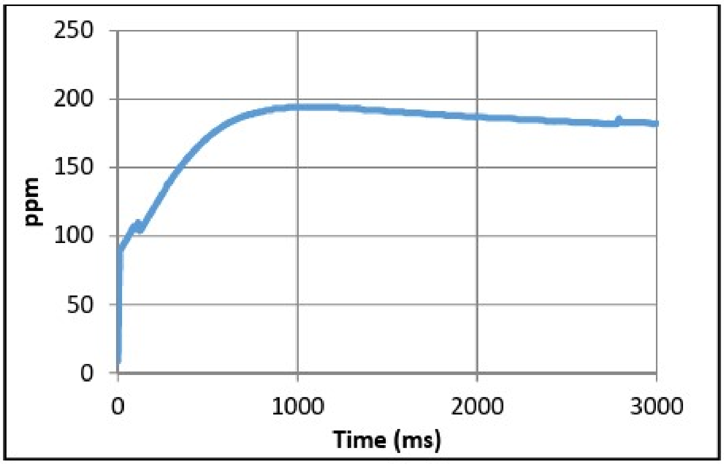

Fig. 4.1 time vs ppm curve of fresh mango

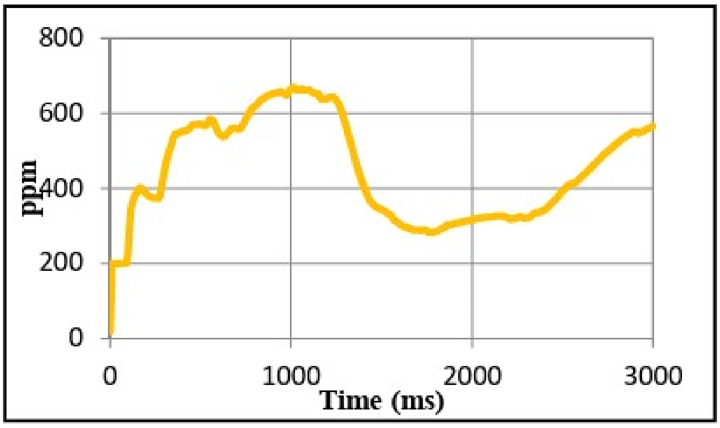

Fig. 4.2 time vs ppm ccurve of rotten tomato

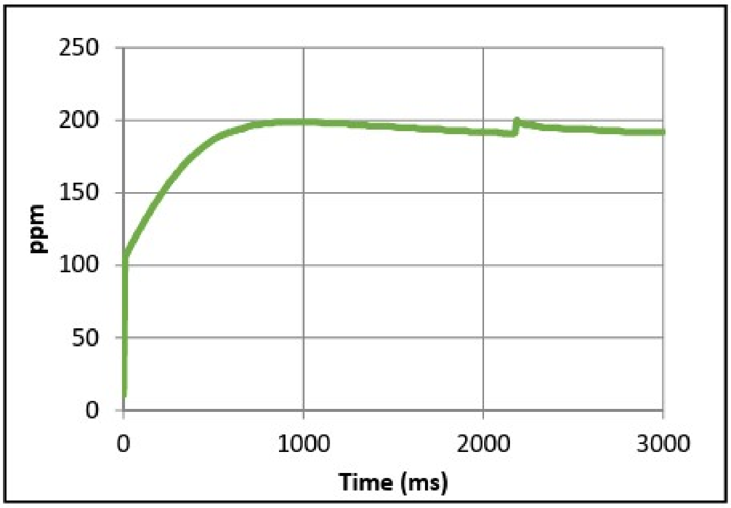

Fig. 4.3 time vs ppm curve of moderately fresh banana

Fruit/Vegetable	ppm	%Freshness	Edibility
Mango	190	99.69%	Highly Edible
Banana	199	78.75%	Moderately Edible
Tomato	572.3	< 20%	Not Edible

Table 1. Comparative study between fruits and vegetables

CHAPTER 4: TECHNICAL IMPLEMENTATION

This is our model for code representation:

```
//ultrasonic connector
const int pingPin = 7;
const int echoPin = 6;
//buzzer adding
const int buzzer = 10; //buzzer to Arduino pin

int pot=A0;
int MQ2pin=A1;
void setup()
{//setup for lcd
  Serial.begin(9600);
  //sound setup for buzzer
  pinMode(buzzer, OUTPUT);
  pinMode(A0,INPUT);
}
int potentio=0;
void loop()
{
//gassensor value indicator
  potentio=analogRead(pot);
  float sensorValue;
  sensorValue=analogRead(MQ2pin);
  //declaration for ultrasonic sensor
  long duration, cm;
   pinMode(pingPin, OUTPUT);
   digitalWrite(pingPin, LOW);
   delayMicroseconds(2);
   digitalWrite(pingPin, HIGH);
   delayMicroseconds(10);
   digitalWrite(pingPin, LOW);
   pinMode(echoPin, INPUT);
   duration = pulseIn(echoPin, HIGH);
   cm = microsecondsToCentimeters(duration);
   delay(100);
  //condition for banana
```

```
 if (potentio==0){
   //condition for ultrasonic distance ditaction
   if(cm<20)
   {
     Serial.println("Distance is:");
     Serial.println(cm);
     //condition for analysis of gas
     if (401<sensorValue && sensorValue<450)
     {
       Serial.println(sensorValue);
       Serial.println("Banana is 25% ROTTEN");


     }
     else if (449<sensorValue && sensorValue<500){
       Serial.println(sensorValue);
       Serial.println("Banana is 50% ROTTEN");
        //sound function for buzzer
       tone(buzzer,300); // Send 1KHz sound signal...
       delay(1000);        // ...for 1 sec
       noTone(buzzer);     // Stop sound...
       delay(1000);        // ...for 1sec
     }
     else if(sensorValue>=500){
       Serial.println(sensorValue);
       Serial.println("Banana is 100% ROTTEN");
       //sound function for buzzer
       tone(buzzer,1000); // Send 1KHz sound signal...
       delay(1000);        // ...for 1 sec
       noTone(buzzer);     // Stop sound...
       delay(1000);        // ...for 1sec
     }

     //another condition for analysis of gas
     else
     {
       Serial.println("sensorValue:");
       Serial.println(sensorValue);
       Serial.println("BANANA is FRESH");
     }
     //time delay for whole void loop operation
     delay(300);

   }
   //another conditon for ultrasonic distance measurment
   if(cm>20)

   {

     Serial.println("PLACE PROPERLY...!!");
```

```
    }
  }
  delay(500);
  //condition for apple checking
  if (potentio==1023){
    if(cm<20)
    {
      Serial.println("Distance is:");
      Serial.println(cm);
      //condition for analysis of gas
      if (sensorValue>350 && sensorValue<390)
      {
        Serial.println(sensorValue);
        Serial.println("APPLE is 25% ROTTEN");

      }
      else if(sensorValue>389 && sensorValue<430){
        Serial.println(sensorValue);
        Serial.println("APPLE is 50% ROTTEN");
         //sound function for buzzer
        tone(buzzer,300); // Send 1KHz sound signal...
        delay(1000);        // ...for 1 sec
        noTone(buzzer);     // Stop sound...
        delay(1000);        // ...for 1sec
        }
      else if (sensorValue>=430){
        Serial.print("APPLE is 100% ROTTEN");
         //sound function for buzzer
        tone(buzzer,1000); // Send 1KHz sound signal...
        delay(1000);        // ...for 1 sec
        noTone(buzzer);     // Stop sound...
        delay(1000);        // ...for 1sec
      }
      //another condition for analysis of gas
      else
      {
        Serial.println("sensorValue:");
        Serial.println(sensorValue);
        Serial.println("APPLE is FRESH");
      }
      //time delay for whole void loop operation
      delay(300);

    }
    //another conditon for ultrasonic distance measurment
    if(cm>20)

    {
```

```
      Serial.println("PLACR PROPERLY....!!");

    }
    delay(500);

  }
  if(0<potentio && 1023>potentio)
  {
    Serial.println("Place the NOBE Correctly");
  }
  delay(500);

}
long microsecondsToCentimeters(long microseconds) {
  return microseconds / 29 / 2;
}
```

CHAPTER 5: RESULTS AND DISCUSSION

The microcontroller board Arduino Uno along with food detection sensor(GAS SENSOR) MQ2 senses the gases coming out from the rotten/ripped food.

If the values of the Methane level is high from a set level the signal are sent to the Arduino and it displays the value of methane on the 16*2 LCD display.

Exp. N°	Content (Biomass and RSU)	CH_4 (%)	CO_2 (%)	Time (days)	Vol. (mL)
1	Potato peel. Sediment and water.	35.64	42.22	19	500
2	Papaya peel. Sediment and water	1.64	12.35	10	500
3	Pineapple peel. Sediment and water	0.11	98.22	10	400
4	Pea shell. Sediment and water.	16.13	24.57	21	500
5	Banana peel. Sediment and water.	0.39	93.7	19	400
6	Bean peel. Sediment and water.	0.76	78.53	21	400
7	Sugarcane bagasse. Sediment and water	80.85	17.43	78	625
8	Wet sugarcane bagasse. Sediment and water	96.06	3.57	78	675
9	Semi-dry sugarcane bagasse. Sediment and water.	91.39	8.17	78	750
10	Potato peel. Sugarcane bagasse. Sediment and water.	58.74	26.46	78	350

Table 2. Results for higher Ch4 and Co2 yield from bioreactors

CHAPTER 6: CONCLUSION AND FUTURE SCOPE

CONCLUSION

The early detection of the gases from different food items like ammonia, methane etc. can help the gas sensor to detect gas emission from food items even before the presence of any visible sign of spoilage. The consumer gets the information about the food item wherein he can monitor the perish ability of that food item. This will help in maintenance of health and prevents the consumer from consuming bad food. The use of technology helps in food processing industry wherein they can mention the duration of perish ability of the food item on the packet so that proper control on consumption can be done. The monitoring and detection of the food items is very necessary as most of the consumers buy packed food from the malls wherein date of expiry is important parameter.

FUTURE SCOPE

0ur fruit ripe and rotten detection system lays a solid foundation for future enhancements and applications. Here's a brief look at the potential future scope:

- Expand Fruit Compatibility:
  Extend the system to accommodate a wider variety of fruits, each with its unique ripening characteristics. This could involve more sophisticated sensors and algorithms.
- Integration with IoT:
  Connect the system to the Internet of Things (IoT) to enable remote monitoring and control. Users could receive alerts or check fruit status through a mobile app or web interface.
- Machine Learning Integration:
  Implement machine learning algorithms to improve the system's accuracy over time. This would enable the system to adapt and optimize its performance based on historical data.
- Data Analytics for Quality Trends:
  Incorporate data analytics to track and analyze trends in fruit quality over time. This information could be valuable for farmers, distributors, and retailers to make informed decisions.
- Automated Sorting System:
  Integrate the system into automated fruit sorting processes, contributing to more efficient and precise sorting in large-scale production environments.

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APPENDIX-I

(Description of few components used)

- **Arduino Uno:**
  The central microcontroller that controls and coordinates the entire system. It processes data from sensors, makes decisions based on predefined criteria, and activates the buzzer when a rotten fruit is detected.

- **Ultrasonic Sensor (HC-SR04):**
  Used for precise fruit placement. It measures the distance between the sensor and the fruit, ensuring accurate detection and assessment.

- **MQ2 Gas Sensor:**
  This sensor plays a crucial role in detecting methane levels, which are indicative of fruit ripeness. Elevated methane levels signify ripe fruit, while lower levels suggest a rotten one.

- **Potentiometer:**
  Acts as a user interface component, allowing users to select the type of fruit being examined. It provides a variable input to the system based on the user's fruit selection.

- **Buzzer:**
  An audible alert system that activates when a rotten fruit is detected. The buzzer provides immediate feedback to the user, enhancing the system's usability.

- **Breadboard:**
  A breadboard is a solderless device for temporary prototype with electronics and test circuit designs.