III Semester B.Tech. (E & C Engineering)

EC280 Mini-Project in Circuits And Systems

IOT SYSTEM BASED FOOD SPOILAGE DETECTION SYSTEM

By

GAGAN.P.HEBBALLI(221EC215)

SUPERVISED BY
Dr.SUSHIL KUMAR PANDEY

Abstract:

Our Food Spoilage Detection System uses Arduino Uno and ESP8266 with a methane gas sensor to keep your food safe. When spoilage is detected, it sends alerts to your phone, preventing you from consuming contaminated food. This project showcases an easy-to-use solution for detecting spoilage gases, promoting food safety, and reducing unnecessary waste.

Introduction:

The issue of food spoilage is a pervasive concern, with both health and environmental implications. As the global population continues to rise, the need for efficient methods to monitor and prevent food spoilage becomes increasingly critical. In response to this challenge, we present a novel solution that harnesses the capabilities of Arduino Uno, ESP8266, and a methane gas sensor to create an effective Food Spoilage Detection System. This system is designed to detect and alert users to the presence of methane gas, a byproduct of food spoilage, ensuring timely intervention to prevent the consumption of unsafe food.

Motivation:

HAVING SPOILT FOOD AROUND US CAN GENERATE FOLLOWING PROBLEMS

- **Foodborne Illnesses:** Spoiled food often harbors harmful bacteria, viruses, and other pathogens that can cause foodborne illnesses. Consuming such contaminated food can lead to symptoms such as nausea, vomiting, diarrhea, stomach cramps, and fever.
- **Nutrient Loss:** As food spoils, it undergoes chemical changes that can result in the degradation of essential nutrients. Consuming spoiled food may lead to a loss of nutritional value, affecting the intake of vitamins, minerals, and other vital nutrients.

- **Dehydration and Malnutrition**: Spoiled food may not only lack essential nutrients but can also contribute to dehydration and malnutrition. This is particularly true if the spoiled food is a significant part of one's diet.
- **Financial Loss:** Consuming spoiled food can result in financial loss due to medical expenses, wasted groceries, and potential productivity loss if individuals need to take time off work or school due to illness.
- **Food Waste:** Spoiled food contributes to the global issue of food waste. When food goes bad and is discarded, it not only affects individuals but also has environmental implications, contributing to landfill waste and resource depletion.
- **Contamination of Other Foods:** Spoiled food can contaminate other items in the refrigerator or pantry. Cross-contamination may occur when pathogens from spoiled food come into contact with fresh, unspoiled items, leading to a broader risk of illness.

There is no system in the market that can tackle the above problems: The motivation behind this mini-project is to develop a low-cost, efficient ,portable and reliable food spoilage detection system that can help prevent food wastage and ensure food safety. The system can be used in food stores, supermarkets and homes to monitor the quality of food items and detect any signs of spoilage at an early stage.

Objectives:

The main objectives of this mini-project are as follows:

1) To develop an IoT-based food spoilage detection system using a gas sensor.
2) Connect the sensors to an Arduino board and collect and process the data.
3) To send the processed data to a Blynk server for real-time monitoring.
4) To determine the system's effectiveness in detecting visible signs of spoilage and low amounts of gas emission.
5) Alert and notify users promptly about potential food spoilage conditions.
6) Enable remote monitoring and data analysis through IoT connectivity.
7) Enhance food safety by providing a reliable tool to detect spoilage early.
8) Contribute to sustainability efforts by reducing food waste through timely spoilage detection.
9) Explore potential applications of the system in households, restaurants, and food storage facilities.
10) Investigate future enhancements and collaborations to improve the system's capabilities and impact.
11) The main objective of this project is to develop a iot based food spoilage detection system which will help people identify which food is spoiled and which is good, thereby reducing many causes of food spoilage.
12) Gas sensors are widely used in food spoilage detection systems because they can detect the emission of gases such as methane, ammonia and ethylene, which are naturally produced during food decay. The MQ4 sensor is used to detect the emission of methane-type gases emitted during food decay.

Literature Review:

• **In paper 1**: The paper addresses the need for an efficient system to detect food spoilage, focusing on using gas sensors and the ESP8266 microcontroller. The primary objective is to develop a system that can detect spoilage from food items, especially the emission of gases like ammonia and methane. By monitoring these gases and employing embedded systems, the system aims to provide early alerts to users, preventing the consumption of spoiled food and reducing food waste.

• **In paper 2:** The research paper discusses the creation of a smart food quality monitoring device utilizing IoT technology, designed to detect food spoilage early and prevent food-related health issues and waste. The device incorporates a range of sensors, including pH, moisture, and gas sensors, interfaced with an Arduino Uno microcontroller and a Bluetooth module. Users select the food item for monitoring through an Android app, enabling the microcontroller to collect data from the sensors. This IoT-enabled system sends data to the IBM Watson platform for visualization. By monitoring factors like humidity, temperature, and gas levels, the device helps ensure the freshness of food items and provides real-time data accessible from anywhere, facilitating early intervention in the case of spoilage.

• **In paper 3:** The research paper introduces a food monitoring system that harnesses the power of Bluetooth Low Energy (BLE) and the Internet of Things (IoT). This system employs various sensors to detect gases, monitor temperature, and assess humidity in food storage areas. The collected data is then seamlessly transmitted to an application using BLE or IoT technology, optimizing cost efficiency and expanding the scope of tracking capabilities. The paper emphasizes the vital role of this technology in ensuring food safety, addressing challenges in the food supply chain, and providing a comprehensive solution to monitoring, tracing, and evaluating food quality. The study highlights the potential of BLE and IoT

technologies to revolutionize food safety management across multiple industries, offering improved efficiency and safety.

• **In paper 4:** The research paper introduces an innovative system for food spoilage detection utilizing advanced sensors and wireless data transmission. Comprising two modules for solid and liquid foods, the system employs an MQ-4 gas sensor to identify harmful gases like methane from spoiling solid foods and a pH sensor to monitor the acidity of liquid foods. This approach enables the early detection of food spoilage, thus ensuring food safety and preventing health issues associated with consuming spoiled items. The paper demonstrates the system's effectiveness in experiments, affirming its practical utility in safeguarding food quality and consumer well-being.

Methodology:

The food spoilage detection system developed in this mini-project is based on an Arduino board, which is connected to gas sensor. The MQ4 sensor is used to detect the emission of methane gases. The ESP8266 Wi-Fi Module is used to connect the Arduino board to the internet and send the data to a blynk server for real-time monitoring. The sensors are calibrated to detect visible signs of spoilage and low amounts of gas emission, which are indicators of food spoilage.

How to connect Buzzer, LEDs, MQ4 Sensor and NodeMCU to Arduino UNO R3:

1)Connect Buzzer to Arduino UNO:

i)Positive terminal(long end) should be connected to any digital pin say digital pin D10 on Arduino
ii)Negative terminal(short end) should connected to common ground on breadboard.

2) Connect LEDs to Arduino UNO:

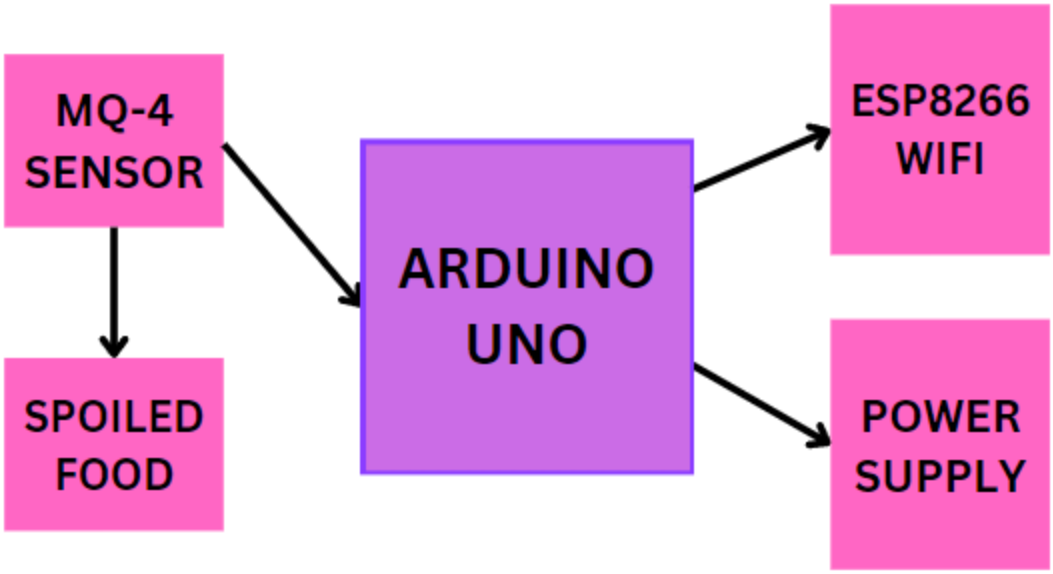
i)Positive terminal to digital pin D13 or any other digital pin on Arduino
ii)Negative terminal to common ground on bread board.

3) Connect NodeMCU to Arduino UNO:

i)Here we are using NodeMCU with ESP8266 12E WiFi Module. Serial communication is required to transfer data between arduino and nodemcu.
ii)Rx of NodeMCU to any digital pin say D9
iii)Tx of NodeMCU to any digital pin say D8
iv)GND to GND of arduino(or common GND)
v)Vin pin of NodeMCU to 3.3v supply of Arduino.

4) How to connect MQ4 Sensor to Arduino UNO R3:

i)Analaog pin of sensor i.e AD to A5 or any analog pin of Arduino
ii)DO digital pin is kept as it is
iii)GND pin of sensor is connected to GND pin of arduino (or common GND)
iv)Vcc pin of sensor 5v power supply pin of Arduino.



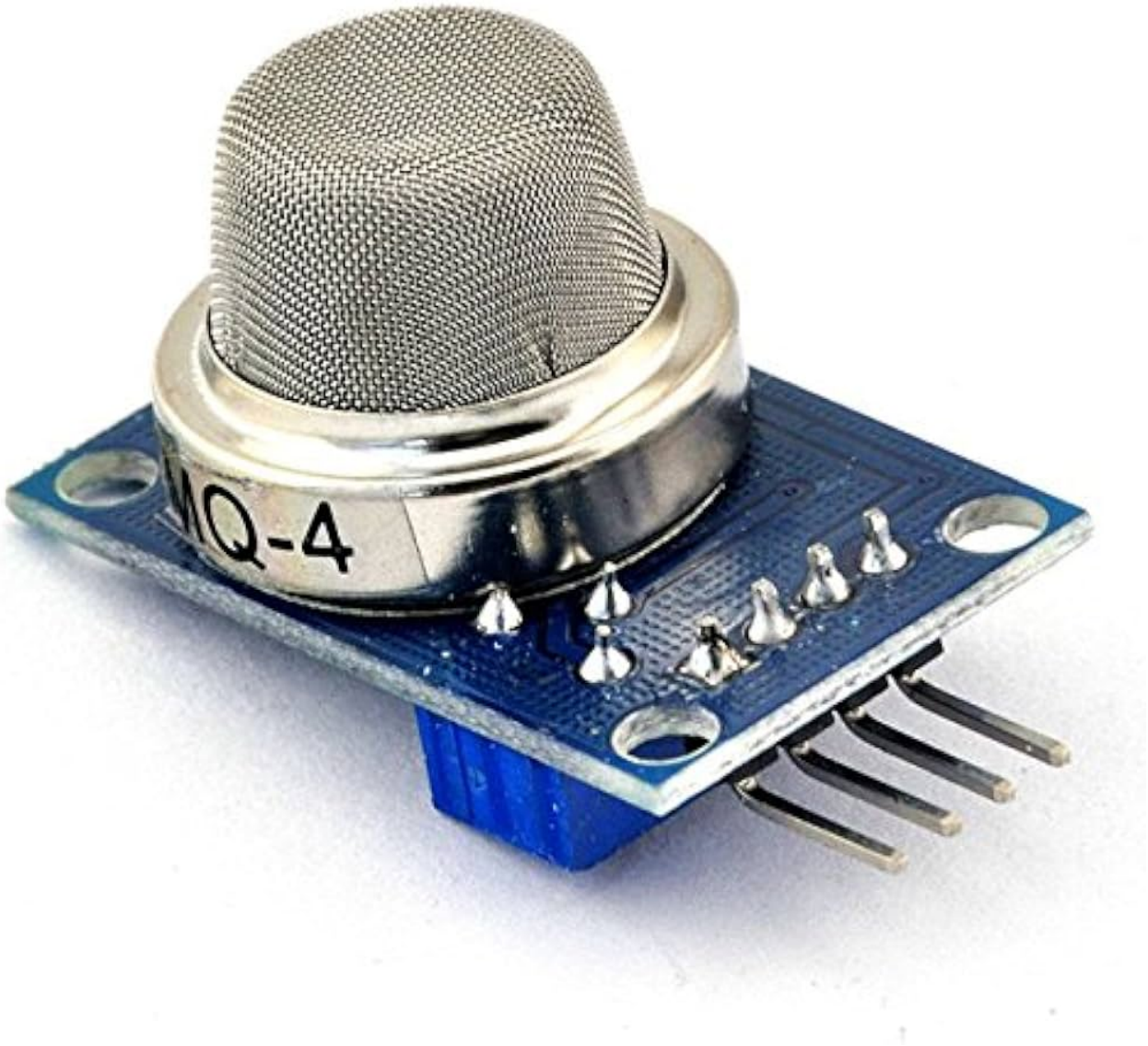
Components Required	Quantity
MQ4 METHANE Sensor	1
Arduino UNO	1
ESP-8266	1
Connecting wires	few
Breadboard	1
L.E.D	2

Parameters to be analyzed

Gas : Sensor clusters can recognize the prompts of a ruining procedure always by methods for gas and vapors produced, diverse unstable and different conditions nourishment decay can be distinguished by gas sensors.

A. **Gas sensor*:*** Sail food emits light hydrocarbon gases,there gases are generally greenhouse in nature and harms the human respiratory system,gas sensor is used to detect them,It works on the principle of adsorption,when quantity above a threshold value is detected some electrochemical reaction which leads to current
In the project **MQ4 methane gas sensor** is used with the following specifications-

- .The concentration sensing range of 250 ppm to 10,000 ppm is suitable for leak detection.
- . The sensor can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5 V



Credits:https://www.google.com/url?sa=i&url=https%3A%2F%2Fm.indiamart.com%2Fproddetail%2Fmq4-methane-gas-sensor-module-19966392148.html&psig=AOvVaw0ZzMzZ6dLT86jCZKEqfpp6&ust=1701963935304000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCIjgg_OT-4IDFQAAAAAdAAAAABAH

B.Arduino UNO:

- The Arduino based IoT device has the following circuit connections -Arduino UNO - The Arduino UNO is ATmega328 based microcontroller board. It is a standout amongst the most prevalent prototyping sheets.
- The board accompanies worked in arduino boot loader. It has 14 GPIO pins, 6 PWM pins, 6 Analog sources of info and on board

UART, SPI and TWI interfaces, an on-board resonator, a reset catch, and openings for mounting pin headers

- . While programming the board, it very well may be associated with the PC utilizing a USB port and the board can keep running on USB control.
- The Arduino UNO has 32 Kb Flash memory, 1 Kb EEPROM and 2 Kb SRAM. The board accompanies the bootloader.

It can be boarded and associated with various Arduino Shields for availability with Ethernet, Bluetooth, Wi-Fi, Zigbee or Cellular systems and it tends to be associated with the majority of the IoT stages. The ATmega328 controller has the following pin configuration –

Pin Number	Pin Name	Function
1	PC6	Reset
2	PD0	Digital Pin (RX)
3	PD1	Digital Pin (TX)
4	PD2	Digital Pin
5	PD3	Digital Pin (PWM)
6	PD4	Digital Pin
7	Vcc	Positive Voltage (Power)
8	GND	Ground
9	XTAL 1	Crystal Oscillator
10	XTAL 2	Crystal Oscillator
11	PD5	Digital Pin (PWM)
12	PD6	Digital Pin (PWM)
13	PD7	Digital Pin
14	PB0	Digital Pin
15	PB1	Digital Pin (PWM)
16	PB2	Digital Pin (PWM)
17	PB3	Digital Pin (PWM)
18	PB4	Digital Pin
19	PB5	Digital Pin
20	AVCC	Positive voltage for ADC (power)
21	AREF	Reference Voltage
22	GND	Ground
23	PC0	Analog Input
24	PC1	Analog Input
25	PC2	Analog Input
26	PC3	Analog Input
27	PC4	Analog Input
28	PC5	Analog Input

Arduino UNO pin diagram

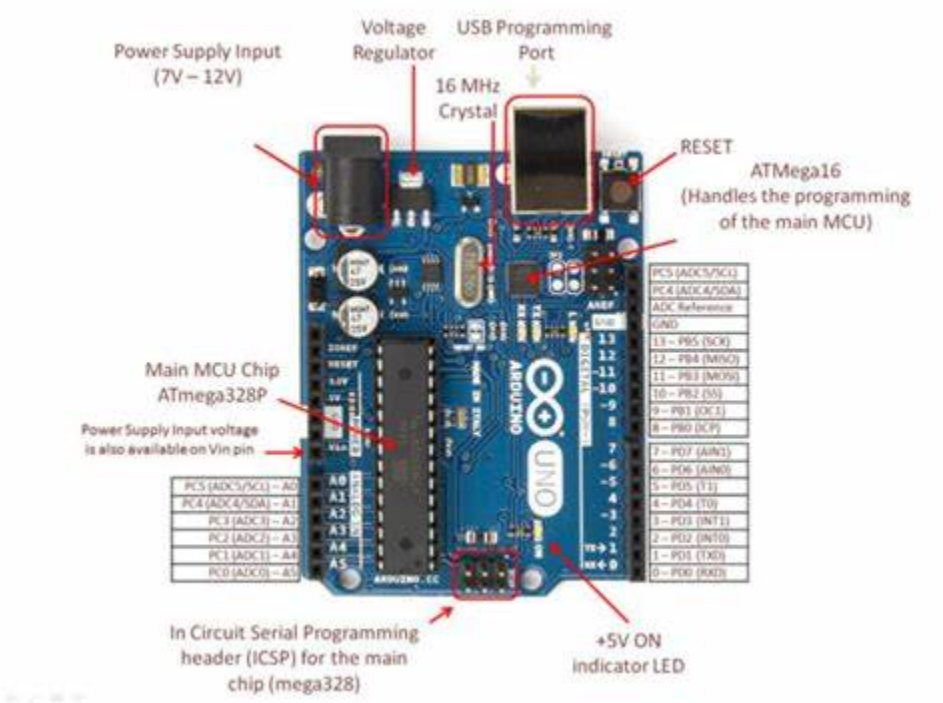
The Arduino Uno R3 board includes the following specifications.

• The Operating Voltage of the Arduino is 5V

• The recommended input voltage ranges from 7V to 12V

• The I/p voltage (limit) is 6V to 20V

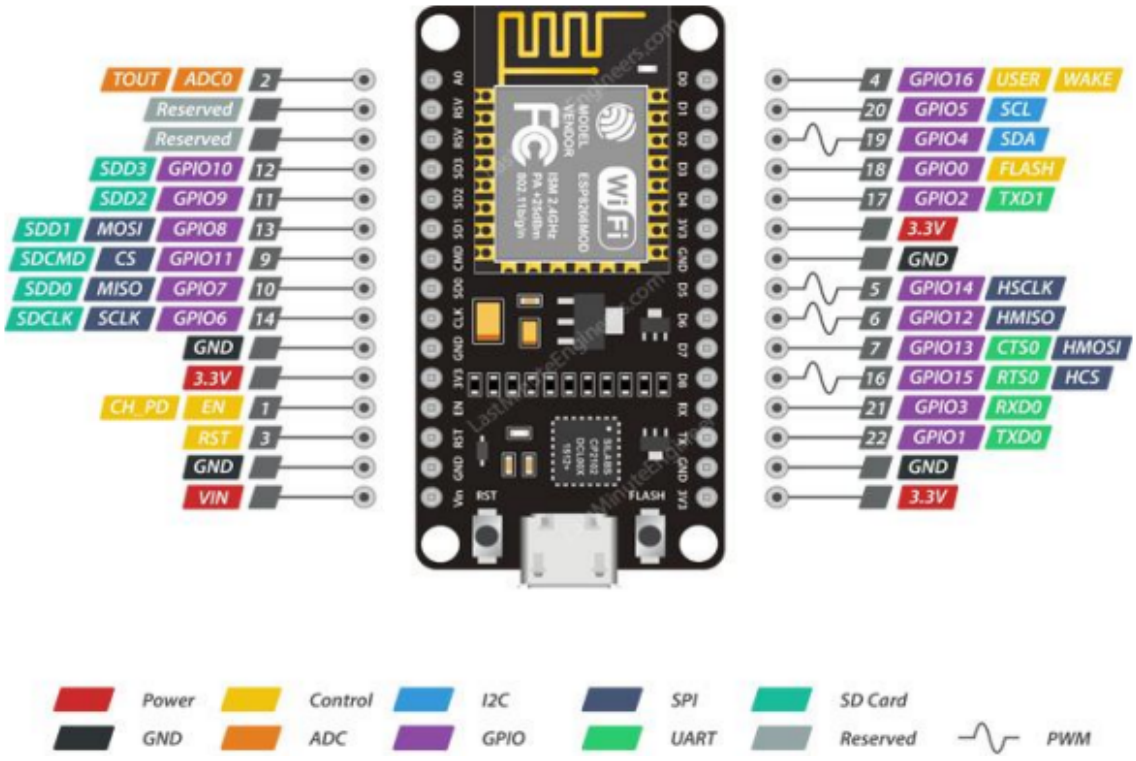
• Digital input and output pins-14
• Digital input & output pins (PWM)-6
• Analog i/p pins are 6
• DC Current for each I/O Pin is 20 mA
• DC Current used for 3.3V Pin is 50 mA
• Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader
• SRAM is 2 KB
• EEPROM is 1 KB
• The speed of the CLK is 16 MHz
• In Built LED
• Length and width of the Arduino are 68.6 mm X 53.4 mm
• The weight of the Arduino board is 25 g



credits:https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FPin-diagram-of-ARDUINO-The-board-has-14-Digital-pins-and-6-Analog-pins-It-is_fig1_332309027&psig=AOvVaw2rrPObIQ8_QFXuErV2NkOs&ust=1701889353469000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCKD76oX--IIDFQAAAAAdAAAAABAK

C.ESP8266 Module - The ESP8266 Wi-Fi Module is an independent SOC with coordinated TCP/IP convention stack that can access to a Wi-Fi arrange.

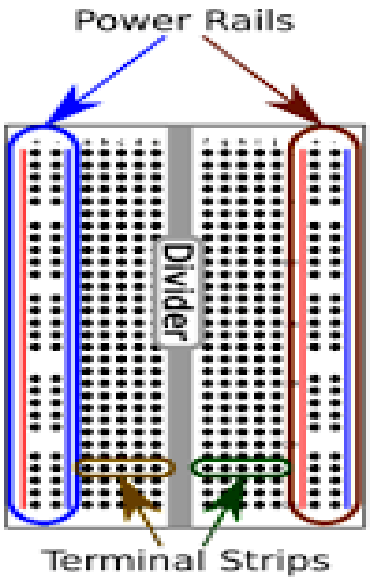
- The ESP8266 is able to do either facilitating an application or off stacking all Wi-Fi organizing capacities from another application processor.
- Each ESP8266 module comes pre-modified with an AT order set firmware. The module comes accessible in two models - ESP-01 and ESP-12. ESP-12 has 16 pins accessible for interfacing while ESP-01 has just 8 pins accessible for use.
- The ESP-12 has the following pin configuration - The RESET and VCC pins of the module are associated with the 3.3 V DC while Ground stick is associated with the shared belief.
- The Tx and Rx pins of the module are associated with the 12 and 13 pins of the Arduino UNO. Power Supply - The circuit works on 5V DC. The AC mains is utilized as the essential wellspring of intensity.
- The supply from the mains is ventured somewhere near a transformer and redressed by a full-connect rectifier.
- The corrected yield is directed to 5V and 12V utilizing 7805 and 7812 ICs. The stick 1 of both the voltage controller ICs is associated with the anode of the battery and stick 2 of the two ICs is associated with ground.
- The individual voltage yields are drawn from stick 3 of the separate voltage controller ICs.
- A LED alongside a 10K Ω pull-up resistor is likewise associated between shared opinion and yield stick to get a visual trace of supply progression.



- credits:https://www.google.com/url?sa=i&url=https%3A%2F%2Fdiyusthad.com%2F2020%2F05%2Fnodemcu-esp8266-pinout.html&psig=AOvVaw2X2veSjnIm1Fytrael6-ci&ust=1701889631130000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCKD_p4r_-IIDFQAAAAAdAAAAABAE

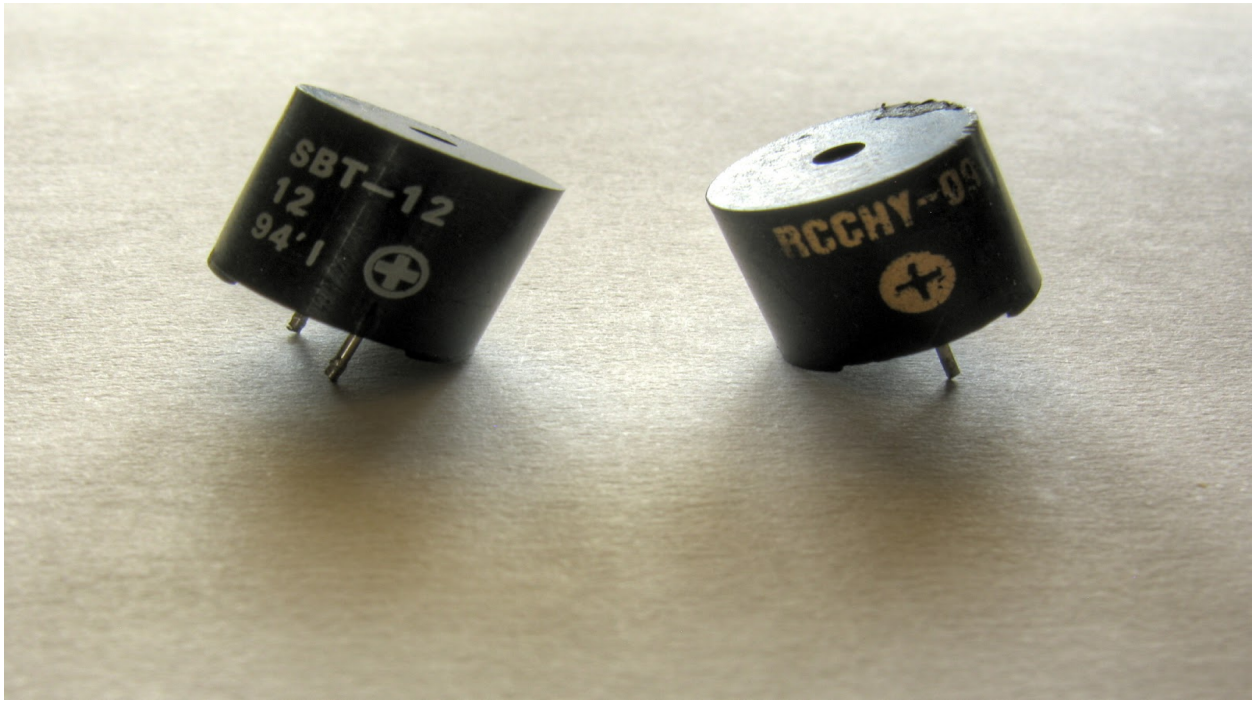
E.Breadboard-

- A breadboard typically consists of a plastic board with a grid of holes and metal strips that connect the holes in certain patterns.
- The holes are used to insert electronic components, such as resistors, capacitors, and integrated circuits.
-In a breadboard,the holes in a single row of power rails are all connected together and have same potential
-The holes in the ertical column of terminal strips also have the same potential



credits:https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.pngegg.com%2Fen%2Fsearch%3Fq%3Dbreadboard&psig=AOvVaw1wuEnzk6fi8HELE-8MeWfx&ust=1701969406679000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCPil2aOo-4IDFQAAAAAdAAAAABAG

F.BUZZER-



credits:JDX WELL PCB

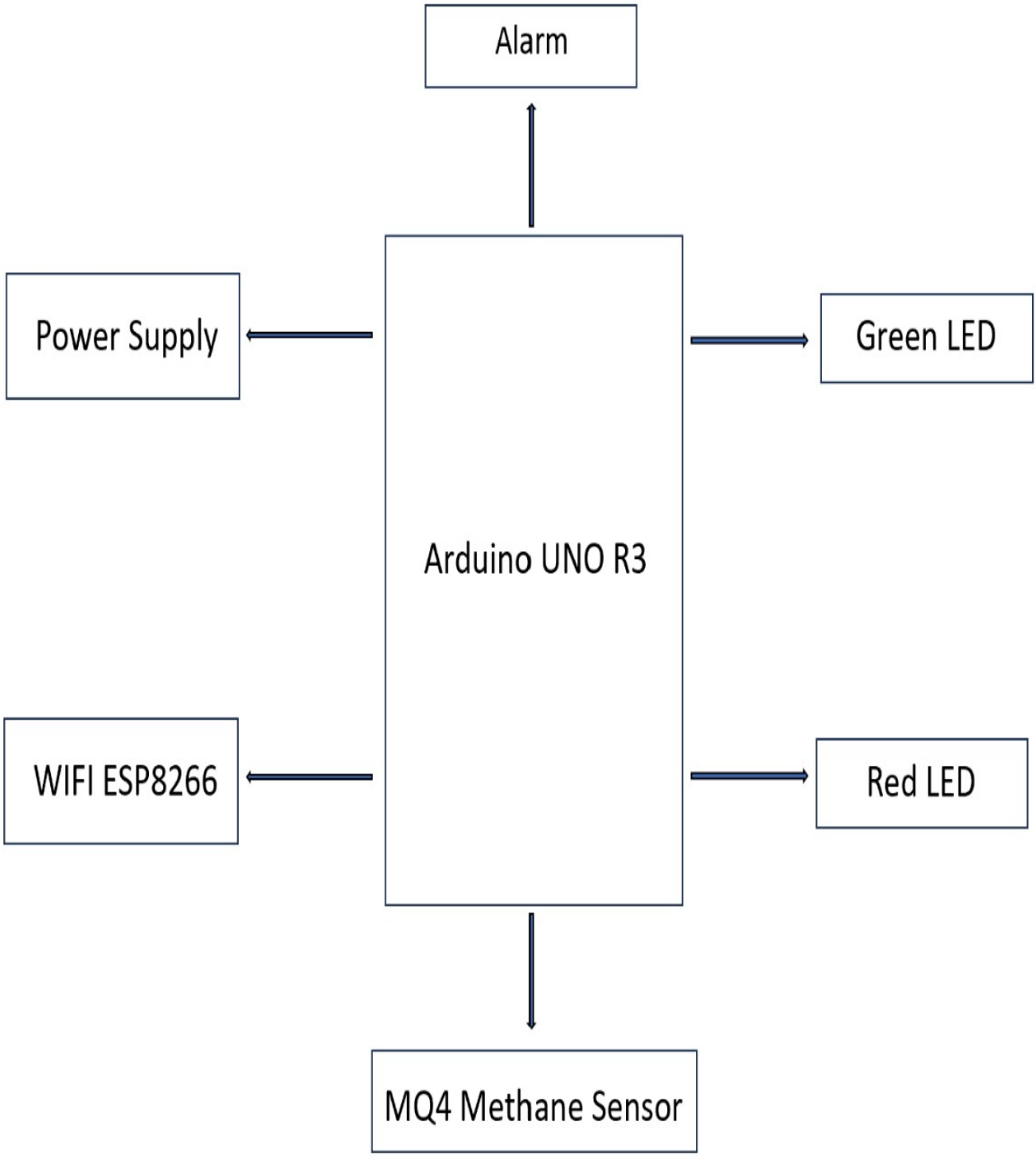
Work Done: In this mini-project, we developed an IoT-based food spoilage detection system using gas and humidity sensors connected to an Arduino board. The sensors were calibrated to detect visible signs of spoilage and low amounts of gas emission, which are indicators of food spoilage. The ESP8266 Wi-Fi Module was used to send the data to a Blynk server for real-time monitoring. The system was tested on various food items, and the results showed that the sensors were able to detect visible signs of spoilage and low amounts of gas emission, which correlated with the degree of spoilage of food.

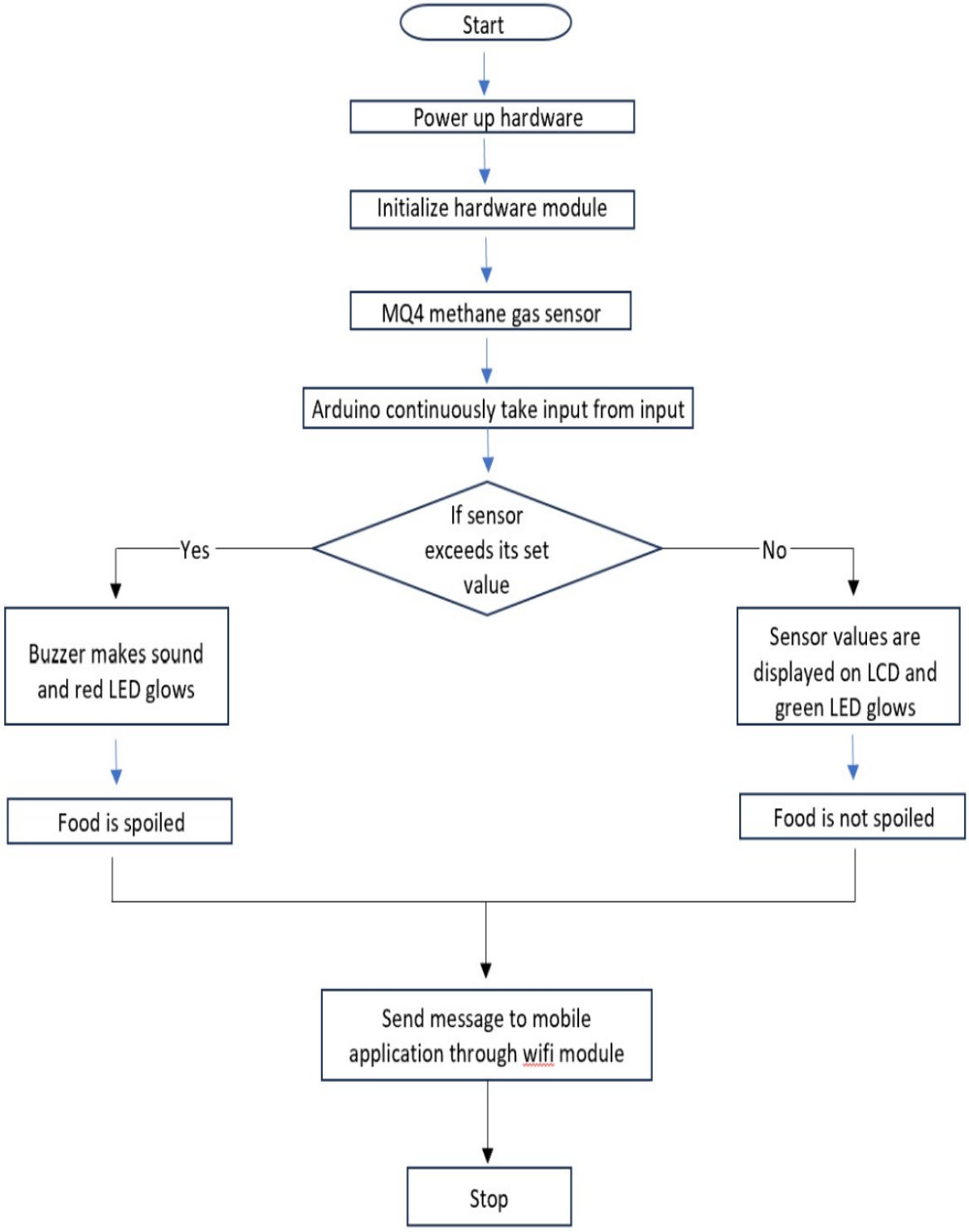
1.HARDWARE SELECTION

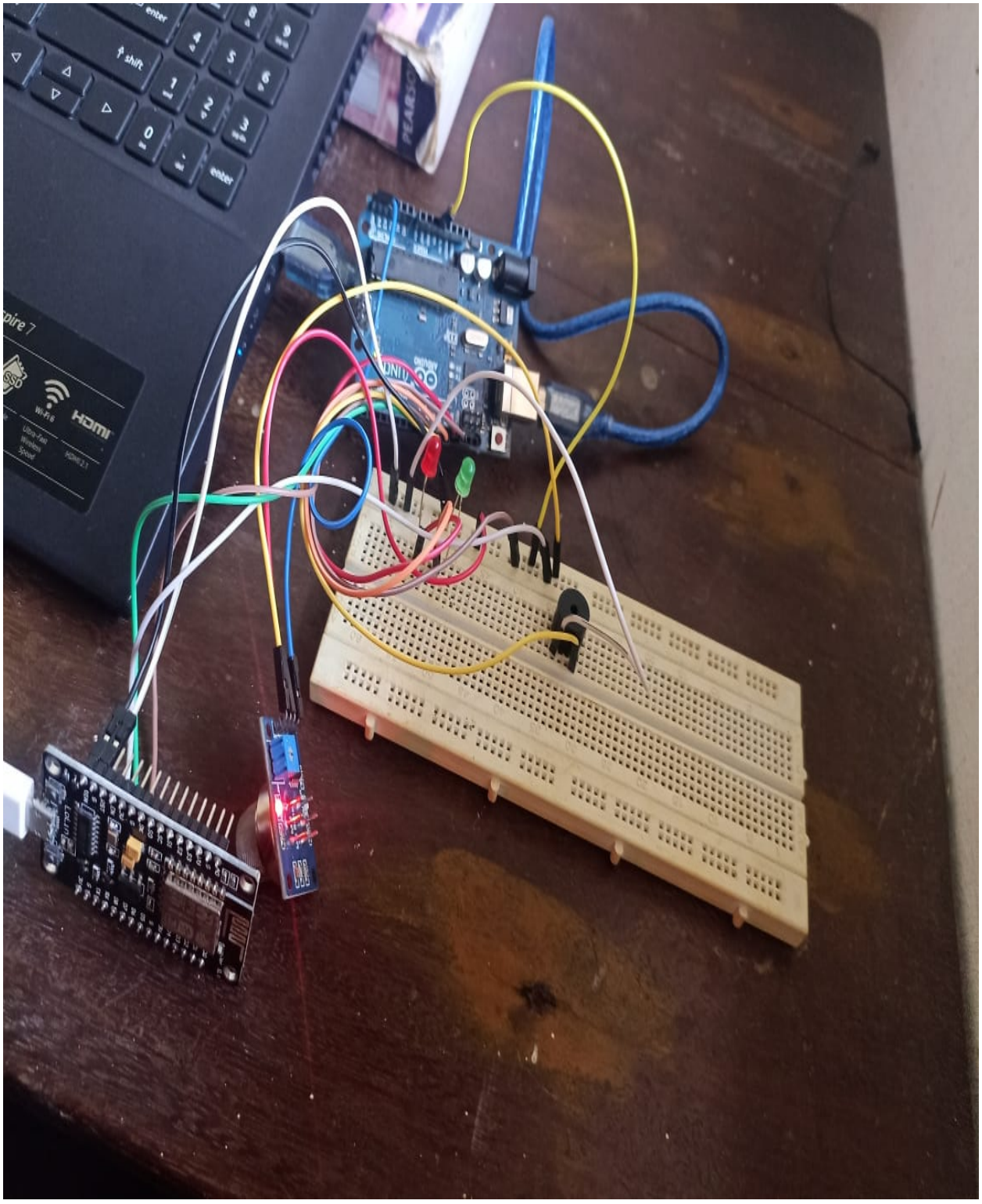
In view of our project's requirements, we have carefully chosen the following components: the MQ4 Methane Sensor, Arduino UNO, [Plate Number 1], and connecting wires. We believe that these components will effectively meet our project's objectives.

2.HARDWARE CONNECTION

This mini-project involves the implementation of a food spoilage detection system utilizing an Arduino board connected to a gas sensor, specifically the MQ4 sensor designed to identify methane gas emissions. To enable real-time monitoring, the Arduino board is integrated with an ESP8266 Wi-Fi Module, establishing a connection to the internet. The collected data is then transmitted to a Blynk server. Through sensor calibration, the system is optimized to recognize visible indications of spoilage and detect minimal gas emissions, serving as reliable indicators for the occurrence of food spoilage.


Alarm
Power Supply
Arduino UNO R3
Green LED
WIFI ESP8266
Red LED
MQ4 Methane Sensor


Start
Power up hardware
Initialize hardware module
MQ4 methane gas sensor
Arduino continuously take input from input
If sensor exceeds its set value
Yes
No
Buzzer makes sound and red LED glows
Sensor values are displayed on LCD and green LED glows
Food is spoiled
Food is not spoiled
Send message to mobile application through wifi module
Stop



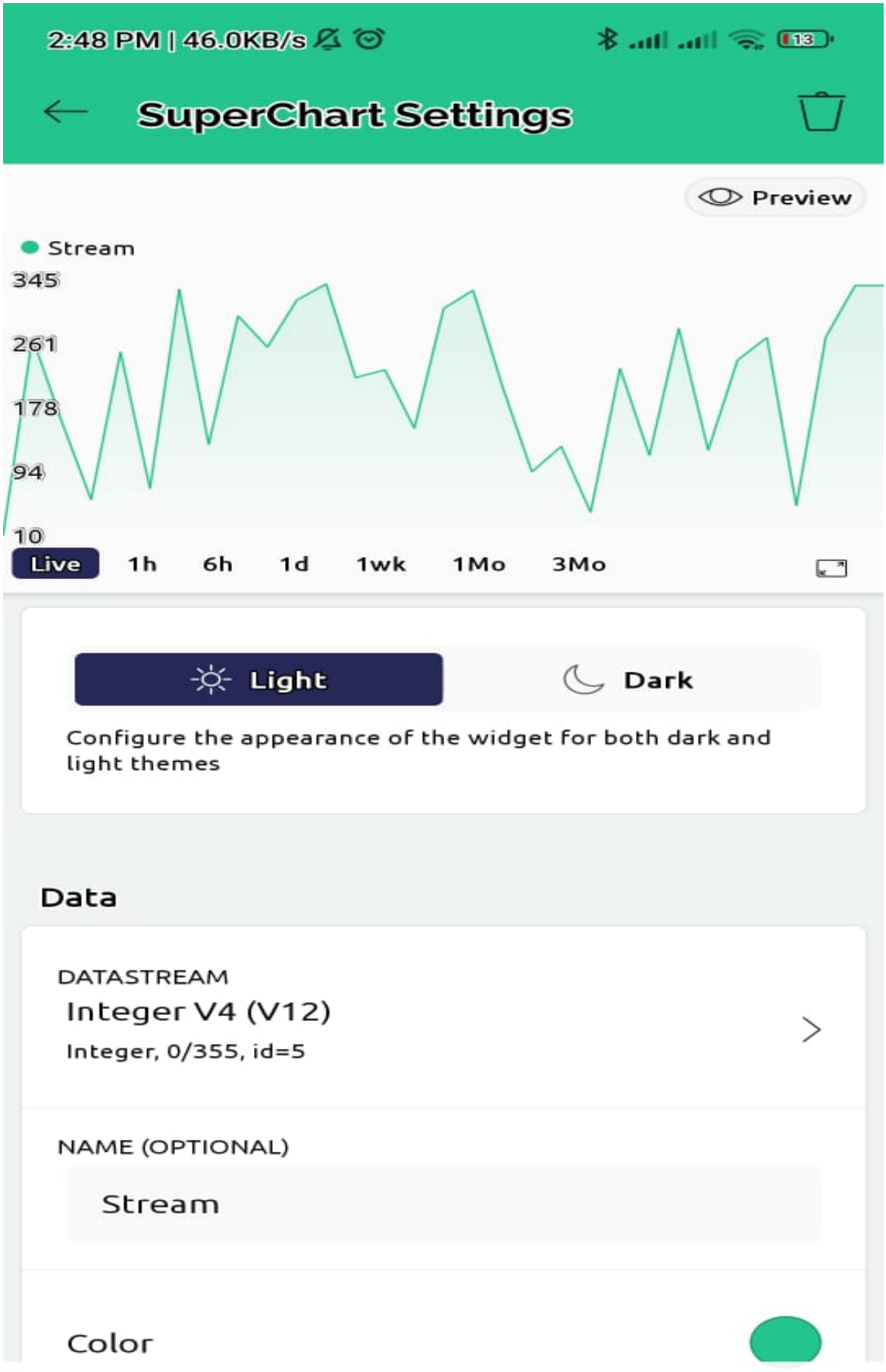
CODE:

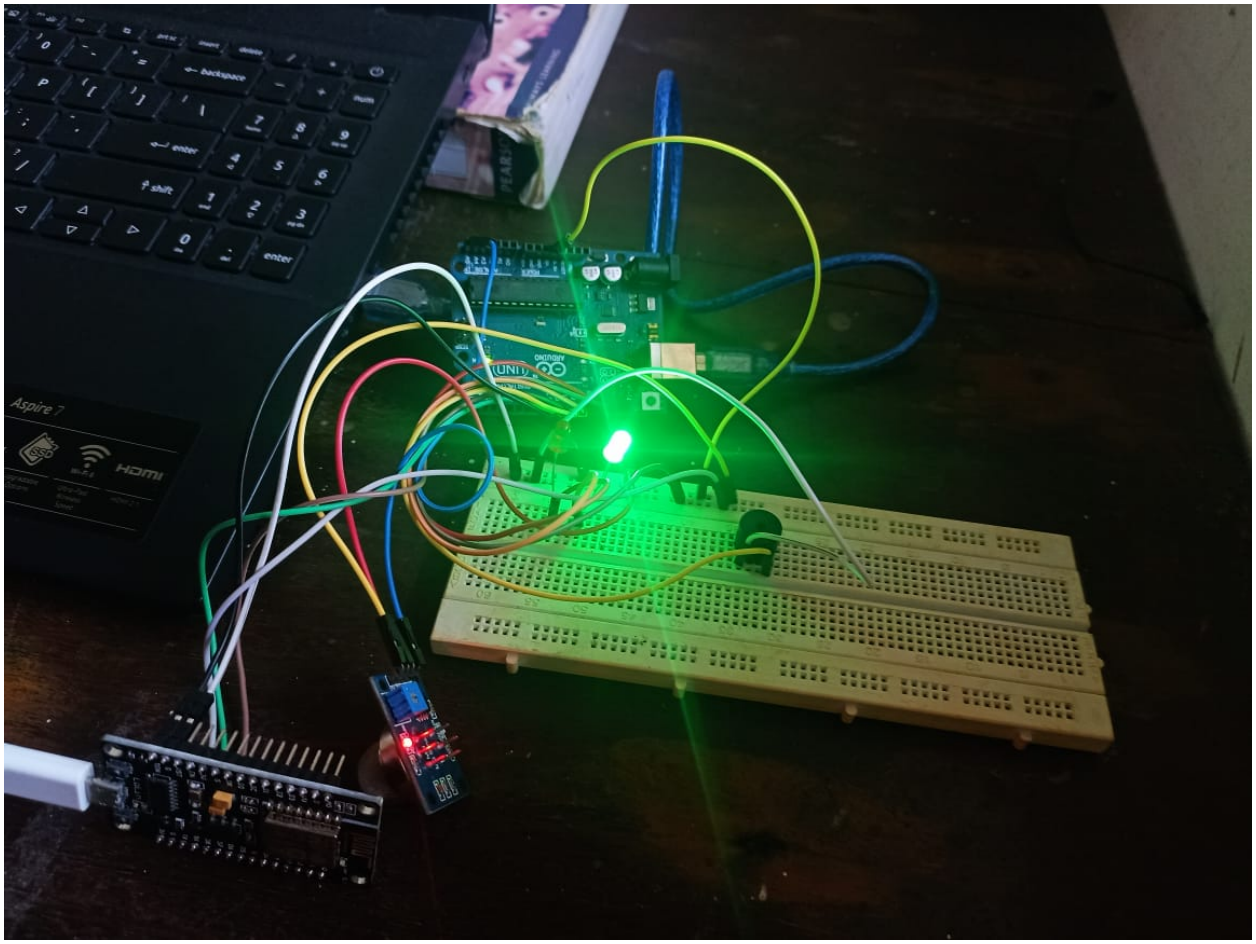
```
#include <SoftwareSerial.h>

SoftwareSerial nodemcu(8, 9);


int pinRedLed = 12;
int pinGreenLed = 11;
int pinSensor = A5;
int THRESHOLD = 250;
int buzzer = 10;



int rdata = 0;
String mystring;
void setup()
{
Serial.begin(9600);
nodemcu.begin(9600);


pinMode(buzzer, OUTPUT);
pinMode(pinRedLed, OUTPUT);
pinMode(pinGreenLed, OUTPUT);
pinMode(pinSensor, INPUT);



}

void loop()
{



int rdata  =  analogRead(pinSensor);
```

```
Serial.print("Methane Range: ");
Serial.println(rdata);

if(rdata >= THRESHOLD){
   digitalWrite(pinRedLed, HIGH);
   digitalWrite(pinGreenLed, LOW);
   digitalWrite(buzzer, HIGH);

   delay(50);

}else
  {
    digitalWrite(pinRedLed, LOW);
    digitalWrite(pinGreenLed, HIGH);
    digitalWrite(buzzer, LOW);

  }

  if (nodemcu.available() > 0)
  {
  char data;
 data = nodemcu.read();
  Serial.println(data);
  }
  if(rdata < 250){
  mystring = mystring + "Methane Range: " + rdata;
  nodemcu.println(mystring);
  Serial.println(mystring);

  }else
{
    mystring = "Food Spoiled";
    nodemcu.println(mystring);
    Serial.println(mystring);

  }

 mystring = "";
delay(1000);
```

```
}

#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#define BLYNK_TEMPLATE_ID           "TMPL3U5wIwI0y"
#define BLYNK_TEMPLATE_NAME         "Quickstart Device"
#define BLYNK_AUTH_TOKEN            "4UJYZmXwiR7T6wqhMnB57uYSkW7yPCt8"
#include <BlynkSimpleEsp8266.h>
#include <SoftwareSerial.h>



String sdata;
char auth[] = "4UJYZmXwiR7T6wqhMnB57uYSkW7yPCt8";


char ssid[] = "GAGAN-LAPTOP 0958";
char pass[] = "12345678";

BlynkTimer timer;

String  myString;
char rdata;



void myTimerEvent()
{

  Blynk.virtualWrite(V1, millis() / 1000);

}



void setup()
{

  Serial.begin(9600);
```

```
  Blynk.begin(auth, ssid, pass);

  timer.setInterval(1000L, sensorvalue1);

}

void loop()
{
   if (Serial.available() == 0)
   {
  Blynk.run();
  timer.run();

   }

  if (Serial.available() > 0)
  {
    rdata = Serial.read();
    myString = myString + rdata;

  }

}

void sensorvalue1()
{
sdata = myString ;

  Blynk.virtualWrite(V12, sdata);
   myString = "";
}
```


2:48 PM | 46.0KB/s
SuperChart Settings
Preview
Stream
345
261
178
94
10
Live
1h
6h
1d
1wk
1Mo
3Mo
Light
Dark
Configure the appearance of the widget for both dark and light themes
Data
DATASTREAM
Integer V4 (V12)
Integer, 0/355, id=5
NAME (OPTIONAL)
Stream
Color



Results and Discussion:

• Quality is monitored constantly by sensors and readings are displayed on screen.

• When abnormal readings are detected in any readings i.e., MQ4 sensor, it displays the food spoiling message the LED screen.

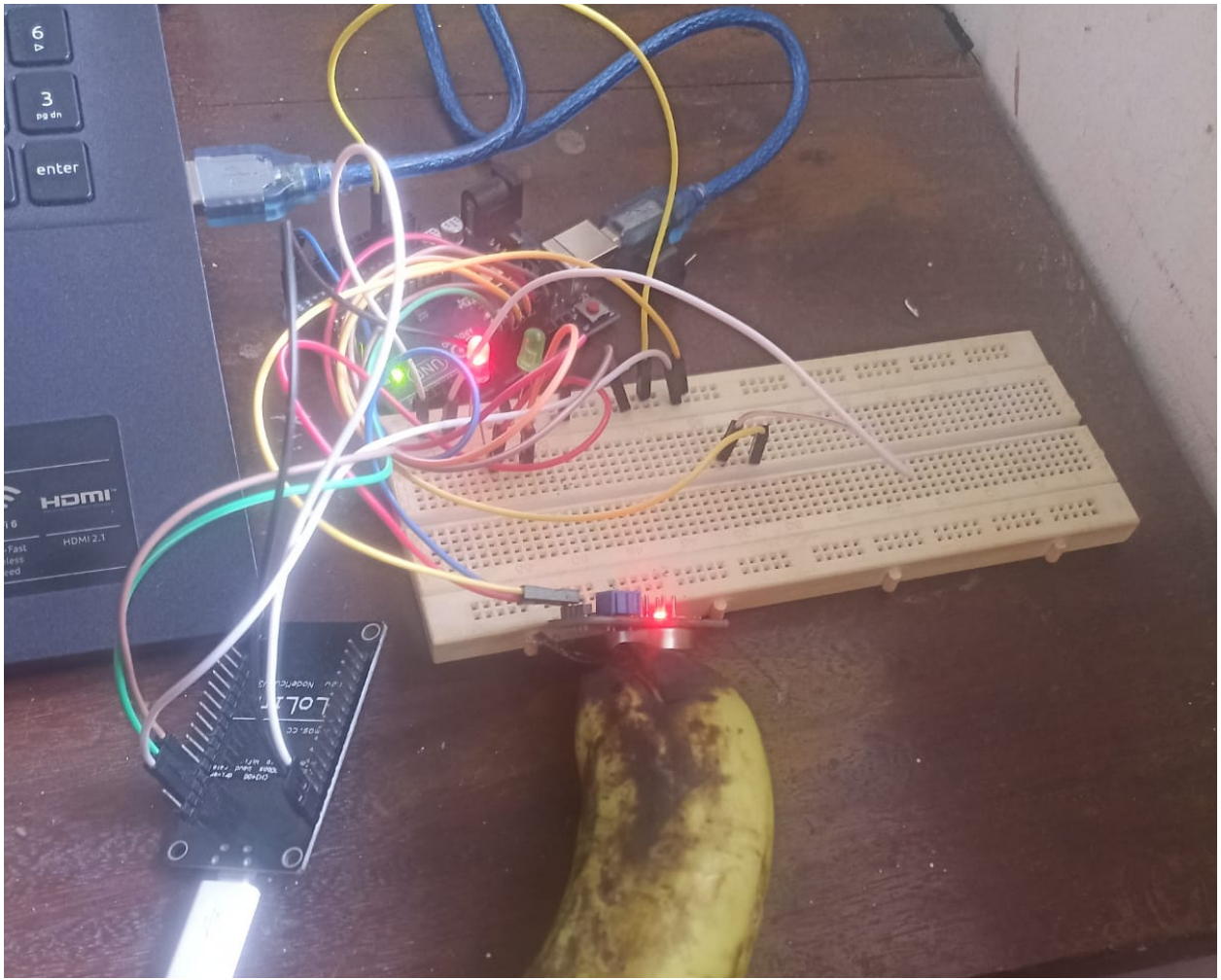
• It also displays a message of “Food Spoilage” on the Blynk application dashboard.

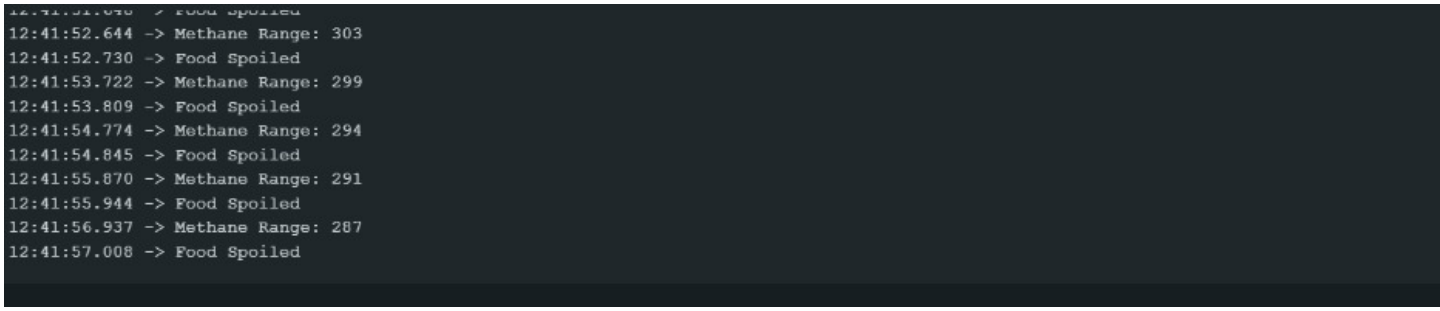
• The data over Dashboard gets updated every seconds.

• User will also be able to see the values on serial monitor of Arduino IDE and the specific graph on the serial plotter of Arduino IDE

```
12:40:50.162 -> Methane Range: 128
12:40:50.162 -> Methane Range: 128
12:40:51.183 -> Methane Range: 128
12:40:51.183 -> Methane Range: 128
12:40:52.213 -> Methane Range: 128
12:40:52.213 -> Methane Range: 128
12:40:53.236 -> Methane Range: 132
12:40:53.236 -> Methane Range: 132
12:40:54.249 -> Methane Range: 128
12:40:54.286 -> Methane Range: 128
```

Ln 17, Col 2 Arduino Uno on COM12





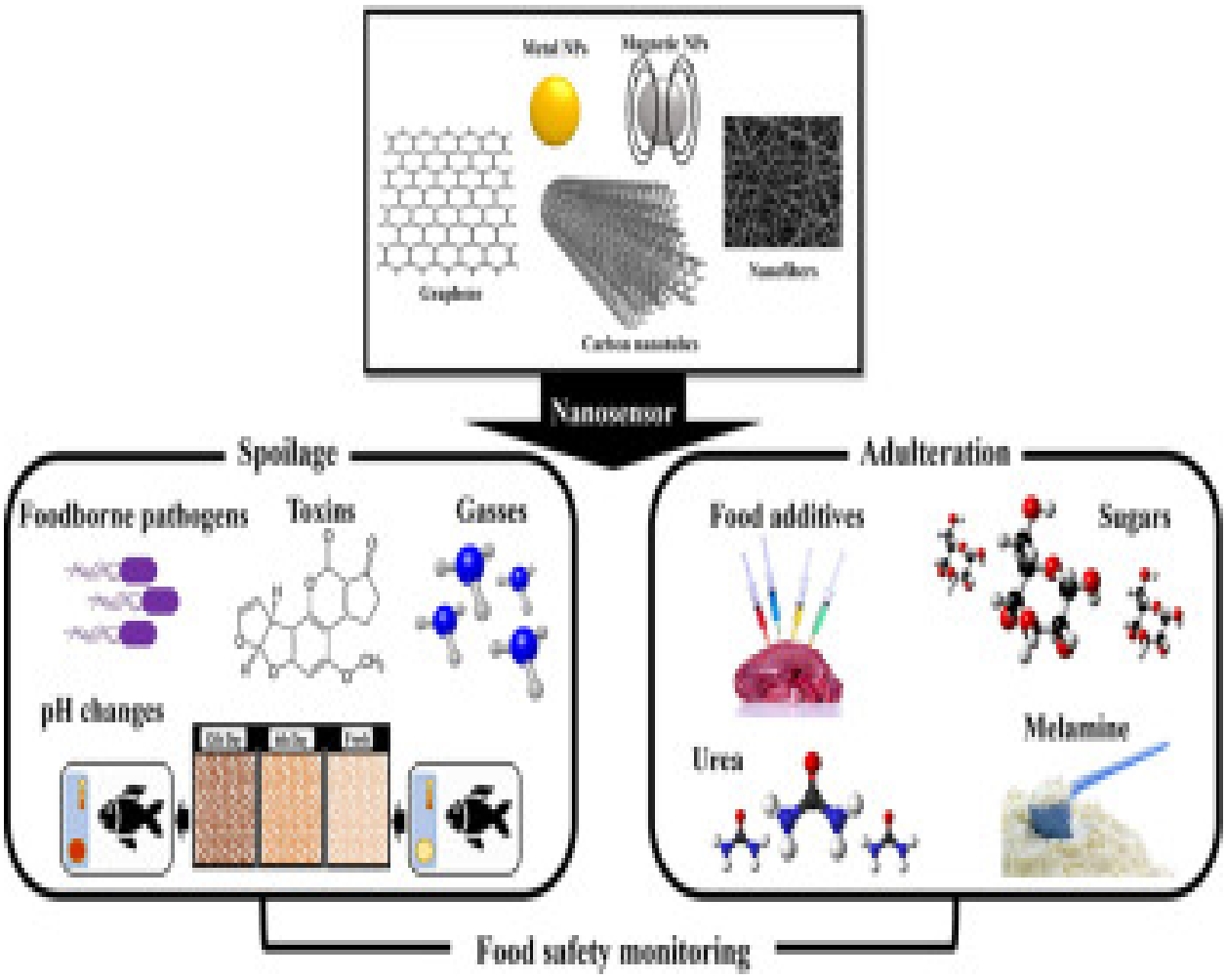
Conclusion:

In this mini-project, we developed an IoT-based food spoilage detection system that uses gas and humidity sensors to determine the freshness of various food items. The system was able to detect visible signs of spoilage and low amounts of gas emission, which correlated with the degree of spoilage of food. The system can be used in food stores, supermarkets and homes to monitor the quality of food items and detect any signs of spoilage at an early stage.

Future Work:

- Future work includes improving the sensitivity of the gas ,adding humidity,temperature(DHT-11) and moisture sensors to detect low levels of gas emission anmoisture content.To make system faster and portable.
- The system can also be expanded to include other sensors such as pH sensors, which can detect the acidity of food items, and colour sensors, which can detect changes in the colour of food items.
- we can expand the scope of this project to assess the quality of liquid products.
- By incorporating machine learning and AI algorithms, we can also predict the shelf life of food items under specific environmental conditions.

- This extended system could offer valuable recommendations and feebacks to farmers, food processing companies, and government storage facilities for more sustainable food production and preservation methods
- . Additionally, with the integration of microbial growth detecting
- sensors, it has the potential to detect the presence of adulterants in food items, enhancing its functionality



credits:https://www.sciencedirect.com/science/article/abs/pii/S0001868620305662

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