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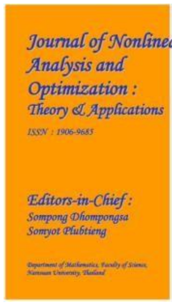

IOT BASED DETECTION OF PESTICIDE IN ORGANIC FRUITS AND VEGETABLES

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Abstract:
This paper presents an IoT-based solution for the detection of pesticide residues in organic fruits and vegetables without the use of artificial intelligence. The system is built around an Arduino controller, which interfaces with a combination of sensors, including gas sensors for pesticide detection, LDR sensors for light intensity measurement, and IR sensors for object identification. The collected data is displayed on an LCD screen for immediate user feedback. To enable remote monitoring and data transparency, a Node- MCU with WiFi connectivity is integrated into the system, allowing the sensor data to be efficiently uploaded to a central server over a wireless network. This innovative framework offers a practical and cost-effective way to ensure the safety and authenticity of organic produce by providing real-time pesticide residue detection and data access.

The Arduino controller serves as the brain of the system, orchestrating the operation of various sensors that collectively assess the presence of pesticide residues on organic fruits and vegetables. The gas sensor detects the presence of pesticides, while the LDR sensor measures the light intensity, and the IR sensor aids in object identification, enhancing the accuracy of the analysis. The LCD screen provides users with immediate information about the pesticide levels detected on the produce. Furthermore, the NodeMCU, with its WiFi capabilities, ensures that the sensor data is seamlessly transmitted to a centralized server, making it accessible for remote monitoring and analysis. This project offers a practical and efficient solution for consumers and producers alike to verify the quality of organic produce and make informed choices regarding pesticide contamination. Keywords: Arduino, Node MCU, Sensors, Server

1.Introduction

Fruits and vegetables can be tested for pesticide residues using a variety of techniques. These can be more sophisticated procedures based on nanotechnology or more conventional chromatographic techniques. High-performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GC-MS) are two well-established methods that are frequently used to detect pesticides in fruits and vegetables [4]. Using either gas or liquid chromatography, these techniques first separate the pesticide from the sample before detecting it with UV-Vis spectroscopy or mass spectrometry, respectively. Fruits and vegetables have also been subjected to advanced methods for pesticide detection, including pre-treating them with polystyrene-coated magnetic nanoparticles and developing sensors based on nanotechnology [5]. In these techniques, pesticide residues are extracted and concentrated from the sample using magnetic nanoparticles, and then they are detected using a variety of sensors. A Chinese research team recently devised a revolutionary tablet-based colorimetric approach for plant herbicide detection [6]. With this approach, indoxyl acetate is hydrolyzed into indole using an enzyme tablet containing acetylcholinesterase. Indole is subsequently oxidised in the air to generate a blue-green colour. These methods require selective quantitative analysis, but they are laborious, costly, slow, and challenging to spread and advertise. Moreover, they are devoid of the ability to share information and operate remotely. They are therefore inappropriate for rapid detection and agricultural (farming) goods. Sensor technologies and wireless technology systems have become essential tools in daily life with the rapid rise of smartphones. Real-time monitoring and remote access are made possible by IoT-based technologies, which can help consumers and farmers save time and money. Additionally, IoT technology can be utilised to trace agricultural items and give consumers transparency regarding the source and calibre of the food they eat[7].

2. Proposed method

In order to identify pesticide residues in organic fruits and vegetables, the suggested study presents an advanced technology that makes use of a combination of sensors and two serially communicating controllers, Arduino and Node-MCU. This technique uses a gas sensor to find pesticide residues, an IR (infrared) sensor to help identify objects, and an LDR (light dependent resistor) sensor to monitor ambient light intensity. Together, these sensors determine whether the product has been contaminated with pesticides. These sensors are controlled by the Arduino controller, which also gathers data and conducts preliminary analysis. Furthermore, serial connectivity is established between the Arduino and Node-MCU controllers in order to share data and send orders.

2.1 Proposed Design

Node MCU devices establish connectivity with the cloud server, enabling seamless data transmission and remote monitoring. This allows continuous uploading of sensor data for monitoring and management. Additionally, a motor automates bin door operations based on fill level, enhancing operational efficiency. Overall, the proposed method aims to revolutionize dust management with improved accuracy, real-time monitoring, and automated operations.

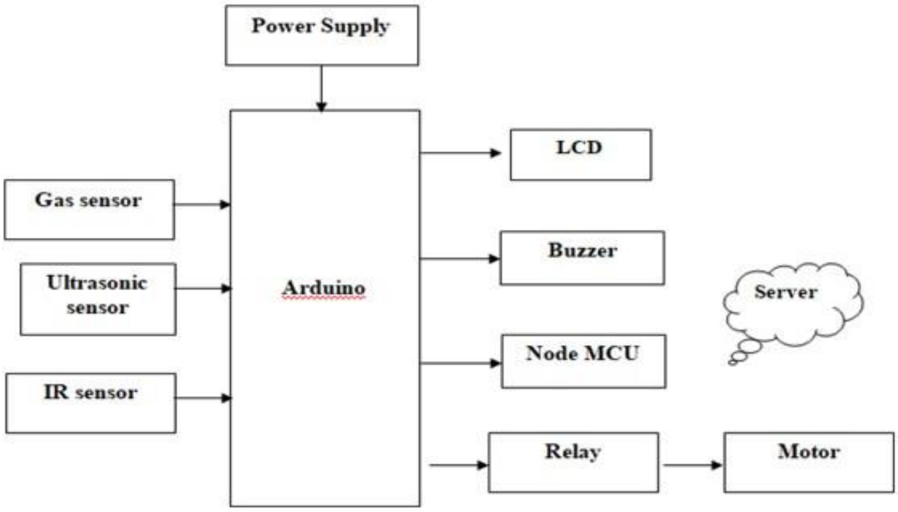


Figure.1Block diagram

2.1 Hardware description

2.1.1 Introduction to Aurdino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller that can be programmed to sense and control objects in the physical world. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. They are used for a variety of purposes, including creating interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino boards come in various shapes and sizes, each with its own set of features and capabilities. Some of the most popular Arduino boards include:

Arduino Uno: The Uno is one of the most popular Arduino boards. It features a microcontroller, digital and analog input/output pins, USB connection, and a power jack.

Arduino Mega: The Mega is similar to the Uno but with more digital and analog input/output pins, making it suitable for larger projects that require more I/O.
Arduino Nano: The Nano is a compact board with similar features to the Uno but in a smaller form factor, making it ideal for projects with space constraints.
Arduino Due: The Due is based on a more powerful microcontroller than the Uno, making it suitable for projects that require more processing power.
Arduino Leonardo: The Leonardo is similar to the Uno but with built-in USB communication, making it easier to interface with computers.
In addition to the hardware, Arduino also provides a software development environment that allows users to write, compile, and upload code to their Arduino boards. The Arduino IDE (Integrated Development Environment) is a simple yet powerful tool that is used to write code in the Arduino programming language, which is based on Wiring, and upload it to the board.
Overall, Arduino is a versatile platform that is used by hobbyists, students, and professionals alike to create a wide range of projects, from simple blinking LED lights to complex robotics projects. Its ease of use, coupled with its affordability and flexibility, has made it one of the most popular platforms for electronics prototyping and experimentation.

2.1.2 Features of the Arduino

Arduino boards come with a variety of features that make them suitable for a wide range of projects. Some of the key features of Arduino boards include:
Microcontroller: Arduino boards are equipped with a microcontroller, which is the brain of the board. The microcontroller is responsible for executing the program and controlling the inputs and outputs of the board.
Digital Input/Output Pins: Arduino boards come with a number of digital input/output (I/O) pins that can be used to connect the board to external devices such as sensors, LEDs, and motors. These pins can be configured as either inputs or outputs, allowing the board to read data from sensors or control external devices.
Analog Input Pins: In addition to digital I/O pins, Arduino boards also feature analog input pins that can be used to read analog signals from sensors. These pins allow the board to measure variables such as light intensity, temperature, and sound level.
PWM (Pulse Width Modulation) Pins: Some Arduino boards come with PWM pins, which can be used to generate analog-like signals. PWM is often used to control the brightness of LEDs or the speed of motors.
USB Connection: Arduino boards feature a USB connection, which allows them to be connected to a computer for programming and serial communication. The USB connection also provides power to the board, eliminating the need for an external power source.
Power Jack: Arduino boards come with a power jack that can be used to connect an external power source, such as a battery or a wall adapter. This allows the board to be powered independently of the USB connection.
Reset Button: Arduino boards feature a reset button that can be used to restart the board and re-run the program.
Integrated Development Environment (IDE): Arduino boards are programmed using the Arduino IDE, which provides a simple and intuitive interface for writing, compiling, and uploading code to the board.
Open-Source: Arduino is an open-source platform, which means that the hardware designs and software libraries are freely available for anyone to use and modify. This has led to a large community of Arduino users who share their projects and collaborate on new ideas.
Overall, Arduino boards are versatile and easy-to-use platforms that are ideal for beginners and experienced makers alike. Their combination of features, affordability, and flexibility make them a popular choice for a wide range of projects, from simple blinking LED lights to complex robotics applications.

2.1.3 Arduino Pinout

• Arduino Uno is based on an AVR microcontroller called Atmega328. This controller comes with 2KB SRAM, 32KB of flash memory, and 1KB of EEPROM. The Arduino Board comes with 14 digital pins and 6 analog pins. ON-chip ADC is used to sample these pins. A 16 MHz frequency crystal oscillator is equipped on the board. The following figure shows the pinout of the Arduino Uno Board

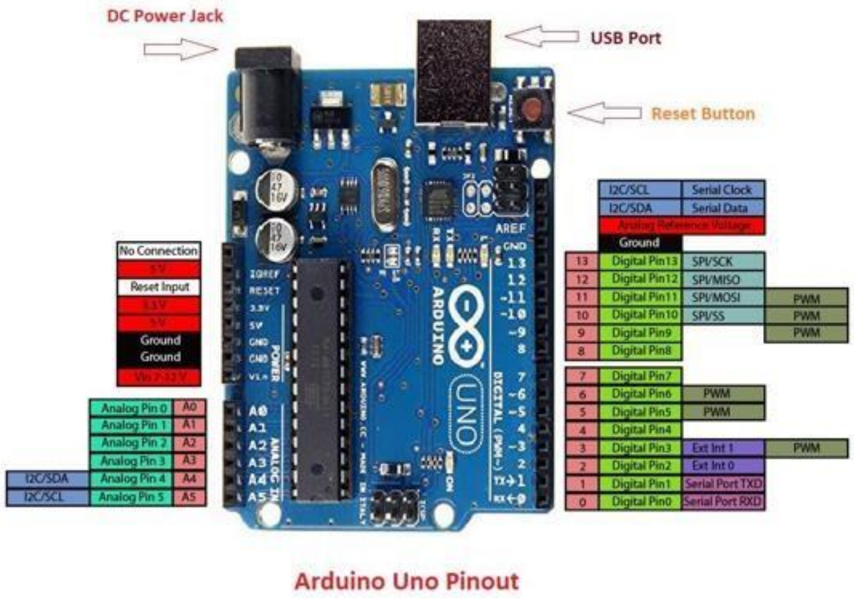


Figure.2. Arduino UNO Pinout diagram

3. Results and Discussion

3.1 Code

```
#include <SoftwareSerial.h> SoftwareSerial espSerial(5, 6);

#include<LiquidCrystal.h> LiquidCrystallcd(12,11,10,9,8,7); int ir=2; int gas=A0; int ldr=A1; int
led=3; int buz=4; int object,gas_value,light; String str;

void setup() {
Serial.begin(9600); espSerial.begin(9600); lcd.begin(16,2); pinMode(ir,INPUT);
pinMode(gas,INPUT); pinMode(ldr,INPUT); pinMode(led,OUTPUT); pinMode(buz,OUTPUT);
digitalWrite(led,LOW); digitalWrite(buz,LOW); lcd.clear(); lcd.setCursor(0,0);
lcd.print("PESTICIDE"); lcd.setCursor(0,1); lcd.print("DETECTION");
}

Void loop()
{ object=digitalRead(ir); lcd.clear(); lcd.setCursor(0,0); lcd.print("OBJECT:"); lcd.setCursor(7,0);
lcd.print(object); gas_value=analogRead(gas); lcd.setCursor(9,0); lcd.print("GAS:");
lcd.setCursor(13,0); lcd.print(gas_value); light=analogRead(ldr); lcd.setCursor(0,1);
lcd.print("INTENSITY:"); lcd.setCursor(11,1); lcd.print(light); delay(500);

if(object==0)
{ lcd.clear(); lcd.setCursor(0,0); lcd.print("OBJECTDETECTED"); delay(1000);
if(gas_value>700&&light<500)
{ digitalWrite(led,HIGH); digitalWrite(buz,HIGH); lcd.clear(); lcd.setCursor(0,0); lcd.print("GAS
DETECTED"); delay(1000);
}
```

```
Else if(light>500&&gas_value>700)
{
digitalWrite(led,HIGH); digitalWrite(buz,HIGH); lcd.clear(); lcd.setCursor(0,0);
lcd.print("INTENSITY CHANGE");
lcd.setCursor(0,1); lcd.print("GASDETECTED"); delay(1000);
} }
else
{
digitalWrite(led,LOW); digitalWrite(buz,LOW);
}
s t r
=String(object)+String("@")+String(gas_value)+St ring("#")+String(light); espSerial.println(str);
delay(1000);
}
#include <ESP8266WiFi.h> #include "ThingSpeak.h"
const char* ssid = "project"; // your network SSID (name) const char*
password = "1234567890"; // your network password
WiFiClient client;
unsigned long myChannelNumber= 2408388; const char
* myWriteAPIKey = "4WTM2BH6MQRGSENF";
// Timer variables unsigned long lastTime = 0; unsigned long timerDelay = 30000; String
String_main; String String_1;

String String_2; String String_3;

void setup() { Serial.begin(9600); WiFi.mode(WIFI_STA); ThingSpeak.begin(client); while
(!Serial) {
; // wait for serial port to connect. Needed for native USB port only
} } V
o i d l o o p (
) { if ((millis() – lastTime) >
timerDelay) {

// Connect or reconnect to WiFi if(WiFi.status() != WL_CONNECTED){ Serial.print("Attempting to
connect"); while(WiFi.status() != WL_CONNECTED){ WiFi.begin(ssid,
password); delay(5000);
}
Serial.println("\nConnected.");
} if
(Serial.availab le()) {
String_main=Serial.readString(); Serial.println(String_main); String_1=String_main.substring(0,1);

Serial.print(String_1); delay(500);
String_2=String_main.substring(2,5); Serial.print(String_2); delay(500);
String_3=String_main.substring(6,10); Serial.print(String_3); delay(500);
ThingSpeak.setField(1,String_1); ThingSpeak.setField(2,String_2); ThingSpeak.setField(3,String_3);
int x = ThingSpeak.writeFields(myChannelNumber,myWriteAPIKey); if(x == 200){
Serial.println("Channel updatesuccessful.");
```

```
} e l s
e {
Serial.println("Problemupdatingchannel. HTTP error code " + String(x));
}
lastTime = millis();
}
}
```

3.2 Results

3.2.1 OBJECT DETECTION USING IR SENSOR

Detection of pesticides in fruits, by using the values of change in light intensity, when fruit is kept near the LDR Sensor. If the light intensity exceeds the default value then the intensity change is shown by LCD display that means intensity is changed hence pesticide is detected in the fruit.

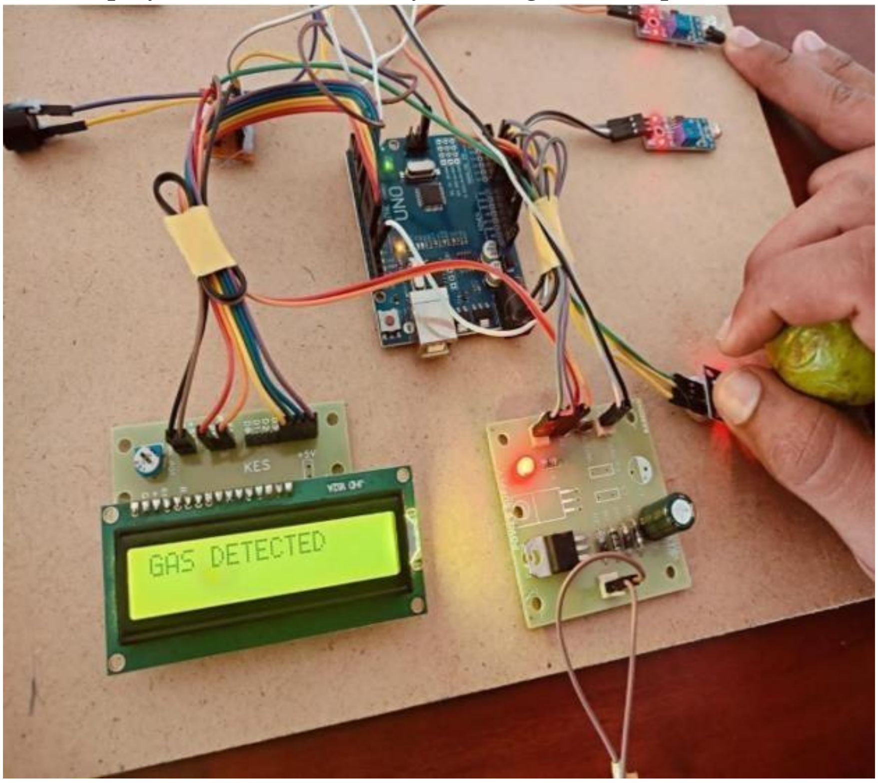


Figure.3. Inorganic Fruit

3.2.2 PESTICIDE DETECTION

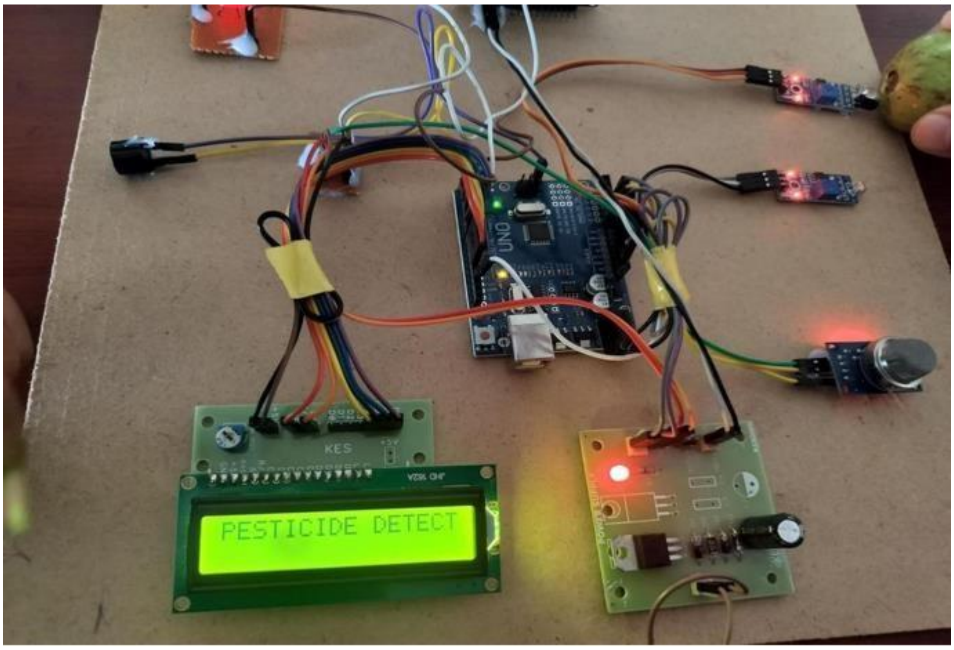


Figure.4. Inorganic Fruit

If either intensity or gas value changes then pesticide is detected in the fruit then that fruit is called Inorganic Fruit.

3.2.3 OBJECT DETECTION USING IR SENSOR

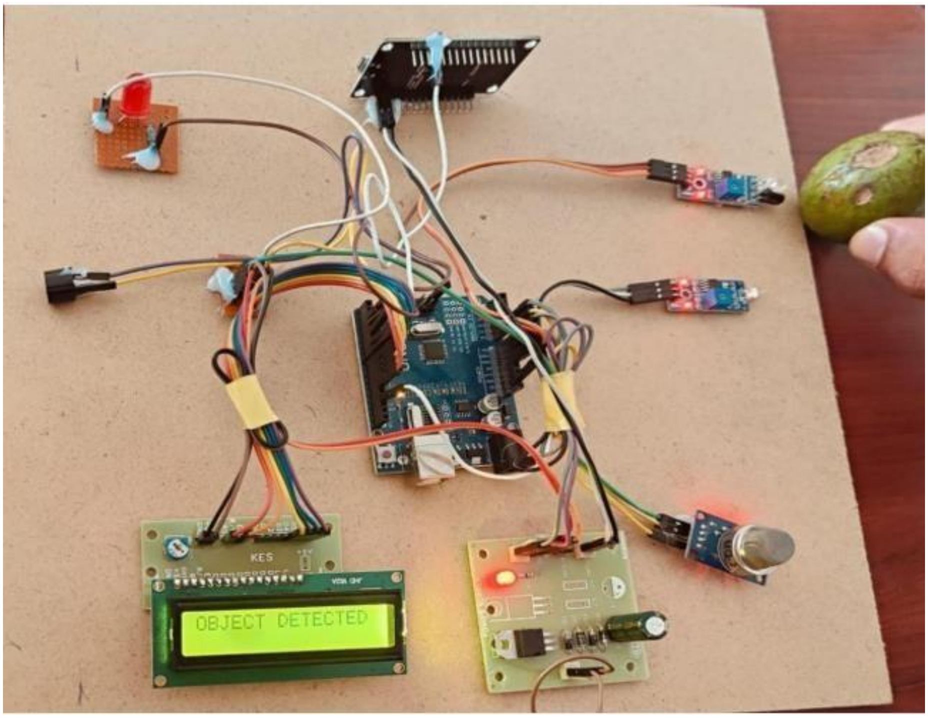


Figure.5. Organic Fruit

Detection of object, Whether the is kept to detect the pesticide present in it, by using IR Sensor.

If the object is kept near the IR Sensor then object is detected.

3.2.4 INTENSITY DETECTION USING LDR SENSOR

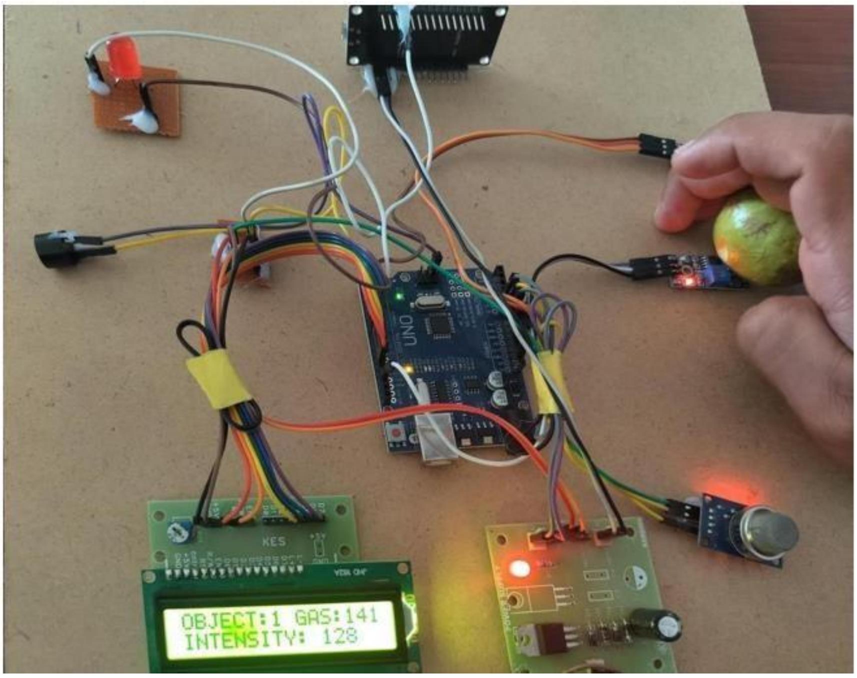


Figure.6.Organic Fruit

When the fruit is kept near the LDR Sensor if the light intensity is less then the default value then LCD Display will not show intensity change.

3.2.5 GAS DETECTION USING GAS SENSOR

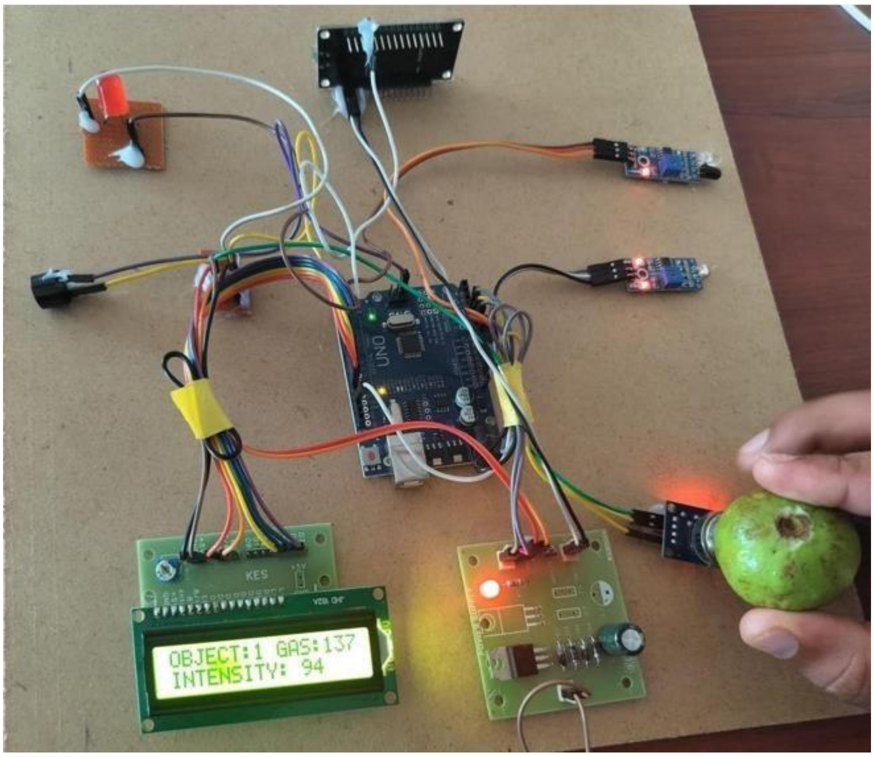
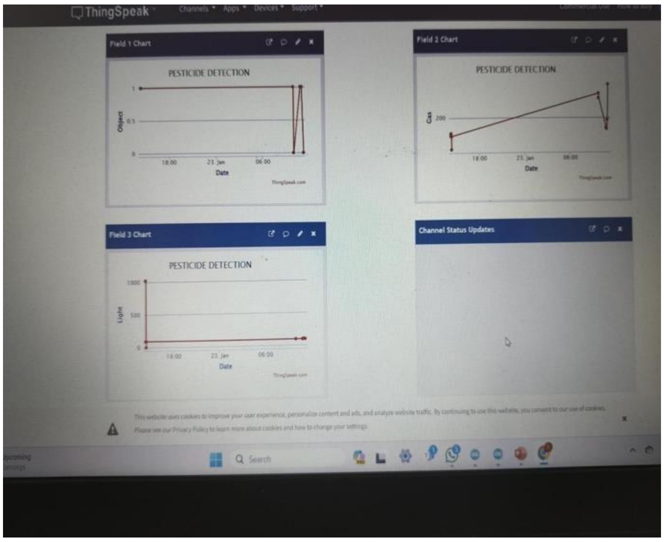


Figure.7. Organic Fruit

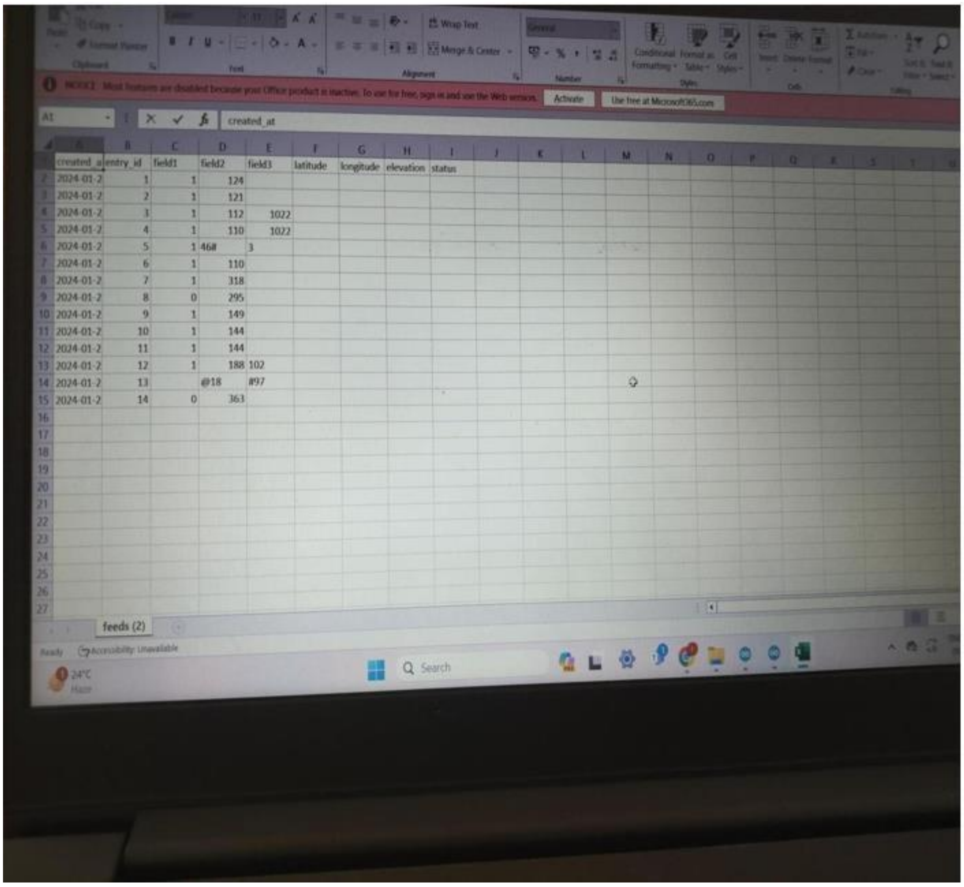
When the fruit is kept near Gas Sensor if the gas value present in fruit is less than default value then Gas is not detected by the sensor. If the both Intensity change and Gas Detection is not done by the sensors then the fruit is called Organic Fruit.

3.2.6 GRAPHICAL REPRESENTATION IN THINGSPEAK



The values of change in Intensity and Gas values when the fruit is kept near the IR Sensor is shown by the ThingSpeak server connected to the WIFI module present in the project individually

3.2.7 OUTPUT Values in Excel Sheet



created_a	entry_id	field1	field2	field3	latitude	longitude	elevation	status
2024-01-2	1	1	124					
2024-01-2	2	1	121					
2024-01-2	3	1	112	1022				
2024-01-2	4	1	110	1022				
2024-01-2	5	1	468	3				
2024-01-2	6	1	110					
2024-01-2	7	1	318					
2024-01-2	8	0	295					
2024-01-2	9	1	149					
2024-01-2	10	1	144					
2024-01-2	11	1	144					
2024-01-2	12	1	188	102				
2024-01-2	13		@18	#97				
2024-01-2	14	0	363					

Different values like number of times fruit is kept near sensor and either object is detected or not intensity value and gas values of fruits for each attempt is shown in Excel sheet by using ThingSpeak server.

3.2.8 ADVANTAGES

1. Enhanced Detection Accuracy:
2. Real-Time Monitoring:
3. Cost-Efficient Solution:
4. Immediate User Feedback:
5. Improved Data Transparency

3.2.9 APPLICATIONS

1. FARMERS' ASSURANCE: Farmers can use the system to verify the effectiveness of their pesticide management practices and ensure compliance with organic farming standards.
2. QUALITY CONTROL IN DISTRIBUTION: Distributors and retailers can employ the system to verify the absence of pesticide residues in organic produce before it reaches the market, ensuring product quality and consumer safety.
3. CONSUMER CONFIDENCE: Consumers can scan fruits and vegetables at grocery stores or markets to verify their organic status and reassure themselves of their safety for consumption. 4. FOOD SAFETY AUTHORITIES: Regulatory agencies can use the system to monitor pesticide levels in organic produce and enforce compliance with food safety regulations.
5. EXPORT COMPLIANCE: Exporters can utilize the system to demonstrate compliance with international food safety standards and gain access to lucrative organic markets abroad.
6. HEALTHCARE INSTITUTIONS: Hospitals and healthcare facilities can implement the system to screen organic produce used in patient diets, minimizing the risk of pesticide exposure to vulnerable individuals.
7. EDUCATIONAL INSTITUTIONS: Universities and research institutes can utilize the system for academic studies on pesticide residues in organic farming and related environmental impacts.
8. CERTIFICATION BODIES: Organic certification agencies can integrate the system into their inspection procedures to enhance the accuracy and efficiency of organic certification processes.
9. COMMUNITY GARDENS: Community gardens and urban farming initiatives can use the system to monitor pesticide levels in locally grown produce, promoting sustainable and safe food production practices.
10. HOME CONSUMERS: Individuals can have portable devices or smartphone applications to assess the pesticide content of fruits and vegetables purchased for home consumption, supporting healthier dietary choices.

4. Conclusion

In summary, the implementation of an IoT-based detection system for pesticides in organic fruits and vegetables marks a significant step forward in enhancing food safety, promoting organic farming practices, and safeguarding consumer health. This project leverages advanced technologies, such as IoT sensors and data analytics, to offer a comprehensive solution to address concerns about pesticide residues in agricultural produce. By seamlessly integrating into various stages of the supply chain, from farm to fork, the system ensures transparency, accountability, and traceability, thereby instilling confidence in organic products among stakeholders.

Moreover, the project highlights the transformative potential of technology in revolutionizing food production and consumption paradigms. By providing real-time information on pesticide levels to farmers, distributors, regulators, and consumers, the system enables informed decision-making, encourages sustainable agricultural practices, and reinforces the integrity of organic certifications. Looking ahead, continued research, collaboration, and adoption of innovative solutions will be crucial in establishing resilient and transparent food systems that prioritize safety, sustainability, and the wellbeing of both people and the planet.

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