PESTICIDE DETECTION & CONTROL MEASURES IN FRUITS AND VEGETABLES USING INTERNET OF THINGS

Dr. M. Purna Kishore [1], Kandula Y T Siva Sai Ganesh [2], Koduru Venkata Siva Naga Sai Tarun [3], Malapati Venu Babu[4], Moparthi Naveen Kumar[5]

[1]Assosciate Professor, Department of ECE, KKR & KSR Institute of Technology and Sciences, Vinjanampadu, Guntur Dt., Andhra Pradesh
[2-5]UG-Students, Department of ECE,
KKR & KSR Institute of Technology and Sciences, Vinjanampadu, Guntur Dt.,Andhra Pradesh

---***---

Abstract - *The growing concerns about pesticide residues in fruits and vegetables have led to the development of advanced monitoring and detection techniques. Among these, the Internet of Things (IoT) has emerged as a transformative technology for ensuring food safety and enhancing agricultural practices. This paper explores the application of IoT-based systems in the real-time detection and control of pesticide levels in agricultural produce. By integrating sensors, connectivity, and data analytics, IoT devices provide a comprehensive platform for continuously monitoring pesticide residues. We discuss various sensor technologies that are capable of detecting specific pesticide chemicals at low concentrations and propose a model for an IoT-enabled network that communicates these data to stakeholders. The system facilitates immediate decision-making regarding the safety of produce and the implementation of corrective actions in farming practices. Control measures, including the adjustment of pesticide applications and alerts for potential hazards, are automated, enhancing the effectiveness and responsiveness of agricultural management. This paper also reviews the challenges in deploying IoT technology in diverse agricultural environments and suggests potential solutions for widespread adoption.*

***Key Words*: Internet of Things, IoT, pesticide detection, food safety, agricultural technology, sensor networks, real-time monitoring, sustainable farming.**

1.INTRODUCTION

The pervasive presence of pesticides in fruits and vegetables has raised significant public health concerns globally, necessitating the development of efficient detection and control mechanisms. Traditionally, the assessment of pesticide residues has relied on laboratory-based tests that are often time-consuming and costly. However, the advent of the Internet of Things (IoT) offers a promising alternative by enabling real-time monitoring and management of pesticide levels directly in the field. IoT technology leverages a network of sensors and connected devices to collect, transmit, and process data concerning environmental conditions and pesticide concentrations. This approach not only enhances the accuracy and speed of detection but also facilitates proactive interventions to mitigate risks associated with pesticide exposure. The integration of IoT in agricultural practices aligns with the broader goals of precision agriculture, aiming to maximize yield while minimizing environmental impacts and ensuring the safety and quality of agricultural produce. This paper provides an overview of how IoT technologies can be strategically employed to monitor and control pesticide residues in fruits and vegetables, thereby supporting sustainable farming practices and protecting consumer health.

Advantages

- Real-time Monitoring of Pesticide levels
- Enhanced food safety and consumer protection.
- Increased efficiency in farming practices.
- Reduced environmental impact.
- Improved compliance with regulatory standards

Applications

- Continuous monitoring of pesticide residue in commercial agriculture.
- Automated alert systems for high pesticide detection.
- Data-driven decision-making for pesticide application.
- Supply chain monitoring from farm to consumer.
- Integration with smart farming solutions for precision agriculture.

1.1 Components

1.1.1ESP01

The ESP01 module, powered by the ESP8266 microcontroller, is a popular choice in the IoT (Internet of Things) landscape due to its compact size, low cost, and Wi-Fi capability. This module facilitates the wireless connection of various devices to the internet, enabling the creation of a network of smart devices that can communicate with each other and with cloudbased platforms. The ESP01 provides two GPIO (General Purpose Input Output) pins, which can be used for basic input and output operations, such as reading sensors or controlling relays. In IoT applications, the ESP01 is often used for remote data monitoring, control systems, and as a subordinate connectivity module integrated within larger systems. For example, it can be used to transmit environmental data collected by sensors—such as temperature, humidity, or air quality—to a central server for analysis and action. It's also commonly employed in home automation systems, allowing users to control lighting, HVAC (heating, ventilation, and air conditioning), and other home appliances remotely through smartphone apps. Despite its limited number of GPIO pins, the ESP01's capability to run on a simple Lua-based firmware or through the Arduino IDE platform makes it accessible for beginners and versatile enough for complex projects, ensuring its widespread use in the IoT development community.

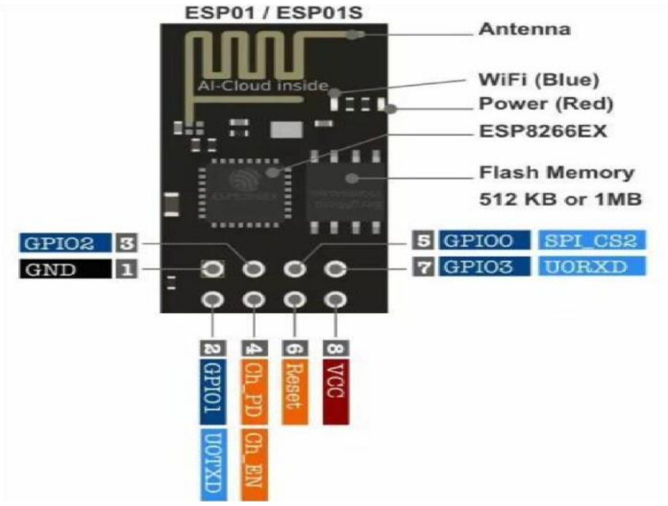

Fig:1.1.1.1 ESP01

Specifications	**Range**
Operating voltage	3.3V
GPIO	2
ADC	1 port
DAC	No
Flash memory	1 Mbyte
SRAM	80 Kbyte
CLOCK SPEED	upto 240 MHz
Wi-Fi	2.4 GHz
Sleep current	10 uA

Specifications of ESP01

1.1.2 GSM Module (SIM800L)

The SIM800L is a compact and versatile quad-band GSM/GPRS module from SIMCom that enables devices to communicate via voice, SMS, and data. Its small form factor and low cost make it particularly attractive for IoT projects that require cellular communication but are constrained by size and budget. Designed to work on frequencies 850/900/1800/1900 MHz, it is capable of functioning globally on all existing GSM networks. The Internet of Things (IoT) is revolutionizing how we interact with technology, making our environments smarter and more responsive. At the heart of many IoT devices is a need for connectivity, whether it's to send data to a remote server, receive commands, or notify users about system statuses. The SIM800L GSM/GPRS module emerges as a critical player in this domain, providing wireless network connectivity across a wide range of applications.

One of the main advantages of the SIM800L is its integration ease with microcontrollers, thanks to its support for serial communication (UART), which allows it to interface seamlessly with popular development platforms like Arduino and Raspberry Pi. This feature simplifies the design of IoT solutions that need to operate over cellular networks to send or retrieve data.

Fig:1.1.2.1 GSM Module (SIM800L)

1.1.3 MQ4 Gas Sensor

The MQ-4 gas sensor is a widely used electronic device designed specifically for detecting methane (CH_4) gas levels in the air. This sensor has significant applications across various sectors, including environmental monitoring, home safety, and industrial processes. With the advent of IoT, the MQ-4 sensor has found new applications, enabling remote monitoring and smart automation capabilities that enhance safety and efficiency. The MQ-4 gas sensor operates on the principle of gas adsorption onto a sensitive material and subsequent changes in its electrical resistance. It consists of a metal oxide semiconductor layer that reacts with methane present in the air. When methane gas molecules are absorbed by the sensor, the conductivity of the semiconductor changes, which is then translated into an electrical signal proportional to the concentration of the gas.

Integrating MQ-4 sensors into IoT systems involves connecting the sensor with microcontrollers or microprocessors that can transmit data to a cloud platform via Wi-Fi, GSM, or other IoT communication protocols. This connectivity enables real-time data analytics and monitoring from remote locations.

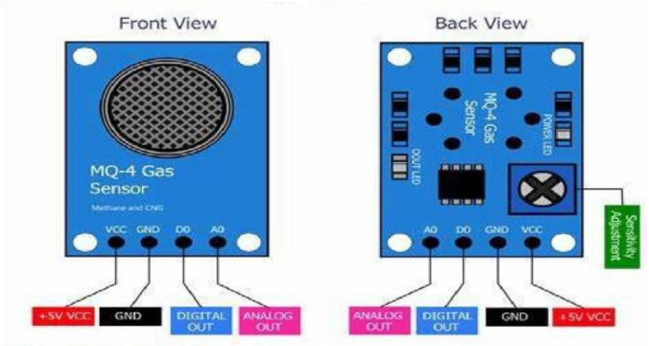

Fig:1.1.3.1 MQ4 PinOut

1.1.4 MQ7 Gas Sensor

The MQ-7 gas sensor, a crucial component in the detection of carbon monoxide (CO) levels, plays a significant role in the Internet of Things (IoT) ecosystem, especially in safety and environmental monitoring applications. This sensor is designed to detect CO concentrations in the air, making it an essential tool in both residential and industrial settings. As IoT technologies advance, the integration of sensors like the MQ-7 has become pivotal in developing smart systems that enhance human health and safety while offering new levels of environmental intelligence. The MQ-7 sensor operates on the principle of gas sensitization using a $SnO2$ (tin dioxide) semiconductor, which has a lower conductivity in clean air. When the air contains CO gas, the conductivity increases as the gas reacts with the oxygen on the heated surface of the sensor, altering the resistance across the sensor element. This change in resistance can be measured and translated into CO gas concentration. For IoT applications, this data is crucial for real-time monitoring and response systems.

Fig:1.1.4.1 MQ7 PinOut

1.1.5 IOT Thingspeak app

ThingSpeak is an IoT analytics platform service that allows users to aggregate, visualize, and analyze live data streams in the cloud. Users can send data from IoT devices, such as sensors and microcontrollers, to ThingSpeak, which then provides tools for plotting graphs, creating visualizations, and triggering alerts based on the incoming data. It supports MATLAB® analytics and visualization, enabling users to perform online analysis directly on the data without needing additional software. Ideal for IoT applications like remote monitoring, ThingSpeak facilitates easy data collection and operation, helping developers and researchers turn data into actionable insights efficiently and effectively.

2. Methodology

This project represents a significant step forward in food safety and public health. Utilizing IoT technology, the system employs Arduino UNO board coordination with MQ4 and MQ7 gas sensors to detect unsafe levels of methane and carbon monoxide, which indicate the presence of harmful pesticide residues in produce. Data from these sensors is displayed in real-time via an LCD and transmitted to the ThingSpeak cloud platform for ongoing analysis, facilitating remote monitoring. This system enhances consumer safety by using visual (LEDs) and audible (buzzer) alerts to notify users when pesticide levels exceed safe thresholds. The incorporation of a GSM module allows the system to send immediate alerts to users, enabling swift decisionmaking about the safety of consuming affected produce. This proactive approach not only helps prevent health issues related to pesticide exposure but also contributes valuable data for researching safer pest control methods. By integrating advanced sensor technology and real-time data analysis, this project not only ensures the safety of fruits and vegetables but also empowers communities with knowledge, promoting healthier lifestyles and enhanced food safety standards worldwide.

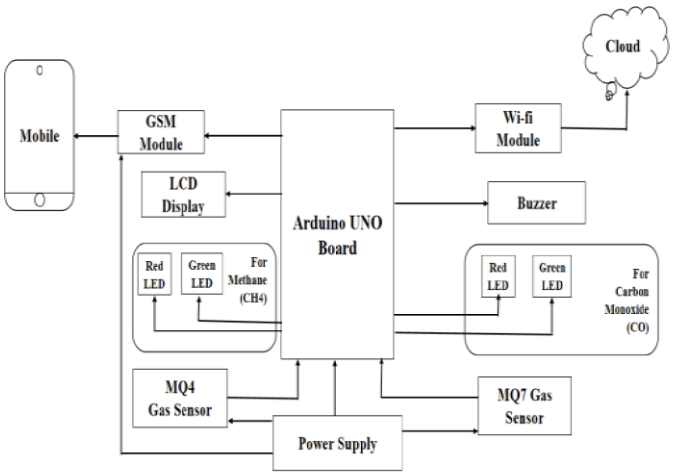

Fig:2.1 block diagram of proposed system

3.Flow chart

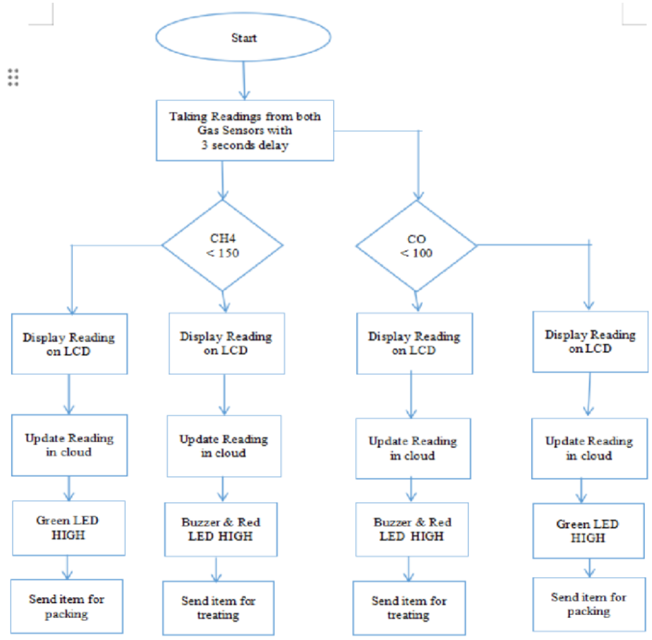

Fig:3.1 flowchart of proposed system

4.Results

In this, the user can see the content of pesticides in a fruit or vegetable. After crossing the minimum level, the device will warn to give the safety measures based on its toxic category

Sample paragraph Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

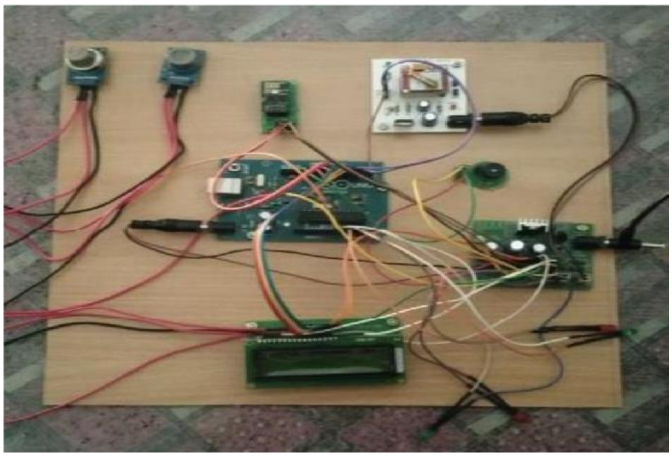

Fig:4.1.1 Circuit Connection

Once the fruit has no excess content then the both green LED's will be high and the item is sent for packing.

Here, for every reading both the LCD and Cloud is updated time to time.

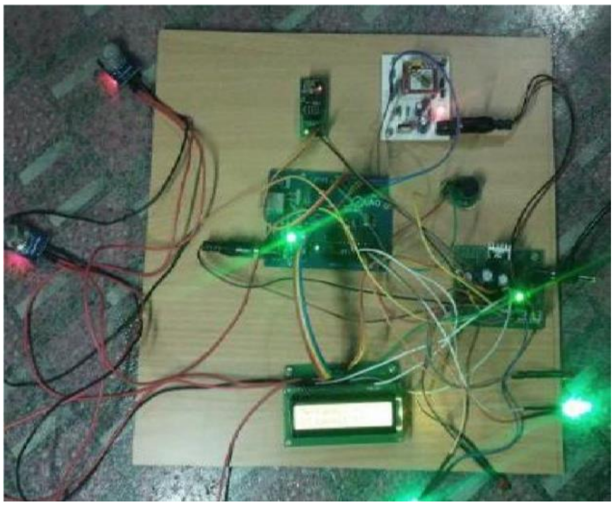

Fig:4.1.2 Both Gases are within ranges

Once the fruit has excess content of CH4, then the red LED referring CH4 and Buzzer will be high and the item is sent for threatening.

Here, for every reading both the LCD and Cloud is updated time to time

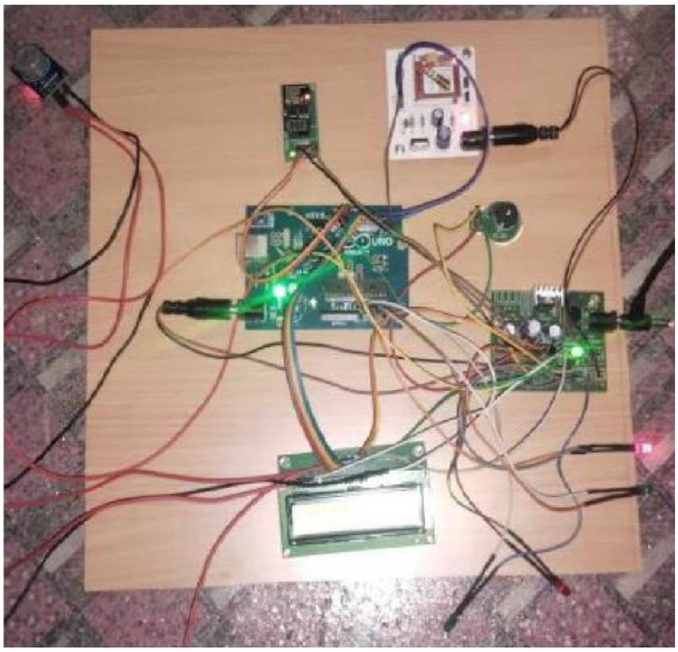

Fig:4.1.3. CH4 Exceeds the range

Once the fruit has excess content of CO, then the red LED referring CO and Buzzer will be high and the item is sent for threatening

Here, for every reading both the LCD and Cloud is updated time to time.

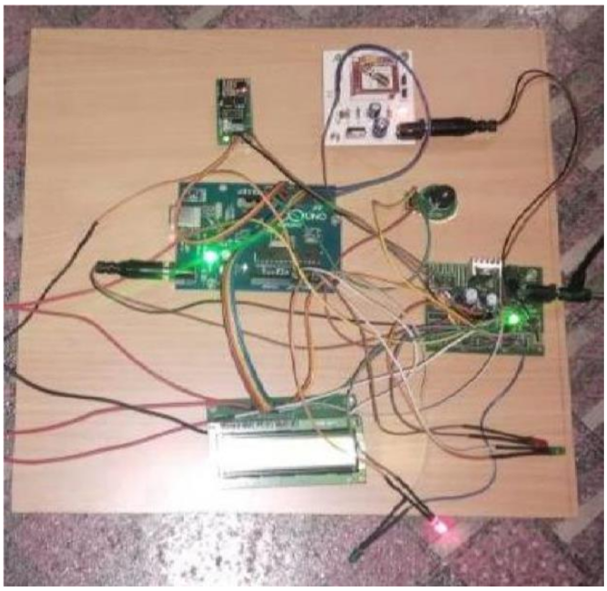

Fig:4.1.4. CO Exceeds the range

Once the fruit has both gases excess in content then the both red LED's and the Buzzer will be high and the item is sent for threatening.

Here, for every reading both the LCD and Cloud is updated time to time

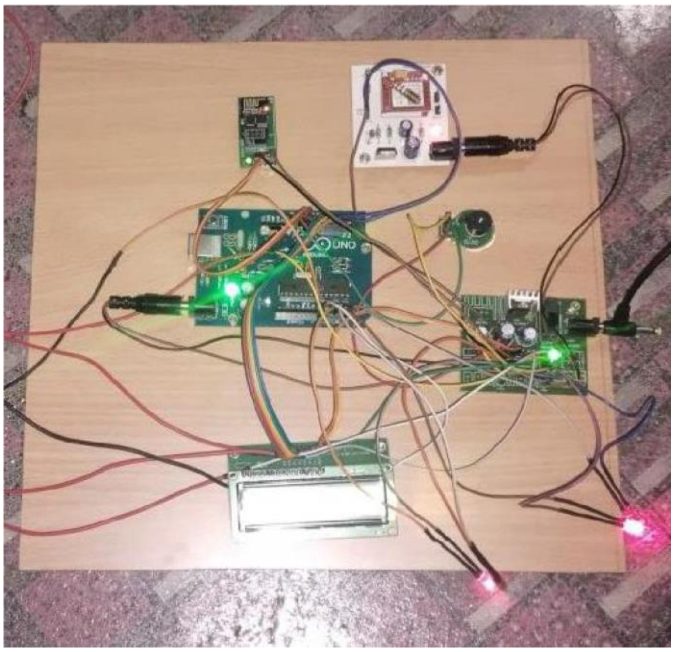

Fig:4.1.5 Both Gases Exceeds the range

5. Conclusion

The integration of the Internet of Things (IoT) in agricultural practices has opened new vistas in the monitoring and management of food safety, specifically in the detection of pesticide residues in fruits and vegetables. Our project, "Pesticide Detection and Control Measures in Fruits and Vegetables Using IoT," demonstrates a successful application of IoT technology to address critical issues of public health and safety. Through the deployment of advanced sensor technology, namely MQ4 and MQ7 sensors, the project effectively monitors the levels of methane and carbon monoxide, which are indicative of pesticide presence. The use of Arduino UNO as a central processing unit facilitates the seamless collection, processing, and analysis of data in real time.

The integration of these components within an IoT framework allows for immediate detection and alerts, which are crucial for preventing the consumption of contaminated produce. Moreover, the system's capability to alert users via SMS through the GSM module ensures that critical information reaches the relevant stakeholders promptly. This immediacy of communication is pivotal in preventing the distribution and sale of contaminated goods, thereby protecting consumers and helping vendors maintain their reputations for safety and quality

6.Future Scope

The project also underscores the potential for scalability and adaptability in different environmental conditions and agricultural settings. The flexibility of IoT architectures allows for tailored configurations that can meet diverse operational requirements, making this technology universally applicable across various domains beyond agriculture, such as environmental monitoring and industrial process control.

Furthermore, the educational and awareness-raising components of the project are significant. By demonstrating the effectiveness of IoT in real-world applications for food safety, the project not only promotes technological adoption among farmers and producers but also educates the general public about the importance of pesticide monitoring. This knowledge dissemination is crucial for fostering a culture of safety and responsibility across the food supply chain

7.References

1. Biswas, P. K., & Karmakar, N. C. (2019). Internet of Things (IoT) and Sensor Networks for Precision Agriculture and Smart Farming.

2. Jayasundera, M., Adikari, A. B., & Adikari, J. (2021). IoTBased Smart Agriculture: A Review.

3. Lee, M., & Khan, R. (2018). Integrating Internet of Things (IoT) into Agriculture and Smart Farming Towards Enhancing Agricultural Productivity.

4. Sharma, A., Tyagi, S., & Gupta, P. (2020). IoT-based Monitoring System Using MQTT for Agricultural Environment

5. Thakur, D., & Kumar, Y. (2019). A Study on the Role of Internet of Things (IoT) in Smart Agriculture.

6. Feng, X., & Zhang, S. (2018). Application of the Internet of Things Technology in Precision Agriculture: A Review.

7. Li, X., Li, D., Wan, J., Vasilakos, A. V., Lai, C., & Wang, S. (2017). A Review of Industrial Wireless Networks in the Context of IoT and Industry 4.0.

8. Singh, R., Sharma, P., Sharma, V., & Kalia, A. (2020). Detection of Pesticide Residues in Food Using IoT Technology.

9. Smith, L., & Sulaiman, T. (2022). Emerging Sensor Technologies for Agriculture: Current Progress and Future Implications.