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DETECTION OF PESTICIDES IN FRUITS AND VEGETABLES USING IOT

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*Abstract:*The excessive use of pesticides in fruits and vegetables has become a major health concern. Consumption of pesticide-contaminated food can cause harmful effects on human health. This project presents an IoT-based pesticide detection system using sensors and a microcontroller to monitor pesticide levels in fruits and vegetables. The system uses an ESP32 controller, MQ135 gas sensor, IR sensor, DHT11 sensor, LCD display, and buzzer. The MQ135 sensor detects harmful gases released from pesticide residues, while the IR sensor identifies the presence of fruits or vegetables. The DHT11 sensor monitors environmental temperature and humidity. The collected data is processed by the ESP32 and displayed on the LCD. When pesticide levels exceed the safe limit, the buzzer gives an alert notification. The proposed system provides a low-cost, simple, and efficient method for monitoring food safety and reducing health risks.

IndexTerms **- IoT, ESP32, MQ135 Sensor, Pesticide Detection, Food Safety, DHT11 Sensor, LCD Display.**

INTRODUCTION

Agriculture plays an important role in food production, but the excessive use of pesticides in farming has created serious health and environmental problems. Farmers use pesticides to protect crops from insects and diseases, but the remaining chemical residues on fruits and vegetables can be harmful to consumers. Continuous consumption of contaminated food may cause skin diseases, respiratory problems, cancer, and other health issues.

Traditional laboratory methods for detecting pesticides are expensive, time-consuming, and require skilled professionals. Therefore, there is a need for a low-cost and portable system that can quickly detect pesticide residues in food products. The Internet of Things (IoT) provides smart solutions for monitoring and controlling devices through sensors and wireless communication.

The proposed system uses IoT technology for detecting pesticides in fruits and vegetables. The system consists of an ESP32 microcontroller connected with MQ135 gas sensor, IR sensor, DHT11 sensor, LCD display, and buzzer. The MQ135 sensor detects harmful gases released due to pesticides. The ESP32 processes sensor values and displays the results on the LCD screen. If the detected pesticide level is above the threshold value, the buzzer alerts the user.

This system helps consumers identify contaminated fruits and vegetables easily and improves food safety. The project is simple, affordable, portable, and suitable for homes, markets, and agricultural industries.

OJECTIVES OF THE PROJECT

The major objectives of the proposed system are:

1. To develop an IoT-based pesticide detection system using the ESP32 microcontroller.
2. To detect harmful pesticide gases and chemical residues using the MQ135 gas sensor.
3. To monitor environmental temperature and humidity using the DHT11 sensor.
4. To identify the presence of fruits and vegetables using the IR sensor.
5. To display real-time sensor data and warning messages on the LCD screen.
6. To activate a buzzer alert when pesticide levels exceed the safety threshold.
7. To provide a low-cost and portable food safety monitoring solution.
8. To improve consumer awareness regarding pesticide contamination in food products.

LITERATURE SURVEY

Several researchers have worked on smart agriculture and pesticide detection systems using IoT technology. Naikwadi et al. (2025) proposed an IoT and machine-learning-based pesticide detection system for fruits and vegetables, which improved monitoring accuracy and food safety awareness.[1]

Raut et al. (2024) developed an IoT-based pesticide level monitoring system using gas sensors and wireless communication modules for real-time analysis of harmful chemicals in agricultural products.[2]

Sharma and Patel (2023) introduced a smart food-quality monitoring system using gas sensors and cloud integration for detecting contamination in vegetables and fruits. Their work demonstrated the importance of real-time monitoring and alert systems.[3]

Research by Kumar et al. (2022) focused on sensor-based agricultural monitoring systems using ESP32 and IoT platforms to improve automation and reduce manual effort.[4]

Although previous studies focused mainly on environmental monitoring or food-quality assessment, very few systems integrated gas sensing, environmental monitoring, alert systems, and IoT communication into a single low-cost platform. The proposed system addresses this gap by combining multiple sensors with ESP32-based IoT monitoring for pesticide detection

PROPOSED SYSTEM ARCHITECTURE

The proposed system consists of hardware and software modules integrated through the ESP32 microcontroller.

WORKING PRINCIPLE

The MQ135 gas sensor continuously monitors harmful gases and pesticide residues present around fruits and vegetables. The IR sensor detects the presence of the food item and activates the monitoring process. The DHT11 sensor measures temperature and humidity conditions of the surrounding environment.

The ESP32 microcontroller collects data from all sensors and processes the readings. The real-time values are displayed on the LCD screen. If the pesticide level exceeds the predefined threshold value, the ESP32 activates the buzzer and displays a warning message such as “High Pesticide Detected” on the LCD.

The IoT-based ESP32 module can also upload sensor readings to cloud platforms through Wi-Fi connectivity for remote monitoring and analysis. This helps users monitor food safety conditions from anywhere.

The system provides a simple, portable, and effective method for detecting pesticide contamination in fruits and vegetables.

METHODOLOGY

The methodology adopted in this project includes the following stages:

1. System Design: The complete pesticide detection system was designed using ESP32 as the central controller for sensing, processing, and communication operations.

2. Sensor Integration: MQ135, DHT11, and IR sensors were connected to the ESP32 microcontroller for collecting environmental and gas-sensing data.

3.Data Acquisition: The MQ135 sensor detects harmful gases and pesticide residues, while the DHT11 sensor measures temperature and humidity. The IR sensor identifies the presence of fruits and vegetables.

4. Data Processing: The ESP32 processes sensor readings and compares them with predefined threshold values for pesticide detection.

5. Display and Alerts: The LCD displays real-time values, and the buzzer produces an alert whenever harmful pesticide levels are detected.

6. IoT Communication: The ESP32 uploads real-time sensor data through Wi-Fi for cloud-based monitoring and analysis.

7. Testing and Validation: The system was tested with different fruits and vegetables to verify sensor response, alert accuracy, and monitoring performance.

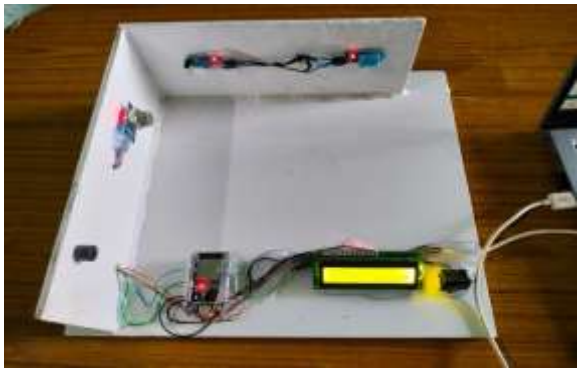
RESULTS AND DISCUSSION

The developed IoT-based pesticide detection system successfully detected harmful gases and chemical residues using the MQ135 sensor. The ESP32 accurately processed sensor readings and displayed real-time data on the LCD screen.

The IR sensor effectively detected the presence of fruits and vegetables and initiated the monitoring process automatically. The DHT11 sensor monitored environmental temperature and humidity conditions successfully.

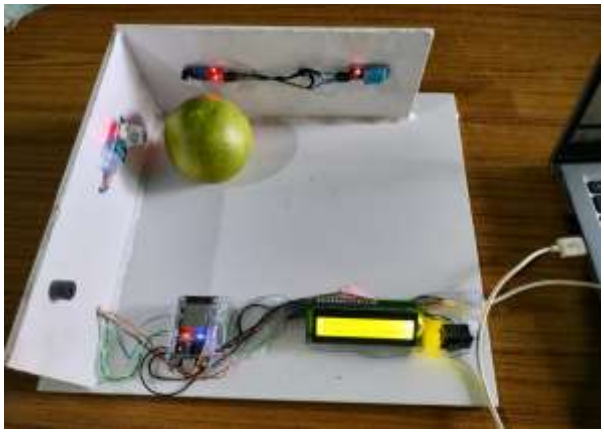
Whenever pesticide levels exceeded the safety threshold, the buzzer alert activated immediately, and warning messages were displayed on the LCD screen. The system demonstrated good responsiveness, reliability, and low power consumption.

The IoT monitoring capability allowed real-time observation of sensor readings through wireless communication. Experimental testing showed that the system can provide a low-cost and portable solution for food safety monitoring in homes, markets, and agricultural applications.



Prototype Model

Initial Display



System Setup

Safe Status

Warning Alert

CONCLUSION

The IoT-based pesticide detection system for fruits and vegetables was successfully designed and implemented using ESP32 and multiple sensors. The system effectively monitored harmful pesticide gases, environmental conditions, and food-item presence in real time.

The MQ135 sensor successfully detected pesticide-related gases, while the LCD display and buzzer provided immediate alerts to users whenever contamination levels exceeded the safety threshold. The integration of IoT technology enabled remote monitoring and improved accessibility.

The proposed system provides a low-cost, portable, and efficient solution for detecting pesticide contamination in food products. It improves food safety awareness and supports smart agriculture and healthy living applications.

FUTURE WORK

The future scope of the proposed system can be expanded in several directions:

1. Integration of Artificial Intelligence and Machine Learning for accurate pesticide prediction.
2. Development of mobile applications for remote monitoring and notifications.
3. Integration with cloud platforms for large-scale food-quality analysis.
4. Addition of advanced sensors for detecting multiple pesticide types.
5. Improvement of sensor sensitivity and detection accuracy.
6. Development of portable handheld devices for commercial use.
7. Integration with smart agriculture and automated food-sorting systems.
8. Implementation of data analytics for food safety monitoring.
9. Expansion into industrial food-processing and packaging applications.
10. Enhancement of wireless communication and cybersecurity features.

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