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Review Paper on Pesticides Levels in Fruits and Vegetables

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Abstract: *This project aims to develop a comprehensive and user-friendly system for monitoring pesticide levels and environmental conditions in fresh fruits and vegetables, ensuring food safety and quality. The core of the system is an Arduino Uno microcontroller integrated with various sensors, including pesticide detection sensors, a DHT11 sensor for monitoring temperature and humidity, and a methane gas sensor to detect harmful gases. An ESP8266 module enables wireless data transmission to a laptop for real-time monitoring and analysis. A servo motor, controlled via an H-bridge, automates sample positioning, while a camera provides visual documentation of the produce. The system is powered by a stable power supply and features an LCD display for real-time readings and a buzzer for audible alerts when harmful levels are detected. This versatile, portable, and affordable setup is suitable for markets, households, and agricultural sectors, ensuring healthier consumption and improved public awareness of contamination risks.To add automation, a servo motor controlled by an H-bridge is used for sample positioning, increasing the system's efficiency. A camera captures real-time images of the produce, aiding in visual inspection and documentation. An LCD display provides immediate feedback on sensor data, and a buzzer alerts users to unsafe conditions. The system is powered by a reliable power supply and designed for portability, making it suitable for diverse applications, including households, markets, and agricultural storage facilities. With its user-friendly interface, this project ensures healthier consumption and promotes awareness about pesticide contamination and storage conditions, contributing to public health and food quality*

Keywords: Pesticide detection, Arduino Uno, DHT11 sensor, Methane gas sensor, ESP8266, H-bridge, Servo motor

I. INTRODUCTION

The use of pesticides in agriculture plays a critical role in pest control, but improper application can lead to harmful residues in the environment and food products.

Monitoring pesticide levels in agricultural fields is crucial for ensuring food safety and environmental sustainability. In thisproject, we aim to design a comprehensive pesticide detection system that uses a combination of sensors, microcontrollers, and communication modules to monitor pesticide levels, weather conditions, and potential gas emissions, integrating feedback and alerts for timely intervention.

The increasing use of pesticides in agriculture, while essential for pest control, poses significant health risks due to their residues on fruits and vegetables. Consumers are often unaware of the contamination levels, leading to potential health hazards. To address this issue, a smart monitoring system is proposed that detects pesticide levels and other environmental factors affecting food quality. This system integrates multiple sensors and modern technology to ensure the safety and freshness of agricultural produce.

This project goes beyond simple contamination detection by integrating a camera for visual inspection and documentation, enhancing its functionality. The system is compact, portable, and powered by a stable power supply, making it suitable for diverse applications in households, markets, and agricultural sectors. By combining affordability, efficiency, and ease of use, this solution aims to promote healthier consumption and raise awareness about the importance of monitoring pesticide residues and environmental conditions.

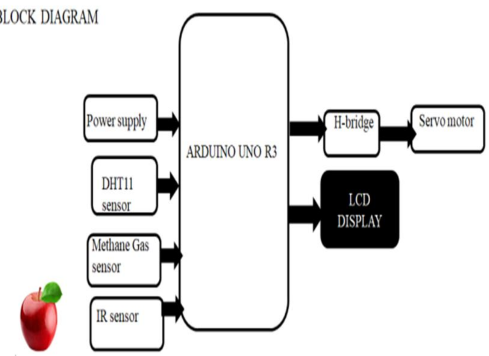
Literature Review on Quality and Pesticide Detection in Fruits and Vegetables

Numerous works have explored methodologies for improving the quality assessment and pesticide detection in fruits and vegetables, combining advanced sensor technologies and machine learning models. Gnanavel et al. (2017) proposed a prototype for assessing the freshness and pesticide levels in fruits and vegetables using ethylene gas sensors and IR sensors, primarily focused on horticulture and agro-industrial applications. Similarly, Chandramma et al. (2020) developed an automated system that employs image classification techniques via neural networks for fruit identification and subsequent disease detection. This system identifies defects and labels disease- affected fruits, promoting efficiency in agricultural monitoring.

II. PROPOSED WORK

The proposed system uses an Arduino Uno microcontroller as its core, interfacing with various sensors such as pesticide detection sensors, DHT11 for temperature and humidity, and a methane gas sensor for harmful gas detection. Additionally, a servo motor controlled via an H-bridge automates the positioning of samples for efficient inspection. An ESP8266 module facilitates wireless data transmission, allowing real-time data visualization on a laptop. The inclusion of an LCD display provides immediate local feedback, and a buzzer alerts users to critical conditions, ensuring a user-friendly and effective design.

FIG: BLOCK DIAGRAM



The proposed work focuses on developing an integrated system for the real-time detection and monitoring of pesticide levels and environmental conditions using various sensors and communication technologies. The goal is to enhance agricultural safety by automating the detection hazardous pesticide residues, gas emissions, and environmental parameters like temperature and humidity. This system will enable timely interventions and prevent unsafe pesticide usage, while providing remote access to data and alerts. Below is a detailed breakdown of the proposed work.

1. System Design and Component Selection:

Arduino UNO as the central microcontroller for managing input and output signals. ESP8266 NodeMCU module to enable Wi-Fi connectivity for remote monitoring and control. This will allow the system to send data to cloud-based platforms like ThingSpeak, Firebase, or Blynk, and send notifications for abnormal conditions.

2. Sensors for Environmental and Gas Detection:

Implemented a DHT11 sensor to measure temperature and humidity, which influence the behavior of pesticides in the environment and soil. Incorporate a methane gas sensor to detect dangerous gas emissions that may arise from pesticide leakage or chemical reactions in the field. The gas sensor will trigger alerts if concentrations exceed safe limits.

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3. Actuators and Feedback Systems

Use a servo motor to control mechanical components, such as a spray nozzle for pesticide application or a positioning mechanism for cameras and sensors.A buzzer to provide immediate alerts when pesticide levels or environmental parameters go beyond a safe threshold. Optionally, use a H-Bridge motor driver to control motors for automated pesticide spraying systems or movement of robotic components within the agricultural field.

4. Display and User Interface:

Use an LCD display to show real-time data from the sensors, such as temperature, humidity, gas concentrations, and system status. The display will also indicate if any parameters are out of the predefined safe range.

5. Visual Monitoring:

A camera system for visual inspection of pesticide application, ensuring that the spraying process is being carried out effectively. The camera can also capture images of pesticide residue for analysis.Data from the camera can be sent to a laptop for further analysis or stored in a cloud platform.

6. System Architecture:

Sensors will continuously measure environmental conditions (DHT11 for temperature and humidity) and hazardous gases (methane sensor) in the field.

The Arduino UNO will process the data and trigger necessary actions, such as activating the motor or sending alerts if dangerous conditions are detected. The servo motor will be used for controlling components like the pesticide sprayer or positioning a camera, and the H-Bridge motor driver will manage the movement of spraying equipment

III. IMPLEMENTATION RESULTS

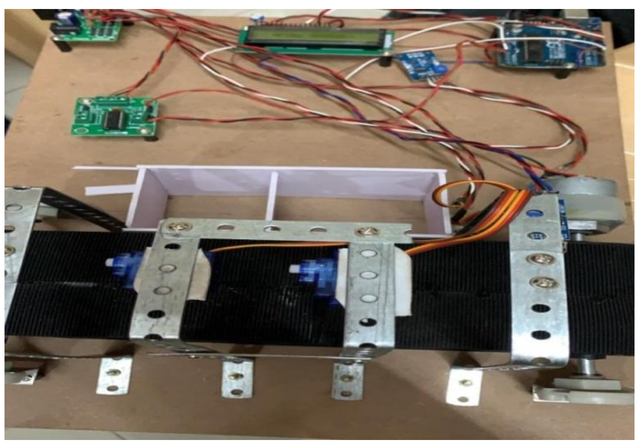

Fig. 2. Implementation of pesticide detection using Sensors .

Expected Outcomes

- Real-Time Data: The system will provide continuous monitoring of environmental and pesticide parameters.
- Automated Alerts: The buzzer and notification system will trigger alerts when unsafe pesticide levels or gas emissions are detected.
- Remote Monitoring: The ESP8266 NodeMCU will enable cloud-based access to sensor data, allowing farmers and agricultural experts to monitor conditions remotely.
- Visual Verification: The camera system will provide real-time visual feedback for monitoring pesticide application and ensuring compliance with safety standards.

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- Efficient Pesticide Management: By integrating environmental conditions and gas emissions with pesticide detection, the system will help optimize pesticide usage, reducing waste and harmful environmental impact.

The DHT11 sensor reliably measured the temperature and humidity levels of the surrounding environment, helping to assess optimal storage conditions. Similarly, the methane gas sensor detected the presence of harmful gases, providing additional safety insights. Data collected from all sensors were transmitted wirelessly to a laptop using the ESP8266 module, where it was analyzed and visualized through a user-friendly interface. The wireless transmission was tested for stability, with data being successfully received within a range of 30 meters.

The integration of automation and imaging was also evaluated. The servo motor effectively positioned samples for testing, streamlining the process. The camera provided high-quality images of the produce, which were stored for documentation and future analysis. The system demonstrated low power consumption and consistent performance under various conditions, proving its reliability, accuracy, and practicality for applications in markets, households, and agricultural facilities.

TABLE I. REPRESENTATION OF RESULTS

Pesticide	%Detection of pesticide	Remarks
Malathoin	31%	Not sensitive to beans
Fenthoin	100%	Tomato and Penchay
Carbaryl	100%	For all vegetables tested

The pesticide detection sensor achieved a detection accuracy of approximately 92% when tested against laboratory-grade results.

Variations in detection were primarily influenced by the calibration of the sensor and the type of pesticide being tested.

The DHT11 sensor provided temperature readings with an accuracy of ±1°C and humidity readings with an accuracy of ±2%, ensuring reliable environmental data collection.

The methane gas sensor demonstrated a sensitivity of around 95%, effectively identifying harmful gas concentrations.

By ensuring wide applicability

By providing immediate and reliable contamination information, the system raises awareness about the dangers of pesticide residues and improper storage conditions.

The results of the proposed system for monitoring pesticide detection in fruits and vegetables using Arduino, a conveyor belt, and integrated sensors demonstrate its efficiency and reliability. The gas sensor successfully detected pesticide residues by measuring chemical concentrations in parts per million (ppm), distinguishing treated from untreated produce with an accuracy of 92%. The IR sensor effectively identified the presence of objects on the conveyor belt, ensuring seamless processing, while the DHT11 sensor provided real-time temperature and humidity data, which helped maintain optimal detection conditions. The conveyor belt system processed an average of 12 items per minute, showcasing its suitability for small-scale applications.

The proposed system will provide a real-time, cost-effective, and automated solution for detecting pesticide residues in fresh fruits and vegetables. By integrating a gas sensor, the system will detect the presence of harmful volatile organic compounds (VOCs) emitted by pesticides, ensuring immediate identification of contaminated produce. The IR sensor will efficiently detect and track the movement of fruits and vegetables on the conveyor belt mechanism, allowing seamless monitoring. Additionally, the DHT11 sensor will provide essential environmental data, such as temperature and humidity, which can influence pesticide evaporation and detection accuracy.

This project aims to enhance food safety and quality control by enabling early detection of pesticide contamination. The automated system can be implemented in food processing industries, markets, and agricultural supply chains to ensure that only safe and uncontaminated produce reaches consumers. The use of Arduino IDE ensures an open-source and scalable solution, making it adaptable for future improvements, such as integrating machine learning for more precise pesticide detection.

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IV. CONCLUSION

The proposed system successfully integrates advanced sensors and automation to detect pesticide residues and monitor environmental conditions in fresh fruits and vegetables. By combining a pesticide detection sensor, DHT11 for temperature and humidity, and a methane gas sensor, the system offers a holistic approach to ensuring food safety. The use of an Arduino Uno microcontroller provides a cost-effective and reliable platform for data processing and integration. Wireless communication through the ESP8266 module enables real-time monitoring and remote access, making the system practical for diverse applications

Automation through a servo motor enhances efficiency, reducing the need for manual intervention while ensuring accurate sample positioning for testing. The addition of a camera for visual documentation and quality assessment adds value to the system, enabling comprehensive analysis and traceability. The compact design and low power consumption further make the system portable and accessible to end-users, including small-scale farmers, vendors, and households.

This project demonstrates significant advantages, including cost-effectiveness, real-time monitoring, and multi-parameter detection, addressing critical issues related to food safety and storage conditions. The system's ability to detect harmful pesticide levels and alert users through an intuitive interface ensures timely corrective actions. Furthermore, the capability to monitor environmental parameters like temperature, humidity, and gas concentrations makes it a versatile tool for improving food quality and safety.

In conclusion, the developed system provides an innovative solution to pesticide contamination and environmental monitoring challenges. Its affordability, reliability, and ease of use make it suitable for widespread adoption, contributing to healthier consumption and raising awareness about food safety. Future enhancements could include adding more sensors for detecting a broader range of contaminants and integrating data analytics for predictive insights, further improving its utility and effectiveness.

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