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IoT Based Pesticides and Nutrients Detection in Fruits and Vegetables

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ABSTRACT*:* This project presents an IoT-based system designed to detect pesticide residues in organic fruits and vegetables, without relying on artificial intelligence. At its core is an Arduino microcontroller that coordinates a suite of sensors to analyze produce quality. A gas sensor is utilized to identify potential pesticide presence, an LDR sensor measures ambient light intensity, and an IR sensor detects objects, aiding in accurate detection. Real-time feedback is provided to the user through an LCD display.

To enable remote monitoring and data logging, the system incorporates a NodeMCU microcontroller equipped with Wi-Fi connectivity. This module transmits the sensor data to a central server, allowing users to access and analyze information online. The integration of these components creates a cost-effective, efficient, and user-friendly solution for verifying the safety and authenticity of organic produce. This system empowers both consumers and producers with real-time data on pesticide contamination, enabling them to make informed decisions about food quality.

KEYWORDS: Arduino, NodeMCU, Gas Sensor, LDR Sensor, IR Sensor, LCD, IoT, Pesticide Detection, Organic Produce, Server Communication.

I. INTRODUCTION

The IoT-based Pesticide and Nutrient Detection System addresses the vital concern of food safety by employing Internet of Things (IoT) technologies to monitor and evaluate the quality of agricultural produce. In light of increasing worries about pesticide residues and nutrient imbalances in fruits and vegetables, this system integrates various sensors—most notably infrared (IR) sensors—to detect hazardous substances and assess nutrient levels. An Arduino microcontroller serves as the central processing unit, collecting and analyzing data from the sensors and providing instant visual feedback via an LCD screen.

To enable real-time monitoring and remote accessibility, the system incorporates a NodeMCU Wi-Fi module that transmits sensor data to an Automotive IoT server. This seamless data flow allows consumers, farmers, and regulatory bodies to remotely monitor produce quality, leading to more informed decisions and improved agricultural practices. Designed to be intuitive and cost-effective, the system ensures that users receive timely and accurate updates regarding food safety. By encouraging proactive quality checks and enhancing transparency in the food supply chain, this project aims to promote healthier consumption habits and support sustainable farming practices.

II. LITERATURE SURVEY

- **Rohinee M. Misal, Dr. Ratnadeep R. Deshmukh (2016)** In their study, "Nondestructive Detection of Pesticide Residue on Banana Surface Based on Near Infrared Spectroscopy," published in the International Journal of Science and Research, Rohinee M. Misal and Dr. Ratnadeep R. Deshmukh explore the application of near-infrared (NIR) spectroscopy for detecting pesticide residues on banana surfaces without causing damage to the fruit. The authors highlight the advantages of this nondestructive method, which allows for real-time monitoring of food safety. Their findings demonstrate that NIR spectroscopy can effectively identify specific pesticide residues, thereby providing a viable solution for ensuring the safety of agricultural products. This research underscores the potential of advanced spectroscopic techniques in enhancing food safety protocols and offers insights for further developments in smart agricultural monitoring systems.

- **Guo Zhao et al. (2015)** The paper titled "A System for Pesticide Residues Detection and Agricultural Products Traceability Based on Acetylcholinesterase Biosensor and Internet of Things," authored by Guo Zhao, Yemin Guo, Xia Sun, and Xiangyou Wang, appears in the International Journal of Electrochemical Science. This study presents a novel detection system that combines an acetylcholinesterase biosensor with IoT technology to monitor pesticide residues in agricultural products. The authors emphasize the system's ability to provide real-time data on pesticide levels, enhancing traceability in the food supply chain. By integrating biosensor technology with IoT, the researchers propose a solution that not only ensures food safety but also improves transparency and accountability in agricultural practices. Their work contributes significantly to the field of smart agriculture, showcasing the effective use of technology in addressing food safety concerns.
- **Zaneta Barganska et al. (2018)** In the article "Problems and Challenges to Determine Pesticide Residues in Bumblebees," published in Critical Reviews in Analytical Chemistry, Zaneta Barganska, Dimitra Lambropoulou, and Jacek address the complexities involved in detecting pesticide residues in non-target organisms, particularly bumblebees. The authors discuss various analytical techniques and their limitations, highlighting the challenges posed by environmental variables and the biological variability of the bees. They stress the importance of developing standardized methods for residue analysis to ensure reliable and comparable results. This study not only sheds light on the intricacies of pesticide residue detection but also emphasizes the broader implications for environmental monitoring and regulatory frameworks, contributing valuable insights for future research in pesticide impact assessments.
- **Jameer Basha A. et al. (2011)** In their paper "Efficient Multimodal Biometric Authentication Using Fast Fingerprint Verification and Enhanced Iris Features," published in the Journal of Computer Science, Jameer Basha A., Palanisamy V., and Purusothaman T. explore advanced biometric authentication methods. Although primarily focused on biometric security, the methodologies discussed can be applied to sensor technology in agricultural monitoring systems. The authors present a multimodal approach that combines fingerprint and iris recognition for improved accuracy and security. Their findings highlight the potential for integrating multiple authentication modalities in various applications, including IoT systems in agriculture, where secure access to data is crucial. This research provides a foundational understanding of how biometric technologies can enhance security in IoT frameworks, indirectly supporting food safety initiatives.
- **Deepali Gupta et al. (2016)** In the study "Design and Development of Pesticide Residue Detection System Using EC and pH Sensor," published in the International Journal of Engineering and Manufacturing, Deepali Gupta, Balwinder Singh, and Harpreet Singh present a novel detection system employing electrochemical (EC) and pH sensors for pesticide residue analysis. The authors detail the design process and functionality of their system, demonstrating its effectiveness in detecting pesticide residues in various agricultural products. Their research highlights the advantages of using low-cost sensors for real-time monitoring, making the technology accessible for small-scale farmers. By focusing on practical applications, this study contributes to the ongoing efforts to improve food safety and pesticide management practices, aligning well with the goals of IoT-based monitoring systems in agriculture.

III. PROBLEM STATEMENT

The growing concern over food safety and quality in agricultural produce, especially regarding pesticide residues and nutrient deficiencies, highlights the urgent need for a practical and efficient monitoring solution. Traditional approaches to detecting pesticide contamination often require advanced laboratory testing, which is not only expensive and time-consuming but also inaccessible to most farmers and consumers.

Similarly, conventional methods for evaluating nutrient levels tend to lack real-time responsiveness and can be cumbersome.This project proposes the development of an IoT-based system that offers a real-time, cost-effective, and user-friendly alternative. By integrating an Arduino microcontroller, a range of sensors (such as infrared sensors), and a NodeMCU module for wireless communication, the system is capable of detecting pesticide residues and assessing nutrient content directly from fruits and vegetables.The goal is to provide immediate feedback on produce quality, empowering users with timely information, enabling farmers to adopt safer agricultural practices, and helping consumers make healthier food choices. traditional nutrient assessment techniques can be inefficient and may not provide real-time information. This project aims to develop a user-friendly, IoT-based system that utilizes an Arduino controller, various sensors (including infrared sensors), and a Node-MCU with Wi-Fi capabilities to enable real-time detection of pesticide levels and nutrient content in agricultural products. By providing immediate insights into the safety and quality of fruits and vegetables, this system seeks to empower consumers, support farmers in adopting safer practices, and promote healthier food choices.

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IV. PROPOSED SYSTEM

The proposed system for the IOT based pesticides and nutrients detection in fruits and vegetables aims to create an integrated solution that ensures the safety and quality of agricultural produce. At its core, the system utilizes an Arduino controller to manage various sensors, including infrared sensors, which detect pesticide residues, and additional sensors that assess nutrient levels in fruits and vegetables. Data from these sensors is displayed in real-time on an LCD screen for immediate feedback, allowing users to quickly determine the safety of their produce. The Node-MCU with a Wi-Fi module enables seamless connectivity, allowing the collected data to be transmitted to an Automotive IoT server for further analysis and long-term storage. This connectivity facilitates remote monitoring,

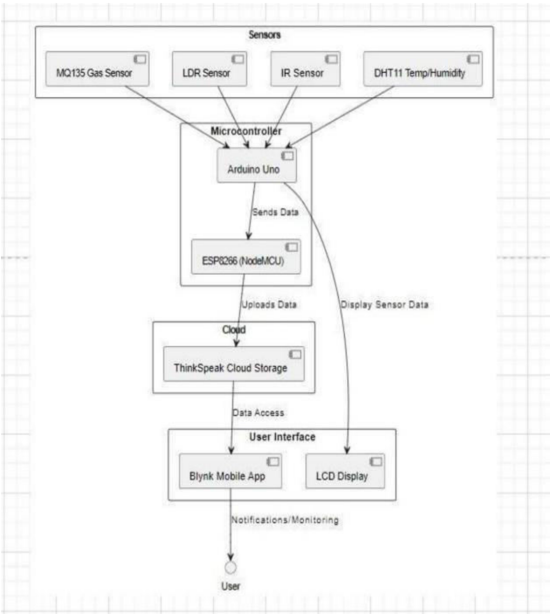

Fig.1: Proposed System Architecture

empowering farmers and consumers to access important information about their food quality from anywhere using a smartphone or computer. By combining sensor technology with IoT capabilities, this system provides a comprehensive approach to enhancing food safety, enabling informed decisions about agricultural practices and consumption.

- **Arduino Controller:** Acts as the central unit to process data from all connected sensors, ensuring effective coordination and management of the system.
- **IR Sensor for Pesticide Detection:** Utilizes infrared technology to non-destructively identify pesticide residues on the surface of fruits and vegetables, providing immediate results.
- **Nutrient Sensors:** Incorporates specific sensors to measure key nutrients like nitrogen, phosphorus, and potassium, ensuring comprehensive quality assessment.
- **LCD Screen Interface:** Displays real-time data from the sensors, allowing users to easily view pesticide levels and nutrient content directly on-site.
- **Node-MCU with Wi-Fi Module:** Facilitates wireless connectivity, enabling data transmission to a centralized Automotive IoT server for remote monitoring and analysis.
- **Automotive IoT Server:** Stores collected data and provides a platform for further analysis, generating insights that can be accessed remotely via smartphones or computers.
- **User-Friendly Mobile Application:** Offers an interface for users to view data, receive alerts about unsafe levels of pesticides or nutrients, and track historical trends.
- Alerts and Notifications: Implements a notification system to alert users when pesticide residues or nutrient levels exceed safe thresholds, promoting timely actions.
- **Scalability:** Designed to be easily expandable, allowing the integration of additional sensors or features as technology advances or user needs change.

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- **Data Security:** Ensures secure handling of data transmitted over the internet, protecting user information and maintaining the integrity of the monitoring system.

V. RESULTS AND DISCUSSION

The proposed system is designed to detect the presence of pesticides in samples of apples, tomatoes, and cabbages obtained from both local markets and agricultural farms. Four samples of each type of produce were analyzed. The results revealed a significant variation in sensor readings between the pesticide-contaminated samples and the organic ones. This considerable difference in values indicates the presence of harmful pesticides in the market-sourced samples, posing a serious risk to human health. Table 1 illustrates the percentage difference between the contaminated and organic samples. The high percentage deviation further confirms that the market samples contain pesticides, whereas the organic farm samples are largely pesticide-free.

VI. SNAPSHOT

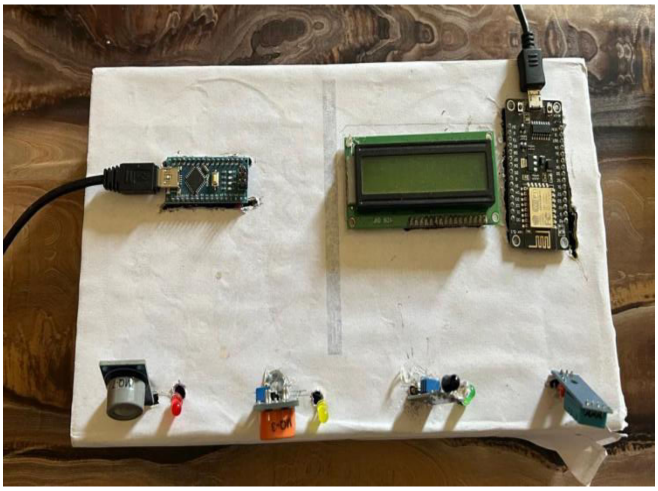

Fig 2. Hardware model

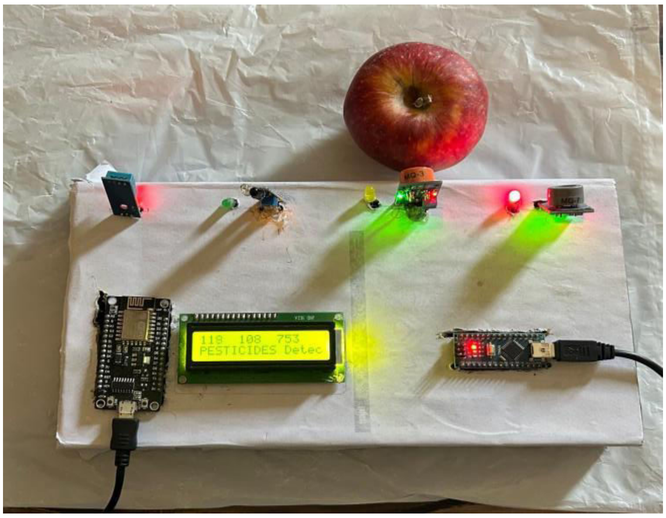

Fig 3. Final Output

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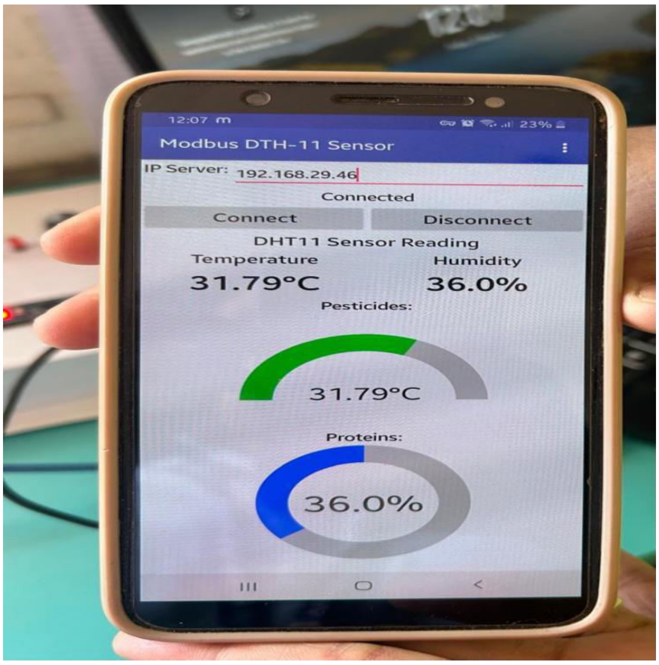

Fig 4. Android Application

VII. CONCLUSION

Pesticides present in fruits and vegetables pose significant health risks to humans, and several techniques have been developed to detect their presence. This study explores multiple methods for pesticide detection and highlights technical advancements in the field of agricultural product safety, particularly through the use of IoT-based systems. The integration of IoT technology proves to be a practical solution for evaluating the quality of produce, utilizing sensors to assess parameters such as gas concentration, pH level, and temperature. These parameters are monitored to identify the presence of pesticide residues in various fruit and vegetable samples. Experimental results demonstrate noticeable variations in sensor readings, corresponding to differing pesticide levels across the samples. This system effectively detects pesticides in agricultural produce and, when compared with existing solutions, offers improved reliability, real-time monitoring, and higher accuracy. The system's performance is both efficient and highly precise.

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