IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

IOT-Based Pesticide Level Monitoring In Fruits And Vegetables

[1]Prachi S. Raut, [2]Shreyash D. Chaudhari, [3]Sumit S. Deshmukh, [4]Shreeyash A. Pawar

[1]Student, [2]Student, [3]Student, [4]Student,

[1]Computer Science and Engineering,

[1]Prof. Ram Meghe College of Engineering and Management Badnera, Amravati, India

Abstract: The excessive use of pesticides in agriculture poses serious health risks to consumers and affects food safety. This project proposes an IoT-based solution for monitoring pesticide levels in fruits and vegetables in real-time. The system integrates sensor technology, machine learning, and cloud computing to detect and analyze pesticide residues. The IoT-enabled sensors collect chemical composition data from the produce, which is then processed using a machine learning algorithm to determine pesticide concentration levels. The data is transmitted to a cloud-based platform for storage, analysis, and visualization, providing real-time alerts to farmers, vendors, and consumers. This solution enhances food safety, promotes sustainable agricultural practices, and ensures regulatory compliance by enabling continuous monitoring and early detection of harmful pesticide residues.

Index Terms **-** IoT, Pesticide Monitoring, Food Safety, Smart Agriculture, Wireless Sensors, Machine Learning, Cloud Computing, Precision Farming, Real-time Monitoring.

I. INTRODUCTION

The excessive use of pesticides in agriculture has raised significant concerns about food safety, human health, and environmental impact. Fruits and vegetables, being an essential part of our daily diet, often contain pesticide residues that exceed safe consumption limits. Traditional methods for pesticide detection are time-consuming, expensive, and require laboratory facilities, making them impractical for real-time monitoring. To address this issue, an IoT-based solution for monitoring pesticide levels in fruits and vegetables is proposed. This system integrates smart sensors, wireless communication, and cloud-based data analysis to provide real-time pesticide detection and monitoring. The IoT framework enables automated data collection, remote access, and quick analysis, ensuring safer food consumption and regulatory compliance. By leveraging machine learning algorithms and data analytics, the system can detect patterns and predict contamination risks efficiently. This project aims to develop a cost-effective, user friendly, and portable solution that can be used by farmers, food inspectors, and consumers to ensure the safety of agricultural produce. The real-time insights generated by the system will help in minimizing health hazards, improving food quality, and promoting sustainable agricultural practices.

A.Importance of Real-Time Monitoring

Real-time monitoring of pesticide levels in fruits and vegetables is crucial for ensuring food safety, protecting consumer health, and maintaining regulatory compliance. It enables rapid detection of harmful residues, reducing reliance on time-consuming laboratory tests. IoT-based monitoring provides instant alerts, helping farmers, retailers, and authorities take immediate action to prevent contaminated produce from reaching consumers. Additionally, it supports sustainable agricultural practices by minimizing excessive pesticide use and promoting safer alternatives.

B. Objectives of study

a. Assessing Pesticide Residue Levels – Quantifying the concentration of various pesticide residues in commonly consumed fruits and vegetables.
b. investigating Decontamination Methods – Evaluating the effectiveness of washing, peeling, and other treatment methods in reducing pesticide residues.
c. Public Health and Environmental Impact – Assessing the potential health risks associated with pesticide consumption and environmental contamination

II. LITERATURE REVIEW

Monitoring pesticide residues in fruits and vegetables is crucial for ensuring food safety and public health. Various studies have explored different detection methods, regulatory frameworks, and mitigation strategies.

a. Chromatographic Methods: Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Liquid Chromatography (HPLC) are widely used for precise pesticide residue analysis
b. Spectroscopic Techniques: Raman Spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR) offer non-destructive and rapid screening
c. Biosensors and Nanotechnology: Recent advancements include enzyme-based biosensors and nanomaterials for real-time detection with high sensitivity Advancements in chromatographic, spectroscopic, and biosensor-based methods have improved pesticide monitoring. However, stricter regulations, awareness, and alternative farming practices are essential for ensuring food safety.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. Block Diagram

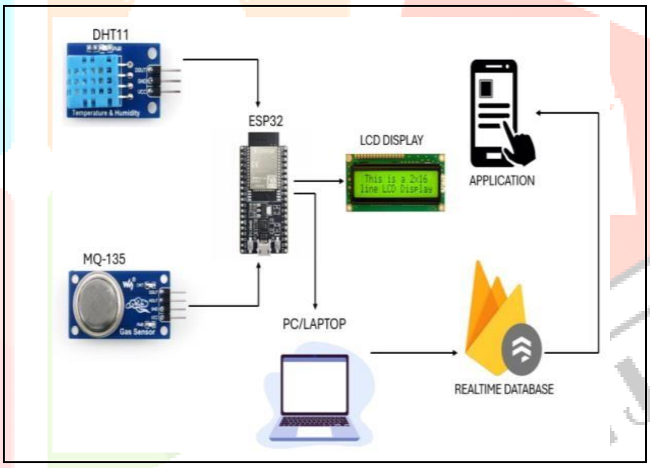

Fig. 1. Block Diagram

This Research work is an IOT based system and using this we will come up with the solution that will measure the pesticides level in fruits and vegetables which can show whether it can be consumed or not. The pesticide detector is made up of both hardware and software units. Architectural design Hardware unit helps to gather the input. In this research work temperature, humidity and air quality (alcohol content) are considered for inputs. These values are measured with the help of sensors, the hardware also includes an integration unit for these sensors, authors and affiliations.

B. MQ-135 Gas Sensor.

The MQ-135 gas sensor is commonly used for air quality monitoring due to its ability to detect harmful gases such as ammonia (NH_3), benzene (C_6H_6), Sulphur dioxide (SO_2), and carbon dioxide (CO_2). Since pesticides often contain volatile organic compounds (VOCs) and gases like organophosphates and carbamates, the MQ-135 can help in identifying the presence of residual pesticides in fruits and vegetables by detecting these gases as they evaporate.

To use the MQ-135 for pesticide level monitoring, the sensor should be placed in a sealed chamber containing the fruit or vegetable sample. Over time, as pesticide residues volatilize, the sensor detects the change in air composition and generates an analogue signal proportional to the concentration of gases. This signal is processed using a microcontroller (such as ESP32), which converts the raw values into parts per million (ppm) to estimate pesticide levels. Additionally, environmental factors such as temperature and humidity (measured using a DHT11 sensor) can be considered, as they influence the evaporation rate of pesticide residues.

For accurate results, the MQ-135 sensor should be calibrated using known pesticide concentrations, ensuring it differentiates pesticide-related VOCs from other gases. The processed data can be displayed on an LCD screen or transmitted to an IoT platform for remote monitoring. If the detected pesticide concentration exceeds safe limits, an alert system can notify users to take action, such as further washing or rejecting contaminated produce

Fig. 2. MQ-135 Gas Sensor.

C. *DHT11 Sensor*

The DHT11 sensor is a digital sensor that measures temperature and humidity, which are crucial factors influencing the evaporation and dissipation of pesticide residues in fruits and vegetables. Since many pesticides contain volatile organic compounds (VOCs) that evaporate over time, the rate of this evaporation is significantly affected by ambient temperature and humidity levels. By integrating the DHT11 sensor with an MQ-135 gas sensor and an ESP32 microcontroller, we can improve the accuracy of pesticide residue detection by correlating gas concentration levels with environmental conditions.

To use the DHT11 for monitoring pesticide levels, it should be placed inside a sealed chamber along with the MQ135 and the produce sample. As pesticide residues evaporate, the DHT11 sensor continuously measures temperature and humidity, providing real-time environmental data that helps in analyzing how quickly pesticides are released into the air. This data can be processed to adjust the pesticide concentration readings from the MQ-135, ensuring that variations in temperature and humidity do not cause false readings. For example, at higher temperatures, pesticides may evaporate more quickly, leading to temporarily high gas concentrations that should be interpreted accordingly.

By incorporating the DHT11 sensor into the pesticide monitoring system, we can enhance the accuracy, reliability, and effectiveness of detecting pesticide contamination in fruits and vegetables.

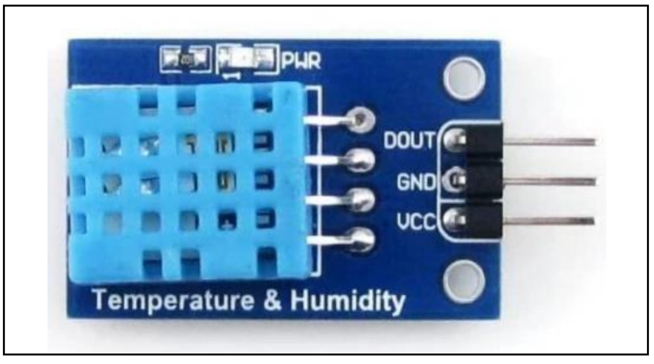

Fig. 3. Temperature and `Humidity Sensor

D. ESP32 Microcontroller.

The ESP32 microcontroller plays a central role monitoring pesticide level in fruits and vegetables by integrating multiple sensors, processing data, and enabling real-time monitoring through IoT connectivity. The MQ-135 gas sensor is used to detect harmful gases, such as ammonia (NH_3), benzene (C_6H_6), and carbon dioxide (CO_2), which are often released from pesticide residues. Additionally, the DHT11 sensor measures temperature and humidity, as these factors influence the volatilization of pesticide residues. The ESP32 reads sensor data, processes it using predefined threshold values, and determines whether the pesticide concentration exceeds safe limits.

Once the sensor data is collected, the ESP32 can display real-time pesticide levels on an LCD screen with I2C or send alerts via LEDs or buzzers if contamination is detected.

Furthermore, leveraging the ESP32's built-in Wi-Fi and Bluetooth capabilities, the data can be transmitted to an IoT platform such as Blynk, Firebase, or Thing Speak, allowing users to remotely monitor pesticide contamination through a smartphone or web dashboard. The ESP32 can also log historical data for further analysis, helping to identify patterns in pesticide residue levels over time.

This system is highly useful in agriculture, food markets, and home kitchens, enabling quick and cost-effective pesticide detection without the need for expensive laboratory testing. By integrating IoT features, the ESP32 enhances food safety and provides a scalable solution for large-scale pesticide monitoring applications.

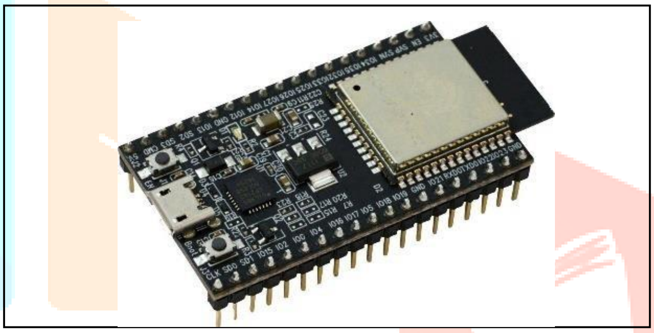

Fig. 4. ESP32 Microcontroller

E. Using LCD Display with I2C.

In a pesticide monitoring system, an LCD display with I2C is used to visually present real-time sensor data from the MQ135 gas sensor and DHT11 temperature-humidity sensor, which are interfaced with the ESP32 microcontroller. The MQ-135 sensor detects the presence of harmful gases, such as ammonia (NH_3), benzene (C_6H_6), and carbon dioxide (CO_2), which are often released by pesticide residues. The DHT11 sensor measures temperature and humidity, as these environmental factors influence the evaporation of pesticide residues. The ESP32 reads the values from both sensors, processes the data, and determines the level of pesticide contamination.

To make this information easily readable, the LCD display with I2C interface is used to show real-time values such as gas concentration (in ppm), temperature, humidity, and pesticide risk level. The I2C module simplifies the connection by reducing the number of required wires, making the system more efficient and easier to build. When the MQ135 sensor detects high pesticide residue levels, the ESP32 can display an alert message such as "High Pesticide Level! Unsafe for Consumption", prompting users to take necessary precautions.

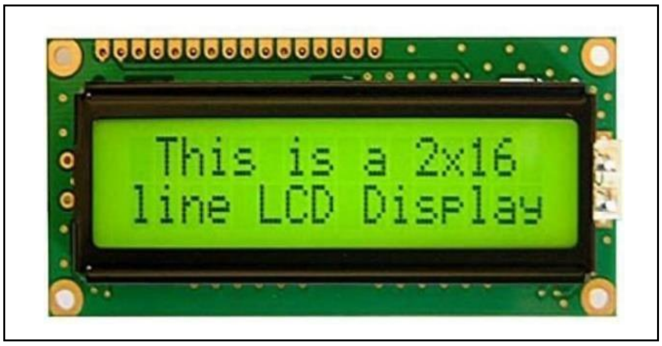

Fig. 5. LCD Display

IV. Result and Discussion

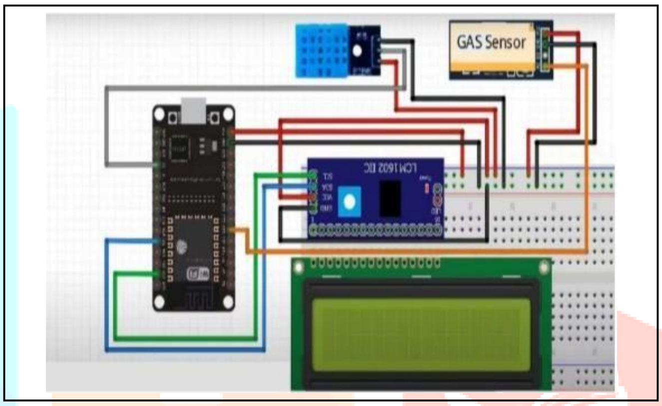

Fig. 6. Circuit Diagram

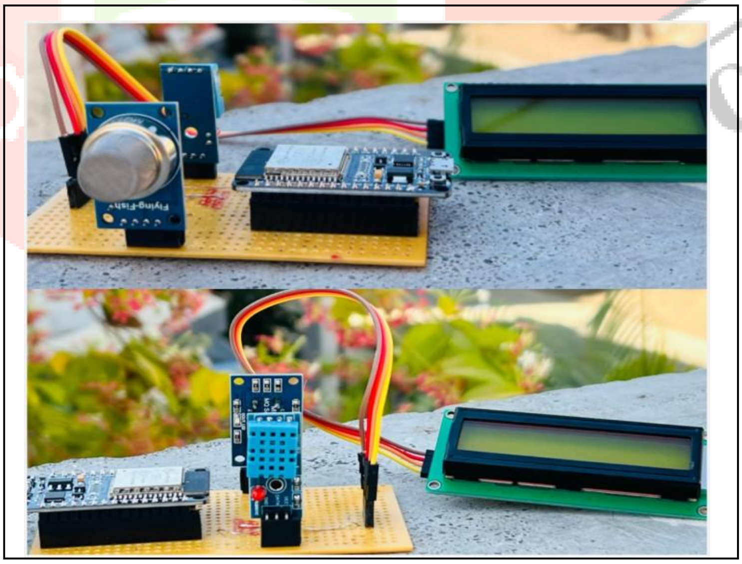

Fig. 6. IOT Connections with Sensors

The insecticides and pesticides can pollute the environmental factors like water, soil, vegetation, and turf etc. There will be severe losses in the environmental life cycle. The overview of the proposed system is as displayed in Fig 6 and 7.

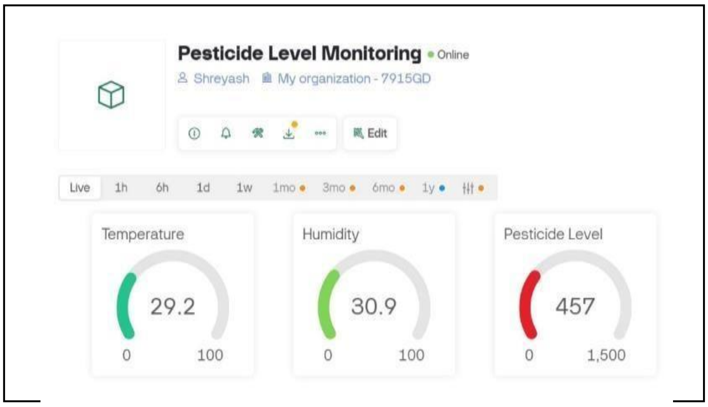

Fig. 7. Screenshot of Blynk Application when displaying the sensor values.

The food chain of organisms will also have adverse effects with high usage of insecticides and pesticides, most of the harmful chemicals present in pesticides are non-biodegradable hence they tend to accumulate in an organism's body over a period, which may lead to several other genetic disorders and biomagnification.

Hence, detection of the levels of pesticides is very important. It will also encourage organic farming between farmers, usage of organic fertilizers and biotechnology for cultivating plants.

Parameters	Measurements
Temperature	29.2C
Humidity	30.9
Pesticide Level	457ppm

Table 1. Parameters with Measurements

The detection of pesticides is displayed on the application as in Fig 8. Also, the values are as in Table 1 detects the level of pesticides not with in the safe limit. This in turn increase the quality of food for humans as well as for other organisms that consume it.

The measured values are accurate as per the sensor readings and we can successfully monitor the pesticide level is recorded and displayed through an Android app interface and email to the consumer.

V. Conclusion

After successful completion of the research work, we can understand that IoT will emerge as an advanced and powerful technology such that the agricultural products quality will be measured effortlessly by automating the process effectively and in safe manner. Further, this research does not only help the farmer but also help the end user or customer in analysing the safety of the food like fruits and vegetables with a higher quality in a secure manner.

In recent years, the IoT technology has been used to monitor the quality process in automation of agricultural products. Further, the review of the products enhances the supply chain for enhancing the quality and safety, also revels the necessary information required for the customers. Based on this process, the agricultural products can be tracked and compared timely basis and maintain the track record of the vendor and help society in improvising the quality of the yield with minimal effort. The analysis of the results obtained is presented in the article based on the actual samples collected.

Fig. 8. Screenshot of Email Notification

VI. Acknowledgment

We would like to express our heartfelt gratitude for the opportunity to work on and develop this base paper titled "IoT-based Solutions for Monitoring Pesticide Levels in Fruits and Vegetables." This work has been a result of our own efforts, dedication, and continuous exploration in the field of IoT and food safety.

We acknowledge the motivation, critical thinking, and teamwork that guided us throughout the research and development process. The journal of creating this paper has deepened our understanding of smart agricultural solutions and their importance in ensuring public health.

We also appreciate the availability of relevant literature, tools, and technologies that supported our self-guided efforts in completing this paper successfully.

References

[1] Fauzan Khairi Che Harun, Andik Marwintan, Jumadi, Asrul Humaimi Mahmood, "Carbon black polymer composite gas sensor for electronic noise" International Journal of Scientific & Engineering Research, ISSN 2229- 5518 , Volume 2, Issue 11, November 2011.

[2] Xiaoxu SUN, Lu QIAO,Xia SUN, Xiangyou WANG, "Sensors & Transducers", Vol. 155, Issue 8, August 2013.

[3] Tilman D., Cassman K.G., Matson P.A. Naylor R., Polasky.S, "Agricultural Sustainability and Intensive Production Practices", 2002.

[4] Cecchi A., Rovedatti G.M., Sabino G., Magnarelli G. "Environmental exposure to organophosphate pesticides: Assessment of endocrine disruption and hepatotoxicity in pregnant women, Ecotoxicol, Environ. Saf", 2017.

[5] Guo Zhao1, Yemin Guo1, Xia Sun, Xiangyou Wang." A System For Pesticide Residues Detection And Agricultural Product s Traceability Based On Acetylcholinesterase Biosensor And Internet Of Things" School of Agriculture and Food Engineering, P.R. China. [6]

[6] Kaviyashree.M, Nikitha.R, Vijayalakshmi." IoT based solution for monitoring of pollution through pesticide in fresh fruits and vegetables available in the market". International Journal of Scientific & Engineering Research Volume 10, Issue 3, March-2019 760 ISSN 2229- 5518

[7] vijayakumar . T and Mr R . vinoth Kannan. "mellowness detection of dragon fruit using deep learning strategy." journal Of innovative image processing (JIIP).

[8] MS Thakur, KV Ragavan,"Biosensors in food processing", Springer, Journal of food science and technology, August 2013, Volume 50, Issue 4, pp 625–641.