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Crop Disease Detection Using IoT with Smart Treatment Guidance

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Abstract **- Agriculture is a fundamental sector that supports the livelihood of millions of people and ensures food security across the globe. However, crop diseases pose a significant threat to agricultural productivity, often leading to reduced yield quality and financial losses for farmers. Early detection and proper treatment of these diseases are essential to maintain healthy crops and improve farming outcomes. Traditional methods rely on manual observation, which may result in delayed or inaccurate diagnosis.**

This paper presents an IoT-based system designed to detect crop diseases and provide smart treatment guidance. The system collects crop-related data such as temperature, humidity, soil moisture, and leaf condition, and analyzes it using predefined logic to identify diseases. Once detected, it provides recommendations including fertilizers, pesticides, and preventive measures.

An additional feature of the system is a store locator that helps farmers identify nearby agricultural stores to purchase required materials. The proposed system reduces crop loss, improves productivity, and promotes sustainable farming practices.

Keywords: IIoT, Crop Disease Detection, Smart Agriculture, ESP32, Treatment Guidance, Precision Farming.

I. INTRODUCTION

Agriculture plays a crucial role in providing food, raw materials, and employment opportunities. However, crop diseases significantly affect productivity and result in financial losses for farmers. These diseases are caused by fungi, bacteria, viruses, and environmental conditions such as temperature and humidity.

Traditional disease detection methods rely on manual observation, which is time-consuming and often inaccurate. Farmers in rural areas also lack access to expert guidance. Therefore, an efficient automated system is required.

The Internet of Things (IoT) enables real-time monitoring of crop conditions using sensors. It allows the collection of environmental data such as temperature, humidity, and soil moisture. By analyzing this data, crop diseases can be detected early. This project proposes an IoT-based system that detects crop diseases and provides treatment recommendations along with a store locator feature to help farmers access agricultural resources easily.

1.1 IoT-Based Crop Monitoring System

The proposed system uses IoT technology to continuously monitor crop conditions. Sensors are used to collect data such as temperature, humidity, soil moisture, and leaf condition. This data is processed using an ESP32 microcontroller, which analyzes the parameters based on predefined conditions to identify possible crop diseases.

The system operates in real time, enabling early detection of abnormalities in crop health. Once a disease is identified, the system generates appropriate treatment recommendations, including fertilizers, pesticides, and preventive measures. This automation reduces dependency on manual inspection and improves the accuracy of disease detection.

1.2 Need for Smart Treatment Guidance and Resource Accessibility

Identifying a crop disease alone is not sufficient; providing proper treatment guidance is equally important. Farmers often face difficulties in selecting the right fertilizers or pesticides due to lack of knowledge and availability of multiple options. Incorrect usage can lead to further crop damage and environmental issues.

To address this problem, the proposed system provides smart treatment recommendations based on the detected disease. In addition, a store locator feature is integrated into the system to help farmers identify nearby agricultural stores where required materials are available. This feature improves

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accessibility, reduces effort, and ensures timely action in managing crop diseases.

II. METHODOLOGY

The proposed system is designed to detect crop diseases and provide smart treatment guidance using IoT technology. The system integrates data collection, processing, disease identification, and recommendation modules to assist farmers in real-time decision-making. It also includes a store locator feature to enhance accessibility to agricultural resources.

The overall working process begins with collecting environmental and crop-related data such as temperature, humidity, soil moisture, and leaf condition. This data is processed using an ESP32 microcontroller, where predefined logical conditions are applied to identify possible diseases. Once a disease is detected, the system generates appropriate treatment recommendations and provides information about nearby agricultural stores.

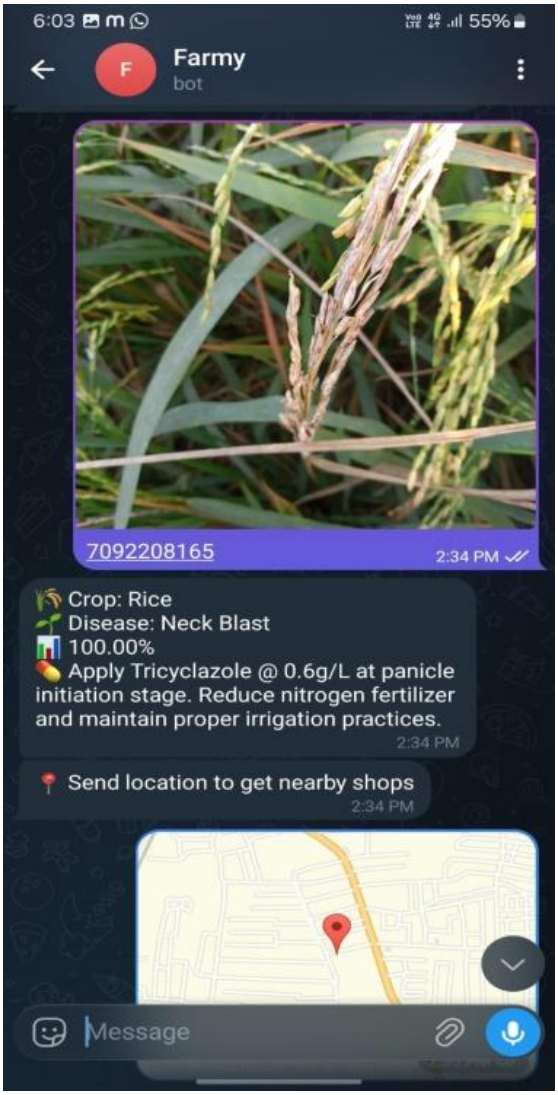

Figure 1: Crop Disease Detection and Treatment Output

Description:

The above figure shows the output of the proposed system where the crop image is analyzed and the disease is detected as *Neck Blast* in rice. The system provides a high confidence level along with treatment recommendations such as applying Tricyclazole at the appropriate stage and maintaining proper irrigation practices. This demonstrates the system's ability to accurately identify diseases and provide effective solutions.

2.1 Data Collection and Disease Detection

The first stage of the system involves collecting data from sensors and user inputs. The parameters include temperature, humidity, soil moisture, and visual symptoms such as leaf discoloration or spots. These parameters play a crucial role in determining crop health.

The collected data is processed using the ESP32 microcontroller. The system uses predefined logical conditions to identify diseases. For instance, high humidity combined with leaf spots may indicate fungal infection, while yellowing of leaves along with low soil moisture may indicate nutrient deficiency.

Table 2: Disease Identification Based on Parameters

Condition Observed	Identified Disease
High humidity + leaf spots	Fungal Disease
Yellow leaves + low moisture	Nutrient Deficiency
Brown patches + high temperature	Bacterial Infection
Severe wilting	Root Rot Disease

2.2 Treatment Guidance and Store Locator

Once the disease is detected, the system provides appropriate treatment recommendations. These include fertilizers, pesticides, and preventive measures required to control the disease. The recommendations are based on predefined data stored in the system and are presented in a simple and understandable format. In addition to treatment guidance, the system includes a store locator feature. This feature helps farmers identify nearby agricultural shops where the required materials are available. It provides details such as shop name, distance, and map location, enabling easy access to resources.

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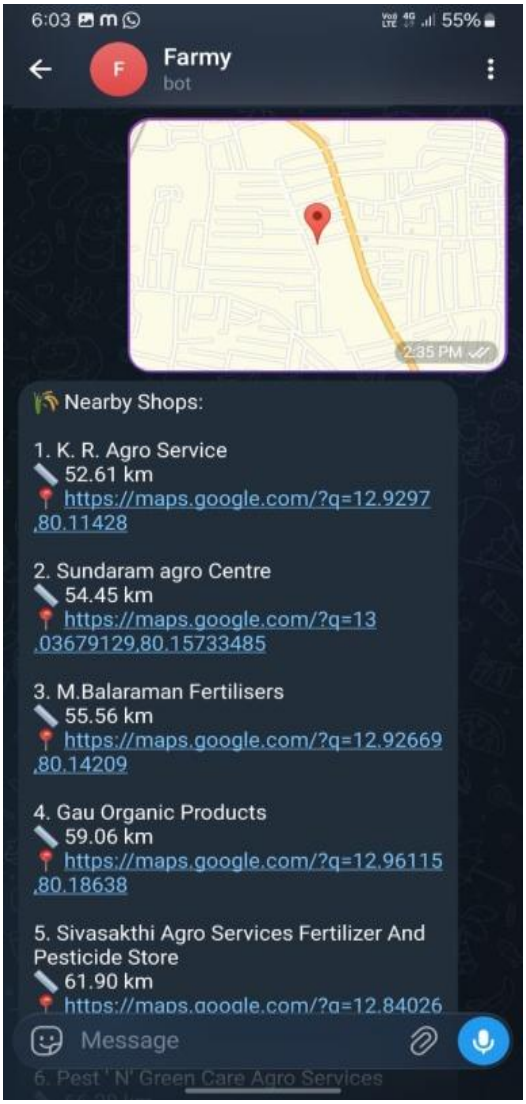

Figure 2: Nearby Agricultural Stores using Location

Description:

The above figure shows the store locator feature of the system. After receiving the user's location, the system displays nearby agricultural shops along with their distance and navigation links. This allows farmers to quickly locate and purchase fertilizers and pesticides required for crop treatment.

2.3 System Output and Monitoring

The final stage of the system involves displaying the output to the user in a clear and user-friendly format. The system provides information such as detected disease, treatment recommendations, preventive measures, and nearby store details. The system also supports real-time monitoring and communication using a GSM module, which enables alerts and updates to be sent to the user. This ensures that farmers receive timely information and can take immediate action to prevent crop damage.

2.4 System Output and Monitoring

The final stage of the system involves displaying the output to the user. The system provides detailed information including the detected disease, recommended treatment, preventive measures, and nearby store details.

The output is designed to be user-friendly, enabling farmers to take immediate action. The system also supports real-time monitoring and can send alerts using GSM communication, ensuring that users receive timely updates even in remote areas.

III. RESULTS AND DISCUSSIONS

The proposed IoT-based crop disease detection system with smart treatment guidance was successfully implemented and tested under different conditions to evaluate its performance and reliability. The system collects crop-related data, processes it using predefined logical conditions, and generates outputs that include disease identification, treatment recommendations, and nearby store details. The results obtained from the system demonstrate that it is capable of accurately detecting crop diseases based on both environmental parameters and visual inputs. During testing, the system was able to identify diseases such as fungal infections by analyzing conditions like high humidity and the presence of leaf spots. In the sample output, the system correctly detected Neck Blast disease in rice crops with a high confidence level.

The treatment guidance provided by the system was found to be relevant and effective. Based on the detected disease, the system recommended the use of appropriate pesticides such as Tricyclazole and suggested preventive measures like reducing nitrogen fertilizer and maintaining proper irrigation. This ensures that farmers receive clear and actionable instructions without requiring expert intervention. Another important outcome of the system is its ability to provide real-time assistance. The results show that the system processes input data quickly and generates output without noticeable delay. This real-time capability is essential in agriculture, where early detection and timely action can significantly reduce crop loss.

The store locator feature of the system further enhances its practicality. Upon receiving the user's location, the system identifies nearby agricultural shops and displays relevant details such as shop names, distances, and navigation links. This reduces the effort required for farmers to search for resources and ensures quick access to fertilizers and pesticides needed for treatment. The integration of GSM communication enables the system to send alerts and updates to users even in areas with limited internet connectivity. This makes the

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system suitable for rural environments where reliable communication is often a challenge.

However, certain limitations were observed during testing. The system relies on predefined conditions for disease detection, which means it may not identify unknown or newly emerging diseases. Additionally, the accuracy of the system depends on the quality of input data. Incorrect or incomplete data may lead to inaccurate results. Overall, the results indicate that the proposed system is efficient, reliable, and practical for real-time agricultural applications. It successfully combines disease detection, treatment guidance, and resource accessibility into a single platform. The system has the potential to improve crop productivity, reduce losses, and support farmers in making informed decisions.

IV. CONCLUSION

The proposed IoT-based crop disease detection system with smart treatment guidance and store locator provides an effective and practical solution for modern agricultural challenges. The system successfully detects crop diseases using environmental parameters and visual inputs, enabling early identification and reducing the risk of crop loss. By automating the detection process, it minimizes the dependency on manual observation and improves accuracy in diagnosis.

One of the key strengths of the system is its ability to provide smart treatment recommendations. Based on the identified disease, the system suggests appropriate fertilizers, pesticides, and preventive measures in a clear and user-friendly manner. This helps farmers take immediate and correct actions without requiring expert assistance, thereby improving overall crop health and productivity. The integration of the store locator feature further enhances the usability of the system. By providing information about nearby agricultural stores along with location details, the system ensures that farmers can quickly access the required resources.

Additionally, the use of GSM communication enables real-time alerts and updates, making the system suitable for rural and remote areas with limited internet connectivity. The system demonstrates reliable performance, low power consumption, and real-time operation using the ESP32 microcontroller.

Although the system shows promising results, certain limitations exist. The current approach relies on predefined conditions for disease detection, which may not cover all possible diseases. Future improvements can include the integration of machine learning and image processing techniques to enhance accuracy and enable detection of a wider range of crop diseases. Overall, the proposed system contributes to the development of smart agriculture by combining IoT technology with practical farming solutions. It has the potential to improve crop productivity, reduce losses, and support farmers in making informed and timely decisions.

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