AI-Based Smart Farming Assistant for Crop Health Monitoring and Agricultural Risk Management

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Abstract- Agriculture is an essential sector that contributes significantly to food production and economic development. However, farmers frequently encounter challenges such as crop diseases, changing weather conditions, and inefficient irrigation practices. Identifying these problems at an early stage is important for maintaining crop health and improving farm management. To address these challenges, this paper presents an AI-Based Smart Farming Assistant that uses artificial intelligence and digital technologies to support agricultural decision-making.

The proposed system applies image processing and a deep learning model based on ResNet-50 to identify diseases in tomato leaves from uploaded images. It also uses weather information obtained through the Meteo service to display environmental conditions and provide weather-based risk indicators and irrigation guidance. The application is developed using Python and Streamlit, offering a simple interface for farmers to access crop-health information and weather updates.

The system aims to assist farmers in detecting crop diseases at an early stage, planning irrigation more effectively, and reducing dependence on manual observation. It provides a foundation for future improvements through IoT sensor integration and support for additional crops.

Key Words: Artificial Intelligence, Smart Farming, Crop Disease Detection, Deep Learning, ResNet-50, Weather Monitoring, Irrigation Management.

I. INTRODUCTION

Agriculture is an essential part of human life and plays an important role in food production, employment, and economic development. As the demand for food continues to increase, farmers need effective ways to monitor crop conditions and manage agricultural activities. However, farming is affected by several difficulties, including plant diseases, unexpected weather changes, irregular rainfall, and inefficient water usage. These challenges can affect crop growth, reduce product quality, and create financial difficulties for farmers.

Plant diseases are one of the major concerns in agricultural production because they can affect the healthy growth of crops and spread to nearby plants. In many cases, farmers identify diseases by observing changes in the colour, shape, and appearance of leaves. Monitoring large agricultural fields manually also requires considerable time and effort. Therefore, the use of automated image analysis can provide additional assistance in recognising visible signs of crop diseases.

Recent progress in Artificial Intelligence (AI), Machine Learning (ML), and image processing has introduced useful methods for analysing agricultural information. Deep learning techniques can examine plant images and recognise visual patterns associated with different diseases. Convolutional Neural Networks (CNNs) are particularly useful for image classification because they learn important features directly from image data. ResNet-50 is one such deep learning architecture that uses residual connections to improve the learning process. In this project, a ResNet-50-based model is used to classify diseases in tomato leaf images.

Apart from crop health, environmental conditions also have a considerable influence on agricultural activities. Factors such as temperature, humidity, and rainfall can affect plant development and influence irrigation requirements. Unplanned irrigation may result in unnecessary water consumption, whereas insufficient watering can affect plant growth. Weather-based information can therefore provide useful guidance when making irrigation decisions.

Artificial Intelligence-based agricultural applications can bring different farming support features together in a single digital platform. Combining crop image analysis with weather information allows users to access important details without depending on multiple separate applications. Such platforms can make basic agricultural information easier to understand and reduce the effort involved in routine crop monitoring. They can also provide preliminary information that supports farmers while making day-to-day farming decisions.

The proposed system, **AI-Based Smart Farming Assistant**, is developed using Python and the Streamlit framework. It provides an interface for uploading tomato leaf images and identifying disease categories using a ResNet-50-based deep learning model. The application also obtains weather information through the Open-Meteo service and presents environmental conditions, weather-based risk indicators, and basic irrigation guidance. By combining these features, the application aims to improve access to crop-health information and support better awareness of weather conditions.

The main objective of this work is to develop a simple software-based agricultural support system that assists with early tomato leaf disease identification and weather-related farm planning. The application is intended to act as a decision-support tool rather than replace agricultural experts or direct field measurements. Further development may include support for additional crops, integration of soil-moisture sensors, IoT-based monitoring, and more advanced agricultural recommendation.

II. LITERATURE SURVEY

The application of Artificial Intelligence in agriculture has received increasing attention because of its ability to support crop monitoring and improve farming practices. Earlier agricultural methods mainly depended on manual inspection and farmers' experience to identify crop-related problems. Recent research has explored Machine Learning, Deep Learning, and image-processing techniques to automate agricultural activities and provide useful information for crop management.

Mohanty et al. (2016) investigated the use of deep learning techniques for identifying plant diseases from leaf images. Their research demonstrated the potential of convolutional neural networks and transfer learning for classifying different plant disease categories. The study highlighted how image-based analysis could support automated disease identification. However, performance on controlled images does not always represent the results obtained under actual field conditions.

Research on computer vision has further explored different deep learning architectures for plant disease classification. ResNet-based models are among the architectures considered for image recognition because residual connections help in training deeper neural networks. These models can learn visual characteristics from plant images and classify disease-related patterns. Their effectiveness depends on factors such as image quality, dataset size, training methods, and the similarity between training images and real agricultural conditions.

Recent studies have also examined the role of weather information and environmental monitoring in precision agriculture. Temperature, humidity, and rainfall are important factors that influence crop growth and farming activities. Weather-based agricultural applications can help farmers understand changing environmental conditions and plan their activities accordingly. Research on precision irrigation has also explored the use of environmental information and sensor-based measurements to improve water management.

The integration of Artificial Intelligence with the Internet of Things (IoT) has created further opportunities for smart farming. IoT-based systems can collect information from field sensors, including soil moisture and temperature measurements, while machine learning techniques can analyse the collected data. These approaches support continuous crop monitoring and data-driven agricultural decisions. However, sensor requirements, installation costs, internet connectivity, and system maintenance can create difficulties in adopting such solutions in certain farming environments.

A review of recent research indicates that deep learning and computer vision are widely explored for plant disease identification, while weather monitoring and IoT technologies support other aspects of precision agriculture. Based on these observations, the proposed AI-Based Smart Farming Assistant integrates a ResNet-50-based tomato leaf disease classification model with weather information obtained through the Open-Meteo service. The application is developed using Python and Streamlit to provide crop-health information, weather-based risk indicators, and basic irrigation guidance in one platform.

III. METHODOLOGY

The proposed AI-Based Smart Farming Assistant combines artificial intelligence, image processing, and weather information to support agricultural activities. The application is developed using Python and Streamlit. It is designed to identify tomato leaf diseases and provide weather-related information and basic irrigation guidance. The complete methodology is divided into the following stages.

A. User Input

The first stage involves collecting the necessary information from the user through the application interface. The user can enter the farmer's name and select the required crop option. For disease identification, a

tomato leaf image is uploaded to the application. These inputs are used by the system to perform the required analysis and display the results.

B. Image Acquisition

Image acquisition is the process of obtaining a digital image of a tomato leaf for disease identification. The user uploads an image through the Streamlit application in a supported format. The uploaded photograph acts as the input for the classification model. A clear image with visible leaf symptoms is preferred because image quality can influence the classification result.

C. Image Preprocessing

Image preprocessing is performed to prepare the uploaded photograph for analysis by the deep learning model. Images may have different sizes, formats, and pixel values, so they must be adjusted according to the model's input requirements. The preprocessing stage includes resizing, format conversion, and normalization where required. This helps maintain consistency between the input image and the model's training data.

D. Disease Classification Using ResNet-50

The proposed system uses a ResNet-50-based deep learning model to identify diseases in tomato leaf images. ResNet-50 is a convolutional neural network that uses residual connections to learn important image features. The result is displayed to the user as preliminary information about the condition of the tomato leaf.

E. Weather Data Collection

Weather information is collected through the Open-Meteo service, which provides access to weather-related data. The application retrieves available environmental details based on the configured location and weather request. Parameters such as temperature, humidity, and rainfall can help users understand the surrounding environmental conditions. This information is displayed within the application to support agricultural planning and improve awareness of changing weather conditions.

F. Irrigation Guidance

Proper water management is necessary for maintaining healthy crop growth. The proposed system provides basic irrigation guidance by considering available weather information, particularly rainfall conditions. However, the current application does not directly measure soil moisture or calculate exact crop water requirements. Therefore, the suggestions should be treated as general guidance.

G. Application Development Using Python

Python is used as the primary programming language for developing the proposed application. Different software components are connected using Python to perform the required tasks. Its available libraries make it suitable for developing an application that combines image classification and weather information.

H. User Interface Development Using Streamlit

Streamlit is used to create the graphical interface of the proposed system. It provides a simple way for users to interact with the application through a web browser. The interface includes input fields, crop selection, image upload, and result display sections. This makes the application easier to operate and understand.

I. System Integration

System integration connects the different modules into a single working application. The image preprocessing module sends the prepared photograph to the ResNet-50-based classification model, while the weather module retrieves environmental information from Open-Meteo. The outputs generated by these modules are combined through the Streamlit interface.

J. Result Display

After completing the required processing operations, the application presents the generated information to the user.

The predicted tomato leaf disease category is displayed along with the available weather details. Weather-based risk indicators and basic irrigation suggestions are also provided through the interface. The results are arranged in a simple format so that users can understand the information and use it as preliminary support for agricultural decision-making.

IV. EXISTING SYSTEM

The existing agricultural practices mainly depend on traditional observation, manual crop inspection, and separate sources of information for managing farming activities. Farmers generally identify plant diseases by examining leaves and observing visible changes in the crops. Weather information is usually obtained through weather applications or forecasts. Although these methods provide useful support, they may require considerable time and effort. The absence of an integrated platform can make crop monitoring and agricultural decision-making more difficult.

A. Manual Crop Disease Identification

In traditional farming, crop diseases are commonly identified by observing changes in the appearance of leaves, stems, and other plant parts. Farmers use their experience and agricultural knowledge to recognise possible disease symptoms. However, some diseases show similar visual characteristics, which can make identification difficult. Manual inspection of large agricultural areas also requires more time and attention, particularly when symptoms are not easily visible during the early stages.

B. Traditional Weather Monitoring

Farmers generally obtain weather information through television forecasts, newspapers, mobile applications, and other available sources. These platforms provide details such as temperature, rainfall, and general weather conditions. However, weather information is often accessed separately from crop disease monitoring activities. Farmers may need to compare information from different sources before making decisions related to irrigation and crop maintenance.

C. Conventional Irrigation Practices

Traditional irrigation methods often depend on fixed schedules, personal experience, and visual observation of crop conditions. This can result in unnecessary water consumption or insufficient watering. Such practices highlight the importance of using updated weather information and other relevant agricultural data while planning irrigation activities.

D. Limitations of the Existing System

The existing approaches provide basic support for agricultural activities, but they also have certain limitations. Manual disease identification can be time-consuming and may depend heavily on individual experience. These limitations create a need for a simple digital system that brings important agricultural support features together.

E. Need for an Improved System

The challenges associated with conventional farming methods indicate the need for technology-assisted agricultural solutions. Artificial Intelligence can support the analysis of plant images, while online weather services can provide updated environmental details. Combining these functions can make agricultural information easier to access and support more informed farming decisions.

V. PROPOSED SYSTEM

The proposed AI-Based Smart Farming Assistant is designed to support farmers by combining crop disease identification and weather monitoring in a single software application. The system uses Artificial Intelligence and deep learning techniques to analyse tomato leaf images and identify disease categories supported by the trained

model. It also retrieves weather information through the Open-Meteo service to display environmental conditions and provide basic irrigation guidance. The application is developed using Python and Streamlit to offer a simple and user-friendly interface.

A. AI-Based Crop Disease Detection

The proposed system uses artificial intelligence to analyse uploaded tomato leaf images and identify possible disease conditions. A ResNet-50-based deep learning model processes the image and predicts the corresponding disease category. The classification result provides preliminary information about crop health and can help users become aware of possible disease-related problems at an early stage.

B. Deep Learning Model Integration

A ResNet-50-based architecture is integrated into the application for image classification. The model uses residual connections to learn important visual characteristics from the input images. Before classification, the uploaded leaf image is resized and prepared according to the model's input requirements. The trained model then generates a prediction based on the disease categories included in its training data.

C. Weather Monitoring and Information Retrieval

The proposed application integrates the Open-Meteo service to obtain weather-related information. It retrieves available environmental details based on the configured location and displays them through the application interface. Parameters such as temperature, humidity, and rainfall help users understand the surrounding weather conditions. Providing this information alongside crop disease results creates a convenient platform for accessing important agricultural details.

D. Weather-Based Risk Indicators

The system uses available weather information to present basic environmental risk indicators. These indicators help users understand conditions that may influence crop growth and agricultural activities. This feature is intended to improve awareness of environmental changes and provide general support for farming decisions rather than predict diseases with guaranteed accuracy.

E. Smart Irrigation Guidance

The proposed system provides basic irrigation guidance by considering available weather information. Rainfall details and other environmental conditions can help users plan watering activities more carefully. This feature aims to encourage better awareness of water usage and reduce unnecessary irrigation where weather conditions indicate possible rainfall. Since the current application does not include direct soil-moisture measurement, the suggestions are general and should be considered along with actual field conditions.

F. User-Friendly Application Interface

The application is developed using Streamlit to make its features accessible through a simple interface. Users can enter their details, select the available crop option, upload a tomato leaf image, and view the generated results. The interface is designed to present crop-health information and weather updates in an understandable manner.

G. Integration of Agricultural Support Features

One of the important features of the proposed system is the combination of crop disease classification and weather monitoring in a common application. In conventional approaches, these activities may require separate tools or information sources. The proposed application brings the available features together, allowing users to view disease classification results, environmental conditions, risk indicators, and irrigation guidance through a single platform.

VI. ADVANTAGES

The major advantages of the proposed system are

A. Early Identification of Crop Diseases

The system uses a ResNet-50-based deep learning model to analyse uploaded tomato leaf images and identify disease categories supported by the trained model. This provides preliminary information about possible crop-health problems. Early awareness of visible symptoms can encourage farmers to examine affected plants and seek suitable agricultural advice before the problem becomes more serious.

B. Reduced Manual Inspection Effort

Traditional crop disease identification often requires farmers to examine leaves and recognise symptoms through personal experience. Users can upload a leaf image and obtain a prediction through the application, reducing the effort required for basic visual assessment.

C. Easy Access to Weather Information

The integration of the Open-Meteo service allows users to access available weather details through the same application. Information such as temperature, humidity, and rainfall helps farmers understand environmental conditions. Having these details in one place makes it more convenient to check weather information while reviewing crop-health results.

D. Support for Better Irrigation Planning

The application provides basic irrigation guidance using available weather information. Rainfall details and environmental conditions can help users consider whether additional watering may be required. Actual watering decisions should also consider soil moisture and crop requirements.

E. Simple and User-Friendly Interface

The application is developed using Streamlit, which provides a straightforward interface for interacting with the system. Users can enter basic details, upload leaf images, and view the generated information without needing to understand the internal programming process. The simple design makes the application easier to access and operate.

F. Integration of Multiple Features

The proposed system combines tomato leaf disease classification, weather monitoring, environmental risk indicators, and basic irrigation guidance within one software platform. Users do not need to depend entirely on separate applications to access these features.

G. Cost-Effective Software-Based Approach

The current implementation is developed as a software application using Python and Streamlit. It does not require dedicated field sensors for its existing image classification and weather information features. This reduces the need for additional hardware investment during initial use and provides a foundation that can be expanded with further technologies when required.

H. Scope for Future Development

The modular structure of the application makes it possible to introduce additional agricultural features in future versions. Disease detection models for other crops, IoT-based soil-moisture monitoring, and regional language support can be incorporated.

VII. CONCLUSION

The AI-Based Smart Farming Assistant provides a software-based approach to supporting agricultural activities through artificial intelligence and digital technologies. The proposed system combines tomato leaf disease classification with weather monitoring to provide useful information through a single application. By using a ResNet-50-based deep learning model, the application analyses uploaded tomato leaf images and predicts the disease category supported by the trained model. It also retrieves weather information through the Open-Meteo service to display environmental conditions, weather-based risk indicators, and basic irrigation guidance.

The application is developed using Python and Streamlit, making its features accessible through a simple and user-friendly interface. The integration of image classification and weather information helps users obtain important agricultural details without depending on multiple separate platforms. It aims to support early awareness of crop-health problems, improve understanding of environmental conditions, and assist farmers in planning irrigation activities.

Although the current implementation focuses on tomato leaf disease identification and weather-related guidance, it provides opportunities for further improvement. Future development may include disease detection for additional crops, IoT-based soil-moisture monitoring, real-time sensor integration, and location-specific agricultural recommendations. Overall, the proposed system demonstrates how artificial intelligence and accessible digital tools can be combined to support informed agricultural decision-making and encourage the adoption of smart farming practices.

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