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IMAGE-BASED BANANA PLANT DISEASE DIAGNOSIS USING ARTIFICIAL INTELLIGENCE

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ABSTRACT

Banana cultivation is highly vulnerable to various leaf diseases such as Sigatoka, Black Sigatoka, and Panama disease, which significantly reduce crop yield and quality. Early detection and accurate diagnosis of these diseases are crucial for effective crop management and minimizing economic losses. This project presents a Machine Learning (ML) and Computer Vision-based approach for automatic banana leaf disease detection. The proposed system utilizes image processing techniques to analyze leaf images and identify disease patterns based on color, texture, and shape features.

The system collects a dataset of healthy and diseased banana leaf images, which are preprocessed using techniques such as image resizing, noise removal, and segmentation. Feature extraction methods are applied to capture relevant visual characteristics, and these features are then fed into machine learning classifiers such as Support Vector Machine (SVM), Random Forest, or Convolutional Neural Networks (CNN) for accurate classification. Deep learning models, particularly CNNs, play a significant role in improving detection accuracy by automatically learning complex patterns from the data.

Keywords: Banana Leaf Disease Detection, Machine Learning, Computer Vision, Image Processing, Convolutional Neural Networks (CNN), Deep Learning, Agriculture Technology, Plant Pathology, Feature Extraction, Classification Algorithms

I. INTRODUCTION

Agriculture plays a vital role in the economy of many countries, especially in regions like India, where a large portion of the population depends on farming for their livelihood. Among various crops, banana is one of the most widely cultivated and economically significant fruits. However, banana plants are highly susceptible to a variety of diseases, particularly those affecting the leaves, such as Sigatoka, Black Sigatoka, and Fusarium wilt. These diseases not only reduce the quality of the fruit but also lead to substantial yield losses, posing a serious challenge to farmers.

Traditionally, disease detection in banana plants relies on manual inspection by farmers or agricultural experts. This approach is time-consuming, labor-intensive, and often prone to human error, especially in the early stages of infection where symptoms are not clearly visible. Moreover, in rural and remote areas, access to expert advice is limited, which further delays proper diagnosis and treatment. As a result, there is a growing need for automated, accurate, and efficient systems that can assist farmers in identifying plant diseases at an early stage.

With the rapid advancement in the field of Machine Learning and Computer Vision, new opportunities have emerged for developing intelligent agricultural solutions. Machine learning techniques enable systems to learn from data and make predictions, while computer vision allows machines to interpret and analyze visual information from images. By combining these technologies, it is possible to build robust models that can automatically detect and classify banana leaf diseases based on visual features.

II. LITERATURE REVIEW

Several research works have been carried out in the domain of plant disease detection using Machine Learning and Computer Vision, highlighting the effectiveness of automated approaches over traditional methods. Early studies focused on basic image processing techniques such as color segmentation, edge detection, and thresholding to identify diseased regions in plant leaves. These methods were simple and computationally efficient but often lacked accuracy due to variations in lighting conditions, background noise, and complex leaf patterns.

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With the advancement of machine learning, researchers began applying supervised learning algorithms such as Support Vector Machines (SVM), k-Nearest Neighbors (KNN), and Random Forest classifiers for plant disease classification. These approaches relied heavily on feature extraction techniques, including texture analysis using Gray Level Co-occurrence Matrix (GLCM), color histograms, and shape descriptors. While these methods showed improved performance compared to traditional techniques, their effectiveness was limited by the quality of handcrafted features and the need for domain expertise.

Recent developments in Deep Learning, particularly Convolutional Neural Networks (CNNs), have significantly enhanced the accuracy of plant disease detection systems. CNN-based models automatically learn hierarchical features from raw images, eliminating the need for manual feature extraction. Several studies have demonstrated high accuracy in detecting diseases in crops such as tomato, potato, and banana using pretrained models like AlexNet, VGGNet, and ResNet. Transfer learning techniques have also been widely used to improve performance, especially when dealing with limited datasets.

III. EXISTING SYSTEM

The existing system for banana leaf disease detection primarily relies on traditional farming practices and manual inspection methods. Farmers typically identify diseases by visually examining the leaves and comparing symptoms such as discoloration, spots, or wilting with their prior knowledge or guidance from agricultural experts. While this approach has been used for decades, it is highly dependent on human experience and may not always provide accurate results, especially in the early stages of disease development.

In some cases, farmers consult agricultural officers or plant pathologists for proper diagnosis. This process can be time-consuming and costly, as it may require physical travel, laboratory testing, or expert consultation. Moreover, in rural areas where access to agricultural specialists is limited, delays in diagnosis often lead to the rapid spread of diseases, causing significant crop damage and yield loss.

With the introduction of digital technologies, a few semi-automated systems have been developed using basic Image Processing techniques. These systems typically involve capturing leaf images and applying simple algorithms such as color thresholding, segmentation, and edge detection to identify diseased regions. However, these approaches are limited in their ability to handle variations

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in lighting, background noise, and complex disease patterns.

Some existing solutions also incorporate traditional Machine Learning algorithms like Support Vector Machines (SVM) and k-Nearest Neighbors (KNN). These methods require manual feature extraction, where characteristics such as color, texture, and shape are predefined and fed into the model. Although these systems improve detection accuracy compared to manual methods, they still face limitations in scalability and adaptability to new disease types.

IV. PROPOSED SYSTEM

The proposed system introduces an intelligent and automated solution for banana leaf disease detection using advanced Machine Learning and Computer Vision techniques. Unlike traditional approaches, this system is designed to provide accurate, fast, and real-time disease identification by analyzing images of banana leaves captured through mobile devices or digital cameras.

The system begins with image acquisition, where users capture leaf images in real-time. These images undergo preprocessing steps such as resizing, noise removal, contrast enhancement, and background segmentation to improve image quality and isolate the leaf region. After preprocessing, important features such as color variations, texture patterns, and shape characteristics are extracted. In advanced implementations, Deep Learning models—especially Convolutional Neural Networks (CNNs)—are used to automatically learn these features without manual intervention.

The processed data is then fed into trained classification models capable of distinguishing between healthy and diseased leaves. The system can identify multiple banana leaf diseases such as Sigatoka, Black Sigatoka, and other common infections. The trained model is optimized to achieve high accuracy and robustness even under varying environmental conditions like lighting and background complexity.

A key feature of the proposed system is its deployment as a user-friendly mobile or web application. Farmers can simply upload or capture an image of a banana leaf, and the system will instantly analyze and provide disease predictions along with possible remedies or treatment suggestions. This reduces dependency on expert consultation and ensures timely action to prevent disease spread.

V. METHODOLOGY

The proposed banana leaf disease detection system follows a structured methodology that integrates Machine Learning and Computer Vision techniques to achieve accurate

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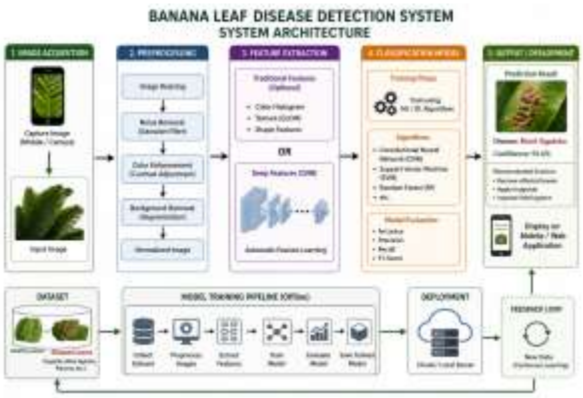
classification. The process begins with dataset collection, where images of healthy and diseased banana leaves are gathered from real-time field conditions or publicly available datasets. These images are then subjected to preprocessing steps such as resizing, normalization, noise reduction, and background removal to enhance image quality and ensure consistency across the dataset. Following preprocessing, image segmentation techniques are applied to isolate the leaf region and highlight affected areas.

VI. SYSTEM MODEL

System Architecture



VI. RESULTS AND DISCUSSIONS

In above screen python server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and then press enter key to get below page

In above screen click on 'Registration Here' link to get below page

In above screen user is entering sign up details and then press button to get below page

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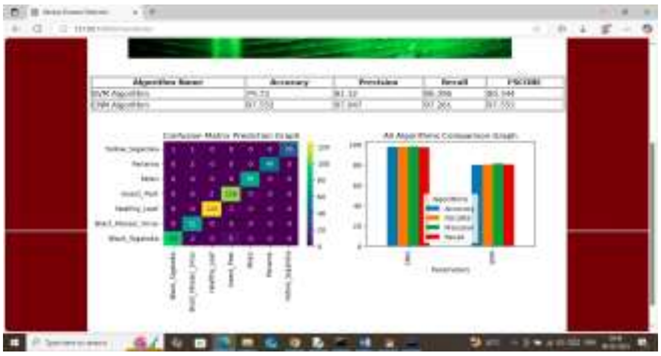
In above screen user sign up process completed and now click on 'User Login Here' link to get below page

In above screen user is login and after login will get below page

In above screen user can click on 'Load & Process Banana Dataset' link to load dataset and then will get below page

In above screen can see number of images loaded and processed from dataset and then can see train and test size. Now click on 'Train Detection Model' link to train SVM and CNN algorithm and then will get below page



In above screen in table format can see accuracy, precision, recall and FSCORE of CNN and SVM algorithm. In above screen can see CNN can detect banana with an accuracy of 97% and SVM can detect with 79% accuracy. In confusion matrix graph x-axis represents Predicted Labels and y-axis represents true labels and then yellow and green boxes in diagonal represents correct prediction count and remaining blue boxes represents incorrect prediction count which are very few. In second graph showing comparison graph between both algorithms where x-axis represents algorithm names and y-axis represents accuracy and other metrics in different colour bars and in both algorithms CNN got high accuracy. Now click on 'Predict Banana Disease' link to get below page

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In above screen selecting and uploading image and then click on buttons to get below page

In above screen can see uploadedimage detected as ‘Black_Sigatoka’ and similarly you can upload and test other images. In below screen showing another example

In above screen uploading another image

In above screen in blue and red text can see predicted disease name

Above image detected as Healthy.

VIII. CONCLUSION

The Banana Leaf Disease Detection System using Machine Learning and Computer Vision provides an efficient, accurate, and automated solution for identifying plant diseases at an early stage. By leveraging advanced techniques such as image preprocessing, feature extraction, and classification algorithms—including Deep Learning models like Convolutional Neural Networks (CNNs)—the system significantly improves the reliability of disease detection compared to traditional manual methods.

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The proposed system reduces the dependency on expert knowledge and minimizes human error, enabling farmers to quickly diagnose diseases and take appropriate actions. Its ability to deliver real-time results through mobile or web-based platforms makes it highly practical and accessible, especially in rural agricultural environments. Furthermore, the system contributes to increased crop productivity, reduced economic losses, and better disease management practices.

In conclusion, the integration of machine learning and computer vision technologies in agriculture represents a major step toward smart farming. The developed system not only enhances the efficiency of banana leaf disease detection but also supports sustainable agricultural practices.

IX. FUTURE WORK: Future work for this

Although the proposed banana leaf disease detection system demonstrates promising results, there are several areas for future enhancement to improve its performance, scalability, and real-world applicability. One important direction is the expansion of the dataset by collecting more diverse images under different environmental conditions such as varying lighting, backgrounds, and leaf orientations. A larger and more balanced dataset will help improve the accuracy and generalization capability of Machine Learning models.

Another area of improvement is the integration of advanced Deep Learning architectures such as EfficientNet, MobileNet, or transformer-based vision models. These models can provide higher accuracy while maintaining computational efficiency, making them suitable for deployment on mobile devices. Additionally, optimizing the system for real-time processing and low-power devices will enhance its usability for farmers in remote areas.

Future work can also focus on developing a fully functional mobile application with offline capabilities, multilingual support, and voice-based interaction to improve accessibility. Integration with IoT-based sensors can further enhance the system by providing additional data such as soil moisture, temperature, and humidity, enabling more comprehensive crop health monitoring.

Another significant enhancement is the inclusion of a recommendation system that not only detects diseases but also suggests appropriate treatments, fertilizers, and preventive measures. This system can be linked with agricultural databases or e-commerce platforms to assist farmers in purchasing necessary products.

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