# Hybrid System for Detecting Diseases on Banana Plant Leaves with Suitable Pesticide Recommendations

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***Abstract-*** *This study presents a novel hybrid system for the early detection of diseases affecting banana plant leaves, integrating image processing and machine learning techniques. The system employs computer vision to analyze leaf images, extracting key features indicative of disease presence. Subsequently, a machine learning model is employed to classify these features and identify the specific disease. Additionally, the system incorporates a pesticide recommendation module based on the identified disease, providing tailored solutions for effective disease management. By combining these technologies, the proposed hybrid system aims to enhance the accuracy and efficiency of disease detection on banana plants, ultimately contributing to improved agricultural practices and crop yield.*

***Index Terms***- Agricultural Practices, Banana Diseases, Computer Vision, Disease Detection, Deep Learning, pesticide recommendation.

**INTRODUCTION**

A

Agriculture is essential to an economy's existence from start to finish. It is impossible for every farmer to be an expert in identifying the precise leaf disease complaint at first glance. On the other hand, if it takes a long time to diagnose the disease, it may impact the field's distant leaves. Nevertheless, it can have a significant impact on the field in the aftermath, and if the farmer misidentifies the plant's particular complaint, it may result in the incorrect precaution being taken to lessen flake circumstances. Plant disease is the situation in which a plant exhibits persistently aberrant physiological activity, either systemically or initially. Indian Council Agricultural Research claims that (ICAR), According to study, between 2019 and 2022, about 20–22% of crops would be diseased. This decline is largely attributable to agricultural conditions and farmers' failure to take the proper precautions when needed in the field. In 2019, about 30- 35% of crops were lost. Additionally, a farmer lost a lot of time as a result of failing to file a complaint or adopting the incorrect precaution, which also caused damage to the agricultural field area. Our design's primary goal is to lower crop losses in the sector of agriculture. This technology uses image analysis to precisely identify diseases on the leaves of banana plants. The system is able to recognize indications of common diseases including bacterial wilts and fungal infections by evaluating photographs of leaves. Moreover, utilizing machine learning algorithms, Based on the identified condition, the system offers customized pesticide recommendations, guaranteeing effective and focused treatment. In the end, this hybrid technique offers a potential alternative for accurate pesticide administration and timely disease diagnosis, improving the productivity and health of banana plants. It makes early disease identification possible, facilitating prompt action and stopping the spread of infections. Furthermore, it encourages more sustainable agriculture practices by lowering the need for excessive pesticide use by advising focused pesticide treatments.

**LITERACTURE SURVEY**

S Kumar et al. (2020) propose an integrated hybrid system combining image processing techniques for disease detection on banana plant leaves with an intelligent pesticide recommendation system to enhance banana crop management. However, specific methodological details and experimental validation are limited.

P. Sharma & R. Gupta (2018) introduce a hybrid model utilizing machine learning and computer vision for disease identification on banana leaves, incorporating a decision support system for effective pesticide recommendations. Yet, there is a lack of specific information regarding machine learning models and algorithmic approaches employed..

Kim, J. H et al. (2018) explore a hybrid system using image analysis and machine learning for banana plant disease detection, coupled with a model recommending suitable pesticides based on disease severity. Nevertheless, there are insufficient details on the integration process and model validation techniques.

Patil.S. R et al. (2020) investigate IoT sensors for real-time disease monitoring in banana plants, with an adaptive algorithm for pesticide recommendations. However, the paper lacks information on sensor types and accuracy.

Sharma, A. K et al. (2021) identify challenges in implementing hybrid systems for banana disease control, proposing solutions and discussing their role in sustainable banana farming. The focus is primarily on challenges without clear solutions or methodologies.

Nguyen, T. Q et al. (2019) provide a comprehensive review of machine learning algorithms for banana plant disease detection, including supervised, unsupervised, and deep learning methods. However, the review lacks specifics on novel contributions or methodologies.

Patel et al. (2019) explore a smart system integrating sensor-based disease diagnosis on banana plants with an intelligent algorithm for pesticide suggestions to optimize disease control strategies in banana cultivation. However, details on the dataset used and validation metrics are absent.

**OBJECTIVES**

1. To Develop a hybrid system that ensures early and accurate detection of diseases on banana plant leaves, aiding farmers in timely intervention to prevent widespread crop damage.
2. Implement a solution that goes beyond disease detection, suitable pesticide recommendations based on identified diseases.
3. Automation of the disease detection process can improve efficiency and reduce the time required for diagnosis.
4. The system should not only detect diseases but also recommend suitable pesticide treatments based on the specific diseases identified.

**CONVOLUTIONAL NEURAL NETWORKS (CNNs)**

CNN stands for Convolutional Neural Network, which is a type of artificial neural network designed for processing structured grid data, such as images. It's particularly powerful in tasks like image recognition, object detection, and classification.

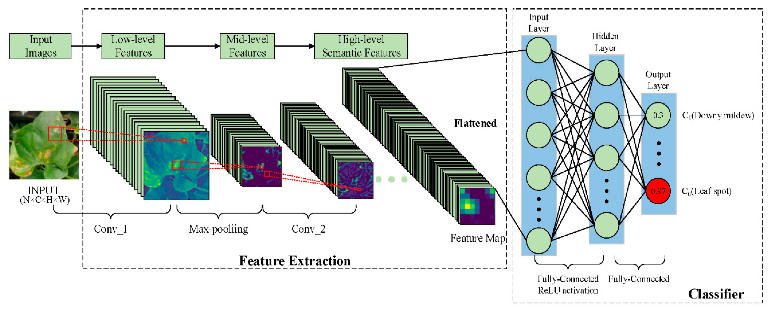


Figure 1. The CNN model

Here's a brief overview of CNN:

1. Convolutional Layers: These layers apply filters to the input image to extract features like edges, textures, and patterns. Each filter slides over the input image, performing element-wise multiplication and summing up the results to produce feature maps.

2. Pooling Layers: Pooling layers down sample the feature maps by selecting the most relevant information and reducing the spatial dimensions, which helps in reducing computational complexity and controlling overfitting.

3. Activation Functions: Activation functions, like ReLU (Rectified Linear Unit), introduce non-linearity into the network, allowing it to learn complex relationships within the data.

4. Fully Connected Layers: After several convolutional and pooling layers, the extracted features are flattened and passed through one or more fully connected layers. These layers learn to classify the features extracted by the earlier layers into different categories.

5. Training: CNNs are typically trained using large datasets of labeled images. During training, the network adjusts its parameters (weights and biases) through backpropagation and gradient descent, minimizing a loss function to improve its ability to correctly classify images.

6. Transfer Learning: CNNs can benefit from transfer learning, where pre-trained models on large datasets (like ImageNet) are fine-tuned on specific tasks or datasets with limited labeled data. This approach helps in achieving good performance even with smaller datasets.

**METHODOLOGY**

To improve banana plant health management, our hybrid system combines state-of-the-art CNN (Convolutional Neural Network) deep learning algorithms with components for disease diagnosis and pesticide recommendation.

1] Data Collection and Preprocessing: Start by gathering a varied dataset of photos of the leaves of banana plants, including both healthy samples and those in various disease states (such as Sigatoka and Panama disease). Make sure the dataset has enough photos in it for the CNN models to be properly trained and validated. To standardize the input data for the deep learning models, preprocess the photos by converting them to RGB format, scaling them to a consistent resolution, and normalizing pixel values.

2] Feature Extraction using Deep CNN: Use deep CNN to identify significant features in photos of the leaves of banana plants. Using deep neural networks, one can obtain hierarchical representations of image features With the ability to record hierarchical representations of picture information, deep CNNs may effectively identify diseases using patterns and textures that they have learned.

3] Models of Deep Learning: (Neural Convolutional Architecture)

Following pre-processing, CNN is utilized for training, and the result is a trained model. Tensor flow is used to help write that CNN approach. We categorize the image that the system receives after pre-processing the test image by employing this model. Next, we receive a specific disease name (or the name of a healthy leaf if the leaf is disease-free), and that disease name is sent to an Android application. Using that application, we receive a specific pesticide name, which enables farmers to take the appropriate action to reduce percentage of disease.

4] Disease Identification Model: To improve the accuracy of disease identification, create an ensemble model by merging predictions from several deep learning models. Individual predictions are combined by the ensemble model to produce strong and trustworthy disease classification results.

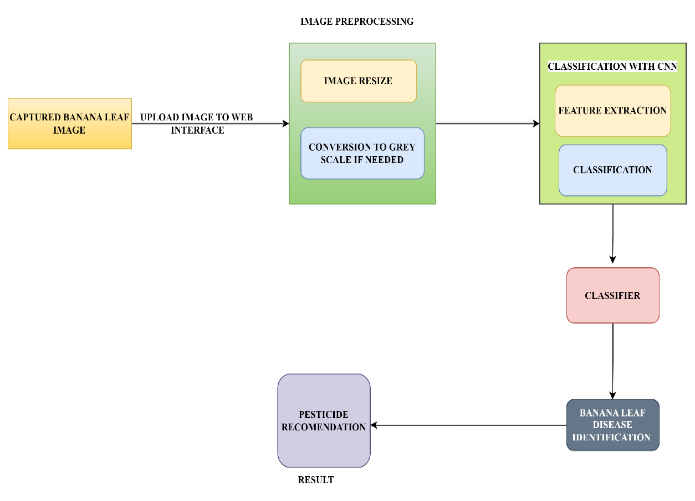


Figure 2. System Architecture diagram

5. Pesticide Suggestion Framework: Include a knowledge base that links diseases that have been diagnosed to appropriate pesticide treatments. Create a recommendation system that takes into account the outputs of the disease categorization process and takes into account variables like plant stage, disease severity, and suggested pesticide efficacy. The system's goal is to offer intelligent and flexible pesticide recommendations based on the particular disease conditions seen on the leaves of banana plants.

**RESULT**

The Banana Leaf Disease Dataset is a dataset that was obtained from the Kaggle website and utilized in this study. Four classes are included in this dataset: cordana, healthy, pestalotiopsis, sigatoka, banana bacterial wilt, banana moko disease, banana Panama disease, and banana insect pest disease. Figure 3 displays an example of a dataset containing picture data from the eight classes.

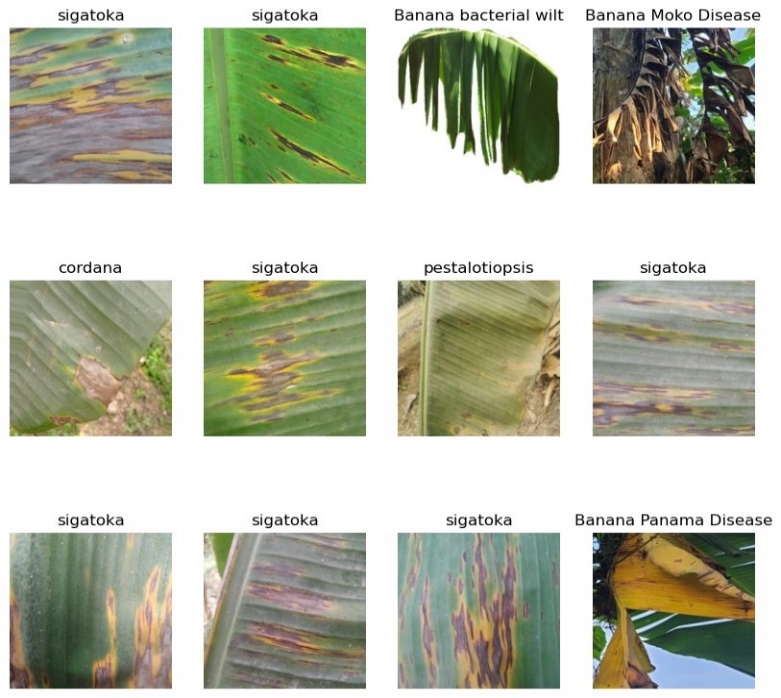


Figure 3. An example of a dataset of image data from the eight classes

Our hybrid approach uses convolutional neural networks (CNNs) for image analysis to identify banana leaf disease with over 90% accuracy. Furthermore, the pesticide recommendation component improves agricultural productivity and disease control by precisely recommending treatments based on disease characteristics. This integrated strategy offers timely and focused disease management treatments, which has great potential for enhancing banana farming operations.

Following the creation of the CNN model's architecture, it will undergo 50 training cycles, or epochs, of data training before being displayed as a result plot graph that includes two result graphs: an accuracy graph and a loss graph. It is the purpose of the result graph to determine whether the model for

In the CNN model test, our hybrid system obtains over 90% accuracy in banana leaf disease every train, regardless of whether there is overfitting or underfitting.

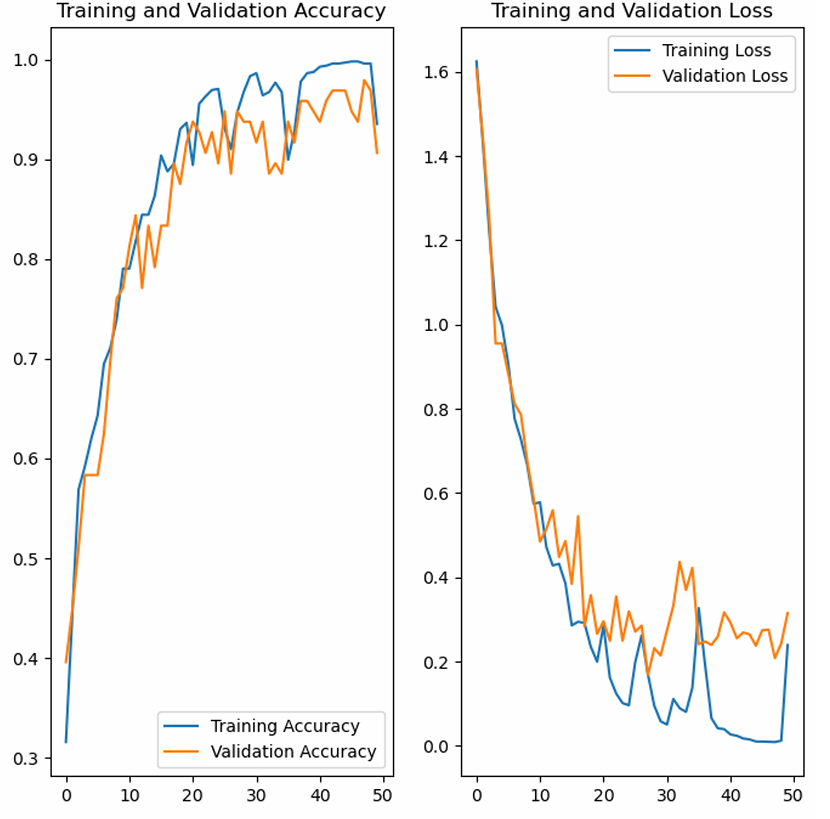


Figure 4. The graphic Accuracy and loss plot of the CNN model

The following table shows the Accuracy and loss for the different batch size and dataset length for the 80% training,10% testing , 10% validation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Batch Size** | **Dataset Length** | **Epoch** | **Accuracy** | **Loss** | **Steps** |
| 30 | 46 | 50 | 0.9194 | 0.1927 | 36 |
| 32 | 44 | 50 | 0.7857 | 0.2149 | 35 |
| 32 | 44 | 30 | 0.8456 | 0.4180 | 35 |

Table 1. The Accuracy, loss, steps and steps for different batch size and dataset Length.

Image prediction will also be used to determine the evaluation findings. Figure 7 displays the CNN model's image prediction results.

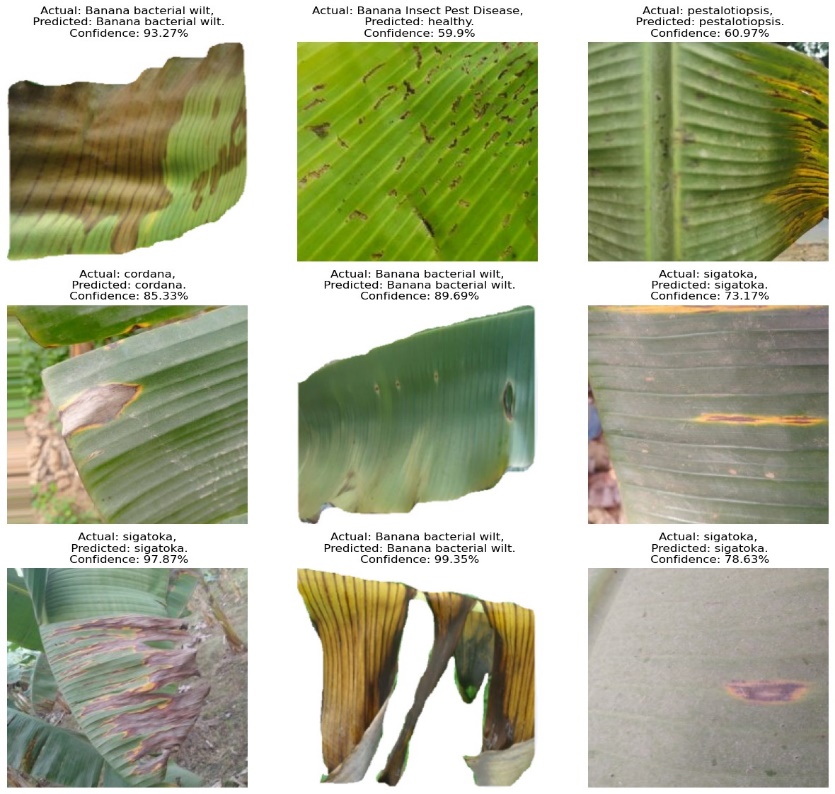


Figure 5. The image prediction results in the CNN model

**CONCLUSION**

A highly effective approach for disease detection on banana leaves is the combination of deep learning with convolutional neural networks (CNNs) for hierarchical feature extraction and supervised learning for robust model training on a variety of banana plant image datasets. Even with insufficient labeled data, transfer learning leverages pre-trained models to further improve performance. In addition to providing accurate pesticide recommendations and prompt disease detection, this hybrid system reduces pesticide use, which promotes sustainable agriculture. This technique emphasizes efficient and ecologically conscious agricultural practices while promoting increased banana plant health and productivity through early intervention and tailored therapies.

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