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# Tomato Plant Leaf Disease Classification using Deep Learning: A Review

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**ABSTRACT-**

Tomato plants regularly suffer from diseases that can harm crops and reduce farmers' income. Finding these diseases early is very important for managing them that affect tomato plants, like Yellow Leaf Curl Virus, Leaf Mold , Late Blight, Early Blight, Septorial Spot , Bacterial Spot, Target Spot, Mosaic Virus, Healthy, Two Spotted Spider Mite , Powdery Mildew .We use deep learning techniques, particularly EfficientNet-B0 , to analyze images of tomato leaves and determine if they are healthy or diseased. The model learns to spot the specific signs of each disease, ensuring accurate detection. The system also suggests the best pesticides for treatment. By providing both disease identification and pesticide recommendations, this system helps farmers make better decisions to protect their crops, improve plant health and increase yield. This helps farmers grow healthier crops and increase food production in a sustainable way.

**Keywords-** Tomato Leaf Disease Classification, Deep Learning, Efficient Net- B0 Model, Pesticide Suggestion.

## 1. Introduction:

Tomato plants are important crops, but they can easily get sick due to diseases like Yellow Leaf Curl Virus, Leaf Mold, Late Blight, Early Blight, and Powdery Mildew.

These diseases can reduce crop yield and affect farmers earnings. Finding and treating them early is very important.

This project uses EfficientNet-B0, a deep learning model, to detect 11 types of tomato leaf diseases from images. The model is fast, accurate, and does not require much computing power. It learns from existing data to recognize diseases correctly.

The system also suggests the best pesticide for each disease. This helps farmers take quick action to protect their crops, reduce damage, and use pesticides wisely. This smart system makes farming easier and more effective.

***1.1 Block Diagram:***

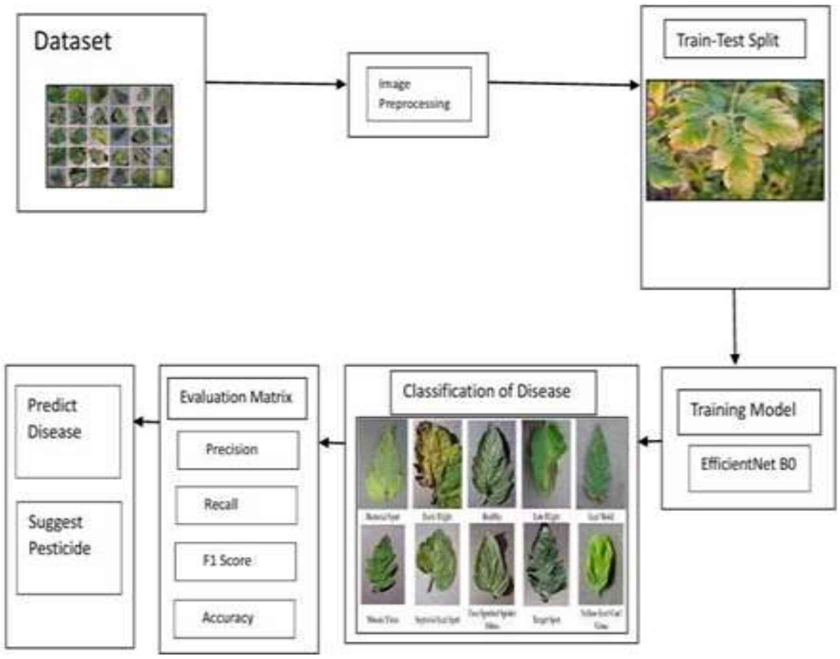


Fig. Block Diagram of Tomato Disease and Pesticide System

This system automatically classifies tomato leaf diseases using deep learning and suggests appropriate pesticides. It processes input images of tomato leaves, identifies the disease, and provides treatment recommendations. The Tomato Leaf Disease Dataset is collected from sources like PlantVillage or Kaggle, and a Pesticide Dataset maps diseases to their respective pesticide recommendations. The images undergo preprocessing by resizing, normalizing, and denoising before being inputted into the system. Using EfficientNet B0, a state-of-the-art CNN, the model learns to classify diseases. The dataset is split into training and testing sets to evaluate performance. Metrics like accuracy and precision assess the model's effectiveness. Once a disease is identified, the system recommends a suitable pesticide based on predefined rules or an additional model.

## 2. Literature Survey:

[1] Precision agriculture advances plant disease detection using deep learning, with CNNs and YOLO excelling. Enhanced YOLOv7, MPConv, and SIFT improve accuracy, achieving 98.8%, enabling early tomato disease detection and better yield estimation.

[2] Deep learning aids plant disease detection, with CNNs like MobileNetV3 achieving 92.59% accuracy. Challenges in real-world applications highlight the need for data augmentation and model refinement for robust in-field detection.

[3] CNNs enable fine- grained plant disease classification, distinguishing similar diseases for precise treatment. ResNet, VGG, and Inception enhance accuracy, with data augmentation and transfer learning improving performance, optimizing crop health and reducing pesticide use.

[4] A compact six-layer CNN achieves 99.70% accuracy in tomato disease detection, outperforming larger models. Trained on PlantVillage, it enables real-time, cost- effective recognition, benefiting agriculture with high efficiency in low-resource settings.

[5] FL-ToLeD, a lightweight model for tomato leaf disease detection, achieves 99.5% accuracy using soft attention and depth- wise convolution. Its 2.5MB size suits low- resource devices, ensuring efficient real-time agricultural disease management.

[6] A GAN- based augmentation method using DCGAN improves tomato leaf disease identification, achieving 94.33% accuracy with GoogLeNet. It enhances dataset diversity, reduces data collection costs, and boosts model generalization for better recognition performance.

[7] A lightweight MobileNetV2-based model achieves 99.30% accuracy in tomato leaf disease detection. Using illumination correction and runtime augmentation, it ensures efficiency (9.60MB size), enabling real- time deployment on low-end agricultural devices.

[8] A restructured Residual Dense Network (RDN) achieves 95% accuracy in tomato disease detection, enhancing food security. It optimizes computational efficiency, surpassing state-of-the- art models for large-scale agricultural applications.

[9] An enhanced Faster R-CNN model improves tomato disease recognition by replacing VGG16 with a deeper residual network and using k-means clustering for better bounding box alignment, increasing accuracy by 2.71%.

[10] LFC-Net, a self-supervised model with Location, Feedback, and Classification networks, achieves 99.7% accuracy in tomato disease recognition, outperforming pre-trained models and offering a powerful tool for agricultural disease detection.

## 3. Identification of Tomato Leaf Disease Classification using Deep Learning:

This system automatically classifies tomato leaf diseases using deep learning and suggests appropriate pesticides. It processes input images of tomato leaves, identifies the disease, and provides treatment recommendations. The Tomato Leaf Disease Dataset is collected from sources like PlantVillage or Kaggle, and a Pesticide Dataset maps diseases to their respective pesticide recommendations. The images undergo preprocessing by resizing, normalizing, and denoising before being inputted into the system. Using EfficientNet B0, a state-of-the-art CNN, the model learns to classify diseases.

The dataset is split into training and testing sets to evaluateperformance. Metrics like accuracy and precision assess the model's effectiveness. Once a disease is identified, the system recommends a suitable pesticide based on predefined rules or an additional model.

### *3.1. System Architecture:*

Here's a concise architecture for Tomato Leaf Disease Classification and Pesticide Suggestion using Deep Learning:

**Dataset:** Collect labeled images of healthy and diseased tomato leaves from sources like PlantVillage, Kaggle, or field surveys. The dataset includes various tomato diseases for classification.

**Image Processing:** Preprocess images by resizing to a fixed size, normalizing, and augmenting the data to improve model robustness. Denoise and apply techniques like color segmentation and edge detection to highlight relevant features.

**Train-Test Split**: Split the dataset into training and testing sets to ensure unbiased model evaluation.Typically, 80% of data is used for training, and 20% is reserved for testing.

**Training Model:** Train the model using deep learning techniques, such as Convolutional Neural Networks (CNN), with architectures like EfficientNet B0. Utilize transfer learning or ensemble models to enhance performance.

**Classification of Disease: T**he model classifies the leaf diseases based on the features extracted during preprocessing. It assigns each image to a specific disease category.

**Evaluation Metrics:** Evaluate the model's performance using metrics such as accuracy, precision, recall, and F1-score to ensure reliable prediction.

**Predict Disease:** Input a new leaf image to predict the disease with a confidence score.

**Suggest Pesticide**: Based on the predicted disease, the system suggests an appropriate pesticide for treatment.

## 4. Benefits of Tomato Leaf Disease Classification and Pesticide Suggestion using Deep Learning:

### *4.1 High Accuracy*

- EfficientNet B0 achieves excellent accuracy in classifying tomato leaf diseases, ensuring precise identification and reducing misclassifications.

### *4.2 Efficiency*

- The model's compact architecture makes it computationally efficient, ideal for deployment on low-resource devices like smartphones and edge computing systems.

### *4.3 Real-time Detection*

- With fast processing speeds, the system can provide real-time disease identification, helping farmers take quick action to prevent crop loss.

### *4.4 Resource Efficiency*

- EfficientNet B0 uses fewer parameters than traditional models, reducing the need for extensive computational resources, making it cost-effective for farmers in resource- constrained environments

### *4.5 Improved Disease Management*

- Early detection allows for timely interventions, which reduces the spread of diseases and minimizes the use of pesticides.

***4.6 Pesticide Suggestion***

- By linking diseases with appropriate pesticide recommendations, the system ensures the use of targeted treatments, reducing unnecessary pesticide use and promoting sustainable farming.

***4.7 Scalability***

- The model can be scaled to other crops, enhancing its application in diverse agricultural settings.

## 5. Main Objectives

Here are the main objectives for the project:

***5.1 Tomato Leaf Disease Detection:***

Develop a deep learning-based system to detect and classify specific tomato leaf diseases, helping farmers identify and address issues such as blight, mildew, and other diseases affecting tomato plants.

***5.2 Nutrient Deficiency Identification:***

Incorporate a feature that identifies nutrient deficiencies in tomato plants, such as nitrogen or phosphorus shortages, based on visible symptoms, aiding in better nutrient management and improving plant health.

***5.3 Pesticide Suggestion System:***

Create a recommendation engine that suggests the most suitable pesticides for the identified diseases, ensuring timely and accurate treatment, reducing crop losses, and optimizing pesticide usage for sustainable farming.

## 6. Conclusion

In conclusion, our system, powered by EfficientNet-B0, effectively detects tomato leaf diseases and recommends appropriate pesticides. By providing accurate and timely disease identification, it enables farmers  take swift action, minimizing crop damage and enhancing yield. This approach not only helps improve farming practices but also contributes to more sustainable agriculture. The system's efficiency in recognizing plant health issues ensures optimal use of resources, reducing pesticide overuse and promoting eco- friendly solutions. Ultimately, this solution helps farmers make informed decisions, increasing productivity while ensuring the long-term health and sustainability of crops.

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