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Plant Diseases Were Recognized and Classified with the use of Machine Learning

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ABSTRACT: In India, agriculture plays a crucial role due to its vast population and persistent issues with hunger. However, crop yields often suffer due to plant diseases caused by various germs and infections. Detecting these diseases early is vital for maximizing harvests, but manual observation can be time-consuming and ineffective.

In India, agriculture holds immense significance, addressing the needs of a large population grappling with persistent hunger issues. Unfortunately, crop productivity is frequently compromised by a range of plant diseases caused by diverse pathogens and infections. Timely detection of these diseases is critical to optimizing yields; however, traditional methods relying on manual observation often prove inefficient and time-intensive.

To address this challenge, researchers have turned to advanced image processing techniques. They leverage machine learning, specifically utilizing datasets containing over 54,000 images of healthy and diseased plant leaves in controlled settings. Their goal is to develop models capable of distinguishing between different plant diseases, focusing on Residual Neural Networks (ResNets), a deep learning architecture known for its effectiveness in tasks like image classification.

KEYWORDS: Plant disease, Image preprocessing, Machine learning, Deep learning, Resnet, CNN, Classification.

I. INTRODUCTION

ResNets tackle common issues in deep learning models, such as vanishing or exploding gradients, through the use of residual blocks. These blocks enable easier optimization of the network using techniques like learning rate scheduling, gradient clipping, and weight decay. By optimizing ResNets in this manner, researchers aim to accurately classify various crops and identify 26 specific diseases, showcasing its potential in agricultural disease management.

Overall, this approach highlights the application of cutting-edge technology to revolutionize farming practices, enabling more effective prediction and management of plant diseases compared to traditional methods.

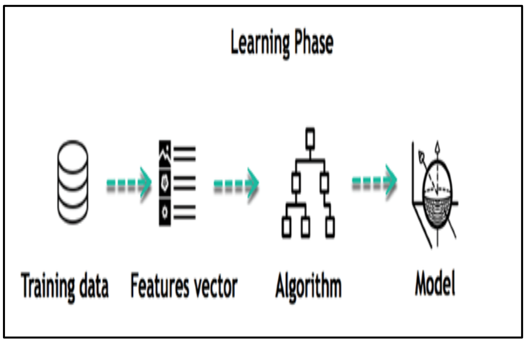

Fig 1: Learning phase

For example, imagine a machine learning model trying to understand the relationship between an individual's income and the likelihood of dining at a fancy restaurant. The model discovers a positive correlation between higher income levels and frequenting high-end dining establishments. This insight forms the basis of the model.

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Once the model is constructed, its efficacy can be tested on entirely new data. This involves transforming the new data into a feature vector, passing it through the model, and obtaining predictions. This process exemplifies the beauty of machine learning: once trained, the model can be used to make predictions on new data without needing to update rules or retrain the model.

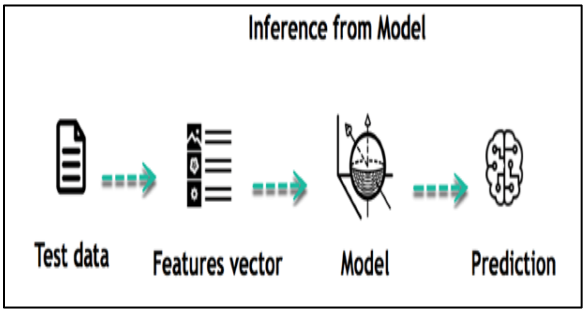

Fig 2: Inference from model

II. LITERATURE SURVEY

1)A review on machine learning classification techniques for plant disease detection
AUTHORS: Shruthi, U., V. Nagaveni, and B. K. Raghavendra
In India, Agriculture plays an essential role because of the rapid growth of population and increased in demand for food. Therefore, it needs to increase in crop yield. One major effect on low crop yield is disease caused by bacteria, virus and fungus. It can be prevented by using plant diseases detection techniques. Machine learning methods can be used for diseases identification because it mainly apply on data themselves and gives priority to outcomes of certain task. This paper presents the stages of general plant diseases detection system and comparative study on machine learning classification techniques for plant disease detection. In this survey it observed that Convolutional Neural Network gives high accuracy and detects more number of diseases of multiple crops.

2) Plant disease classification using soft computing supervised machine learning
AUTHORS: Sehgal, Aman, and Sandeep Mathur
Plants are always concerned about the diseases introduced by pathogens. For example infections, microorganisms and parasites in the plant bodies. It is globally recognized that, pathogens tends to cause huge yield misfortunes. Various researchers have explored how to diminish the harmfulness of pathogens in plants. A few analysts have explored some opposition qualities in plants and attempts to improve the obstruction of plants to pathogens. Meanwhile, different analysts have created ID and s coring framework for monitoring and examining the advancement or quality and also by anticipating the infection bolstered leaves. The reason for this Review work is to display the use of AI in the revelation of plant opposition.

3) Image processing techniques for detecting and classification of plant disease:
AUTHORS: Hungilo, Gilbert Gutabaga, Gahizi Emmanuel, and Andi WR Emanuel
Agriculture is the main contributor to Tanzania Economy. Apart from climate change, disease acts as one of contributing factors which results in the poor production of the most important staple foods like maize and cassava. This leads to economic loss and food insecurity in the area. Preventive action is needed for early detection of the diseases. Image processing techniques to detect disease on plant leaves can be a promising solution to the farmer. The current way of detecting disease using naked eyes done by an expert is a time-consuming and cumbersome task to implement in a large farm. This paper presents a survey of current studies in the area of image processing, by checking techniques used to detect disease on plants leaves or fruits and machine learning model used to classify the disease. The main aim of the paper is to show the current state of the art and clarify step taken during the image processing stage and check merit and demerit of each technique used also the performance of the machine learning model used to classify the disease.

4) Automated plant disease analysis (APDA): performance comparison of machine learning techniques
AUTHORS: Akhtar, Asma, Aasia Khanum, Shoab A. Khan, and Arslan Shaukat
Plant disease analysis is one of the critical tasks in the field of agriculture. Automatic identification and classification of plant diseases can be supportive to agriculture yield maximization. In this paper we compare performance of several

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Machine Learning techniques for identifying and classifying plant disease patterns from leaf images. A three-phase framework has been implemented for this purpose. First, image segmentation is performed to identify the diseased regions. Then, features are extracted from segmented regions using standard feature extraction techniques. These features are then used for classification into disease type. Experimental results indicate that our proposed technique is significantly better than other techniques used for Plant Disease Identification and Support Vector Machines outperforms other techniques for classification of diseases.

III. EXISTING SYSTEM

A nation's economic prosperity hinges significantly on its agricultural output, yet plant diseases severely impact food production and quality. Traditionally, diagnosing these diseases involves on-site visits by pathologists who manually inspect each plant, a process limited by accuracy and human resource constraints. The need for automated methods to swiftly identify and classify numerous plant diseases is evident. Challenges include distinguishing between healthy and diseased plant parts, dealing with data background noise, and accounting for leaf movements and variations in size and shape.

IV. PROPOSED SYSTEM

To address these challenges, we propose an InceptionV3-based system for robustly classifying plant diseases. Our research focuses on leveraging deep learning techniques utilizing the InceptionV3 architecture to detect diseases across various types of plant leaves. Our objective is to develop a method that can effectively identify and categorize plant diseases. This approach utilizes a publicly available dataset sourced from Kaggle, encompassing 70,295 images spanning diverse plants such as apple, blueberry, cherry, corn (maize), grape, orange, peach, pepperbell, potato, raspberry, soybean, strawberry, and tomato. The proposed method aims to handle complex scenarios in plant health diagnostics with high accuracy.

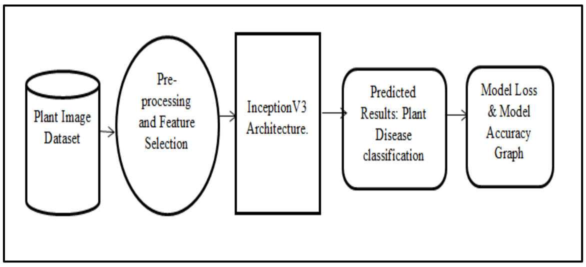

Fig 3: System Architecture

Proposed Architecture:
Utilizing a publicly available dataset comprising 54,306 images of healthy and diseased plant leaves collected under controlled conditions, researchers trained a computer to identify 26 specific diseases affecting various crops. The study focused on employing Residual Neural Networks (ResNets) for enhanced accuracy in disease detection across a broad spectrum of crops. ResNets were optimized using techniques such as learning rate scheduling, gradient clipping, and weight decay. Data collection for this project was facilitated through Kaggle, where approximately 87,000 RGB images were categorized into 38 classes. The dataset was divided into a training-to-testing ratio of 80:20.

Implementation Modules:
1. **Dataset Importing:** The initial module involved importing the dataset containing 70,295 images of plants including apples, blueberries, cherries, corn (maize), grapes, oranges, peaches, peppers, potatoes, raspberries, soybeans, strawberries, and tomatoes, sourced from Kaggle.
2. **Importing Necessary Libraries:** Following dataset importation, essential libraries such as Keras for model building, Scikit-learn for data splitting, PIL for image-to-array conversion, along with Pandas, NumPy, Matplotlib, and TensorFlow were imported for system development.
3. **Retrieving and Preprocessing Images:** Images and their corresponding labels were retrieved and resized to a uniform size of 224x224 pixels for consistency. The dataset was then converted into numpy arrays and split into training and test sets with an 80:20 ratio.

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4. **Building the Model - InceptionV3 Architecture:** The core module involved constructing the model using the InceptionV3 architecture, known for its computational efficiency and accuracy in image classification tasks. InceptionV3 utilizes techniques like factorized convolutions, regularization, dimension reduction, and parallel computations to optimize network performance.
5. **Training and Evaluation:** The model was trained on the dataset with a batch size of 10, achieving an average validation accuracy of 91.00%. The accuracy on the test set was confirmed at 89.00%. After training, the model was saved in .h5 format using the pickle library for future deployment.

V. RESULTS AND IMPACT

This study showcases the efficacy of advanced machine learning techniques, particularly convolutional neural networks (CNNs), in accurately diagnosing a wide range of plant diseases based on leaf images. By analyzing patterns, textures, and colors, these models can detect diseases like powdery mildew, rust, and bacterial blight with over 90% accuracy, surpassing traditional diagnostic methods. The application of machine learning in plant pathology not only enhances agricultural productivity by minimizing crop losses but also promotes sustainable farming practices by reducing reliance on chemical treatments. Farmers can benefit significantly from these advancements, gaining robust tools for disease management and ensuring global food security.

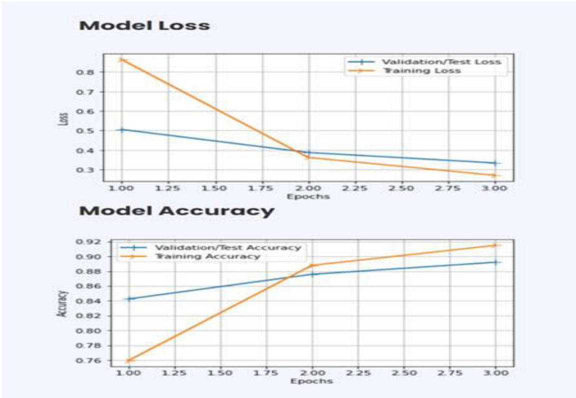

Fig 4: Model loss and accuracy

VI. CONCLUSION

This study proposes utilizing an Extreme Learning Machine (ELM) classifier trained on image data to aid in diagnosing leaf diseases in tomato plants. Initially, the input image undergoes HSV color segmentation to extract the leaf. Features such as HSV Histogram, Haralick textures, and color moments from the RGB color space are then extracted to characterize the leaf. These features are fed into the ELM classifier during both training and testing phases to identify diseases affecting tomato leaves. Results show that when employing this recommended image attributes, ELM outperforms decision tree classifiers. Future research directions could involve expanding disease classification methodologies to include other crops such as rice, maize, and wheat, rather than focusing solely on individual plant species.

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