

Approach for Chilli Disease Diagnose and prediction through Machine Learning Algorithms

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Abstract: To detect diseases in chili plants using deep learning, we first need a large set of images that include both healthy plants and those affected by various diseases, such as Anthracnose or Bacterial Wilt. These images must be carefully labelled so the model can learn to differentiate between healthy and diseased plants. Once we have the images, we need to prepare them for training the deep learning model. This preparation includes resizing the images to a standard size, normalizing the pixel values for consistency, and augmenting the data by applying transformations like rotating or tipping the images. These steps help the model recognize plants in various conditions and increase the amount of data available for training. The core of the system relies on Convolutional Neural Networks (CNNs), which are specialized for analyzing images. To improve performance, we can use a technique called transfer learning, where we take a model that has already been trained on large datasets (like those used for general image recognition) and re-tune it with our specific chili plant data. This approach allows the model to learn to detect plant diseases more effectively, even if the dataset is small. After training, the model can automatically classify images of chili plants.

Keywords: Deep learning; Convolutional Neural Networks (CNNs).

Introduction

To improve reliability and effectiveness in agricultural disease management, deep learning models for disease prediction in Solanaceae (Chilli) use sophisticated neural networks to examine a variety of data, including genetic and environmental parameters. India ranks as the second largest global producer of Chilies, boasting a substantial production volume of 12.6 million tonnes cultivated throughout a vast agricultural expanse. The bacterium *Ralstonia solanacearum* is a major problem in the realm of Chilli agricultural land due to its abilities to promote bacterial wilt and its ability to persist in the soil, which causes issues due to its competitive nature. After potatoes and onions, Chilies are India's third-most significant crop. India is the

second-biggest Chilli producer in the world. Andhra Pradesh, Gujarat, Tamil Nadu, Karnataka, Madhya Pradesh, Odisha, West Bengal, Telangana, Uttar Pradesh, Himachal Pradesh, Chhattisgarh, Haryana, Maharashtra and Bihar are the main Chilli-producing states in India. Approximately 90% of nation's Chilies are produced in these states. India had produced 193.97 lakh tones of Chilies in 2018–19, an increase of 8% when compared to 2017. Twenty percent of India's total Chilies are produced in Andhra Pradesh. At 12% of global Chilli production, Madhya Pradesh is the second-biggest producer. Karnataka ranks third in terms of output and accounts for 10% of the overall Chilli production in India. Maharashtra, Gujarat, Tamil Nadu, Chhattisgarh, and Telangana are the next most productive states. Deep learning models have transformed Chilli disease identification and precision farming. These algorithms can accurately detect diseases early by using satellite imagery, sensor networks, and historical records, helping farmers prevent crop losses. This increases production and promotes sustainable farming. Chilies also affect international trade balances and economic interdependencies, making them economically important. Beyond their economic significance, Chilli are nutrient-dense powerhouses, exceptionally rich in Vitamin C (often containing more per serving than citrus fruits) and Vitamin A (via beta-carotene). Understanding culture, including the numerous agricultural methods used to grow Chilies throughout culinary geographies, is crucial.

Discussions

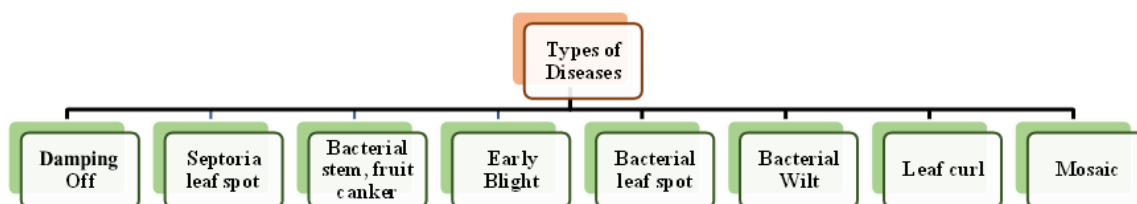
- ✎ Chillies exhibit resistance to a range of pests and diseases, such as aphids, whiteflies, nematodes, bacterial spots, early and late blight, and fusarium wilt. These infestations can result in decreased yield, low fruit quality, and even total crop loss.
- ✎ Chillies need a precise climate for best growth. Temperature, rain/drought, and humidity can harm the crop. Climate change makes predicting the ideal growing conditions difficult.
- ✎ Soil health is crucial for successful Chilli cultivation. Inadequate nutrient

levels or imbalanced pH can hinder growth and yield. Farmers head to manage soil fertility carefully.

- ↳ Adequate water is important for Chilli growth. Insufficient irrigation can lead to fruit problems. Efficient water management is crucial for successful Chilli cultivation.
- ↳ Weeds and Chilli plants compete for vital resources. Uncontrolled weeds can harm crop yield and quality. Farmers should use weed control methods to minimize their impact on Chillies .
- ↳ Choosing suitable Chilli varieties for a particular area is vital. Consider factors like disease resistance, adaptability, and market demand. Also, ensure high-quality seeds that align with cultivation goals for a successful harvest. Market fluctuations can affect the viability of Chilli farming. Price changes impact farmers' income. Diversifying crops helps mitigate this challenge

Types of Disease:

The variety of plant Solanace, commonly known as Chilli is subject to a range of ailments that can have major effects on its development, productivity, and overall botanical well-being. They can be broken down into numerous classifications owing to the sources of infection and the means of transmission. Types of leaf used in plant village dataset are Chilli yellow leaf curl virus, Chilli healthy, Chilli mosaic virus, Chilli early blight, Chilli leaf mold, Chilli bacterial spot, Chilli spider mites, Chilli target spot, Chilli late-blight, and Chilli-septoria leaf spot. Types and various kinds of diseases are shown in below Figure:



Techniques used for Plant Disease Detection

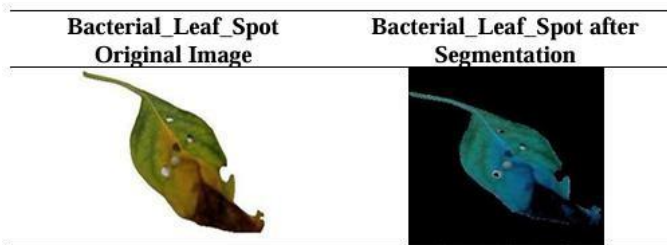
DL techniques are being applied to the image processing of *Lycopersicum* infections, which involves using advanced methods to automatically analyze and classify images of affected Chilli plants. DL models, primarily CNNs, form the foundational framework for this technique. The accurate prediction of diseases in *Lycopersicum* (Chilli plants) through the utilization of DL techniques entails the application of sophisticated artificial intelligence models, namely deep neural networks, to forecast and identify diseases affecting Chillies. Collect photographs of Chillies that are accompanied by labels indicating whether the plants are in a healthy or unhealthy state. The dataset ought to be separated into several subsets for training, validation, and testing [25]. CNNs play a major role in the identification of plant diseases by assisting in the very accurate and precise identification of visual cues associated with disease. Because CNNs can learn picture representations hierarchically, they can recognize intricate patterns and details, including those associated with specific diseases. These networks can automatically extract pertinent elements from plant photos, which are useful for identifying illness symptoms. Examples of these features include color shifts, texture details, and spatial correlations among pixels. Convolutional neural networks (CNNs) are an invaluable tool for automating disease identification in agriculture. Their capacity to handle vast amounts of visual data and their resilience to changing picture conditions allow for early interventions and effective crop management techniques.

1. Problem statement Addressed/ Motivation: This study aimed to explore the challenges associated with Chilli farming, specifically focusing on agricultural situation in India. among the main challenges faced in this investigation was the discovery of the bacterium *Ralstonia solanacearum*, that led to bacterial wilt and proved persistence over time in the soil, so posing an important risk to Chilli plants. Another issue that emerged was the occurrence of diseases, such as Chilli leaf curl disease. The disease under consideration was mostly associated with begomoviruses, which were spread by whiteflies. Imbalanced datasets are characterized by an uneven distribution of samples across disease classes, which can result in biased models and reduced performance for minority classes.

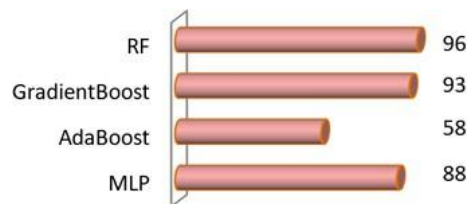
Consequently, this poses a substantial challenge in the context of illness prediction and therapy. Market fluctuations and price differences have the potential to exert a major effect on the economic feasibility of Chilli production as well as the revenue of farmers. This underlined the significance of crop diversification and considering market demand. The challenges faced during the creation of DL models for disease prediction in Chilli plants encompassed limitations in computational resources and vulnerability to adversarial attacks. The research also emphasized the need of integrated systems and decision support systems in effectively disseminating timely warning messages and assisting farmers in forecasting and preparing for potential disease outbreaks.

2. Methodology: The methodology consists of multiple detailed steps: segmentation via an optimized OptiFPN-RCNN model; advanced feature extraction covering texture, color, and shape descriptors; and optimal feature selection using a novel hybrid optimization algorithm, the Spring Search Pelican Optimization Algorithm (SPOA). The creation and training of an aggregated deep learning model for improved illness detection accuracy, which includes attention-based CNNs, RNNs, and Transformer-based neural networks.

3. Key findings: The implementation of proposed model is made by using python3.9.11 and GoogleCOLab. The images are preprocessed and segmented by Color and edge detection. Table 4 represents the diseased image after segmentation. Then features were extracted by Haralick and Hu moments methods later classification takes place. The performance of the ML techniques is represented in the Table. Models were trained with 926 images; got accuracy around 95% later decreased it to 868 images and got an accuracy of 97% with RF and 93 % with Gradient Boosting, got an accuracy of 97% with RF and 93% with MLP and below 70% accuracy with AdaBoost. Table illustrates the Accuracies of various classifiers vs. ratio of the training and testing images.



4. CONCLUSIONS The proposed method uses Color and Edge detection, Haralick et al. [30] moments feature extraction methods and four state of the art machine learning algorithms in order to detect the real field chili crop images captured with Red Mi Note 7 mobile phone namely AdaBoost, Gradient Boosting, Multi-Layer Perceptron and Random Forest. The experiment recorded in 3 cases i.e., 80:20, 75:25 and 70:30 of training and testing images. The experiment results shown that Random Forest and Gradient Boosting scored top i.e. nearer to 95% of accuracy with 75:25 ratio of training and testing. The Curl class has predicted very accurately among all classes. The dataset used in this study contains four diseases, although the chili crop contains many more. Farmers can protect their crops from diseases using the method described above. Our future works may be adding more diseases to the dataset and detection of the disease module can be converted into an application for the mobiles so that it can be exploited in the field by the farmers for immediate detection of the disease.



Please note- Not all articles will have similar conclusions mentioned as above. Review articles differ in the way they are written.

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