

Plant Image Recognition and Disease Prediction using CNN

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Abstract—India's economy is heavily reliant on agriculture, ranking among the top crop producers globally. With farm production contributing approximately 18.1 percent to the nation's GDP, it holds a pivotal role in the agribusiness sector.

Challenges such as unproductive farmland and crop diseases hinder annual food production rates. Accurately detecting crop infections is challenging, as inaccuracies could lead to decreased yields and diminished market value. Innovative approaches are thus crucial to facilitate early detection and the development of resilient crops. This study aims to integrate agricultural practices with artificial intelligence to mitigate losses from plant leaf infections. Crops like apples, potatoes, cherries, and grapes exhibit distinct disease symptoms, enabling prompt identification and preventive actions. Employing four models utilizing various CNN architectures—VGG16, VGG19, InceptionV3, and ResNet50—we aimed to identify and predict plant diseases. Through trials on the standard PlantVillage dataset, VGG19 demonstrated superior accuracy compared to other models.

We categorized the data into 38 classes for prediction purposes. This proposed model targets agriculture and agro-based businesses, empowering farmers with early intervention strategies to enhance crop productivity.

Index Terms— Plant identification, Plant Disease Prediction, Machine Learning, CNN.

I. INTRODUCTION

Diagnosing plant diseases poses a significant challenge for the agricultural sector, often requiring advanced technological solutions to complement traditional observation methods.

Observable symptoms on plant leaves serve as vital indicators, facilitating disease recognition and allowing for timely interventions to curb their spread. Despite these visual cues, the complexity and diversity of plant diseases render accurate identification a daunting task, even for seasoned observers. The reliance on manual prediction accuracy underscores the importance of individual expertise and experience in the field. In response to these challenges, this study advocates for a state-of-the-art approach that integrates deep learning methodologies with agricultural practices. Departing from Conventional machine learning techniques, which depend on manual feature extraction, contrast with deep learning models offer a more sophisticated and autonomous solution. Leveraging artificial neural networks, these models can discern intricate and analyzing patterns and features within input images enhances their effectiveness in tasks related to image classification.

One such model proposed in this study utilizes convolutional neural networks (CNNs) to categorize a wide range of plant leaf diseases swiftly and accurately. By automating the identification process, this model presents a promising alternative to time-consuming and error-prone manual observation methods. Moreover, the integration of such technology into mobile applications empowers farmers to detect and address plant illnesses promptly using nothing more than their smartphones. Training the model with a comprehensive dataset, such as the PlantVillage dataset, allows for robust performance across various disease categories. Through extensive experimentation, employing CNN architectures like VGG16, VGG19, InceptionV3 and ResNet50, it was revealed that VGG19 exhibits superior accuracy among them. This innovative approach not only enhances disease diagnosis and management but also signifies a significant step forward in leveraging technology to address challenges in agriculture effectively.

II. LITERATURE REVIEW

In [1], creators introduced a technique for grouping and Utilizing the EfficientNet profound learning model to recognize an extensive variety of plant illnesses. The Plant Town dataset, involving 55,448 photographs, close by an extended variant containing 87,867 pictures, filled in as the preparation information. Execution evaluation included contrasting the proposed EfficientNet model and state of the art innovation and Using cutting edge CNN models like ResNet, VGG, AlexNet, and Commencement, with all layers designed as teachable during move learning, yielding the most positive results with the EfficientNet models B5 and B6. To address the arrangement of plant leaf infections, in paper [2] utilized different strategies including the Single Shot Multibox Identifier (SSD), Quicker District based CNN (Quicker R-CNN), and Locale based Completely Convolutional Organization (R-FCN).

Their dataset ncompassed pictures of plant leaf sicknesses in business crops like guava, wheat, rice, stew, carrot, brinjal, potato, cotton, sugarcane, and banana, obtained from both manual catches and online vaults. Increase procedures like revolutions, relative changes, point of view changes, and force of picture adjustments were applied to expand dataset and moderate overfitting during preparing of model.

In an alternate report [3], specialists applied the Caffe profound learning system and Imagenet loads for grouping plant illnesses. Their model, highlighting five convolutional and completely associated layers alongside eight learning layers, accomplished an excellent 96% exactness rate. Dataset planning included downloading photographs from the web, with increase methods utilized to forestall overfitting. Through the use of picture handling procedures, Sanjay and Shrikant [4] conceived a framework fit for focusing on illness impacted regions and distinguishing plant infections in that. Utilizing essential thresholding strategies and triangle thresholding methods, they portioned leaf and sore regions for sickness order, accomplishing a praiseworthy framework precision of 98.60%.

In paper [5] used Molecule Multitude Enhancement (PSO) for include extraction and a Cross Data Gain Profound Forward Brain Organization to group different cotton leaf sicknesses with a general exactness of 95%. Their methodology included removing surface, shape and variety highlights utilizing PSO, improving generally precision and working with the identification of infected leaf patches.

Additionally, in [6] utilized processing of image methods and artificial neural networks (ANN) to identify plant leaf diseases. Employing the Gabor filter for image filtering and segmentation, their ANN model, trained on retrieved features distinguishing healthy and diseased samples, and attained an accuracy level of 91%.

III. METHODOLOGY

- Utilization of a Convolutional Brain Organization (CNN) for characterizing different plant sicknesses, as portrayed in Fig. 1.
- The introductory layer of the model is the convolution layer, liable for separating data from input pictures.

- Feature guides are produced and highlight extraction worked with by applying numerous channels to the picture inside the convolution layer.
- Following the convolution layers are pooling layers, which mean to diminish the quantity of boundaries and picture size.
- Common pooling systems incorporate max pooling, normal pooling, and total pooling.
- Subsequently, the framework is leveled into a vector and sent to the completely associated layer subsequent to going through convolution and pooling processes.
- In this review, the corrected straight initiation capability (ReLU) is utilized for the convolution layer.
- The Softmax actuation capability is used for the result layer.
- The ReLU actuation capability yields zero assuming the information esteem is zero or less, and yields the info esteem in the event that it is more noteworthy than zero [1].

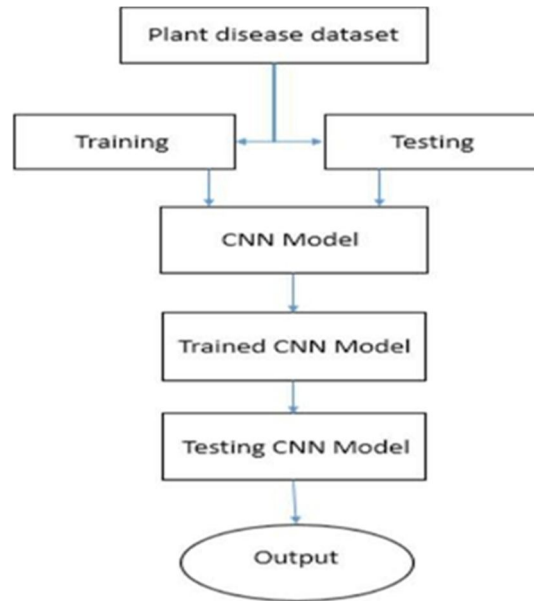


Figure 1. The classification system diagram

IV. IMPLEMENTATION DETAILS

A. Dataset

The information used in this review was gathered from the Plant Town dataset, which contains north of 87,000 photographs addressing 38 groupings across 14 different plant species [7]. Among these groupings, 9 component sound leaves, while the rest of sick leaves [8]. Shown in Figures 2-4 are instances of photos from each class of Potato plant leaves [9, 10]. Powerful execution of profound learning models requires a significant dataset [11, 12]. To this end, the photos go through upgrade strategies like pivot, zooming, and shift, worked with by Keras' Picture information generator, bringing about resizing to 224x224 pixels [13, 14]. The essential points of these expansion techniques are to broaden the dataset and forestall overfitting during preparing [15, 16]. For trial purposes, the dataset is divided into preparing and approval sets with an 80:20 proportion [17, 18]. The preparation set incorporates north of 70,000 pictures, while the approval set involves in excess of 17,000 pictures [19, 20].



Figure 2. Potato Healthy Leaves



Figure 3. Potato Early Blight Leaves



Figure 4. Potato Late Blight Leaf

B. Training a Neural Network

This study includes preparing a convolutional brain organization (CNN) utilizing the plant dataset and consequently contrasting the outcomes and those got from laid out pre-prepared models like VGG16, VGG19, InceptionV3, and ResNet50 [21, 22]. The CNN model used comprises of sets of convolutional and pooling layers [23, 24]. These convolutional layers apply channels to the info picture to separate highlights, while the pooling layers help in diminishing the information picture size, in this manner working with the organization's calculation [25, 26]. A schematic portrayal of the CNN model is portrayed in Figure 5 [27, 28].

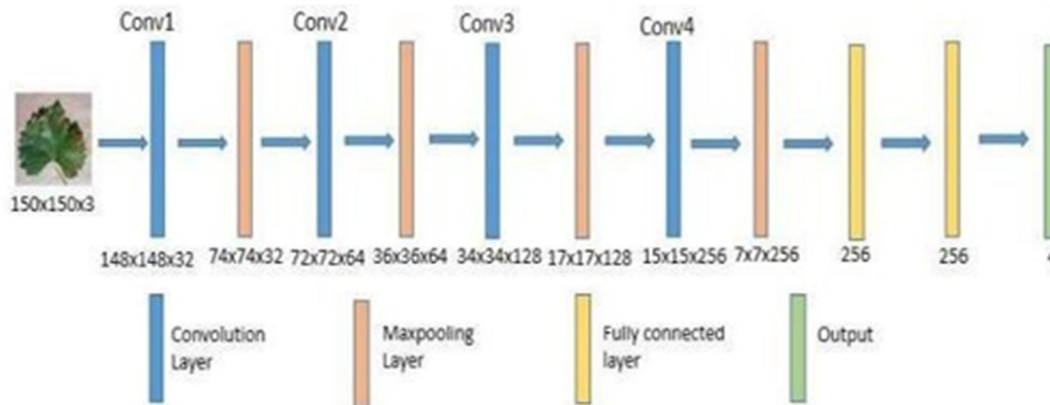


Figure 5. Representation of CNN model schematics

Existing writing shows the viability of using move learning-based pre-prepared models for the arrangement of plant illnesses [29, 30]. Exploratory outcomes are thought about utilizing eminent pre-trained models like Initiation, ResNet and VGG. Prior to handling, the pictures are resized to 224x224 pixels to fit the models [31, 32]. Eminently, the VGG19 model beats all others with a precision of 88.54%. The order execution of each model is assessed in light of the exactness metric [33].

V. CONCLUSIONS AND FUTURE SCOPE

This study contributes to early plant disease detection to mitigate crop loss and disease spread. It encompasses plant disease detection employing various architectures or algorithms. The CNN model, VGG16, VGG19, InceptionV3, and ResNet50 represent distinct architecture implementations. These models underwent training using an augmented dataset comprising over 87,000 images. Model performance evaluation was conducted based on accuracy scores. The VGG19 architecture achieved the highest accuracy of 88.54%, while the CNN model scored 82.84% accuracy. Notably, VGG19 features a deeper neural network and more

convolutional layers compared to VGG16. Deeper networks have the potential to capture intricate and abstract features beneficial for challenging tasks. Additionally, the model has been integrated into a web-based Flask application to enhance accessibility.

Future endeavors aim to enhance efficiency by incorporating additional classes of various plants and training models with diverse hyper parameters.

TABLE I. ACCURACY OF DIFFERENT ALGORITHMS FOR PLANT DISEASE DETECTION

Algorithm	Accuracy (%)
VGG16	85.22
VGG19	88.54
InceptionV3	87.00
ResNet50	86.20
CNN	82.84

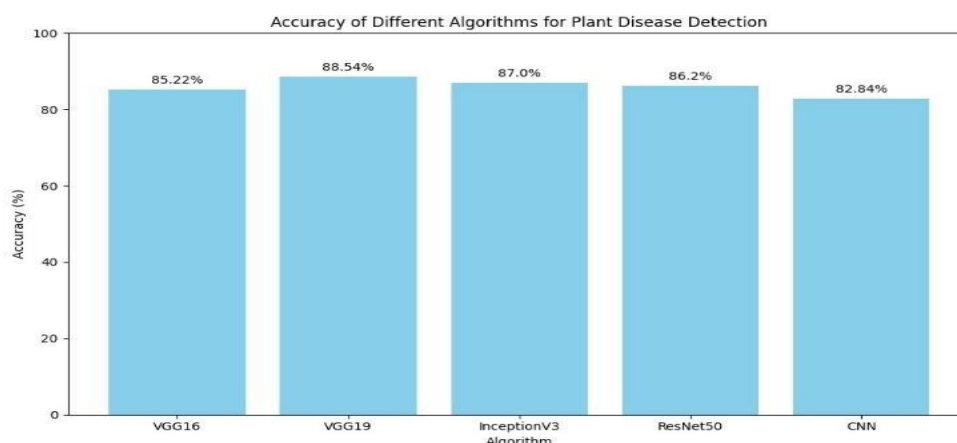


Figure 6. Accuracy of Different algorithms for Plant Disease Detection

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