# Classification of Plant leaf diseases: A Deep Learning Method

**Taruna Sharma, Ruchi Mittal**

***Abstract*: *For the continuous existence of human life, agriculture plays a vital role due to the dependency of lives of people on it for production of food. In order to meet high production rate, precision farming is required. Presently, substantial developments attained "in the field of image processing and recognition" which has being a foremost challenge earlier in the practice of Precision farming. The reduction in the growth, quality and quantity of plants is due to expansion of plant diseases.The survey literature confers various plant leaf diseases and their detections during different phases through various state of art machine and deep learning techniques. The particular emphasis in this paper is on detection and classification of plant "leaf diseases" through deep "convolutional neural networks algorithms.***

***Keywords*: *Classification, Plant Leaf, Production of foof, Convolutional.***

## I. INTRODUCTION

Worldwide food security needs an in depth investigation of various threats posed to several food plants. Plant diseases add up to just about 10–16% losses in the global harvest of plants each year[1].Timely and accurate analysis of plant diseases aids us in attaining healthier plant production.

With the growing increase in the population, the demand for agricultural production needs to be increased to satisfy food requirements of individuals. The researchers employed various promising areas like image processing and advances in computer vision for plant disease detection.[2] Earlier farmers used methods like color or shape observation for disease identification in plant leaves. It was very laborious and time consuming. In addition to that the detection was not reliable. To overcome these limitations, a fast automated system for disease detection and classification was developed in the field of agricultural research . Various methodologies and techniques have been employed so far for classification of various plant diseases like K-nearest neighbour, artificial neural network, support vector machine etc. Hence, this study reviews various deep learning techniques employed for classifying various plant diseases to avoid the gravity of disease. The given study is distributed into the following sections. Section 1 gives general introduction about plant diseases. Section 2 includes discussion on various kinds of diseases in plants. Section 3 gives basic architecture for plant disease detection system. Literature review part is being discussed in Section 4 and finally concluded in Section 5.

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## II. CATEGORIES OF PLANT LEAF DISEASES

**Table 1: Categories of plant leaf diseases**

| Fungal diseases | Bacterial Diseases | Vira Diseases |
|---|---|---|
| •Molds<br>•Rust<br>•Mildews<br>•Rots<br>•Cankers<br>•Spots<br>•Wilts | •Soft spot<br>•spot<br>•Wilt | •mottling<br>•distortion<br>•dwarfing |

Plant leaf diseases are categorized as fungal, bacterial and viral diseases as shown in Table-1. Fungal diseases are plant infections caused by fungi . Fungal diseases include symptoms like spots, yellowing of leaves, and birds-eye spots on berries . In some cases, the organism can really be observed on the leaves as a mold, mildew or spores . Bacteria are single-celled organism which multiplies through division. Few examples of bacterial diseases include soft spot, wilt etc. Lastly virus symptoms include mosaic leaf pattern, yellowed, or crinkled leaves with no associated protein such as mottling, distortion etc. [3].

## III. METHODOLOGY

The basic architecture of plant disease detection system consists of various phases as shown in figure 1 and is explained subsequently as: image acquisition, labelling and pre-processing of data followed by data augmentation. After this phase training and testing of dataset performed through various learning techniques and classification through deep Convolutional neural networks.

**Image Acquisition:** In image acquisition step, images are acquired through high resolution digital camera or from various sources of internet [4].Few standard datasets like Plant Village, APS etc. are also available for the researchers [4, 5] The images are collected under wild, controlled or uncontrolled conditions.

**Preprocessing:** Preprocessing is a technique of removing noises or distortions in an image to improve its quality. Various preprocessing methods includes Contrast Stretching, Noise filtering and Histogram modifications etc. Various filters like low pass, high pass, etc. are applied to get rid of various types of noises [6].

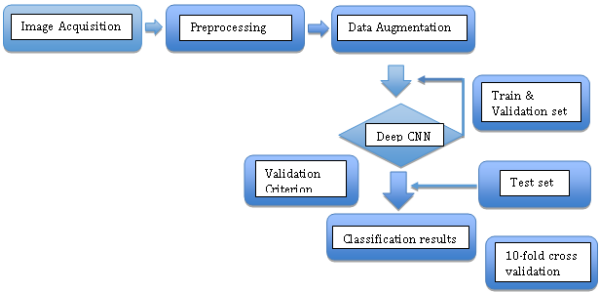


**Figure 1: Steps of plant disesase detection system**

**Data augmentation**: Since most of the datasets are not available easily. In order to create large datasets, data augmentation techniques applied on the smaller datasets for enhancement. Big datasets reduces the problem of overfitting.
**Training and Testing of data:** Training and testing of data includes splitting of datasets into various train-test splits. The model is trained through various learning techniques like baseline training, fine tuning or transfer learning.
**Classification:** Classification of diseases is based on the predefined dataset values. For classification phase, different kind of machine learning techniques are being employed to allocate a class to a set of unclassified data .The main techniques used for classification are Support Vector Machine(SVM),Neural Networks, FuzzyClassifier, Linear Discriminant Analysis, KNNetc.
Deep learning is an emerging research area in the field of machine learning as well as in convolutional neural network**.** It is a subset of machine learning techniques**.** Various deep learning approaches have been used for image classification and recognition. In deep learning, CNN is one of the most prominent approach. It consists of two core structures: a convolutional layer and a pooling layer. This paper concentrates mainly on the crops which have been classified through deep learning convolutional neural networks.

## IV. REVIEW OF LITERATURE

Amara J et al. [7] presented classification method based on deep learning for detection of banana diseases namely Banana Speckle and Banana Sigatoka using Lenet architecture underwild and challenging conditions.These diseases detected early and accurately with very less computational work. The dataset consists of 3700 images collected for classification through CNN.The future work includes automatic severity estimation of disease detection to help farmers to interfere to prevent plant from disease infections.
Atabay Ha [8] suggested deep residual learning approach for detection of tomato leaf diseases using CNN architectures. Results revealed that proposed methodology outperforms in comparison to VGG models in terms of training of dataset as well as in terms of accuracy without the need of additional hardware. In addition to that various feature visualization and verification techniques were also applied on 19742 samples of tomato for attaining better results.
Oppenheim D et al. [9] presented deep CNN based classification algorithm for detection of four potato diseased classes and a healthy potato class . The dataset of potato diseases was collected during wild conditions. CNN algorithms were applied for classification purpose. Classification accuracy range from83% to 96% taking very less trained data to 90% trained data.
Wang G et al. [10] proposed deep learning model for the detection of automatic disease severity in apple leaf diseases namely black rot through fine grained classification. Author trained four deep learning models through CNN from scratch to fine tuning namely VGG16, VGG19, Inception-v3, and ResNet50 . The fine-tuned VGG16 model performed better as compared to other models with an accuracy of 90.4%.
Atole RR et al. [11] implemented three class classifier using deep convolutional neural network to detect rice diseases such as normal, unhealthy and golden apple snail infection using Alexnet deep learning architecture through transfer learning. Best accuracy results of 91.23% achieved on rice leaf disease image dataset.
Liu B et al. [12] presented an approach based on deep CNN was proposed to detect four apple diseases based on AlexNet architecture. Dataset of 13,689 images acquired for training and testing of diseased apple leaves. Author concludes that the proposed approach achieved 97.62% accuracy by reducing model parameters and faster convergence. Also image formation enhances convolutional neural networks.
Llorca C et al. [13] created image classifier by applying transfer learning on Google's Inception-V3 model for the detection of various types of tomato pests and diseasesnamely cuteworms, whiteflies, early blight, powdery mildew, and hornworms . Future work reduces overfitting of dataset by increasing the number of classes in tomato diseases.Better classification results of 88.9% achieved during recognition process.
In Paper [14] authors discovered symptom-wise four cucumber diseases through Deep CNN. Image segmentation method applied to segment the leaf disease dataset. Excellent classification accuracy achieved with the use of both Alexnet architecture and DCNN under field conditions.

## V. COMPARISON OF DIFFERENT PLANT LEAF DISEASE DETECTION METHODS USING DEEP LEARNING

| Author & Year | No. of images | Plant name | Disease/ Deficiency | Techniques/Classifier used | Findings |
|---|---|---|---|---|---|
| Amara J et al.[7] | 3700 | Banana | Banana Sigatoka, Banana speckle | Deep CNN | With little computational work, good classification results attained during detection of banana leaf diseases |
| Atabay Ha [8] | 19742 | Tomato | Bacterial Spot,Early Blight,Late Blight, Septoria Leaf Spot, Spider Mites, Tomato Mosaic Virus, Leaf Mold Target Spot, and Yellow Leaf Curl | Deep residual learning | Proposed approach shows improvement in terms of accuracy and training time other than VGG models. |

| | | | | | |
|---|---|---|---|---|---|
| Oppenheim D et al. [9] | 2465 | Potato | Black Scurf, Silver Scurf,Common Scab,black dot | Deep CNN | Classification accuracy range lies between 83% to 96% |
| Wang G et al. [10] | 2086 | Apple | Black rot | Deep CNN | VGG16 model shows better performance as compared to other models |
| Atole RR et al. [11] | 857 | Rice | Normal, unhealthy,golden apple snail | Multiclass Deep CNN | Multiclass classifier achieves accuracy of 91.23% |
| Liu B et al. [12] | 13689 | Apple | Mosaic rust, Alternaria leaf spot and brown spot | Deep CNN | Proposed model reduces parameters in comparison to the standard Alexnet model along with faster convergence rate and increasing accuracy rate by 10.83% |
| Llorca C et al. [13] | 2779 | Tomato | Cuteworms, whiteflies, early blight, powdery mildew, and hornworms | Transfer learning through Deep CNN | Better accuracy achieved along with reduced overfitting. |
| Ma J, Du K, Zheng F, Zhang L, Gong Z, Sun Z[14] | 14208 | Cucumber | anthracnose,downy mildew, powdery mildew, and target leaf spots | Deep CNN | Better results attained by combining both Alexnet and DCNN |

## VI. CONCLUSION

This paper presented a study based on leaf disease detection and classification through deep learning techniques through Convolutional Neural Networks.In case of large data, this method gives accurate and fast results for leaf disease detection.It has also been observed that the results obtained are better in case of deep convolutional neural networks as compared to the previously used classifiers such as SVM and ANN.

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