

DETECTION OF DISEASES FROM CROP LEAF IMAGES USING MACHINE LEARNING TECHNIQUES: A REVIEW

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Abstract - Agriculture plays a vital role in our day-to-day life. Identification of the disease of plant leaves is very important to prevent the losses in the yield. The plant diseases such as fungi, bacteria and viruses. The leaf diseases completely destroy the quality of the leaf. In this review we present some critical survey on the challenges which we are currently facing and also various methodology which includes Machine learning, deep learning and image processing algorithms which are tested on various plant leaves to detect diseases which helps to increase the yield.

Finally, we identify the challenges and some opportunities for future developments in this area

Key Words: Image processing; Machine Learning; classification; SVM, CNN, Deep Learning, Disease, Neural network

1. INTRODUCTION

India is a land of agriculture and the role of agriculture in our country is very essential because a lot of the people are dedicated to the agricultural industry. Crop production is one of the major factors which affects the domestic market in our country[15]. The most important component is identifying crop diseases, which have a direct impact on the economy and food security. Earlier farmers generally used naked eye observation to judge the diseases. But sometimes this may be inaccurate. So, many times farmers used to call the experts for detecting the diseases which was time consuming in big large farms. Therefore, for analysis in various agricultural applications, digital image processing techniques have been established as an effective way such as plant recognition, soil quality estimation, crop yield estimation etc. Image Processing is one of the widely used techniques which is adopted for the plant leaf diseases detection purposes[16].

Thus, disease detection in leaves is an important topic that provides many benefits in monitoring large fields of crops. To detect the diseases properly we use deep learning so, basically the idea of deep learning is: using neural network for data analysis and feature learning, data features are extracted by multiple hidden layers, each hidden layer can be regarded as a perceptron, the

perceptron is used to extract low-level features, and then combine low-level features to obtain abstract high-level features, which can significantly alleviate the problem of diseases in crop[16].

Identifying plant disease wrongly will lead to huge loss of yield, time, money and quality of product. Hence, identifying the condition of the plant plays an important role for successful cultivation.[17]. Therefore, some main steps for disease detection need to be consider. The below fig[2] shows the steps in the training and testing phase.

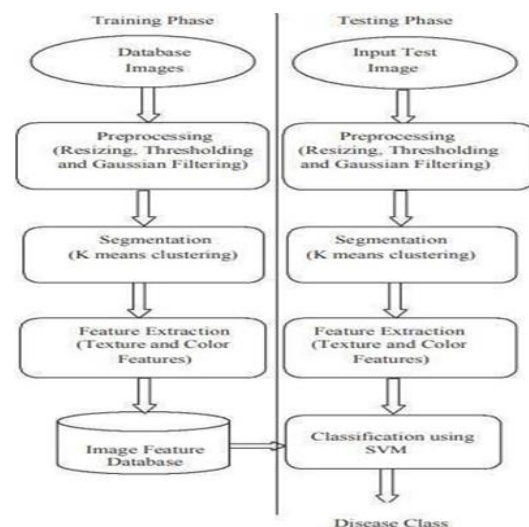


Figure 1. System Block Diagram [16]

2. LITERATURE REVIEW

Sagar Vetal and R.S. Khule [1] has proposed Tomato Plant Disease Detection using Image Processing for detecting 4 commonly occurring diseases like Early Blight, Septoria Leaf Spot, Bacterial Spot, Iron Chlorosis in Tomato. They followed some steps like Image acquisition, smoothing of images using filters and Kurtosis, image segmentation using inverse difference method and feature extraction. And they gave equations for features like energy entropy, correlation, and homogeneity. Using the SVM model they achieved percentage accuracy of 93.75%.

Shima Ramesh et al [2] have proposed Plant Disease Detection Using Machine Learning. In this paper they used a random forest algorithm for the detection of plant diseases. And also, Histogram of an Oriented Gradient (HOG) is used for feature extraction. The authors make use of 3 component descriptors like Hu moments, Haralick texture, Color Histogram. As they compared with other algorithms like Gaussian Naïve bayes, regression, linear discriminant analysis, Random forests gave more accuracy with 70%.

Mrs.N. Saranya et al [3] have proposed Detection of Banana Leaf and Fruit Diseases Using Neural Networks. The authors used ANN- Artificial Neural Network algorithm for the detection of some leaf and fruit diseases of bananas. Fuzzy c means clustering as their Image segmentation technique, detection and classification by ANN algorithm. They considered mean, variance, skewness to determine accuracy. The authors concluded image processing has the higher degree of detecting and classifying the diseases in banana plants.

Saraansh Baranwal .et al[4] proposed a model which takes the apple leaves and it detects and classifies the input leaf as healthy or unhealthy and it further identifies which type of disease. They used Convolutional Neural Network which is popularly used for processing and image classification ,for accomplishing the task. In CNN ,each neuron receives several inputs in the form of raw image matrices, calculates a weighted sum over them , and it passes through an activation function ,and gives output. The best accuracy achieved by this algorithm is 98.42 % in the overall dataset at dropout 0.2.

Badam .et al [5] proposed a model which helps to identify and classify unhealthy leaves . And they used hardware which is a webcam for taking real time images of the plant leaves , and sending the attachment of the image to email for this they used an embedded system . Convolution Neural Networks is designed for accurate analysis and they used the unsupervised learning algorithm as the dataset is unknown . And this gives the output as whether the leaf is healthy or unhealthy and if the leaf is unhealthy gives the disease name and accuracy of this model is above 90%.

Anil A. Bharate, and M. S. Shirdhonkar [6] proposed methods for disease in plants such as apples, grapes, pepper, tomato, and pomegranate. They use image segmentation where they divide the image into many segments. They use color feature extraction such as color histogram, histogram intersection, etc. Texture features, Morphological features, Pattern Matching,classification

in which classification techniques have supported vector machines, k-nearest neighbors, etc.

Draško Radovanović 1, and Slobodan Đukanović [7]have compared the machine learning algorithms with the deep learning algorithm to check which is faster and more efficient to stay up to date with the current trends.

Classic methods mostly use image pre-processing. Algorithms used generally are SVM, k-NN, Decision Trees, etc. The classical ML approach has the following steps Region Segmentation, Feature extraction, and Support Vector Machines are used for classification or regression problems, and it has an accuracy of 91.74%. k-nearest algorithms-It is parametric and lazy learning, and this has an accuracy of 78.06% with k=5. Fully Connected Neural Network-It is a supervised learning algorithm able to modify non-linear functions, it has an accuracy of 91.46%. Deep Learning uses multiple layers. The DL algorithm is based on artificial neural networks. The accuracy of this algorithm is 99.32%.

Sakshi Raina and Dr . Abhishek Gupta[8] have proposed all the techniques you can use to find the effective technique and use them appropriately. Since detecting plant disease in the early phase is very important and knowing the Plant disease takes a lot of time, we use many ML techniques to figure out the diseases to save time. This has all the techniques needed which are Artificial Neural Network ,Convolution Neural Network GPD ,CNN ,Generative Adversarial Networks (GANs),Support Vector Machine, Particle Swarm Optimization (PSO).

Pallapothala Tejaswini . et al [9] have discussed the rice crop and the disease Hispa which are frequently occurring leaf diseases in rice crops. The paper includes some experimental results performed using different deep learning models with their accuracy rates. The VGG 16 with 58.4%, VGG 19 with 72.4%, Xception with ResNet50 with 72.2% and 5- layer convolution with 78.2% accuracy rates.

SK MAHMUDUL HASSAN. et al [10] have proposed a novel CNN model which is based on the inception and residual connection and can effectively classify diseases in plants.The accuracies are proposed on all three models as 99.39%, 99.66% and 76.59% on PlantVillage, Rice and Cassava datasets respectively. The accuracy using a plain convolution neural network is 52.87% and using a deep residual neural network is 46.26%.

Title & year	Methodology & Algorithm used	Plants/crops & Data collected	Challenges identified	Future work
[11] Recognition of plant diseases using convolutional neural network 2020	methods: Deep Learning Algorithm: deep CNN,SGD algorithm	The dataset contains 54323 plant leaves images of 38 different categories,which includes images of common diseases of the plant.	There is a limitation of vanishing gradient which can be overcome by sgd algorithm If the learning rate value is large it may start diverging and if the value is too small converging takes more time	In the future, it is possible to work on different learning rates on the proposed system.
[12] Plant Disease Detection Techniques: A Review.2019	The major techniques employed are: BPNN, SVM,K-means clustering,Otsu's algorithm, CCM and SGDM.	acquisition of images either through digital camera and mobile phone or from web. For classification, a software routine is required to be written in MATLAB, also referred to as classifier.	Various challenges arise in this process including the automation of the detection system using complex images captured in outdoor lightning and intense environmental conditions.	In the future we can work on the training time of the SVM.
[13] Ramakrishnan, M., Groundnut leaf disease detection and classification by using back propagation algorithm,2015	Leaf image capturing RGB to HSV conversion Feature extraction BPN-FF training Image Classification Result Back Propagation Algorithm	The dataset of groundnut leaf was taken for testing	Authors classified only four types of diseases using this method	Need of classify the more types of diseases and also should focus more on accuracy
[14] P Mathai, Sasyasneha-An Approach for Plant	Image capturing Image Pre-processing Extract feature	Here the picture of plants directly taken	Here while taking the photo, It should be clear and focused with a white	

Leaf Disease Detection. 2019	<p>Classification diseases Result Solution for diseases</p> <p>Convolutional neural networks, SVM Classifier.</p>	from the camera ,Or imported by gallery	background. This is the main challenge.	Large training samples or dataset is needed for getting the maximum accuracy
[15] Plant diseases and pests detection based on deep learning: a review,2021	<p>The network structure of deep learning is done by three aspects Classification network uses CNN and DCNN</p> <p>Detection network uses two stage Faster R-CN one stage SSD and YOLO</p> <p>The Segmentation network uses Mask R-CNN and FCN</p>	<p>Data Sets are compared with the help of ImageNet, PASCAL-VOC2007/2012 and COCO in computer vision tasks.</p> <p>Datasets are typically taken from PlantVillage.</p>	<p>Evaluation indices depend on the focused studies which include Precision, Recall, mean, Average Precision and harmonic mean.</p> <p>Data amplification strategy is required for optimal results.</p>	Author believes that the joint efforts from relevant disciplines should be taken for effective integration of experienced knowledge of agriculture and plant protection
[16] SVM Classifier-Based Grape Leaf Disease Detection ,2016	<p>SVM classification technique is used for detecting the affected region of the leaf. The segmentation is done by K-mean clustering. PCA method is used to extract the shape features.</p>	two classes of grape leaves are considered namely, Downy Mildew and Powdery Mildew	<p>More optimization is needed.</p> <p>More dataset is required to detect the diseases accurately.</p>	To develop the combinations of more algorithms by using fusion classification techniques, as to improve the detection rate of the classification process. To design an automated system with the help of an embedded system so that this fungicide mixture will be automatically sprayed using a spraying mechanism.
[17] A Review on Leaf Disease Detection using Feature Extraction ,2019	<p>There are some steps taken during the disease detection of a diagnosed plant. The steps are image acquisition, image processing, Image Segmentation, Feature Extraction and Statistical Analysis For calculation of the texture features, statistics NN is used.</p>	Various crop and fruits diseases based images and the leaves of apple and vegetable.	<p>Here KNN is used ,It has the disadvantage of time complexity of making predictions</p> <p>Because of some noisy inputs it is difficult to understand the structureof the algorithm.</p>	In future trying to identify more diseases and classify and give the remedy for those diseases.
[18] Plant Disease Detection Using Deep Learning, 2021	<p>dataset description, image processing and augmentation</p> <p>Deep learning techniques:CNN Transfer Learning - INCEPTIONv3 Visual</p>	Plant-disease pairs of 38 classes were taken as a dataset and divided into 80 percent of training and 20 percent of validation.	<p>CNN gives highest training accuracy but gives the lowest validation accuracyof all.</p> <p>INCEPTIONv3. This model gave the lowest training accuracy but</p>	Even though in image processing CNN plays major role , In future visual transformer will be best suited in computer vision due to high accuracy achieved

	transformer - Small Transformer Network (STN) and Long Transformer Network(LTN)	For training its about 70295 images and for validation its about 17572 images out of 54k images. Each image is of resolution 256*256.	better validation accuracy compared to custom CNN. LTN achieved the highest validation accuracy. STN also achieves comparable accuracy as that of LTN.	
[19]Detection and Classification of Groundnut Leaf Diseases using KNN classifier,2019	Image acquisition, Pre-processing, Image Segmentation, Feature Extraction and Image Classification. Image classification is carried out using KNN K - nearest neighbors algorithm	Dataset contains 250 images where 45 images are trained with KNN classifier. And for pattern recognition their features are used. And the remaining 105 images used for test data.	The work is efficient, accurate for detecting only 4 diseases of groundnut so need to expand it.	With the help of extra classifier can decrease the false classification for feature extraction.
[20] Agricultural Plant Leaf Disease Detection Using Deep Learning Techniques,2021	Read the images from dataset preprocessing of image Data augmentation Getting bounding boxes Applying rotation to image predicting output getting output as disease name YOLOv3 algorithm built using CNN	Tomato leaf, Cucumber, green apple, green capsicum and citrus leaf images.	Wide range rotation of the image is required for more accurate results. The approach of pre-processing and data augmentation should use less time.	Here another method can be used to get more efficiency while detecting the diseases of leaves.

5. CONCLUSIONS

This model is designed to contribute towards determining plant diseases at the early phase in order to help the farmers to determine the plant diseases so that they can save their crops from diseases and give them the required treatment which helps in having a good crop yield. Machine learning, deep learning and image processing algorithms which are tested on various plant leaves to detect diseases which helps to increase the yield.

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