A Review on Machine Learning Classification Techniques for Plant Disease Detection

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Abstract— **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.**

Keywords— Plant disease detection; Classification; Machine Learning.

I. INTRODUCTION

In India, agriculture has become important source of the economic development. Farmer selects the suitable crop based on type of soil, weather condition of the location and economic value. The agriculture industries started searching new methods to increase production of food because of increasing population, changes in weather and instability in politics. This makes researchers to search new efficient and precise technologies for high productivity.

Farmers can collect the information and data by use of precision agriculture in in-formation technology to take best decision on high output from the farm. Precision agriculture is new technology, which provides advanced techniques to improve farm output. By utilizing these advanced technologies, it is possible to achieve economic growth in agriculture. Precision agriculture can be used for many applications like pest detection in plants, weed detection, yield production of crops and plant disease detection etc. A farmer uses pesticides to control pest, prevent diseases and to in-crease crop yield. The diseases in crop are creating problem of low production and economic losses to farmers and agricultural industries. Therefore identification of disease and its severity based as become necessary.

Disease identification in plant is most important in successful farming system. In general, a farmer recognizes the symptoms of disease in plants by using naked eye observations and this requires continuous monitoring. However, this process is more expensive in large plantations and sometimes this may be less accurate. In some countries like India, farmers may have to show the specimen to experts, this makes time consuming and more expensive. The following sections in this paper contains general steps of plant diseases detection system and survey on machine learning classification techniques used to recognize and classify plant diseases.

II. GENERAL PLANT DISEASE DETECTION SYSTEM

The plant diseases can be identified by observing leaf, stem and root part of the plant. The digital image processing can be used to detect diseased leaf, stem, fruit and flower, shape and colour of affected area. Image processing technique involves five basic steps and the data flow diagram is as shown below in Fig 1.

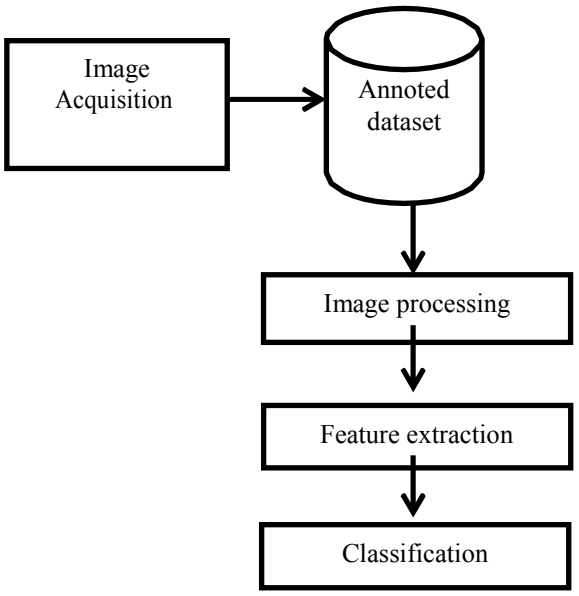

Fig. 1. Plant disease detection system.

- **Image Acquisition:** First stage of plant disease detection system is image acquisition. High quality plant images can be acquired using digital cameras, scanners or drones.
- **Annoted Dataset:** Knowledge based dataset to be created for captured images with different classes.
- **Image processing:** Acquired images to be involved in pre-processing stages to improve some image features important for further processing. Segmentation pro-cess is used to partition the plant image in various segments. This can be used for the extraction of diseased area in leaf, stem or root of plant from background.
- **Feature extraction:** Extraction of Colour, shape and texture feature of disease part of the plant can be done

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using grey level Co-occurrence Matrix(GLCM), Blend vision and machine intelligence etc.

- **Classification:** Finally, any of the machine learning techniques can be used to classify the various diseases in plants.

III. Related Work

Extensive survey has been conducted to compare disease detection and classification techniques in Machine learning. We studied Support Vector Machine (SVM) Classification Technique, Artificial Neural Network (ANN) Classification Technique, K- Nearest Neighbor Classification Technique, Fuzzy C-Means Classifier and Convolutional Neural Network Classification methods used in detection of plant diseases and its efficiency.

A. SVM Classifier

SVM Classifier is supervised learning method in Machine learning here analysed data is used for classification. The following authors used SVM Classifier in disease detection of different crops. [1] Detection of diseases on citrus trees which include grapefruit, lemons, lime and oranges leaf attack by canker and anthracnose diseases. The experimental result obtained 95% of genuine acceptance rate. [2] Grape plant diseases Downy Mildew and Powdery Mildew detected and give 88.89% average accuracy for both the diseases. [3] oil palm leaf diseases Chimaera and Anthracnose detection achieves accuracy of 97% and 95% respectively. [4] Potato plant diseases are Late blight and Early blight detection over 300 publically available images with accuracy 95%. [5] Grape leaf diseases Black Rot, Esca and Leaf Blight are classified with accuracy using features from both LAB and HSI colour model. [6] Developed a method to identify diseases in Tea plants. Three different types of diseases with less in features are detected using SVM classifiers. The developed method classified the diseases with accuracy of 90%. [7] Used for soybean culture to detect three different diseases Downy Mildew, Frog eye, and Septories leaf blgh. They reported with average classification accuracy approximately 90% using big dataset.

B. ANN Classifier

Artificial Neural Network is computational model in machine learning and pattern recognition. Related work on Plant disease detection using ANN classifier as follows. [8] Evaluated a proposed work for recognition of plant diseases using feed forward back propagation algorithm and it performed well with a precision of around 93%. They tested solution on early scorch, cottony mold, late scorch, and tiny whiteness diseases which effect on plants. [9] Developed a model to increase the accuracy in identification of two types of diseases caused by fungus are Downy Mildew and Powdery Mildew in cucumber plant. [10] Introduced a system to recognize and classify diseases like leaf spot, bacterial blight, fruit spot and fruit rot diseases of pomegranate plant using back-propagation algorithm and the experimental result shows around 90% accuracy. [11] Proposed a work on identification of groundnut plant disease is cercospora (leaf spot) using neural network Back propagation method. The experimental results and observation shows out of 100 sample diseased leaf images they classified four types of diseases and secured 97.41% of accuracy. [12] Proposed a method to detect pomegranate plant disease and observed using 40 images with accuracy of 90%.

C. KNN Classifier

K-Nearest Neighbors has been used for pattern recognition, statistical estimation and classification in Machine Learning. We made survey on plant disease detection using KNN classifier as follows. [13] Proposed an algorithm for identification of disease in sugarcane culture. Image processing algorithms are used for feature extraction. It secured an accuracy of 95% for Leaf scorch disease detection in sugarcane leaf. [14] Developed a method to estimate severity and detection of cotton plant disease Grey Mildew disease achieved with accuracy of 82.5% using 40 images. [15] Proposed an algorithm for plant disease detection using GLCM feature extraction method and KNN classifier. The KNN classifier is proposed rather than SVM classifier to classify data in multiple classes. The performance is tested in the terms of accuracy is in-creased compared with SVM classifier.

D. FUZZY Classifier

Related work on Fuzzy Classifier in plant disease detection is an author [16] presented a method to identify the presence of infection in wheat crop images using Fuzzy Classifier. This algorithm is tested with the dataset of healthy and unhelthy leaves. The classification of healthy and unhelthy leaves found with accuracy of 88% and recognition of disease accuracy is 56%.

E. Deep Learning

Deep learning is a defferent learning method in ANN and also a part of machine learning methods. [17] Proposed a model to detect healthy leaves and 13 different diseased leaves of peach, cherry, pear, Apple and Grapevine using CNN classification technique. More than 30000 images used in dataset, achieved accuracy between 91% and 98% for separate class test and average accuracy 96.3%. [18] Developed a method for plant disease detection using public dataset 54306 images of 14 crops and 26 diseases and performed with accuracy 99.35% using 20% of testing data and 98.2% using 80% of testing data. [19] Designed a model to identify Soybean plant diseases Septoria, Frogeye and Downy Mildew using CNN classifier. A dataset contains 12673 leaf images with four classes and achieved 99.32% accuracy. [20] Developed CNN classification technique for recognition of diseases in crops. The dataset containers 87848 images of 25 different plants in set of 58 disease and achieved with accuracy 99.53%.

The comparison of different type of Machine Learning classifiers used in plant disease detection is summarized and is given in Table 1.

Table 1. Comparison of classification techniques.

Classification Technique	Culture	No. of Diseases	Result
SVM Classifier	Citrus [1]	2 diseases	95% of genuine acceptance rate.
	Grape [2]	2 diseases	Average accuracy 88.89%.

	Oil palm [3]	2 diseases	97% accuracy for Chimaera and 95% accuracy for Anthracnose disease.
	Potato [4]	2 diseases	Accuracy 90%.
	Tea [5]	3 diseases	Accuracy 93%.
	Soybean [6]	3 diseases	Accuracy is approximately 90%
ANN Classifier	Not Mentioned [8]	5 diseases	Accuracy around 93%.
	Cucumber [9]	2 diseases	Increased accuracy
	Pomegranate[10]	4 diseases	Accuracy around 90%
	Groundnut [11]	4 diseases	Accuracy 97.41%.
KNN Classifier	Sugarcane [13]	1 disease	Accuracy 95%[13]
	Cotton [14]	1 disease	Accuracy 82.5%[14]
Fuzzy Classifier	Wheat [16]	1 disease	Disease detection accuracy 88% and recognition of disease type accuracy56%.
CNN Classifier	Peach, Cherry, Pear, Apple and Grapevine [17]	13 diseases	Average accuracy 96.3%.
	14 crops [18]	26 diseases	Accuracy 99.35%.
	Soybean [19]	3 diseases	Accuracy 99.32%.
	25 plants [20]	58 diseases	Accuracy 99.53%[20]

IV. CONCLUSION

A comparative study is carried out on five types of machine learning classification techniques for recognition of plant disease is done in this review. SVM classifier is used by many authors for classification of diseases when compared with other classifiers. The result shows that CNN classifier detects more number of diseases with high accuracy. In future, other classification techniques in machine learning like decision trees, Naïve Bayes classifier may be used for disease detection in plants and in the sense of helping farmer an automatic detection of all types of diseases in crop to be detected.

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