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# DETECTION OF PLANT LEAF DISEASES IN AGRICULTURE USING RECENT IMAGE PROCESSING TECHNIQUES – A REVIEW

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***Abstract***

**Purpose:** Agricultural productivity is something on which the economy highly depends in India as well in all over the world. India is an agriculture-dependent country; wherein about 70% of the population depends on agriculture.

**Methodology:** This is one of the main reasons that disease detection in agriculture plays an important role, as having the disease in plant leaf is quite natural. If proper observations are not taken in the agriculture field then it causes serious effects on plants due to which respective product quality and productivity are affected. Detection of plant leaf disease through effective and accurate automatic technique is beneficial at the starting stage as it reduces a large work of monitoring in big farms of crops.

**Result:** This paper presents the review on the state of the art disease classification techniques presently used using image processing that can be used for plant leaf disease detection in agriculture.

***Keywords:*** *Plant Leaf Disease, Classification Techniques, Image Processing.*

## INTRODUCTION

India is an agricultural country; agriculture has a very large contribution to the economy of this country. The disease in the leaves of the plants is a matter of great concern for any farmer as well as for the higher scale farming. Knowing disease at the beginning stage is a very difficult task with naked eyes, it is very important for someone to know this work very well to identify which type of disease started, because of which the crops sometimes get infected because they are not treated at the right time. This research paper shows the research work done to solve this problem in the past years and tried to understand how the methodology of image processing detects the disease at an early stage.

## LITERATURE REVIEW

The analysis of the research works done for the consolidation of this problem is summarized as follows in table 1.

**Table 1:** Summary of Literature Survey

| S No. | Researchers | Detection Algorithms | Evaluating Parameters |
|---|---|---|---|
| **1.** | Li et al. (2013) | Statistical Pixel Method | Plant disease severity 11.0337% |
| **2.** | Shrivastava et al. (2015) | SVM | Accuracy 89% |
| **3.** | Mohanty et al.(2016) | Deep learning | Accuracy 99.35% |
| **4.** | Küçük et al. (2016) | SVM with the linear and nonlinear kernel, kNN, and DT | Accuracy 80% |
| **5.** | Sabu et.al (2017) | ANN, PNN, SVM and kNN | kNN is the best method as compare to ANN PNN and SVM |
| **6.** | Truong et.al (2017) | System of IoT and SVM | Real-Time Analysis |
| **7.** | Islam et.al (2017) | support vector machine | Accuracy 90% |
| **8.** | Singh et.al (2017) | Image segmentation using genetic algorithm | Accuracy 97.6% |
| **9.** | Kaur et al. (2018) | The semi-automatic system using concepts of k-means | Accuracy 90% |

Li et al. (2013) proposed an automatic grading method determines the disease severity for a single grape leaf only. This work explains the accurate determination of disease severity and the grading level of the disease using the k-means clustering algorithm for segmentation. For the classification of disease detection, the statistical pixel method is used resulting in plant disease severity by 11.0337%.

Shrivastava et al. (2015) detected five different severity levels of soybean plant foliar diseases. The authors explained that the severity level estimation method can be combined with disease detection and plant identification to develop a complete automatic plant monitoring system with disease warnings and administration. This research uses the support vector machine models for classification and achieves the classification accuracy of 89%.

Mohanty et al. (2016) highlighted the combination of increasing global Smartphone penetration and recent advances in computer vision made possible by deep learning. This proved the way for a Smartphone-assisted disease diagnosis system. This research uses a public dataset of 54,306 images of disease and healthy plant leaves collected under controlled conditions. This paper trains a deep learning convolution neural network to identify crop species and 26 diseases. The trained model achieves an accuracy of 93.35%.

Küçük et al. (2016) proposed a feasible phenology classification scheme for paddy-rice using multi-temporal co-polar Terra SAR-X images for detection. Here phenology classification was introduced with support vector machines (SVM) with the linear and nonlinear kernel, k-nearest neighbors (kNN), and decision trees (DT). The results of these experiments enable one way to draw a conclusion about the feasibility of machine learning (ML) algorithms in operational technology monitoring.

Sabu et.al (2017) proposed that plants have essential medicinal properties Automatic recognition of plant leaf is a challenging problem and difficult to search out in the area of computer perception. So basically survey on the ayurvedic plant leaf recognition, with the help of image processing and pattern recognition is done. An artificial neural network (NN), probabilistic neural network (PNN), nearest neighbor method (KNN) and support vector machine (SVM) techniques are very helpful to detect the ayurvedic plant leaf diseases based on its different features and appearance. A leaf is studied and observed. After study and comparison of ANN, PNN, KNN and SVM, the nearest neighbor method is the best classifier for the prediction and classification.

Truong et.al (2017) exhibited the plan about analyzing the fungal disease on crops due to environmental effect by using real-time approach, internet of things and prevent it by using machine learning in which SVM (support vector machine regression) algorithm is used to process the data and predict day by day according to the environmental parameter. This paper shows the design of an Internet of Things (IoT) system consisting of equipment that is capable of sending real-time environmental data to cloud storage and a machine-learning algorithm to predict environmental conditions for fungal detection and prevention.

Islam et.al (2017) highlighted in the current scenario, to cure the plant leaf disease by image processing and machine learning to achieve the optimum results with the help of a plant leaf database called plant village. The approach named image segmentation with support vector machine manifests the classification of disease of 300 images with more than 90% accuracy by automatic disease detection and implementation on a vast scale.

Singh et.al (2017) explored that if desirable measures are not taken diseases may adversely affect the plants which in turn reduces the productivity and quality of the plant. A typical example of disease name little leaf disease mainly found in pine trees in the United States of America. An automatic technique, in the very first stage itself, detects the symptoms of disease when they come in the leaf of plants. The automatic technique is used to detect and classify using an image segmentation algorithm, which is a profound for genetic algorithm and the classification of plant leaf diseases later. However, the efficiency of the algorithm for classification and reorganization of the plant leaf disease was found good.

Kaur et al. (2018) focused on the development of automatic disease detection and classification system. Here a rule-based semi-automatic system using concepts of k-means is designed and implemented to distinguish healthy leaves from diseased leaves. A diseased leaf is classified into one of the three categories (downy mildew, frog eye, and Septoria leaf blight). Testing operations are performed by separately utilizing color features, texture features, and their combinations to train three models based on the support vector machine classifier. Results are generated using thousands of images collected from the Plant Village dataset. This study also trying to discover the best performing feature set for leaf disease detection in Soybean.

Singh, G., Kumar, G., Bhatnagar, V., Srivastava, A., & Jyoti, K. (2019) developed an environment to control and detect the environmental pollution using IoT. It includes different sensors that work and sense data and submit the data to the main server.

## DETECTION METHODOLOGIES

Various leaf diseases cause severe losses to farmers resulting in a major threat to the growers. To minimize losses, a support system is required to detect plant leaf diseases. The image processing approach is a non-invasive technique that provides a reliable, cost-effective, and accurate solution to the farmers in minimal time to optimize the yield losses. Basic steps for the identification and classification of plant disease detection and classification are shown in the following figure 1.

- Input Image set: Plant leaf images will be imported from the field directly or from the different database like plant leaf village (Sharda P. Mohanty, David P. Huges and Marcel Salathe (2016)) and (Konstantios P Ferentinos (2018)) available from the research center and institution of the government firms.

- Image pre-processing: This step is used to specify a suitable color transformation that best highlighted the diseased regions shown in the picture using different tools available in the MATLAB.
- Image Enhancement: This step is used to develop the filter that could highlight those regions considered target (target diseased area).
- Image Segmentation: This step is to recognize the region that was likely to qualify as the diseased region in the image. For the segmentation of the target part, so many classifier algorithms are present in which k- means clustering (G Li, Z Ma H Wang, (2016)), (Çaglar Küçük, Gül¸ sen Ta¸ skın, and Esra Erten (2016)), (A Sabu, K Sreekumar (2017)), (Sukhvir Kaur, Shreelekha Pandey, and Shivani Goel (2018)) is widely used algorithms.
- k- Means Clustering Algorithm

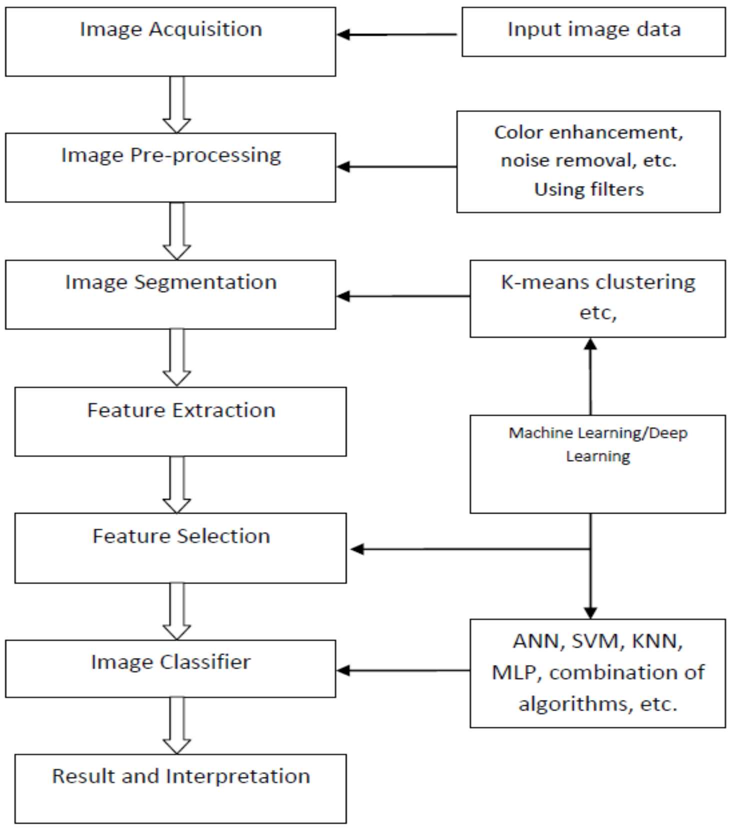


**Figure 1:** Block Diagram of Detection Algorithm

A non - hierarchical way of clustering is the k-means (Çaglar Küçük, Gül¸ sen Ta¸ skın, and Esra Erten (2016)), (A Sabu, K Sreekumar (2017)) and (Sukhvir Kaur, Shreelekha Pandey, and Shivani Goel (2018)) procedure, which is as follows:

1. Consider k of the r given patterns to each form of clusters. We thus have k clusters, each with one pattern. The remaining patterns remain as such.
2. The k patterns to form clusters may be chosen arbitrarily: they are usually the first k patterns. In this step, the centroid of a given cluster is the coordinates of the pattern in the cluster in the A1- A2-…….-AM coordinate space.
3. For i = k+1, k+2 ,……, r do. Put the pattern in the cluster whose centroid is the nearest to the pattern. Compute the cluster's new centroid.
4. For i = 1,2,……. , r do steps 4.1, 4.2, 4.3.

**Step 1:** Let C' be the cluster that has the $i^{th}$ pattern. Calculate the distance between the $i^{th+1}$ and the centroids of each of the k Clusters. If the pattern is closet to the centroid of C', then pattern need not changed its cluster, hence go to step 3.

**Step 2:** Let **C"** be the cluster whose centroid is closest to the $i^{th}$ pattern. Move the pattern from cluster C' to **C"**. Compute the new centroids of clusters **C'** and **C" .** Go to Step **4.**

**Step 3:** Continue.

 

**Step 4:** No patterns changed clusters in the last iteration; hence return from the procedure with the **k** clusters.

- As should be clear from the above steps, the **k-**means procedure begins by putting each pattern in one of the k clusters (steps 1 and 3). Then, in step 4, it ensures that every pattern is in a cluster is closest to it.
- The procedure is said to be the **partitional** because it partitions the set of clusters into clusters.
- Feature Extraction: After Segmentation of the region of interest selected which is having better image data using various features extracted from different feature extraction techniques. Reducing the amount of resources required to describe a large dataset. Here we extract color features and shape features.
- Classification: This is the final stage of the proposed work where we used machine learning techniques (S Shrivastava, S K Singh, D S Hooda (2015)), Çaglar Küçük, Gül¸ sen Ta¸ skın, and Esra Erten (2016), (A Sabu, K Sreekumar (2017)), (T Truong, A Dinh , and K Wahid (2017)), (M Islam, A Dinh , K Wahid ,and P Bhowmik (2017)) and deep learning (Sharda P. Mohanty, David P. Huges and Marcel Salathe (2016)) and (Konstantios P Ferentinos (2018)) for classification. This gives better and more accurate results. The classifier is tested using a different combination of various features.
- Support Vector Machine (SVM)

An SVM provides a leading method for a supervised learning classification algorithm, as discussed by Vapnik (Vapnik V N, Vapnik V (1998)). Datasets with feature vectors and class labels use a supervised learning SVM, while datasets without feature vectors or class labels use unsupervised learning clusters. If the leaf input image has only two classes—healthy and unhealthy regions—then an SVM binary classifier can be applied. There are two types of SVM: linear and non-linear. The SVMs allow the drawing of a hyperplane that determines the maximum distance (margin) between the data samples of either class. If the data are distributed uniformly, then a linear SVM (Çaglar Küçük, Gül¸ sen Ta¸ skın, and Esra Erten (2016)) classifier allows a straight hyperplane to be drawn between classes. A non-linear SVM (Çaglar Küçük, Gül¸ sen Ta¸ skın, and Esra Erten (2016)) classifier is used in real-world applications where the data are scattered in various directions and have high dimensions. The hyperplane shown in Figure 2 is constructed by considering various non-linear kernel functions, such as the homogeneous polynomial, non-homogenous function and radial bias function (RBF).

Implementation of an SVM for the classification of images is obtained by considering the "p" number of a training feature vector in an "n-dimensional space Figure 2 Hyperplane separating two different types of classes having b, the class label of 1 and −1 is compared with each test feature vector ai to determine the target class, as shown in Eq. (1):

P= {(a,b)|ai ϵ $R^n$ , bi ϵ {1, -1}}t1=1 .................................(1)

For example, the target class may be a variety of diseases, such as mildew, late blight and early blight, which are classified based on their texture or color features.

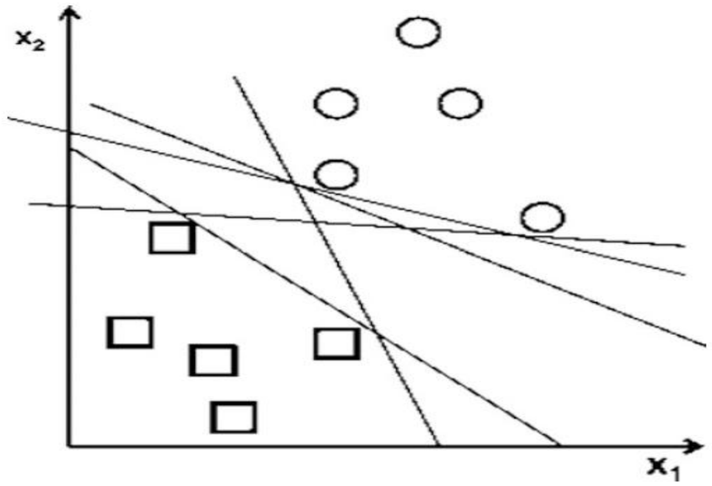


**Figure 2:** Hyperplane separating of two different types of classes

**CONCLUSION**

This paper focused on plant leaf disease detection and classification methods using image processing, machine learning, and deep learning. Through this review, concluded that the plant disease detection techniques consist of common three steps which are pre-processing, segmentation and feature extraction, and classification. Image segmentation is performed by the K-means clustering algorithm. Deep learning models are also introduced in recent times for the detection of the plant leaf disease and found that convolutional neural network through deep learning classifier gives the 99.53%

 

accuracy as compared to previously used SVM models. In the future, the technique will be designed with 100% accuracy for the detection and classification of plant leaf disease.

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