An Analytical Survey on the Plant Leaf Disease Detection Techniques

Dr. Amit Verma[1*], Gifty Aggarwal[1], Bharti Chabbra [2]

[1*]*Professor and Head of Department, Computer Science& Engineering, Chandigarh Engineering College, Landran, Punjab, India*

[1] *M. Tech. Research Scholar, Computer Science & Engineering, Chandigarh Engineering College, Landran, Punjab, India*

[2]*Assistant Professor, Computer Science& Engineering, Chandigarh Engineering College, Landran, Punjab, India*

Abstract— Plants provide a way of living to humans in the form of breathing oxygen to other essential resources. A plenty of medicines and food bases are the gift of plants to humans. So, plants are essential components of human life and needed to be protected at each stage. In Plants, major useful species is known in the form of agriculture crops. These crops are the feed for more than 70% of our country population. But the production of crops can be affected by diseases and these diseases are not visible with naked eyes. Plant diseases are analyzed from the affected leaf portion. One method to detect these diseases is manually detection with the help of some botanic expert but manually detection of leaf diseases is much laborious and time consuming task. So, there is the need of some autonomous method to detect the plant diseases with more efficiency as compare to manual detection. It is very essential task to identify the correct disease of the plant to reduce the further crop loss. In this paper, we are presenting a review on the existing work of plant leaf disease detection. The considered work discusses about the various types of disease symptoms like fungal, bacterial and viral diseases. Also a disease detection timeline for the traditional & advanced approaches is presented.

Keywords— Plant Leaf Diseases, Pattern Recognition, Texture, Agriculture, Image Processing.

I. INTRODUCTION

Natural Plants provide ways to life from animal species to human, entire species are directly or indirectly dependent upon plants. So, there is the need to proper take care of plants. Plant diseases are one of the common factors responsible for the decrease in plant growth [1]. Fortunately, people are aware about the importance of plants and they want to save plants and earth but they are not aware about the different categories of plants their different diseases. Different plants suffer with different diseases. The main part of plant to examine the plant diseases is leaf [2]. The Diseases on leaf can reduce both the quality and quantity of crops and their further growth. The easy method to detect the plant diseases is with the help of expert having knowledge of plant diseases. But this manual detection of plant disease takes so much time and is much laborious work. So, there is the need of some automatic method to detect the leaf diseases. Computer can play a major role to develop the automatic methods for the detection of leaf diseases. The major categories of plant leaf diseases are based on viral, fungal and bacteria [3].

A. Fungal disease symptoms

Plant leaf diseases, those caused by fungus and can be seen its affects with spots. Late blight caused by the fungus. Initially the effect of fungal diseases can be seen on older leaves like gray-green spots and water-soaked. But after sometime the size of these spots increases and becomes blacker.

B. Bacterial disease symptoms

The disease is characterized by tiny pale green spots which soon come into view as water- soaked. The lesions enlarge and then appear as dry dead spots.

C. Viral disease symptoms

Among all plant leaf diseases, those caused by viruses are the most difficult to diagnose. Viruses produce no telltale signs that can be readily observed and often easily confused with nutrient deficiencies and herbicide injury. Aphids, leafhoppers, whiteflies and cucumber beetles insects are common carriers of this disease, e.g. Mosaic Virus, Look for yellow or green stripes or spots on foliage. Leaves might be wrinkled, curled and growth may be stunted [4].

To sense the availability of disease symptoms there are the disease sensing methods like remote sensing, Thermograph Techniques, Laser Sensing, Visible Spectroscopy, Light Reflectance.

Remote sensing technology is used in agriculture for yield crop estimation. It depends on the spatial resolution of the digital image and it is affected in growing crops estimation. This method is more robust because it's established the relation between yield monitor data and remotely sensed images. Thermograph techniques are depending upon the biomass of the fruit or disease. This technique refers to identifying and classifying between fruit and shrubs and trees. Laser sensors are used for fruit recognitions technique. Image processing and laser based application systems are used for navigating a tractor through the alleyway of a citrus grove. Visible spectroscopy techniques applied in soil testing and characterization. There are various methods like NIR reflectance spectroscopy, Raman spectroscopy, VIS, VV, etc. which are applied in agriculture sector. Light reflect work on law of reflection, and the result shows the reflection occurs off a curved surface or off a flat surface. Light reflectance is used for disease classification. Each disease has own fundamental color properties and light reflectance works on the bases of wave length and spectrum.

In this research work, we are showing the existing work of plant leaf disease detection. There are mainly two kinds of methods traditional and advanced approaches. The timeline for the traditional and advanced approaches is shown in figure 1.

Traditional Approach	Advanced Approach
•Presence of Infected Vectors •Early Stage I (Isolated Plants Infected) •Early Stage II (Pathogen Established Many Plants Infected) •Late Stage (Symptomatic Phase Disease Spread) •Detection of Visual Symptoms by Scout Team	•Volatile Organic Compounds •Gene Expressions Changes based on Colorimetric signals •Biosensors based on phase display and biophotonics •Spectroscopy based methodologies •Remote Sensing technologies

Figure 1: Traditional Approach and Advanced Approach

The discussion for the rest sections is structured as below: Section II describe the basic concept for the identification & classification of plant leaf disease identification. Section III explains the literature review and Section IV concludes the paper.

II. BASIC CONCEPT OF LEAF DISEASE IDENTIFICATION

This section describes the basic process of image processing to detect & classify the plant disease. The basic concept involves five steps image acquisition, image pre-processing, image segmentation, feature extraction, identification & classification of plant diseases and final optimization. These are explained as below:

A. Image Acquisition

Image acquisition involves the steps to obtain the plant leaf and capture the high quality images to create the required database. The efficiency of the concept depends upon the quality of database image. So, images should be considered of high quality with RGB color [5].

B. Image Pre-processing

Image preprocessing involves the steps of image contrast enhancement. Here, the captured image is enhanced to remove the noise from image, and then RGB color image is converted into HSV plane image.

C. Image Segmentation

Image segmentation is applied to simplify the illustration of image with segments so that it can be easily analysed. Image segmentation is performed to segment the disease affected and unaffected portions of the leaf [6].

D. Feature Extraction

After the segmentation, disease portion from the image is extracted. This leaf diseases area is treated as region of interest for the image processing. Then, further features are extracted based on the disease symptoms that are used to detect the disease types.

E. Identification & Classification

Then, classifiers are used for the training and testing of the dataset. These classifiers may be fuzzy logic based, neural network, support vector machine, k-nearest neighbour etc. These methods are used to classify and detect the diseased and healthy leaves [7].

F. Optimization

Finally, optimization step is performed to optimize the obtained solution in the form of accuracy of the concept used for the disease detection and classification.

III. LITERATURE REVIEW

In this section, the existing work of plant leaf disease detection is presented. Various authors have used the different approaches to detect the leaf diseases for different types of plants and crops etc. The review of these considered approaches is summarised in table 1 with their key features.

Khirade et al. [8] has discussed some segmentation and feature extraction algorithm that can be used for the detection of plant diseases by using the images of their leaves. It is very difficult to detect the plant diseases manually due to requirement of excessive time, knowledge of plant diseases and much amount of work. The author has divided the entire process of plant leaf disease detection into five steps: Image Acquisition, Pre-processing, Segmentation, Feature Extraction and Final Classification of diseases. Image acquisition used the transformation structure for RGB leaf image. Then image is pre-processed to remove the noise and enhance the image contrast. Segmentation is done for the partitioning of image into various feature parts using k-means clustering, ostu filters etc. This segmented image is further used for feature extraction and then final classification is performed using various classifications. In this way, plant diseases can be efficiently identified . Ramakrishnan et al. [9] has used back propagation algorithm for the identification of groundnut leaf diseases. Cercospora is the common groundnut disease. Its further stage is cercosposium personatum, then phaeoisariopsis and final stage is alternaris. This classification with the proposed concept shows efficient results.

Singh et al. [10] has presented the existing work for the detection of unhealthy region of plant leaves. Authors have described the framework for the detection and classification of plat leaf diseases. Authors have also performed an important step of image segmentation for leaf disease detection. For segmentation, genetic algorithm is used by the authors and segmented the healthy and unhealthy region of the plants. The overall results are efficient for plant leaf diseases but authors have also suggested to use Bayes classifier, ANN, Fuzzy Logic etc. for the further improvement of concepts. Dandawate and Kokare [11] have used support vector machine concept for the detection and classification of soybean plants as diseased or healthy species. Authors have used the SIFT approach that automatically recognizes plant species by their leaf shape. The proposed concept for soybean plant diseases shows an average accuracy of 93.79%. For experimentation, authors have prepared the data manually and launch a mobile application for the farmers. The main objective of the research is to build an autonomous decision support system that can help for the plant leaf diseases information over the mobile internet .

Sannakki et al. [12] has used feed forward back propagation Neural Network based technique for the diagnosis and classification of diseases in grape leaf. Author has used the images of grape leaf with complex background for the diagnosis as input. Further anisotropic diffusion is used to remove the noise of the image which is further segmented using k-means clustering. Finally results are observed using neural network. Results are experimented on downy mildew and powdery mildew images with simulation in MATLAB. Confusion matrix is considered with the true positive and false positive parameters for the validation of results. The author claimed to have the training accuracy of 100% if used hue feature alone. Akhtar et al. [13] have used the support vector machine approach for the classification and detection of rose leaf diseases as black spot and anthracnose. Authors have used the threshold method for segmentation and Ostu's algorithm was used to define the threshold values. In this approach, features of DWT, DCT and texture based eleven haralick features are extracted which are further used with SVM approach and shows efficient accuracy value.

Al Bashish et al. [14] have used the neural network for the classification of five diseases as tiny whiteness, late scorch, ashen mold, cottony mold and early scorch. For this experimentation, leaf image dataset is taken from Al-Ghor region situate in Jordan. Authors have identified both the leaf as well as stem diseases in plants. The experimentation was based on the process of image processing where segmentation is done with k-means clustering approach whose results are further used for the neural network. Kim et al. [15] have used the texture features based discriminant function model with squared distance approach for the classification of citrus peel leaf. The considered peel diseases that were classified are wind scar, melanose, greasy spot, copper burn, canker etc. Classification was performed based on the texture features based on intensity, saturation, hue etc. and shows efficient results for the detection of these considered disease types.

TABLE I
SUMMARIZATION OF PLANT LEAF DISEASE DETECTION APPROACHES

Reference Number	Type of Plants and Diseases	Classification Technique	Key Features
[8]	Review with exp[e] on different plants and crops	SVM[a]	• Plant leaf disease detection & classification methods • Image Processing technique work well for the identification of leaf diseases
[9]	Groundnut leaf diseases	BPNN[b]	• Cercospora and its various stages in groundnut leaf
[10]	Different plant leafs	GA[c]	• efficient results of genetic algorithm
[11]	Soybean plants	SVM[a]	• Soybean plant diseases show an average accuracy of 93.79%. • Mobile based application launched for soybean disease detection
[12]	Grape diseases	BPNN[b]	• Grape diseases viz. Powdery Mildew and Downy Mildew are identified.
[13]	Rose leaf diseases	SVM[a]	• Eleven features are extracted, further used with SVM approach and shows efficient accuracy value.
[14]	Different leaf diseases	NN[d]	• Classified five disease types as tiny whiteness, late scorch, ashen mold, cottony mold and early scorch.
[15]	Citrus Peel Diseases	Discriminant function & Squared distance approach	• Citrus peel diseases that were classified as wind scar, melanose, greasy spot, copper burn, canker etc.

a- Support vector machine, b- back propagation neural network, c- genetic algorithm, d- neural network, e- experiment

IV. CONCLUSIONS

Plants are precious for life. From animal species to human, entire species are directly or indirectly dependent upon plants. So, there is the need to proper take care of plants. The decrease in crop production also affects the economy of the country. There is the need of appropriate research method that can automatically detect the plant leaf disease. In this research paper, we have determined the different approaches used by different authors for different kind of plant diseases. The considered concept used for classification are SVM, neural network, genetic algorithm, discriminant function approach, back propagation neural network etc. The detected diseases plant are grape, soybean, citrus, grape, groundnut and some other available disease types. From these classification and detection method, there is need to develop some optimized method as existing approaches are not fit for multiple leaf disease types and efficiency of results is also not much higher.

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