International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 05 | May 2021 www.irjet.net p-ISSN: 2395-0072

Plant Disease Identification System – A Review

Vidhula Thomas[1], Sruthy K B[2]

[1,2]Assistant Professor, Department of Computer Science, College of Applied Science, Managed by IHRD, Puthenvelikkara, Kerala, India

---

Abstract - *Agriculture production plays a vital role in the economic development of the country. Farmers have a variety of choices for the cultivation of different crops. But plant disease can harm any agricultural crops. Advancement in information technology can be used as a solution for real time crop disease detection and recognition. Thus yield and quality can be improved. Classification of plant disease is necessary for evaluating agricultural production, increasing market value, and meeting quality standards. Many eminent researchers have put forward their ideas for developing such systems but there are a few limitations in the proposed and developed systems*

The review provides detailed discussions on plant diseases, disease detection systems, and classification using image acquisition, image pre-processing, image segmentation, feature extraction, and classification.

Key Words: Plant Diseases, Image Processing, Classification, Feature Extraction.

1. INTRODUCTION

Agriculture sector contributes 6.1% in India GDP. Plants are threatened by a variety of diseases. This will affect the quality of agriculture crops. In early days detection of these diseases was done manually i.e., visual inspection by human experts with their experience but this detection was inefficient as it lacked accuracy and a time consuming one. Many farmers want to adopt modern agriculture methods but they can't because of several reasons like lack of awareness about latest technology, high cost of the technology etc. However, if plant diseases are properly identified early, the loss of crops can be reduced and specific treatments can be designed to combat certain diseases. In the new era a large number of plant disease identification systems are developed and through the proper usage of these systems, we can easily identify diseases at the early stage of plant growth. So we can take necessary actions to prevent those diseases. Research on automatic plant disease identification system plays a vital role for monitoring large number of crops and identifying the symptoms of diseases whenever they appear on plants.

In this paper, different disease identification techniques are surveyed. This paper includes 4 sections. Section 1 explains the literature reviews of researchers from all around the world. Section 2 defines different plant diseases. Section 3 describes the plant disease identification system and section 4 defines the conclusion.

2. LITERATURE REVIEW

Kishori Patil et al. [1] proposed Leaf Disease Detection using Deep Learning Algorithm. CNN algorithm comprises of two layers .First is the extraction layer of the feature and other is feature extraction layer. CNN method gives the accuracy up to 86.26% for recognition of plant leaf disease.

Dey et.al [2] proposed Otsu method for segmenting rot disease in betel vine plant leaf. Twelve diseased images were captured using an image scanner. In pre-processing step images were cropped then color conversion were applied for accurate detection of diseases. Finally diseased area of the leaf was detected and severity scale prepared. Author concluded that the pesticide usage can be reduced based on severity which will be helpful in reducing environment pollution.

Simranjeet kaur et al. [3] proposed Image Processing and Classification technique for Plant Disease Detection. Author used GLCM method for feature analysis and KNN classifier for detection. Accuracy of proposed system was 95% for recognition.

Joshi and Jadhav [4] put forward an Image processing system for detection and classification of four rice diseases ie, bacterial blight, blast brown spot and sheath rot. Image samples of affected rice plant were collected and stored in jpeg format. Then color space conversions were done. RGB images were converted to YCbCr during which color and shape features were extracted. Finally Minimum Distance Classifier and K-nearest neighbour were used for classification of diseases. Authors concluded that different texture features can even be extracted from the samples and other rice diseases can also be identified using the identical algorithm.

Khaing War Htun et al. [5] proposed a paddy diseased leaf classification system using modified color conversion method. 143 data samples were used for classification and identification of diseased paddy leaf. This model is applicable only for four diseases namely leaf blight, brown spot, leaf blast and leaf streak. The paddy diseases can be recognized and categorized efficiently using statistical, color and texture features based on SVM.

G. Saradhambal, et.al [6] proposed a system for automatic plant disease detection. It predicts the infected area of the leaves by applying k-means clustering algorithm and Otsu method. Shape and texture features were extracted. Shape oriented features like area, color axis length, eccentricity, solidity and perimeter, whereas the texture oriented features were contrast, correlation, energy, homogeneity and mean. Finally classification in this research was done using a neural network based classifier.

Ratnasari et.al [7] proposed a model for determining severity of leaf spot in sugarcane plant. On the idea a* component of L*a*b color space segmented spot was obtained. SVM based classifier was used. It uses color features (L*a*b color space) as well as texture features (GLCM) for classifying type of spot disease. Accuracy of this model was 80% with 5.73 error severity calculation average. Authors concluded that the proposed model has high accuracy rate with low error and in future pre-processing can be performed for reducing this error.

Hiteshwari Sabrol,satish kumar[8] proposed a digital image acquisition method for infected and non-infected plants. Performed image pre-processing, differentiate disease infected region from a non-infected region using colour space conversion, segmentation, extract features from segmented images for recognition and classification based on Feature Analysis, Neural Network, Support Vector Machine and Fuzzy and Rule-Based Classification. This model expected to be useful for researchers from plant pathology and pattern recognition field.

A model based on Digital image analysis was proposed by Majumdar et.al [9] to recognize wheat leaves diseases. Fuzzy c means clustering algorithm was used for extracting features. ANN was used for recognition of diseases. Author concluded that this model can identify rust diseases of wheat. In future a web based interface can be developed for efficient detection.

K. R. Aravind, et.al [10] surveyed maize crop diseases for automatizing the disease detection system. From each image Speeded Up Robust Features (SURF) were extracted. These features were clustered using k-means algorithm. For feature extraction two methods were used namely, histogram and GLCM method. These methods were used for studying various textural features. Multi-class SVM was used based on various kernel functions like linear, polynomial and Radial Basis Function, etc for classification. A median accuracy of 83.7% was achieved.

A system proposed by Sannakki et.al [11] was based on image processing and AI techniques for diagnosing grape plant diseases. Background of input grape leaf image was removed using thresholding and masking techniques. Pre-processing was used for segmentation, later GLCM method was used to extract texture features which served as input to BPNN classifier. Authors concluded that it can be applied for detection of other grape diseases and other segmentation techniques can also be used in this system.

Mokhtar et.al [12] introduced image processing technique to detect diseased tomato leaves. This approach was divided into three phases i.e. pre-processing phase, feature extraction phase and classification phase. Texture features were extracted using GLCM method for determining state of tomato leaves. Later these features acted as an input to SVM based classifier for identifying whether a leaf is healthy or not. Author claimed that by using this approach 99.83% accuracy was achieved.

A survey made by Barbedo [13] was based on methods of image processing techniques for detecting and classifying crop diseases. Author collected the images of leaves and stems for disease detection because techniques handling with other parts of plants i.e., fruit, root, seeds etc. have some abnormal characteristics. This survey was divided into three sections namely detection, quantification of severity and classification. Based on these sections several methods were presented.

Suresha et.al [14] surveyed on two major fungal diseases of rice crops namely Rice blast and Rice brown spot using KNN classifier. RGB color images were converted into HSV images in segmentation step. Features like perimeter, area, major and axis were extracted and were provided to KNN classifier for recognition. Authors concluded that accuracy was 79.59% which was much better than SVM classifier.

Xiao et.al [15] used PCA and BPNN techniques for classifying and detecting Rice blast disease. The proposed system eradicates existing problems like inaccuracy and inefficiency. F Color, shape and texture features were extracted from the lesion of each image then step wise regression analysis was performed. PCA method was applied to map 21 features to 6 features as an input parameter to BPNN. Accuracy of proposed model was 95.83%.Author recommended that this survey can be used for rapid detection of Rice Blast disease in real time environment.

Table -1: Plant Disease Identification and Recognition Techniques

Author	Plant	Disorder	Major Tools Used	Accuracy
Kishori Patil et al.	Cotton	Fungus, foliar leaf, and Alternaria leaf spot.	Convolution Neural network (CNN)	86.26%
Dey et.al	Betel vine	Rot disease	Otsu thresholding method	-
Simranjeet kaur et al.	N/A	N/A	GLCM, feature extraction and KNN classifier	95%.
Joshi and Jadhav	Rice	Bacterial blight, blast brown spot	MDC and KNN	87.02% and 89.23%
Khaing War Htun et al.	paddy	Leaf blight, brown spot, leaf blast and leaf streak	SVM, GLCM	90%
G. Saradhambal, et.al	Rice	Leaf blight, brown spot and leaf streak	KNN and Otsu thresholding method	-
Ratnasari et.al	sugarcane	Spot disease	SVM and GLCM	80%
Hiteshwari Sabrol,satish kumar	N/A	N/A	PCA and SVM	100%(for SVM)
Majumdar et.al	Wheat	Rust disease	ANN	85%
K. R. Aravind, et.al	Maize		Histogram, GLCM and SVM	83.7%
Sannakki et.al	Grape	Downy Mildew, Powdery Mildew	K-Mean clustering and Forward feed BPNN	100%(in training phase)
Mokhtar et.al	Tomato	Powdery Mildew, Downy Mildew	K-Mean clustering and SVM	99.5%
Suresha et.al	Paddy	Blast, Brown spot	KNN classifier	76.59%
Xiao et.al	Rice	Blast	PCA and ANN	95.83%

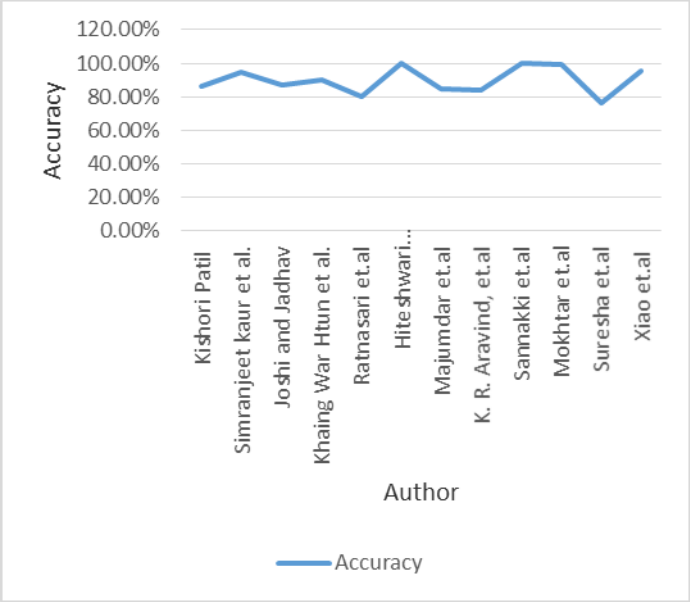

Chart -1: Authors vs. Accuracy

3. PLANT DISEASES

Plant disease is an impairment in the vital functions of a plant that results in disruption or modification. All species of plants, wild or cultivated , are subject to disease. Anything that prevents a plant from achieving its maximum potential or yield, is termed as Plant disease. Plant disease will degrade agriculture production. Plant diseases are caused mainly by pathogens.

3.1 Classification of Pathogens

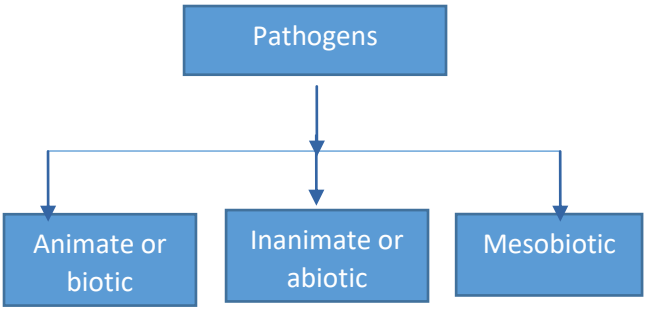

Fig -1: classification of pathogens

3.1.1 Animate or biotic pathogens

Pathogens of living nature are classified into the following groups. (i) Fungi (ii) Bacteria (iii) Phytoplasma (iv) Nematodes(v) Algae (vi) Phanerogams (vii)Rickettsia-like organisms(viii) Protozoa

3.1.2 Inanimate or abiotic Pathogens

These factors cause disruption to the plants instead of causing disease.

The major causes are: (i) Deficiencies or excess of nutrients (ii) Light (iii) Moisture (iv) Lack of oxygen (v) Improper cultural practices (vi)Temperature (vii) Toxicity of pesticides (viii) Air pollutants (ix) Abnormality in soil conditions (acidity, alkalinity)

3.1.3 Mesobiotic pathogens

These infectious agent are neither living nor non-living, e.g. (i) Viruses (ii) Viroides

3.2 Classification of Plant Diseases Based On Causal Agents

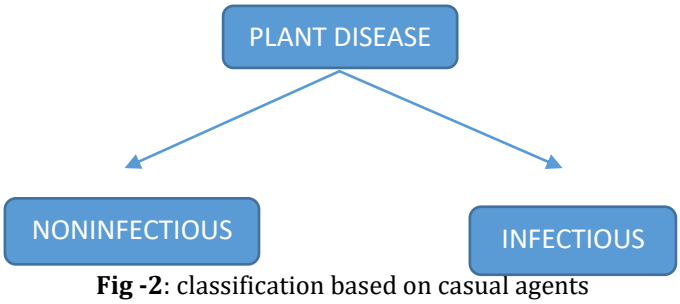

Fig -2: classification based on casual agents

3.2.1 Non-infectious

Non-infectious are associated with inanimate or abiotic pathogen. So they are not transmissible. These are caused by the disturbances in the plant body because of lack of certain inherent qualities by improper environmental conditions of soil, air and by mechanical influences.

Examples:

i. Low/high temperature
ii. Unfavorable oxygen levels
iii. Unfavorable water levels
iv. Hail
v. Wind
vi. Air pollution toxicity etc.

3.2.2 Infectious

Infectious diseases are caused by pathogenic organisms or viruses under a set of environmental conditions. Pathogens can be fungi, bacteria, viruses, nematodes or parasitic flowering plants. They get nutrients, water & everything they need to reproduce from their host. Most of the plant diseases are caused by fungal & viral pathogens and bacterial & nematode pathogens cause a few. Some pathogens can infect several kinds of plants while others require a specific type of host. Pathogens like fungi & bacteria differ in their ability to survive, spread & reproduce.

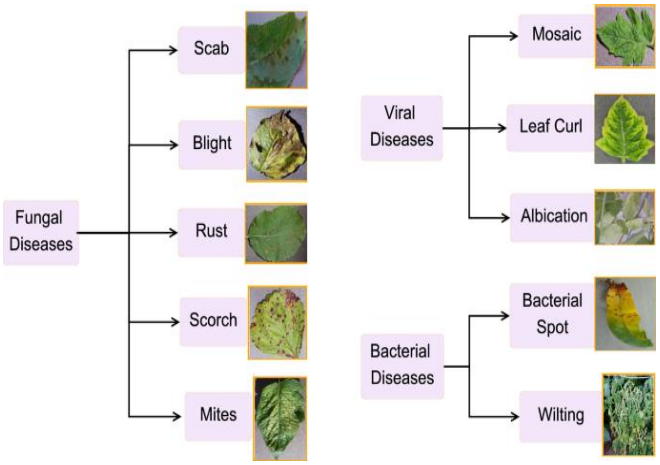

Fig -3: fungal diseases, viral diseases, bacterial diseases

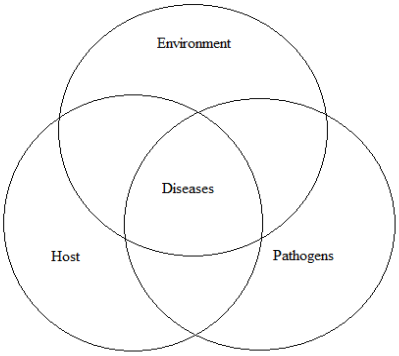

Fig -4: shows the correlation between host, environment and pathogen

Three components are necessary for a disease to occur in any plant. They are:

i. a susceptible host plant
ii. a virulent pathogen
iii. a favorable environment

4. PLANT DISEASE DETECTION

Plant disease identification system (PDIS) comprises of 5 steps. Each step uses different technique for diagnosis and detection. The selection of technique is based on the researcher's choice. Based on the literature review most of the researchers use the following steps to identify plant diseases.

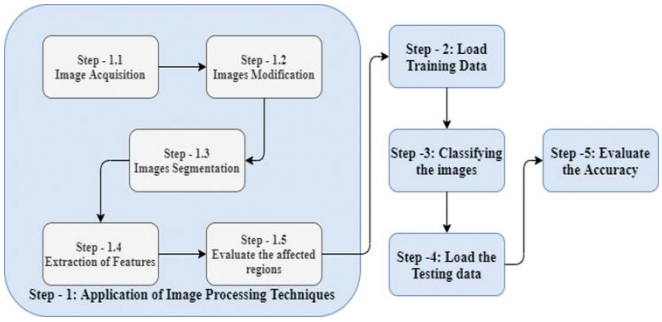

Fig -5: Steps to identify plant diseases.

1. Application of image processing techniques

This step comprises of:

Image Acquisition

It is used to acquire the diseased plant image. To do so an image sensor is used. The system should be capable of digitizing the signal produced by the sensor.

1.2 Image modification

It is used to process an image so that the result is more suitable than original image for the specific application. It is a subjective process.

1.3 Image segmentation

The purpose of this step is to partition an image into meaningful regions for a particular application. The image segmentation is based on the measurements taken from the plant image and might be grey level, color, texture, depth, or motion.

1.4 Extraction of features

The common goal of feature extraction is to convert the segmented objects into representations that better describe their main features and attributes.

1.5 Evaluate the affected region

In this step, the quality of the image segment is evaluated using various methods and techniques to find out the disease-affected region.

2. Load training data

Properties of the diseased images are loaded into the database for detection.

3. Classifying an image

The main goal of this step is to categorize all pixels in an image into land cover classes or themes. The important techniques used in this step are ANN, SVM, KNN, K Means clustering, etc.

4. Load the testing data

Here image properties are tested against the data stored in the training phase to check whether the result fulfils the expected outcome.

5. Evaluate the accuracy

Calculates the accuracy of the outcome.

5. CONCLUSIONS

This paper reviews different plant disease detection techniques using image processing that has been used by several researchers all around the world. The ultimate goal is to minimize the impact of diseases on agricultural crops by using image processing techniques. The major techniques reviewed in this paper are GLCM, KNN Classifier, K Mean Clustering, ANN, CNN, MDC, Otsu Thresholding Method, SVM, Feed Forward BPNN, and PCA. The accuracy rate of various methods are mentioned in detail. This would help researchers to select an optimum method for their model. The key findings of this paper can also be investigated for other problems and their solutions.

REFERENCES

[1] Kishori Patil, Santosh Chobe," Leaf Disease Detection using Deep Learning Algorithm," International Journal of Engineering and Advanced Technology (IJEAT)", ISSN: 2249 – 8958, Volume-9 Issue-3, February 2020, pp.3172-3175.

[2] Dey, A. K., Sharma, M., & Meshram, M. R. (2016). Image processing based leaf rot disease, detection of betel vine (Piper BetleL.). Procedia Computer Science, 85, 748-754.

[3] Simranjeet kaur, Geetanjali Babbar, Gagandeep," Image Processing and Classification, A Method for Plant Disease Detection", International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-8, Issue-9S, July 2019, pp. 869-871.

[4] Joshi, A. A., & Jadhav, B. D. (2016, December). Monitoring and controlling rice diseases using Image processing techniques. In 2016 International Conference on Computing, Analytics and Security Trends (CAST) (pp. 471-476).IEEE.

[5] Khaing war Htun & Chit Su Htwe"Development of paddy diseased Leaf classification system using modified color conversion".iJournals: International Journal of software & Hardware Research in Engineering, ISSN-2347- 4890, Volume 6 Issue 8 August, 2018, pp 24-32.

[6] Saradhambal, G., Dhivya, R., Latha, S., Rajesh, R., „Plant Disease Detection And Its Solution Using Image Classification", International Journal of Pure and Applied Mathematics, 2018,Volume 119, No. 14, pp. 879-884

[7] Ratnasari, E. K., Mentari, M., Dewi, R. K., & Ginardi, R. H. (2014, September). Sugarcane leaf disease detection and severity estimation based on segmented spots image. In Proceedings of International Conference on Information, Communication Technology and System (ICTS) 2014 (pp. 93-98). IEEE.

[8] Hiteshwari Sabrol, Satish Kumar, "Recent Studies of Image and Soft Computing Techniques for Plant Disease Recognition and Classification", International Journal of Computer Applications (0975-8887), Volume 126 – No.1, September 2015

[9] Majumdar, D., Kole, D. K., Chakraborty, A., & Majumder, D.D. (2015, August). An integrated digital image analysis system for detection, recognition and diagnosis of disease in wheat leaves. In Proceedings of the Third International Symposium onWomen in Computing and Informatics (pp. 400-405).

[10] Aravind, K.R., Raja, P., Mukesh, K.V., Aniirudh, R., Ashiwin, R., „ Disease Classification in Maize Crop using Bag of Features and Multiclass Support Vector Machine", Proceedings of the Second International Conference on Inventive Systems and Control (ICISC), 2018, pp. 1191-1196

[11] Sannakki, S. S., Rajpurohit, V. S., Nargund, V. B., & Kulkarni, P. (2013, July). Diagnosis and classification of grape leaf diseases using neural networks. In 2013 Fourth International Conference on Computing, Communications and Networking Technologies (ICCCNT) (pp. 1-5). IEEE.

[12] Mokhtar, U., Ali, M. A., Hassenian, A. E., & Hefny, H. (2015, December). Tomato leaves diseases detection approach based on support vector machines. In 2015 11th International Computer Engineering Conference (ICENCO) (pp. 246-250). IEEE.

[13] Barbedo, J. G. A. (2013). Digital image processing techniques for detecting, quantifying and classifying plant diseases. SpringerPlus, 2(1), 660.

[14] Suresha, M., Shreekanth, K. N., & Thirumalesh, B. V. (2017, April). Recognition of diseases in paddy leaves using knn classifier. In 2017 2nd International Conference forConvergence in Technology (I2CT) (pp. 663-666). IEEE.

[15] Xiao, M., Ma, Y., Feng, Z., Deng, Z., Hou, S., Shu, L., & Lu, Z. (2018). Rice blast recognition based on principal component analysis and neural network. Computers and electronics in agriculture, 154, 482-490.

BIOGRAPHIES

Vidhula Thomas,
Assistant Professor,
College of Applied Science,
Managed by IHRD,
Puthenvelikkara, Kerala, India

Sruthy K B,
Assistant Professor,
College of Applied Science,
Managed by IHRD,
Puthenvelikkara, Kerala, India