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Leaf disease detection and analysis using different techniques: A Review

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Abstract - It is an undeniable fact that agriculture is the back bone of the economy of developing countries like India. India's agriculture is composed of many crops and according to survey approximately 70% populace depends on agriculture. In the present climate, technology delivers an essential role in the field of agriculture however due to industrialization and globalization concepts the field is facing obstacles. The identification of disease on the plant is a very principal key to avert a heavy loss of revenue and the quantity of agricultural product. There are numerous techniques of classification like k-Nearest Neighbour Classifier, Probabilistic Neural Network, Support Vector Machine, Artificial neural network and Fuzzy logic which are used for plant disease detection. To select appropriate technique it is problematic for different inputs to be computed as quality of output can vary. The chief objective of this paper is to provide a survey on various classification techniques that can be used for plant leaf disease detection in the area of image processing and accordingly to choose the best technique of current era.

Keywords: Image Processing, ANN, Leaf Detection.

I. INTRODUCTION

The Agriculturalists have variety of crops with number of disease parameters so to select required pesticides superiority and quantity of agricultural products is diminished by plant diseases [26]. The production of agricultural crops can be enhanced by detecting the leaf diseases which are responsible for loss in the growth of crops [20]. Machine learning is used with the copious image processing techniques for leaf detection as well as for detecting the diverse feature of the crops image processing technique is becoming the most popular practice. The main steps such as image acquisition, image pre-processing, image segmentation, feature extraction and classification are included in the procedure for disease recognition. A classification is a practice where leaf are being classified based on their distinctive morphological features [14].

KEY ISSUES AND CHALLENGES IN THE FIELD OF DISEASE ANALYSIS

Several techniques are given by scientists to recognize the diseases of different plants. Pondering the various research paper the chief issues and challenges on identifying the disease and techniques are discussed as follow:

- Image quality of plant leaves to be detected
- Data set need to be deliberated in large amount.
- The captured images are influenced by background data and noises
- Segmenting the exact spot in a leaf into meaningful disease. Preparation of training and testing samples from input image.
- Choosing best Classification technique plays a vital role in recognizing segmented spot into meaningful disease.
- Different parameters such as Colour, size and texture of a plant leaf tend to vary due to the climate changes. The field expert and regular inspections are required well in time.
- Detecting diseases for various plant leaves is challenging.

It is proposed from the reviews that image processing and machine learning techniques have more potential and ability to find diseases however some limitations are also introduced by these techniques. Consequently, a chance of development is anticipated in the current investigation [18].

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II. ALGORITHM USED FOR LEAF DETECTION

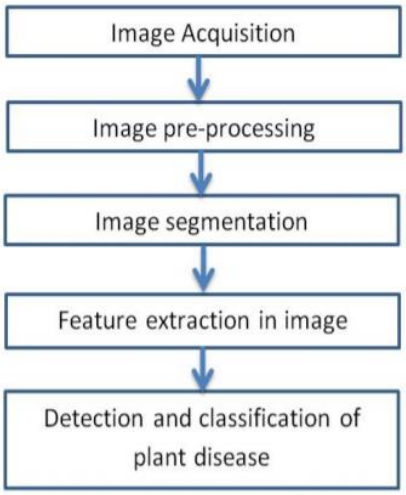

Figure 1.1 Basic steps for plant disease detection and classification [20]

MAJOR TYPES OF LEAF DISEASE

In the agricultural field, plant disease is considered as a significant aspect which is responsible for lowering the worth and quantity of the vegetation. Classification and detection model are the general methods which are used in plant disease diagnosis. In the area of engineering and IT, both the classification and detection model are comprehensively examined. The leading types of plant disease are as follows:

a) Bacterial Diseases: It is frequently indicated as the "Bacterial leaf spot". Its initiative symptoms are the minor, yellow green grazes on new leaves which classically seen as distorted and twisted, or as greasy, dark, water-soaked, emerging abrasions on older vegetation [23].

b) Viral Diseases: Life span of virus influenced plants is habitually small and viral disease grants some amount of diminishing in production. The comprehensible symptoms of virus-influenced plants are typically grow on the leaves, although leaves, fruits and roots may also effected by certain virus. It is very challenging to investigate the viral disease. The key symptoms can be seen as wrinkled and curled leaves as well as because of the virus growth may be underdeveloped [23].

c) Fungal Diseases: Muddy seed, soil, yield, weeds can be effected by fungal disease through water and wind. It appears on lower or more hardened clears out as water-soaked, gray-green spots in the preliminary form. Subsequently in which stage these spots are incomprehensible the white fungal is cultivated in the undersides. Yellow to white streak are built up in wool on the upper sides of more weathered clears out occurs and leaf turns into yellow when it distributes outward on the leaf surface [23].

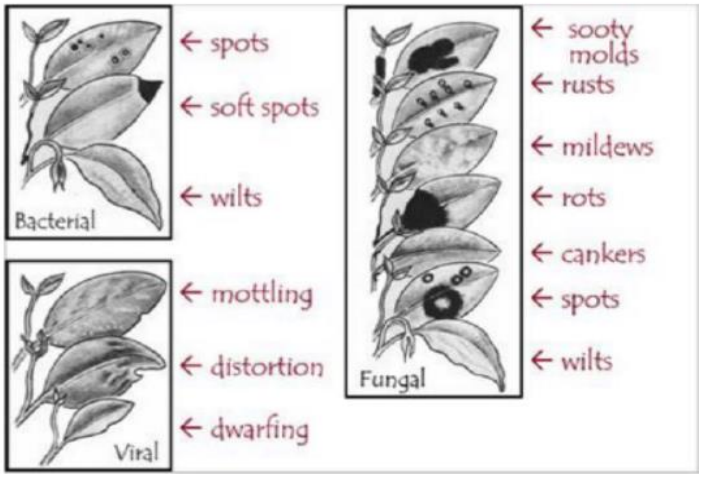

Figure 1.2 Various Types of leaf Diseases [8]

III. REVIEW OF LITERATURE

Numerous researches have been carried out by the researches to detect the various plant leaves. Different techniques and researches regarding to the plant leaf diagnosis have been discussed in this literature survey:

Pydipati et al. (2005) exploited a texture analysis method called the color co-occurrence method (CCM) to regulate whether classification algorithms could be used to recognise diseased and normal citrus leaves. The classification approaches used were based on a Mahalanobis minimum distance classifier, using the nearest neighbor principle, along with neural network classifiers based on the back-propagation algorithm and radial basis functions .The analyses corroborated that such methods could indeed be used for classifying diseased citrus leaves under controlled laboratory lighting conditions. Subsequently, it was advocated that the Mahalanobis statistical classifier achieved 95% accuracy whereas the back-propagation neural network classifier obtained 90% accuracy and both could be further considered when applying the texture-based features in an outdoor scene in the future.

Gang Wu et al. (2007) executed a general purpose automated leaf diagnosis system by using PNN (Probabilistic Neural Network) with data and image processing methods. It consisted of 1800 leaves which are trained by probabilistic neural network and 32 types of plants were classified. About 90% accuracy was postulated by this research. Classification based on leaf image was suggested better choice as compare to the other methods such as cell and molecule Biology. The main improvements of this investigations were feature extraction and the classifier. This study introduced a neural network approach for plant leaf recognition. PNN was adopted for its fast speed on training and straightforward structure.

Boissard et al. (2010) depicted an advance approach for automatic clarification of rose images scanned in situ. The main objective of this research was detection of bioagressors in early stage. A cognitive vision strategy was intended that

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combined image processing, learning and knowledge-based classifiers. Automatic detection and counting of a white fly i.e. Trialeurode Vaporariorum Westwood at mature stage was demonstrated in this exploration. It was found that automatic processing is trustworthy than manual approaches. 2.7% false positive rate (over detection) and 11% false negative rate (under detection) was attained from 162 samples in this research. It elaborated the relationship of complementary exercises as well as methods which led to an automated, vigorous and flexible system.

Patil and Kumar (2011) studied for increasing throughput & reducing subjectiveness arising from human experts in detecting the plant diseases. The author concluded that innovative, efficient & fast Interpreting algorithms of plant disease detection can be achieved using machine learning methods. Development of hybrid algorithms such as genetic algorithms and neural networks for boosting the detection ratio of the final classification process were proposed for future work in this paper.

Kaur and Monga (2012) communicated review of leaf architecture and various techniques for automated plant classification and recognition**.** This research was concerned with use of digital image processing for the purpose of automate classification and recognition of plants based on the images of the leaves**.** Techniques like SVM, KNN, Bayesian classification and neural networks were suggested to find the most optimal classifier which gives output in terms of very high accuracy using minimal computational resources.

Suhartono et al. (2013) created an application that can help researchers or observers working in coffee plantation to diagnose diseases of coffee plants. The method used was fuzzy logic-based expert systems, and decision tree using a hierarchical classification. Knowledge about coffee, its symptoms, and its disease was extracted from human expert and then converted into a decision tree which was result on the fuzzy logic-based expert systems. Use of additional variables such as weather and temperature was suggested for future work. Accuracy calculation of the system was about 85%.

Rathod et al. (2014) anticipated proposed work in different stages. In the primary step median filter was used to filter the image after that RGB was converted to CIELAB colour component. In the next step image is segmented using k medoid method following that green pixels are masked and removed. In the final stage image is passed to the neural network after computing texture feature statistics of the image. The result was calculated using five diverse diseases (early scorch, cottony mold, late scorch, brown spot and bacterial fungal) by achieving 96% accuracy hence, recognition rate of final classification process was increased by neural networks.

Lopez (2015) implemented a technique which was used for acquiring and processing images for agricultural yields. Software and hardware was developed for acquiring the images using model helicopter which contained the video camera with 640x480 resolution. Differential correction of errors which was created by GPS (global positioning system) was achieved by a software application along with this it allowed to detect the position of helicopter. Two photo cameras, an inertial measurement unit, a pressure and altitude sensor, a magnetometer as well as one GPS were used to generate a telemetry system. Conclusively, an image processing software was created which generated the three dimensional maps of yields and also used to regulate the vegetation indexes.

Azfar et al. (2015) exemplified a wireless sensor network to monitoring pest disease and different pest control mechanisms. In this paper author reviewed pest control literature and classify control mechanism as non-technological, technological and integrated pest management. In this paper all existing mechanisms were compared with the help of certain parameters and the wireless sensor network was considered cost effective. Designing and implementing WSN test beds for pest monitoring and control system had been intended for future.

Sharma et al. (2016) exposed that there are number of classification methods like KNN (k-Nearest Neighbour) Classifier, PNN (Probabilistic Neural Network), Genetic Algorithm, SVM (Support Vector Machine), and PCA (Principal Component Analysis), ANN (Artificial neural network) and Fuzzy logic. It is very hard to choose the appropriate classification technique because for diverse input data the quality of result may vary. There are various applications of plant leaf disease classification in numerous areas like agricultural and biological research fields etc. In this paper it was concluded that Image processing is the best approach to process the plant leaf images and detection of the associated disease.

Amara et al. (2017) suggested an automatic system to classify banana leaves using deep learning methodology along with LeNet architecture as a convolution neural network to analyse the leaf images. The primary outcomes validated the efficiency of the intended method throughout the tough conditions like size, illumination, pose and orientation and complex background different resolution of the original view of the image. It was found that banana is threatened by diverse kind of diseases like banana speckle (1817 images) and banana sigatoka (240 images). It was revealed that fungus My-cosphaerella fijiensis was the main cause of black sigatoka and development of brown streaks bounded by leaf veins was detected as its symptoms. The training was implemented for percentage of entire data set and accuracy for the training dataset (20%, 40%, 50%, 60%, 80%) was noticed as (0.9861, 0.9861, 0.9972, 0.9676, and 0.9288) correspondingly.

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Astonkar and Shandilya (2018) deliberated a user friendly methodology used to identify plant leaf diseases with deep learning and K mean clustering technique. K mean clustering method was implemented to segment an image and initial centroid was generated using cluster then last segmented outcome was compared with samples. It was noticed as better segmentation method, deep learning process was employed to the formatted clusters to locate the matching image, dataset images was compared with the computed value of z in each step and the value obtaining less z value was the absolute value. It was noticed that deep learning algorithm delivered the applicable outcome of the diseases and consumed less amount of time for identification than other algorithms.

Mangla et al. (2019) projected a process that helped to detect the leaf diseases and classify the leaf by various image processing techniques and neural network classifier. This paper pondered 3 chief diseases which are occurred in Paddy. These diseases are named as Brown spot of Rice Rice Blast, and Sheath Blight of Rice. It was revealed that organism Pyricularia oryzae is the main cause of blast disease, owing to which small water soaked bluish green specks with grey centre and dark brown margin starts to develop in paddy leaves. Image pre-processing and segmentation technique along with diverse types of classification features like SVM was used to detect and diagnose paddy leaf diseases. The advantages of the suggested system was that it was able to diagnose the disease at the stage in which it starts to occur on the leaf.

Arsenovic et al. (2019), in the paper entitled **"Solving Current Limitations of Deep Learning Based Approaches for Plant Disease Detection"** The author conferred and presented the current limitations and deficiencies of existing plant disease detection models. Moreover, in this exploration a new dataset containing 79,265 images was introduced with the intention to become the largest dataset containing leaf images. Apart from that two approaches were used to augment the number of images in the dataset: traditional augmentation methods and state-of-the-art style generative adversarial networks. Several experiments were conducted to test the impact of training in a controlled environment and usage in real-life situations to accurately identify plant diseases in a complex background and in various conditions including the detection of multiple diseases in a single leaf. Finally, a novel two-stage architecture of a neural network was projected for plant disease classification focused on a real environment. The trained model assumed to achieve an accuracy of 93.67% due to its architectural design as well as it was planned to prove effective in situations with composite surroundings.

Khan and Oberoi (2019) illuminated various practises of segmentation, feature extraction and classification of plant disease detection in terms of different parameters. After doing analysis on several techniques and algorithms the author concluded that compared to other algorithms, SVM algorithm gives the better result. The plant disease detection consisted of two steps, in the first step the image segmentation was done and in the second step technique of feature extraction and classification was applied which classified diseases and normal portion in the image. According to the writer normal methods such as JAVA could be used to develop this approach although resourceful and effective result was obtained by using Matlab.

Table 1.1 Comparison of disease classification techniques

Sr. No.	Methods	Description	Merits	Demerits
1	KNN (K-Nearest Neighboring)	Compute the smallest distance between the points. [21]	Outcome is fairly good as well as simple to execute. [16]	Learning process is slow, in bulky training example, it is not robust to the noise data. [16]
2	SVM (Support Vector Machine)	It works by fabricating Hyper plane in infinite dimensional space. [16]	Highly accurate, vigorous performance when errors are contained in training example. [24]	Training time is lengthy, learned function is hard to grasp. Huge number of support vectors are used from the training set for classification purpose. [24]
3	PNN (Probabilistic Neural Network)	Its four layer configuration involves Votes evaluation, Distance computation and predictor variable storage. [16]	Much faster and more precise. [19]	Require large storage space. [19]
4	Fuzzy Logic	Real world data value is converted into membership degree using membership function. [7]	High speed, preferable in limited precision. [24]	Dimensionality (Large no. the features), Poor performance. [24]
5	ANN (Artificial Neural Network)	Fundamental type of ANN is Multilayer Perception in which weights are updated through basic propagation. [16]	Suitable for nonlinear, high dimensionality noisy, complex and imprecise problems. [11]	Entail more time. [16]
6	Genetic Algorithm for segmentation	The process contains division of chromosomes into natural selection and fitness of chromosome. [13]	Reduced computational efforts and the optimum results .[3]	Efficiency and time of the process depends upon the initial generated population of chromosomes. [3]

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IV. CONCLUSION

In this paper literature survey of diverse techniques used for plant leaf diagnosis has been introduced. The major issues and challenges of leaf disease detection are also conferred in this paper. The research concerns delivered here would assist the investigators, algorithm implementers and cultivators for taking the appropriate action. The review illustrates that image processing is the imperative technique as well as after comparing the different classification techniques it is concluded that ANN gives precise solution to classify complex problems in leaf detection.

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