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A Review : Plant Disease Detection Various Techniques

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ABSTRACT

In terms of productivity, economics, quality, and quantity of agricultural goods, plant diseases result in significant losses. Since agriculture accounts for 70% of India's GDP, it is important to reduce the damage that plant diseases do. To prevent such illnesses, plants need to be watched carefully from the very beginning of their life cycle. The conventional approach to this monitoring is naked eye inspection, which takes more time, costs more money, and requires a high level of competence. Therefore, the illness detection system needs to be automated in order to speed up this procedure. Image processing techniques must be used to create the illness detection system. Numerous researchers have created systems based on various image processing methods. In order to promote agriculture, this research examines the possibilities of plant leaf disease detection techniques. It involves a number of steps, including picture capture, image segmentation, feature extraction, and classification.

Keywords - Plant Disease Detection, Image Processing, Image Acquisition, Segmentation, Feature Extraction, Classification.

I. INTRODUCTION

India's economic development relies heavily on agriculture. India's economy is mostly dependent on agriculture—about 70%. Therefore, crop damage would result in a significant loss in production, which would have an impact on the economy. The most vulnerable component of plants, the leaves, are where disease symptoms first appear [1]. From the very beginning of their life cycle until they are ready to be harvested, the crops must be inspected for illnesses. Initially, specialists manually observed agricultural fields using the time-consuming approach of traditional naked eye surveillance to keep a check on the plants for illnesses [2]. A variety of methods have been used in recent years to create autonomous and semi-automatic plant disease detection systems. As of yet, these methods have shown to be quicker, less costly, and more precise than farmers' manual observation, which has been the norm [3]. This encourages scientists to develop technology systems that are more sophisticated and don't need human participation to identify plant diseases.

This paper's goal is to explore several methods for identifying plant diseases and to discuss them in terms of various parameters. The portions of the paper are as follows. The significance of plant disease detection is briefly discussed in the first section. The second section addresses the methods employed as well as the latest work that has been done in this field. The basic approach used to construct the illness detection system is included in Section 3. The fourth portion finishes this essay and offers suggestions for the future.

II. LITERATURE REVIEW

K-means segmentation was used by D.A. Bashish et al. (2010) to divide the leaf picture into four clusters using squared Euclidean distances. For both color and texture characteristics, the Color Co-occurrence technique is used for feature extraction [4]. Using a neural network detection strategy based on the Back Propagation method, classification is finally achieved. The total system's accuracy in identifying and classifying diseases was determined to be 93%.

Bhange, M., et al. (2015) By contributing fruit images to the system, a web-based tool for diagnosing fruit illnesses has been created [5]. Utilizing variables including color, morphology, and CCV (color coherence vector), features have been extracted. K-means method has been used for clustering. SVM is used to determine whether something is contaminated or not. This research identified pomegranate illness with an accuracy rate of 82%.

To find fungal infections on plant leaves, J.D. Pujari et al. (2015) used a variety of crop kinds, including commercial crops, cereal crops, fruit crops, and vegetable crops. Each sort of crop has been treated differently [6].

The segmentation approach utilized for fruit crops is k-means clustering, and texture characteristics have been concentrated on and identified using ANN and closest neighbor algorithms, resulting in an overall average accuracy of 90.723%.

For vegetable crops, the Chan-Vase technique, local binary patterns, SVM, and k-nearest neighbor algorithm are employed for segmentation, texture feature extraction, and categorization with an 87.825% total average accuracy.

The grab-cut algorithm was used to segment the commercial crops. Mahalnobis distance and PNN have been used as classifiers in wavelet-based feature extraction, with an overall average accuracy of 84.825%.

K-means clustering and canny edge detector were used to segment the cereal crops. Features have been retrieved for color, shape, texture, color texture, and random transform. The combined average accuracy using SVM and closest neighbor classifiers was 83.72%.

In order to automate the identification and categorization of plant diseases, V. Singh et al. (2016) used genetic algorithm as the picture segmentation method. For the training and test sets for the leaves of the four plants—banana, beans, lemon, and rose—a minimal number of photos were employed. The color co-occurrence approach has been used to extract characteristics that take into account both texture and color information. Diseases have been classified using the Minimum Distance Criterion with k-mean clustering and the SVM classifier, with accuracy rates of 86.54% and 95.71%, respectively [7]. The accuracy is increased to 93.63% when the genetic algorithm and the Minimum Distance Criterion classifier are combined.

A fuzzy decision maker was used by E. Kiani et al. (2017) to try to identify disease-infected leaves in a strawberry field outside. An average degree of accuracy Plant disease detection and segmentation had a 97% detection rate, and disease detection took 1.2 seconds to process [8].

Ali, H., et al. (2017) Their research intends to employ the E color difference technique to segregate the disease-affected region and uses color histogram and textural cues to diagnose illnesses, obtaining a 99.9% overall accuracy [9]. Different classifiers, including fine KNN, Cubic SVM, boosted tree, and bagged tree classifiers, have been employed. In comparison to the other classifiers, the bagged tree classifier outperforms them, scoring 99.5%, 100%, and 100% accuracy on the RGB, HSV, and LBP features, respectively. The accuracy rates for the Fine KNN, Cubic SVM, and Boosted tree classifiers were 88.9%, 90.1%, and 50.90%, respectively.

A method to create a system for automated plant disease detection was put out by G. Saradhambal et al. (2018). Through the use of the k-means clustering method and the Otsu's classifier, research was done to estimate the area of the leaves that were infected. In the suggested study, characteristics for both form and texture were retrieved. Area, color axis length, eccentricity, solidity, and perimeter were among the shape-oriented variables that were retrieved in this study, whereas contrast, correlation, energy, homogeneity, and mean were texture-oriented features [10]. And lastly, a neural network-based classifier was used to do classification in this paper.

Sandhu, G. K., & Kaur, R. (2019, April). Plant diseases cause major losses in terms of production, economy, quality and quantity of agricultural products. Since, 70% of Indian economy is dependent on agricultural yield, there is a need to control the loss incurred by plant diseases. The plants need to be monitored from a very initial stage of their life-cycle to avoid such diseases. The traditional method being followed for this supervision is naked eye observation which is more time-consuming, expensive and a lot of expertise is required. So, in order to speed up this process there is a need to automate the disease detection system.

Shruthi, U., V. Nagaveni,(2019), 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.

Li, Lili, Shujuan Zhang, and Bin Wang. (2021) Deep learning is a branch of artificial intelligence. In recent years, with the advantages of automatic learning and feature extraction, it has been widely concerned by academic and industrial circles. It has been widely used in image and video processing, voice processing, and natural language processing. At the same time, it has also become a research hotspot in the field of agricultural plant protection, such as plant disease recognition and pest range assessment, etc. The application of deep learning in plant disease recognition can avoid the disadvantages caused by artificial selection of disease spot features, make plant disease feature extraction more objective, and improve the research efficiency and technology transformation speed.

Singh, V., Sharma, N., & Singh, S. (2020). Agriculture is the basis of every economy worldwide. Crop production is one of the major factors affecting domestic market condition in any country. Agricultural production is also a major prerequisite of economic development, be it any part of any country. It plays a crucial role as it even provides raw material, employment and food to different citizens. A lot of issues are responsible for estimated crop production varying in different parts of the world.

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Ali, H., Lali, M.I., Nawaz, M.Z., Sharif, M., Saleem, B.A.	Symptom based automated detection of citrus diseases using color histogram and textural descriptors	Computers and Electronics in Agriculture	2017	Volume 138	92-104

Barbedo, J.G.A.	A review on the main challenges in automatic plant disease identification based on visible range images	Biosystems Engineering	2016	Volume 144	52-60
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Bashish, D.A., Braik, M., Ahmad, S.B.	A Framework for Detection and Classification of Plant Leaf and Stem Diseases	International Conference on Signal and Image Processing	2010	N/A	113-118
Bhange, M., Hingoliwala, H.A.	Smart Farming: Pomegranate Disease Detection Using Image Processing	Second International Symposium on Computer Vision and the Internet	2015	Volume 58	280-288
Dey, A.K., Sharma, M., Meshram, M.R.	Image Processing Based Leaf Rot Disease, Detection of Betel Vine (Piper Betle L.)	International Conference on Computational Modeling and Security	2016	Volume 85	748-754
Gavhale, K.R., Gawande, U.	An Overview of the Research on Plant Leaves Disease Detection using Image Processing Techniques	IOSR Journal of Computer Engineering	2014	Volume 16, Issue 1	42644
Gharge, S., Singh, P.	Image Processing for Soybean Disease Classification and Severity Estimation	Emerging Research in Computing, Information, Communication and Applications	2016	N/A	493-500
Kiani, E., Mamedov, T.	Identification of plant disease infection using soft-computing: Application to modern botany	9th International Conference on Theory and Application of Soft Computing, Computing with Words and Perception	2017	Volume 120	893-900
Li, Lili, Shujuan Zhang, and Bin Wang	Plant disease detection and classification by deep learning—a review	IEEE Access	2021	Volume 9	56683-56698

Omrani, E., Khoshnevisan, B., Shamshirband, S., Saboohi, H., Anuar, N.B., Nasir, M.H.N.	Potential of radial basis function-based support vector regression for apple disease detection	Journal of Measurement	2014	N/A	233-252
Pujari, J.D., Yakkundimath, R., Byadgi, A.S.	Image Processing Based Detection of Fungal Diseases In Plants	International Conference on Information and Communication Technologies	2015	Volume 46	1802-1808
Sandhu, G. K., & Kaur, R.	Plant disease detection techniques: a review	2019 International Conference on Automation, Computational and Technology Management (ICACTM)	2019	N/A	34-38
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, Issue 14	879-884
Shruthi, U., V. Nagaveni, and B. K. Raghavendra	A review on machine learning classification techniques for plant disease detection	2019 5th International conference on advanced computing & communication systems (ICACCS)	2019	N/A	281-284
Singh, J., Kaur, H.	A Review on: Various Techniques of Plant Leaf Disease Detection	Proceedings of the Second International Conference on Inventive Systems and Control	2018	Volume 6	232-238
Singh, V., Misra, A.K.	Detection of Plant Leaf Diseases Using Image Segmentation and Soft Computing Techniques	Information Processing in Agriculture	2016	Volume 8	252-277
Singh, V., Sharma, N., & Singh, S.	A review of imaging techniques for plant disease detection	Artificial Intelligence in Agriculture	2020	Volume 4	229-242

Zhou, R., Kaneko, S., Tanaka, F., Kayamori, M., Shimizu, M.	Disease detection of Cercospora Leaf Spot in sugar beet by robust template matching	Computers and Electronics in Agriculture	2014	Volume 108	58-70

III. PLANT DISEASE DETECTION PROCESS

As seen in Fig. 1, there are fundamentally four stages to the plant disease detection procedure. Images are acquired during the first phase using a digital camera, a mobile device, or the internet. The picture is divided into varying numbers of clusters in the second phase, each of which can be treated using a different approach. The following phase includes strategies for feature extraction, while the last step discusses the categorization of disorders.

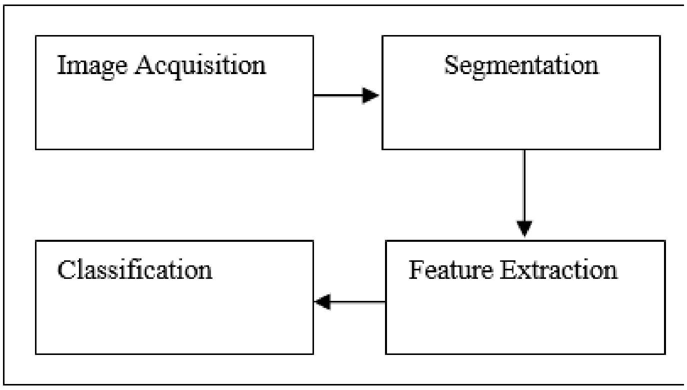

Fig. 1. Phases of plant disease detection system

Image Capture

Using digital devices like cameras, smartphones, and other devices with the necessary quality and size, plant leaf photos are collected during this phase. Additionally, photos from the web can be used. The application system developer is solely responsible for creating the picture database. The last step of the detection system's classifier is more effective thanks to the picture database [11].

Segmentation of Images

This step seeks to make an image's representation more understandable and straightforward to examine [12]. This stage is the essential method of image processing since it serves as the foundation for feature extraction. Images can be segmented using a variety of techniques, including thresholding, Otsu's algorithm, and k-means clustering. Based on a collection of characteristics, the k-means clustering divides objects or pixels into K number of classes. By reducing the sum of squares of distances between the items and their related clusters, classification is accomplished [13].

Extraction of Features

The region of interest is the output thus far after segmentation. Therefore, the characteristics from this region of interest must be extracted in this stage. To interpret an example image, these qualities are required. Color, form, and texture are all possible bases for features [14]. The majority of academics now want to utilize textural traits to identify plant diseases. The system may be developed using a variety of feature extraction techniques, including histogram-based feature extraction, the gray-level co-occurrence matrix (GLCM), the color co-occurrence approach, and the spatial grey-level dependency matrix. The GLCM approach is a statistical technique for classifying textures.

Classification

Identifying whether the input picture is healthy or unhealthy is the goal of the classification step. If it is determined that the image is sick, several previously published papers have further categorised it into various disorders. A MATLAB software procedure, also known as a classifier, must be built in order to do classification. Researchers have utilized a variety of classifiers recently, including Naive Bayes, Support Vector Machines (SVM), Artificial Neural Networks (ANN), Back Propagation Neural Networks (BPNN), and Decision Tree classifiers. The SVM classifier is determined to be the most popular one. Although each classifier has benefits and drawbacks, SVM is a straightforward and reliable approach [15].

IV. RESULTS AND DISCUSSION

The plant disease detection has the three major phases which are features extraction, segmentation and classification. The k-mean segmentation technique is applied for the image segmentation. The GLCM algorithm is the applied for the feature extraction. The technique of classification is applied for the disease name prediction. In the research work, two classification techniques are compared which are SVM and Naïve Bayes for the disease prediction. The results of these two classifiers are compared in terms of execution time and accuracy.

Accuracy is defined as the number of points correctly classified divided by total number of points multiplied by 100

$$Accuracy = \frac{Number\ of\ points\ correctly\ classified}{Total\ Number\ of\ points} * 100$$

Execution Time

Execution time is defined as difference of end time when algorithm stops performing and start time

Execution time = End time of algorithm- start of the algorithm

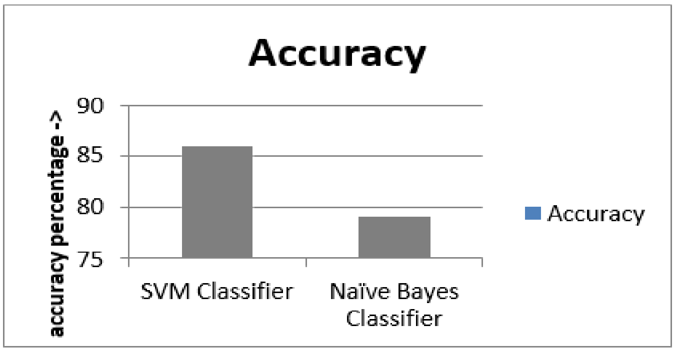

Figure. 2. Accuracy Comparisons

Figure 2 compares the accuracy of SVM and Naive Bayes classifiers for the identification of plant diseases. When compared to Nave Bayes, SVM is found to be more accurate in detecting plant diseases.

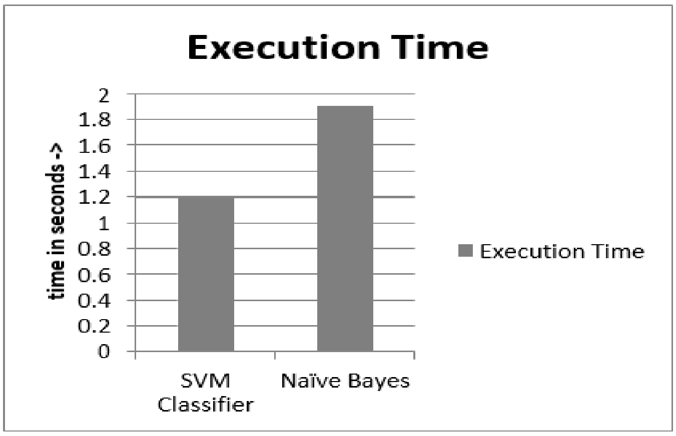

Figure. 3. Execution time

As seen in figure 3, the performance study compares the execution times of the SVM and naive bayes classifiers. Comparing the SVM classifier to the naive Bayes classifier, the SVM classifier executes faster.

V. CONCLUSION

The methods for detecting plant diseases using image processing that have been employed by a number of researchers over the past several years are reviewed and summarized in this work. BPNN, SVM, K-means clustering, Otsu's method, CCM, and SGDM were the main approaches used. These methods are employed to determine if the leaves are sick or healthy. The automation of the detection system employing intricate photos recorded under harsh environmental circumstances, such as outside lightning, presents a number of problems in this procedure. This review study comes to the conclusion that, while having certain drawbacks, these disease detection approaches demonstrate an efficiency and accuracy sufficient to enable them to operate the system designed for the detection of leaf diseases. Therefore, there is still much that may be done in this area to improve the already-existing activities.

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