Plant Disease Detection Techniques: A Survey

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ABSTRACT

The core of this research work is the detection of plant diseases. The technology used for detecting plant diseases is unification of image processing and classification schemes. At one side, image processing methods involve processing of pictures that are saved as pixels. At the other side, the classification approaches can predict different types of infections. There are various steps in plant disease detection such as data input, pre-processing, segmentation and classification. Data that is used as input can undergo processing to improve the contrast of the image data. Segmentation techniques can split the input image into many segments so that the execution time is low. The various machine learning algorithms are reviewed in this paper for the plant disease detection.

KEYWORDS

Plant Disease detection, Segmentation, Feature Extraction, Classification

1. INTRODUCTION

The agriculture is the backbone of economy of diverse emergent countries. In general, agriculture acts significantly in the commercial progress of India. Most of the part of Indian economy is depending upon the agriculture to fulfill the daily necessities. Thus, in case of any harm to the harvest causes a great loss in productivity which has great impact on the progress of nation. The sensitive portion of plants is its leaves. The diseases signs are depicted on the leaves of plant in initial phases. The development of plant defines the quantity and quality of crop productivity. Therefore, the detection of diseases occurred on the leaves of plant is required at the primary phase [1]. When the disease is detected, some essential steps must be taken for preventing its spread to other areas of the farm. Particularly, the framers can monitor the color and shape of the leaves of plant to detect the disease. There is necessity of higher proficiency and much regular hard work in this procedure. However, it is not possible in the big farms. Various infections occurred on the diverse portions of plant are recognized by monitoring the variations in plant features. The agriculture sector requires a time effective and automated diagnosis technique in order to enhance the productivity rate of harvest. At present, the image processing methods are adopted to generate a solution for overcoming distinct issues on the basis of farming applications such as to detect the infected leaf, stem and fruit. Several researchers aim to evaluate and recognize the leaf diseases with the implementation of image processing.

Different image processing methods are put forward for recognizing the diseased leaves. There are a variety of image processing schemes for identifying infections of plants. Various phases utilized to locate the diseases through image processing are demonstrated in Figure 1. The phases are discussed as:

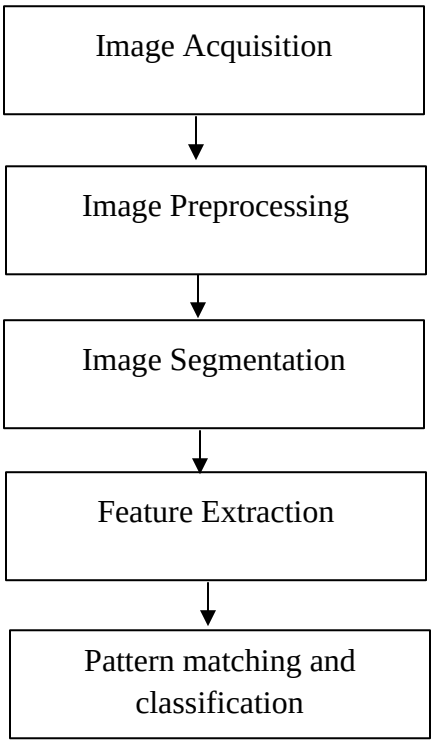

Figure 1: Different Stages in Plant Disease Detection

These stages are explained as:

a. Image Acquisition: This process focuses on generating the graphic image of an actual view or the internal composition of an element. Particularly, it is process to restore an image from some origin. The restoring of the image is done from a hardware-oriented sources [2]. The procedures are executed to process this source whose emergence is essential later on. It is the initial stage of work flow sequence of image processing owing to the obligation of a photo for processing. The captured is completely normal.

b. Pre-processing: The image is pre-processed for enhancing the information related to image having redundant distortions or strengthening some image attributes for processing. This phase includes diverse techniques such as dynamic image size and form, to perform noise filtration, to translate the image, enhance an image and morphological operations.

c. Image Segmentation: This method is implemented to split a digital image into numerous segments portions. The image segmentation technique emphasizes on recognizing the entities or retrieving the information from photographs. In this technique, the image is examined. The objects and bounding line of images are located using this technique. The pixels of similar label portion are utilized to attain differentiated attributes so that each pixel is labeled in an image. The images can be segmented through KMC (K-means clustering), Otsu's algorithm and thresholding. Some of the techniques of segmenting image are defined as:

- **Segmentation using Boundary and spot detection algorithm:** The RGB image is transformed into the HIS model to segment an image. The boundary and the spot are detected to recognize the infected part of the leaf [3]. The boundary is detected on the basis of connectedness of pixels. After that, the boundary detection algorithm is utilized.

- **K-means clustering:** This algorithm is deployed to classify the object in accordance with a set of attributes into K number of classes. The object is classified with the minimization of sum of the squares of the distance from the object and the equivalent cluster.

- **Otsu Threshold Algorithm:** The thresholding is employed to generate the binary images from grey-level images. The procedure sets some pixels below some threshold to 0 while some pixels above that threshold to 1. The color of the leaf is varied to represent the symptoms of the infection with the diseased leaf. Hence, the greenness of the leaves is utilized for detecting the infected portion of the leaf. The image is considered to generate the R, G and B elements. The threshold is computed using Otsu's method. The green pixels are masked and eliminated in case the green pixel brightness is lower than the computed threshold

d. Feature Extraction: The attained outcome is known as the RoI (region of interest). Thus, the attributes are extracted from RoI of image in this phase. The feature extraction is a scheme in which a set of values known as features are extracted from an image. The information regarding an image can be generated from

these attributes to execute the further processing. The infection is recognized in the plant using several attributes such as color, texture, morphological and color coherence vector. Various methods are adopted to extract the attributes. Some of these techniques are GLCM (gray-level co-occurrence matrix), spatial grey-level dependence matrix, and histogram based system of extracting features. The GLCM is a statistical method for classifying the texture attributes.

e. **Pattern Matching and Classification:** The stated sequence of tokens is analyzed for the subsistence of the components of some pattern in the pattern matching. This approach emphasizes on comparing the attributes with index attributes of the image which are available in the database. In the classification, the type of the observed pattern is recognized. Two kinds of classifiers are presented: Supervised learning and Unsupervised learning algorithms. The initial classifiers require the training and allow the users to select the sample pixels in order to generate a class. The latter classifiers have not required any training and the outcomes which are based on analyzing the software, do not utilize sample classes. The diseases on plants are detected using several classifiers like SVM (support vector machine), NNs (neural network), K-NN (k- nearest neighbour) and FL (fuzzy logic), etc.

Diverse algorithms to detect the plant disease are discussed as:

- **K- Nearest Neighbour (KNN):** This classification algorithm is implemented to classify the unknown samples with the help of separation or such similarity functions. This algorithm has slow learning process. This testing and preparing of this classifier is easy. The K-nearest centers are utilized in this algorithm for allocating the class of bigger part to the unknown instance [4]. This algorithm is a very simple. This classification is planned on the basis of majority vote and its k neighbor. KNN is an effective algorithm to accomplish the tasks of classification and regression.

- **Fuzzy classifier:** This method emphasizes on spotting 4 completely diverse organic procedure scarcities in plants. An image has segmental consistency with color similarities. When various color and texture alternatives are extracted, the fuzzy classification algorithm deploys the extracted attributes that leads to reveal the volume of fertilizers which assist in correcting its limitations.

- **Support Vector Machine (SVM):** This algorithm is implemented to deteriorate, classify and to perform prototype recognition of the data. SVM emphasizes on mapping the key information in non-linear way to linearly detached information in a number of high dimensional gaps for which high-quality categorization or classification presentation is provided. Two different groups of SVMs are deployed to develop the multiclass classification so that the complexity can be resolved through individual-versus-all or single-versus-single [5]. After that, the highest yield application or the greatest number of votes is utilized to resolute the significant group. Support Vector Machine algorithm provides optimal results, thus, it is considered as the effective classification algorithm which the developers have introduced.

- **Decision Tree Learning:** In this algorithm, a set of rules are included. These rules are assisted in generating the means to related specific molecular attributes and/or image values with the RoI (region of interest). The DT (Decision Tree) algorithm is capable of selecting the most differentiated attributes. The continuous as well as discrete data can be handled using this classification algorithm. Though, such classifiers cannot offer stability. The complexities are occurred in these algorithms with the time.

2. LITERATURE REVIEW

Vijay Singh, et.al (2015) put forward an innovative algorithmic approach for segmenting photographs. The objective of this schemes was to locate and categorize infections in the [7] plants. Different sorts of classifier algorithms were studied here. These schemes were suitable to identify various diseases within the leaf of a plant. This work applied Genetic algorithm for segmentation process. This algorithm contributed significantly in the detection of diseases in the plants' leaves.

Abirami Devraj, et al (2019) discussed the role of agriculture in meeting the food needs for a ever-growing population. Agriculture was the main source of income for about 70% of the people of the countries of the continent of Asia [8]. However, a variety of

diseases degraded the quality of the crops. Damage to agriculture was preventable through effective illness identification. The key objective of this project was to design a software by automating the disease classification and recognition process. The process of infection recognition involved various steps. Infections were detected within plants using leaf photos. Therefore, it was beneficial to apply image process methods in the agricultural industry.

R. Meena Prakash, et al (2017) applied image processing algorithms to distinguish contaminations inside plant leaves [9]. The primary goal of this work was to apply image examination and grouping algorithms to recognize and arrange leaf illnesses. The developed system consisted of four steps. The affected parts were identified by segmenting the leaf images using a K-means clustering algorithm. The use of GLCM algorithm helped in the extraction of texture features. Finally, SVM was applied to classify the plant leaves.

Sharath DM, et al (2019) expressed that plant illnesses had turned into a significant issue in development as these infections caused misfortune in yield. This likewise affected the nature of farming yield [10]. Monitoring plant health and identifying various pant infestations by hand was an amazingly perplexing operation. This cycle required expertise in the recognition of plant infections. In addition, this operation consumed a lot of time. Consequently, image processing came into play for plant infection detection. The process involved various stages. The disease affected plant was monitored based on the output of these steps. Photos of contaminated plants were used in this work to select the most efficient method of plant disease identification.

Gurleen Kaur Sandhu, et al (2019) studied and outlined various image processing-based plant disease detection methods. Over the years, these methodologies fascinated research community to identify plant diseases [11]. The prominent image processing algorithms included BPNN, SVM etc. These methodologies performed the classification of plant leaves into healthy and diseased. However, the process had some loopholes. These loopholes included automation of detection frameworks by outdoor lighting and complex photographs clicked under extreme environmental conditions. In summary, the existing methods showed capability and accuracy. These techniques could drive a system developed to identify plant diseases despite some limitations. Thus, more research work will be done in the future to upgrade the preceding works in this realm.

Sachin D, et al (2015) discussed that the scale of crop loss and cultivated yield can be largely prevented by detecting diseases in plants' leaves [12]. Plant pathology was based on the study of clearly identifiable patterns of plants. For sustainable farming, monitoring of plant health and disease detection was extremely important. However, monitoring plant diseases physically was quite laborious. This process needed considerable efforts and efficiency in plant diseases. In addition, this operation required a considerable amount of time. Therefore, image processing technology came into the play. The process of plant disease detection consists of several steps. In this work, the recognition of plant infection with the help of leaf images was discussed. This work also talked about some commonly used algorithms of plant disease detection.

Xulang Guan, et.al (2021) constructed a novel technique for detecting the disease in plants in which four CNN (convolutional neural networks) models were implemented which were Inception, Resnet, Inception Resnet, and Densenet [13]. A stacking technique was utilized in order to process the outcomes obtained from the constructed technique. An open-source database consisted of 36258 images taken from ten plant species was applied for conducting the experiments. The results demonstrated that the stacking method had provided the accuracy rate around 87% that led to a considerable enhancement in comparison with to the result of an individual CNN model. Moreover, the higher accuracy rate proved that the constructed model performed efficiently with stacking technique approach for detecting disease in plant in practical cultivation conditions.

Eftekhar Hossain, et.al (2019) developed a method in order to detect and classify the diseases occurred in plant leaf with the implementation of KNN (K-nearest neighbor). The texture features were extracted from the leaf disease images to perform the classification [14]. The developed algorithm assisted in classifying

the diseases. This algorithm was also utilized for segmenting the disease portion. The result generated higher accuracy for detecting the plant disease and the performance of developed algorithm was quantified with regard to DSC, MSE and SSIM parameters. The results exhibited that the developed method was efficient for detecting and recognizing the selected diseases and provided the accuracy around 96.76%.

Herlambang Dwi Prasetyo, et.al (2020) intended a website-based system in order to detect the rice plant diseases for the optimization of agricultural sector [15]. The DL (Deep Learning) method was applied to construct the system. The CNN (Convolutional Neural Network) was executed with GoogLeNet in order to process the images. The results revealed that the accuracy of intended system was maximized in the increasing number of epochs for CNN training models. This application was useful for farmers to analyze the diseases in rice plants with the objective of preventing and handling the plants.

Table 1: Table of Comparison

Author Name	**Year**	**Description**	**Outcomes**
Xulang Guan	2021	Constructed a novel technique for detecting the disease in plants in which four CNN (convolutional neural networks) models were implemented which were Inception, Resnet, Inception Resnet, and Densenet.	The results demonstrated that the stacking method had provided the accuracy rate around 87% that led to a considerable enhancement in comparison with to the result of an individual CNN model. Moreover, the higher accuracy rate proved that the constructed model performed efficiently with stacking technique approach for detecting disease in plant in practical cultivation conditions.
Herlambang Dwi Prasetyo	2020	Intended a website-based system in order to detect the rice plant diseases for the optimization of agricultural sector. The DL (Deep Learning) method was applied to construct the system. The CNN (Convolutional Neural Network) was executed with GoogLeNet in order to process the images.	The results revealed that the accuracy of intended system was maximized in the increasing number of epochs for CNN training models. This application was useful for farmers to analyze the diseases in rice plants with the objective of preventing and handling the plants.
Eftekhar Hossain	2019	Developed a method in order to detect and classify the diseases occurred in	The result generated higher accuracy for detecting the plant disease

		plant leaf with the implementation of KNN (K-nearest neighbor). The texture features were extracted from the leaf disease images to perform the classification	and the performance of developed algorithm was quantified with regard to DSC, MSE and SSIM parameters. The results exhibited that the developed method was efficient for detecting and recognizing the selected diseases and provided the accuracy around 96.76%.
Gurleen Kaur Sandhu	2019	The prominent image processing algorithms included BPNN, SVM, etc. These schemes performed the classification of plant leaves into healthy and diseased. However, the process had some loopholes. These loopholes included automation of detection frameworks by outdoor lighting and complex photographs clicked under extreme environmental conditions. In summary, the existing methods showed capability and accuracy.	These techniques could drive a system developed to identify plant diseases despite some limitations. Thus, more research work will be done in the future to improve the earlier studies in this realm.
Sharath DM	2019	Plant diseases is a grave concern in cultivation as these infections brought about loss in yield. This also influenced the quality of agricultural produce [10]. Monitoring plant health and identifying various pant infestations by hand was no to easy. This process required expertise in the recognition of plant infections.	The disease affected plant was monitored based on the output of these steps. Photos of contaminated plants were employed in this work to select the most efficient method of plant disease identification.
Abirami Devraj	2019	Agriculture was the main source of income for about 70% of the people of the countries of the continent of Asia. However, a variety of diseases degraded the quality of the crops. Damage to agriculture was preventable through efficient disease detection.	The process of disease detection involved various steps. Infections were detected within plants using photos. Therefore, it was beneficial to apply image process techniques for plant disease recognition and

		The key objective of this project was to design a software by automating the disease classification and recognition process. The process of infection recognition involved various steps.	classification in the agricultural industry.
R. Meena Prakash	2017	Applied image processing algorithms to distinguish contaminations inside plant leaves [9]. The primary goal of this work was to apply image examination and grouping algorithms to recognize and arrange leaf illnesses. The developed system consisted of four steps.	The use of Gray-scale co-occurrence matrix (GLCM) algorithm helped in the extraction of texture features. Finally, SVM (Support Vector Machine) was applied to classify the plant leaves.
Vijay Singh	2015	An innovative algorithmic approach for segmenting photographs. The objective of this schemes was to locate and categorize infections in the [7] plants. Different sorts of classifier algorithms were studied here.	This work applied Genetic algorithm for segmentation process. This algorithm contributed significantly in the detection of diseases in the plants' leaves.
Sachin D	2015	Plant pathology was based on the study of clearly identifiable patterns of plants. For sustainable farming, monitoring of plant health and disease detection was extremely important. However, monitoring plant diseases physically was quite laborious. This process needed considerable efforts and efficiency in plant diseases	This work also talked about some commonly used algorithms of plant disease detection.

Conclusion

This project is contingent upon plant infection recognition frameworks. In earlier days, diseases in plants were detected using microscopes. Thus, a quick and competent methodology to understanding the disease using remote sensing has been devised. Machine learning techniques have demonstrated profound effectiveness for detecting symptom-based disease recognition in the beginning phase. The experts apply digital image processing methods to identify infections in plants. The automated processing is adopted to locate the leaf and fruit infections in agriculture. The framework of plant disease recognition framework consists of different stages. There are some universal metrics on the basis of which the performance of machine learning methods is checked.

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