International Journal of
Human Computations & Intelligence
Vol. 02, Issue 06, Nov/Dec 2023

REVIEW ARTICLE OPEN ACCESS

A Review on Plant Leaf Disease Detection

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DOI: **10.5281/zenodo.10444452**
Received: 18 October 2023 / Revised: 16 November 2023 / Accepted: 01 December 2023

Abstract – Even though there is a rapid increase in the world's population, agriculture provides food to all the human beings. Since it is essential to cater food to overall population, it is recommended to predict plant leaf diseases at their early stages. This paper presents a survey on plant leaf disease detection using various, image processing techniques, machine learning and deep learning techniques and also various algorithms can be used for identification and classification of plant leaf diseases in plant. This paper compares and contrast different techniques used by different researcher to identify plant leaf disease.

Index Terms – Image processing, machine learning and deep learning techniques

I. INTRODUCTION

The diagnosis of plant leaf diseases is important because one of the biggest concerns in agriculture is that crop yields would not be able to keep pace with the growing global population. The diagnosis and treatment of disease are essential to improving the growth and yield of agricultural plants. Since food is important for every human being. The diagnosis and treatment of plant leaf disease are important to avoid low yield in of crop production. Typically, the diagnosis of plant pests and diseases is usually analyzed by visual inspection based on the appearance, morphology, and other characteristics of the leaves. It is suggested that this visual examination be performed and analyzed only by a highly trained biologist, as misdiagnosis can lead to irreparable loss of yield. It should be noted that pest and disease control research is usually costly and requires the presence of a specialized biologist to diagnose and prevent the spread and transmission of any disease as early as possible. With the use of image processing, deep learning, machine learning technologies, disease can be detected in their early stages, resulting in less crop loss. Section 1 gives an introduction of leaf disease detection. Section 2 gives brief literature survey which includes all techniques used by all authors. Section 3 presents a review table for quick information about techniques used by all authors for different papers. Section 4 provides conclusion for this paper.

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Electronic ISSN: **2583-5696**

II. LITERATURE REVIEW

In paper [1] researcher presents automatic leaf disease detection system. This system offers the farmer with a fast and accurate diagnosis of the plant disease. This system can accept a leaf image as an input. Firstly, leaf images are preprocessed in order to remove noise from the pictures. The mean filter is used to filter out background noise. Histogram equalization is used to enhance the quality of the image. The division of a single image into multiple portions or segments is referred to as segmentation in photography. It assists in establishing the boundaries of the image. Segmenting the image is accomplished using the K-Means approach. Feature extraction is carried by using the principal component analysis. Following that, images are categorized using techniques such as RBF-SVM, SVM, random forest, and ID3. In paper [2] this study, they proposed a novel 14-layered deep convolution neural network (14-DCNN) to detect plant leaf diseases using leaf images. A new dataset was created using various open datasets. Data augmentation techniques were used to balance the individual class sizes of the dataset. Three image augmentation techniques were used: basic image manipulation (BIM), deep convolutional generative adversarial network (DCGAN) and neural style transfer (NST). The dataset consists of 147,500 images of 58 different healthy and diseased plant leaf classes and one no-leaf class. The proposed DCNN model was trained in the multi-graphics processing units (MGPUs) environment for 1000 epochs. The random search with the coarse-to-fine searching technique was used to select the most suitable hyperparameter values to improve the training performance of the proposed DCNN model.

In paper [3] this study, the samples of tomato leaves having disorders are considered. With these disorder samples of tomato leaves, the farmers will easily find the diseases based on the early symptoms. Firstly, the samples of tomato leaves are resized to 256 × 256 pixels and then Histogram Equalization is used to improve the quality of tomato samples. The K-means clustering is introduced for partitioning of dataspace into Voronoi cells. The boundary of leaf samples is extracted using contour tracing. The multiple descriptors viz., Discrete Wavelet Transform, Principal Component Analysis and Grey Level Co-occurrence Matrix are used to extract the informative features of the leaf samples. Finally, the extracted features are classified using machine learning approaches such as Support Vector Machine (SVM), Convolutional Neural Network (CNN) and K-Nearest Neighbor (K-NN). In paper [4] this study, they proposed an automatic plant disease detection technique using deep ensemble neural networks (DENN). Transfer learning is employed to fine-tune the pre-trained models. Data augmentation techniques include image enhancement, rotation, scaling, and translation are applied to overcome overftting. This paper presents a detailed taxonomy on the performance of different pre-trained neural networks and presents the performance of a weighted ensemble of those models relevant to plant leaf disease detection. Further, the performance of the proposed work is evaluated on publicly available plant village dataset, which comprises of 38 classes collected from 14 crops. The performance of DENN outperforms state-of-the-art pre-trained models such as ResNet 50 & 101, InceptionV3, DenseNet 121 & 201, MobileNetV3, and NasNet. Performance evaluation of the proposed model demonstrates that effective in categorizing various types of plant diseases that comparatively outperform pre-trained models.

In paper [5] this study, follows two methodologies and their simulation outcomes are compared for performance evaluation. In the first part, data augmentation is performed on the PlantVillage data set images (for apple, corn, potato, tomato, and rice plants), and their deep features are extracted using convolutional neural network (CNN). These features are classified by a Bayesian optimized support vector machine classifier and the results attained in terms of precision, sensitivity, f-score, and accuracy. The above said methodologies will enable farmers all over the world to take early action to prevent their crops from becoming irreversibly damaged, thereby saving the world and themselves from a potential economic crisis. The second part of the methodology starts with the preprocessing of data set images, and their texture and color features are extracted by histogram of oriented gradient (HoG), GLCM, and color moments. Here, the three types of features, that is, color, texture, and deep features, are combined to form hybrid features. Thee binary particle swarm optimization is applied for the selection of these hybrid features followed by the classification with random forest classifier to get the simulation results. Binary particle swarm optimization plays a crucial role in hybrid feature selection; the purpose of this Algorithm is to obtain the suitable output with the least features. 'e comparative analysis of both techniques is presented with the use of the above-mentioned evaluation parameters..

In paper [6] researches proposes a fine-grained disease categorization method based on attention network to solve the problem. In ‘‘Classification Model’’, attention mechanism is used to increase identification ability. ‘‘Reconstruction-Generation Model’’ were added during training and the ‘‘Classification Model’’ have to pay more attention to differentiate areas to find differences instead of paying more attention to global features. And adversarial loss was applied to distinguish the generated image from the original image to suppress the noise introduced by the ‘‘Discrimination Model’’. Due to the feature that ‘‘Reconstruction-Generation Model’’ and ‘‘Discrimination Model’’ are only used in training and do not participate in the operation of inference phase, which cannot increase the complexity of the model. Compared with the traditional classification network, the method of generalization ability enhancement further enhances the identification accuracy. And the method needs less memory but can achieve low performance terminal real-time identification of peach and tomato leaf diseases. And it can be applied in other crop disease identification fields with the similar application scenarios.

In paper [7] this study, Detecting disease early saves crop from further damage. Cotton is susceptible to several diseases, including leaf spot, target spot, bacterial blight, nutrient deficiency, powdery mildew, leaf curl, etc. Accurate disease identification is important for taking effective measures. Deep learning in the identification of plant disease plays an important role. The proposed model based on meta Deep Learning is used to identify several cotton leaf diseases accurately. We gathered cotton leaf images from the field for this study. The dataset contains 2385 images of healthy and diseased leaves. The size of the dataset was increased with the help of the data augmentation approach. The dataset was trained on Custom CNN, VGG16 Transfer Learning, ResNet50, and our proposed model: the meta deep learn leaf disease identification model. A meta learning technique has been proposed and implemented to provide a good accuracy and generalization.

In paper [8] this paper presents the recently developed computer vision (CV) and deep learning (DL) models with an effective design can be employed for the detection and Classifcation of diseases in sugarcane plant. The disease detection in sugarcane plant is not accurate in the existing techniques. The quantum behaved particle swarm optimization based deep transfer learning (QBPSO-DTL) model for sugarcane leaf disease detection and Classifcation which produces high accuracy. The proposed QBPSO-DTL method is designed and trained for the prediction of diseased leaf images. The proposed QBPSO-DTL technique encompasses the design of optimal region growing segmentation to determine the affected regions in the leaf image. In addition, the SqueezeNet model is employed as a feature extractor and the deep stacked auto encoder (DSAE) model is applied as a Classifcation model. Finally, the hyperparameter tuning of the DSAE model is carried out by using the QBPSO algorithm. For demonstrating the enhanced outcomes of the QBPSO-DTL approach, a wide range of experiments were implemented and the results ensured the improvements of the QBPSO-DTL model.

In paper [9] this study presents a new support vector machine and image processing-enabled approach for detecting and classifying grape leaf disease. The given architecture includes steps for image capture, denoising, enhancement, segmentation, feature extraction, classification, and detection. Image denoising is conducted using the mean function, image enhancement is performed using the CLAHE method, pictures are segmented using the fuzzy C Means algorithm, features are retrieved using PCA, and images are eventually classed using the PSO SVM, BPNN, and random forest algorithms. The accuracy of PSO SVM is higher in performing classification and detection of grape leaf diseases. In paper [10] this study aims to accurately identify and classify the infection based on the leaf descriptions. Disease recognition in plants plays a vital role in agriculture applications. Having diseases in plants is a general fact. The detection of these diseases at the initial stage is very important to avoid loss in quality, quantity, and production in the crop. Manual detection of diseases in plants could not only be a time taking and costly process but also a difficult task in the case of large fields. The main objective of this research paper is to recognize and categorize the infection precisely from the folio descriptions. This step is compulsory in the improvements for training, pre-processing, and identification. The infections are measured by Downey Mildew and Powdery Mildew which can cause heavy loss to grapes fruit. For recognition of illness features of folio such as the main axis, small axis are removed from leaf and specified to classifier for identification. As a result, applied of the image processing method to come across and categorize the disease in the undeveloped application is helpful.

III. COMPARISION TABLE OF RELATED WORK

Paper	Techniques Used
[1] Performance of machine learning and image processing in plant leaf disease detection.	The CNN-LSTM hybrid technique is used
[2] Plant disease detection using deep convolutional neural network.	a new 14-layered deep convolutional neural network (14-DCNN), neural style transfer (NST), deep convolutional generative adversarial network (DCGAN), and basic image modification (BIM)
[3] Plant leaf disease detection using computer vision and machine learning algorithms	Support Vector Machine (SVM), Convolutional Neural Network (CNN), and K-Nearest Neighbor (K-NN)
[4] Transfer learning-based deep ensemble neural network for plant leaf disease detection.	Using deep ensemble neural networks (DENN)
[5] Hybrid feature-based disease detection in plant leaf using convolutional neural network Bayesian optimized SVM and random forest classifier.	convolutional neural networks (CNNs), histogram of oriented gradient (HoG), GLCM, and color moments.
[6] Plant Leaf Diseases fine-grained categorization using Convolutional Neural Networks	network-based, fine-grained disease classification technique.

[7] Meta deep learn leaf disease identification model for cotton crop.	Custom CNN, VGG16 Transfer Learning, ResNet50
[8] Quantum-behaved particle swarm optimization-based deep transfer learning model for sugarcane leaf disease detection and classification.	quantum-behaved particle swarm optimization
[9] Improved support vector machine and image processing enabled methodology for detection and classification of grape leaf disease	The PSO SVM, BPNN, and random forest algorithms. While it origin
[10] Recognition of plant's leaf infection by image processing approach	ANN-based systems

IV. CONCLUSIONS

This paper presents the survey on plant leaf disease detection techniques using image processing. Different authors used different algorithms for accurate detection of diseases. Purpose of using image processing method is that the Image processing provides modern and effective methods to detect plant leaf diseases at its early stage. The researchers used CNN-LSTM, 14-DCNN, SVM, CNN, etc. These methods save time and provide efficient results.

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