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A thorough study of techniques for finding diseases on banana leaves that use machine learning and deep learning

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ABSTRACT

Infection of plants is a major limitation and a difficult effort. Diseases affecting plants have the potential to harm fruit and foliage, causing the agriculture sector to suffer large financial losses. Infections of plants are primarily evident on the foliage and stems of the plants. Disease categorization and identification by hand takes a lot of effort and requires the participation of professionals. But quickly, this procedure may be aided by the installation of a system that is computerized. An autonomous maladies identification and categorization system is presented by many existing researchers, which can aid those who cultivate banana crops and make a contribution to the nation's economy thanks to advancements in Machine Learning (ML) and Deep Learning (DL) strategies. The principal objective of this work is to conduct a thorough examination of existing works that have used ML and DL approaches in the agricultural sector, specifically concerning the development of banana plants. As a result, it can be useful for upcoming investigators to determine the caliber and nature of prior studies. The researchers looked at issues about banana plantations. Additionally, the researchers have examined the ML-based models that have been put into use, the data-gathering resources, and the thorough outcomes attained for every study.

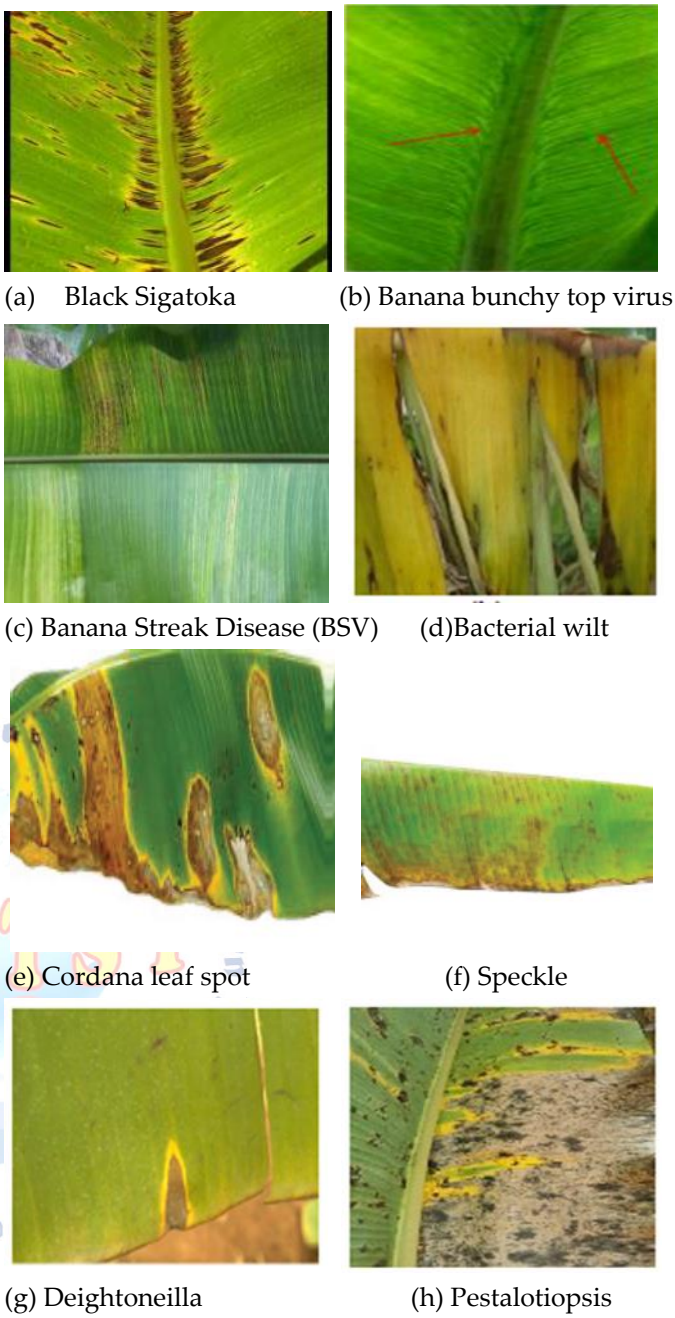
INTRODUCTION

ML and DL strategies are widely applied in different sectors like agriculture for disease identification in plants, cyber security for intrusion detection [1], health care for disease prediction in human beings [2], meteorology for rainfall prediction [3], education for academic performance prediction, businesses for decision-making, and banking for fraud detection, etc. India is famous for its agricultural operations and farming. Bananas are one of the most important cultivars

of fruit for commercial cultivation in India. In addition to being the most significant and well-liked fruit crop in India, bananas rank as the fourth most significant agricultural commodity globally. Infections that harm banana leaves are increasingly influencing the production of agricultural commodities. Both the amount and quality of agricultural commodities have sharply declined as a result of these illnesses. Thus, it's more crucial than ever to identify and classify banana leaf illnesses early on. However, the

antiquated technique of identifying illnesses by visual inspection is no longer useful in this situation as it needs a great deal of information and expertise about banana diseases and manifestations, both of which today's agriculturalists sadly lack. Consequently, utilizing cutting-edge techniques like autoML, DL, Image processing, and APIs is crucial for improving the effectiveness of the disease recognition procedure, ensuring the veracity of the diagnostic procedure, and continuing to keep agricultural workers informed about imminent dangers to their plantation, including those that have recently materialized and those that are nearby.

Currently, banana disease identification is carried out physically. By inspecting healthy and diseased plants, one may diagnose banana plant diseases using the old approach, which again calls for professional agriculturists. This is a laborious and difficult process. In the realm of the agricultural sector, it is important to identify unwell plants. The rapid identification of these plants would enable agriculturalists to implement the necessary mitigation strategies. The banana plant was prone to many diseases, which were seen in its foliage. The diseases depicted in Fig. 1 include the Banana Bunchy Top Virus, Yellow Sigatoka, Panama, Black Sigatoka, and banana speckle. Bacterial chlorosis, black spot, Panama disease, banana streak virus, banana bunchy top, Sigatoka disease, and Moko disease are among the ailments that affect banana leaves. Employing a computerized approach would therefore be quite beneficial.



(a) Black Sigatoka (b) Banana bunchy top virus

(c) Banana Streak Disease (BSV) (d)Bacterial wilt

(e) Cordana leaf spot (f) Speckle

(g) Deightoneilla (h) Pestalotiopsis

Different banana leaf diseases

RELATED WORKS

The purpose of the present literature review was to identify illnesses of banana leaves. To meet the demand for environmentally friendly farming, artificially sophisticated technologies like Artificial Neural Networks (ANN), ML, and DL are currently employed in the field of farming. DL algorithms for the identification of diseases in crops are currently being researched. Using ML and DL strategies, multiple investigators worldwide carried out studies on the autonomous diagnosis of plant diseases. The creation of mechanisms that automatically detect and classify

diseases in plants is a necessary discipline that also requires the establishment of computerized vision systems employing methods for processing images. The initial identification is essential in these domains to preserve the superiority of the goods. To give a mechanism for diagnosing problems early, the latest findings have recommended the employment of novel techniques in addition to computer vision and artificial intelligence. A major emphasis of these recent investigations and studies has relied on ML and DL approaches. The data is instantly and effectively analyzed and classified using ML classifiers like K-nearest neighbor (KNN), Support Vector Machine (SVM), fuzzy inference systems, and ANN.

In agricultural applications, computer vision and DL techniques have made significant strides in the past couple of decades. Technologies for personalized farming help identify and categorize agricultural pests and diseases as well as educate agriculturalists on how to spot illnesses quickly. Personalized farming's main component is the early identification and categorization of illnesses. With the advent of computer vision, several ML and DL strategies are employed to identify and categorize both good and sick leaves of the crops. The model is trained and the leaf surfaces are classified using the photos of various damaged and healthy leaves that were taken. A significant number of vision-based technologies now in use need for clear, high-quality pictures.

The automated categorization of images of crops with damaged banana leaves is a significant problem. Agriculturalists can identify and diagnose the illness by using DL methods. DL produces comparable outcomes in classifying images with sick banana leaves when compared to ML and image processing methods. Current traits only employ manual inspection of leaves, which are frequently labor intensive and limited in their applicability to certain diseases. Particular diseases will affect producers' agricultural losses as well as the growth of the nation's economy. Therefore, it's critical to identify banana sickness.

Because the infected areas begin to appear as dots and patches on leaves, there are several approaches to address recognizing problems for plants thanks to the advancements in computer vision. Scientists have proposed various techniques to accurately diagnose and classify plant diseases. A few utilize traditional image processing techniques, such as manual or computer-based segmentation and feature extraction. The main drawback of current systems is that most of them rely on image-processing technologies that need lengthy and costly processes for complex picture segmentation. Numerous diseases exhibit an absence of specific indications and might easily go unnoticed among the unaffected portions of the leaf, posing challenges in their identification by existing techniques and requiring the implementation of a reliable classification system. Some accessible approaches will only work with specific types of plants or be appropriate for certain plants. Classifying the disease takes longer and is less accurate when using methods like ANN, KNN, fuzzy inference systems, and other image processing techniques. While most studies primarily focus on the leaf, diseases in banana plants typically affect other sections of the plant as well. A review of banana leaf disease detection techniques is given in

Table I. A REVIEW OF BANANA LEAF DISEASE DETECTION TECHNIQUES

Study	Method	dataset	Analysis	Demerits
[4]	AutoML	Public dataset	97% of accuracy	One drawback of this investigation might be the identification of just Yellow Sigatoka and Panama illnesses. This method may be extended to detect additional banana illnesses, such as infections caused by bacteria or fungi. The model is not trained using real-time data. The overlapping of two or more diseases on the same banana leaf is not studied.

[5]	CNN+SVM	Images of banana leaves taken from various locations in the region of Assam.	92.8% of accuracy	The dataset can be expanded. Research can be extended to classify different banana leaf diseases.
[6]	The authors of this research concluded that DCNN can offer greater computational efficacy compared to other classifiers.			
[7]	KNN, SVM, Alexnet	Images were gathered utilizing basic camera equipment from several banana fields in Kerala. The dataset was created using both collected photos and photographs from publicly available sources.	Accuracies of different methods used in this research are KNN=76.49% SVM= 84.86% Alexnet= 96.73%	Only two banana leaf diseases Leafspot and Sigatoka were considered for study. This method may be extended to detect additional banana illnesses, such as infections caused by bacteria or fungi. The overlapping of two or more diseases on the same banana leaf is not studied.
[8]	CNN+SVM	Public dataset	94% of accuracy	The model must be verified using a sizable dataset of banana leaf data. The model is not trained using real-time data.
[9]	CNN+SVM	The images were taken using mobile devices in the Tamilnadu location and were gathered in different resolutions.	99% of accuracy	Authors can create an easy-to-use smartphone application that assists agricultural workers in quickly identifying the illness and taking appropriate action. Rather than focusing on a single banana plant, writers may examine the extent to which a disease has propagated over an agricultural land using an aerial view drone camera. This method also aids in determining the total production and damage in the event of a transmittable disease. The dataset used in this work is very small leading to high accuracy. Moreover, the imbalanced class nature of the dataset is not considered. Overfitting of data is not considered.
[10]	CNN	PlantVillage	DenseNet-121 achieved 99.81% accuracy	Authors need to work on real-time data collection. The dataset used in this work is very small leading to high accuracy. Moreover, the imbalanced class nature of the dataset is not considered. Overfitting of

				data is not considered.
[11]	ANN	self-built dataset that contains images taken in Kerala Agricultural University's banana farms.	95.9% of accuracy	Only three banana leaf diseases Sigatoka, Deightoneilla, and Cordana were considered for study. This method may be extended to detect additional banana illnesses, such as infections caused by bacteria or fungi. The overlapping of two or more diseases on the same banana leaf is not studied.
[12]	Faster R-CNN	Collected from Kaggle.com	94.63 of accuracy	Overfitting of data is not considered. Training time is more. Accuracy is low. The model is not trained using real-time data.
[13]	Shufflenet V2 CNN	Public dataset	95% accuracy	Only one banana leaf disease Black Sigatoka is considered for study. This method may be extended to detect additional banana illnesses, such as infections caused by bacteria or fungi. The model is not trained using real-time data.
[14]	YOLOV4	Every image was taken at different banana tree planting locations in the Philippines.	90.0% accuracy	Only one banana leaf disease Panama is considered for study. This method may be extended to detect additional banana illnesses, such as infections caused by bacteria or fungi.
[15]	Minimum Euclidean distance classifier	All photos were taken at different Chinese banana farming locations.	91.7% recognition rate	The study focused only on two diseases affecting banana leaves: grey leaf spot and Sigatoka. This method may be extended to detect additional banana illnesses, such as infections caused by bacteria or fungi. The severity of disease in banana plant leaves has not been studied. The overlapping of two or more diseases on the same banana leaf is not studied. The recognition rate is low.

OPEN CHALLENGES

Here are a few challenges that arise while detecting banana leaf diseases by existing researchers:

(i) Investigations showed that there are limited possibilities for diagnosing "Panama disease" early on. Nevertheless, there aren't many studies or apps now in use for image-based Panama disease detection. These circumstances, however, only analyze photos that show a portion of a banana leaf or images taken by unmanned aerial vehicles. The RGB-formatted images are used by the software to assess the leaf portion. However, investigations show that the leaf's color is only one factor in an infection's detection. It requires a thorough examination of several observations to get an outcome with a better degree of accuracy and confidence.

(ii) Most of the researchers concentrated only on a few banana diseases like Panama, Yellow Sigatoka, and Speckle.

(iii) A small number of images with the diseases were included.

(iv) Grey specks in the image are examples of extremely small things that the recognition method is unable to recognize.

(v) A large number of existing works did not use the actual image data for classification.

(vi) The time existing methods take to recognize an image is long.

(vii) Most existing works indicated if the plant leaf had been infected, but did not estimate the infection's intensity.

(viii) It is necessary to create a multi-object DL system that can even identify plant illnesses from multiple foliage as opposed to only one leaf.

(ix) It is necessary to have a mobile application that assists agricultural producers and the farming community in identifying leaf diseases promptly.

(x) Just a single orientation is taken into account while taking pictures of fruits or foliage; however, additional perspectives must be covered up during the process, as illnesses can also be present on the fruit's dangling tip or the bottom portion of the foliage. Furthermore, diseases may occasionally spread from stems and roots to other portions of the plant, and in certain cases, detection of the sick portion becomes impossible too late. Thus, this may be even another obstacle in the way.

(xi) The PlantVillage dataset serves as the primary data source for evaluating the accuracy and efficacy of the applicable deep learning model in most of the experiments. Additionally, it has a tonne of pictures of various plants that have the illnesses either in their fruit or foliage. All of the pictures have an unadorned backdrop; however actual environment must be taken into account for beneficial applications.

(xii) The need for enormous datasets that might be used as inputs during the process of training is an additional substantial issue.

(xiii) A significant problem with many datasets is the substantial variation across the different classes, or distortion, which includes poor resolutions, inaccurate perceptual tools, output obstructions, foliage interfering, classification, and many other issues.

ANALYSIS OF BANANA LEAF DISEASE IDENTIFICATION METHODS

Microbes, viruses, and fungi are the main suspects behind plant illnesses. The preliminary identification of infections in banana plants is crucial. The plant village dataset was utilized in some research, the godliver and scotnelson dataset in others, and real-time images captured from agricultural fields or small-scale private datasets were the basis for the other investigations, it has been analyzed. To improve the process of identifying diseases and address other issues (such as the ripening phase of the fruit, fruit quality, nutrient deficiency, severity of chilling injuries, etc.) Related to agricultural products, additional datasets must be obtained. Various open difficulties are tackled in the present research, which makes it possible to monitor crop-related issues and recognize various illnesses before symptoms appear. Currently, the predominant application of ml and dl techniques involves the analysis of photographs and the execution of computer vision analysis on banana fruit and leaves to identify existing ailments. The analysis of the current research review shows that the majority of studies have been done to find diseases in the leaves of banana plants. The current research review analysis also showed that to extend the shelf life of banana fruit, attention must be paid to the remaining factors, such as identifying moisture present, tracking banana ripening phases, identifying missing nutrients, and recognizing chilling damage. It is analyzed from the current literature review that most of the existing authors used hybrid cnn+svm models [5] [8] [9] and single cnn models [10] [12] [13] for banana leaf disease detection. It is also

analyzed that the accuracies ranged from 92.8% to 99% using hybrid CNN+SVM models. It is also analyzed that the accuracies ranged from 94.63% to 99.81% using single CNN models

CONCLUSION

The state's and the country's economic development are significantly influenced by farming. Because of this, managing farming techniques has become increasingly crucial given the world's population growth. One significant food crop in the globe is the banana. For the banana trees to deliver the maximum amount of agricultural products, disease identification is necessary. An efficient plant leaf ailment identification method is required since it takes a lot of time and labor to keep an eye on the crop in farms for infections. This work's main goal is to do a detailed analysis of previous studies that have applied ML and DL techniques in the agricultural industry, with a focus on banana plant development. Therefore, it might be helpful for future researchers to ascertain the standard and character of previous research. The researchers examined plantation-related difficulties. The researchers have also looked at the ML-based models that have been used, the resources used to collect data, and the comprehensive results obtained for each study.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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