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Review Of Various Methods And Algorithms For The Disease Detection From Plant Leaf Images. *

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Abstract: Learning software for machines is quickly becoming the most popular and widespread form of agricultural technology. Artificial machine learning is one of the sectors of the agriculture industry that is growing at the fastest rate. The application of artificial technologies in the field of agriculture has led to improvements in accuracy as well as the finding of answers to previously unresolved issues. In agriculture, the application of machine learning should work towards improving crop quality while also increasing plant output. Cotton is the most essential crop for producing fiber, not only in India but also around the world. The cotton textile industry stands to benefit from the acquisition of this since it is the raw material used in the production of fiber (cotton fiber). Infections caused by bacteria, fungus, and worms, as well as unregulated agricultural practices that are harmful to the leaves, are the primary challenges that cotton growers confront. Therefore, in order to prevent a low yield, farmers need to be aware of the crop diseases that have hurt the crop in the past. The consistent use of pesticides, together with the evolution of pests into organisms that are increasingly resistant to the effects of chemical control, has resulted in yields that have remained flat or fallen, in addition to a decline in the quality and productivity of the soil. Although a great number of cutting-edge machine learning models have been developed and examined, widespread application of these models in agricultural contexts has not yet been achieved. Transfer learning is a method that can be used to adapt and apply existing models in order to improve disease detection in plants and crops. In order to diagnose diseases that affect cotton plants, we have utilized contemporary methods and presented a hybrid methodology. In a hybrid method, contemporary computer vision models such as Faster RCNN and Single Shot Detector (SSD) are employed to recognize plant leaves and locate ROI (Region of Interest).

***Index Terms* - Plant disease detection, image processing, image acquisition, segmentation, feature extraction, classification.**

I. Introduction

Cotton, which is cultivated in India, is one of the most significant agricultural products grown here, and it holds a very specific place in the structure of the economy of the country. One more argument is that cotton is beneficial to the economy of India. Because cotton harvesting results in the creation of a substantial number of byproducts, those byproducts, in turn, are seen as having significant value. However, in recent years, cotton farming has evolved into an endeavor that is fraught with significant risk. People who worked in the cotton industry were thought to have committed suicide at a high rate. The widespread use of pesticides and fertilizers on cotton crops leads to a significant decline in the standard of living of farmers, many of whom ultimately succumb to financial ruin. Cotton output has suffered a substantial setback as a direct consequence of the prevalence of diseases and pests. The majority of these practices were not based on scientific evidence and resulted in a wide range of unintended consequences. Nevertheless, farmers utilized a great deal of pesticides and fertilizers in an effort to avert crop failure and illness. Due to the nature of this condition, the scientific study of disease identification and early disease control through the implementation of necessary activities is of the utmost importance.

By utilizing autonomous detection systems, the process of diagnosing diseases will be simplified, accelerated, and improved in its level of precision.

One of the main issues with cotton import and export rules has long been plant disease. This is due to the fact that plant disease drastically lowers the amount of cotton that can be harvested as well as the quality of the cotton itself. The process of accurately and precisely diagnosing diseases has historically been highly challenging. In most cases, the identification of signs of plant diseases has been accomplished through human observation and examination of their appearance. Today, it is sometimes coupled with or supplanted by other technologies like as immunoassays (such as the chemically linked immunosorbent test, or ELISA), PCR, or RNA-seq in order to differentiate pathogen-explicit antigens or oligonucleotides on an individual basis.
In addition, the ongoing specialized advancements and significant price cuts in the field of digital picture security have made it feasible to present a variety of image-based analysis strategies at a level that is workable. This has made it possible to present these strategies at a level. Because the obtained image comprises dense data that is exceedingly difficult for the PC to interpret, preprocessing is required in order to extract a certain feature (such as shading and form) that has been physically determined by specialists. Deep learning is a technique that is widely utilized in these contexts since it enables a computer to discover the most useful characteristic on its own, independent of any input from a human. In 2016, the first attempt was made to employ deep learning for image-based plant disease

diagnosis. When compared to visual evidence, the trained algorithm achieved an accuracy of 99.35\% when classifying 14 different crops and 26 different diseases.

II. LITERATURE SURVEY

When investigating how to recognize and diagnose plant diseases using computer vision intelligently in agriculture, one of the most important questions to ask is "how do you determine the features?" Feature determination is a crucial question in pattern recognition, and it affects the design and operation of the classifier.

The diagnosis of cotton leaves has been suggested in a variety of articles using a variety of methodologies, and numerous usage patterns have been advised, all of which are represented and assessed here.

A simplified approach of extracting form and color data **[1]** employs an image with a homogeneous background to assist segmentation. This helps to reduce the amount of manual labor required.
Due to the fact that both shape and color are subject to change depending on the environment, these characteristics cannot be employed alone in the classification process. Instead, decision level fusion is utilized in this situation. Both the Polar Fourier Transform (PFT) and geometric techniques are utilized in the process of feature extraction. One example of this would be shape. Because the amount of pixels in the image is decreased when it is shrunk, the aspect ratio of the image is altered to be the same as that of the original image in order to cut down on the amount of processing required. The kurtosis feature is paired with other characteristics such as the mean, standard deviation, and skewness in order to obtain the color feature.

The k-Nearest Neighbor (k-NN) technique is used to process the collected data. This algorithm categorizes objects in feature space based on how close they are to one another. They assert that this method achieves an accuracy of 91.34 percent by utilizing the Polar Fourier Transform in conjunction with four geometry features and four-color features.

A technique for analyzing the visible phenotype of plant diseases by making use of photographs taken with a cell phone **[2]**. Utilizing characteristics such as texture, edge-based techniques, or the color histogram can assist in the production of homogenous areas within an image. In order to segment photographs, the k-means clustering method is applied, with the presumption that the backgrounds of the pictures are all the same. In order to create a hardware-independent image, the RGB image is converted to the color model L*a*b used by the Commission International de l'Eclairage (CIE), which is recommended by the International Commission on Illumination. An average filter mask with a size of 5 x 5 is applied in the L*a*b color space in order to rectify the image and remove the unwanted distortion. The image is segmented using the clustering technique in order to obtain three distinct images: one of the green, disease-free part of the leaf; one of the diseased areas of the leaf; and an image with a backdrop that is constant in intensity. The photograph of the leaf, including the diseased region, is sent to the pathology lab so that a diagnosis can be made.

[3] A technology that provides farmers with an interface for locating and treating plant disease on the leaves.
The purpose of the study is to determine the extent of the damage that has been done to the plant's leaves and then, with the use of that data, to forecast the extent of the harm that has been done to the plant as a whole. This will allow for improved disease control and increased crop yield. In most cases, a mobile device is used to perform the scanning of the leaf. Leaf capture, pre-processing, segmentation, and damage level estimates are some of the procedures that can be taken in order to detect and quantify damage. The photograph was taken against a backdrop that stays constant throughout. In order to prevent false predictions caused by dust, the sand or mud leaf is rinsed just before the photo is taken.

Entropy is applied to the process of selecting individual movie frames for image capture. Preprocessing the image includes performing a space transform, removing noise, and normalizing the image. This is done so that the image may be viewed on any device. After the image has been transformed from RGB to CIE (International Commission on Illumination) L*a*b format, a 5X5 filter-mask is utilized on it.

A model based on Artificial Neural Networks (ANN) that simplifies the process of identifying and classifying unwanted organisms **[4]**. The model is composed of three stages, with the first stage being the earliest discovery of the invasive species possible. In the first stage of the process of detecting pests, called pre-processing, the acquired image will have its level of noise reduced, and it will be made ready for the next stage of processing. After the image has been preprocessed, the k-means clustering technique is implemented to do the segmentation of the processed image. The next step is to identify the traits that are associated with the pest.
In order to extract features, DCT is typically applied. Classification is the third and final phase, and it is during this phase that pests are categorized according to the features that have been extracted. For the purpose of classification, artificial neural networks (ANN) are utilized because the feature set that was acquired was so extensive—almost 50 X 50. They used PCA in order to accomplish the goal of dimensionality reduction (Principal Component Analysis).

They assert that their strategy was successful in controlling White Flies, Convergent Lady Beetles, Assassin Bugs, and T. Plant Bugs at a rate of 94\% or higher.

A method that can detect and classify plant diseases in an automated fashion. The prior response **[6]** given by the author has been made more accurate by the solution **[5]**. The proposed solution may essentially be broken down into four stages. In the first step of the process, a device-independent color space transformation is applied to the color transformation structure for the leaf image. This structure was initially designed in RGB color space. The next stage includes applying the k-means clustering approach to the photographs in order to segment them. After the stage of segmentation is complete, the pixels with a predominant amount of green are located. The Otsu method is then utilized to establish a threshold value, which is then put to use to mask these individual pixels. After going through this process, the pixels that are truly green will be masked. The pixels that were found to have zero red, blue, or green value were then removed from the image. Also removed were the pixels that were found to be on the margins of the infected cluster. They claim that the algorithm can accurately detect and classify the disease with a detection rate that ranges between 83\% and 94\%. Because of this, the suggested technique is a powerful instrument for the identification of plant diseases.

A system that utilizes image processing techniques as well as Support Vector Machines (SVM) **[7]** for the purpose of providing an accurate and timely diagnosis of pomegranate leaf diseases. The region of interest from the input image of pomegranate leaves is extracted using the K-means clustering technique, which is also used in the process of color image segmentation. Following this, the region of interest is analyzed in order to collect substantial information regarding its color and texture for the SVM classifier's training. When classifying photos, entropy in conjunction with saturation and hue in conjunction with entropy are two distinct feature sets that are taken into consideration.

They claim that the system had an accuracy rate of 97.30\% when it came to detecting illness spots and classifying an image of a leaf that was taken using SVM. A technique that identifies and classifies plant illnesses by combining the Particle Swarm Optimization (PSO) algorithm with the Support Vector Machine (SVM) **[8]**.

The infected plant leaves that are included in the dataset were injured by a total of four different diseases. These diseases are referred to as Cercospora leaf spot, Bacterial Blight, Anthracnose, and Alternaria alternate. PSO is utilized in this technique in order to maximize the number of possible iterations that a solution for the detection of plant diseases can be optimized to. The classification and regression models are both implemented using Support Vector Machine. The image of a sick leaf serves as the input for the concept that is being suggested, and the illness kind may be determined to be the output of this concept. After the input image has been enhanced, the k-means clustering method is then used to construct clusters based on the feature classes. Disease symptoms are extracted using the feature values of standard deviation, skewness, homogeneity, contrast, smoothness, kurtosis, entropy, mean, variance, correlation, energy, root-mean-square, and inverse distance-mean. Later, the Particle Swarm Optimization technique is used to finish off the optimization and classification steps. They claimed that the strategy that was suggested demonstrated results with an accuracy that ranged from 95.16 percent to 98.38 percent.

A method for determining the location of the Pomegranate Leaf Disease The proposed methodology consists of five different stages **[9]**. During the initial stage of the process, which was dedicated to image capture, the method obtained photographs from the dataset. Images of a pomegranate leaf in both healthy and sick states were included in the dataset that was analyzed. The second stage of image enhancement involves increasing the contrast of the image in order to reduce the amount of noise that is already present in it. This is done in order to improve the quality of the image. The third stage consisted of segmenting the images that were being processed. Image separation is achieved through the application of the K-means clustering method. The fourth stage of the approach is the process of extracting features. At this point in the process, the following essential properties are extracted: mean, entropy, standard deviation, IDM, RMS, smoothness, variance, kurtosis, correlation, contrast, homogeneity, and energy. The feature vector is then constructed out of the subsequent values in that order. The procedure concludes with the fifth and final step of classification. The photographs are categorized using SVM, which is capable of dividing into a wide variety of classes.

A computer application that can automatically identify and classify the diseases that affect plant leaves. The methodology **[10]** can be broken down into four distinct elements and centers mostly on the processing of images. Once the color transformation structure has been created for the RGB color space image of a leaf, the device-independent color space transformation is carried out. Following this step, the image is transformed into the desired color.

In the second step of the process, the k-means clustering technique is utilized in order to fulfill the objective of segmenting the photos. In the third stage, the texture features of the segmented objects that have been infected are analyzed and estimated. During the last step, also known as the fourth phase, the collected features are provided to the previously trained neural network. According to the authors, the proposed method has an accuracy of approximately 93\% for both image detection and classification.

III. PLANT DISEASE DETECTION PROCESS

As can be seen in ***Figure 1***, there are fundamentally four stages involved in the process of identifying plant diseases. During the first part of the process, images can be obtained by using a digital camera, a mobile device, or the internet. In the second phase of the process, the image is segmented into a variable number of clusters, each of which has the potential to be processed using a different method. In the subsequent phase, which is called "the following phase," we will discuss the methods for feature extraction. In the last phase, we will discuss the classification of illnesses.

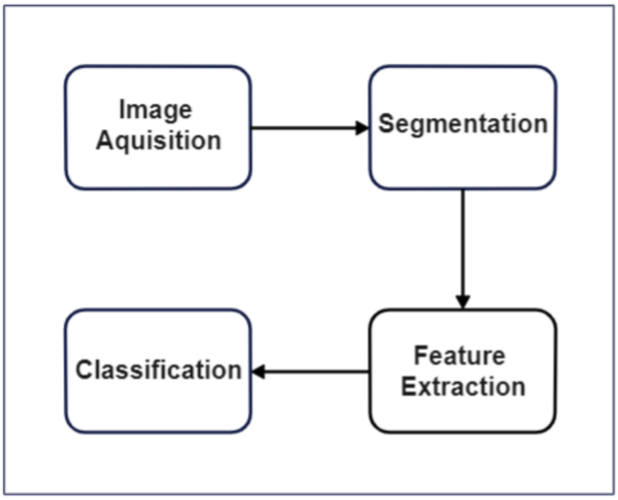

Figure 1 Phases of disease detection system

3.1 IMAGE ACQUISITION

In this stage, plant leaves are photographed digitally with the desired resolution and size using a variety of digital devices, including cameras, smartphones, and so on. The pictures can also be obtained from the internet. It is entirely up to the application system developer to determine whether or not a database of photos is created. The image database is what makes the classifier in the very final phase of the detection system so much more effective **[11]**.

Figure 2 Healthy Cotton Leaf

Figure 3 Unhealthy Cotto Leaf

3.2 IMAGE SEGMENTATION

[12] The goal of this phase is to simplify the representation of a picture so that it can be analyzed in a more understandable and straightforward manner. Because it acts as the foundation for feature extraction, this stage is also crucial to image processing. There are several different approaches that can be used to segment images, including k-means clustering, Otsu's algorithm, thresholding, and many others. The k-means clustering algorithm divides an input dataset into K classes by clustering pixels or objects according to a given set of features. The classification is carried out by reducing, as much as possible, the sum of squares of the distances that exist between the objects and the clusters to which they belong **[13]**.

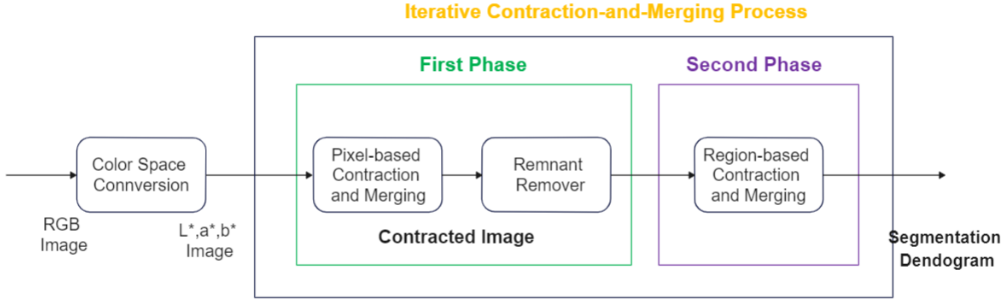

Figure 4 Image Segmentation

3.3 FEATURE EXTRACTION

Following segmentation, the output that has been accomplished up to this point is the area of interest. As a result, at this stage of the procedure, the features from this region of interest must be extracted. To understand the relevance of an example image, several qualities are necessary. Features can be distinguished by color, form, and even texture **[14]**. Recently, the majority of researchers have shown an interest in using characteristics of plant textures in their quest to identify plant diseases. The development of the system can make use of a wide variety of feature extraction strategies, all of which are available.

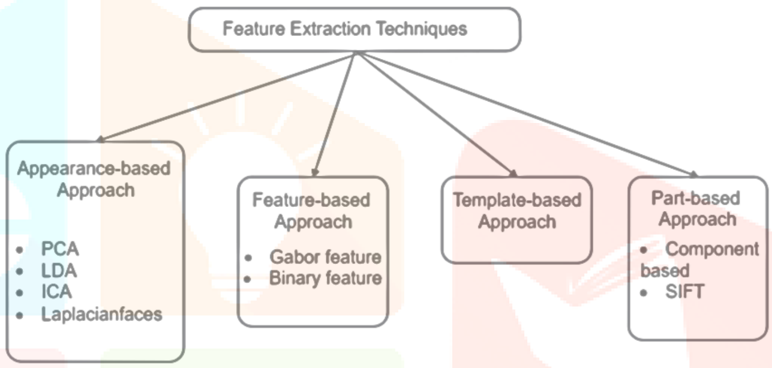

Figure 5 Various types of Extraction techniques

3.4 CLASSIFICATION

During the classification phase, it will be determined whether or not the input image shows a diseased or healthy state. In the event that the image is determined to be unhealthy, several previously published publications have additionally categorized it into a number of different disorders.

IV. CONCLUSION

The application of various methods and algorithms for the identification of illnesses in plant leaf images is given a high-level overview in this paper. The ability to accurately diagnose an illness requires a high level of both speed and precision. As a result, attempts are being undertaken to improve technology that can be used to identify diseases on diseased leaves in a manner that is rapid, programmable, effective, and more exact. The system that can identify a variety of leaf diseases and pests is amenable to being improved, which is conceivable.

The proliferation of pests has resulted in a greater drop in productivity as of recent times. As a result of this, there is a requirement for a system that is capable of performing automatic identification of pests that are difficult to see with the human eye. A method similar to this one can be of tremendous assistance to farmers in enhancing the quality of their crops and their overall output.

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