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Different Plant Disease Detection and Pest Detection Techniques Using Image Processing

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Abstract: *In India, agriculture is a significant industry. Our Indian economy is also heavily reliant on agriculture; given that agriculture employs near about 70% of the population, it is critical to boost crop/plant productivity. Farmers have struggled to achieve higher productivity and better market prices due to many sorts of crop diseases. As a result, early detection of plant diseases becomes an essential strategy for avoiding losses in an agricultural production system. The disease's symptoms are mostly noticeable on leaves. It's difficult to keep track of each plant manually across a large area. As a result, image processing techniques are used to observe and diagnose plant diseases, which may be a better option for detecting diseases fast and accurately. This paper provides the review of different plant disease and pest control techniques using image processing in the recent years.*

Keywords: *Image Processing, Agricultural, Disease Techniques, Pest Control.*

I. INTRODUCTION

Agriculture is straining to meet its needs as the global population grow is growing at a rapid rate. Agriculture is the primary source of food, raw materials, and fuel for a country's economic prosperity. A Crop disease has a negative impact on food output and quality. Crop diseases have a negative impact on small-scale farmers whose livelihood is dependent on proper cultivation. The ability to control agricultural diseases by identifying them as soon as they appear on crops has an advantage. Crop infections have grown significantly in recent years as a result of extreme climate changes and a lack of immunity in crops. This results in large-scale crop destruction, reduced, and eventually financial loss for farmers. Identification and treatment of disease has become a serious concern due to the fast expansion of a range of diseases and lack of basic knowledge among farmers [1].

Diseases, pests, poor circumstances, and nutrient shortage harm the plant in general. Infectious agent plant and microorganism diseases are measured using the classification of plant diseases squares. Clean eye observation by experts is a typical method of detecting disease. However, in order to prevent the plant from becoming infected, a quick and early detection is required [2]. Plant disease detection can be done using image processing techniques. Symptoms of disease can be noticed on the leaves, stems, and fruits in the majority of cases. The symptoms are shown on the plant leaf, which is used to detect the sickness [3]. The remaining part of the paper, is organized as follows. Section 2 deals with the different imaging techniques used in image processing. Section 3 includes the related work done in this particular area and finally Section 4 gives conclusion of the overall paper.

II. IMAGING TECHNIQUES

Following are the different imaging techniques used in image processing.

- 1) *Magnetic Resonance Imaging (NMR):* It is commonly referred to as a magnetic resonance imaging device and is distinguished by its powerful magnets. These magnets are useful because they efficiently polarize and further excite the focused proton individually contained in water molecules present in the tissue, resulting in a measurable signal that can be spatially encoded to produce different views of the body.
- 2) *Photo Acoustic Imaging:* Photo acoustic imaging is a hybrid biomedical imaging approach that was developed in response to the photo acoustic effect. It combines several advantages, such as optical absorption contrast and ultrasonic spatial resolution, to perform deep imaging of diffusive and other regimes.
- 3) *Tomography:* Tomography is one of the imaging techniques that uses a single plane or object to produce a tomogram. Tomography can be classified into linear, poly tomography, zonagraphy, computed type or computed axial, and Positron Emission tomography.

- 4) *Thermography*: Breast imaging is one of the most prevalent uses for it. Telethermography, dynamic angiothermography, and contact thermo graph are the three most prevalent techniques. The advantage of the idea gained from metabolic activity is used in imaging thermo graphic digital technologies.
- 5) *Multispectral Imaging*: Multispectral imaging techniques capture all forms of images, whether they are invisible or visible images of fruits, crops, or vegetation, using different types of wavebands such as green, red, or near infrared wavebands. For the detection of plant diseases, multispectral photos are combined with machine learning and classification algorithms, which transform the information into useful data.
- 6) *Hyper Spectral Imaging*: To combine different spectrum information concurrently, hyper-spectral imaging employs a combination of classic imaging techniques and spectroscopy. The goal of this technique is to determine the spectrum of each concerned pixel in the image under consideration.
- 7) *Fluorescence Techniques*: Plant photosynthetic performance has long been studied using fluorescent methods. This method is highly important for crop monitoring since it allows us to remove stress at an early stage, minimizing yield losses significantly.
- 8) *Thermal Imaging*: This is a method of converting the numerous forms of radiation detected from an item into multiple sorts of images in order to extract various attributes, analyze them, and classify them. It was initially developed for defensive purposes, but it has since found widespread application in a variety of disciplines, including agricultural engineering techniques.
- 9) *3D Imaging*: Data is collected from two different dimensions in 2D imaging, which distinguishes given plant identifiers such as development, overall height, and yield estimation. As a result, 3D imaging looks to be a requirement for automatic plant disease identification.

III. LITERATURE SURVEY

Omkar Kulkarni [1] suggested a Deep Convolutional Neural Networks algorithm that is trained using photos of healthy and damaged crop leaves from a public dataset. The program achieves this goal by categorizing images of leaves into ill or healthy categories based on defect patterns. For each class, the proposed methodology was tested on five different types of crops and three different forms of crop diseases. The InceptionV3 model outperforms the Mobile Net model in terms of accuracy and validation loss, according to the results. J. Karthika et al. [2] claimed that disease analysis is practicable and that the detection of cotton leaf illnesses is possible. The analysis of the various diseases present on cotton leaves is frequently early discovered in the early stage before it damages the entire plant, according to J. Karthika et al. To discover diseases in cotton leaves, k-means clustering will be utilized for feature extraction, and a support vector machine will be employed to find them.

R. Mounika et al. [4] describe a method for detecting and classifying several forms of crop diseases using image processing techniques. One of the picture techniques that automatically detects and classifies diseases is image segmentation. It is used to carry out a method for identifying and ordering leaf diseases. K-Means is used to divide the ill section. The surface highlights of the GLCM are then separated, and the arrangement is completed with SVM. For the location of infections in citrus leaves, this technique is being tested. Using image processing techniques, Md. Abdul Awal et al. [5] devised a method for detecting agricultural illnesses and providing a solution. The system was created using Android Studio. The image of afflicted crops is compared with the CDDASS database by the crops diseases detection and solution system (Crops Diseases Detection and Solution system). If CDDASS detects any disease symptoms, it will make recommendations to farmers so that they can make the best decision possible about whether or not to treat the affected crops with drugs. Various ways for segmenting the disease section of the plant were explored by Sachin D. Khirade and A. B. Patil [6]. This research also examined feature extraction and classification strategies for extracting infected leaf features and plant disease categorization. For disease classification in plants, ANN approaches such as self-organizing feature maps, back propagation algorithms, and SVMs can be employed well. Utilizing image processing techniques, we can accurately identify and classify numerous plant diseases using these methods. Muhammad Hammad Saleem et al. [7] carried out the difficult task of disease localization and categorization in plant leaves. The Tensor Flow object identification framework was used to apply three DL meta-architectures: the Single Shot MultiBox Detector (SSD), Faster Region-based Convolution Neural Network (RCNN), and Region-based Fully Convolution Networks (RFCN). To recognize disease in plant species, all of the deep learning models were trained and tested in a controlled environment dataset. The development and comparison of two alternative techniques for vision-based automated pest detection and identification utilizing learning algorithms is presented by Aitor Gutierrez et al. [8]. A deep learning solution is contrasted to a solution that combines computer vision and machine learning. The Region Proposal Network (RPN) is used to generate region proposals, while the Disease Detection Network (DDN) is used to identify diseases in the selected regions. The RPN proposes a collection of varied sized zones that appear to have a disease. In order to locate regions having an insect or an egg, a repressor and a classifier inspect proposed locations.

An automatic detection and extraction system was published by Johnny L. Miranda et al. [9], in which multiple image processing techniques were employed to detect and extract the pests in the acquired image. The system given is basic but effective. The procedure for extracting the detected objects from the image is straightforward: the image was scanned horizontally and vertically to determine each coordinate and store the object image. Faithpraise Fina et al. [10] offer a method for detecting and recognizing pests that combines the k-means clustering algorithm with the correspondence filter. The dataset is detected by dividing the data space into Voronoi cells, which tend to discover clusters of similar geographic extents, isolating the objects (pests) from the background (pest habitat). The detection is made by collecting the many distinguishing characteristics of the pest and its habitat (leaf, stem) and applying the correspondence filter to identify plant pests in order to produce correlation peak values for various datasets. This research also found that the recognition likelihood from a pest image is proportional to the height of the output signal and inversely proportional to viewing angles, confirming that plant pest recognition is a function of their position and viewing angle. It's heartening to see that the correspondence filter can achieve pest rotational invariance up to 360 degrees, demonstrating the algorithm's usefulness in detecting and recognizing plant pests

IV. COMPARISON

Table 1 shows the comparison overview of techniques that are used in the recent years for the detection of plant diseases.

| Journal | Title | Author | Description |
|--|--|--|--|
| Fourth International Conference on Computing Communication Control and Automation (ICCUBEA),IEEE | Crop Disease Detection Using Deep Learning | Omkar Kulkarni | Proposed a deep learning based model which is trained using public dataset containing images of healthy and diseased crop leaves. |
| Journal of Physics: Conference Series, ICCCEBS | Disease Detection in Cotton Leaf Spot Using Image Processing | J. Karthika et al. | Cotton leaf diseases detection and classification using image processing |
| International Journal of Engineering Research & Technology (IJERT) | Plant Disease Detection using Image Processing | Mr. V Suresh et al. | image processing is used for the detection of plant diseases by capturing the images of the leaves and comparing it with the data sets |
| Journal of Critical Reviews | Detection of Plant Leaf Diseases Using Image Processing | R. Mounika and Dr. P. Shayamala Bharathi | Detection of different types of diseases that are occurring for the crops and an algorithm. |
| Journal of Sensors | A Benchmarking of Learning Strategies for Pest Detection and Identification on Tomato Plants for Autonomous Scouting Robots Using Internal Databases | Aitor Gutierrez et al. | A dataset with a huge number of infected tomato plants images was created to generate and evaluate machine learning and deep learning models. |
| International Journal of Informatics and Communication Technology (IJ-ICT) | Density Based Clustering with Integrated One-Class SVM for Noise Reduction | Md. Abdul Awal et al. | This research developed for crops diseases detection and to provides solution by using image processing techniques. |
| International Conference on Computing Communication Control and Automation, IEEE | Plant Disease Detection Using Image Processing | Sachin D. Khirade and A. B. Patil | This paper not only discussed the methods used for the detection of plant diseases using their leaves images but also segmentation and feature extraction algorithm. |
| Plants, MDPI Journals | Image-Based Plant Disease Identification by Deep Learning Meta-Architectures | Muhammad Hammad Saleem | perform the complex task of plant disease localization and classification in a single framework |

Table 1. Comparison Overview

A. Few Mathematical Terms

1) *Mean*: Mean is the first moment of first order data statistics. It provides the average color value of whole image.

$$\text{Mean} = \mu = \frac{1}{n} \sum_{i,j} p(i,j)$$

where n = Number of pixels in image i = Number of rows j = Number of columns μ = Mean

2) *Variance*: Variance gives the square of the deviation of image distribution.

$$\text{Variance} = \sum_{i,j} p(i,j - \mu)p(i,j)$$

where i = Number of rows j = Number of columns μ = Mean

3) *Standard Deviation*: Standard Deviation is the second moment of first order data statistics. It gives the square root of variance of image distribution.

$$\text{Standard Deviation} = \sqrt{\frac{1}{n} \sum_{i,j} (p(i,j) - \mu)^2}$$

where n = Number of pixels in image i = Number of rows j = Number of columns μ = Mean

4) *Skewness*: Skewness is the third moment of low order data statistics. It gives measure of asymmetry in the distribution.

$$\text{Skewness} = \sqrt[3]{\frac{1}{n} \sum_{i,j} (p(i,j) - \mu)^3}$$

where n = Number of pixels in image i = Number of rows j = Number of columns μ = Mean

V. CONCLUSION

In the India, Agriculture employs near about 70 percent of the population, either directly or indirectly. Crop infections have grown significantly in recent years as a result of extreme climate changes and a lack of immunity in crops. This results in large-scale crop destruction, reduced cultivation, and eventually financial loss for farmers. Identification and treatment of disease has become a serious concern due to the fast expansion of a range of diseases and a lack of basic knowledge among farmers. Hence, in order to prevent the plant from becoming infected, a quick and early detection is required. The investigation of various image processing approaches and applications for pest identification and plant disease detection was developed in the recent year, and it is presented in this research.

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