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Survey on Plant Leaf Diseases Detection and Classification Using Image Processing and Deep Learning Techniques

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Abstract *– Destructive insects and plant leaf diseases pose serious problems for the agricultural industry. A quicker and more precise prediction of leaf diseases in crops could aid in the creation of an early treatment method while significantly lowering financial losses. Researchers have been able to significantly increase the performance and accuracy of object identification and recognition systems because to recent advances in deep learning. This paper details the development of deep learning technologies in recent years for the diagnosis of crop leaf diseases. Using deep learning and cutting-edge imaging techniques, we explain the current trends and difficulties in the identification of plant leaf disease in this study. We anticipate that this work will be a useful tool for scientists looking into the identification of plant diseases and insect pests.*

Keywords*: Deep Learning, Plant Leaf Disease Detection, Visualization, Small Sample, Hyperspectral Imaging,*

I. Introduction

The backbone of the Indian economy is agriculture.

Agriculture's massive commercialization has had a very bad impact on the environment. Chemical pesticides have caused a massive buildup of chemicals in our environment, including the land, water, air, wildlife, and even our own bodies. Artificial fertilizers have a short-term positive impact on productivity but have a longer-term detrimental impact on the environment, poisoning ground water after years of leaching and runoff. This trend has also had a detrimental impact on the fortunes of farming communities around the world. Despite this allegedly enhanced production, farmers' fortunes have declined in nearly every nation in the world. Herein lies the value of organic farming. Each of these issues can be resolved by organic farming. The main techniques used in organic farming include fertilization, insect and disease management.

Plant diseases have a detrimental effect on agricultural production. Food insecurity will rise if plant diseases are not identified in time [1]. Plant diseases must be prevented and controlled effectively on the basis of early detection, and they are a key factor in managing and making decisions regarding agricultural productivity. Identification of plant diseases has been a critical concern in recent years.

Plants with a disease typically have noticeable stains or lesions on their leaves, stems, flowers, or fruits. The majority of diseases and pest conditions exhibit a distinct visual pattern that can be utilised to specifically identify irregularities. Most disease signs may first develop on the leaves of plants, which are typically the main source for identifying plant illnesses.

On-site identification of diseases and pests of fruit trees is typically done by agricultural and forestry experts, or by farmers using their own knowledge. This approach is not only subjective, but also arduous, time-consuming, and ineffective.

Farmers with little experience could make mistakes and utilize medications carelessly when making identifications. Environmental contamination brought on by quality and output will result in avoidable financial losses. The use of image processing methods for plant disease recognition has emerged as a popular study area to address these issues.

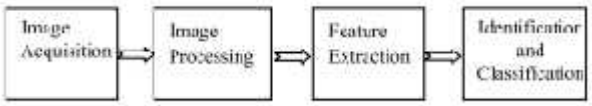

Fig.1 Traditional image recognition processing

The general process of using traditional image recognition processing technology to identify plant diseases is shown in Fig. 1.

The ability to diagnose plant diseases by visual inspection of their signs on plant leaves is becoming increasingly complicated. Due to this complexity, the

vast array of cultivated crops, and the psychopathological issues they currently face, even seasoned agricultural experts and plant pathologists frequently struggle to accurately diagnose particular diseases, which results in them drawing incorrect conclusions and worrying solutions. Inexperienced farmers could benefit greatly from an automated system that can recognize plant diseases based on the way the plant looks and its visible symptoms. Farmers will find this to be a valuable strategy that will warn them just in time to prevent the disease from spreading over a vast area.

Fig.2 Diseases affected leaf images

II. Literature Survey

Marwan Adnan Jasim et. al. have Convolutional neural networks (CNNs) are employed in the proposed system to classify plant leaf diseases into 15 different categories, including 3 classes for healthy leaves and 12 classes for diseases of various plants that were found to exist. As a result, they were able to achieve very high accuracy in both training and testing, with accuracy values of (98.29%) for training and (98.029%) for testing for all employed data sets.

Lili L et al. have described the prevailing patterns and difficulties in the identification of plant leaf disease utilising deep learning and cutting-edge imaging methods. They anticipate that this work will be a useful tool for scientists looking into the identification of plant diseases and insect pests. They also talked about some of the present difficulties and issues that need to be fixed at the same time.

M. Akila et al. have proposed a deep-learning-based method to identify leaf diseases in numerous plant species using plant leaf photos. Our objective is to identify and create deeper learning approaches that are better suited to our mission. As a result, we focus on three primary families of detectors: Single Shot Multibox Detector (SSD), Region-based Fully Convolutional Network (R-FCN), and Faster Region-based Convolutional Neural Network (Faster R-CNN). The suggested method has the capacity to handle complex situations from a plant's area and can successfully identify various disease types.

Mr. Sanjay Mirchandani et al. 38 photos were used for the collection of algorithms that were used for neural training. The algorithms can be improved by increasing the number of features and inputs to the neural network. The agriculture industry may benefit greatly if this method is expanded into a complex user interface in the form of a website or Android application.

Sripada Swain et al. India is known for its fame in agriculture among farmers. All countries rely on agricultural products to grow their economies. Plant diseases cause a decrease in agricultural productivity in both quantity and quality. Examination of the study of blatantly obvious patterns on plant leaves is referred to as plant disease. Therefore, identifying diseased plant areas may be a technique to prevent crops from declining in output. To control and treat plant illnesses caused by viruses, bacteria, fungi, etc., early identification is crucial. The procedure of manually identifying diseases takes a lot of time. To identify the condition, several professionals are therefore needed. There are numerous established techniques, including machine learning models, image processing, and classification models.

Muhammad Hammad Saleem et al. have Early detection of plant diseases is crucial since they affect the development of the affected species. For the identification and classification of plant diseases, many Machine Learning (ML) models have been used, however with the development of a Deep Learning subset of ML. According to (DL), this field of study has a lot of promise for improved accuracy. In order to identify and categories the signs of plant diseases, numerous developed/modified DL architectures are used in conjunction with a number of visualization techniques. Additionally, a number of performance indicators are employed to assess these structures and methodologies. This article offers a thorough justification of the DL models used to depict various plant diseases. Additionally, several research holes are noted in order to provide transparency for identifying disorders in plants, even before their symptoms appear clearly.

III. Existing Work

Existing work related to leaf disease detection using CNN show to detect and classify leaf disease using image processing techniques that follow steps like.

Image Acquisition: image acquisition in the first load the image in digital picture process and that consist capturing the image through digital camera and stores it in digital media for additional MATLAB operations.

Image Preprocessing: The main aim of image pre-processing is to enhance the image information contained unwanted distortions or to reinforce some image features for any processing. Preprocessing technique uses various

techniques like dynamic image size and form, filtering of noise, image conversion, enhancing image and morphological operations.

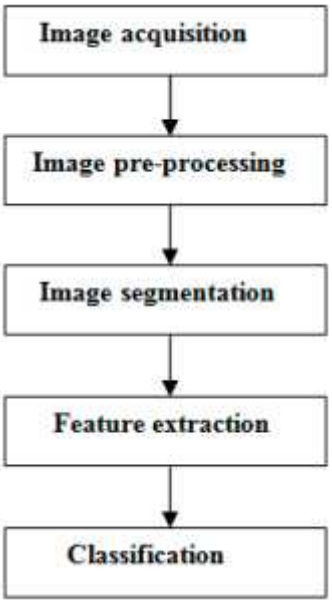

Fig.3 General Block Diagram of Feature Based Approach

Image Segmentation: In image segmentation is used K-means cluster technique for partitioning of pictures into clusters during which a minimum of one part of cluster contain image with major space of unhealthy part. The k means cluster algorithmic rule is applied to classify the objects into K variety of categories per set of features.

Feature extraction: After clusters are formed texture features are extracted using GLCM. (Gray-Level Co-occurrence Matrix).

Classification: In classification is used for testing the leaf disease. The Random forest classifier is used for classification.

IV. Deep Learning

A subclass of machine learning, deep learning (DL) underwent three stages of development after its introduction in 1943. The first version of neural network-MCP (1943–1969) is a linear model that can only handle linear classification problems. It was developed in 1943.

Back propagation (BP) neural networks, second generation (1986–1998) Hinton developed the sigmoid function for nonlinear mapping and the BP algorithm suitable for multi-layer perceptrons (MLP) in 1986, which successfully addressed the issue of nonlinear learning and classification. The second surge in neural networks was brought on by this technique. However, a gradient vanishing issue with the BP method was identified in 1991.

The third-generation DL neural network: Hinton gradient vanished in the deep web training in 2006, although this problem's solution is not given any special attention or effective experimental verification. ReLU activation function, which effectively prevents the gradient disappeared problem, was not proposed until 2011. Once the outbreak period in 2012 arrived, the Hinton team used a deep learning model called AlexNet to win the renowned ImageNet image recognition competition, outperforming the second method by a wide margin (SVM). Since then, other researchers have become interested in CNN.

Following the launch of AlexNet, the DL architecture started to change over time, as depicted in VI. In order to detect plant diseases, a variety of cutting-edge DL models and architectures were used for picture recognition, segmentation, and classification.

V. Conclusion

Crop protection in organic farming is not an easy task. It requires in-depth understanding of the crops that are farmed as well as their possible weeds, diseases, and pests. This study taught the fundamentals of deep learning and provided a thorough analysis of recent research on the use of deep learning to identify plant leaf diseases. This article provides a thorough analysis of the detection and classification of plant leaf diseases. With several ML classifiers, the literature review finds superior outcomes for plant leaf disease detection and classification. The difficult challenge, according to some, is performance enhancement for the identification and categorization of plant leaf disease. The article's review contributes to achieving that.

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