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Machine Learning Based Plant Leaf Disease Detection - A Review

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***Abstract*—In this Review paper discuss on the Machine Learning (M.L.) algorithms have been widely used in the field of plant disease detection. Because of their ability to make accurate predictions and learn from data. This study provides an overview of the application of machine learning for plant leaf disease detection. Early detection and diagnosis of plant diseases from leaf photos using machine learning is an important and demanding research subject in the realm of agriculture. The article starts out by describing the numerous kinds of plant leaf illnesses before talking about the various methods for detecting plant leaf diseases, including image processing and machine learning algorithms. The article also discusses some recent developments in the field, such as the use of deep learning architectures and transfer learning for the identification of plant leaf diseases.**

Keywords*— *Plant Disease; Machine Learning; Feature Extraction;Plant Leaf Disease.

I. INTRODUCTION

Agriculture is considered as one of the main sources of the economy in India. Like human beings, plants also suffer from diseases which affect the normal growth of a plant. Diseases can be in any part of the plant including leaf, flower, fruit and root. Due to the complexity and huge number of crops and cultivated plants, the number of diseases is also large. Thus, a pathologist may often fail to diagnose a disease accurately [9]. The precise and timely diagnosis of plant diseases protects crops from quantitative and qualitative loss. Most farmers have a lack of knowledge about the effective detection of plant diseases. The identification of plant disease by the naked eye is also time-consuming, requires continuous monitoring and is less accurate in nature. The automated identification of diseases reduces human effort and also provides accurate results. Automated plant disease detection is highly beneficial to farmers, since they know less about plant disease [10].

Many works are ongoing in the domain of machine learning, which can be used effectively in the field of health monitoring, the identification of diseases in plants, etc. This kind of system provides reliable, precise results and reduces the time, cost and manpower for maintaining and ensuring quality in real-time applications. In the field of agriculture, there are a lot of opportunities for researchers to apply machine learning techniques in many aspects, such as the identification of plants, early detection of diseases, pesticide, nutrition requirement, etc [11]. In this paper, we consider the diseases which occur on the leaves of the plant. Several machine learning techniques are discussed in this paper, which were proposed by different researchers based on colour, shape, texture features and deep learning models for detecting diseases in plant leaves [12].

The automated detection of diseases in plants has been studied largely in recent times. The identification of diseases in plants requires accurate and precise information regarding the quantitative measurement of diseases. the authors studied potato and tomato diseases and showed how these crops were affected by viruses. surveyed several papers on the classification of rice diseases and also considered different criteria such as the dataset used, disease classes, pre-processing and segmentation techniques along with the classifier used. To classify the diseases using handcrafted features, there is a need for the

pre-processing, segmentation and extraction of features from the images, which is laborious and time-consuming.

II. LITERATURE SURVEY

MD Tausif Mallick, et. al. (2023)- In this research study, A large part of the population in India is completely dependent on *mung bean*. So, high production efficiency for the *mung bean* is required, which does not happen due to the excessive damage from pests and diseases. Recently, with the advancement of Deep Learning techniques, remarkable performance has been achieved in the field of image classification by employing Convolution Neural Networks (CNNs). This brings a lot of promise in the field of pest and disease identification by effective image classification. In this paper, we have proposed a novel deep learning-based technique to identify the *mung bean* pest and disease. In order to handle the limitation arising due to less number of *mung bean* crop images for the purpose of training, we have adopted transfer learning, which is able to generate a very promising result for quick and easy pest and disease detection [01].

Rabbia Mahu., et. al. (2023) - This research work, an automated technique for disease detection and classification for potato leaves is proposed. The proposed model is trained for the five classes such as Potato Healthy (PH) and four diseased classes i.e., Potato Late Blight (PLB), Potato Early Blight (PEB), Potato Leaf Roll (PLR), and Potato Verticillium wilt (PVw). Moreover, due to limited datasets, the 1700 leave images for the PLR (750), PVw (750) and PH (200) have been captured under a normal environment to make the proposed algorithm more robust and contextual independent [02].

Raj Kumar., et.al. (2022) – In this research work presented, Computer vision-based systems employ a well-defined series of steps starting from image acquisition followed by various image-processing tasks including scaling, filtering, segmentation, selection, and extraction of features, and eventually, machine learning- or deep learning-based algorithms are used for recognition and classification. We also looked at a variety of current research studies that used machine learning- or deep learning-based algorithms to recognize and analyze plant diseases. Further, we presented parameter-wise dissection for the parameters like type of crop used, classifiers used, nature of datasets, and highest accuracy achieved by different classes of classifier [03].

Hilman F. Pardede et. al. (2020) - The presented machine learning technologies for management and monitoring of agricultural products are gaining significant interests. One of them is for plant diseases detection. Plant diseases are major cause of crop losses. The existence of automatic plant diseases detection is essential to predict the plant diseases as early as possible, and hence, reducing the crop losses. In this paper, we present a review of advancement of machine learning technologies for plant diseases detection. Various approaches have been proposed in the field. In this review, we group them into two: works that focus on finding good features for shallow machine learning architectures such as SVM, those that focus on applying deep architectures of machine learning such as deep convolution neural networks (CNN). For the later, we observe that the works either applied CNN as classifier or as feature learning. Our survey shows that while (CNN), have become the lead technologies in the field, replacing shallow architectures like SVM, many challenges still remain. First is the issue of robustness against environmental conditions. Second in on how to deal large variety of data and diseases with limited number of data [04].

Muhammad Hammad Saleem, et. al. (2020) - In this research work, The identification of plant disease is an imperative part of crop monitoring systems. Computer vision and deep learning (DL) techniques have been proven to be state-of-the-art to address various agricultural problems. This research performed the complex tasks of localization and classification of the disease in plant leaves. In this regard, three DL meta-architectures including the Single Shot MultiBox Detector (SSD), Faster Region-based Convolution Neural Network (RCNN), and Region-based Fully Convolution Networks (RFCN) were applied by using the Tensor Flow object detection framework. All the DL models were trained/tested on a controlled environment dataset to recognize the disease in plant species. Moreover, an improvement in the mean average precision of the best-obtained deep learning architecture was attempted through different state-of-the-art deep learning optimizers [05].

L. Sherly Puspha Annabel, et. al. (2019) - In this research work, summaries various techniques used for classifying and detecting various bacterial, fungal and viral plant leaf diseases. The classification techniques helps in automating the detection of plant leaf diseases and categorizing them cantered on their morphological features. The future work of this paper focuses on identifying the mulberry plant leaf diseases with CNN as classifier. It is also intended to focus on increasing the recognition rate and classification accuracy of severity of leaf diseases by using hybrid algorithm [06].

Pragati Pukkela, et. al. (2018) - This research work, Agriculture plays a crucial role in the economic growth of a country as it is one of the main means of subsistence. Recently, technological methods have been designed for the identification of plants and detection of their diseases in order to meet the new challenges facing farmers and their learning needs. This chapter provides an overview of various methods and techniques for feature extraction, segmentation and the classification of patterns of captured leaves in order to identify plant leaf diseases and the estimation of their severity. This chapter analyses various automatic grading systems and parameters used in

estimating the severity of different plant diseases and discusses a variety those plant diseases [07].

Jihen Amara, et. al.(2017) **-** This research work as a result, Agriculture suffers from a severe problem, plant diseases, which reduces the production and quality of yield. Besides, the shortage of diagnostics tools in underdeveloped countries has a devastating impact on their development and quality of life. Hence, there is an urgent need to detect the plant diseases at the early stage with affordable and easy to use solutions. To this end, in this paper, we presented an approach based on convolution neural networks to identify and classify banana diseases. The proposed model can serve as a decision support tool to help farmers to identify the disease in the banana plant. Hence, the farmer can take a picture of the leaf with the symptoms and then the system will identify the type of the disease. Our main contribution is to apply deep neural networks to detect two famous banana diseases which are banana sigatoka and banana speckle in real scene and under challenging conditions such as illumination, complex background, different images resolution, size, pose and orientation [08]**.**

III. Basic Steps in Identification of Diseases from Leaf Images

For the effective identification of plant diseases from the leaves of a plant, several steps are required, and among all those, data collection and pre-processing are the first steps. After pre-processing, the next step in the identification of diseases is the extraction of features. Finally, the features are fit into different classifiers for classification

A. Data Collection

The first step in plant disease identification is the collection of image data. Several standard plant diseases datasets are available online such as the Plant Village dataset, Cassava dataset, Hops dataset, Cotton disease dataset and Rice disease dataset. The Cassava disease dataset consist of five different classes of diseases and the images are real-time field-captured images. Diseases in the Cassava dataset includes cassava mosaic disease, cassava bacteria blight, cassava brown streak disease, cassava green mite and cassava healthy. The Hops dataset consists of five different classes of diseases with no uniform background conditions. Diseases include downy, powdery, healthy, nutrient and pest diseases. The Cotton dataset consists of healthy and diseased cotton leaves and plants. The Rice disease dataset consists of four different classes of diseases captured in field conditions. Diseases in the Rice disease dataset are bacterial blight, blast, brown spot and tungro. Some of the researchers built their own diseases dataset in their work. .

B. Preprocessing

Preprocessing is one of the most important steps in the identification of plant diseases. Several preprocessing steps exist such as the resizing of the images to fit the model, the removal of noises, color transformation, morphological operations, the segmentation of the disease region, etc. Different filtering techniques, such as the Wiener filter, median filter and Gaussian filter, are used to remove the noises in the disease-affected image. Different color spaces are used in image processing, such as RGB, HSV, CIELYCbCr. To find the region of interest (ROI)/disease area in the leaf images, different segmentation techniques are used such as color thresholding the Sobel edge detector Otsu's segmentation and K-means clustering.

C. Feature Extraction

Features play an important role in machine learning. Features are used to describe the disease information in mathematical form, which makes the classification easier. For an effective classification, a feature should contain the necessary information that is required to differentiate the classes. Different types of features are used for the identification of diseases, and they can be classified as colour features, shape features, texture features] and deep-learning-based features. Colour features define the different colour values of the disease region. The area, perimeter, minor/major axis length, eccentricity, etc., are some of the shape features. Texture-based features such as local binary pattern (LBP), gray-level co-occurrence matrix (GLCM) gray-level run-length method (GLRLM), Gabor texture features are used for the identification of diseases. **Figure 1** shows some of the features that are used in classification of plant diseases.

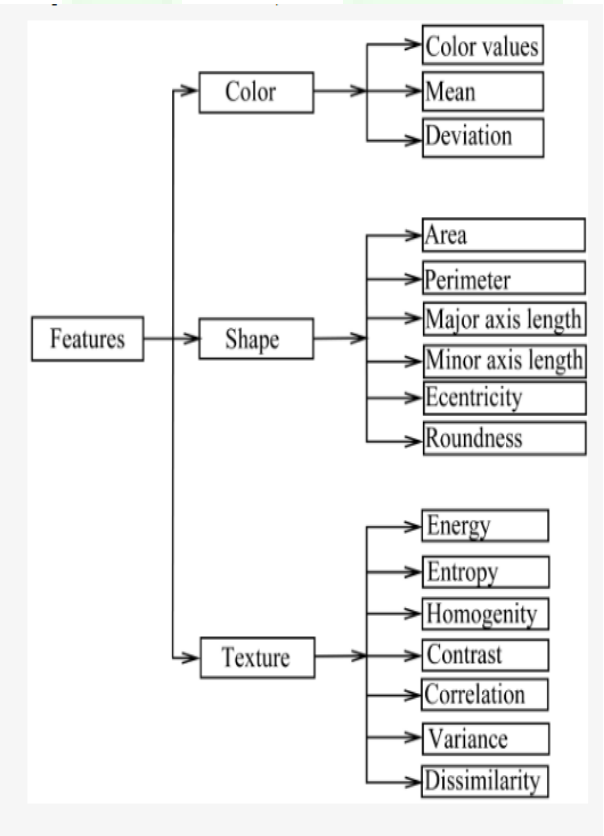

Fig.2. Some of the features used in plant disease detection.

D. Classification

Classification is the numerical analysis of various image features, and it organizes the leaf image data into some of the disease categories. Classification is categorized as supervised and unsupervised classification. Some of the commonly used classification techniques are K-nearest neighbor (KNN), support vector machine (SVM), logistic regression (LR), random forest (RF), decision tree (DT), naive Bayes (NB), artificial neural network (ANN)and probabilistic neural network (PNN).

IV. Different Existing Machine Learning Based Techniques for Plant Disease Detection

Numerous works have been conducted to date related to the identification of plant diseases. In this section, we discuss different methodologies that have been proposed by researchers for the detection of different plant diseases. It is found that the disease detection techniques based on machine learning can be classified by color, shape-, texture-based features and deep learning models. **Figure 2** shows the basic steps in the identification of plant diseases [14].

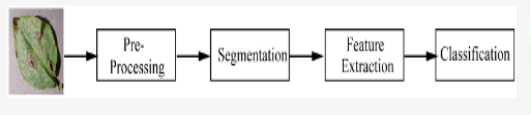

Fig.3. Basic handcrafted-features-based steps for identification.

A. Deep-Learning-Based Identification of Diseases

Deep learning (DL) has achieved an exponential growth in the field of computer vision tasks such as object detection, pattern recognition, classification and biometry [15]. DL models exhibit outstanding performance in image recognition task such as the Image Net challenge. This image recognition idea extended to the agricultural field plant identification, disease detection, pest recognition fruit identification and weed detection. In DL, there is no need for segmentation and feature extraction as a DL model has the ability to learn the features automatically from the input images [18].

Deep learning-based identification of diseases is a field of study that utilizes advanced artificial neural networks to automatically detect and diagnose various diseases. Deep learning is a subset of machine learning that uses complex neural networks to process large amounts of data, recognize patterns, and make accurate predictions [15-16].

The goal of deep learning-based disease identification is to create models that can analyze medical images, electronic health records, and other medical data to identify signs of diseases accurately and quickly. This technology can help doctors and healthcare professionals to make more accurate diagnoses, identify diseases earlier, and provide better treatment options to patients [20-22].

Deep learning-based disease identification has shown promising results in various areas, such as identifying skin cancer, diagnosing lung cancer, detecting diabetic retinopathy, and predicting heart disease. The ability to accurately diagnose and predict diseases can significantly improve patient outcomes and reduce healthcare costs. However, there are still challenges to be addressed, such as the need for large and diverse datasets, robust model training and validation, and ethical considerations regarding privacy and bias [25].

V. CONCLUSION

In this survey paper discuss survey of different machine learning approaches for the identification of plant diseases using leaf images. plants suffer from different diseases which affect their normal growth. This survey consisted of the identification of diseases using handcrafted-features-based method and DL-based methods. Through the survey of the identification of diseases using shape- and texture-based features, we can conclude that pre-processing and segmentation techniques play a major role in increasing accuracy and other result parameters.

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