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Detection of Plant-Leaf Diseases with the Application of Deep Learning Techniques: A Review

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Abstract- In India, a considerable proportion of the population relies on agriculture as their primary source of income, as well as meeting one of the fundamental requirements for human survival. Agriculture is an essential component in the economic development of many nations. The harvest is contaminated with a wide variety of diseases due to the varied weather and environmental conditions that exist there. In the early phase of the disease, it is possible to see the majority of symptoms on the plant's leaves; nevertheless, the disease will ultimately affect the whole plant, which may result in less crop yield. The diagnosis of diseases in plants is an essential step in reducing production losses in the agricultural sector and improving the overall quality of food and other products derived from agriculture. When there are a large number of plants in a field, it may be challenging to recognise illness and to identify specific plant breakdowns from natural eye observation in agricultural settings. It is essential to do checks on all crops in order to prevent the illness from spreading over a vast area. It is essential to have precise sickness diagnosis and control measures in order to prevent disease in its early stages in order to maintain superior product quality while simultaneously increasing production levels. This recommended model will be AI-based software for the detection of crop leaf infections, which will make the diagnostic process more expedient and straightforward. Subsequently, it will evaluate this information and generate solutions that are foreseeable with the goal of preventing enormous crop cultivation loss. This strategy seeks to increase the profitability of farming by increasing the value of the crops produced. In this model, we are required to perform a number of operations, including the collecting of image data sets, the pre-preparation of the data, the selection of features from the leaf image, the evaluation, and the categorization of diseases..

Keywords- Deep Learning, Plant Disease Identification, Plant Health Assessment..

I. INTRODUCTION

Agriculture has evolved into a critical need for human survival as well as for the development of any nation. In India, agriculture employed more than half of the population in 2018 and contributed around 17-18 percent to the country's gross domestic product [1]. Food is a necessary for all humans, and in this day and age of technology and knowledge, any individual who want to work in an industrial setting and enjoy a lavish lifestyle must meet this requirement. As the number of farmers continues to decline and the global population continues to grow, it becomes more important to maintain continual scale-up in agricultural output.

Crops are subjected to a variety of features or illnesses as a result of differences in weather, soil, and local conditions; thus, having a disease in plants is rather normal. More leaf falls, less growth, worse-quality product and lower product production are all possible consequences of the illness having an influence on the practical limit of the plants. In certain circumstances, the illness is spread from one location to another by the spread of seeds, or it may spread fast through the spread of germs and insects. Bacteria, pests, viruses, and fungus are the most common causes of crop disease in the United States. As a result, in the agricultural industry, the identification of plant diseases is very crucial for crop production. Plant disease is a major source of worry because, if it is not detected and treated in a timely manner, it may have a considerable impact on the quality and quantity of agricultural products. It has been observed that crops are contaminated in a vast region owing to illness, which has a negative influence on the country's development, and that a scarcity of food has led to a rise in hunger and inflation.

Before the widespread use of information technology, the most common method of recognising plant disease was by direct observation with the naked eye. This method requires the participation of huge groups of plant specialists, the monitoring of plants, and the conducting of frequent inspections on agricultural fields. In addition to being prohibitively costly, this manual disease detection approach is not ideal for broad agricultural regions. [2]

All of the farmers do not have the competence to spot pests, and manual analysis is less reliable. As a result, farmers may use incorrect pesticides, which results in lower yields. Eye-naked observation takes a long time, requires a great deal of effort, and is not practicable for vast fields of view. Automated plant disease detection will be particularly useful in this situation, since it will allow for the early diagnosis of illness in broad agricultural regions.

This procedure of disease identification is mostly accomplished by the observation of indications and characteristics on a plant's leaf. It has the potential to be more precise and efficient, requiring less time and effort while still being ideal for big farms. Fungal organisms are the most common source of plant infections; however, other species such as bacteria and viruses are also responsible for the illness of feed crops and other plants.

Plant disease symptoms are obvious signals of infection that have a perceptible effect on the plant, while plant disease signs are observable evidence of infection on the plant. Single and multicolor spots, observable colour change, the shape of leaves, early and late scorch, bird-eye spot on barriers, brown and yellow spots, and other symptoms of plant disease include: single and multicolor spots, observable colour change, the shape of leaves, early and late scorch, bird-eye spot on barriers, brown and yellow spots, and so on.

II. LITERATURE SURVEY

Many analysts have collectively contributed to the achievement of the goal of plant disease detection through the use of advancements in technologies and computational capability, such as artificial intelligence, image pre-processing, machine learning, deep learning, transfer learning, genetic algorithms, big data, the Internet of Things, and so on. There are various limitations to the models that have been offered. Because the data pre-processing is difficult, and the selection of characteristics is dependent on the model, the accuracy of illness diagnosis is not always high, even when analysing a large range of pests and diseases, according to the authors.

Ghaiwat et al. (2014) "Detection and Classification of Plant Leaf Diseases Using Image Processing Techniques" (Detection and classification of plant leaf diseases using image processing techniques) "Several classification approaches, such as artificial neural networks, super vector machines, self-organizing maps, and fuzzy logic, were used in the study's classification. They discovered the k-nearest-neighbor strategy is the least difficult and typically plausible among the variety of computations for class prediction. If the training information is not separable, then it will be difficult to determine the optimal parameter in a super vector machine [3, for example].

Adhikari Santosh and colleagues (2018) published "Tomato Diseases Detection System Using Image Processing" in Scientific Reports "the data set contains 520 images of tomato leaves with three different leaf diseases, including Bacterial Canker (111 examples), Gray spot (113 examples), Late Blight (121 examples), and healthy tomato leaf images. Based on the plant village dataset, they were able to attain an accuracy of 89 percent with their method. There is a restriction in that this method can only identify three types of illnesses and one healthy plant at the same time. [5] To identify different types of illnesses, data must be trained on the present model in order to detect them.

Wu Jianyu and colleagues (2019) "Detection of Crop Pests and Diseases Using Deep Convolutional Neural Network and Improved Algorithm", in Proceedings of the National Academy of Sciences of China. A machine learning technique combined with sophisticated architecture AlexNet and GoogleNet **-** is used to diagnose plant illnesses in this research work, which is published in the journal Plant Disease. The author has put in a lot of effort into presenting a network that is reliant on transfer learning and information-development and that enhances the accuracy of identification and hence increases its effectiveness. In this study, 38 different kinds of normal and diseased leaf samples were utilised. The model proposed here is complicated, and it requires a quicker rate of convergence [6].

Sardogan Melike and colleagues (2018) published "Plant Leaf Disease Detection and Classification Using CNN with LVQ Algorithm" in Nature Communications. For the purposes of plant health assessment and disease detection, this model makes use of the CNN classifier. The author has utilised a dataset of 500 photos in this model, with 20% of the images being used to test the proposed model and the remaining 80% being used to train the system. They found a total of 5 classes of plant leaves for categorization, one of which was healthy and the other four of which were contaminated. They have employed pictures of 512x512 pixels in size, which are fairly good, and have used the R, G, and B channels matrix for the CNN contribution, with the result being fed into the Learning Vector Quantization algorithm. It was possible to achieve a normal precision of around 88 percent. This technique was shown to be suitable for identifying tomato-specific disorders[4].

Using a Convolutional Neural Network model, Hyeon Park et al. (2017) published "Image-based disease diagnosing and prediction of the crops by the deep learning mechanism." The model was utilised for leaf disease detection in their paper. The author has only completed a restricted categorization of strawberries that are healthy and free of powdery mildew. Infected flowers, foliage, and fruits are susceptible to powdery mildew, a moderate disease. The author has employed a relatively limited dataset of just 500 images for his research. The system consists of two convolutional networks and three fully linked networks, which are used to identify illnesses of the strawberry leaf. On a CPU, this model achieves an overall accuracy of 89.7 percent. The images in this model have been reduced to 227x227 pixels, and the objective function is being used to train the model.

Saradhambal.G. and colleagues (2018) "Detection and Treatment of Plant Diseases Using Image Classification" is the title of the paper. The Otsu classifier and the K-means clustering approach were utilised in this model. By employing the segmentation approach, this model was able to analyse the affected portion of the leaf. With the use of a feature extraction and classification technique, it can distinguish between healthy and sick leaves on the plant and categorise them accordingly. In this paradigm, the integrated voice navigation system is responsible for guiding the user through the whole procedure. They have not mentioned the accuracy that was attained with the suggested technique, nor have they discussed how tiny the dataset was.

III. PROPOSED METHEDOLOGY

It is intended to analyse and diagnose plant disease using the suggested deep learning algorithm, which is based on deep learning algorithms. This Model includes leaf retrieval, picture segmentation, and identification, all of which are accomplished via the use of a focused deep learning algorithm.

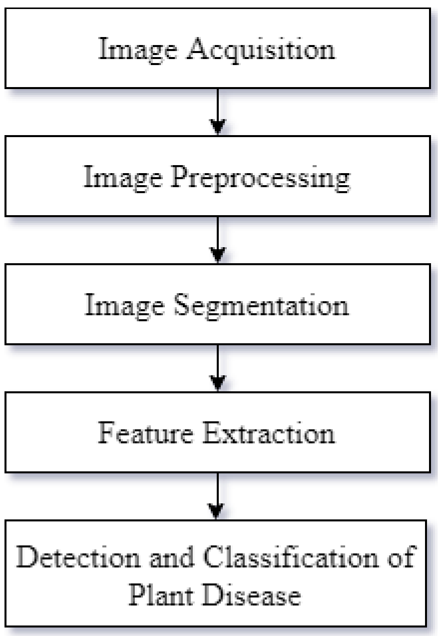

Fig 1. The basic procedure of the proposed approach.

1. Image Acquisition:
The initial stage in this strategy is to acquire data from the publicly available repository (see Figure 1). Various types of plant leaves are included in this dataset, including healthy leaves as well as samples of leaves that have been harmed by a disease or insect attack. This phase prepares the picture for further processing by importing it.

2. Image Preprocessing:
The noise from the input image is removed during this step, which involves the use of noise filtering algorithms. Water spots, spores, and dust on the picture leaf surface may be present as noise, which may be used to alter the pixel values. For the purpose of speeding up the calculating process, input photos are reduced in size and deformity is removed when possible. When the smoothening filter is used, image distortion is reduced to a minimum.

3. Image Segmentation:
The purpose of segmenting a plant leaf is to separate the image from its backdrop and arrange it into several components. Image segmentation may be accomplished in a variety of ways. The K-mean clustering and the Otsu classifier algorithms are used in this stage, during which segmented pictures are grouped into separate sectors according to our suggested model. The LAB colour model has the advantage of being able to cluster the segmented picture with ease, and as a result, the RGB colour model is turned into the Lab colour model. The segmentation process is used to extracted features detected on plant leaves, such as segment, borders, and color-related data, which are then used to create segments [11].

4. Feature Extraction:
Images include a wealth of information about their contents, and they also carry descriptions of some unique qualities that may be used to distinguish between the categories of images in the given pattern. The colour co-occurrence approach will be used in the Feature Extraction strategy. Color, shape, and surface of the leaf are taken into consideration while extracting features. Using three significant number sequences, the colour co-occurrence approach may be used. First, it transforms photos in RGB format to images in Hexadecimal colour space (HIS). A colour co-occurrence matrix for H. S. I. is then created by using each pixel map.

5. Detection and Classification of Plant Disease:
The extracted characteristic was used in this classification procedure to distinguish between infected and healthy plant leaves. Detailed information about the leaves and their associated features may be found in the feature dataset. For the classification process, it makes use of the Minimum distance Criterion and Deep learning CNN classifier. The retrieved characteristics of the plant leave include homogeneity, contrast, energy, standard deviation, correlation, variance, and mean. These extracted features are delivered to the convolutional neural network, which utilises the target data as a class vector. It is possible to determine whether a certain plant leaf is healthy or sick during the classification process, according to model architecture.

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IV. MODEL ARCHITECTURE

The input layer, output layer, and hidden layer are the three primary components of the CNN model architecture [4]. The convolution layer, fully connected layer, pooling layer, activation functions, and usually rectified units (ReLUs) layers are the most important components of the hidden layer.

The number of layers utilized in their arrangement and introduction of other image processing units varies from one architecture to a different determining their specificity.

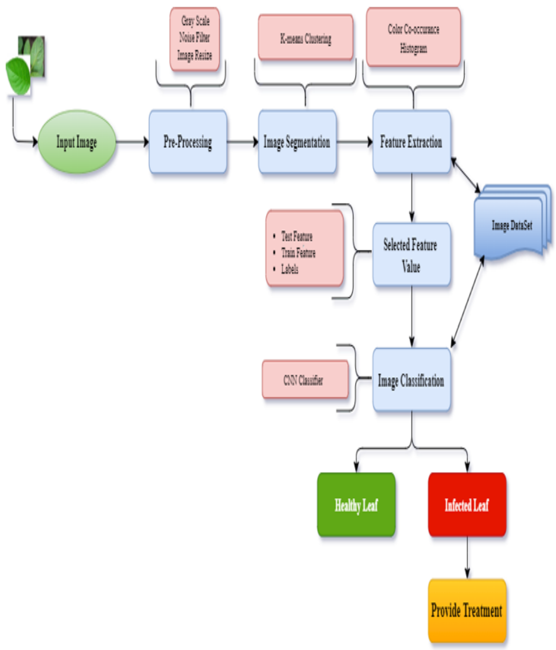

Fig 2. Proposed Model for plant disease detection.

1. AlexNet:
The CNN architecture grows in size in tandem with technological advancements in hardware. Among the layers in AlexNet's structure are one SoftMax, two normalisation layers, three max-pooling layers, two fully connected layers, and five convolutional layers [16]. Among the convolutional layers are convolutional filters, frequently corrected unit layers, and a nonlinear activation function, all of which are included in every layer. The pooling layers are in charge of performing the maximum pooling. Because it contains completely linked layers, the size of the inputs remains constant. In this model, there are sixty million different parameters.

2. GoogleNet:
The structure of GoogleNet contains 27 pooling layers and 22 deep layers and 9 inception modules linearly stacked. After the inception modules, it is attached with the global average pooling layer. GoogleNet has about 4 million parameters.

V. EXPECTED OUTCOME

One of the primary goals of this model is to precisely analyse and diagnose plant illness, which will aid in the effective growth of the crop. This model will identify plant illness by using a plant health assessment model that is based on the conclusion of a deep learning algorithm.

This study is directed at the achievement of the objective of developing an innovative system that can detect illness in plants at an early stage, hence increasing the productivity of crops and the production of agricultural products in the field. Deep learning methods are used to create the model that is being suggested. By doing this study, we want to address the limitations of manual procedures for detecting plant disease that are time-consuming, costly, and yield lower yields owing to ambiguity in knowledge. Our goal is to develop a more efficient and accurate model for detecting early-stage plant disease in order to improve plant health.

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