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Disease Detection in Maize Crops Using Deep Learning - A Review

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***Abstract*: The major goal of this work is to give a survey and comparison of several plant disease detection strategies in the field of image processing. As we all know, India is a predominantly agricultural country, with agriculture serving as the primary source of income for the vast majority of the population. It is critical to focus on the domain of farming with modern technology to make their lives more comfortable and simpler. Crop productivity can be increased by introducing modern technologies. An autonomous plant disease detection technology using image processing and a neural network approach can be utilized to solve problems with plant and agricultural diseases. Detecting maize leaf disease is an important endeavor during the maize planting stage. The detection of these disorders necessitates the use of several patterns. There are various classification techniques available, including Naive Bayes (NB), Decision Tree (DT), K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest (RF), Artificial Neural Network (ANN), Back Propagation (BP) Network, Support Vector Machine (SVM), and Convolution Neural Network (CNN).**

***Keywords*: Naive Bayes (NB), Decision Tree (DT), K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Random Forest (RF), Artificial Neural Network (ANN), Back Propagation (BP) Network, Support Vector Machine (SVM), and Convolution Neural Network (CNN).**

1. Introduction

Agriculture employs more than 70 percent of India's population. To avoid crop losses, it is important to diagnose plant diseases. Observing plant diseases by hand is extremely inconvenient. It takes a large amount of time and effort, as well as knowledge of plant diseases. To live, all of these plants rely on the power of their leaves and roots. Plant leaf diseases are caused by a range of reasons, which cause harm to crops and, as a result, have an economic impact on the country. As a result, image processing and machine learning models can be used to detect plant illnesses. [1]– [3]

We can analyze several photo metrics or features to identify distinct plant leaf diseases in this project to attain the best accuracy. The core purpose of machine learning is to understand training data and integrate it into models that are supposed to be useful to humans. As a result, it can assist in making smart decisions and anticipating the optimal output by utilizing a large amount of training data. The color of the leaves, the degree of damage to the leaves, the area of the leaf, and textural characteristics can all be used to classify them.

Maize is a member of the Gramineae family, which ranks third in terms of cultivated area and total output only after wheat and rice. Maize is a good animal feed, in addition to being a human diet. In addition, it is a crucial raw material for the light and medical industries. Diseases are the most common source of loss in maize production, accounting for 6–10 percent of annual losses. There are over 80 maize diseases globally, according to statistics. Sheath blight, rust, northern leaf blight, curcuma leaf spot, stem base rot, head smut, and other diseases are currently widespread and have devastating implications. Sheath blight, rust, and northern leaf blight are among the pathogens that cause lesions in maize leaves, which have distinct characteristics [4].

2. Methodology

Rapid and accurate diagnosis of these illnesses is crucial for improving yields, as well as monitoring the crop and taking prompt action to treat the infections. Machine vision and deep learning technology have advanced to the point that machine vision can now swiftly and accurately diagnose certain maize leaf diseases. The automatic identification of maize leaf diseases requires accurate detection of maize leaf. However, detecting maize leaf diseases with machine vision technologies is difficult. Because the shape, size, texture, and posture of maize leaves differ greatly between maize cultivars and phases of maturation. Natural light is nonuniform and continually changing, making reliable automatic recognition of maize leaf diseases more difficult. As a result, models for detecting maize leaf diseases must be created in order to be more generalizable in varied situations.

a) Image Acquisition: It is the procedure for converting captured photos to the desired output format for further processing. Authors may obtain images on their own or from any benchmarking data set.
b) Image Pre-Processing: The goal of image pre-possessing is to highlight the region of interest in plant leaves (the disease-infected area). Image segmentation, image augmentation, and colour space

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conversion are all common image pre-processing techniques. For starters, a filter enhances a digital image. The background image is filtered off, and RGB colours are transformed into colour space parameters. A meaningful area of the image is segmented for easy analysis. Unfortunately, removing background is challenging and often necessitates user participation, which reduces the system's automation. [5]

c) Feature Extraction: To create feature vectors, features are taken from the image. Statistical, structural, or signal processing could all be used in this extraction. The shape aspects of leaves are studied using the Scale Invariant Feature Transform (SIFT). Deep learning has the advantage of automatic feature extraction, which contributes to improved accuracy when compared to other traditional techniques.

d) Classification: Using a classification model, the last phase detects the plant disease present in the leaf. Learning techniques and examples with known illness images should be used to train the model. The algorithms for classification are detailed in the following section. [6]

e) Techniques for disease identification: Image processing-based approaches and machine learning-based techniques are the two types of illness identification techniques. Image processing techniques must be followed by some machine learning methods that can operate on huge datasets for the goal of disease identification.

f) Image processing techniques: : For effective detection and classification of the plant, image processing techniques were widely and successfully applied. An ANN-based classifier was utilized to develop a methodology for early and accurate plant disease diagnosis employing a variety of image processing techniques such as the Gabor filter for feature extraction and classification, with identification accuracy of up to 91 percent. [7]

g) Machine learning: Machine learning is concerned with algorithms that can learn on their own from a given collection of input data in order to achieve a specific goal. Its high-performance computer opens up new possibilities for agriculture. The most commonly utilized learning algorithms in the literature studied are the Naive Bayes (NB), Decision Tree (DT), Support Vector Machine (SVM), k-nearest neigh-bours (KNN), and artificial neural network (ANN). [8] In linearly separable cases, the SVM method optimizes the margin between classes. By voting between the K nearest instances in the features space, the KNN algorithm identifies an image.[9]

h) Neural networks: With their exceptional ability to infer meaning from complicated data, neural networks can be used to extract and find patterns that are too difficult to detect using human brain or computer procedures. [10] Adaptive learning, self-organization, real-time operations, and so on are some of the other benefits of ANNs. For efficient grape leaf colour extraction with a complicated background for a diagnostic system of grape leaf diseases, a back propagation neural network (BPNN) was used. [11]

i) Deep learning: Deep learning is a type of machine learning that uses deep neural networks to learn hierarchical representations of data at various levels of abstraction. Convolutional Neural Networks are one of the most powerful and basic deep learning methods for modelling complex processes and pattern recognition (CNNs). [12] CNN maps an input, such as a photograph of a diseased plant, to an output, such as crop illness. Convolution, pooling, and fully linked layers are the three primary layers that make up a CNN. Convolution's main goal is to extract features from each input image automatically. It is made up of a series of filters that may be learned [13]. Each filter is applied in a sliding window method to the image's raw pixel values, computing the dot product between the filter pixel and the input pixel. The feature map is a two-dimensional activation map of the filter as a result of this. As a result, the network learns filters (e.g., edges, curves) that activate when known features in the input are found. During the training process, the CNN learns the values of these filters on its own. Sub-sampling layers follow these convolution layers. Each sub-sampling layer shrinks the convolution maps and introduces invariance to low rotations and translations that may be present in the input [14]. The maximum activation value in the input layer is used to calculate the pooling layer's output over sub windows within each feature map, lowering the feature's dimensionality. The completely connected layer towards the conclusion of the model is based on the SoftMax activation. The class scores are computed using this function. The SoftMax classifier takes a vector of features learned throughout the learning process as input and returns a probability that a picture belongs to a predetermined class as output. LeNet, AlexNet, GoogleNet, VGGNet, and Inception- ResNet are examples of CNN de-signs [15].

3. Related Work

Maize, also known as corn, is a crucial crop that is adaptable to a variety of climatic conditions. Maize disease can affect any part of the plant, including the stem, leaf, or panicle. We've only looked at diseases that are related to leaves in this area.[16] Proposed an artificial neural network (ANN) model for Phyllanthus Elegant Wall leaf disease categorization into two categories: healthy and unwell. They used image processing techniques to change the colour structure of herb plant photos. The leaf colour and area are used to categorize the photos [17]. Described the linear SVM that was used to classify leaf diseases. The input photos of the grapes and disease regions are subjected to preprocessing procedures. Clustering methods are used to recognize these, and colour and texture information is collected from them. [6] For leaf disease identification, a convolution neural network (CNN) was deployed. They used photos from a big dataset that included both healthy and diseased plant leaves. They tried out three different types of datasets: colored, grayscale, and segmented. This CNN model is capable of quickly identifying 26 illnesses in 14 crop species. Similarly, SVM was used to detect illnesses in soy-bean leaves. The scale-invariant feature transform technique was employed in this system to detect plant diseases based on their shape.

This provides assistance to the farmer via the internet with minimal effort. [18] To classify the diseases, the input image is preprocessed and segmented using a genetic algorithm. The authors discovered that the best result was attained at a lower cost of computing. For improving the recognition rate, the author suggests using fuzzy logic, ANN, and hybridization of different methods. components of green and blue These characteristics are used to classify illnesses. [19] Focuses on assisting farmers in producing acceptable crops based on soil quality Crop predictions are made using machine learning techniques. The presence of nutrients in the soil is examined, and crop production in a certain region is projected. [11] Provided a model for the advancement of precision agriculture in the field. Soil moisture prediction was created to predict moisture depending on environmental conditions. For a longer length of time, this prediction is more accurate [20].

4. Conclusion

In this study, the NB, KNN, DT, CNN, SVM, and RF machine learning methods are applied to diagnosis various maize leaf diseases. Multiple image pre-processing approaches, meanwhile, models were employed to extend and augment the data of illness samples because the NB, KNN, DT, SVM, and RF were unstable, non-convergent, and overfitting when the picture set was insufficient. The CNN and AlexNet methods were adopted to accelerate the training speed of the model. The proposed optimized module in this paper can be applied to a large number of CNNs. We will be able to make attempts in the future to replace the combination of linear and nonlinear activation functions with nonlinear activation functions and to include more network parameters in model training. Farmers can take the required precautions to prevent maize illnesses if they receive an early diagnosis. However, each model in the classification process has its own set of problems that may or may not apply to all data sets. These models can be used to differentiate in the future using high-dimensional data sets in a variety of ways.

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