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A Review on Deep Learning for Plant Disease Prediction and Fertilizer Recommendation

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ABSTRACT: Agriculture is important in emerging nations like India. About 58% of rural India's livelihood is affected by agricultural intervention. In order to minimize considerable loss in quantity and yield of plant species, it is crucial to identify and classify any illnesses that a plant may have. To address these problems, various types of approaches and algorithms are applied, including cutting-edge technology like image processing. When a plant acquires a certain sort of illness, the tomato plant's leaves are initially harmed. There are four successive steps in this research to determine the type of sickness. Pre-processing, segmenting leaves, extracting features, and classification are the four steps.

KEYWORDS:neural network, convolutional neural network, leaf segmentation, disease detection

I. INTRODUCTION

Bringing technical innovation to the domains associated with crop productivity is crucial in nations like India. In the important area of qualitative farming, research initiatives and speculative study techniques aim to raise yield and food crop quality at a cheap cost while providing more income. Agricultural structures are made possible by the complex interactions between soil, seeds, and growth-promoting chemicals. Fruits and vegetables are one of the major agricultural products produced nowadays. The assessment of product value and its improvement have always been significant components of the policy for purchasing surplus and valuable goods. The normal state of a plant is impaired by diseases, which alter or stop vital processes including transpiration, photosynthesis, fertilisation, pollination, and germination, among others. Because of unfavourable environmental conditions, microorganisms including fungi, bacteria, and viruses create diseases that are distorted.

As a result, the initial step of plant disease diagnosis is a substantial responsibility. Regular expert monitoring of farmers is necessary, but it can be costly and time-consuming. inexpensive, finding rapid, and accurate ways to intelligently identify illnesses from symptoms that appear to be on a plant leaf is therefore of utmost practical significance. In this work, we provide a method for determining the specific illness that a tomato leaf might be carrying. Implementing image recognition technologies, which show the application working graphically, is one way to identify the type of disease an essential crop like tomatoes may have. This is also a key factor in the rising popularity of digital technologies.

II. LITERATURE SURVEY

In J. Arun Pandian et.al [1], the author suggested an innovative Identifying plant diseases from leaf images using 14-layered DCNN. Using a number of open datasets, a new dataset was produced. The dataset's individual class sizes were balanced using approaches for data augmentation. Basic Image Manipulation (BIM), Deep Convolutional Generative Adversarial Networks, and Neural Style Transfer were the three strategies used to enhance the images (NST). The collection includes 147,500 photos of 58 different leaf classes of healthy and ill plants as well as one leafless class. A multi-graphics processing unit (MGPU) environment was used for training the proposed model of DCNN over the course of 1000 epochs.

In Sk Mahmudul Hassan et.al [2], the author describes the traditional classification methods including KNN, SVM, RF, LR, ANN, and others were outperformed by deep learning-based algorithms. In deep learning, features are automatically learned from the networks, which is more efficient and produces more accurate classification results than the conventional feature extraction approaches that rely on features like colour, shape, SIFT, texture-based, GLCM, histogram, Fourier description, etc. For the purpose of identifying plant diseases, numerous deep learning architectures are employed.

In Gaurav Shrivastava et.al [3], the author first analysed new developments in plant disease detection by the use of Machine Learning and techniques of image processing on plant leaves. The algorithms and datasets are created after that. The machine learning model was then presented. With the help of a sophisticated edge detection technique, the model gathers edge characteristics, colour characteristics, and texture analyses, utilising a local binary pattern (LBP). After that, they combined the features to create a feature vector, which they used to train the Artificial Neural Network (ANN) and Support Vector Machine (SVM) approaches. Because of the way these machine learning algorithms are structured, the suggested model of decision support system can recognise and distinguish between the distinct plant leaves.

In Sunil S. Harakannanavar a et.al [4], the author describes that the Aura leaf spot, Rust,Brown spot, Gray spot are five types of apple leaf diseases visible on leaf , are discussed in this essay. In Apple, that is an issue. In this study, Techniques of Deep Learning were used for enhancing the Convolution Neural Networks for illness detection in apple leaves. This study makes use of the complex pictures and laboratory images from apple leaf disease dataset (ALDD). The following photos were produced using tools for image annotation and data augmentation. Using Rainbow concatenation along with the Google net inception structure, a fresh deep –CNN was created. A testing dataset containing 26,377 pictures of sick leaves of apple was used for evaluating the INAR model that was proposed. The model was trained to recognise five common illnesses leaves of apple. The obtained results demonstrate that INAR-SSD model, compared with previous approaches, offers an efficient high-performance approach for diagnosing apple leaf illness and can detect these diseases in real-time with increased precision and faster detection speed.

In Jun Liu et.al [5], The author contrasts standard methods with the challenge of identifying plant pest and diseases. The classification network, detection network, and segmentation network are used in this article to highlight recent discoveries on detection of plant diseases and pests using Deep Learning approach. Additionally, the advantages and disadvantages of each technique are looked at. We introduce typical datasets and evaluate the efficacy of past studies. The performance of previous studies is evaluated and common datasets are introduced. In light of this, this article highlights possible difficulties in using deep learning in real-world applications for identifying plant diseases and pests. The issues are also discussed, along with potential answers, lines of inquiry, and recommendations.

In Gokulnath BV et.al [6], the author intends to conduct a thorough analysis of the various computational techniques used in the system for classifying and identifying plant diseases. The accomplishment of the desired job required the use of numerous sophisticated algorithms. Additionally, a variety of additional fusion models were developed and extensively discussed in order to increase the computational model's predictability. The conclusion of this study highlights the importance of automated systems for helping end users locate plant diseases without the need for human interaction. Prescriptive models, which are highly desired in the near future, must be constructed. This study looks at multiple machine learning methods that are often used to predict plant diseases in order to see how they could be enhanced in the future for increased precision, robustness, and affordability. In this survey, the steps of image processing techniques like pre-processing, segmentation, extracting features, and classification based on plant symptoms are covered.

In Dr. Gajula Ramesh et.al [7], the author describes human vision is limited in its ability to detect and analyse plant diseases since they fully depend on microscopic activities. In order to accurately classify and identify plant diseases, computer-based image rearrangement algorithms are used. On a real-time leaf image that has been captured, a k-mean clustering process is used to detect disease. Following detection, the GLCM filter extracts the data’s features. Typically, SVM-based techniques are used for classification, however they have poor accuracy when it comes to texture features. Back Propagated ANN, a cutting-edge kind of artificial intelligence, is used to implement features-based matching operations. The suggested method is applied in the Matlab software and greatly outperforms conventional methods in terms of accuracy.

In Ms. Nilam Bhise et.al [8], According to the author, crop ailments are detected using the Deep Neural Network, a part of the Deep Learning algorithm. In essence, the approach is verified on a wide range species of plants with different disorders. This model was implemented on Android and was built with Keras and Tensorflow frameworks. Overall finding of the system shows that the Mobile Net model outperforms the competition and provides higher illness detection accuracy. The experiment will be expanded to include more types of plants and their illnesses.

In Bin Liu et.al [9], the author describes Samples of tomato leaves with anomalies are taken into consideration from their survey. These disease samples of tomato leaves will make it simple for farmers to recognize infections based on the symptoms that show up early. The tomato leaf samples are first scaled to 256 by 256 pixels , so that the quality of the samples could be increased. The data space is divided into Voronoi cells by K-means clustering. Utilizing contour tracing, the leaf sample's borders are retrieved. Following feature extraction, the features collected are categorized using techniques of Machine Learning such as KNN, SVM, and CNN. To assess the accuracy of the suggested model on disordered data, CNN(99.6%), SVM(88%), KNN(97%) are used.

In Shima Ramesh Maniyath et.al [10], the author describes the goal of the algorithm is to identify anomalies that appear on plants in their natural or greenhouse environments. In order to avoid occlusion, the background of the image is often plain. The algorithm's accuracy was compared to that of other machine learning models. The Random Forest classifier was used to validate the algorithm using 160 images of papaya leaves. With about 70% accuracy, the model could classify. The accuracy can be increased by using a large number of images for training and by mixing feature points like SURF and SIFT (Scale Invariant Feature Transform) with global features (Speed Up RobustFeatures).

Figure: Table Analysis

Author and year	Dataset Used	Methodology/Algorithm	Drawback
J. Arun Pandian, 2022 et.al [1]	collection of open datasets of images of 16 species	Deep Convolutional Neural Network (DCNN)	The proposed model is trained only on face-up leaf images.
Sk Mahmudul Hassan,2022 et.al [2]	Plant Village data, Cassava data, Hops data, [illegible]n disease data, Rice disease data	CNN architecture	Although a number of models were compared, accuracies of the models are ambiguous.
Gaurav Shrivastava, 2022 et.al [3]	Rice disease dataset, Plant Village dataset	ANN and SVM classifiers	Proposal of low-cost decision system while two different models are used in which SVM is less accurate, efficient.
Sunil S. Harakannanavara, 2022 et.al [4]	Tomato leaf samples	k-means, Discrete Wavelet Transform (DWT), Support Vector Machine (SVM), KNN and CNN	Only one crop dataset used, hence the model could have been trained to detect a greater number of diseases.

Jun Liu, 2021 et.al [5]	Tomato leaf samples	Convolutional Neural Networks (CNN)	Small dataset size problem due to self-collection.
Gokulnath BV, 2020 et.al [6]	open dataset	Machine Learning	Lack of comparison on the different techniques presented
Dr. Gajula Ramesh, 2020 et.al [7]	open dataset of ten species	Back propagated ANN approach	Focus lies majorly on generalised disease classification for multiple diseases
Ms. Nilam Bhise, 2020 et.al [8]	Plant Village dataset	Convolutional Neural Networks	Limited information on accuracy and precision
Bin Liu, 2019 et.al [9]	The apple leaf disease dataset (ALDD)	Convolutional Neural network	Limited number of diseases detected with reduced detection performance
Shima Ramesh Maniyath, 2018 et.al [10]	Papaya leaf	HoG feature extraction, random forest classifier	Training dataset size is very less and hence the accuracy is also reduced

III. DISCUSSION

Convolutional neural networks (CNN) are indeed a potent method for creating computer models that transform unstructured visual inputs into labels for appropriate classification. They are categorized as multi layered Neural Networks, which may be trained for learning the features that are required for classification. Compared to conventional methods, less pre-processing is necessary, multi layered Neural Networks, which may be trained for learning the features that are required for classification. The best outcomes may be found while using a variant of the LeNet architecture for the aim of detecting leaf illness.

LeNet includes of layers that are completely linked, max-pooling, convolutional, and activated. A basic CNN model is LeNet. The LeNet model classifies leaf diseases according to this architecture. In this model, additional pooling layers, layers of convolution and activation are added to the original architecture of LeNet. All the three layers are present in each and every block. Soft-max activating, completely associated three such blocks are used in the architecture. Pooling layers and Convolutional layers are used for feature extraction, for classification, a fully connected layer is used. The network is given non-linearity by using activation layers. Convolution layer extracts features using convolution technique. The intricacy of the retrieved features also gets more sophisticated as depth goes up.

While the number of filters gradually increases as we travel from one block to the next, the size of the filter is unchanged. In the first convolution block, there are 20 filters; in the second and third, there are 50 and 80, respectively. The feature map size has decreased since pooling layers are used in each of the blocks; this must be compensated for by a greater number of filters. After the convolution process has been completed, to ensure that the size of the images are maintained. To reduce the dimension of feature maps, max pooling layers are used, which also helps in speeding the training process and reduce the sensitivity of the model for any slight change in the input.

IV. CONCLUSION

Although there are numerous automated or computer vision approaches for classifying and detecting plant diseases, this area of study still needs improvement. Additionally, the only commercially available methods deal with identifying plant species using images of the leaf. In this research, a unique approach utilizing Deep Learning techniques were investigated, to effectively categories and diagnose diseases of plants from leaf images. The model that was developed could recognise patterns in leaves and differentiate healthy and 13 different visually diagnosable diseases. Collecting the photos needed for needed for pre-processing, augmenting, training, validating are all parts of the whole detection process. A variety of tests were run to evaluate how well the newly developed model performed. Since the supplied method hasn't been used to the domain of detecting plant diseases, there has been no comparability with findings achieved using a method that was similar. A continuation of this research will focus on obtaining photographs to enhance the database and enhance the model's accuracy utilising various augmentation and fine-tuning strategies. The main aim of the future works is to build a comprehensive system composed of components of server-side architecture with a training sample and an android application for smartphones that may show illnesses in fruits, vegetables, as well as based on plant photographs obtained with the phone's camera. This application will be helpful to farmers by making it easier to quickly and accurately identify plant diseases and make choices about when to use chemical pesticides.

Future research will also concentrate on broadening the application of the model by teaching it to recognise plant illnesses across a wider variety of geographic regions, combining drone-shot aerial images of orchards, vineyards with convolutional networks that recognises objects, and more. By further extension of the research and raising quality of crops for coming generations, the authors hope to significantly promote sustainable development.

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