A Literature Review of Identification of Corn Leaf Disease using CNN

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Abstract**:** *In farmer's life agriculture is one of the important aspect, and in that the words most important food crop is corn. But diseases harm the quality and quantity of agricultural crops production. Crop leaf disease identification and classification are critical for improving crop cultivation quality. Furthermore, misdiagnosis of disease lowers crop yield performance and increases income loss. In comparison to manual diagnosis, deep learning-based automatic detection of crop leaf disease is more cost effective and does not rely on subjective judgement. The deep neural network produces good results when using deep learning and assists us in improving the classification system's accuracy. This survey presents various real-time methods for corn leaf disease classification based on CNN. The correlation between the corn leaf classes and the impact of data augmentation in pre-trained models are among our findings. In this survey, We explored deep neural network transfer learning for the detection of leaf diseases, taking into consideration the use of a pre-trained model learned from traditional large data and then sending it to a particular task trained with data. Using the transfer learning method, a previously trained model is reused as the initial point for a model on a new task.*

Keywords— Convolutional neural network(CNN), Classification, Deep Learning, Data augmentation, Image Processing, Transfer learning.

1. Introduction

The global population is expected to reach nearly 10 billion by 2050, putting additional strain on agriculture and food systems. Moreover, crop production is constrained by agricultural biodiversity loss, loss of food, water resources, and climate change. [1].

Plant disease is a major problem in agriculture, which is an important factor of the economic growth of the country. Plant diseases have a catastrophic effect on food safety and can lead to reductions in both the quantity and the quality of agricultural components. Corn diseases are caused by a various factors, including pests[2], climatic change[3], and disease severity[4]. Leaf disease is one of the most serious diseases that affect corn crops, reducing food production and food nutritive values[5]. Corn leaves display a wide range of symptoms, such as grey leaf spots, common rust, northern leaf blight[6], and brown spots.

These diseases can be identified using deep learning techniques[7]. Because of its impressive performance, deep learning is quickly becoming the preferred method[8]. There are different types of techniques in deep learning such as Convolutional neural networks (CNNs), Feedforward neural networks, etc. Deep neural networks are used in deep learning to process classification of data, pattern discovery, and feature extraction[9]. The transfer learning technique effectively detects plant diseases by utilizing various models such as ResNet, EffecientNet, VGG, and DenseNet [8]. Among these techniques, VGG provides the highest accuracy, approximately 98%. Several researchers have been conducted to highlight various applications of deep learning in agriculture[7,8,9]. Shima Ramesh et al. [9] discuss some areas of plant disease detection where deep learning can be useful. Roman-Belmonte et al. [10] in their review, cover the existing and potential applications of CNN in the fields of tomato plant disease diagnosis. Serawork et al. [11] explore different areas of application where CNN can be used such as soybean plants.

After the survey, we identified various existing limitations among the papers. In some methods, models required high computational power, and some of the systems used less number of attributes by which the model accuracy increased but the model was not useful for other kinds of categories.

The remainder of the paper, as shown in Fig. I describes the context diagram for leaf disease detection. Fig II. shows the design of the proposed model in groundnut disease prediction is shown. Section II begins with a review of some important and useful deep learning concepts, followed by a discussion of some various innovative learning techniques. Section III examines the existing method in terms of pre-processing techniques and models. Section IV contains the conclusions.

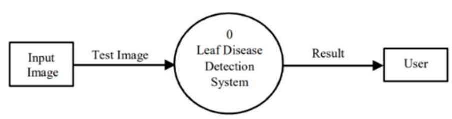

Fig. I Context Diagram for Leaf Disease Detection

I.1. Contribution

The goal of this study is to discuss the various applications of deep learning in agriculture, as well as some of the challenges. Our contributions are as follows

- We have surveyed existing literature works involving the use of deep neural networks in the field of agriculture.
- We have analyzed the different approaches used in the proposed solutions in those works, and have presented them in a simplified manner.

2. Literature Survey

In this section, we described existing techniques and methods used by various authors and solutions for the problem in the field of agriculture.

Erik Lucas et al. used Bayesian hyperparameter optimization to detect the diseases of maize plants [12]. In the real world, the approach saves time since the corn leaves can be obtained without having to place them on a plain background. The results show that for all CNNs models tested, maize leaf disease classification achieved 97% accuracy. Furthermore, our approach, which is based on computer vision strategies, opens up new possibilities for the identification of corn leaf diseases. However, the author did not classify additional types of corn leaf as well as other types of crop diseases, evaluate additional optimization techniques, or employ additional data expansion methods.

Rongie Hu et al. propose a system for the detection of corn leaf disease using transfer learning methods and data augmentation[13]. Author uses the Googlenet network and Vgg19 networks and gives an accuracy of 99%, which is compared with the other models like Resnet18 and Vgg16. Because of the small amount of data, this model avoids the problems that traditional neural network classification has, such as falling into the local optimal solution and overfitting. This study combined data augmentation with transfer learning using an enhanced deep neural networks algorithm.

Yuhao Wu et al. implemented a model for the classfication of corn leaf diseases using convolutional neural network to help with the automatic recognition of maize leaf disease based on CV[14]. It is highly efficient and does not rely on subjective errors. By using two-channel deep learning models like VGG and ResNet, it achieves an accuracy of 98.33%. We note that in this approach, This study's data set only included leaves from the same growth period. Further research should include a broader evaluation using a larger number of leaves from multiple growth periods. In addition, an operational graphical interface should be designed.

K. Elangovan et al. discussed classification methods for feature extraction from infected leaves as well as the identification of symptoms using an SVM classifier[15]. This paper proposes and employs the Support Vector Machines (SVM) classification approach. Plant leaf health and disease on plant leaves are major elements in the effective farming of crops.

Hafiz Tayyab et al. suggested method processes the data in four main phases, starting with (a) improving the dataset[16]. Lesion segmentation, which emphasizes the contaminated area, in step (b), followed by feature extraction from the infected area, step (c), and step (d), which involves visually picking features and doing classification. To further enhance the contrast of the image, it makes use of the Top-hat technique and the Gaussian function. The extraction is carried out based on colour, texture, and geometric features.

Md. Tarek Habib et al. used bicubic interpolation, the created model transforms a picture into a fixed-sized image[17]. The image is then given more contrast using the histogram equalization approach. The RGB colour space of a histogram-equalized image is changed to the L*a*b colour space. K-means clustering is used for segmentation, while SVM is used for feature extraction. It achieves a 90.15% accuracy rate. They were unable to conduct many experiments due to lack of utilization of proper GPU in the system.

Mohamed Kerkecha et al. built the system for Vine disease detection utilizing multispectral UAV pictures was proposed. LeNet5 and SegNet were effectively utilized in the strategy. The image processing model was able to categorize the data into four types. The tiny size of the training data was the model's drawback. 90% classification accuracy and 95% illness detection accuracy were attained by the model.

Alvaro F Fuentes et al. used a model that is being suggested to identify pests and diseases on tomato plants[18]. The technique used AlexNet, GoogleLeNet, and SENet to manage the data. The model has a 96% accuracy rate. False positives from the bounding box generator and class unbalance, which are particularly frequent on datasets with minimal data, were handled by the system.

Md. Selim e al. introduced a technique to locate and diagnose diseases in tea leaves. SVM was effectively included in the approach to achieve an accuracy of 93%[20]. Image normalization and colour space conversion were the two stages of the image processing process. The newly constructed model performed well when the number of dimensions exceeded the amount of samples and in high-dimensional environments..

Anuradha Anumolu et al. implemented a model for plant disease detection that utilizes the VGG-19 and EDLCA[21]. It also had GoogleNet and DC-GAN to improve the calibre of the processing. The newly developed mode's capacity to spot ailments in their early stages was its main advantage. The clustering accuracy and illness-affected area of the model were 94% and 93.6% accurate, respectively.

Divyansh Tiwari introduced a new method for detecting illnesses in potato leaves[22]. The machine over which this research has been accomplished was an NVIDIA GeForce N16VGMR1 graphic card. To reach the accuracy of 97.8%, the method utilized VGG16, VGG19, and KNN models. SVM was also incorporated into the model to process the data.

Yang Lu et al. introduced a new approach to identifying the diseases that impact rice[23]. Three convolutional layers are present in the suggested CNNs, which have a hierarchical design. Edges, lines, and other low-level characteristics from the input picture are extracted using the first convolutional layer. The other two are eligible for advanced features. The model made efficient use of the ImageNet ILSVRC dataset, Particle Swarm Optimization, and BP Algorithm. The proposed strategy has a 95.48% accuracy rate. The model performed better throughout training and converged more quickly.

Sumita et al. propose real-time corn disease detection using a deep learning networks for identification and classification of major corn diseases without the need of Internet[24]. Here they used hyperparameter tuning and pooling layers to get good accuracy (88%). But the author trained the model for only two diseases of corn plants; this is one of the limitations of this paper.

Md Shafiul et al. used YOLOv4 to detect infected areas in corn leaves and VGG to classify and detect corn leaf disease[25]. On the corn leaf diseases dataset, this paper proposed to achieve high classification accuracy by using fewer parameters and a high mean Average Precision (mAP). The model's Training was used as a time-consuming task by the author. They were unable to not able to use a appropriate GPU in this study, so they were unable to perform several studies.

M.P. Vaishnnave1 et al. received instructions from the program to automatically classify and categorize the diseases affecting groundnut leaves[26]. Crop yield will increase thanks to this technique. Picture acquisition, pre-processing, extraction of features, and classifier using KNN are some of the procedures that it entails (KNN). The KNN classifier is used in place of the SVM classifier to improve the performance of the current algorithm. Using the KNN classifier algorithm, we only classified 4 distinct diseases in this paper. However, this paper only addresses four distinct diseases with performance. The investigated work can be expanded to reduce false classifiers by employing additional classifiers for feature extraction among the numerous peanut plant diseases.

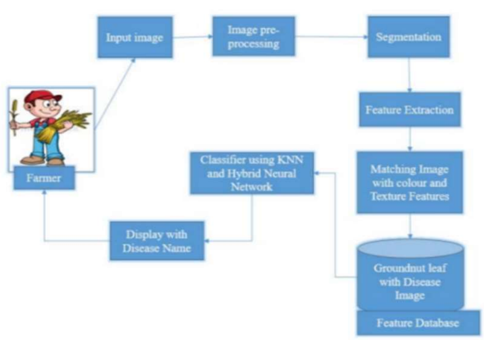

Fig.II Overall architecture of the proposed model[26]

Padilla et al. detect diseases of corn leaf using CNN and OpenMP[27]. Using a Convolutional Neural Network classifier, the study is successful in determining and categorising the type of sickness present in the leaf. Convolutional Neural Network implementation with OpenMP combines its benefits, particularly in terms of implementation rate. As a result, the accuracy in detecting northern leaf blight, leaf spot and leaf rust was 93%, 89%, and 89%, respectively.

Pushkar et al. used ML and image processing to classify plant diseases in this technique, which included logistic regression, KNN, and SVM[28]. The main benefit of this paper was that it presented identifying and categorising various crop diseases using a CNN for identification purposes. If they used hyperparameter tuning, they could extend the dataset by using an even larger dataset with more disease categories and accuracy.

S. W. Zhang et al. propose a K-nearest-neighbor algorithm to recognize plant leaf disease[29]. The proposed algorithm was based on five different types of maize diseases. The experimental results show that the proposed method has a high recognition rate for recognizing and classifying plant diseases. A major limitation of this study will require more data to increase disease detection accuracy

Dor Oppenheim et al. examine the uses of a CNN for the purpose of classifying picture patches of infected leaves of potato into four different disease classes and a healthy class using a model built with ImageNet, VGG architecture, and CNN-F algorithm[35]. The outcomes show that the classification method is reliable even under uncontrolled acquisition settings. According to the findings, fully trained CNN models have an accuracy ranging from 83% for models trained on the smallest amount of data to 96% for models trained on 90% of the data. The utilization of 493 photos from our data set is adequate to achieve classification rates better than 90%. The future aim
is to create a categorization algorithm that includes a greater variety of disease types. Data acquisition is simple because
there are no restrictions on it

Sukhvir et al. distinguish between healthy and infected leaves, and a semi-automatic system based on k-means concepts is developed and implemented[31]. Three models based on the SVM classifier were tested in experiments. are trained using independent applications of colour features, texture characteristics, and their combinations. All of the combinations taken into consideration have average accuracies that have also been found to be superior to those currently in use. The claimed average categorization accuracy stands at 90%. utilising a large collection of 4775 images.

Dengshan Li et al. are developing a ML model that uses the deep neural network technique to solve the issue by allowing them to identify the paddy plant disease using an image and offer a suitable cure[32]. The remedies provide the needed details on how to treat the condition with insecticides. A CNN is made up of an input layer, several hidden layers, and an output layer. The hidden layer is made up of the convolution layer, Relu, Avg pooling layer, and fully connected Layer. Compared to the current way, the technology is more dependable, user-friendly, rapid, and economical. Future paddy crop disease training programs and free mobile apps from the Google Play Store may be created.

Hossain et al. build a model to detect pests and plant diseases in videos, and a CNN based video detection design was presented[33]. The video was first transformed into a static frame, which was then detected by a static image detector before being combined to create the video. Employed with the framework of faster-RCNN for the still-image detector. To find somewhat unclear films, used image-training models. A set of video evaluation criteria based on machine learning was also proposed, and they accurately represented the effectiveness of video detection with in trials. According to studies, the system was better suited for detecting untrained rice movies than Vgg16, Resnet50, Resnet101 system, and Yolo version 3 with the experimentation study. VGG net, Residual net, ImageNet, and YOLOv3 are some of the modules used and the algorithms used are R-CNN, closed-loop architecture, and Non-maximum Suppression. The video detection method, which was consistent in the detection of the disease and method could be used to treat other agricultural pests and illnesses.

Eftekhar Hossain et al. suggested a method for classifying plant leaf diseases utilizing the K-nearest neighbour (KNN) classifier, K means Clustering, and linear Support Vector Machine classifier[34]. For categorization, the leaf disease photos' textural features are retrieved. KNN classifier will categorize the various diseases in this work. This method has a 96.76% accuracy rate for detecting and identifying the chosen diseases.

Ms Deepa et al. developed ANN and SVM classifiers that are used in a model to automatically detect plant diseases[36]. Finding a cure as soon as possible to stop the loss may be made possible by the accurate detection of plant diseases. The only restriction is there are fewer parameters used compared to other models.

Abirami et al. used automatic illness detection using image pre-processing, Random-Forest, Segmentation, and Extraction with Matlab to detect and categorise diseases in plants[37]. Matlab picture processing begins with the capture of digital high resolution images to identify unhealthy and healthy leaves. The images are then preprocessed using the k-means clustering method to generate clusters and random-forest classifiers for classification and training before the symptoms are detected. This method can be improved by including additional diseases for detection.

Junde Chena et al. identified rice plant leaf diseases using deep neural networks transfer learning[8]. In this technique authors have used convolutional neural network architecture models, such as VGGNET and the Inception module. It employs techniques such as K nearest neighbour, SVM, and random-forest for classification. Using this model improves performance significantly, as it provides 91.83% accuracy on public datasets and an average accuracy of 92% for complex conditions. This method can be improved by determining the features required for detection, which reduces the overfitting problem.

Serawork et al. utilized a CNN to detect soybean plant disease[11]. The LeNet Architecture was proposed as a model for detection of disease in soybean plant, and it is composed of almost 12,000 samples that contain image datasets from four classes, including healthy leaf images. For image classification, author have used machine learning methods such as Decision-Trees, K-means, K-nearest neighbours, and SVM. On the dataset, this model achieves a 99.32% accuracy. This method can be improved by using batch normalisation to accelerate training and improve model accuracy.

Jyoti Shirahatti et al. used Machine learning methods were used by this author to identify plant diseases[7]. The input images are first preprocessed before being classified using techniques such as Decision-Tree Learning, SVM, Clustering, and K nearest neighbor.

Andre da Silva et al. used a system to train and evaluate the dataset for plant disease detection; this paper proposes CNN models trained from start to end as well as an M-CNN method[38]. AlexNet and GoogleNet are models used in CNN architecture, and M-AlexNet and M-GoogleNet are models used in M-CNN architecture. The CNN results are compared to the M-CNN architecture results. M-CNN architecture produces better results than CNN architecture because it increases accuracy while reducing processing time.

Ahmed kwacher et al. proposes a CNN-based method for detecting diseases in Tomato plant using the Conditional Generative adversarial network to produce images of leaves of Tomato plant[39]. The author used the DenseNet121 model for image training and transfer learning for classifying the images on the PlantVillage dataset. This method correctly classified tomato leaf images into three different classes with accuracy of 99%, 98%, and 97% respectively.

3. Conclusion

This paper is a review of several methods for identifying plant leaf diseases that used deep learning methods. We studied various deep learning methods used by researchers to recognize diseases and classify them based on the survey results. Through image processing, these deep-learning techniques will assist the model in identifying plant diseases, and the model will instruct the farmer about the illnesses and specify the remedy to resolve the diseases in plants.

We surveyed relevant papers of research on deep learning technology and how deep learning is used in agriculture, and we mapped all of the relevant research into a literature review. This paper's overall goal was to investigate the research topics of deep-learning technology in the field of agriculture, as well as the key impacts this technology will have on the field. Our findings show that deep-learning has caused a significant amount of interest and attention as a platform for improving disease detection accuracy in agriculture.

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