2024 2nd International Conference on Intelligent Data Communication Technologies and Internet of Things (IDCIoT) | 979-8-3503-2753-3/24/$31.00 ©2024 IEEE | DOI: 10.1109/IDCIOT59759.2024.10467587

Potato Leaf Disease Detection using Dense Net-CNN

Animesh Srivastava [1]
Assistant Professor [1]
Department of Computer Science & Engineering
Graphic Era Hill University, Dehradun
er.animesh10@gmail.com [1]

Parveen Kumar Saini [2]
Assistant Professor
Department of Computer Science and Engineering
Chandigarh University, Gharuan, Mohali, Punjab
parveen.e13339@cumail.in [2]

Kamal Kumar [3]
Assistant Professor.
Department of Computer Science and Engineering.
Chandigarh University, Gharuan, Mohali, Punjab
kamal.e13941@cumail.in [3]

Shweta Tiwari [4]
Assistant professor
Department Computer Science & Engineering Department / University Institute of Engineering
Chandigarh University, Gharuan, Mohali, Punjab
shweta.tiwari2006@gmail.com [4]

Navin Garg [5]
Associate Professor
Computer Science & Engineering
Graphic Era (Deemed to be University), Dehradun, Uttarakhand, India
ngarg@gehu.ac.in [5]

***Abstract* - There needs to be accurate detection and identification of crop diseases because they hurt crop yield. Using DenseNet-CNN and smart farming methods might make it possible for infected crops to be found accurately. This research study discusses about the DenseNet-CNN architectures that are effective in finding leaf diseases. A potato leaf database is utilized in the training and testing phases. The proposed DenseNet-CNN model was employed to extract disease-specific features from the images present in the training dataset, which were subsequently utilized for performing disease classification. The proposed model has achieved a remarkable accuracy of 99.6% based on the results obtained from training, testing, and experimentation.**

Keywords: Potato, Leaf Disease, DenseNet, Convolutional neural networks.

I. INTRODUCTION

Plat diseases occur due to the changes that affect or stop the basic physiological processes. Most of the time, bacteria, fungi, microbes, or viruses are blamed for this problem as they lower the crop yields. Before any evaluations are done, it can be said that 60% of the world's population gets most of their food from farming. Nevertheless, potato disease plays a substantial role in reducing both the quality and quantity of crops. Misclassification and delayed identification of disease types significantly contribute to the decline of plant health.

The agricultural sector is the primary source of food, income, and employment on a global scale. In India, the industrial sector, which is characteristic of low- and middle-income countries, accounts for 18% of the Gross Domestic Product (GDP) and employs 53.3% of the labor force [1]. The contribution of agriculture's gross value added (GVA) to India's GDP has risen from 17.6% to 20.2% [2][3] in the last three years, playing a significant role in driving the country's economic expansion. Preventative drugs have limited efficacy in halting epidemics or endemics of diseases that afflict plants and insects, thereby posing a potential threat to agriculture and consequently, the quality of food production. Early detection and surveillance of crop diseases can effectively mitigate production quality losses, particularly when complemented by appropriate crop protection measures.

A. DenseNet-CNN

DenseNets establish connections between every node in a given layer and every node in the subsequent layer to operate. This enables the network to acquire intricate details and establish connections among the input image's features. DenseNets are superior to other CNN architectures due to their reduced training parameters, enabling training on smaller datasets and faster execution on less powerful hardware [9][18].

DenseNets can be used for both disease categorization and localization. The model is trained to identify the specific attributes of a particular disease in an image. The objective of disease accurate detection and identification is to train a model to accurately identify the precise location in an image where the disease is evident. This technology is advantageous for farmers and other agricultural experts as it enables them to accurately identify the precise location of infected plants, facilitating prompt and efficient treatment or removal [10][11].

To conclude, DenseNet-CNN exhibits great potential as a method for accurately detecting diseases in potato leaves. It is a highly effective and efficient method that can be utilized to classify diseases and accurately determine their precise locations.

II. RELATED WORKS

This related work presents a concise summary of the investigation on the identification of leaf diseases in plants. CNN (Convolutional Neural Network) offers the highest estimated accuracy for identifying leaf diseases in plants. In a study conducted by researchers, leaf images were utilized to train a deep-learning model equipped with a specialized convolution network to accurately detect plant diseases. In [2], the system successfully acquired the ability to differentiate between early blight, late blight, and healthy potato leaves. It achieved an impressive overall classification accuracy of approximately 98% when tested on separate datasets. This technology has the potential to enable farmers to promptly detect diseases in their crops during the initial stages, thereby enabling them to implement preventive measures.

The potato leaf disease described in [3] is detected using CNN. The classification of the disease in potato leaves achieved a 99 percent accuracy rate by utilizing a dataset consisting of 700-800 pictures. An inherent limitation of the aforementioned dataset is the potential need for supplementary photographs to attain enhanced outcomes [4]. The method proposed has the potential to achieve an exceptionally high rate of accurate predictions. Not only does it diagnose plant illnesses, but it also can treat them. Acquiring knowledge about the disease and its treatment is essential for enhancing the plant's overall health and productivity. The CNN algorithm implemented in Python guarantees a framework accuracy of 80% [5].

In the fifth experiment, a combination of Dense Net and three plant species (tomato, potato, and bell pepper) is employed to accurately identify and classify various types of leaf diseases [17]. The Plant Village dataset acquires all data through the utilization of a mobile camera and instantaneous detection. Subsequent efforts on this system or investigation should prioritize enhancing the precision of the model, optimizing computation for portable devices, and creating a mobile application that is user-friendly and readily implementable.

The authors of the paper [6] utilized different machine learning algorithms, including naive Bayes, K-nearest neighbors (KNN), and support vector machines (SVM), to attain accuracies of 88.67%, 94.00%, and 96.83%, respectively.

The feasibility of using a Convolutional Neural Network model to predict plant diseases was investigated by the authors of [7]. They utilized images from a specific dataset collected from the field, along with prior knowledge indices.

A technique is utilized in [8] to classify leaf diseases. To complete the process of dividing the sick part, we employ the K-Means algorithm. This article proposes the potential future application of deep learning algorithms to diagnose plant diseases. The study explores different methodologies for developing an effective Introduction of a potato leaf disease classifier utilizing RGB image data. According to the study findings, it is recommended to create a substantial input dataset.

To ascertain the accuracy of the models' learned features in representing the overall structure of an image, it considers not only the leaves and affected region but also other factors [19].

Potato leaf diseases pose a significant threat to potato production worldwide, causing substantial yield losses and economic damage [14][15].

Figure 1. Illustrative images representing each category within the dataset. [13].

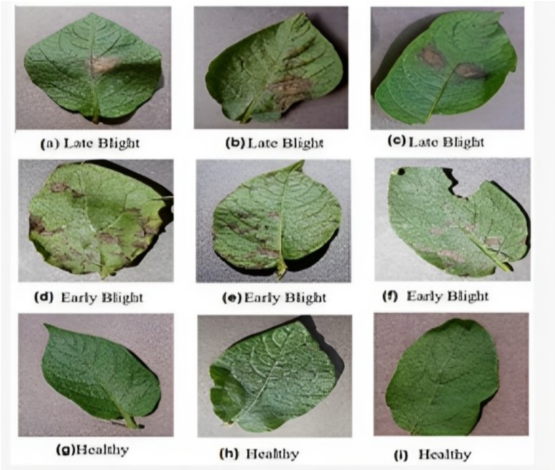

Figure 1. Illustrative images representing each category within the dataset.

A. *Research Gap*

- The research Gap found in the Existing Model is complex and requires a substantial amount of data for training.
- The model may not be applicable for disease detection in plant species other than the ones it was trained on.
- The model has not undergone testing on an extensive dataset comprising real-world images.

III. PROPOSED METHODOLOGY

This study proposes a method for the precise detection and identification of crop diseases. The method involves four stages: data collection, data preprocessing, data enhancement, and image categorization. The study specifically focuses on utilizing DenseNet-CNN algorithms for this purpose.

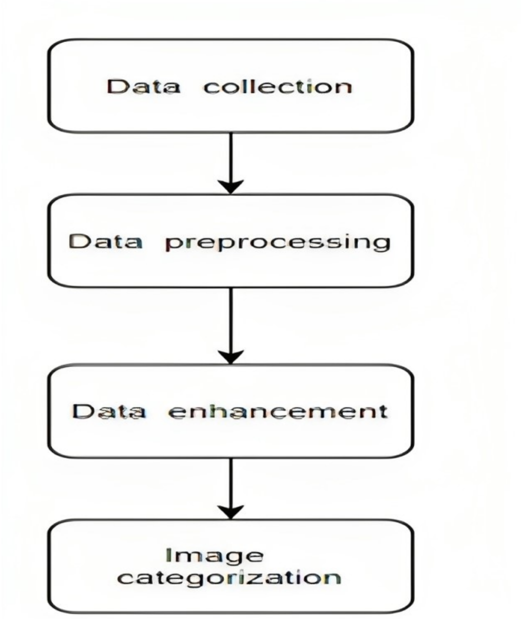

Figure 1. Proposed Methodology

Data Collection: The first step in the process of evaluating and implementing an algorithm is collecting relevant data. If you have a lot of information, you can make a very precise prediction. The proposed method begins with collecting relevant data.

Data Pre-processing: Data pre-processing is crucial for obtaining accurate results from any dataset, and we have performed this step. Enhancing the balance of a plant leaf data set can enhance its efficacy. In this proposed method, only the leaf of the potato plant is in focus in images that have all been cropped to the same size.

Enhancer: Image noise reduction is the first step in the enhancement process. With the help of feature extraction, a large image was compressed to a more manageable size without losing any quality. In addition, it disables any extraneous options.

Catagatized: An image can be categorized using any deep neural network or classification algorithm, including ANN, CNN, and SVM. CNN, a neural network, is the algorithm of choice for image classification due to its superior accuracy compared to other algorithms.

A. Proposed Model

This study has used a trained DenseNet-CNN to accurately find blight on potato leaves. Adding to the data, splitting it up, training, validating, and testing were all parts of the process of classifying potato blight. The data was moved around, resized, and put into different groups. In the preprocessing step, the unbalanced dataset was fixed by adding more images of healthy potato leaves. To do this, we split the data into three sets: training, testing, and validation. To make the training data better, different parameters were used. After that, the data was normalized so that it was between 0 and 1 for testing and validation. Both sets of data were used to teach the model, and testing data were used to see how well it worked.

Balancing a plant leaf data set can increase its effectiveness. If the data set is well-balanced, there should be about the same number of examples in each category. Oversampling the minority group or undersampling the majority group will accomplish this. To oversample, more samples are added to the minority group, while to undersample, more are taken from the majority group.

One method to oversample the minority group is to enhance the data in the images by applying techniques such as flipping, rotating, and cropping.

B. Feature Extraction With DCNN

In this case, a DenseNet, which refers to a dense convolutional neural network, is utilized. DenseNet (Dense Convolutional Network) is a design that enables deep learning networks to achieve greater depth while maintaining effectiveness by employing more constrained connections between the layers. DenseNet is a convolutional neural network that establishes connections between each layer and all

subsequent layers that are deeper in the network. This means that the first layer is connected to the second, third, fourth, and so on. The objective of this initiative is to streamline the unrestricted dissemination of information across all hierarchical levels within the organization. Each subsequent layer maintains the feedforward structure by integrating input from all preceding layers and offering element guidance for all subsequent layers. Thus, the 'ith' layer comprises all the highlight guides from the first convolutional blocks, resulting in 'I' data sources. Each subsequent 'I-I' layer is assigned its element map. Consequently, in the company, we observed associations of '(I*(I+1))/2' rather than the typical 'I' associations found in deep learning models. Learning inconsequential element maps is unnecessary, thus requiring a smaller set of boundaries compared to traditional convolutional neural networks.

IV. RESULTS & DISCUSSION

The Potato Leaf dataset is a collection of images depicting diseased potato leaves, encompassing instances of both Early Blight and Late Blight. The PlantVillage data set is utilized to study machine learning and computer vision. Its primary objective is to develop automated algorithms for the diagnosis of plant diseases.

Instead of a graphics processing unit (GPU), we trained and tested the proposed model on the Python platform. The model was built with TensorFlow 2.6.4 and images of potato leaves.

A. Outcomes

The implementation of our study is done in OpenCV and Python. Enhance agricultural output and enhance the quality of crops by effectively managing the living factors that result in substantial decreases in yield, utilizing deep learning methods to detect diseases in plant leaves. Our study introduces a DenseNet-CNN framework for efficiently and effortlessly classifying diseases in potato leaves. To categorize early blight and late blight in potatoes, the system initially isolated the leaves from an image of a potato leaf. Subsequently, a DenseNet-CNN was trained exclusively to identify diseases in potato leaves. Additionally, it considers the influence of environmental factors on the transmission of diseases on potato leaves.

TABLE 1: COMPARATIVE STUDY

Classifier Name	Accuracy
Proposed - DenseNet-CNN	99.6%
ANN [16]	92%
SVM [16]	84%
RF [16]	79%

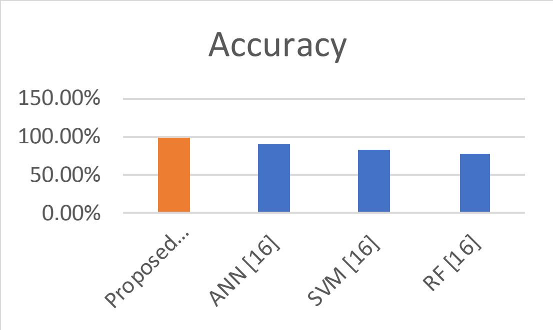

Figure 2: Comparative Study

The key contributions of using DenseNet-CNN for potato leaf disease detection are as follows:

High accuracy: DenseNet-CNN models have been shown to achieve high accuracy in detecting potato leaf diseases.

Early detection: DenseNet-CNN models can be used to detect potato leaf diseases at an early stage before they cause significant damage to the crop.

Robustness: DenseNet-CNN models are robust to noise and variations in image quality.

The utilization of DenseNet-CNN shows great potential in the field of potato leaf disease detection. This technology holds the capacity to assist farmers in enhancing their agricultural productivity and mitigating losses caused by diseases.

V. CONCLUSION

This study suggests using a convolutional neural network to automatically tell the difference between pictures of potato plant leaves with late blight, early blight, and healthy leaves. We know that DenseNet-CNN is the best tool for the job when it comes to putting things into groups. The model is 99.6% accurate when it comes to validation. We think this study will make a big difference in the way our farming industry works. Most of the farmers in the village can't read or write, so they aren't well-equipped to deal with the disease. We think that this work will make a big difference in the lives of Indian potato farmers. In classification tests, pictures of both healthy and sick leaves have been used. The suggested method can find three kinds of diseases that affect the leaves of potatoes. We got better results by cutting down on computation time, information loss, and the number of trainable parameters in the DenseNet-CNN model's structure. We purposely cut down on the number of pooling layers in the design we came up with so that the quality drop would be less severe. A powerful new tool called DenseNet-CNN can be used to find diseases on potato leaves. It could help farmers protect their crops and make their potatoes taste better.

A. Future Work

The ultimate goal of this research work is to design an Android app that can find problems in different crops and suggest the best way to fix them. Increasing the size of the database will also help to get more accurate results. In future, this can be extended by proceeding with the development process of making an app for Android. In addition, a quick way can be devised to find problems in agriculture so that the Indian farmers can get timely help and advice from experts.

REFERENCES

[1] Jha, R. (2018, March 20). Facets of India's Economy and Her Society . Springer. (Jha, 2018)

[2] Divyansh Tiwari, Mritunjay Ashish, Nitish Gangwar, Abhishek Sharma, Suhanshu Patel,'Dr. Suyash Bhardwaj,"Potato Leaf DiseasesDetection Using Deep Learning",[2020]

[3] Sanjay K Hoysala, Santosh K S, Srihari D R, Suhith Shekar Chandra, Ajay Prakash B V," Recognition and Classification of Leaf Disease inPotato plants", [2019]

[4] Pitchai R1, Sharath Kumar G2, Ashutosh Varma D3, Madhu Babu CH4," Potato Plant Disease Detection Using Convolution Neural Network ",[2020]

[5] A T Madhavi,MMYugesh,Srinidhi k, C S SVijayasundar,"Detection of leaf disease using convolutional neural network" ,[2020]

[6] Gautam Trivedi , Ankur Yaduvanshi , M.Hema," IDENTIFICATION OF DISEASES IN PLANTS USING DEEP LEARNING",[2019]

[7] R. Mounika, Dr. p. Shayamala Bharathi," DETECTION OF PLANT LEAF DISEASES USING IMAGE PROCESSING",[2020]

[8] Soma Ghosh, Renu Rameshan and Dileep A. D.," An Empirical Study on Machine Learning Models for Potato Leaf Disease Classification using RGB Images",[2021]

[9] Girish Athanikar et al, International Journal of Computer Science and Mobile Computing, Vol.5 Issue.2, February- 2016, pg. 76-88

[10] V. Veerasamy et al., "LSTM Recurrent Neural Network Classifier for High Impedance Fault Detection in Solar PV Integrated Power System," in IEEE Access, vol. 9, pp. 32672-32687, 2021, doi:10.1109/ACCESS.2021.3060800.

[11] S Jeyalakshmi, R Radha, "An effective approach to feature extraction for classification of plant diseases using machine learning",[2020]

[12] Anjna, Sood, M., & Singh, P. K. (2020). Hybrid System for Detection and Classification of Plant Disease Using Qualitative Texture Features Analysis. Procedia Computer Science, 167, 1056–1065. https://doi.org/10.1016/j.procs.2020.03.404

[13] Al-Adhaileh, M.H.; Verma, A.; Aldhyani, T.H.H.; Koundal, D. Potato Blight Detection Using Fine-Tuned CNN Architecture. *Mathematics* **2023**, *11*, 1516. https://doi.org/10.3390/math11061516

[14] Gulbir Singh, Kuldeep Kumar Yogi, Comparison of RSNET model with existing models for potato leaf disease detection, Biocatalysis and Agricultural Biotechnology, Volume 50, 2023, 102726, ISSN 1878-8181, https://doi.org/10.1016/j.bcab.2023.102726.

[15] Singh, Gulbir & Kumar, Gautam & Bhatnagar, Vivek & Srivastava, Animesh & Jyoti, Kumari. (2019). POLLUTION MANAGEMENT THROUGH INTERNET OF THINGS: A SUBSTANTIAL SOLUTION FOR SOCIETY. Humanities & Social Sciences Reviews. 7. 1231-1237. 10.18510/hssr.2019.75162.

[16] P. Patil, N. Yaligar and S. M. Meena, "Comparision of Performance of Classifiers - SVM, RF and ANN in Potato Blight Disease Detection Using Leaf Images," 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), Coimbatore, India, 2017, pp. 1-5, doi: 10.1109/ICCIC.2017.8524301.

[17] Mohamed, A. P. S. I. (2020, November 30). Potato Leaf Disease Diagnosis and Detection System Based on Convolution Neural Network. *International Journal of Recent Technology and Engineering (IJRTE)*, *9*(4), 254–259. https://doi.org/10.35940/ijrte.d4954.119420

[18] M. R. K. R. Sarker, N. A. Borsha, M. Sefatullah, A. R. Khan, S. Jannat and H. Ali, "A Deep Transfer Learning-Based Approach to Detect Potato Leaf Disease at an Earlier Stage," *2022 Second International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT)*, Bhilai, India, 2022, pp. 1-5, doi: 10.1109/ICAECT54875.2022.9807963.

[19] Gulbir Singh & Kuldeep Kumar Yogi (2023) Performance evaluation of plant leaf disease detection using deep learning models, Archives of Phytopathology and Plant Protection, 56:3, 209-233, DOI: 10.1080/03235408.2023.2183792