Disease Detection in Apple Tree Leaves Using CNN Algorithms

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Abstract
The early identification of diseases among plants and trees is extremely important. Agriculture sector can be uplifted by early detection of plant related diseases. The present research focuses on diseases concerning apple tree leaves. This research article suggests a Convolutional neural network-based model to classify the images of apple tree leaves as diseased and non diseased. A combination of convolution, relu and max pooling layer was considered while constructing the CNN model. The task represents a binary classification problem. The suggested model performs efficiently on the dataset considered with an accuracy of 91.11%.
Keywords: Convolution Neural Network, Machine Learning, Deep Learning.

I. Introduction

Apples are one of the fruits with great nutritive value. However, several diseases like Rust, Mosaic and Gray spot affect the leaves of apple tree leaves. Several diseases occur in an apple tree, leading to financial loss also. Several experts are employed to identify plant diseases. However, the experts' opinions on plant diseases are subjective in nature [1]. There are several spectroscopic techniques that help in detecting diseases in plant leaves. The spectroscopic techniques need instruments that are quite expensive [2], [3]. The advancement in digitalization has resulted in development of several machine learning, ensemble machine learning and deep learning techniques that can detect diseases among plants automatically [4], [14], [15],[16],[19]. The neural network algorithms play a very important role in detection of plant leaf diseases. Convolution Neural Networks (CNN) are widely incorporated by researchers for classification of plant diseases [5], [6], [17], [18]. CNN algorithms detects and extracts features from images by eliminating the complicated technique of pre-processing the images [7], [8], [20]. The present research article focuses on building a classifier model that can distinguish between diseased and non diseased plant leaves that belongs to apple tree. The dataset consisting of images of diseased and non diseased leaves of apple tree is obtained from Kaggle website. A convolution neural network model is built to classify the leaves as diseased or non diseased. The accuracy of the constructed model is evaluated.

II. Literature Review

Navneet Kaur and Dr V Devendran have researched on detecting diseased plant leaves by adopting ensemble techniques of machine learning and deep learning considering several feature extraction methods. The dataset considered for the analysis is diseased leaves of potato, tomato and pepper from the Plant Village dataset. To build the ensemble technique, classifiers like Support Vector Machine (SVM), Artificial Neural Network (ANN), K Nearest Neighbour (KNN), Naive Bayes and Logistic Regression have been incorporated. The authors have obtained an accuracy of around 90% and have stated that

they wish to improve the accuracy of the model by adopting Convolutional neural networks as a part of their future work [9].

Muhammad E. H. Chowdhury et al. have proposed a technique to detect disease in plants using deep learning techniques. The authors have stated that detecting diseases among plants manually is very tedious and prone to errors. Artificial Intelligence and Computer Vision techniques help in plant leaf disease detection. The authors have proposed a model called Efficient net using Tomato leaf images for detecting diseases on leaves of tomato. The authors have stated that the model is based on Convolutional Neural Networks and performs better than several other existing models for plant leaf detection [10].

Eisha Akansha et al. have researched diseases in plant leaves based on the probabilistic neural networks that are optimized. Disease detection in maize plant leaves is considered. The authors have suggested a methodology for plant leaf disease detection involving several stages like pre-processing, extracting features, classification and segmentation. The authors have stated that as a part of future work, they wish to perform detection of different types of diseases in the maize plant [11].

Thanjai Vadivel et al. have proposed a methodology to automatically detect tomato leaf disease considering image processing techniques. The authors have also implemented several algorithms like SVM with radial basis function, K - means, neural networks and backpropagation in neural networks and CNN. The authors have stated that they wish to improve the suggested model considering the plant village dataset [12].

Rupali Patel et al. have developed a methodology based on the k- Means clustering approach to detect the disease among the grape leaves. Morphological features of leaves are taken into consideration. The major steps of the research involve the collection of images grape leaves, pre-processing, Segmentation, Feature Extraction, Classification, Solution and evaluating the results [13].

III. Research Methodology

i. Data Collection

100 images of diseased apple tree leaves and 100 images of non diseased apple tree leaves were collected initially from the Kaggle website. 25 images from both the categories i.e diseased apple tree leaves and non diseased apple tree leaves were kept aside for testing. 75 images were considered for training from both diseased and non diseased leaf categories.

Figure 1. Image representing a sample of the data set collected.

ii. Data Pre-processing

Data that is provided as input into the neural networks usually need to be normalized in order to make it suitable for processing by the neural network. Images are pre-processed by normalizing the values associated with the pixels to be in range [0,1]. Using Keras the pre-processing of the images can be performed via keras. preprocessing. image. ImageDataGenerator.

iii. Convnet construction

The images that will be fed into the CNN are images of diseased and non diseased apple tree images of size 150X150, which form the training dataset. The architecture of the constructed CNN consists of three modules namely convolution, relu and max pooling. The combination of convolution, relu and max pooling works well for image classification tasks. The features considered for input images of CNN Algorithm is 150 X 150 X 3. 150 X 150 represents the image pixels. 3 represents the three-color channels Red, Green and Blue. Classification of apple tree leaves as diseased or non diseased belongs to binary classification problem. Sigmoid activation function is considered at the end of the network since the problem under consideration is binary classification.

iv. Evaluating the Accuracy of the model

The suggested model results in an accuracy of 91.11% in the 15 th epoch.

IV. Conclusion

This research has suggested a technique based on Convolution neural networks consisting of convolution, relu and max pooling layers to classify the leaves of Apple tree as diseased or non diseased. The proposed neural network model can easily and automatically extract the features of the diseased and non diseased leaves of Apple Tree. The training dataset consisted of 75 images of diseased and non diseased leaves of Apple tree. The algorithm was trained on the training dataset obtained from Kaggle. The proposed model resulted in a classification accuracy of 91.11 % in the 15th epoch.

V. Future Work

Future work involves developing a hybrid algorithm based on deep learning techniques considering a huge dataset.

References

[1] M. Dutot, L. M. Nelson, and R. C. Tyson, ‘‘Predicting the spread of postharvest disease in stored fruit, with application to apples,’’ *Postharvest Biol. Technol.*, vol. 85, pp. 45–56, Nov. 2013.

[2] A.-K. Mahlein et al., ‘‘Development of spectral indices for detecting and identifying plant diseases,’’ *Remote Sens. Environ*., vol. 128, pp. 21–30, Jan. 2013.

[3] L. Yuan, Y. Huang, R. W. Loraamm, C. Nie, J. Wang, and J. Zhang, ‘‘Spectral analysis of winter wheat leaves for detection and differentiation of diseases and insects,’’ *Field Crops Res*., vol. 156, no. 2, pp. 199–207, Feb. 2014.

[4] F. Qin, D. Liu, B. Sun, L. Ruan, Z. Ma, and H. Wang, ‘‘Identification of alfalfa leaf diseases using image recognition technology,’’ *PLoS ONE*, vol. 11, no. 12, 2016, Art. no. e0168274.

[5] C. Wu, C. Luo, N. Xiong, W. Zhang, and T. Kim, ‘‘A greedy deep learning method for

medical disease analysis,'' *IEEE Access*, vol. 6, pp. 20021–20030, 2018.

[6] J. Li, N. Wang, Z.-H. Wang, H. Li, C.-C. Chang, and H. Wang, ''New secret sharing scheme based on faster R-CNNs image retrieval,'' IEEE Access, vol. 6, pp. 49348–49357, 2018.

[7] A. Caglayan and A. B. Can, ''Volumetric object recognition using 3-D CNNs on depth data,'' *IEEE Access*, vol. 6, pp. 20058–20066, 2018.

[8] H. Lu, Y. Li, T. Uemura, H. Kim, and S. Serikawa, ''Low illumination underwater light field images reconstruction using deep convolutional neural networks,*'' Future Gener. Comput. Syst.*, vol. 82, pp. 142–148, May 2018.

[9] N. Kaur and V. Devendran, "Plant Leaf Disease Diagnostic System Built on Feature Extraction and Ensemble Classification," *2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)*, 2021, pp. 1-3, doi: 10.1109/ICRITO51393.2021.9596070.

[10] M. E. H. Chowdhury *et al.*, "Automatic and Reliable Leaf Disease Detection Using Deep Learning Techniques," *AgriEngineering*, vol. 3, no. 2, pp. 294–312, 2021, doi: 10.3390/agriengineering3020020.

[11] E. Akanksha, N. Sharma, and K. Gulati, "OPNN: Optimized Probabilistic Neural Network

basedAutomatic Detection of Maize Plant Disease Detection," *Proc. 6th Int. Conf. Inven.*

Comput. Technol.

ICICT 2021, no. January, pp. 1322–1328, 2021, doi: 10.1109/ICICT50816.2021.9358763.

[12] T. Vadivel and R. Suguna, "Automatic recognition of tomato leaf disease using fast

enhanced learning with image processing," *Acta Agric. Scand. Sect. B Soil Plant Sci.*, vol. 72, no.

1, pp. 312–324,2022, doi: 10.1080/09064710.2021.1976266.

[13] R. Patil, S. Udgave, S. More, D. Nemishte, and M. Kasture, "Grape Leaf Disease Detection

Using K-means Clustering Algorithm," *Int. Res. J. Eng. Technol.*, vol. 3, no. 4, pp. 2330–2333,

2016, [Online].Available: https://www.irjet.net/archives/V3/i4/IRJET-V3I4461.pdf.

[14] Ramesh, Shima, Ramachandra Hebbar, M. Niveditha, R. Pooja, N. Shashank, and

P. V. Vinod. "Plant disease detection using machine learning." In *2018 International*

conference on design innovations for 3Cs compute communicate control (ICDI3C), pp.

41-45. IEEE,2018.

[15] Chug, Anuradha, Anshul Bhatia, Amit Prakash Singh, and Dinesh Singh. "A novel

framework for image-based plant disease detection using hybrid deep learning approach." *Soft*

Computing (2022): 1-26.

[16] Rani, J. Vakula, Aishwarya Jakka, and Hamsini Kanuru. "Disease Detection in Crop

Management Using Ensemble Machine Learning." In *Sentimental Analysis and Deep Learning*,

pp. 907-916. Springer, Singapore, 2022.

[17] Hassan, Sk Mahmudul, and Arnab Kumar Maji. "Plant disease identification using a novel convolutional neural network." *IEEE Access* 10 (2022): 5390-5401.

[18] Maria, Syeda Khadizatul, Shahrun Siddique Taki, Md Mia, Al Amin Biswas, Anup Majumder, and Firoz Hasan. "Cauliflower disease recognition using machine learning and transfer learning." In *Smart Systems: Innovations in Computing*, pp. 359-375. Springer, Singapore,2022.

[19] Rahman, Ashiqur, Md Al Foisal, Md Rahman, Md Miah, and M. F. Mridha. "Deep-CNN for Plant Disease Diagnosis Using Low Resolution Leaf Images." In *Machine Learning and Autonomous Systems*, pp. 459-469. Springer, Singapore, 2022.

[20] Upadhyay, Santosh Kumar, and Avadhesh Kumar. "A novel approach for rice plant diseases classification with deep convolutional neural network." *International Journal of Information Technology* 14, no. 1 (2022): 185-199.