Case Report

Not peer-reviewed version

Plant Leaves Disease Detection using Deep Learning

Abhishek Kandel * , Ujjawal Prakhar , Mandeep Kaur , Parma Nand , Nitin Rakesh

Posted Date: 12 April 2023

doi: 10.20944/preprints202304.0259.v1

Keywords: TensorFlow; Convolutional Neural Network; Machine Learning; Artificial Intelligence; Deep Learning

Case Report

Plant Leaves Disease Detection using Deep Learning

Abhishek Kandel, Ujjawal Prakhar, Dr Mandeep Kaur, Dr Parma Nand and Dr Nitin Rakesh

[Department of Computer Science Engineering, SET, Sharda University];
2021826004.abhishek@ug.sharda.ac.in, 2021478331.ujjawal@ug.sharda.ac.in, mandeep.kaur@sharda.ac.in, parma.nand@sharda.ac.in, nitin.rakesh@sharda.ac.in
* Correspondence: info@abhishekkandel.com.np

Abstract: Advances in computing technology provide an opportunity to grow and develop an effective crop protection system. This study is a new way of diagnosing plant diseases using a deep and convolutional neural network. Deep learning is the strengthened method of machine learning. It uses a neural network that imitates like a human brain and gains certain information. Although powerful, its training process necessitates millions of tagged data points. The study's Methodology consists of three key stages: data acquisition, pre-processing, and Model Building.

Keywords: tensorflow; convolutional neural network; machine learning; artificial intelligence; deep learning

---

Introduction

In Nepal, approximately 80% of the households and 66% of the national labour force are directly dependent on and involved in farming, giving about one-third of the country's total GDP [1]. Similarly, in India, approximately 58% of the nation's population is directly involved in agriculture for their livelihood, whose contribution is estimated to be 19.48 lakh core to the Indian GDP [2]. Despite this vast domain, farmers can cultivate a diverse range of crops, from corn on the plain to tomatoes in the hills to apples in the out street of the mountains. However, the difficulties faced by the farmers are often ignored. To solve this problem, an application powered by Artificial Intelligence(AI) and Deep Learning (DL) is developed to solve the problem by recognising the plant-related disease analysing the plants' leaves, and giving remedies

When pests attack the plants, it impacts agricultural production. Farmers and specialists frequently use their unaided eyes when spotting and identifying illnesses in plants. This strategy, meanwhile, may be time-consuming, pricey, and inconvenient. Results from automatic detection employing image processing techniques are quicker and more precise. This study is about a novel method to develop a plant disease detection model based on the fragmentation of the image of the leaves through deep transformation networks. Advances in computing technology provide an opportunity to grow and develop an effective crop protection system and expand the market for computer vision applications in the agricultural sector.

The new training methodology simplifies the implementation of the system in operation. The essential steps required to use this diagnostic model are explained throughout the paper, from photo collection to archiving, evaluated by agricultural experts, to an in-depth learning framework for conducting in-depth CNN training. This roadmap is a new way of diagnosing plant diseases using a DL and CNN training and is optimised to accurately enter the database of leaves collected independently of various plant diseases. The development and youth of the advanced model lie in its recovery; healthy leaves and background images are compatible with other classes, making the model distinguish between sick and healthy leaves or environment using CNN.

Deep learning is the strengthened machine learning method that uses a neural network that imitates like a human brain and gains certain information. Minimally, it can be said as an automatic predictive method. Therefore, it is very serviceable to the data scientist and analyser who collects, analyses, and interprets large amounts of data. However, traditionally, the learning process used to

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 12 April 2023 doi:10.20944/preprints202304.0259.v1

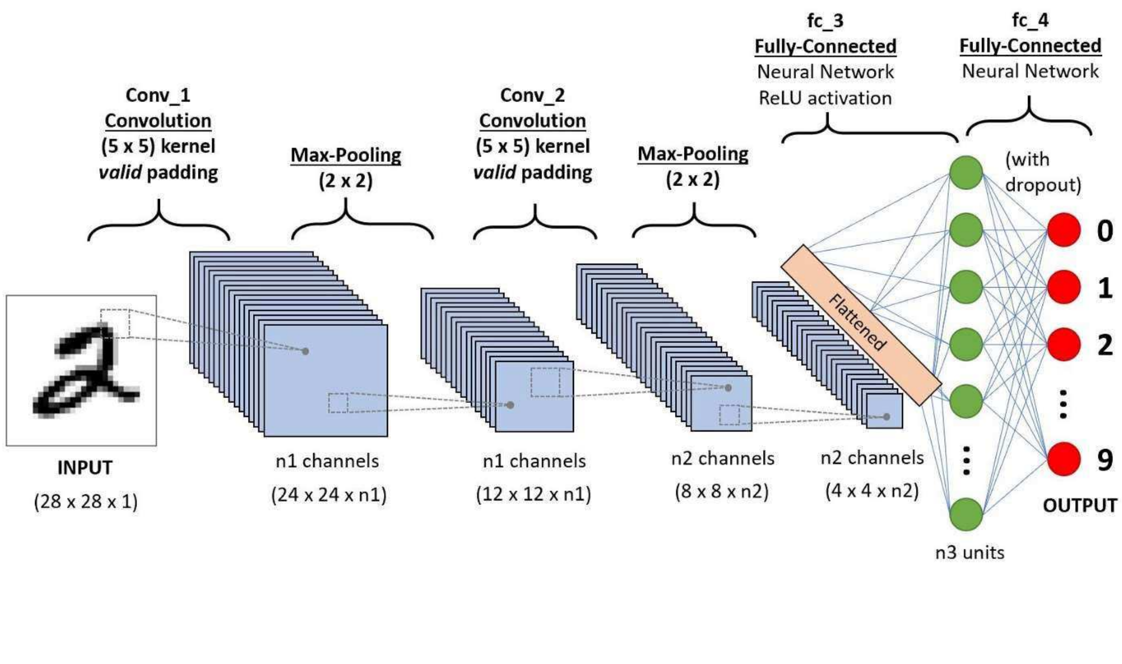
be semantic, meaning the learning process used to be wholly supervised. The coder must be very specific while telling the computer what it should look for in the decided image, whether it contains a dog or not [3].

CNN is a popular and recent DL model extensively used in image processing because of its ability to spot patterns in images. However, despite being a reliable tool, CNN requires millions of labelled data points for its training process. Therefore, high-power processors like a GPU or NPU must be employed in order to train CNNs rapidly enough to be applicable [4]. On this project, We employed InceptionV3 a variation of the Inception family CNN architecture that, among other advancements, includes Label Smoothing, Factorised 7 x 7 convolutions, and an extra classifier to transmit label information farther down the network (with the use of batch normalisation for layers in the side-head) [5].

The study's Methodology consists of three key stages: data acquisition, pre-processing, and Model Building The initial plant leaf disease dataset was obtained from the Mendeley open data repository [6]. The collection contains 54305 colour images of 38 distinct classes of plant leaf categories, both healthy and infected.

Convolutional Neural Network

Convolutional Neural Networks (ConvNet/CNN) are a type of Deep Learning technique that can take in an input image and separate out individual elements and relationships between objects by assigning weights and biases that can be learnt. A ConvNet's structure was modelled after how the visual cortex is organised, and it resembles the way neurons in the human brain link to one another.



(source: Towards Data Science)

Figure 1: Architecture of CNN.

Problem Formulation

Despite having enormous farmers in our country, we cannot produce the food as per our expectations, and we land to various plants' related diseases. In addition, there was Covid-19 in the recent year, which caused farmers difficulty getting the disease diagnosed. As a result, the outcomes of farming were less than expected. Similarly, Infection is widespread in plants due to various factors such as fertilisers, cultural practices, environmental conditions, and many more. These diseases damage the agricultural crop, and ultimately, the economy is based on it.

Any method or method of overcoming this problem and getting a warning before the plants become infected can help farmers grow crops more effectively, both in quality and quantity. Thus, discovering plant diseases plays a vital role in agriculture.

Related Work

Several efforts were made to use leaf image data to determine plant diseases. Due to the disease's obvious manifestation on the leaf, image data are considered natural means in this situation. Therefore, We looked at some relevant research on the system for identifying plant diseases, and some are given below:

Study of K. Pradeepan, V.Rajesh Kumar, M. Rohith, S. Praveen, and V. Vasantha Kumar

This study looks at how procedures for detecting illnesses are carried out utilising inferior image processing methods. According to study, colour, texture, and biological characteristics are the greatest indicators for spotting and differentiating crop illnesses. Convolutional neural networks (CNNs) and support vector machines (SVMs) are the most often utilised techniques for identifying plant diseases (SVMs). Automatic diagnosis of plant diseases will overcome a challenge encountered by professionals in profitable sectors. Early illness detection helps farmers by increasing agricultural yield, which raises India's GDP. [7].

Study of S. Mathulaprangsan, S. Patarapuwadol, D.Jetpipattanapong, K. Lanthong, S. Sateanpattanakul

The five rice diseases that are most common in Thailand were the subject of this study's proposal for an image recognition framework. The five-class dataset for these rice diseases was compiled from real fields in six northernmost provinces of Thailand. Several Deep Neural Network models, including ResNet101, ResNet50, DenseNet169, and DenseNet161, were evaluated in order to address the issue. The experimental results utilising 5-fold cross-validation show that the framework implementing DenseNet161 achieves the best results with a success rate of 95.74%. [8].

Study of A. Devaraj, K.Indira, K.Rathan, S. Jaanhnavi

In this work, automated disease detection for Cercospora, Bacterial Blight, Anthracnose, Leaf Spot, and Alternaria Alternata is accomplished using image processing techniques in MATLAB. The procedure includes image loading, pre-processing, image segmentation, feature extraction, and categorization. Innovative technologies like image processing are used to create automated detection systems that assist farmers in identifying diseases early on and providing helpful information for their treatment. [9].

Research Methodology

The block diagram presented below shows the Methodology of the project.

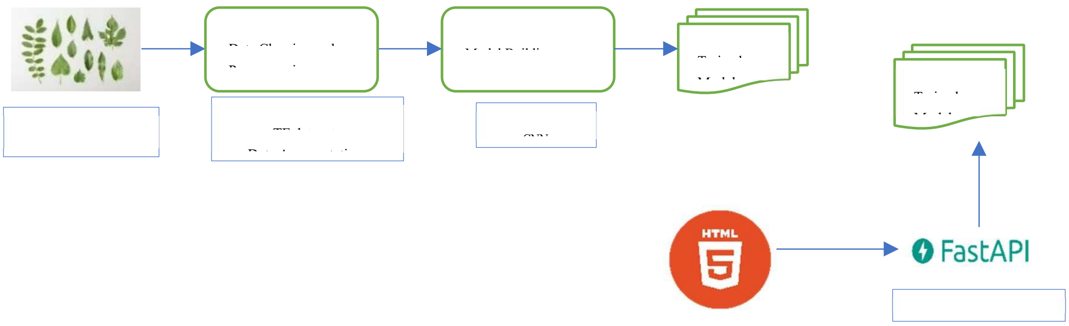


Figure 2. Plant Disease Detection System (PDRS).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 12 April 2023 doi:10.20944/preprints202304.0259.v1

Data Acquisition

The first step in every supervised machine learning project is data gathering, which in this case may be used as a training data set. With the use of datasets from the Mendeley open data repository [6], from which the original plant leaf disease dataset was collected, we need to gather photos of both healthy and diseased plant leaves. 38 variety of healthy and infected plant leaf categories are included in the dataset's 54305 colour photographs. The Mendeley open data collection [6], which contains 54305 colour pictures of 38 different healthy and infected plant leaves, was used to obtain the baseline dataset for leaf images. The dataset that was utilised in this instance is represented in the graph below.

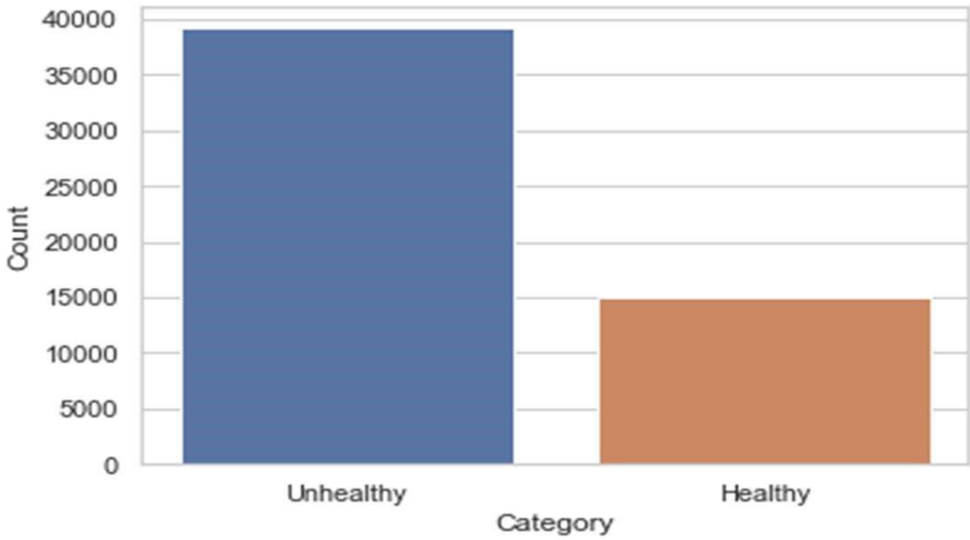


Figure 3. Graphical Classification of healthy and unhealthy leaves/.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 12 April 2023 doi:10.20944/preprints202304.0259.v1

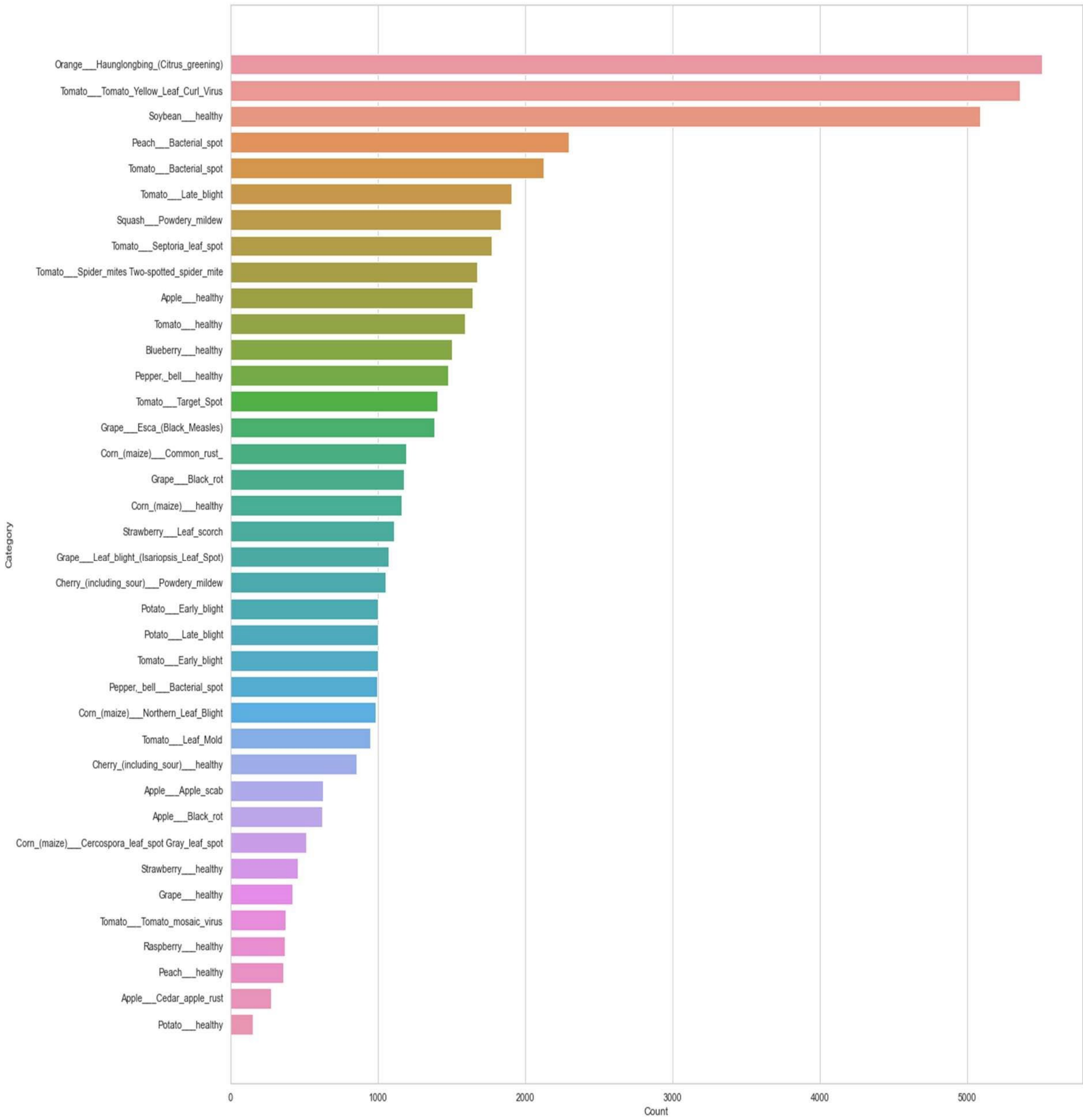


Figure 4. Graphical Classification of all the classes of datasets.

Data Cleaning and Pre-processing

After Data Acquisition comes the data cleaning and pre-processing step, for which we will be using the TF data sets and data augmentation. Data augmentation is necessary since we might need to twist and flip photos in order to obtain extra training examples because we might not have enough varied images. Here, we created the batch size of 32 and image size (240,240). After doing this, it was found that there were 54305 files belonging to 38 classes. Of these, 43444 files were used for training, and 10861 files were used for validation. Similarly, the number of validation batches was 272, and the number of test batches was 68.

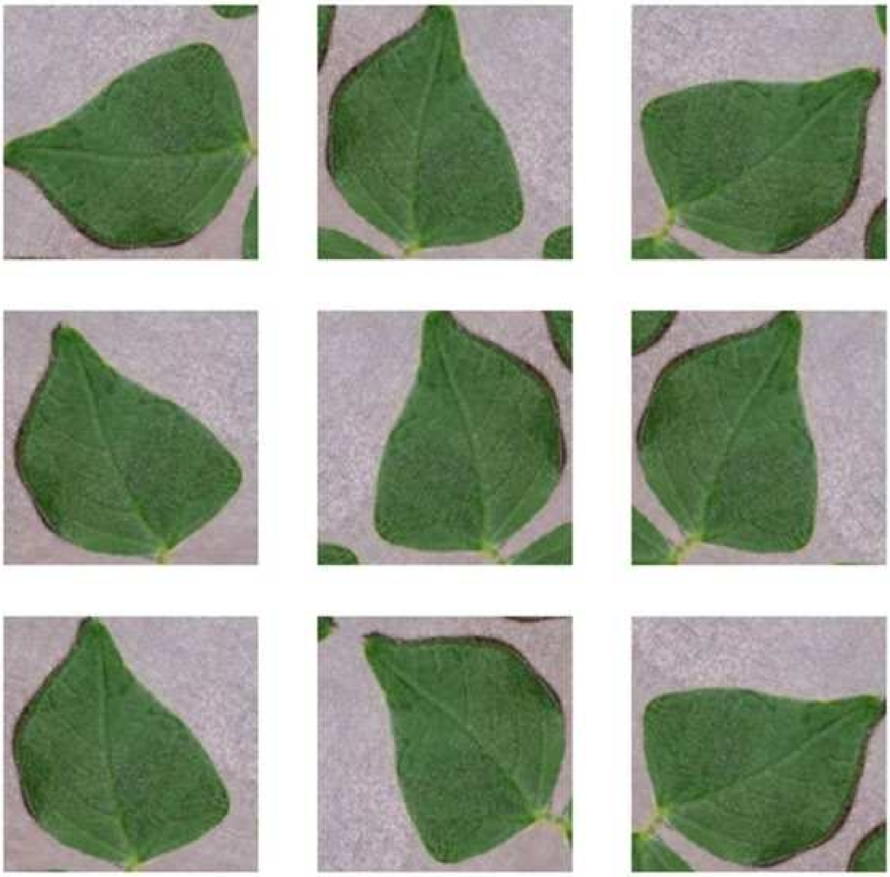


Figure 5. Single Image after Augumentation.

Model Building

We employed a CNN model development after data cleaning and pre-processing. CNN is a standard way of doing image classification as of 2022. Therefore, we will use CNN and export the trained model onto our disk.

After all, this will take input from an HTML document by making a file attach system there. Then HTML calls the FastAPI, and FastAPI calls the trained module to recognise the plant disease. When the model can identify the plant disease, the FastAPI will return a JSON file to HTML containing the remedy with plant name and condition.

Experimental Results

The result of the experiment was mind-blowing. During model training, 99.29 % percent training accuracy and 99.32 % of training precession were achieved after 10 initial epochs and 15 fine-tuning epochs. Similarly, validation accuracy was observed to be 98.40%, and 98.44% validation precision was achieved after 15 epochs. When tested against random plant samples, the model's accuracy rate peaked at 100%. The visualisation of the training and validation plot is given in the figure below.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 12 April 2023 doi:10.20944/preprints202304.0259.v1

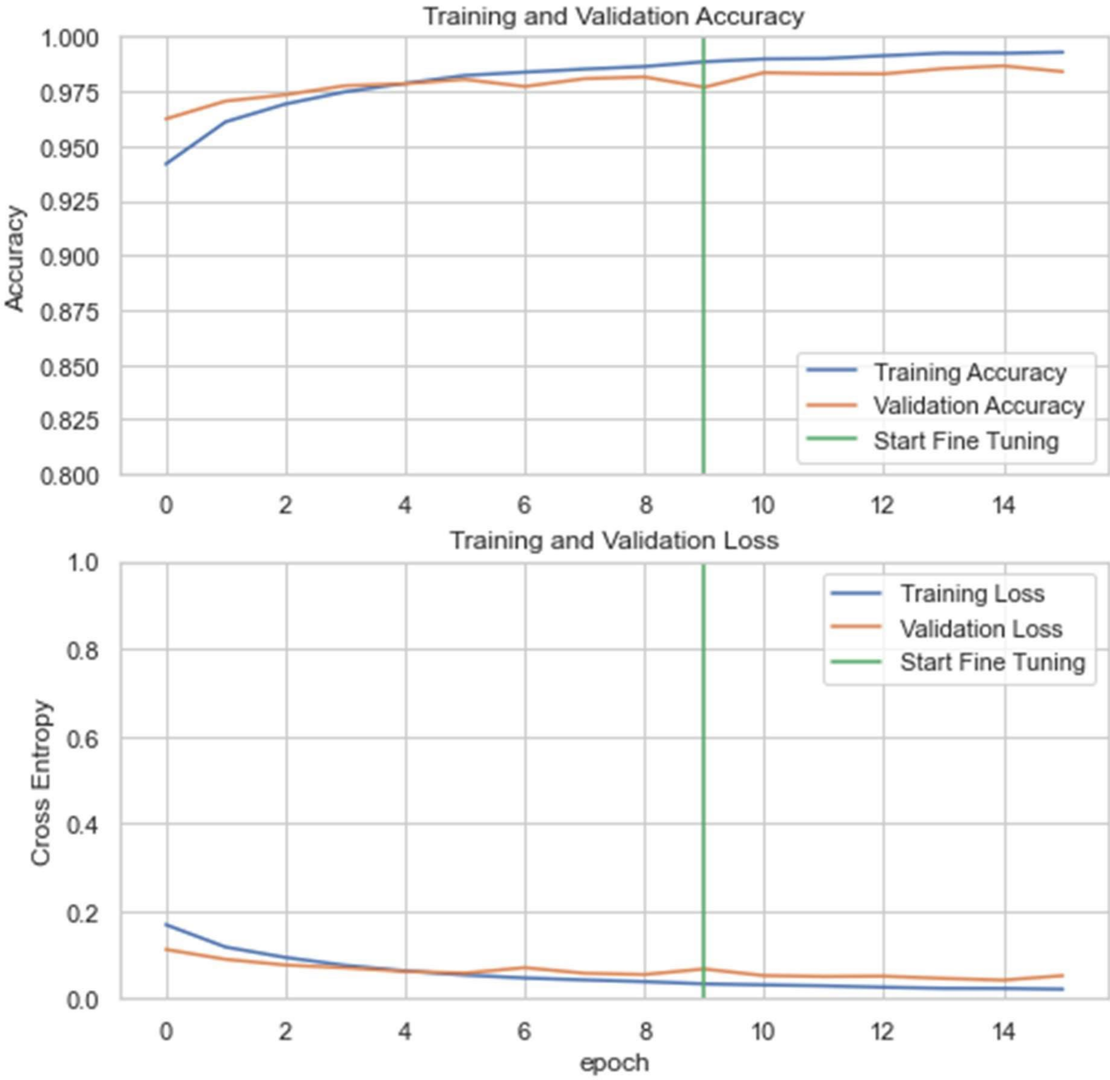


Figure 5. Training and Validation Accuracy and Loss.

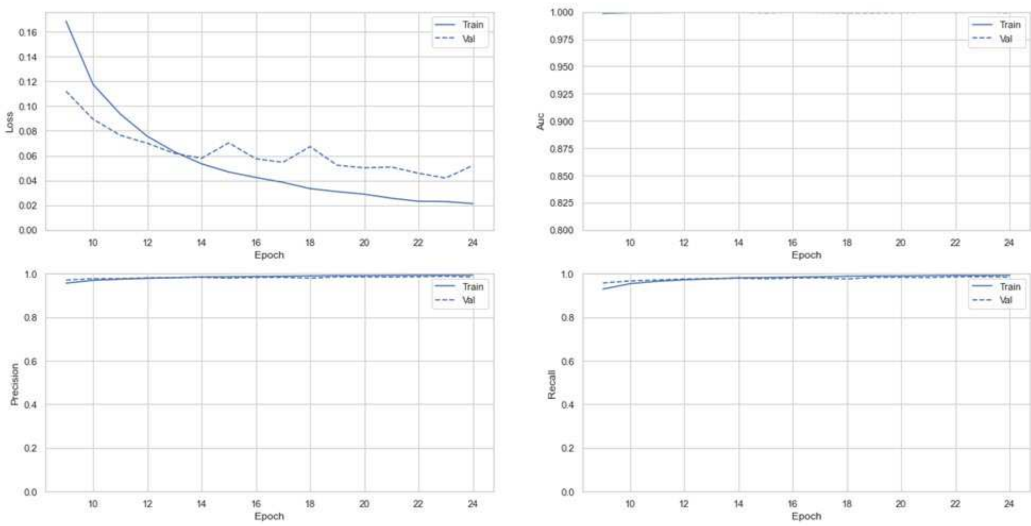


Figure 6. Impact of Fine-tuning Epochs in Training and validation Loss, AUC, Precision, Recall.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 12 April 2023 doi:10.20944/preprints202304.0259.v1

Similarly, when a random picture of an infected orange plant from the internet was given as input, it predicted correctly with 99.42% confidence and nearly the same for others. The result is shown in the figures below:

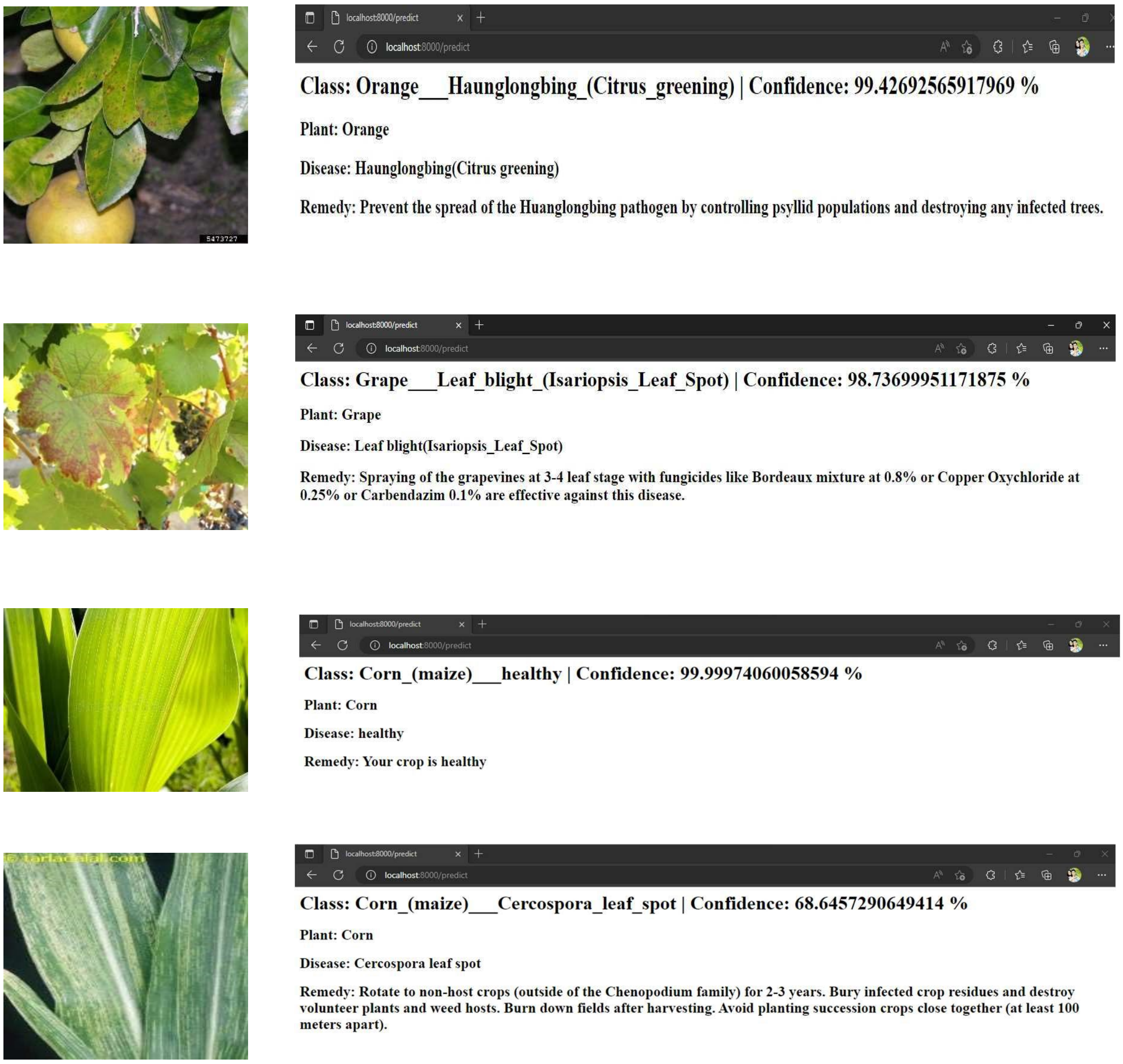


Figure 7. Final result.

Conclusion and Future Work

Millions worldwide depend on agriculture as one of the most significant sectors, as crops are the necessity for food. Early diagnosis and identification of such illnesses are critical for the agriculture business. Using a deep neural network, this research was able to detect and distinguish thirty-eight different plant kinds and plant illnesses. The learning algorithm may be used to recognise plant illnesses in real-time photos. In the future, more plant kinds and plant diseases of various sorts may be added to the existing dataset to improve the classification model. Other CNN designs may also use alternative learning frequencies and optimisers to test the model's performance and accuracy.

Furthermore, mobile applications could be developed using the same model so that farmers can easily access it wherever they go.

 doi:10.20944/preprints202304.0259.v1

Literature Survey

TITLE	AUTHOR	OBJECTIVES	Software / Hardware Requirements / Programming	ALGORITHM / METHODOLOGY / Techniques / Methods	DATASET / Source of Input	RESULT (ACCURACY or ANY OTHER PARAMETER)	FINDING / Achievement	DRAWBACK
Rice Diseases Recognition Using Effective Deep Learning Models	Seksan Mathulaprangsan; Kitsana Lanthong; Duangpen Jetpipattanapong; Siwadol Sateanpatta; Sujin Patarapuwado	Rice Diseases Recognition Using Effective Deep Learning Models	Google Colab with the specs as follows. GPU: 1xTesla K80, compute 3.7, having 2496 CUDA cores, 12GB GDDR5 VRAM, CPU: 1×single core hyper threaded Xeon Processors@2.3Ghz (1 core, 2 threads), RAM: ~12.6 GB Available, Disk: ~33 GB.	DNN (ResNet50, ResNet101, DenseNet161, and DenseNet169)	K5RD dataset	ResNet50 (91.68%) ResNet101 (92.50) DenseNet161 (95.74) DenseNet169 (94.98)	DenseNet161 achieves the best results with 95.74%.	Still there is Room for Improvement
Identification of Plant Diseases Using Image Processing and Image Recognition	V Rajesh Kumar; K Pradeepan; S Praveen; M Rohith; V Vasantha Kumar	Identification of Plant Diseases Using Image Processing and Image Recognition	MATLAB	k-nearest neighbors (KNN), support vector machines (SVMs), convolutional neural networks (CNNs) and backpropagation neural networks.	Taken From Camera and regenerated to RGB	Tomato bacterial Spot (68.62%) Tomato Early Blight (81.86%) Tomato leaf mold (95.87%)	The Performance was better when Compared to R-CNN i.e Tomato bacterial Spot (56.72% VS 68.62%) Tomato Early Blight (66.04% VS 81.86%) Tomato leaf mold (90.13% VS 95.87%)	There is Still area for the improvement on this project as its not nearly Perfect
Identification of Plant Disease using Image Processing Technique	Abirami Devaraj; Karunya Rathan; Sarvepalli Jaahnavi; K Indira	Identification of Plant Disease using Image Processing Technique	MATLAB	image processing techniques in MATLAB	Taken From Camera and regenerated to RGB using MATLAB	Successful in identification of Plant Disease	successfully executed and model was as to find and detect Alternaria Alternata, Antracnose, Bacterial Blight and Cercospora	Was limited to only Alternaria Alternata, Antracnose, Bacterial Blight and Cercospora

References

1. "Nepal," IFAD, 2014. https://www.ifad.org/en/web/operations/w/country/nepal (accessed Jun. 26, 2022).
2. Agriculture in India: Industry Overview, Market Size, Role in Development...| IBEF. (n.d.). Retrieved June 26, 2022, from https://www.ibef.org/industry/agriculture-india
3. Burns, E., & Brush, K. (2021). What is Deep Learning and How Does It Work? Retrieved June 27, 2022, from https://www.techtarget.com/searchenterpriseai/definition/deep-learningdeep-neural-network
4. Ltd., A. (n.d.). What is a convolutional neural network (CNN) – Arm®. Arm Ltd. Retrieved June 28, 2022, from https://www.arm.com/glossary/convolutional-neural- network
5. Szegedy, C., Vanhoucke, V., Ioffe, S., Shlens, J., & Wojna, Z. (2016). Rethinking the inception architecture for computer vision. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 2818-2826).
6. J Arun Pandian, Gopal and Geetharamani, "Data for: Identification of Plant Leaf Diseases Using a 9-layer Deep Convolutional Neural Network", Mendeley Data, vol. 1, 2019
7. V. Rajesh Kumar, K. Pradeepan, S. Praveen, M. Rohith and V. Vasantha Kumar,
8. "Identification of Plant Diseases Using Image Processing and Image Recognition," 2021 International Conference on System, Computation, Automation and Networking (ICSCAN), 2021, pp. 1-4, doi: 10.1109/ICSCAN53069.2021.9526493.
9. S. Mathulaprangsan, K. Lanthong, D. Jetpipattanapong, S. Sateanpattanakul, and S.
10. Patarapuwadol, "Rice Diseases Recognition Using Effective Deep Learning Models," 2020
11. Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMT & NCON), 2020, pp. 386-389, doi:
12. 10.1109/ECTIDAMTNCON48261.2020.9090709.
13. A. Devaraj, K. Rathan, S. Jaahnavi, and K. Indira, "Identification of Plant Disease using Image Processing Technique," 2019 International Conference on Communication and Signal Processing (ICCSP), 2019, pp. 0749-0753, doi: 10.1109/ICCSP.2019.8698056.