# Plant Disease Detection Using Image Processing and Deep Learning

**Mr. Deekshit Bhaskar[1], Vibhash[2], Abhinav[3], Ratan Priya[4], Yash Bilunia[5]**

*1 Assistant Professor, Dept. of Computer Science and Engineering, HMR Institute of Technology & Management, New Delhi, India*

*2345 Students, B. Tech, Dept. of Computer Science and Engineering, HMR Institute of Technology & Management, New Delhi, India*

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## 1. ABSTRACT

Plants play a vital role in the survival of all organisms on Earth. Due to this fact, it is very important to ensure that measures are taken to detect and mitigate any diseases on plants. Identification of the plant diseases is important in order to prevent the losses within the yield. It's terribly troublesome to observe the plant diseases manually. It needs a tremendous quantity of labour, expertise within the plant diseases, and conjointly need the excessive time interval. Hence, with the advancement in deep learning and computer vision it is now possible to detect the plant disease effectively by observing the disease pattern of leaves of plants, which will help the farmers to classify the disease in their plant. Moreover, several performance metrics are also used for the evaluation of this project. This study provides an efficient solution for detecting multiple diseases in many plant families. In this study thousands of images of healthy and infected plant leaves which are available in public domain were used to train deep learning model, which can classify the respected disease. This model has achieved a high level of accuracy in detecting and recognizing the plant variety and the type of diseases the plan was infected with.

## 2. INTRODUCTION

The level of agricultural production is crucial to nation's economic growth. The biggest obstacle to the production and quality of food, though, is plant disease. Early detection of plant diseases is essential for maintaining global health and welfare. Early diagnosis of plant disease may pave the way for better decision-making in managing agricultural production. Manual identification of plant disease is a common practice where farmers try to relate the disease pattern of leaves according to his/her experience. Also, it is not always possible that farmers get prediction of the disease of

crops correctly as in many cases there is hit and trial. The standard method of diagnosis entails a pathologist visiting the location and visually evaluating each plant.

Plant diseases like black measles, black rot, bacterial spot, etc. affect the growth, crop quality of plants and economic impacts in the agriculture industry. To avoid the impact of these diseases, expensive approaches and the use of pesticides are some solutions the farmers usually implement. The use of chemical means damages the plant and the surrounding environment. This kind of approach intensifies the cost of production and major monetary loss to farmers. Early discovery of diseases, as they occur, is the most important period for efficient disease management.

With the evolution of computer vision, there are numerous ways to resolve the detection issues for plants, since the infection spots are initially seen as spots and patterns on leaves. Researchers have proposed several techniques to accurately detect and classify plant infections. With the advancement in deep learning and computer vision technologies, automatic disease detection using images of plant leaves is now possible. In this project, we were able to investigate disease that affects the leaves of the plants.

Machine learning includes a set of techniques known as Deep Learning that employs Artificial Neural Networks to simulate the human brain's neural network. Deep learning is the advanced methods of machine learning that uses neural networks that works like the human brain. Traditional methods involve the use of semantic features as the classification method. Deep learning is a subsection of Artificial Intelligence and machine learning that uses artificial neural networks. Training the deep learning models divides the feature extraction and extracts its features for classification. There are many applications of deep learning which include computer vision, image classification, restoration, speech, video analysis, etc.

CNN is a deep learning system that can automatically identify an image data by figuring out some rules and storing them as weights and biases, which are subsequently utilized in prediction. In deep learning a convolutional neural network (CNN) is a type of deep neural networks most commonly used to analyze the images. Image processing techniques are now commonly employed in agriculture and it is applied for the detection and recognition of weeds, fruit-grading, identifying and calculating disease infestations of plants, and plant genomics.

## 3. CONVOLUTIONAL NEURAL NETWORK

A convolutional neural network (CNN) is a subset of machine learning. It is one of the various types of artificial neural networks which are used for different applications and data types. A CNN is a kind of network architecture for deep learning algorithms and is specifically used for image recognition and tasks that involve the processing of pixel data. There are other types of neural networks in deep learning, but for identifying and recognizing objects, CNNs are the network architecture of choice. This makes them highly suitable for computer vision (CV) tasks and for applications where object recognition is vital, such as self-driving cars and facial recognition.

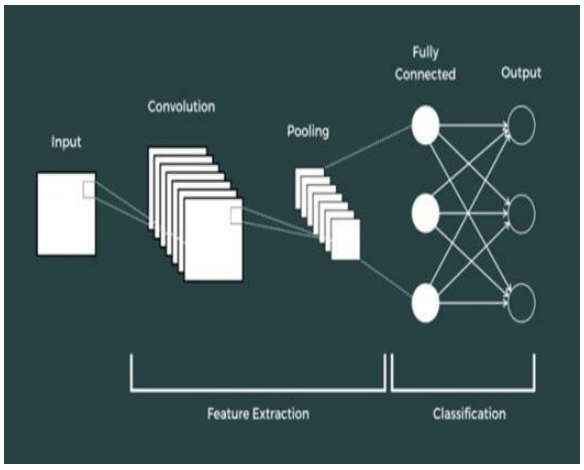


Fig 1. Building a CNN

### A. Convolutional Layer

The convolutional layer is the core building block of a CNN, and it is where the majority of computation occurs. It requires a few components, which are input data, a filter, and a feature map. Let's assume that the input will be a colour image, which is made up of a matrix of pixels in 3D. This means that the input will have three dimensions - a height, width, and depth, which correspond to RGB in an image. We also have a feature detector, also known as a kernel or a filter, which will move across the receptive fields of the image, checking if the feature is present. This process is known as a convolution.

The feature detector is a two-dimensional array of weights, which represents part of the image. While they can vary in size, the filter size is typically a 3x3 matrix; this also determines the size of the receptive field. The filter is then applied to an area of the image, and a dot product is calculated between the input pixels and the filter. This dot product is then fed into an output array. Afterwards, the filter shifts by a stride, repeating the process until the kernel has swept across the entire image. The final output from the series of dot products from the input and the filter is known as a feature map, activation map, or a convolved feature.

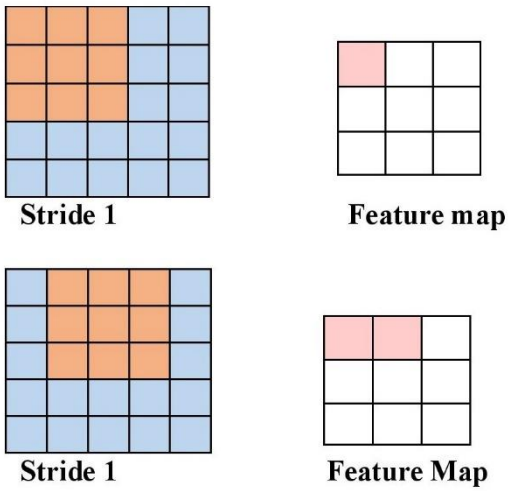


Fig 2. Convolution Filter

**B. Pooling Layer**

Pooling layers, also known as down sampling, conducts dimensionality reduction, reducing the number of parameters in the input. Similar to the convolutional layer, the pooling operation sweeps a filter across the entire input, but the difference is that this filter does not have any weights. Instead, the kernel applies an aggregation function to the values within the receptive field, populating the output array.

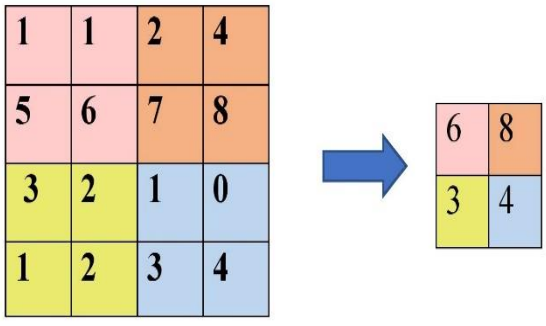


Fig 3. Max Pooling using 2x2 Windows

**C. Re Lu correction layer/ Activation layer**

Utilizes a non-linear ReLU (Rectified Linear Unit)/Activation Layer in every convolution layer. The application of dropout layers to prevent over fitting is also applied in this layer.

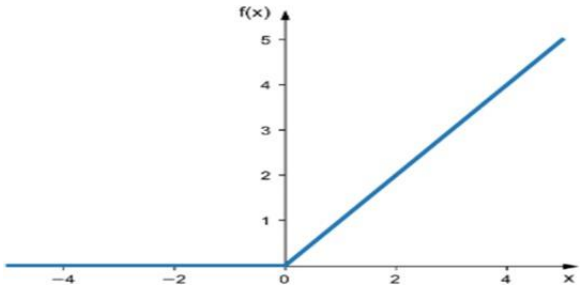


Fig 4. Activation Layer

**D. Fully Connected Layer**

The fully connected layer is a feed forward neural network that is always the last layer of a neural network. The previous layer's input is flattened before being fed to these FC layers. This layer is used to examine the probability of each class. This layer takes an input vector and uses linear combination and activation function to create a new output vector. It returns N-dimensional vector, with N denoting the number of classes in our image classification task.

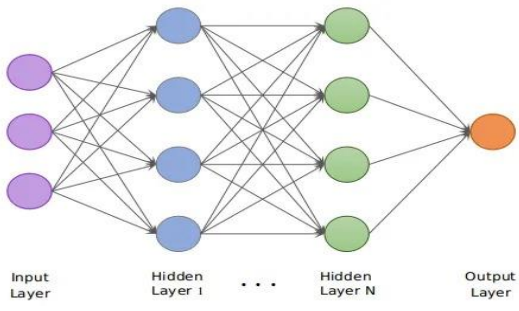

Fig 5. Input-Output Neuron

## 4. METHODOLOGY

### A. Dataset

For this project we have used public dataset for plant leaf disease detection called Plant Village curated by Sharada P. Mohanty. The dataset consists of thousands of images of healthy and unhealthy plant leaves having different plant families.

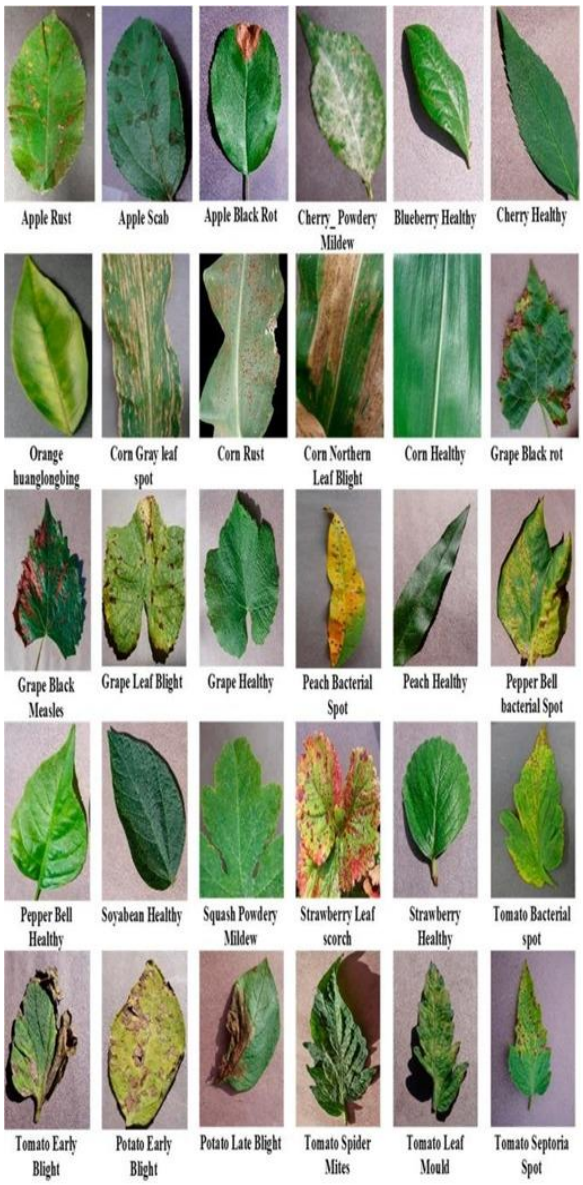


Fig 6. Image Dataset

### B. Image Acquisition

Deep learning requires an image dataset for training that is as accurate as possible to real world conditions to create robust algorithm. The image dataset for training the model was obtained from a variety of open source sites, including the plant village dataset". Images were downloaded and organized into folders based on their appropriate classifications. A python script was used to download images of the plant diseases from the repository. The collected dataset consists of many photos of different plant family leaves of various varieties and diseases.

### C. Image Pre-Processing

Data pre-processing is important task in any computer vision-based system. Pre-processed images are reduced image to minimize their size in order to match the input layer's input criteria. It processes and enhances the image to its needed color scale. The study uses colored and resized images to 96x96 resolution for processing.

### D. Model Building

A typical CNN model was built to train and test the data. CNN model design also plays a vital role in the final accuracy and other results.

### E. Training

The proposed model was trained using the pre-processed dataset.

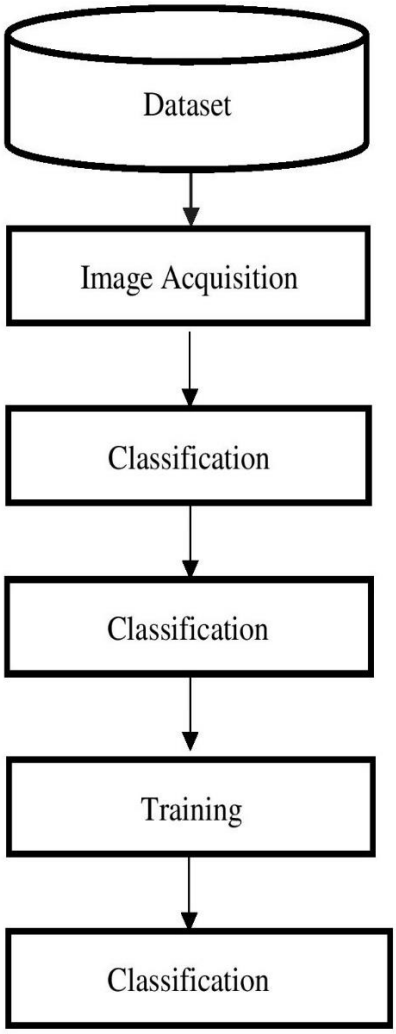


Fig 7. Convolution Filter

### F. Classification

Classification uses fully connected layers and for feature extraction it uses convolutional and pooling layers. The classification processes classify the plant leaf if it is infected with the disease or not, identifies the type of plant disease and recognize the plant variety.

## 5. EXPERIMENTATION

The dataset consists of thousands of images containing different types of plants leaf diseases. This image dataset was used for training & testing. Python programming language was used to create neural network code. A neural network application program interface (API) was applied for the CNN model application. By rotating the photos, flipping and shifting the images horizontally and vertically, data augmentation techniques were also used to improve the image dataset. Data augmentation techniques were integrated into the application to enhance the image dataset. The model also trained a high number of epochs.

## 6. RESULTS AND ANALYSIS

A very high rate of accuracy was achieved during the training of this model. During the training of deep learning model, a very high number of epochs were used to train the model. This model also achieved a maximum accuracy rate of 99% when testing random images of plant varieties and diseases. The visualization of plots of train and test accuracy shows that the model is effective in detecting and recognizing plant diseases.

During Analysis we found that the many outcomes were incorrect in the start due to overfitting but after dimensionality reduction the results were significantly improved and the accuracy of our model was improved.

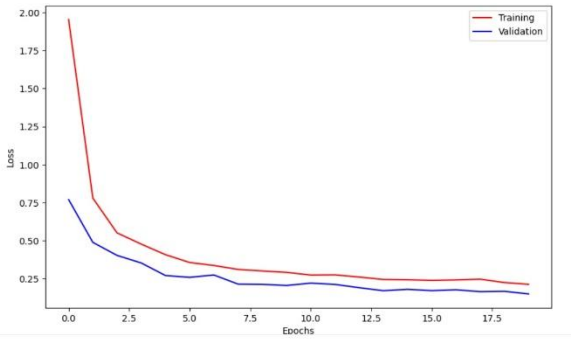


Fig 8. Loss vs Epochs

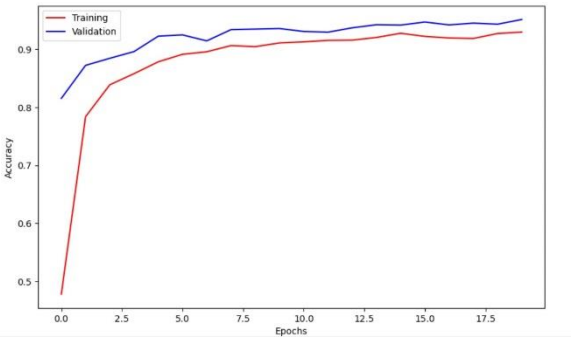


Fig 9. Accuracy vs Epochs

## 7. CONCLUSION

The people around the world rely on the agricultural sector. It is one of the most important sectors because they are the basic need for food. Early recognition and detection of these plant diseases are crucial to the agricultural industry. By using convolution neural networks, we were able to detect and recognize different kinds of plant diseases. This trained model can be used to test real-time images to detect and recognize plant diseases. For future work additional crops and diseases may be added. A feature to also show the prevention technique or pesticides according to the predicted disease may also be added. Other CNN architectures may also use different learning rates and optimizers for experimenting the performance and accuracy of the model. With this high level of accuracy, the proposed model can assist farmers to detect and recognize plant diseases.

## 8. REFERENCES

1. Andrew J., Jennifer Eunice, Daniela Elena Popescu, M. Kalpana Chowdary, and Jude Hemanth, Deep Learning-Based Leaf Disease Detection in Crops Using Images for Agricultural Applications, Agronomy 2022, 12, 2395.
2. K. Elangovan and S. Nalini, Plant disease classification using image segmentation and SVM techniques, International Journal of Computational Intelligence Research, vol. 13(7), pp. 1821-1828, 2017.
3. Mr. Thangavel. M -AP/ECE, Gayathri P K, Sabari K R, Prathiksha V, Plant Leaf Disease Detection using Deep Learning, International Journal of

Engineering Research & Technology, Volume 10, Issue 08.

4. A. Vibhute and S. K. Bodhe, Applications of Image Processing in Agriculture: A Survey, International Journal of Computer Applications, vol. 52, no. 2, pp. 34-40, 2012.
5. S. Militante, Fruit Grading of Garcinia Binucao (Batuan) using Image Processing, International Journal of Recent Technology and Engineering (IJRTE), vol. 8 issue 2, pp. 1829- 1832, 2019.
6. Yugam Bhattania1, Prashant Singhal, Tanish Agarwal, Plant Leaf Disease Detection Using Deep Learning, International Journal for Research in Applied Science & Engineering Technology, Volume 10 Issue V May 2022.
7. [7] A. M. Mutka and R. S. Bart, Image-Based Phenotyping of Plant Disease Symptoms, Frontiers in Plant Science, vol. 5, pp. 1-8, 2015.
8. S.P. Mohanty, D.P. Hughes, and M. Salathé Using deep learning for image-based plant disease detection, in Frontiers in plant science 7, p. 1419, 2016.
9. B. Benuwa, Y. Zhao Zhan, B. Ghansah, D. Wornyo, & F. Banaseka, A Review of Deep Machine Learning, International Journal of Engineering Research in Africa, 24,124-136,2016.
10. Pranesh Kulkarni1, Atharva Karwande, Tejas Kolhe, Soham Kamble, Akshay Joshi, Medha Wyawahare, Plant Disease Detection Using Image Processing and Machine Learning, Department of Electronics and Telecommunication, Vishwakarma Institute of Technology.
11. Y. LeChun, Y. Bengio and G. Hinton, Deep Learning, Nature, vol. 521, pp. 436- 444, 2015.
12. S. H. Lee, C. S. Chan, S. J. Mayo and P. Remagnino, how deeplearning extracts and learns leaf features for the plant classification, Pattern Recognition, vol. 71, pp. 1-13, 2017.
13. D.P. Hughes, and M. Salathé, an open access repository of images on plant health to enable the development of mobile disease diagnostics, arXiv:1511.08060, 2015.vol. 145, pp. 311-318, 2018.
14. H. Durmus, E. O. Gunes¸ and M. Kirci, Disease detection on the leaves of the tomato plants by using deep learning, In Agro-Geoinformatics, IEEE 6th International Conference on, pp.1-5, 2017.

15. Md. Mosaddikul Anwar, Zinat Tasneem, Md. Alamin Masum. "An Approach to Develop a Robotic Arm for Identifying Tomato Leaf Diseases using Convolutional Neural Network", 2021 International Conference on Automation, Control and Mechatronics for Industry 4.0 (ACMI), 2021.
16. D.P. Hughes, and M. Salathé, an open access repository of images on plant health to enable the development of mobiledisease diagnostics, arXiv:1511.08060, 2015.
17. V. Tumen, O. F. Soylemez and B. Ergen, Facial emotion recognition on a dataset using convolutional neural network, 2017 International Artificial Intelligence and Data Processing Symposium (IDAP), 2017.
18. Sudhanshu Kaushik, Khushi Srivastava, Sanyam Kaushik, Ishita Sharma, Isha Jindal, Vaishali, Plant Leaf Disease Detection Using Machine Learning, Journal of Pharmaceutical Negative Results, Volume13, Special Issue10, 2022.