# A Study On Convolutional Neural Networks for Crop Disease Classification

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**Abstract: industry in India suffers from various issues of malnutrition, crop diseases or pest infestations which occur differently at different seasons. Identification of the plant diseases is the key to preventing the losses in the yield and quantity of the agricultural product. It is very difficult to monitor the plant diseases manually. It requires a tremendous amount of work, and also requires excessive processing time. It is also difficult to appropriately identify the type of diseases at an early stage.So, farmers resort to the use of pesticides/fertilizers in excess amounts expecting to save and increase their produce, which may result in reduced yields, and significant adverse health problems to the consumers. Hence, image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. This paper discussed the methods used for the detection of plant diseases using their leaves images.**

## I. INTRODUCTION

This Computerization in the field of agriculture sees an extraordinary achievement in numerous farming perspectives, including detection of different plant diseases. Among the significant difficulties in agriculture, plant disease detection is a critical factor influencing the result of cultivation. Quality of organic products, vegetables and grains is influenced by plant disease, and hefty misfortune underway and therefore monetary losses are watched, so there is a prerequisite of quick and viable plant disease detection and evaluation strategies. Artificial Intelligence and uses of machine learning have entered in these referenced classifications. Artificial intelligence advancements deal with the premise of past learning encounters. Uses of procedures of Machine Learning (ML) such as Back proliferation, artificial neural networks, Convolutional neural networks are computerizing the machine work and creating cutting edge innovations . The sole objective of ML is to take care of a coherent model (machine) with measurable information from past encounters to settle on exact and right choices. ML is a numerical methodology of building smart machines., AI helps in the expectation of the infection and its fix. A significant danger to food security is the plant disease as it legitimately impacts the harvest yield and subsequently diminishes the creation nature of yield. The regular arrangement of plant disease distinguishing proof depends on human intervention. Visual examination of plants, the experience of a farmer and his mind and instincts are being utilized to identify plant diseases. Wrong decisions and delay in settling on the right choice antagonistically influence the profitability. However, presently, human interventions have been joined and some of the time supplanted with various advancements. This paper investigates the manners by which machine learning models can be applied to improve the cycle of plant disease detection in beginning phases to improve grain security and manageability of the agro-biological system.

## II. LITERATURE SURVEY

S. Ramesh and D. Vydeki[1] in their paper propose detecting the disease accurately for the rice crop. The leaf area was captured from a distance of 25cm of the visible region. The leaf was captured for both normal and diseases using a Redmi Note 5 camera with high pixel intensity. V. Agnihotri[2] in their paper proposes identifying pests using the technology and integrating agriculture with technology would result in a better future. In order to make this world a better place farmers need to get familiar with flying quadcopter and technology. It will reduce human effort for identifying the pests that are destroying the yield. Y. Ai, C. Sun, J. Tie and X. Cai[3] in their paper proposes 27 kinds of disease recognition of 10 kinds of crops were studied. The Inception-ResNet-v2 model is constructed by using deep learning theory and convolution neural network technology. Experiments show that the model can effectively identify the data set, and the overall recognition accuracy is as high as 86.1 percent. The results show that the recognition accuracy of this hybrid network model is relatively higher than the traditional model, and it can be effectively applied to the identification and detection of plant diseases and insect pests. S. D. Khirade and A. B. Patil[4] in their paper discusses an overview of the entire process of classification and identification of pests.The paper also discussed some Feature extraction and classification techniques to extract the features of infected leaves and the classification of plant diseases. The use of ANN methods for classification of disease in plants such as self organizing feature map, back propagation algorithm, SVMs etc. can be efficiently used. From these methods, we can accurately identify and classify various plant diseases using image processing techniques. P. K. Mugithe, R. V. Mudunuri[5] in their paper the leaf detection and alerting is done using k-means clustering algorithm in two methods particularly in GUI and Real time, in the GUI results are having accuracy of 95.1613 percent for Alternaria disease and in Real time, when the disease is detected it alerts the people using a buzzer and when the healthy leaf is detected it doesn't turn on the buzzer and remain silent. The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

## III. MISSION STATEMENT

To detect whether a plant is healthy or not by image processing and to indicate which disease it is suffering from.

## IV. PROPOSED SOLUTION

Image processing will be used for the detection of plant diseases; this involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification. High resolution images will be used to analyze plant health and this information can be used to initiate appropriate measures.It is mainly to understand the symptoms that the crops display so that a system can be developed to identify the diseases.

## V. BASIC STEPS OF LEAF DISEASE DETECTION

A. Image Acquisition:

Image acquisition is the action of retrieving an image from a source, usually hardware systems like cameras, sensors, etc. This image is in RGB (Red, Green And Blue) form. Color transformation structure for the RGB leaf image is created, and then, a device-independent color space transformation for the color transformation structure is applied

B. Image Pre-Processing:

Image pre-processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or features associated with that image. Convolutional Neural Network will be used for creating feature maps for reducing computational complexity. Steps involved in image pre-processing: • Read image. • Resize image. • Remove noise(Denoise)

C. Image Segmentation:

Image segmentation is a method in which a digital image is broken down into various subgroups called Image segments which helps in reducing the complexity of the image to make further processing or analysis of the image simpler. Segmentation in easy words is assigning labels to pixels. The segmentation can be done using various methods like

D. Feature Extraction:

Feature extraction plays an important role for identification of an object. In many applications of image processing feature extraction is used. Color, texture, morphology, edges etc. are the features which can be used in plant disease detection. These features need to be trained into the CNN(Convolutional Neural Network) so that the system can understand these features from the processed data. Filters or Layers involved in feature extraction using CNN

E. Classifier:

After the processing the images are classified according to the rules set after the careful examination and study of diseases and malnutrition. This helps in the careful classification of the images according to their corresponding characteristics.After feature extraction is done, the learning database images are classified by using neural network. These feature vectors are considered as neurons in CNN.

F. TRASFER LEARNING USING MATLAB

• Transfer learning is a deep learning approach where an excisting pre-trained Convelutional Neural Network is modified according to our needs. This is more benificial than training from scratch as it reduces the training time and computing resource

• We where successfull in modifying the 5 CNNs namely GoogleNet, AlexNet,Inception-v3,DarkNet-19 and ShuffleNet by changing the last three layers for our particular application and we where able to classifiy the dataset we look which was Potato Leaves in 3 classes which where Healthy,Early Blight and Late Blight

• These 5 CNN are pre-trained networks that have been proved to be efficient and we have modifying it for our need.

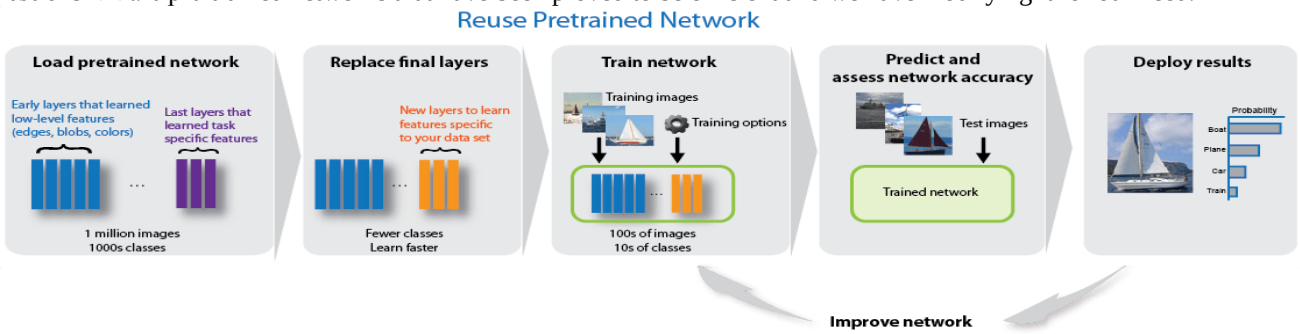



Fig. 1. Transfer learning

## VI. DATASET FOR TESTING

We downloaded a dataset named'Plant Village' from the internet which had a collection of images of symptoms seen on leaves of deseases of the plants- Potato,Tomato and Pepper. Out of these plants, we choose the Potato plant. There where total of 2816 images of Potato leaves, of which 1000 were of leaves infected with Late Blight ,another 1000 where EarlyBlight and 816 where Healthy leaves.

## VII. CNN'S USED

We used transfer learning approach on five different CNN's which include GoogleNet, AlexNet,Inception-v3,DarkNet-19 and ShuffleNet. Out of this DarkNet-19 is the most accurate one and ShuffleNet have the least accuracy.

1. DarkNet-19

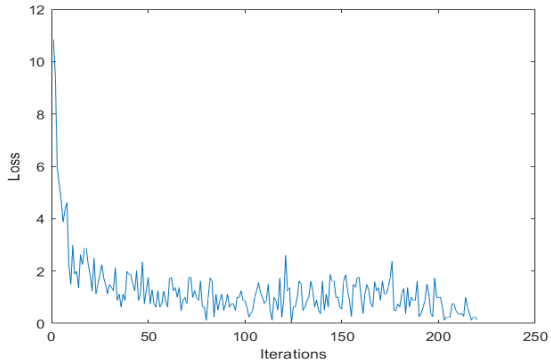
DarkNet-19 is a pretrained model that has been trained on a subset of the ImageNet database. The model is trained on more than a million images and can classify images into 1000 object categories (e.g. keyboard, mouse, pencil, and many animals).

A. Training

| Epoch | Iteration | Time Elapsed (hh:mm:ss) | Mini-batch Accuracy | Mini-batch Loss | Base Learning Rate |
|---|---|---|---|---|---|
| 1 | 1 | 00:00:03 | 28.91% | 10.8522 | 1.0000e-04 |
| 3 | 50 | 00:00:18 | 89.06% | 1.7437 | 1.0000e-04 |
| 5 | 100 | 00:00:31 | 94.53% | 0.8718 | 1.0000e-04 |
| 7 | 150 | 00:00:44 | 96.09% | 0.5487 | 1.0000e-04 |
| 10 | 200 | 00:00:55 | 93.75% | 0.9964 | 1.0000e-04 |
| 10 | 220 | 00:01:00 | 99.22% | 0.1245 | 1.0000e-04 |

Fig. 2. Training Parameters

B. Training Loss




C. Predicted Into Classes

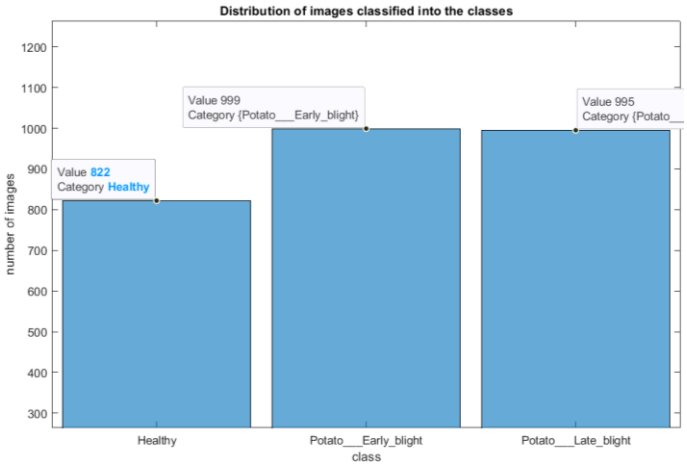



Fig. 4. Predicted Into Classes

D. Confusion Matrix


Fig. 5. Confusion Matrix

2. ShuffleNet

ShuffleNet is a pretrained model that has been trained on a subset of the ImageNet database. The model is trained on more than a million images and can classify images into 1000 object categories (e.g. keyboard, mouse, pencil, and many animals).

A.Training

| Epoch | Iteration | Time Elapsed (hh:mm:ss) | Mini-batch Accuracy | Mini-batch Loss | Base Learning Rate |
|---|---|---|---|---|---|
| 1 | 1 | 00:00:00 | 31.25% | 10.5727 | 1.0000e-04 |
| 3 | 50 | 00:00:11 | 92.97% | 1.1209 | 1.0000e-04 |
| 5 | 100 | 00:00:22 | 96.09% | 0.6227 | 1.0000e-04 |
| 7 | 150 | 00:00:35 | 96.09% | 0.6227 | 1.0000e-04 |
| 8 | 176 | 00:00:40 | 97.66% | 0.3736 | 1.0000e-04 |

Fig. 6. Training

B. Training Loss

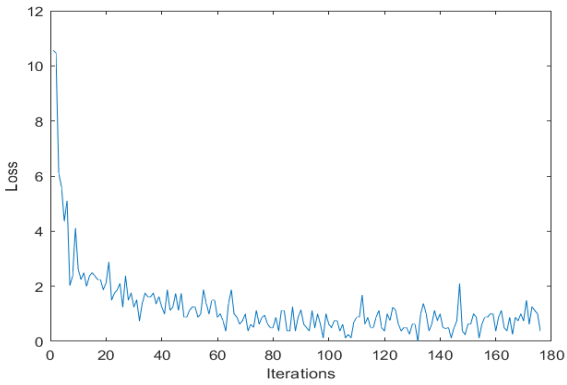



Fig. 7. Training Loss

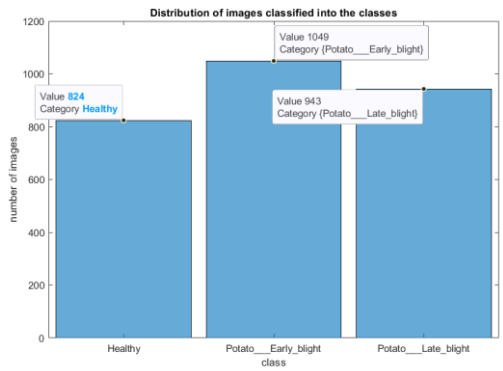



Fig. 8. Predicted Into Classes

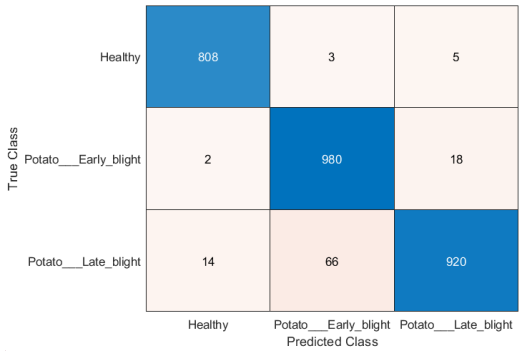



Fig. 9. Confusion Matrix

## VIII. COMPARISON

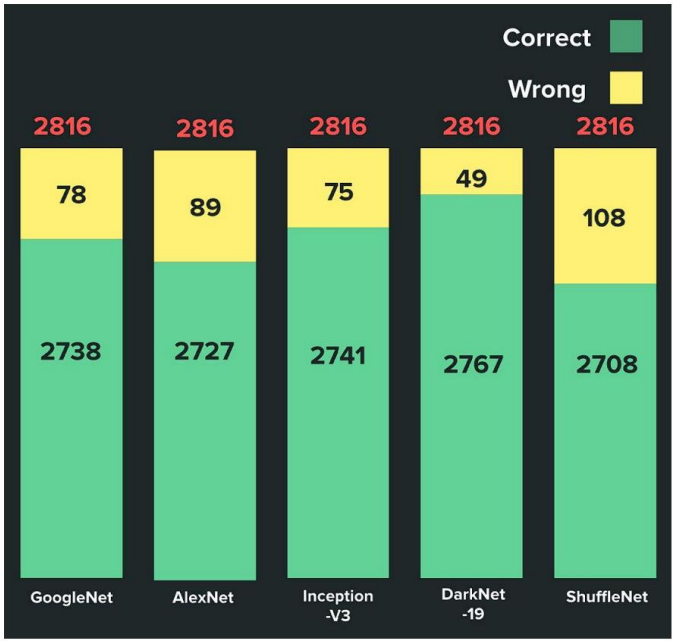



Fig. 10. comparison graph

Table 1. Comparison Table

| CNNs | Definition | Total Number of images used for testing | No. of correct predictions | No. of wrong Predictions | Accuracy in Percentage | Accuracy Rank |
|---|---|---|---|---|---|---|
| GoogLeNet | GoogLeNet is a pertained model that has been trained on a subset of the ImageNet database which is used in the ImageNet Large-Scale Visual Recognition Challenge (ILSVRC). The model is trained on more than a million images, has 144 layers, and can classify images into 1000 object categories (e.g. keyboard, mouse, pencil, and many animals). | 2816 | 2738 | 78 | 97.23 | 3 |
| AlexNet | AlexNet is a pertained Convolutional Neural Network (CNN) that has been trained on approximately 1.2 million images from the ImageNet Dataset. The model has 23 layers and can classify images into 1000 object categories (e.g. keyboard, mouse, coffee mug, pencil). | 2816 | 2727 | 89 | 96.84 | 4 |
| Inception-v3 | Inception-v3 is a pertained model that has been trained on a subset of the ImageNet database. The model is trained on more than a million images, has 316 layers in total, and can classify images into 1000 object categories (e.g. keyboard, mouse, pencil, and many animals). | 2816 | 2741 | 75 | 97.35 | 2 |
| DarkNet-19 | DarkNet-19 is a pertained model that has been trained on a subset of the ImageNet database. The model is trained on more than a million images and can classify images into 1000 object categories (e.g. keyboard, mouse, pencil, and many animals). | 2816 | 2767 | 49 | 98.25 | 1 |
| ShuffleNet | ShuffleNet is a pertained model that has been trained on a subset of the ImageNet database. The model is trained on more than a million images and can classify images into 1000 object categories (e.g. keyboard, mouse, pencil, and many animals). | 2816 | 2708 | 108 | 96.16 | 5 |

## IX. TEXT RESULT

These are some of the individual tests that we did on various images using the above mentioned 5 CNNs

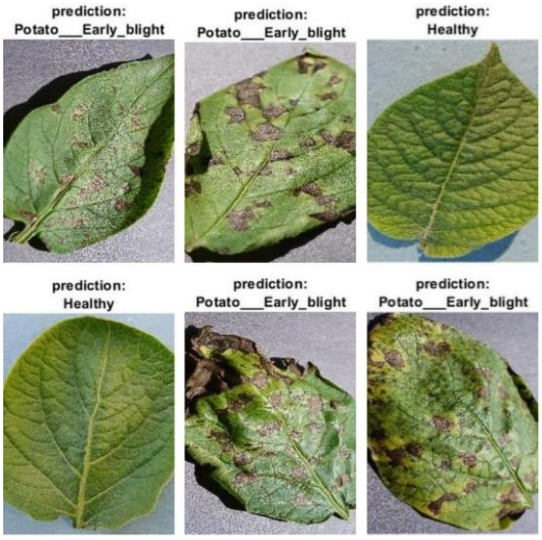



Fig. 12. Test Results

## X. FUTURE SCOPE

The data-set used in this study makes use of only potato leaves. In the future, we can use this data to analyse and identify diseases in paddy leaves. Crop health may be monitored on timely basis for disease from drone images. It will be of great use to farmers to prevent crop loss and hence improve economy of the country. Identification of infestation in the early stages will be highly useful to prevent the spread of diseases and to reduce the use of pesticides, thereby increasing the crop yield. The project can be handed over to agricultural departments or any other institutions supporting farmers which can directly disseminate the findings among the farming community. Eventually, the environment and the product consumers will be benefited by better distribution of resources and improving the efficiency of biodiversity protection.

## XI. CONCLUSION

The accurately detection and classification of the plant disease is very important for the successful cultivation of crop and this can be done using image processing. This paper discussed about how this can be made possible This paper also discussed about how a classifier can easily be constructed and also how it can be used with modifications in the future for the betterment of agriculture

## REFERENCES

1. S. Ramesh and D. Vydeki, ”Rice Blast Disease Detection and Classification Using Machine Learning Algorithm,” 2018 2nd International Conference on Micro-Electronics and Telecommunication Engineering (ICMETE), 2018, pp. 255-259, doi: 10.1109/ICMETE.2018.00063
2. V. Agnihotri, ”Machine Learning based Pest Identification in Paddy Plants,” 2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA), 2019, pp. 246-250, doi: 10.1109/ICECA.2019.8822047.
3. Y. Ai, C. Sun, J. Tie and X. Cai, ”Research on Recognition Model of Crop Diseases and Insect Pests Based on Deep Learning in Harsh Environments,” in IEEE Access, vol. 8, pp. 171686-171693, 2020, doi: 10.1109/ACCESS.2020.3025325.
4. S. D. Khirade and A. B. Patil, ”Plant Disease Detection Using Image Processing,” 2015 International Conference on Computing Communication Control and Automation, 2015, pp. 768-771, doi: 10.1109/ICCUBEA.2015.153.
5. P. K. Mugithe, R. V. Mudunuri, B. Rajasekar and S. Karthikeyan, ”Image Processing Technique for Automatic Detection of Plant Diseases and Alerting System in Agricultural Farms,” 2020 International Conference on Communication and Signal Processing (ICCSP), 2020, pp. 1603- 1607, doi: 10.1109/ICCSP48568.2020.9182065.
6. O. Saxena, S. Agrawal and S. Silakari, ”Disease Detection In Plant Leaves Using Deep Learning Models: AlexNet And GoogLeNet,” 2021 IEEE International Conference on Technology, Research, and Innovation for Betterment of Society (TRIBES), 2021, pp. 1-6, doi: 10.1109/TRIBES52498.2021.9751620.
7. O. Saxena, S. Agrawal and S. Silakari, ”Disease Detection In Plant Leaves Using Deep Learning Models: AlexNet And GoogLeNet,” 2021 IEEE International Conference on Technology, Research, and Innovation for Betterment of Society (TRIBES), 2021, pp. 1-6, doi: 10.1109/TRIBES52498.2021.9751620.
8. S. Ghosal and K. Sarkar, ”Rice Leaf Diseases Classification Using CNN With Transfer Learning,” 2020 IEEE Calcutta Conference (CALCON), 2020, pp. 230-236, doi: 10.1109/CALCON49167.2020.9106423.