Journal of Artificial Intelligence and Capsule Networks (ISSN: 2582-2012)
www.irojournals.com/aicn/

Leaf Disease Detection using Deep Learning

R. Anitha[1], A. Bazila Banu[2]

[1]Assistant Professor, Department of Computer Science and Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu, India.
[2]Professor, Department of Computer Science and Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu, India.

E-mail: [1]anithart@bitsathy.ac.in, [2]bazilabanu@bitsathy.ac.in

Abstract

Agriculture plays an important role in determining India's economy. So, the detection of disease that affects the plants is most important as it affects productivity. The proposed system is designed to detect the diseases that degrade the health of the leaves. The diseases may be of bacterial, viral and late blight. The diseases can be detected with the help of Convolutional Neural Network (CNN). It is composed of several layers that help in the prediction of diseases. The designed CNN classifies the disease into three major categories. An input leaf image is provided to test whether the leaf is healthy or not. The system has been trained with different input leaves. Once it is trained the new input leaves are given to the classifier, then the classifier identifies the label of the affected leaves. Based on the disease identified, the necessary remedies can be taken for curing the disease.

Keywords: Deep Learning, SVM Algorithm, K-Mean Clustering, CNN classifier

1. Introduction

Agriculture is a predominant occupation in india. The economy of the country depends on agriculture as it has been the backbone. The lives of the world depend on agriculture for their survival. In that case, the responsibility towards protecting it should be extended in a larger manner. The FAO surveys say that the production loss occurs mainly due to the pathogens and the diseases that occur because of them. The crop behavior changes from season to season. So, the environmental condition plays an important role in determining the quality of the crop. With respect to season, the maintenance method also varies and the diseases that occur are also different and have different impacts. In the present situation there is an alarming condition where the population and the food production are directly proportional to each other. There exists greater demand for food production. In this

DOI: https://doi.org/10.36548/jaicn.2022.2.002
Received: 21.03.2022, received in revised form: 20.04.2022, accepted: 15.05.2022, published: 26.05.2022

state there exist so many environmental factors that affect the quality of the leaves. The factors can be soil, weather, rain- fall etc.

In traditional methods the farmers observe the crops and they conclude the disease type based on the pattern of diseases similarity gained through their experience. The symptoms of the disease vary from plant to plant [9][10] and it seems a bit complex for farmers to remember it. In case of a new disease the farmer might not be able to recognize the disease or the prediction may lead to a wrong conclusion of disease. So, in all the above cases of incorrect prediction of disease leads to wrong usage of pesticides. If the appropriate pesticide is not used then the outbreak of the usage becomes uncontrollable. The uncontrollable state would be damaging the current state of the crop quality, decreasing the resistant power of the crop to newer disease and some- times it may lead to death of the particular crop. If a single crop gets affected it doesn't affect the survival of the farmer. If it majorly affects the crops it will cause severe loss to the farmer community.

To solve these complications several methods and techniques have been found. Different Machine learning and deep learning techniques like Convolutional Neural network [1][8], Artificial Neural Network [1][6], Support vector Machine [4][7] and K- Means Clustering[6] can be used for detecting the complications in leaves. The pro- posed system is designed by using CNN to detect the disease that occurs on the leaves. The system is implemented by using python programming. The motive of this project is to design an efficient system that detects the disease. The implementation involves training and testing. In training the model the dataset collected from Kaggle is used. In testing, an input leaf image captured through mobile camera used to test whether it predicts the diseases or not.

2. Literature Survey

Neha G.kurale, et al. proposed the classification of leaf diseases using Texture feature and Neural Network classifier. The classification is performed using SVM, K- means and neural network. For detecting the diseases, first they collected the raw input images, convert the RBG image to his and extract some features from the leaf struc- ture to classify the diseases. Once the image has been collected, they apply pre- processing technique to remove the noises for smoothing the images, for smoothing the images median filter is used for removing the noises. To achieve the final type of diseases they have used k- means clustering for segmentation of images, means for means for color extraction and KNN, GLCM for feature extraction, Neural Network and SVM as a classifier. The obtained features are trained

by neural network classifier. The algorithms like decision tree, support vector machine, K-nearest neighbors, and neural network are compared with each other for detecting the leaf diseases where Neural Network gives the highest accuracy. Their study for classification of diseases mainly uses the tool like k-mean clustering and GLSM. This helps in reducing the need for labor in huge farms lands.[1].

Hu Shipping, et al. discussed that the classification of leaf disease explore the detection algorithm on leaf images and built the convolution neural network model to detect the disease based on VGG16 and transfer learning. VGG16 and SVM algorithm are combined to make VGG16 as a image feature extractor. It also combines support vector machine to identify the diseases on leaf. With the help of fine tuning method they have constructed classification model based on the real VGG model. VGG16 utilizes three convolution layer. The diseases are detected based on the leaves as they are important and easily breakable part in the plant.

P. Chalduhary, et al., performed color transform based approach to identify disease in the plant leaf. In the process of disease detection they compare the effect of different color model like CIELAB, HSI, Ycbcr. The collected images are in jpeg format, after collecting it converts the RGB images into many color spaces like HSI, Ycbcr etc. They have used Median filters for image smoothing to remove unwanted spots. In the end they have calculated the threshold by using Otsu method on RGB images and some components in each color spaces is used to identify the diseased spot. To per- form masking on green pixel the threshold is deployed.. The spotted disease images is obtained by three method and they are compared which each other to find the best method for detecting the diseases [3].

Pranjali, et al., identified the leaf disease on graphs using SVM classification Technique. Their methods consist of resizing, thresholding, Gaussian filter for image processing, feature extraction for both color and texture. The disease affected space is identified using segmentation by K-mean clustering. Their system consists of both testing phase and training phase. The training phase undergoes process like image collection, pre-processing, segmentation, feature extraction and input feature data- base. The testing phase involves same process occurred in training phase, but in the final step it uses SVM classifier for classification and also includes features of the images in the database. The result of the decision function depends on the training data called support vector. The filtered images in the process are classified into three segments with K-mean clustering. The support vector machine is a supervised algorithm used as classification tool to classify the leaf disease. The

focus of SVM to create the hyper plane in between the dataset to point out which class it belongs to. In their system they classify the type of leaf disease by two state namely downy mildew and powdery mildew. Finally they get the average accuracy for both leaf disease state with 88.9 percent. Here the efforts and cost are decreased with increasing the productivity [4].

3. Proposed System

The life of all the creatures on the earth depends on the factors namely air, water and food. These three factors determine the existence of the living beings. Among all these factors, food is more important to satisfy the hunger and to increase the survivability of the living beings. In this case, the process of food production must be in standard quantity. The quantity of the production depends on the quality of the crop. Under these circumstances, the identification of the diseases that affects the crops constitutes a vital part.

In the existing system, the machine learning algorithms called SVM is used. First an input leaf image is provided in RGB format. The RGB image is converted into gray scale image. The segmentation process is carried out in the gray scale image. The features are extracted and then the disease is classified by using SVM algorithm. The existing system detects the disease occurred in a particular crop variety. In the existing system the particular crop leaf taken is the grape leaves and the diseases that occur are detected.

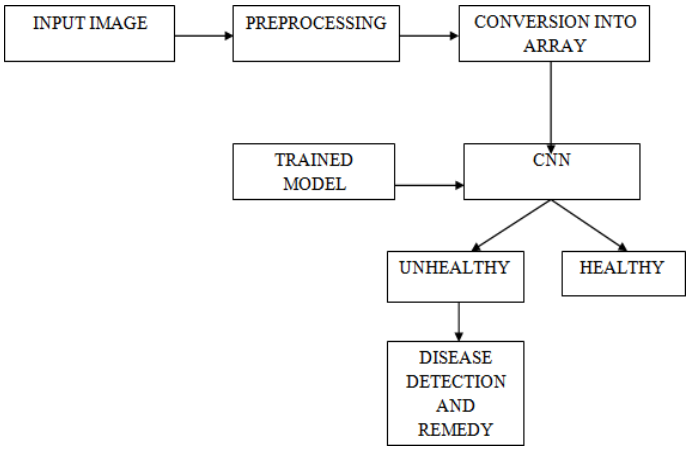

Figure 1. Proposed System

The proposed system is implemented by using one of the neural network called CNN. The network consists of several hidden layers. The layers are maxpooling, convo layer, fully connected layer and softmax. The first two layers forms as the base for feature extraction . The next layers acts as the classifier and provides the probabilities for all the classes of the

diseases. The developed model detects the diseases for all crop varieties of leaves and not for particular crop's leaves as in the existed system. It detects whether the defected leaf belong to the three categories of diseases. They are viral, bacterial and lateblight. On the basis of the features extracted the classifier classifies the disease that already occurred on the leaves. After detection as a step of curing remedies are provided. The remedies provided are accurate because they are pro- vided after the proper prediction of disease.

Preprocessing: This process involves the resizing of the images into the standard size. The images are resized to make the computation in a ease manner.

Conversion into array: All the pixel values of the image are stored in the form of ar- ray. Here, all the computation takes place based on the pixel vales.

CNN classifier: The converted array is compared with the trained model values. Based on the comparison it detects whether the input leaf is infected or healthy. If the leaf is infected then the based on the probability of class values it classifies the dis- ease type. After disease is classified remedies are also provided.

The proposed system is designed by using CNN. The CNN is composed of several like convolutional, maxpooling and fully connected layer. There are about five blocks of layers that is comprised of maxpooling and convolutional layer. In first block, the convolutional layer consists of 32 filters and dimension of filter is 3x3 and in max- pooling the filter dimension is 3x3. In all the blocks of convolutional and maxpooling layer the fixed filter size of 3x3 is used. In second block, the convolutional consists of 64 filters. In third block, the convolutional layer consists of 128 filters. In fourth block, the convolutional layer consists of 32 filters. In fifth block, the convolutional layer consists of 64 filters. Relu layer is used for neglecting the negative values. The two layers of fully connected layer is used as classifier.

4. Convolutional Layer

The purpose of this layer is to reduce the dimensionality of the image without losing the features present in the image. If the dimensionality of the image is 5x5x3 (5- height, 5- weight, 3-channels). The pictorial representation of three channels present in an image. Consider a particular feature (for eg. Curve, shape) has to be detected. First, the feature's pixel values are composed in the form of array and the array is known as the filter. Next, the input image has to be represented in the form of array of pixels. After the representation

process, the matrix multiplication and addition operation is per- formed. After the operation is performed if the result value is greater than zero and the value is high it means the particular feature is present. If the result value is equal to zero it means that there is no presence of the particular feature.

5	10	6	7	2		
8	8	16	20	11	2	
0	2	32	20	0	7	10
11	7	51	8	16	6	23
1	5	4	3	19	15	10
	3	0	7	12	36	9
		21	1	3	2	11

Figure 2. Three Channel

The above process is in case of one channel. In case of three channels in the input image, the filter should also contain the same number of channels. The same process is carried out in individual channels and the resultant value from each channel is summed up. On increasing the number of filters, the depth of the image processed also increases and this result in more number of feature extractions. The features of filters are 1. There can be n number of filters. 2. The dimensionality of filters can vary from layer to layers. 3. The filter size can be fixed in all layers. 4. The channels in image must equal to the channels in the filter.

Figure 3. Input Leaf Image

Table 1. Feature Detection

5	9	7	12	6	1
6	0	1	18	21	0
2	4	17	11	7	8
0	10	8	9	12	2
7	20	11	5	8	7
11	10	6	15	4	6

Table 2. Pixel Representation of Image

1	0	1
0	1	0
1	0	1

Table 3. Filter matrix

31	37	59	53
19	54	53	29
47	48	52	43
55	55	35	40

4.1 Resultant matrix

This is how the operation takes place:
(5*1)+(9*0)+(7*1)+(6*0)+(0*1)+(1*0)+(2*1)+(4*0)+(17*1)=31

4.2 Pooling Layer

The pooling layer works as space dimensionality reduction by taking the maximum and the average value in the particular region.

Max pooling: The maximum value is taken from the particular region.

Average pooling: The average is computed for all the values in the focused region.

Table 4. Resultant Convolutional Layer

37	59	59
54	54	53
55	55	52

Table 5. Maxpooling

35.25	50.75	48.5
42	51.75	44.25
51.25	47.5	42.5

4.3 Average Pooling:-Fully connected layer

After all these layers complete the process, the fully connected layer takes place. The resultant matrixes from the above layers are converted into single vector (i.e. flattened).

Table 5. Average Pooling

37
59
59
54
54
53
55
55
52

5. Experimental Result

Figure 4. Virus Infected Leaf

```
Enter Image File Name:
test1.jpg
Model loaded successfully.
Protect vulnerable plants by preventing attacks from sap-sucking insects, by spr
aying with a suitable insecticide. Sterilise secateurs and lopper blades with ho
usehold bleach. As a result, every effort should be made to prevent the disease
from entering your garden.Plant resistant varieties when available or purchase t
ransplants from a reputable source
Status: Unhealthy.
Disease: Viral.
```

Figure 5. Result Prediction for Viral Leaf

Figure 6. Bacteria Infected Leaf

```
Enter Image File Name:
test2.jpg
Model loaded successfully.
Cut out the infected parts of the crop leaves, stems, branches; make sure to dis
infect the pruning tools that you use. Avoid overhead irrigation to avoid furthe
r spreading. When applicable, practice crop rotation to avoid overwintering of t
he bacterial blight. Use disease free seeds and practice antibiotic seed treatme
nt.
Status: Unhealthy.
Disease: Bacterial.
```

Figure 7. Result Prediction for Bacteria Infected Leaf

Figure 8. Late blight Infected Leaf

```
Enter Image File Name:
test3.jpg
Model loaded successfully.
Apply a copper based fungicide (2 oz/ gallon of water) every 7 days or less, fol
lowing heavy rain or when the amount of disease is increasing rapidly. If possib
le, time applications so that at least 12 hours of dry weather follows applicati
on.
Status: Unhealthy.
Disease: Lateblight.
```

Figure 9. Result Prediction for Late blight Infected Leaf

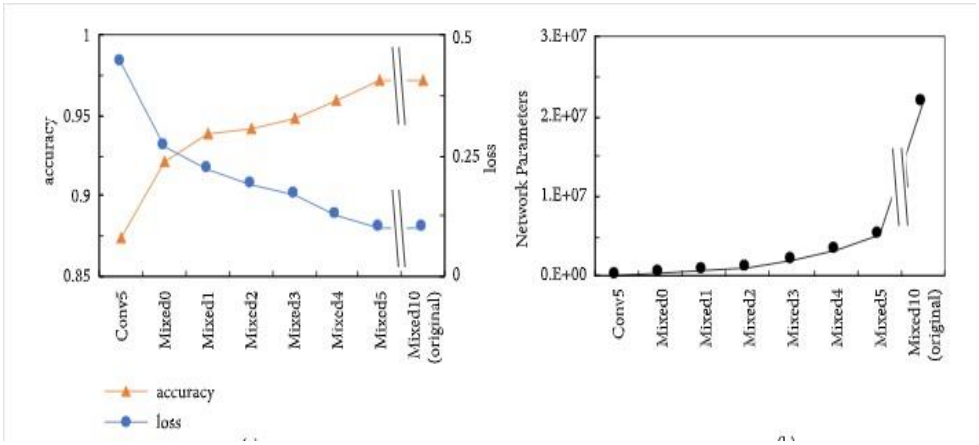

Figure 10. Shaving Feature Extraction Layers from CNN

Early Blight (29)	0.17	0.17	0.15	0.15	0.14	0.13
Bacterial Spot (28)	0.04	0.05	0.08	0.04	0.09	0.06
Late Blight (30)	0.09	0.04	-0.02	0.04	-0.10	-0.01
Leaf Mold (31)	-0.05	-0.02	-0.04	-0.01	-0.10	0.08
Septoria Spot (32)	0.05	0.05	-0.02	-0.02	-0.11	-0.09
Spider Mite (33)	-0.04	-0.09	-0.08	-0.05	0.04	0.05
Target Spot (34)	0.08	0.07	0.03	0.10	0.10	0.08
YLCV (35)	-0.09	-0.08	0.10	-0.01	-0.02	0.05
ToMV (36)	0.02	-0.03	0.09	0.05	0.04	-0.04
Healthy (37)	0.02	-0.06	-0.06	0.04	0.03	0.07

Figure 11. Neuron Index

6. Conclusion

There are several methods for detecting leaf diseases. The proposed system is designed using CNN and it detects disease that occurs in all crop varieties of leaves. The major category of diseases that affect all the crops in common are classified and remedies are provided. In future, the developed system can be installed in drone to cover the entire field under surveillance.

References

[1] Neha G. Kurale Madhav V. Vaidya "Classification of Leaf disease using Texture Feature and Neural Network" Department of Information Technology, SGGS IE&T, International Journal of Technical Research and Application 2015.

[2] Hu Siping, Jia Shijie, Jia Peiyi, Liu Haibo "Automatic Detection of Tomato Diseases and Pests Based on Leaf Images" Electronic&Information College Dalian Jiaotong University Dalian. China, IEE 2017.

[3] Piyush Chaudary, Anand K. Chaudhari, A.N. Cheeran, ShardaGodra "Color Transfor- mation Baased Approach for Disease Spot Detection on Plant Leaf" Veeramata Jijabai Technology Institute, Mumbai, International Journal of Computer Science and Telecom- munications 2012.

[4] Pranjali B. Padol, Anjali A.Yadav "SVM Classifier Based Grape Leaf Disease Detection" STE' Smt.Kashibai Navale College of engineering Pune, Conference on Advanced in Sig- nal Processing 2016.

[5] Sujatha R, Y Saravan Kumar and Garine Uma Abdul “Leaf Disease Detection Using Im- age Processing” Information Technology VIT University , Journal of Chemical and Phar- maceutical Sciences 2017.

[6] S.Jeevan Prasad, G.Mounika and Ch.Usha Kumari “Leaf Disease Detection: Feature Ex- traction with K-means clustering and Classification with ANN”, International Conference on Computing Methodologies and Communication 2019.

[7] Amel H.Abbas and Mohammed A “Plant Leaf Disease Detection Using SupportVector Machine” Department of Computer Science, Mustansiriyah University, IRATQ, Al-Mustansiriyah Journal of Science 2019.

[8] Nagaratna B, Chittaragi, Prajwala TM and Kandiraju Sai Ashritha “Tomato Leaf Disease Detection using Convolutional Neural Network” Department of Computer Science and Engineering, National Institute of Technology, karnataka [IC3].

[9] Muhammad Wannous and Boikobo Tihobogang “Design of plant Disease Detection Sys- tem:A Transfer Learning Approach” International Conference on Applied System Innova- tion 2018.

[10] M.Reyalat, M.Braik, H.AI-hiary, S.Bani-AhmadandZ.ALRahamneh “Fast and Accurate Detection and Classification of Plant Diseases” Department of Information Techonology, International Journel of Computer Application, March 2018.

[11] R. Balodi, S. Bisht, A. Ghatak, and K. H. Rao, “Plant disease diagnosis: Technological ad- vancements and challenges,” Indian Phytopathology, vol. 70, no. 3, pp. 275–281, 2017.

[12] F. Martinelli, R. Scalenghe, S. Davino et al., “Advanced methods of plant disease detec- tion. A review,” Agronomy for Sustainable Development, vol. 35, no. 1, pp. 1–25, 2015. J.

[13] S. West, C. Bravo, R. Oberti, D. Lemaire, D. Moshou, and H. A. McCartney, “The poten- tial of optical canopy measurement for targeted control of field crop diseases,” Annual Re- view of Phytopathology, vol. 41, pp. 593–614, 2003.

[14] A. Singh, B. Ganapathysubramanian, A. K. Singh, and S. Sarkar, “Machine learning for high-throughput stress phenotyping in plants,” Trends in Plant Science, vol. 21, no. 2, pp. 110–124, 2016.

[15] Johannes, A. Picon, A. Alvarez-Gila et al., “Automatic plant disease diagnosis using mobile capture devices, applied on a wheat use case,” Computers and Electronics in Agri- culture, vol. 138, pp. 200–209, 2017.

[16] A. S. P. Mohanty, D. P. Hughes, and M. Salathé, “Using deep learning for image-based plant disease detection,” Frontiers in Plant Science, vol. 7, p. 1419, 2016.

[17] J. Amara, B. Bouaziz, and A. Algergawy, “A deep learning-based approach for banana leaf diseases classification,” in Proceedings of the Datenbanksysteme für Business, Technolo- gie und Web (BTW '17) - Workshopband, 2017.

[18] K. P. Ferentinos, “Deep learning models for plant disease detection and diagnosis,” Com- puters and Electronics in Agriculture, vol. 145, pp. 311–318, 2018.

[19] S. Sladojevic, M. Arsenovic, A. Anderla, D. Culibrk, and D. Stefanovic, “Deep neural networks based recognition of plant diseases by leaf image classification,” Computational Intelligence and Neuroscience, vol. 2016, Article ID 3289801, 11 pages, 2016.

[20] G. Wang, Y. Sun, and J. Wang, “Automatic image-based plant disease severity estimation using deep learning,” Computational Intelligence and Neuroscience, vol. 2017, Article ID 2917536, 8 pages, 2017.