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Grape Leaf Disease Prediction Using Computer Vision and Deep Learning

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***Abstract*: Human beings depend on plants for food. It also protects the earth from global warming and gives us rain. So, growing and saving plants are necessary and in recent days the yield is minimized. The main reason for the loss in agriculture is plant diseases. In the early days, a disease that affected the plant can only be identified by experts but it takes more time. The wrong prediction of the disease that affected the plant leads to incorrect use of pesticides on affected plants. At last, the farmers suffer from loss due to the incorrect usage of pesticides. So, an accurate prediction of the disease that affected the plant is necessary for avoiding other plants from being infected and also loss. Computer vision is used in this paper to identify the disease that affected the plant. In some cases, the disease identified by the computer can be wrong if the data given for the computer is not sufficient. In the proposed system deep learning is used to train the computer using the neural network models and let the computer make the decision so that it can predict the disease with accuracy and the accuracy of the model is 97.27%. The neural network model is built from scratch. The publicly available grapes leaf dataset is collected. The dataset contains the images of diseased leaves with labels and healthy leaves with labels to classify whether the leaf given as input is healthy or unhealthy. The following are steps followed to detect the leaf disease Image Acquisition, Image Preprocessing, Feature Extraction and Classification.**

***Keywords*: Convolutional Neural Network, Computer Vision, Deep Learning, Machine Learning, OpenCV, Python.**

1. Introduction

Food and water are the main source of human beings. Without it, human beings cannot live. Fruits, Vegetables and Rice and etc., that human beings eat are cultivated by farmers. Farmers are facing heavy losses in cultivation in recent years. Some change their occupation but some continue this occupation as it is done by fathers and Grandfathers. Such farmers are one who commits suicide.

One of the main reasons for the loss in cultivation is diseases that affect plants. If farmers detect the disease when it affects a plant then framers can avoid it from spreading and can reduce the loss. The diseases are broadly classified into two: infectious and non-infectious.

Infectious diseases are caused by bacteria, fungus, and viruses. Among them, the viral disease is difficult to control and diagnose.

The diseases that occur in Grapes leaves are

- Black Rot
- Black Measles
- Isriopsis Leaf Spot

Artificial Intelligence is a field that deals with machines programmed to think, act or imitate like humans. Machine Learning is a subset of artificial intelligence that deals with the algorithms used to improve the accuracy of the learning rate of the machines. Machine Learning is divided into the following three categories.

A. Supervised Learning

The data/dataset and the labels are given to the machine to learn from it and classify the newly given input, as it belongs to which category. Supervised Learning is divided into two categories [1].

1) *Classification*: Classification is a technique that classifies the given input as one of the classes. Some of the classification algorithms are Nearest Neighbor, Support Vector Machines, Decision Tree, Boosted Trees, Random Forest, Naïve Bayes, and Neural Networks. Example: to predict the gender of a person by using the handwriting style [2].
2) *Regression*: Regression is a technique that gives a single output based on the previously given data for training. Regression is of five types. They are simple Linear Regression, Polynomial Regression, Support Vector Regression, Decision Tree Regression, and Random Forest Regression. Example: to predict the price of a house [3].

B. Unsupervised Learning

The dataset is given without labels and it works on the data and learns from it. It is more complex than supervised learning and the predicted result is less accurate than supervised learning. It is useful when data is collected from the internet and is not grouped into separate classes and the labels are not given for each class. They are dived into two

1) *Clustering*: Clustering is the process of grouping the uncategorized data into separate categories based on the similarities and labeling it. They are of six types. They are Hierarchical clustering, K-means clustering, K-

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nearest neighbors, Principal Component Analysis, Singular Value Decomposition, and Independent Component Analysis. Example: The images of a men's pants, women's pants, men's shirt, and the women's shirts can be clustered into men and women or shirts and pants [4].

2) *Association*: Association is a process of finding the interesting relationship between variables in the large dataset. Example: a group of shoppers based on their purchasing history [5].

C. Reinforcement Learning

The learning process of a machine in which it learns by interacting with the environment. The machine is trained based on the reward and punishment strategy. It gets the reward when it takes a correct decision in a situation and it is punished when it takes a wrong decision in a situation. This category of machine learning is the same as how a child is trained from childhood from adulthood to adapt to the environment. Some of the examples are self-driving cars and humanoid robots.

Deep Learning is a subset of machine learning in which neural networks are used to train the machines. The word 'deep' refers to the number of hidden layers in the neural network model. The neural network has the following layers.

- Input Layer
- Hidden Layer
- Output Layer

The commonly used neural networks are

- Unsupervised pre-trained networks
- Convolutional neural networks
- Recurrent neural networks
- Recursive neural networks

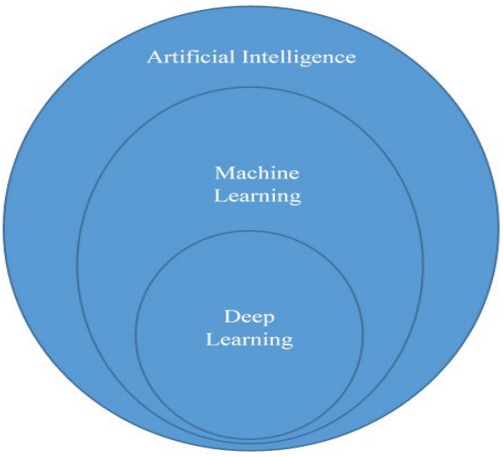

Fig. 1. Deep learning

Computer Vision is a field that makes the machines see the world the same as humans, observe information from it and understand from the digital images or videos.

OpenCV stands for Open-Source Computer Vision. It is a computer vision library that helps in improving the resolution of the image/video so that machines could recognize the patterns from it.

2. Literature Survey

Kiran R. Ghavale and Ujwalla Gawande, proposed the methods to identify the disease in a plant, which are Image Acquisition, Image Preprocessing, Image Segmentation, Feature Extraction, Classification and Detection of Disease.

JeyaPrakash Sethupathi and Veni S., presented the different methods for the detection of disease in a plant whose leaves are deformed by disease and whose leaves are not deformed by disease. To identify the disease in the plant whose leaves are deformed by disease after Image Acquisition the image is converted to a binary image and for feature extraction Principal Component analysis is done and for classification SVM Classification algorithm is used.

G. Prem Rishi Kranth and M. Hema Lalitha used Machine Learning algorithms to detect the plant disease. The algorithms used in this paper are Decision Tree, K-Means Clustering, Random Forest and Neural Networks. In neural networks disease in the plant is predicted with three parameters given as input to the neural network and four parameters given as input.

Saradhambal G and Dhivya R., used given detailed information about the plant diseases that are caused by microorganisms such as bacteria, viruses, and fungus. Matlab is used to program and otsu's classifier is used to classify the type of disease that has affected the plant.

Jihen Amara, Bassem Bouaziz used deep learning for accurate detection of disease in banana leaves. The pre-trained model LeNet is used in this paper.

M. Akila and P. Deepan presented various neural network models for classifying the disease that affected various plants. The neural network used in this paper is Faster Region-based Convolutional Neural Network (Faster R-CNN), Region-based Fully Convolutional Network (R-FCN).

3. Plant Diseases

A plant disease is any abnormal condition that appears in plants to stop it from growing. Once it affects a plant it stops the growth of the plant and it also spreads to other plants in the field, which leads to loss. Plant diseases are classified based on the factors that cause it. They are,

A. Infectious (Biotic)

These diseases are caused by parasite organisms. They are broadly classified into

1) *Bacterial Disease:* The plant diseases that are caused by bacteria comes under this category. Bacteria reproduce through binary fission. One cell gets split into two. So, it gets multiplied rapidly. It gets spread faster compared to other microorganisms. Bacteria get spread through wind, insects, and rain [6]. Some of the symptoms caused by bacteria are leaf spots, wilts, dieback, and galls. Some of the bacterial diseases are Bacterial blights, wilts, and fire blight.
2) *Viral Disease:* The plant diseases that are caused by a virus comes under this category. The virus is the smallest microorganism, which can only be observed under a microscope. They can observe seen through an electron microscope. They can be transmitted by

insects and humans. The symptoms are majorly seen in leaves and it is difficult to analyze. Some of the viral diseases are wheat streak mosaic, potato virus, and cucumber mosaic [7].

3) *Fungal Disease:* The plant diseases that are caused by fungus comes under this category. A fungus is an abundant group of microorganisms. The body of the fungus is composed of threads called 'hyphae'. The fungus reproduces through spores. Spores vary in shape, size, and color. The fungus can reproduce sexually or asexually. Once the fungi spores make contact with another plant it gets easily spread. It can also easily transmitted by humans, wind, water, soil, and animals. Some of the symptoms are spots, wilts, blights, cankers and fruit rot [8]. Some of the diseases caused by fungi are leaf spots, powdery mildew.

B. Non-Infectious Disease (Abiotic)

These diseases are caused by factors other than microorganisms. The symptoms appear as soon as the plant gets affected. Some of the symptoms of this disease occur in leaf tip and margins necrotic. Some of the causing agents are temperature, meteorological conditions, and toxic chemicals.

The Biotic diseases that occur in grapes leaves are described below:

1) *Black Rot:* Black Rot is caused by the fungus Guignardia bidwellii. It is the most destructive disease in hot or cold temperatures. It mostly affects green parts of the grapes plant. Due to this disease, the fruits of the grape get fully rotted at the time of harvesting. It is easy to control using fungicide sprays. Some of the symptoms of black rot are reddish-brown and circular angular spots on the upper surface of the leaves. It affects mostly the young leaves. It starts affecting the fruit after flower petals fall. The pesticides to protect the developing new growth are copper, captan, ferbam, mancozeb, maneb, triadimefon, and ziram. These fungicides should be spread when the shoots are 2 to 4 inches and 10 to 15 inches [9].

Fig. 2. Black rot

2) *Esca Measles:* Esca Measles also called Spanish Measles. The name 'measles' refers to the spots found on fruit. It is caused by fungi Phaeoacremonium, Aleophilum, Phaeomoniella Chlamydospores and Formitiporia Mediterranea [10]. It mostly affects the fruits before harvesting. It appears on leaves, trunk, canes, and berries. The fruit has an acrid taste and fruits get dry. A tiger stripe pattern appears in affected leaves. It can be confused as a nutritional disease. The symptoms that occur in early spring are dieback, leaf discoloration, and defoliation if the disease gets severe. Lime sulfur sprays can manage Esca disease.

Fig. 3. Esca Measles

3) *Isriopsis Leaf Spot:* Isriopsis belongs to the Mycosphaerellaceae fungus family. It is caused by Pseudocercospor Viti's fungus. The symptoms are irregularly shaped lesions in leaves. Initially, it appears in red and it turns to black afterward. The lesions group together after getting severe. The fungicides to manage isariopsis leaf spot are composition of mancozeb at 0.2%, carbendazim at 0.1%, copper oxychloride at 0.2%, propiconazole 25EC at 0.1%, difenoconazole 10WP at 0.1% and neem oil at 3.0% [11].

Fig. 4. Isriopsis leaf spot

4. Proposed Methodology

To find the diseases in the grapes leaf convolutional neural network model is introduced. The steps in the proposed methodology shown as a figure in Fig.5. The steps followed in this methodology are

- Image Acquisition
- Image Preprocessing
- Feature Extraction and classification

Detailed information about every step used in the methodology is presented.

Fig. 5. Step by step process in the proposed methodology

A. Image Acquisition

In this step, the diseased leaf is captured. The images of the diseased or healthy leaves are captured for dataset or else the image also can be captured to give as input for testing whether the script written for detecting the leaf disease works correctly. In this paper dataset that is available publicly is downloaded. So the image is captured only to test the python script. If the dataset collected is too small data augmentation can be used to increase the size of the dataset.

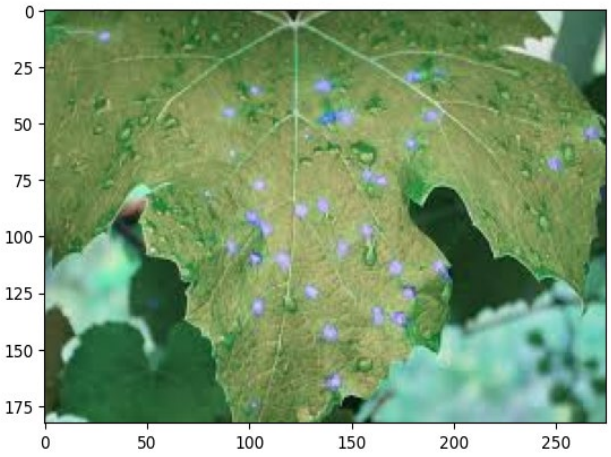

Fig. 5. Captured image

B. Image Preprocessing

After capturing the image should be resized. The images that are captured for the dataset should be cropped and resized to standard resolution. In this paper, every image in the dataset is of 256 height and 256 width. The images are also reshaped before given as input to the neural network model. The image given as input is also resized to the size of images of the dataset and reshaped before prediction.

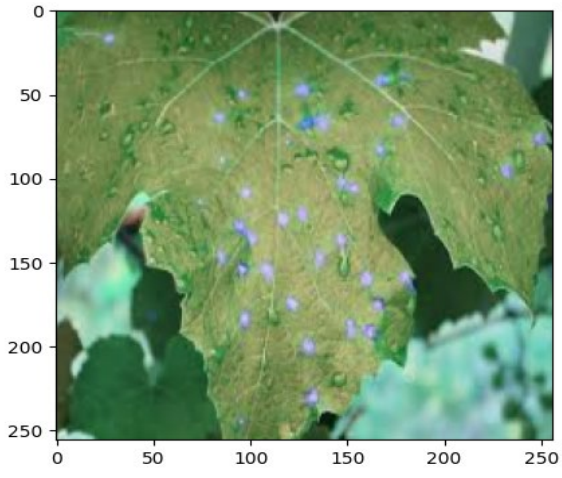

Fig. 6. Pre-processed image

C. Feature Extraction and Classification

The neural network model can extract the feature as well as can classify the type of disease affected. The main advantage of a convolutional neural network is, the feature extraction and classification is not done as a separate process. No separate feature extraction algorithm and classification algorithm is used. The neural network model build in this paper is classified into two: the upper convolution and max pooling layer and the lower dense layer. The upper convolution and max pooling layer are used for feature extraction and the lower dense layer with softmax as activation function can classify the disease as one of the following classes.

The detailed description of each step is shown in the below figure.

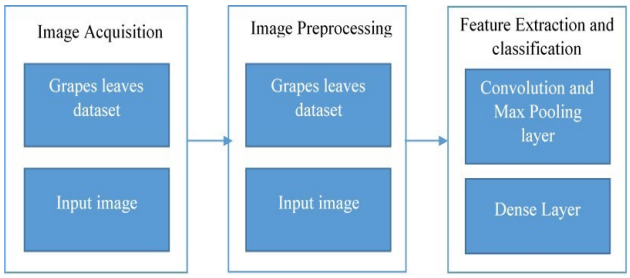

Fig. 7. Detailed step by step processes in the proposed methodology

The step-by-step process done in this proposed methodology is shown in this figure.

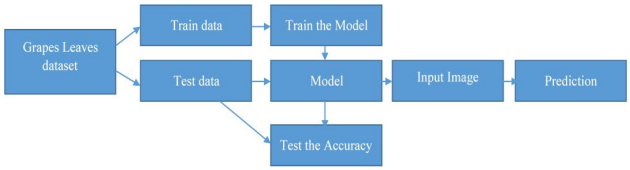

Fig. 8. Proposed methodology architecture

5. Result and Discussion

The result observed using the python script is presented here. The validation accuracy of the training and testing data after every iteration is presented as a graph. The y-axis in this graph denotes the accuracy in the model. The x-axis in this graph denotes the number of iterations that the model has gone through.

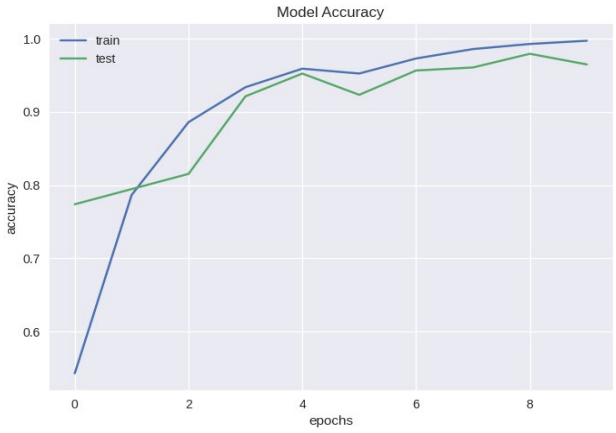

Fig. 9. Model accuracy in train and test data

The validation loss of the training and testing data after every iteration is presented as a graph. The y-axis in this graph denotes the loss in the model. The x-axis in this graph denotes the number of iterations that the model has gone through.

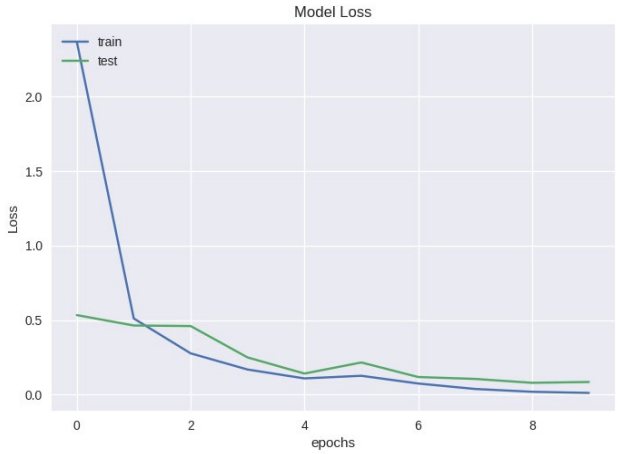

Fig. 10. Model loss in train and test data

The leaf that is affected by black rot is accurately predicted and the biopesticides to treat black rot in the leaf are 'Pseudomonas Florescens' is shown as a remedy in this figure.

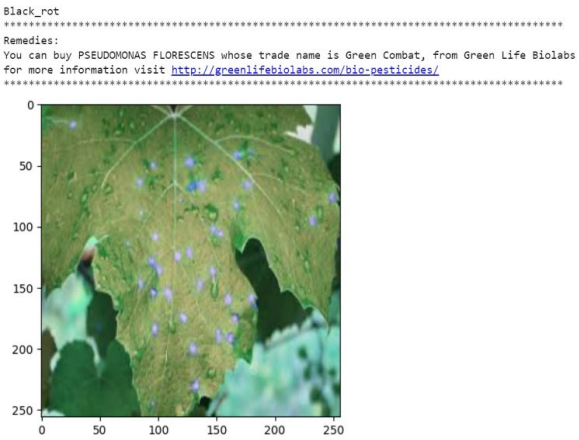

Fig. 11. Black rot detected by proposed model and remedies

The leaf that is affected by Esca Measles is accurately predicted and the biopesticides to treat black rot in the leaf are 'Trichoderm Harianum' is shown as a remedy in this figure.

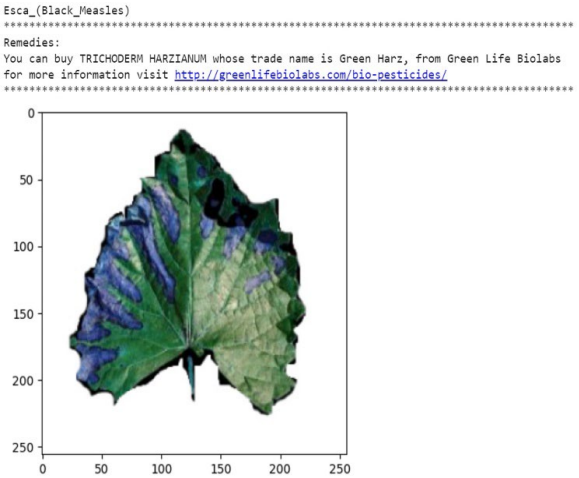

Fig. 12. Esca Measles detected by the proposed model and its remedies

The leaf that is affected by leaf blight is accurately predicted and the biopesticides to treat black rot in the leaf are 'Bacillus Licheniformis' is shown as a remedy in this figure.

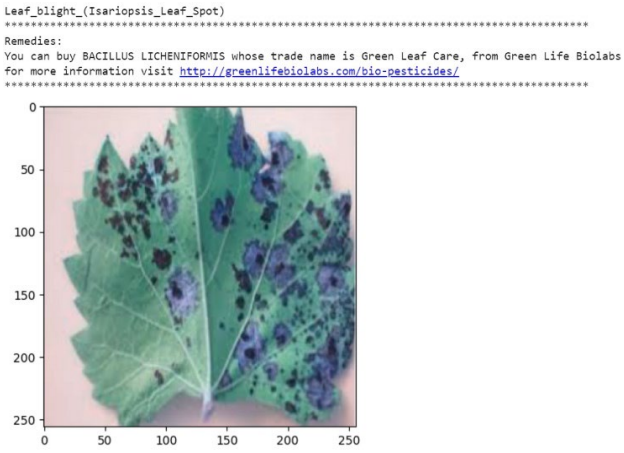

Fig. 13. Isriopsis leaf spot detected by the proposed model and its remedies

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 256, 256, 64)	1792
conv2d_1 (Conv2D)	(None, 254, 254, 64)	36928
max_pooling2d (MaxPooling2D)	(None, 63, 63, 64)	0
conv2d_2 (Conv2D)	(None, 63, 63, 128)	73856
conv2d_3 (Conv2D)	(None, 61, 61, 128)	147584
max_pooling2d_1 (MaxPooling2	(None, 7, 7, 128)	0
flatten (Flatten)	(None, 6272)	0
dropout (Dropout)	(None, 6272)	0
dense (Dense)	(None, 2098)	13160754
dropout_1 (Dropout)	(None, 2098)	0
dense_1 (Dense)	(None, 1000)	2099000
dropout_2 (Dropout)	(None, 1000)	0
dense_2 (Dense)	(None, 4)	4004
dropout_3 (Dropout)	(None, 4)	0

Total params: 15,523,918
Trainable params: 15,523,918
Non-trainable params: 0

Fig. 14. Summary of the proposed model

6. Future Enhancement

In this paper, only the disease in grapes leaf is detected. The vegetables that are mostly cultivated in Tamil Nadu are paddy, tomato, potato, carrot. The fruits that are mostly cultivated in Tamil Nadu are orange, jackfruit and so on. The dataset for each and every vegetable and fruit specified above can be collected and tested using the model proposed in this paper and an app can be created to help our state farmers to identify the disease that affected the plant by simply taking the picture and

showing the disease that affected the plant and the biopesticides can be shown as remedies for the farmers, as synthetic pesticides can cause harm to farmers.

7. Conclusion

Grapes are rich in calcium, phosphorous and glucose as major sugar. Grapevine is prepared from grape juice. Nowadays Artificial Intelligence is used in every area and a humanoid robot that could interact with humans. This can be achieved only by neural networks. The neural networks process the same as the human brain. Grapes are rich in calcium, phosphorous and glucose as major sugar. Grapevine is prepared from grape juice. Production of grapes in a huge amount is necessary. The grapes leaf diseases are black rot, esca measles, isariopsis leaf spot. These diseases reduce the amount of production. These diseases are processed using a neural network model. The accuracy of the model, 97.27% is obtained. Disease in the input image is detected. The biopesticides are the pesticides to naturally treat the pests and microorganisms. These biopesticides are given as remedies for the affected disease.

References

[1] Sujatha R, Y. Sravan Kumar and Garine Uma Akhil, "Leaf disease detection using image processing", JCPS, vol. 10, no. 1, January-March 2017.

[2] Jayaprakash Sethupathy, Veni, "OpenCV Based Disease Identification of Mango Leaves", International Journal of Engineering and Technology, vol. 8, no. 5 Oct-Nov. 2016.

[3] G. Prem Rishi Kranth, M. Hema Lalitha, Laharika Basava, Anjali Mathur, "Plant Disease Prediction using Machine Learning Algorithms", International Journal of Computer Applications, vol. 182, no. 25, November 2018.

[4] G. Saradhambal, R. Dhivya, S. Latha, R. Rajesh, "Plant Disease Detection and its Solution Using Image Classification", International Journal of Pure and Applied Mathematics, vol. 119, no. 14, pp. 879-884, 2018.

[5] Prakash K. Manikar, Shreekant Ghorpade, Mayur Adawadkar, "Plant Leaf Disease Detection and Classification Using Image Processing Techniques", International Journal of Innovative and Emerging Research in Engineering, vol. 2, no. 4, 2015.

[6] Monzurul Islam, Anh Dinh, Khan Wahid,Pankaj Bhowmik, "Detection of Potato Diseases Using Image Segmentation and Multiclass Support Vector Machine", 2017 IEEE 30th Canadian Conference on Electrical and Computer Engineering (CCECE).

[7] C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.

[8] Jihen Amara, Bassem Bouaziz and Alsayed Algergawy," A Deep Learning-based Approach for Banana Leaf Diseases Classification", B. Mitschang et al. (Hrsg.): BTW 2017 – Workshop and, Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2017.

[9] Srdjan Sladojevic, Marko Arsenovic, Andras Anderla, Dubravko Culibrk and Darko Stefanovic, "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification", Hindawi Publishing Corporation Computational Intelligence and Neuroscience, 2016

[10] Anandhakrishnan MG Joel Hanson, Annette Joy, Jerin Francis, "Plant Leaf Disease Detection using Deep Learning and Convolutional Neural Network", International Journal of Engineering Science and Computing, vol. 7, no. 3, March 2017.

[11] D. Deva Hema, Sougata Dey, Krishabh, Anubhav Saha, "Mulberry Leaf Disease Detection using Deep Learning", International Journal of Engineering and Advanced Technology, vol. 9, no. 1, October 2019.

[12] Srdjan Sladojevic, Marko Arsenovic, Andras Anderla, Dubravko Culibrk, and Darko Stefanovic, "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification", Computational Intelligence and Neuroscience, 2016.

[13] M. Akila, and P. Deepan, "Detection and Classification of Plant Leaf Diseases by using Deep Learning Algorithm", International Journal of Engineering Research & Technology, ICONNECT - 2k18 Conference Proceedings, vol. 6, no. 7, Special Issue – 2018.

[14] Ashish Nage, V. R. Raut, "Detection and Identification of Plant Leaf Diseases based on Python", International Journal of Engineering Research & Technology.

[15] Burhanudin Syamsuri, Gede Putra Kusuma, "Plant Disease Classification using Lite Pretrained Deep Convolutional Neural Network on Android Mobile Device", International Journal of Innovative Technology and Exploring Engineering, vol. 9, no. 2, December 2019.

[16] Ms. Kiran R. Gavhale, Prof. Ujwalla Gawande, "An Overview of the Research on Plant Leaves Disease detection using Image Processing Techniques", IOSR Journal of Computer Engineering (IOSR-JCE), vol. 16, no. 1, pp. 10-16, Jan. 2014.

[17] Sanjeev Kumar, Pradip Kumar, Divya Singh, Prashant Mishra and Sukhvindar Singh, "Management of Isariopsis Leaf Spot of Ber (Zizyphus Mauritiana Lamk.) Through Fungicides", Plant Archives, vol. 17, no. 1, pp. 199-200, 2017.

[18] Alex Krizhevsky, Ilya Sutskever, Geoffrey E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks".

[19] Sanjeev S. Sannakki, Vijay S. Rajpurohit, V. B. Nargund, Pallavi Kulkarni, "Diagnosis and Classification of Grape Leaf Diseases using Neural Networks", IEEE – 31661, 4th ICCCNT 2013 July 4-6, 2013.

[20] Jim Travis, Bryan Hed, and Andrew Muza, "Organic Grape Disease Control: Control of Black Rot in Greenhouse and Field Trials Using Organic Approved Materials," 2005.

[21] John Damicone, Lynn Brandenberger, "Common Diseases of Tomatoes Part III. Non-Infectious Diseases", Oklahoma Cooperative Extension Service EPP-7627.

[22] A. Romero, C. Gatta and G. Camps-Valls, "Unsupervised Deep Feature Extraction for Remote Sensing Image Classification," in IEEE Transactions on Geoscience and Remote Sensing, vol. 54, no. 3, pp. 1349-1362, March 2016.

[23] Yuanqing Lin, Fengjun Lv, Shenghuo Zhu, Ming Yang, Timothee Cour and Kai Yu, Liangliang Cao and Thomas Huang, "Large-scale Image Classification: Fast Feature Extraction and SVM Training".

[24] Ryszard S. Choras, "Image Feature Extraction Techniques and Their Applications for CBIR and Biometrics Systems", International Journal of Biology and Biomedical Engineering, vol. 1, no. 1, 2007.

[25] P. Sibi, S. Allwyn Jones, P. Siddarth, "Analysis of Different Activation Functions Using Back Propagation Neural Networks", Journal of Theoretical and Applied Information Technology, vol. 47, no. 3, January 2013.

[26] Uma D. Nadimpalli, Randy R. Price, Steven G. Hall and Pallavi Bomma, "A Comparison of Image Processing Techniques for Bird Recognition", Yusuke Kawasaki, Hiroyuki Uga, Satoshi Kagiwada and Hitoshi Iyatomi, "Basic Study of Automated Diagnosis of Viral Plant Diseases Using Convolutional Neural Networks".

[27] Shreyansh Kothari, Oct 15, 2019, Diseased and Healthy leaves of Grapes are given in the dataset, Github. https://drive.google.com/drive/folders/1m7umLLc8sXCwcsrQF43FOxirHZiT8ev6