

DeepLeaf-AI-Powered Plant Disease Detection and Diagnosis Using CNN and VGG-19

Sinchana K P¹Dept. of CSE
Don BoscoInstitute of Technology
Bengaluru, India

Assistant Professor

sinchkp1999@gmail.com**Pavan B H²**Dept. of CSE
Don BoscoInstitute of Technology
Bengaluru, India

1DB23CS146

pavanh121550@gmail.com**Pavan JP³**Dept. of CSE
Don BoscoInstitute of Technology
Bengaluru, India

1DB23CS147

pavanjp217@gmail.com**Pratheek H⁴**Dept. of CSE
Don BoscoInstitute of Technology
Bengaluru, India

1DB23CS156

1982004prathi@gmail.com**Vivek Chauhan⁵**Dept. of CSE
Don BoscoInstitute of Technology
Bengaluru, India

1DB23CS248

vkchauhanp2022@gmail.com

Abstract

They are well known to have a detrimental effect on the yield and quality of crops, and on the agriculture industry, making early and accurate plant disease diagnosis important for minimizing crop yield loss. The conventional method for plant disease detection is by visual inspection of the plant's leaves by farmers, agriculture experts, and scientists. This method is time-consuming and labor-intensive, and it can be error-prone. To improve this situation, this paper proposes the automatic plant leaf disease detection system based on image processing and deep learning techniques. The proposed system uses a dataset of plant leaf images which are preprocessed using techniques like resizing, grayscaling, and segmentation. Next, deep learning models such as Convolutional Neural Networks (CNNs) and VGG-19 are used to extract features and make predictions, which enables the system to accurately detect and diagnose plant diseases. After uploading the image of the leaf, the system detects whether the plant is suffering from a particular disease or not and predicts the remedy by suggesting the medicine used to cure the disease. A graphical user interface (GUI) is created using Python Tkinter for uploading the image and to display the predicted result. The experimental results show that it is feasible and effective to apply the proposed method for disease early diagnosis, as well as for other clever deep learning technologies in modern agriculture.

I. INTRODUCTION

Among the various sectors, agriculture plays an indispensable part in helping the economy and providing livelihood to millions of people, especially in developing nations like India. Crop health plays a crucial role in determining the efficiency of agriculture and food quality along with the stability of the economy. However, plant diseases form a serious concern in agriculture as they can significantly affect crop productivity and quality, thereby causing huge financial losses to farmers. Most plant diseases usually begin on the leaf of the plant and spread swiftly if not diagnosed at the initial stages.

Traditionally, plant diseases are diagnosed manually through observations made by farmers or experts in the field of agriculture. This method proves to be fairly effective in some cases. Nevertheless, it becomes time-consuming and requires physical presence of experts. Rural regions engaged in agriculture may lack domain knowledge, leading to inefficient diagnosis of diseases and their poor management.

With the recent progress made in the area of artificial intelligence, machine learning, and deep learning, it is possible to design automated disease detection solutions that can help farmers detect diseases through images captured from their

crops. Image processing along with deep learning algorithms have proven themselves highly effective in the domain of image classification and feature extraction. From among all the techniques used, the most effective technique for solving the problem is Convolutional Neural Networks and pre-trained deep learning models such as VGG-19.

In this research paper, an algorithm has been proposed for automated detection of diseases in plant leaves by using image processing and deep learning. The proposed method examines plant leaves' pictures and finds out if there is any disease in the plant or not. It even gives predictions about the type of disease in case there is one. Preprocessing techniques for the images are used before the analysis of images takes place. This process enhances the performance of the model in classifying the images into different categories. Deep learning algorithms such as CNN and VGG-19 have been used in the proposed methodology. In addition to that, this algorithm suggests remedies to manage the disease and improve the health conditions of the plants.

II. RELATED WORK

Diksha Tandekar et al. [3], The authors suggested using the identification of plant diseases in the leaves based on image processing techniques and deep learning approaches such as the CNN and VGG-19 architectures to classify diseased and healthy leaves. Specifically, the authors used a dataset called the Plant Village, which has more than 20,000 images categorized under 15 classes, alongside various preprocessing techniques such as image resizing, grayscale conversion, and segmentation to enhance the accuracy in the identification of plant diseases. Moreover, the authors developed a graphical user interface using the Tkinter module in Python and recommended the remedies for the plant diseases identified in the leaves.

Tandekar et al. [1], The authors discussed the process of detecting plant disease based on the use of image processing, machine learning, and deep learning. They conducted a comparative analysis of several algorithms such as Random Forest, SVM, KNN, and CNN in detecting diseases in the plant leaves utilizing the PlantVillage dataset. The authors highlighted the importance of the use of artificial intelligence in improving the accuracy of detection as well as reducing dependence on visual assessment. The authors provide a general overview of technologies that can be applied to detect plant diseases.

Alyas et al. [2], The authors have developed an automated system for the detection of diseases in plant leaves using image processing and machine learning techniques. In their study, they used methods like preprocessing, segmentation of images, feature extraction, and SVM classification to achieve disease recognition in plants. This research stresses the need for automation in disease detection to decrease manual labor,

increase speed, and help farmers with better crop management. This paper provides useful information about machine learning methods for plant disease classification.

Kundu et al. [4], The authors proposed an approach towards detection of diseases in plant leaves using image processing techniques and CNNs, which can be used to detect diseases in plants that affect their growth and yield. The methodology adopted by the researchers included steps such as image pre-processing, grayscale transformation, edge detection, thresholding, noise filtering, and feature extraction to ensure proper classification of the disease. This research emphasizes that there is a need for automation for detecting the disease at the earliest stage without much loss to the farmer.

Ref.	Approach	Accuracy	Limitation
[1]	Deep Learning (CNN + VGG-19) + Image Processing + Tkinter GUI	VGG-19: 85.4%, CNN: 83%	Accuracy affected by preprocessing quality, requires sufficient dataset size
[2]	Image Processing + ML/DL (RFC, SVM, KNN, CNN)	Random Forest performed best (exact % not clearly specified)	Comparative review study; no dedicated deployed real-time system
[3]	Image Processing + K-Means Segmentation + SVM Classification	High accuracy (exact % not explicitly stated)	Depends heavily on manual feature extraction.
[4]	Image Processing + CNN + AlexNet-based Feature Extraction	Good performance (exact % not explicitly stated)	Sensitive to image noise, environmental conditions

Table I: Summary of Related Work

III. METHODOLOGY

The model employs an organized workflow which includes data collection, pre-processing of images, feature extraction, classification of disease, predictions, and remedy suggestions. There is also a GUI designed for user interaction and efficient display of prediction results.

A. Dataset Collection

In the beginning stages of the development of the suggested methodological approach, one needs to have a dataset comprising the plant leaf images with both healthy and sick leaves included. This will help in developing a disease detection system by using the images available in several categories of plant disease classes.

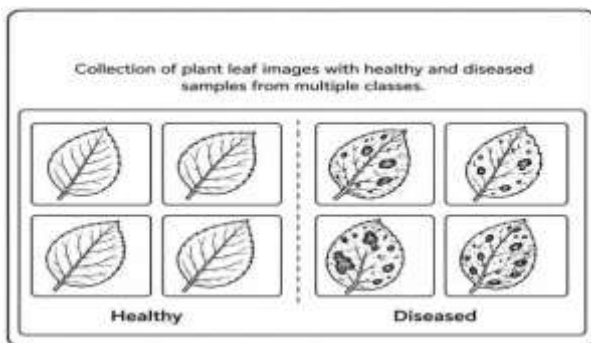


Fig 1: Collection of Healthy and Diseased Plant Leaf Image Samples

B. Image Input

This system receives plant leaf images as inputs for disease detection and analysis using a Graphical User Interface that has

been developed using Python Tkinter technology, making it possible for users to easily upload their image files. The system supports the JPG, JPEG, and PNG image file format as it makes it convenient for the users. The uploaded image acts as the main source for analysis, where it should contain a clear view of the plant leaf for proper detection. The quality of the image plays an important role in this system since a blur or low-quality image could affect performance negatively. Any visible symptoms of the disease such as spots, discoloration, lesions, and unusual patterns will make it possible to determine the type of disease present.

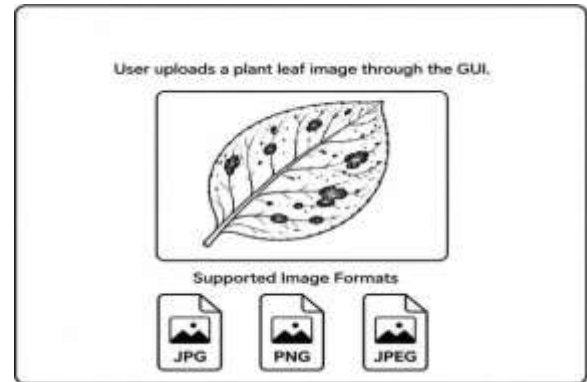


Fig 2: Plant Leaf Image Upload Through Graphical User Interface

C. Image Preprocessing

Preprocessing of the image is done in order to improve the quality of the input image for better analysis and accurate classification of the disease. As the uploaded images of the plant leaves may differ in terms of size, resolution, lighting, and other background information, there is a need to preprocess them in order to create standardized images and extract relevant information from them. Preprocessing involves many vital steps like resizing, converting images to grayscale, and segmentation.

- **Resizing:** Helps to ensure that the input sizes are standardized for processing by the deep learning algorithm.
- **Grayscale:** The images are turned to grayscale to simplify computation.
- **Segmentation:** Diseased parts of the plant are identified and marked.

Preprocessing plays a significant role in increasing accuracy during classification of the plant disease.

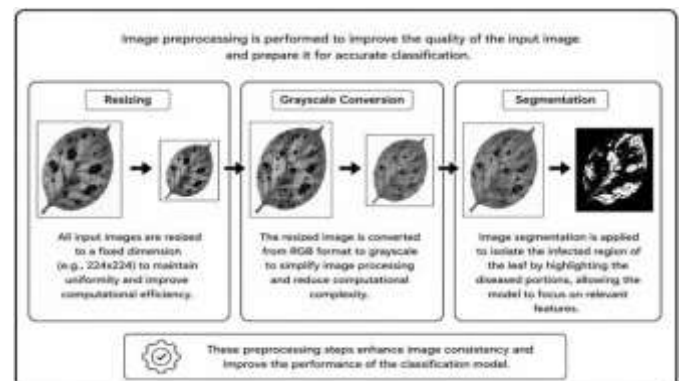


Fig 3: Image Preprocessing for Leaf Image Enhancement and Segmentation

D. Feature Extraction

It is a vital process that forms part of the process of feature extraction where meaningful features are identified from the preprocessed and segmented leaf image. Visual features like texture, shape, color, and other patterns as well as the presence of spots are

some of the critical features that are identified because these are indicators of diseases in the leaves. Different diseases manifest different visual patterns on the leaf. This makes it easy for one to differentiate between healthy and infected leaves.

The features that have been successfully extracted will serve as useful knowledge for the deep learning classification models. Through the use of these features, the model will easily classify the disease in the leaf.

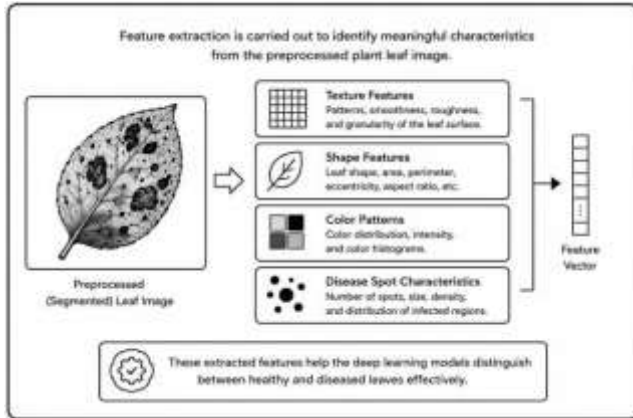


Fig 4: Feature Extraction from Preprocessed Plant Leaf Images

E. Disease Classification

Disease Classification is another very crucial process in the proposed disease detection system for plants, whereby the preprocessed image of the plant leaf is subjected to processes which will enable classification into a disease category or healthiness. This process will be enhanced using deep learning algorithms such as Convolutional Neural Network (CNN) and VGG-19. The reason for the usage of these two algorithms is because of the effectiveness of the two models in image recognition and classification.

CNN is used for automatic learning and classification of the features from the image of the plant leaves based on convolution, pooling, and fully connected layers. It helps in the detection of visual patterns such as spots, edges, and textures from the image. On the other hand, VGG-19 is an effective deep learning algorithm in enhancing classification through extraction of more complex and high-level features from the image. The usage of both models will improve the effectiveness of the disease detection process.

The utilization of CNN and VGG-19 enhances the feature learning and prediction capabilities of the disease detection system. Disease Classification of the plant leaf image will be done based on the training of these models.

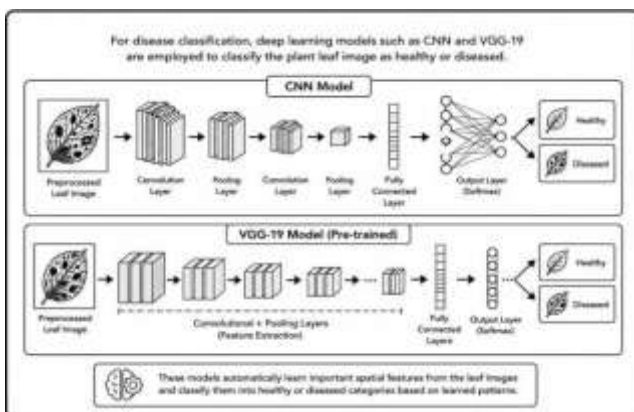


Fig 5: Disease Classification Using CNN and VGG-19 Deep Learning

F. Disease Prediction

Prediction of the disease is the point at which the trained deep learning model produces the output according to the classification results received after processing the uploaded image of the plant leaf. As a result of analyzing the disease-related characteristics and patterns, the software predicts whether the uploaded plant leaf is diseased or healthy. In case a disease is recognized in the uploaded image, then the software predicts the class of the probable disease that is associated with the learned pattern and the input image features.

The output of this stage depends on the confidence of the trained model and is displayed to the user through a GUI.

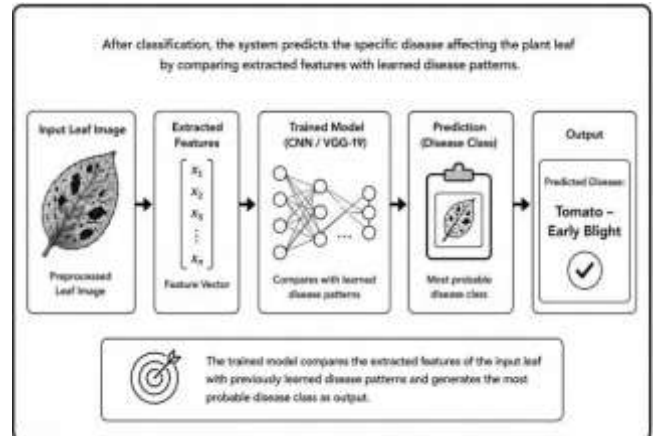


Fig 6: Plant Disease Prediction Based on Extracted Features

G. Disease Factor Identification

Following the prediction of the disease, the system then proceeds to identify the possible causes of the disease that was detected in the plant. The causes may be fungi that usually cause spots, mildew, or tissue damage on leaves; bacteria that may result in lesions, discoloration, or wet patches; or viral infection that may cause abnormal leaf appearance, curled leaves, and stunted plant growth. Nutrient deficiency may also result in color changes, abnormal leaf appearance, or general poor health of the plant, as well as unfavorable weather conditions. As a result of correlating the predicted disease with the probable causes, the system gives more useful data to the user apart from identifying the diseases. Through this, the farmer or the user can have an idea regarding why such a disease is occurring in the plants and make the right decision regarding how to treat the plant in order to keep it healthy. The system can even provide useful suggestions on what can be done to avoid infections in the future and maintain good health in the plants. In addition to that, it helps the users to monitor plant health better by providing knowledge on what causes certain infections in plants.

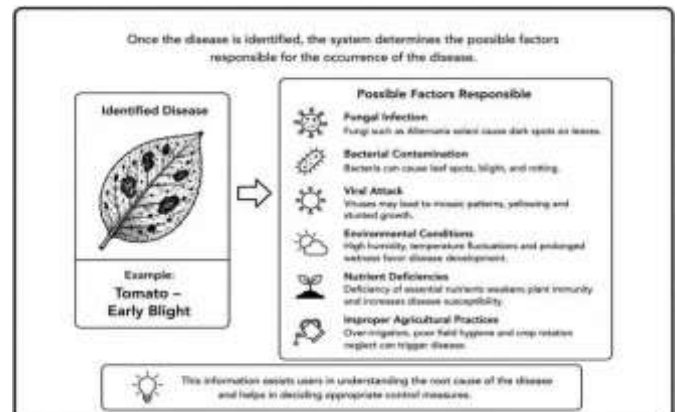


Fig 7: Identification of Factors Responsible for Plant Disease Occurrence

H. Remedy Suggestion

Once the disease and its potential causes are identified, appropriate suggestions for remediating the disease are provided by the system. This ensures that users receive guidance on how to handle the predicted disease. The remedial suggestions could entail using pesticides or fungicides, irrigation management, nutrients, elimination of affected parts of the plants, among others. The provision of remedy suggestions enhances usability and user orientation of the system since it does not merely identify the disease but also guides the management of the disease.

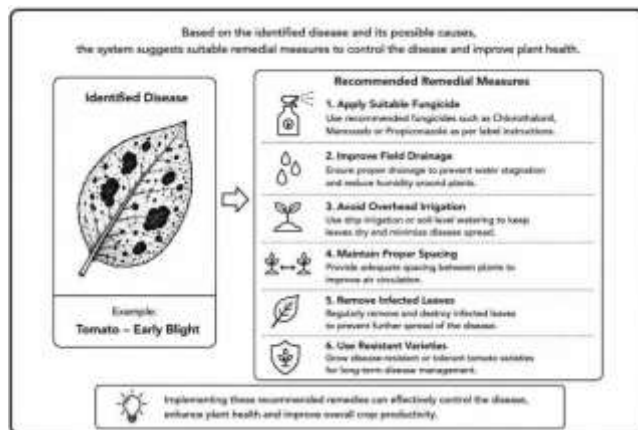


Fig 8: Recommended Remedial Measures for Detected Plant Diseases

I. Graphical User Interface (GUI)

A GUI based on the Python Tkinter is developed to serve as an easy-to-use interface that allows interaction with the plant disease detection system. This graphical interface makes it easier for users to upload images of the plant leaves, execute disease prediction, and get the outcome of the process without having to know anything about the model behind the process.

The GUI displays key results like the image that has been uploaded by the user, preprocessed results, disease prediction, probable causes of the problem, and remedial measures.

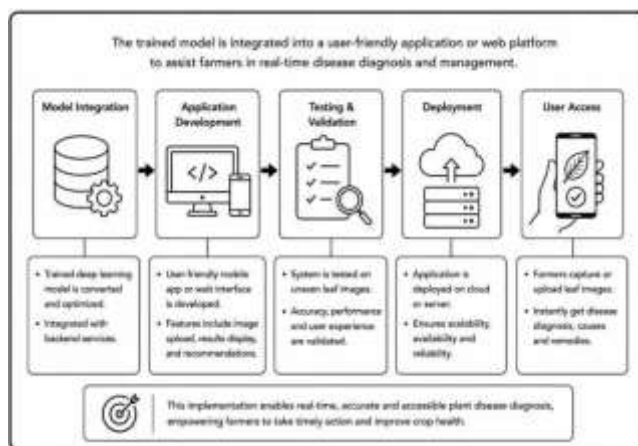


Fig 9: System Integration and Deployment for Real-Time Plant Disease Diagnosis

IV. RESULTS AND DISCUSSION

The performance analysis of the proposed plant leaf disease detection method is conducted based on the methodology in the base reference paper. The model employs image preprocessing operations such as resizing, conversion into grayscale, and segmentation to enhance the image quality and identify the

infected areas in plants for better disease analysis. The deep learning methods such as the Convolutional Neural Network (CNN) and VGG-19 models are utilized for classifying diseases and comparing their performances.

The findings in the base reference paper reveal that VGG-19 performed better than the CNN model in terms of disease classification since it possesses a deep architecture. The classification accuracy of VGG-19 and the CNN models is 85.4% and 83%, respectively. This reveals that the deep pre-trained models perform better in identifying the disease patterns on plant leaves.

Comparing both models, it can be concluded that VGG-19 demonstrates superior feature extraction because of its deeper network architecture which is able to recognize the disease symptoms effectively even when these symptoms are subtle enough. On the other hand, CNN shows good results in classifying the images despite having a simpler architecture with fewer computation costs. The comparison of models can help choose one for developing the classification algorithm to ensure high-quality detection of plant diseases in the designed application.

The proposed solution allows predicting diseases as well as suggesting remedies for them, which makes it useful for agricultural purposes. The use of a Python Tkinter-based user interface increases the convenience and usability of the system since people are able to upload images and get predictions easily. At the same time, the performance of the proposed system might be influenced by certain aspects such as the image quality, lighting, preprocessing efficiency, and the variety of a used dataset.

Hence, the implemented system successfully detects diseases in plants, identifies the causes and suggests suitable remedies.

V. FUTURE ENHANCEMENT

The above-proposed system for detecting plant leaf disease can also be developed even further in order to increase its effectiveness. For instance, there is a possibility to add disease severity detection to define the intensity of the infection. There is also an opportunity to introduce the Internet of Things sensors to monitor environmental parameters like temperature, humidity, and moisture. Another area of improvement is disease detection in other parts of plants, including fruits and flowers. It will expand the usability of this application and allow using it for more plant diseases. Moreover, there is a possibility to introduce offline prediction into the system.

VI. CONCLUSION

The paper developed a disease detection model for plant leaf diseases based on image processing and deep learning techniques that help detect diseases in the early stages of their development. Preprocessing techniques like resizing, converting to grayscale, segmentation, and features extraction can help enhance the quality of input images, making disease prediction easy. The paper employs techniques like CNN and VGG-19 for the purposes of predicting and classifying diseases in the leaves of plants.

The proposed technique is aimed at detecting whether the plant leaves suffer from any disease, finding out some of the causes of the particular disease detected, and providing suggestions on how to prevent the problem. The addition of a GUI created in Python Tkinter allows easier access to prediction and uploading plant leaf pictures. Thus, this method will minimize manual diagnosis and ensure early detection of diseases among crops.

VII. ACKNOWLEDGMENT

The authors would like to express their sincere appreciation to Sinchana K P, Assistant Professor, Department of Computer Science and Engineering, Don Bosco Institute of Technology, Bengaluru, for her continued guidance, constructive criticism, encouragements, and all-round support during the development of this project.

The authors would like to express their sincere gratitude to the Department of Computer Science and Engineering, Don Bosco Institute of Technology, Bengaluru, for providing the necessary infrastructure for this project. Sincere thanks to the professors and colleagues for their constructive criticism during this project.

Lastly, the authors would like to express their sincere thanks to their families for their continued support throughout this project.

VIII. REFERENCES

- [1] D. Tandekar and S. Dongre, "Identification of Various Diseases in Plant Leaves Using Image Processing and CNN Approach," in 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT), IIT Delhi, India, 2023.
- [2] D. Tandekar and S. Dongre, "A Review on Various Plant Disease Detection Using Image Processing," in 2023 3rd International Conference on Pervasive Computing and Social Networking (ICPCSN), 2023.
- [3] R. Kundu, U. Chauhan, and S. P. S. Chauhan, "Plant Leaf Disease Detection Using Image Processing," in 2022 2nd International Conference on Innovative Practices in Technology and Management (ICIPTM), 2022.
- [4] R. M. Alyas and A. S. Mohammed, "Detection of Plant Diseases using Image Processing with Machine Learning," in 2022 2nd International Conference on Computing and Machine Intelligence (ICMI), 2022.
- [5] Md. Nabobi Hasan, Mufrad Mustavi, Md. Abu Jubaer, Md. Tanvir Shahriar, Tanvir Ahmed: "Plant Leaf Disease Detection Using Image Processing: A Comprehensive Review": A Comprehensive Review", Malaysian J. Sci. Adv. Tech., vol. 2, no. 4, pp. 174–182, Oct. 2022.
- [6] Md. Nabobi Hasan, Mufrad Mustavi, Md. Abu Jubaer, Md. Tanvir Shahriar, Tanvir Ahmed: "Plant Leaf Disease Detection Using Image Processing: A Comprehensive Review": A Comprehensive Review", Malaysian J. Sci. Adv. Tech., vol. 2, no. 4, pp. 174–182, Oct. 2022.
- [7] Chohan, Murk, et al. "Plant disease detection using deep learning." International Journal of Recent Technology and Engineering 9.1 (2020): 909-914.
- [8] Santhosh S. Kumar; B.K. Raghavendra "Diseases Detection of Various Plant Leaf Using Image Processing Techniques: A Review" 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS)
- [9] Mohit Agarwal, Abhishek Singh, Siddhartha Arjaria, Amit Sinha, Suneet Gupta: "ToLeD: Tomato Leaf Disease Detection using Convolution Neural Network" International Conference on Computational Intelligence and Data Science (ICCIDS 2019)
- [10] Venkataramanan, Aravindhan, Deepak Kumar P. Honakeri, and Pooja Agarwal. "Plant disease detection and classification using deep neural networks." Int. J. Comput. Sci. Eng 11.9 (2019): 40-46.
- [11] Ramesh, Shima, et al. "Plant disease detection using machine learning." 2018 International conference on design innovations for 3Cs compute communicate control (ICDI3C). IEEE, 2018.
- [12] Ferentinos, Konstantinos P. "Deep learning models for plant disease detection and diagnosis." Computers and electronics in agriculture 145 (2018): 311-318.
- [13] R. M. Prakash, G. Saraswathy, G. Ramalakshmi, K. Mangaleswari, and T. Kaviya, "Detection of leaf diseases and classification using digital image processing," in 2017 international conference on innovations in information, embedded and communication systems (ICIIECS). IEEE, 2017, pp. 1–4.
- [14] S. H. Lee, C. S. Chan, S. J. Mayo, and P. Remagnino, "How deep learning extracts and learns leaf features for plant classification," Pattern Recognition, vol. 71, pp. 1–13, 2017.
- [15] S. A. Tsafaris, M. Minervini, and H. Scharr, "Machine learning for plant phenotyping needs image processing," Trends in plant science, vol. 21, no. 12, pp. 989–991, 2016.
- [16] Aakanksha Rastogi, Ritika Arora and Shanu Sharma: "Leaf Disease Detection and Grading using Computer Vision Technology & Fuzzy Logic" 2nd International Conference on Signal Processing (SPIN)2015.
- [17] X.E.Pantazi,D.Moshou,A.Tamouridou: "Automated leaf disease detection in different crop species through image features analysis and One Class Classifiers" Aristotle University, School of Agriculture, Agricultural Engineering Laboratory, Thessaloniki 54124, Greece
- [18] RenukaRajendraKajale. Detection & recognition of plant Leaf diseases using image processing and android o.s "International Journal of Engineering Research and General Science Volume 3, Issue 2, Part 2, March-April, 2015. ISSN 2091-2730
- [19] PawanP.Warne, Dr.S.R. Ganorkar" Detection of Diseases on Cotton Leaves Using K-Mean Clustering Method",International Research Journal of Engineering and Technology(IRJET) Volume: 02 Issue: 04 | July-2015, 425-43.
- [20] Malvika Ranjan1, Manasi Rajiv Weginwar,NehaJoshi,Prof.A.B. Ingole, detection and classification of leaf disease using artificial neural network, International Journal of Technical Research and Applications e-ISSN: 2320-8163, Volume 3, Issue 3 (May-June 2015), PP. 331-333.