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Identification of Plant Leaf Disease Using CNN and Image Processing

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Abstract: Agriculture is an important sector for the growing people of the world to fulfil the minimum requirements of food. Identifying plant infection in the agricultural sector is complex. If the detection is wrong, there is more damage to crop production and economic loss of the market. Leaf infection identification need a large number of labors, command of plant disorders and requires a lot of observing time. Therefore, this analysis explains detection of plant leaf disease by utilizing CNN and image processing. Alex Net and ResNet-50 are Convolutional Neural Network (CNN) models. First, this method is performed on Kaggle datasets of potato and tomato plants to examine the characteristics of an infected leaves. Then, feature extraction and categorization method is executed on dataset pictures to observe leaf disorders using Alex Net and ResNet-50 models by executing image processing. Observational outputs demonstrate potential of described method, in which it reaches a complete accuracy of 98% and 95% of Alex Net and ResNet50. The output shows that described model particularly predicts defective plant leaves from healthy leaf images.

Keywords: Plant Leaf, Image Processing, CNN, Alex Net, Resnet-50, Disease Detection.

1. INTRODUCTION

India is a rapid growing country and farming is the backbone of the countries growth in the early phase. The sector is facing difficulties because of the concepts of industrialization and globalization. Moreover, understanding and need for agriculture should be developed in the young generation. At present technologies performs a significant part in all areas. Still to this day they are utilizing few ancient methods in farming. In India, agriculture is backbone of the economy. 50% of people are directly or indirectly based on farming. A wide variety of fruits, cereals and vegetables are produced here and exported to other countries. Therefore, it is

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essential to make worth products for best yield production. Since plant diseases are unpreventable, observation of leaf infection is important in the agricultural sector. In plants, diseases appear in different regions like fruits, stems and leaves.

The infection is generally formed with few critical effects on grains and vegetables and it finally decreases production, standards and volume of products. Therefore, correct categorization and detection of plant infection can be an important problem in farming erosion which may be prevented. Leaves of various grains and vegetables are susceptible to various disorders like virus, fungus and bacteria. The general plants disorders are Alternaria Alternata, Anthracnose, Bacterial Blight, Cercospora Leaf Spot, Powdery Mildew, Black mold, Downy Mildew and Rust. If disease starts on plant leaf, indications are revealed by standard of appearance, complexion, pattern and dimension of the leaf. Common indications are very small; hence, detection of disorders is impossible because of finite abilities for person eyesight. Categorization of plant disorders squares infectious agent plant, and calculates microbial disorders. Diagnosis of disease by clear naked eye detection by consultants is general detection. Still, to save the plant from disease, a fast and earlier prediction is necessary. To monitor large fields of crops, mechanically policing is important to identify symptoms of plant diseases. Therefore they wanted a computerized, quick, accurate and cost-effective method to detect plant infection by describing leaf images. The described method will be utilized to detect leaf diseases. Computerized identification of plant infection is a significant investigation matter because it can spontaneously identify infection by the indications seen on leaf.

Image processing is a method utilized to measure the infected region of disorder and distinguish colour of infected region. Image segmentation is the method of dividing or organizing a picture into separate fields. Present several various approaches to perform image segmentation, from easy thresholding models for a modern colour image segmentation model. The fields are usually related to what humans can simply distinguish and see as separate objects. A computer has no way of cleverly identifying targets, and several other approaches have been implemented to divide the pictures. A segmentation method depended on different parameters that can see in a picture. This can be colour data, borders or a segment of picture. The remaining article is arranged as follows: some related work for identification of plant leaf diseases in section II, Section III analyzed the methodology, in section IV, described present algorithm and describes the output, conclusion with some future scope of described framework in Section V.

2. LITERATURE REVIEW

Y. Lu, S. Yi, N. Zeng, Y. Liu, and Y. Zhang, et al. described an advanced rice disorder identification method depended on CNN with image pre-processing to detect and notice rice disorders by utilizing 500 actual pictures from a rice observed area. In addition, the described method produced greater accuracy because of the 10-fold cross-validation plan, higher possibility and capability, quicker convergence rate, and higher detection efficiency than the conventional method of machine learning.

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Pranjali B. Padol, Anjali A. Yadav, ET. Al. analyzes identification and categorization of leaf disorders of grapes using SVM (Support Vector Machine) classification method. The main factor limiting fruit production is disorders and these are hard to prevent. Absence of an appropriate identification, the right prevention measures will not be used at the right time. Image processing is one of the extensively utilized techniques for identification as well as categorization of plant diseases. Initially the infected area is detected using K-means segmentation by clustering, then both colour and appearance parameters are obtained. Lastly categorization method is utilized to identify the kind of leaf disorder. The described method can conveniently identify and categorize the tested disorder with 88.89% accuracy.

R Anand, S Veni, J Aravinth, ET. Al. provides a technique of detecting plant leaf disorder and cautious identification of disorders. The objective of the described task is to detect disorder of brinjal leaves by utilizing image processing and ANN methods. A disorder in brinjal is a difficult problem that can significantly reduce brinjal production. Because 85-95% of infections in brinjal occur on bacteria wilt, Cercospora leaf spot, Tobacco Mosaic Virus (TMV), the knowledge in the leaves alternatively the whole brinjal plant. In this work, the brinjal leaf disease detection method including K-means clustering method for sections and neural network for categorization. The described identification method depended on artificial neural networks are potential in detecting leaf disorders.

Sanjay B. Dhaygude, Mr. Nitin P. Kumbhar ET. Al. Agricultural plant leaf disorder identification by utilizing image processing. The enhanced processing method mostly has four stages, initially the input RGB image, colour transform pattern is made, as this RGB (Red Green Blue) is used for colour formation, and the changed or transformed picture is utilized for RGB, i.e. HSI colour descriptor. In the next stage, by utilizing a threshold value, the green pixels are concealed and taken out. Third, by using a pre-computed threshold stage, this step involves removes and concealed the green pixels for needed segments that are first obtained, but the image is divided. And division takes place in the last or fourth major stage.

S. Arivazhagan, R. Newlin Shebiah, S. Ananthi, S. Vishnu Varthini ET. Al. Provides identification of diseased area of plant leaves. There are several stages in method of disorder identification, of which the four important stages are as follows: Initially, the input RGB picture, a complexion changes the pattern is derived, then by utilizing a certain threshold value, the green pixels are coated as well as taken out this is further followed by a segmentation method and contour statistics are computed to obtain needed components. Lastly, classification is utilized for collected characteristics to categorize the disorder. The described method appears to be organized as and has 94% accuracy in successful identification and categorization of tested disorders. The robustness of the described model is verified by utilizing the observational outputs of 500 leaf images in the database.

Smita Naikwadi, Niket Amoda et. al. Using histogram similarities to detect plant disorders. In plants, the infection indicates on the leaf so histogram similarities are ready based on edge identification method and complexion characteristic. Layers segregation method is utilized to train the model that contains individual coating of RGB picture into red, green and blue layers

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and edge identification method that predicts the edges of layered pictures. A spatial gray-level based matrix is utilized to implement a technique for analyzingcolor emergence texture.

Anand. H. Kulkarni, Ashwin Patil R. K, et al. Describes a method for advance and accurate identification of plant disorders using Artificial Neural Network (ANN) and different image processing methods. As described method is depended on Artificial Neural Network categorize for categorization and Gabor filter for feature extraction, it provides best outputs with an identification rate till 91%. An Artificial Neural Network classifies various leaf disorders and utilizes a compound of patterns, colours as well as attributes to identify the disorders.

J. Zhu, A. Wu, and P. Li, et al. Image recognition-based diagnostic methods for maize leaves disorder identification are discussed. The authors present a model to determine the existence of disease on a corn leaf by observation the shape characteristics parameters of area, perimeter, rectangle and circularity of disease spots from processed divided images. Anyhow, they attained 80% of the detection rate.

3. METHODOLOGY

3.1 Raw Input of Leaf Image

This model describes the concepts of the described method with gathering of pictures. Pictures of tomatoes and potatoes leaves were extracting from Kagle dataset. The methods performed and image pre-processing, image segmentation; feature extractions and categorization is performed on the leave picture datasets. After, it is planned to train ML on dataset picture as well as extract information. This model explains leaf disorder identification model by utilizing CNN architectures, Residual Neural Network-50 (ResNet-50) and Alex Net. They implemented obstruction calculation against leaf infections.

3.2 Image Acquisition

We sampled leaf pictures of tomatoes and potatoes from Kagle dataset for presentation analysis of our research containing good or unhealthy leaves pictures. The dataset consists of above 4000 image samples infected by four kinds of disorders. This dataset also includes 2000 sample pictures of a non-infected leaf to build a leaf disease categorization and identification method.

3.3 Image Pre-Processing

The important purpose of image pre-processing is to make intended selections and defeat few undesired deformation in the non-hereditary image for further processing. A basic pre-processing step is to alter a specified input picture. The initial size of the image is larger and more time consuming for processing duration. Hence, every picture is converted into 512 X 512 dimensions to avoid the long run. The next step is to convert RGB to Hue Saturation Value (HSV). Then segmentation methods are performed.

3.4 Image Segmentation

A segmentation of the image is performed for background subtraction. There are mainly two main methods used for background subtraction: cluster and colour depended. The described

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model gives best outputs by utilizing cluster subtractions. An unnecessary block is removed by using R, G and B components in colour based subtraction. In any pixel where element G is greater than R and B, they are kept and the other element is taken out. In cluster-based background subtraction, linked components in pictures are detected. The vast majority of the image is retained, while the remainder is removed.

The feature extraction step comes after segmentation. It is a significant step of image processing method to produce related object and proper thresholds. The feature extractor of CNN-based identification model extracts image feature vectors of leaves disorders. Leaf parameters such as morphology, texture and colour required to categorize disorders are captured. Feature extraction approximately describes a huge set of data. A gray level matrix formula is used for research format choices. These choices are evaluated from the association of data points connected with remaining part in a particular location.

3.5 CNN Model

Convolutional neural network is one of the form of artificial neural networks and is highly utilized for categorization, image processing, dividing tasks, etc. Convolution is the way of moving a filter by the picture to known few major attributes of the input picture. Deep learning methods: Residual Neural Network-50 as well as Alex Net models utilize to detect different disorders in tomato and potato leaves. The categorization depended on CNN system in image processing model consists of trained as well as tested data of pictures to categorize class of leaves disorders.

3.6 Results and Classification

Here, the pre-trained network systems are presented to spontaneously categorize leaves pictures of potatoes and tomatoes plants into non-infected, early blight as well as late blight infection groups. Initially, the Alex Net as well as Residual Neural Network-50 model categorize the dataset of 6000 various leaf pictures into two distinct groups, like infected and non-infected leaf pictures. This model is taking 2000 non-infected and 4000 infected leaf pictures extracted. These structures are performed the diseased leaves pictures to classify them into various infection groups, namely potato early blight, potato late blight, tomato early blight, as well as tomato late blight. Hence, methods will identify infection group from images of potatoes and tomatoes leaves.

System Architecture

The block diagram of Identification of Plant Leaf Disease using CNN and Image Processing is represented in below Fig. 1.

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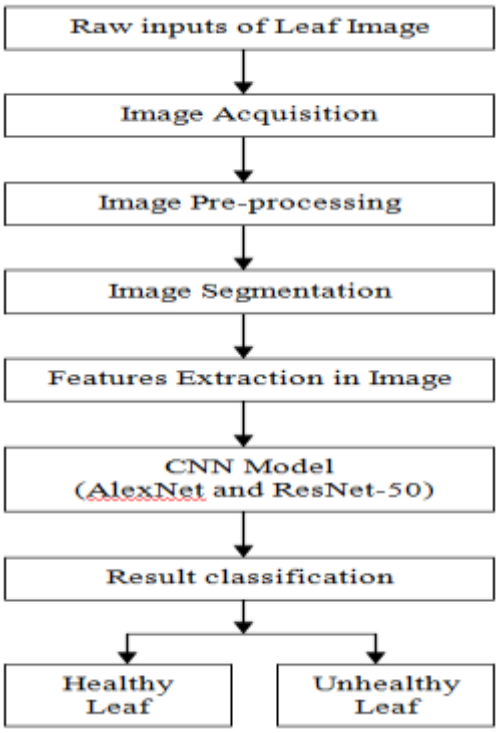

Fig. 1: Block Diagram of Identification of Plant Leaf Disease

4. RESULTS AND DISCUSSION

Here, categorization outputs of tomatoes as well as potatoes leaf pictures are mentioned for performing a unit of investigations on datasets that includes two classes as infected as well as non-infected leaves pictures to represent presentation of the observational outputs where 70% of the leaf images are utilized to train and to test left 30% of the dataset. Deep learning models like Residual Neural Network-50 and Alex Net are performed to gathered picture for leaf disorder categorization as well as identification. The analysis as well as simulations has been performed by MATLAB2020a.
In order to examine the better investigation outputs of disorder identification, a comparison between accuracy, precision and recall phases of two classification methods , which was made for various factors.

Accuracy
Accuracy mention the ratio of correctly predicted to total detection. Accuracy can be analyzed as the capability to approximately determine the results of a condition.

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FN} + \text{FP}} \dots (1)$$

Recall
The correct positive rate, sensitivity/recall, as mentioned here, it refers as the proportion of positive cases that have the disease to the actual positive events.

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$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}} \dots (2)$$

Precision

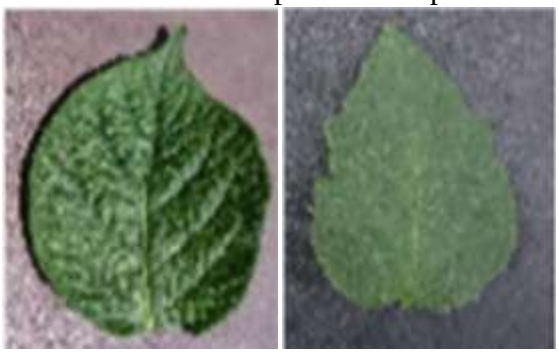
Exact predictive or accuracy is total correct positive scores classified by total of positive values detected by classification model represented in below equation (3)

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \dots (3)$$

Where,

1. True Negative (TN) – A proportion of healthy leaves that are exactly categorized.
2. True Positive (TP) – A ratio of diseased leaves that are exactly categorized.
3. False Positive (FP) - The proportion of healthy leaves which are not exactly categorized such as infected leaves.
4. False Negative (FN) - The ratio of diseased leaves which are not exactly categorized as non-infected leaves.

The healthy leaves of both Tomato and Potato plants are represented in below Fig. 2.



(a) **(b)**

Fig. 2: Healthy Leaves (A) Potato (B) Tomato

The Unhealthy leaves of both Tomato and Potato plants are represented in below Fig. 3.

(a) **(b)**

Fig. 3: Unhealthy Leaves (A) Potato (B) Tomato

The performance of leaf disease detection based on two classification models is analyzed and comparative results are represented in below Table 1.

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Table 1: Comparative Performance Analysis

Parameters	Alex Net	ResNet-50
Accuracy	98	95
Precision	97	94
Recall	96	95

Graphical representation of Accuracy, Recall and Precision values of the two classifier models are shown in below Fig. 4.

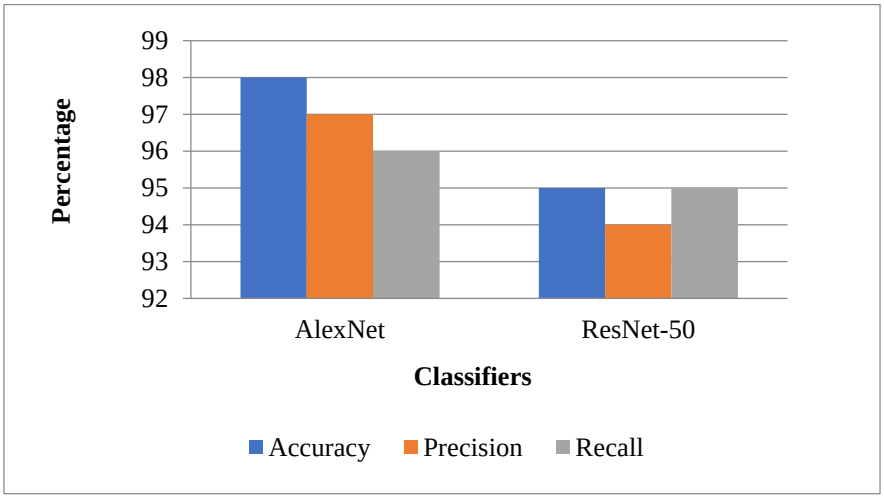

Fig. 4: Performance Comparison

Therefore from outputs it is clear that, performance of Alex Net is better than performance of Resnet-50. Obtained performance values of Alex Net are Accuracy 98%, Precision as 97% and Recall as 96%.

In this discussed about the Identification of Plant Leaf Disease using CNN and Image Processing is described. After properly detecting the plant illness, the deep learning model may be connected to a database containing information on recognized plant diseases and their corresponding therapies. The database can include data pertaining to illness symptoms, afflicted plant sections, and recommended treatments, including the suitable drug. Using this information, the algorithm can accurately forecast the suitable treatment for the identified plant illness. One can do this task using rule-based systems, decision trees, or alternative machine learning methods. Subsequently, the anticipated drug might be shown to the user, along by pertinent details such as dose and directions for use.

5. CONCLUSION

Here, Identification of Plant Leaf Disease using CNN and Image Processing is described. This analysis suggests an important detection method of leaf disorder of tomato and potato plants with graphic representation of protective evaluates using image processing and Convolutional Neural Network. Alex Net and ResNet-50 are pre-trained network systems used in this analysis. Image processing method is executed on potatoes and tomatoes leaves by data pre-processing,

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segmentation and extraction to examine characteristics of infected leaves. Accuracy, Precision and Recall are performance parameters used in this study. From output it is clear that, the evaluation of Alex Net is better than performance of Resnet-50. Obtained performance values of Alex Net are Accuracy 98%, Precision as 97% and Recall as 96%.

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