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Leaf Disease Detection and Classification using Neural Networks

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Abstract: Timely and accurate detection and classification of plant diseases are the crucial factors in plant production and the reduction of losses in crop yield. This paper proposes an approach for leaf disease detection and classification on plants using image processing. The algorithm presented has three basic steps: Image Pre-processing and analysis, Feature Extraction and Recognition of plant disease. The plant disease diagnosis is restricted by person's visual capabilities as it is microscopic in nature. Due to optical nature of plant monitoring task, computer visualization methods are adopted in plant disease recognition. The aim is to detect the symptoms of the disease occurred in leaves in an accurate way. Once the captured image is pre-processed, the various properties of the plant leaf such as intensity, color and size are extracted and sent to SVM classifier with Back propagation Neural Network for classification. The experimental results obtained using 169 images have shown that the classification accuracy by ANN ranges between 88% and 92%.

Keywords: Image pre-processing, Artificial Neural Network, Back Propagation Neural Network, Support Vector Machine.

I. INTRODUCTION

Plants are important for nature and for common life. Most plants are autotrophic, creating their own food using Carbon-di-oxide, water, and light through a process called photosynthesis. Besides food, plant products are essential to humans that include wood and wood products, drugs, fibres, oils, pigments, latex and resins. Coal and petroleum are fossil substances of plant origin. Thus plants give not only food but also provide shelter, clothing, medicines, fuels, and the raw materials from which many products are made. Plants are divided into several kingdoms: Fungi, Protista, and plantae. Most aquatic plants occur in the kingdoms protista and plantae. Plants are the basic source to supply energy for human body. Productions based on farming get easily affected by various plant diseases. These diseases cost as ecological, social and economic loss to farmers. If there is a decrease in agriculture products, total economy will be affected. It becomes important to analyze plant diseases accurately within specific time. Some diseases are recognizable to human eyes and can be easily detected and cured. Some are so complicated which needs powerful microscopes or precise electromagnetic spectrum. Digital technology can process all kind of disease images very accurately. Fungi diseases can be carried out by various automated algorithms of neural networks such as back propagation neural networks. This paper presents an approach for leaf disease detection and classification using image processing.

II. LITERATURE SURVEY

The medicinal plant leaves are screened, analyzed compared with the database to give the required parameters of the texture for each leaf category. The method [3] is used because of the drawback of lookalike leaves. Using image processing technique this drawback of look-alike leaves can be authenticated by various parameters of the leaves.In [6], a Fast and accurate method for detection and classification of plant diseases is developed. The proposed algorithm is tested on main five types of plant diseases like Ashen Mold, Early Scorch, Cottony mold, late scorch tiny whiteness. First the RGB image is taken then a color transformation structure for the acquired RGB leaf image is prepared. Then the color values in RGB are converted to the space which specified in the color transformation structure.

The work [5] presents a method for identifying plant leaf disease and an approach for careful detection of diseases. The goal of proposed work is to diagnose the disease present in the brinjal leaf using image processing with artificial neural techniques. The production of brinjal been affected by the critical issue which makes the sharp The study of interest is the leaf rather than whole brinjal plant because about 85-95 % of diseases occurred on the brinjal leaf like, Cercospora Leaf Spot, Tobacco mosaic virus (TMV), Bacterial Wilt,. The methodology to detect brinjal leaf disease in this work includes segmentation by K-means clustering and Neural-network for classification. The proposed detection model based artificial neural networks are very effective in recognizing leaf diseases.

The system proposed in [1] introduces a neural network approach for plant leaf recognition. The computer can automatically classify 32kinds of plants from the leaf images loaded from digital cameras or scanners. Probabilistic Neural Network (PNN) is adopted for it has fast speed on training and simple structure. Twelve features are extracted and treated by Principal Component Analysis

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(PCA) to form the input vector of PNN. Experimental result indicates that the algorithm is workable with accuracy greater than 90% on 32 kinds of plants. Algorithm is fast in execution, efficient in recognition and easy in implementation. The paper [2] proposed an automated system for plant identification using shape features of their leaves. Two shape modeling methods, invariant-moments model and centroid-radii model are discussed in this system are discussed. These two are compared with regard to classification accuracies. This automated classification algorithm proves extremely beneficial for fast and efficient classification of plant species. The accuracy of the proposed system is compared to those reported in contemporary works. Less complex data modeling scheme are used whereby dimensionality of the feature vectors are typically below 40 is an efficient feature of the current approach.

The processing techniques for several plant species that have been used for recognizing plant diseases. The major techniques for detection of plant diseases are: SVM, SGDM, BPN and K-means clustering. These techniques are used to analyze the healthy and diseased plants leaves. Few of the challenges in these techniques are effect of background data in the resulting image; optimize the technique for a specific plant leaf diseases, and automation of the technique for continuous monitoring of plant leaf diseases under real world field conditions. The review summarizes that the disease detection technique shows best potential with an ability to detect plant leaf diseases and some limitations. Therefore the paper concludes on image scope of improvement in the existing research.

The literature survey projected in [4] provides a new insight in detection of the diseases of plant. There are two main characteristics speed and accuracy of plant disease detection using machine-learning methods that must be achieved. Hence there is a scope for working on development of creative, fast interpreting algorithms, efficient which will help plant scientist in detecting disease. The literature review of automatic and rapid plant's disease segmentation techniques and algorithms are presented. The purpose was to present the existing techniques of plant's disease segmentation. Time and accuracy are the two important things to be considered. Accuracy can be improved by the use of different methods using image processing techniques, as compared to manual systems. Time is also saved by these new techniques.

Among all these different techniques best techniques will be analyzed which have the maximum benefits. But in spite of the maximum benefits every technique has certain limitations. So to overcome the drawback of different techniques fusion of different techniques is the good idea. In the future we will fuse two or three techniques to get accurate results with fastest speed.

III. PROPOSED SYSTEM

First the leaf images are captured, then image processing techniques are applied to extract useful features for disease detection.

The block diagram of the proposed methodology is shown in Fig. 1.

A. Image Analysis

For diseases detection image of an infected leaf should be examined through the set of procedures. The input image should be pre-processed then its feature should be extracted according to the dataset. After then some classifier techniques should be used to classify the diseases according to the specific data set.

B. Image Acquisition

Image acquisition is the process in which acquired and converted to the desired output format. For this application an analog image is first captured and then converted to the digital image for further processing.

C. Image pre-processing

The following pre-processing steps are performed on the acquired image. Increase the contrast of the image by still or active binarisation, look-up tables or image plane separation. Decrease the image resolution decrease via binning. Image rotation. Convert color images to gray scale images.

D. Feature Extraction

The aim of this phase is to extract features such as color and shape. Two shape features such as area and perimeter are extracted from the binary segmentation images. Color features are extracted from color segmentation images. The color features include mean of gray values of

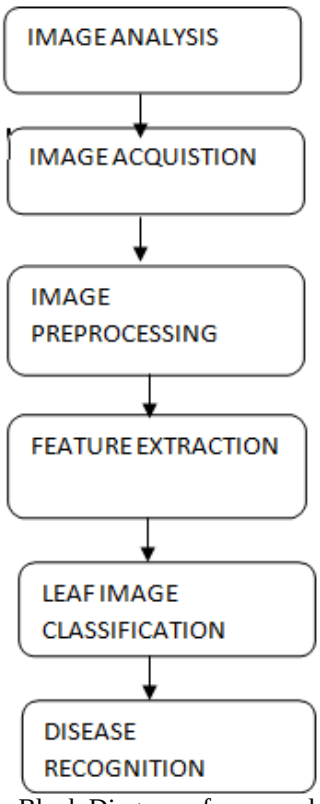

Fig. 1. Block Diagram of proposed method

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R/G/B component, variance of gray values of R/G/B component, skewness of gray values of R/G/B component, color ratio in RGB color model, mean of gray values of H/S/V component, variance of gray values of H/S/V component, and skewness of gray values of H/S/V component [11].

E. Leaf Image Classification

For classification between the affected leaves, classifiers depend upon the Bayes' theorem and SVM were used for classification and differences between the affected leaves [12]. The image of disease affected leaf is depicted in Fig. 2.

First the captured images are classified as affected and unaffected leaves. Distribution of color is the same for unaffected leaves, but for the affected leaves the distribution of color is not uniform. This is because the values of the pixels of the affected leaves were totally different form the pixel values from the normal leaves. The image quality is improved by applying the mean filter after that Segmentation of the image is performed by Otsu's threshold algorithm.

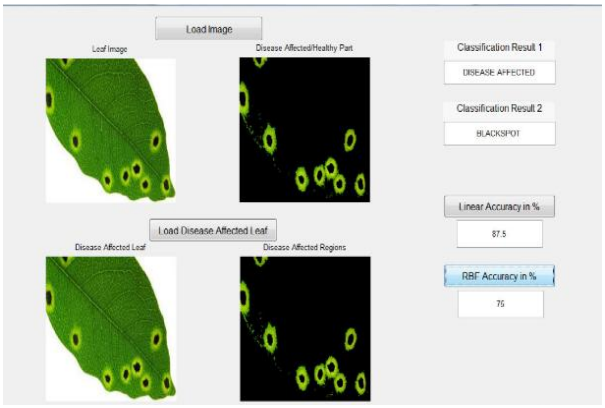

Fig. 2. Disease affected leaf image

After extracting the features from the given leaf image, a recognizer is needed to recognize the disease in the leaf image from the stored database. This paper proposes a recognition method, which uses Back Propagation Network (BPN). Back propagation can train multilayer feed-forward networks which consist of a forward pass and a backward pass as shown in Fig. 3. In the forward pass outputs are calculated and compared with preferred outputs. Errors from preferred and actual output are calculated. In the backward pass this error is used to alter the weights in the network in order to reduce the dimension of the error. Forward and backward pass are repeated until the error is low, users usually set the value of accepted error. When training NN, we are feeding network with set of examples that have inputs and desired outputs. Choose the learning rate and momentum will help with weight adjustment. The output layer contains one neuron. Support Vector Machine (SVM) is a supervised machine learning algorithm which can be used for classification. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each leaf feature.

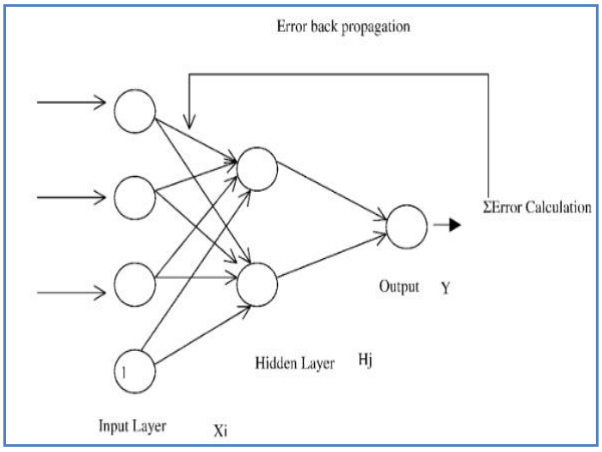

Fig. 3. General Structure of Back Propogation Network

As with any supervised learning model, support vector machine is trained, and then the trained machine is used to classify (predict) new data as shown in Fig. 4.

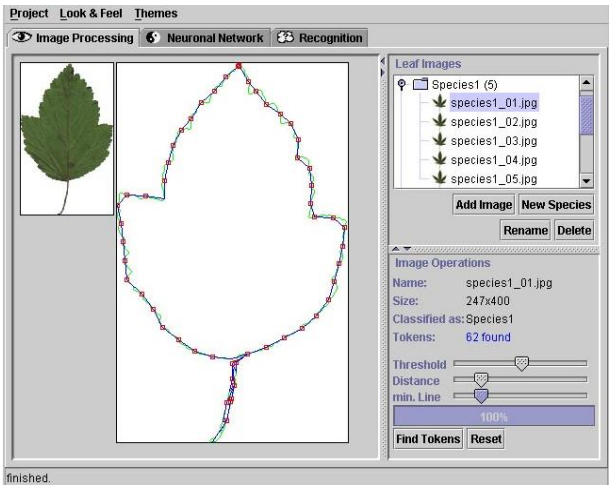

Fig. 4. Output of recognized leaf image

IV. CONCLUSION

Image processing technique based approach is proposed and useful for plant disease detection. Recognizing the disease is mainly the purpose of the proposed approach that can recognize the leaf diseases with little computational effort. This proposed approach consists of 4 phases. Accuracy is improved by the use of different image processing techniques such as image analysis, pre-processing, feature extraction and classification. Speed and accuracy are the two main characteristics of plant disease detection using machine-learning methods that must be achieved. Using the proposed method, the accuracy up to 92% can be achieved. Accuracy of detection can be increased when using SVM classifier with more number of features. This approach can be used for the applications such as classification of diseases of plant parts like leaf with suitable classifier.

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