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A Review on Plant Species Recognition Based on Leaf Images

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Abstract - *Plants play a significant role in the nature and for all living things. They are the essential element that provides environmental stability and everyday requirements such as food, medicinal and commercial products. Identification and classification of plants are useful for humans to successfully understand and preserve plants. Generic steps of an image based plant classification process include image acquisition, preprocessing, feature extraction and classification. For the recognition of plant species a lot of feature extraction methods have been evolved. In recent times, plant species identification based on leaves become a trending subject since they hold different features such as shape, texture and color. Plant leaf recognition technology based on image analysis, evolution of machine vision technology and artificial intelligence are used to upgrade the knowledge of plant classification and protection. Features were extracted from the preprocessed images using different algorithms. Different classification methods such as SMO, CNN, ANN, NB, KNN, SVM, Meta classifier, RF, ELM, Decision tree, Multilayer perceptron are discussed here.*

Key Words: Feature extraction, Artificial intelligence, SMO, CNN, ANN, NB, KNN, SVM, Meta classifier, RF, ELM, Decision tree, Multilayer perceptron

1. INTRODUCTION

Plants are essential for preserving life and maintaining biodiversity on earth by enabling air and water for living beings. The numbers of plant species are extremely enormous, hence it is impossible and not practical for an expert or botanist to be able to identify and classify all the plant species. Traditional methods involve time consuming, detailed and complex process. Computer vision, pattern recognition and image processing technologies provide better results for identification and classification. To preserve their diversity it is essential to be able to recognize plant species. In the field of computer vision and image processing, plant identification using leaf recognition is an important sector. Plant recognition goals are normally based on elements like features of leaf, flower, branch and trunk. Recently plant detection based on leaves has become a well-received concept since they are more convenient part comparing with other parts. Leaf color, texture and shape are the mainly three basis for leaf based classification. The color of most leaves changes slowly with time but the shape features of leaves in distinct stages are homogenous, only changes in the size happens. The texture veins have constant characteristics compared with color and shapes, texture framework differ greatly for different leaves. So it is simple to determine the category of plants. Various methods are used for plant leaf image segmentation and different algorithms are utilized for feature extraction from pre-processed images and classified using different classifiers.

2. LITERATURE SURVEY

Lei Zhang, Jun Kong, Xiaoyun Zeng and Jiayue Ren develop Plant Species Identification based on Neural Network [1].This paper presents SOM (Self-Organizing Feature Map) for plant species identification using leaf image. Features of shape, texture features of venation are focused for stable feature extraction. Kohonen SOM is a popular unsupervised network, widely used in the field of pattern recognition. SOM is operated in 2 phases, training stage and identification stage. The known plant species leaf samples are given to the system in training phase. To train the SOM neural network, the feature values obtained from the feature extraction process are used. Trained SOM neural network will give the decision of the concerned plant species in identification phase. The system contains several modules, acquisition of leaf image and preprocesses, feature extraction, identification. 2-D moment invariants are used for the extraction of shape feature from the leaf .Discrete Wavelet Transform and statistical moments are applied on the leaf image for the extraction of texture information of nervation. These trained SOM neural network can be utilized to recognize the plant. For the experiment 15 kinds of plants are taken and 144 leaf images of these plants are used in the testing phase. From these samples 364 used as train samples. The recognition rate obtained is 95.83%. SOM has the advantage of smooth structure, arranged framing technology and low complication in learning. The experimental results show that this technique is simple and efficient but doesn't consider in the case of complicated background and radiance.

J. S. Cope, P. Remagnino, S. Barman, P. Wilkin proposed a technique for plant texture classification based on joint distribution of Gabor filter responses[2].The first stage of plant texture extraction is to minimize the order of the image by a Gaussian kernel convoluting with it and then subsampling. Otsu's threshold method is used for the removal of image background and then edge detection operator is applied to the images foreground. Texture

analysis method depends on the joint distribution of Gabor filters. To each pixel a set of 128 Gabor filter is applied. The results are merged into sequences of co-occurrences matrices. For classifying these textures the analogous co-occurrences matrices for distinct textures are compared directly. The co-occurrence matrices are operated as probability density functions for this purpose. By using Jeffery divergence measure we can calculate the variation between leaf textures. The experiment was evaluated using 4four texture datasets. Randomly extracted texture samples were the first dataset. The remaining two from Brodatz texture database. The above datasets were also used for comparison with traditional methods such as Fourier descriptors, Gabor filters and co-occurrences matrices. This method attained good recognition rates on Brodatz dataset around 95.50%. The method was effective in the case of laborious task of plant classification based on leaf analysis.

E.Aptoula and B.Yanikoglu develop Morphological Features for Leaf based Plant Recognition [3].Plants further exhibit visible variations depending on their condition and age. This paper presents two descriptors based on mathematical morphology; Contour Covariance (CC) is the first one which focus to distinguish edges of leaves, by calculating the morphological covariance on contour profile of leaf, hence detailing its sharpness and periodicity. Extended Circular Covariance Histogram (ECCH) is the second developed descriptor consist of latterly established Circular Covariance Histogram to capture leafs vein networks properties. The experiment of both descriptors has been validated with the image Clef'12 dataset. A set of experiment is conducted on dataset using their combinations with other descriptors. Initially each descriptor was tested individually and then tested their combination. The combination of ECCH+ACH+CPDH+CC provides 59.09% mean classification accuracy. But, still needed the considerable study of their characteristics and stability levels.

Hulya Yalcin and Salar Razavi proposed Plant Classification using Convolutional Neural Network [4]. Developed CNN technique for the classification of types of plants from the images obtained from Smart Agro Stations. Succeeding the preprocessing step, for the extraction of features CNN architecture is employed. To build CNN, performed with a 16 classes of plants from TARBIL dataset. The training dataset consist of 4800 isolated images which are ordered into 16 distinct classes. Our method is compared with SVM classifier using GIST and LBP features for evaluating the performance and efficiency. The experiment is conducted with SVM classifier using polynomial kernels and RBF. TARBIL Agro-Informatics Research Center provides the dataset for the experiment. Experimental results shows that CNN based technique are crucially effective with high accuracy 97.47% on 16 kinds of plants. When the size of the data enlarges CNN will provide better results.

Asem Khmag, S.A.R Al-Haddad and Noraziahtulhidayu Kamarudin presents a Recognition System for Leaf Images Based on its Leaf Contour and Centroid[5].Proposed an image processing algorithm to detect the tested plants shape structure. FFT algorithm is established for leaf recognition. Initially the preprocessing step convert the digital image into gray scale image and to represent the contour, specific point set is extracted. Next transformed the sequence by Fourier Transform. Finally this feature is used to do experiments on leaf dataset FLAVIA. The invented method is compared with different classifiers for different features and different length. For the evaluation of this method different classification methods such as Naïve Bayes (NB), SMO, K-NN, Meta classifier and Random Forest (RF) are compared. The proposed method shows 97.69% accuracy which outperforms the other methods.

Muammer Turkoglu and Davut Hanbay presents an Improved LBP and Extreme Learning Machine(ELM) for leaf based plant species recognition[6].This paper proposed different approaches based on LBP such as Region mean-LBP, Overall-mean LBP and ROM LBP for the recognition of plant leaves using extracted texture features from the leaves. The method works by way of filtering, considering the overall mean and region in place of the center pixel for coding. Original LBP translate color image to gray, the Overall-mean LBP method and Region mean-LBP were applied using R and G color channels of the images. The fusions of parameters gained from these methods are used for the ROM LBP method. ELM classifier calculates the performance of above methods. FLAVIA, Swedish, ICL and Foliage plant leaf datasets were utilized for the testing of mentioned methods. When comparing with previous LBP method our proposed method shows the largest recognition accuracy for the four different datasets. Performance results shows that the best classification accuracies for FLAVIA, Swedish, ICL and Foliage dataset were 98.94%,99.46%,83.7% and 92.92% . It evidently shows that proposed method have greater level of classification accuracy than original LBP and other image descriptors for both noiseless and noisy images.

Munish Kumar, Surbhi Gupta, Xiao-Zhi Gao, Amitoj Singh introduced plant species recognition using morphological features and Adaptive Boosting Methodology[7].The method consist of pre-processing, feature extraction, feature selection and classification. Several morphological features such as centroid, major axis length, solidity, perimeter and orientation are used for the experiment which is extracted from different leaf images. FLAVIA dataset, containing 32 distinct type plant leaves are used for the experiment. Different classifiers like Decision tree, KNN and Multilayer perceptron are designed for testing the accuracy of the proposed algorithm. For yielding better classification rate of the proposed method, consider

the Adaboost methodology. Good precision rate around 95.42% has been gained for 32 different plant leaves which outperformed the other algorithms. The proposed method is fast and accurate for plant leaves identification and classification.

Jiang Huixian presents Analysis of Plants Image Recognition based on Deep Learning and Artificial Neural Network [8].Features of plant leaves extracted and identify plant species using ANN classification based upon back propagation (BP) algorithm. The texture features of leaf and shape are obtained by various segmentation methods such as edge segmentation, threshold segmentation and region segmentation. For the experiment, 50 plants leaves were obtained from the botanical gardens and 200 samples used for the test and compared with Kohonen network, KNN classifier and SVM. Seven distinct plant leaves were compared and established that Ginko leaves are simple for identification. Plant leaf recognition based on deep learning is described and hierarchial convolution method is studied. The experimental result reveals that the method of ANN (BP) is effective which has smallest recognition time and largest recognition rate, i.e., 92.47%.

3. COMPARISON

This paper discusses different methods for plant species recognition. While comparing all these papers, Deep Learning and Extreme Learning Machine (ELM) provide the better result for plant species classification. A variety of leaf images of different species are used for these experiments .Different types of classifiers are also used for the recognition purpose. Table 1 shows the comparison of eight methods, accuracy and database or images used.

Table -1: Comparison of different methods

Method	Dataset	Accuracy
SOM Neural Network	364plant leaves images	95.85%
Gabor Co-occurrences	Brodatz	95.50%
ECCH+ACH+CPDH+CC	Clef'12	56.09%
CNN	Clef'12	97.475%
SVM	FLAVIA	97.69%
Improved LBP and ELM	FLAVIA Swedish ICL Foliage	98.94% 99.46% 83.71% 92.92%
Multilayer perceptron and Adaboost	FLAVIA	95.42%
BP Neural Network	50plant leaves images	92.47%

4. CONCLUSIONS

This paper discusses various techniques used for plant leaf recognition .The main goal of this work is to provide a timeline view of various methods for the recognition. The technology of plant leaf recognition based on image and intelligent analysis is established. Different algorithms and classifiers are utilized for feature extraction and classification. All the experiment needs substantial no of image datasets. Comparison of various techniques is mentioned above based on their accuracy on different datasets. Based on this view the performance of the system is improved with the development of deep learning. Compared to all techniques ,it is found that deep learning based approach and Extreme Learning Machine makes the process faster and provide greater accuracy. It outperforms the other methods of recognition. These proposed methods are beneficial to farmers and students in plant recognition without the requirement of experts.

However, more précised approaches and techniques can be derived for further work.

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