A Survey on Approaches Used in Classfication of Leaf Images

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ABSTRACT
Plants play an important role in the earth's ecology. Without plants, human lives cannot exists in this world. But in the recent days, people are not having knowledge about many types of valuable plants. They are at the risk of extinction. So, it is necessary to protect plants and to catalogue various types of flora diversities and it is important to maintain plant databases which pave a way towards conservation of earth's biosphere. In the world wide, there are a huge number of plant species available. To handle such volumes of information, development of a quick and efficient classification tool using machine learning algorithms is needed. In addition to the conservation aspect, recognition of plants paves a way to use those plants as an alternative energy source. In this paper, various techniques used to classify the leaf images using machine learning algorithms are studied.

General Terms
Leaf identification, Image, Classifiers, Plants, Feature Extraction

Keywords
Machine learning algorithms, Feature extraction, Leaf classification.

1. INTRODUCTION
The plants produce oxygen. The oxygen keeps our cells and bodies alive. Plants and the animals relay on each other. The study of plants is so important because they are the essential part of our lives. World health organization estimated that 80% of people in Asia and Africa relay on herbal medicines to stay strong and health [1]. In the world wide, there are huge number plant species available and because of the global warming, other issues and lack of knowledge about plant categories, many of them are about to extinct [2]. So, it becomes mandatory to design a plant classification tool using machine learning algorithms and image processing techniques which will help the human society to lead a better life.

There are many parts of the plant like leaves, fruits, flowers, seeds etc can be used to recognize a plant. In this survey, leaves are considered for Plant identification. Leaves are easily collected in around Coimbatore and the same can be captured through camera or mobile phone or through scanners. The digitized leaves can be used for further processing like feature extraction, training and testing dataset creation, model creation and classification.

There are several methods have been used for plant identification. Some of them use shape description method and others deal with color, texture, vein and geometrical features [3]. The objective of this survey paper is to focus on different techniques used in leaf classification. Several classifiers such as Artificial Neural Network (ANN) [7,8], Convolution Neural Network (CNN), Probabilistic Neural Network (PNN)[6], Decision Tree(DT), K-Nearest Neighbor (KNN)[4], RADIAL Basis Function(RBF)[9], Support Vector Machine(SVM)[5] are used to classify the leaves. The rest of the paper is organized as follows: Section 2 deals with general steps used in leaf identification. Section 3 deals with the summary of different classification techniques. Section 4 deals with conclusion.

2. GENERAL STEPS USED IN LEAF IDENTIFICATION
To identify the leaf images the stages involved are 1. Image Acquisition 2. Image Preprocessing 3. Feature extraction and dataset creation 4. Training the model using classifiers 5. Test image acquisition 6. Repeating from step 2 to step 4. 7. Classifying the leaf image.

2.1 Image Acquisition
The primary step in leaf classification is image acquisition. The leaves can be plucked from the plants and the leaf images are captured using camera or mobile phones or scanners. The captured images can be stored in TIFF or JPEG format.

2.2 Image Preprocessing
In this step, image is preprocessed to enhance the quality of the captured image. The steps involved are grayscale conversion, image segmentation, binary conversion, and smoothing. The purpose of the preprocessing is to remove unwanted distortions and improve the quality of image [19, 20]

2.3 Feature Extraction
The next step is feature extraction. The important features which are used in classification process are extracted. Usually the shape, geometric, color, contour and morphological features extraction methods are used to extract the features. The algorithms like Grey Level Co-occurrence Matrices (GLCM), Region covariance matrices, Gabor filters, wavelet transforms, Independent Component Analysis (ICA), Local binary patterns, Fractal measure can be used. The extracted features can be stored in the trained data set. 1.

Some of the calculations used in feature extraction are as follows:

The features extracted from the leaf images are

2.3.1 Geometrical parameter
(Length, Width, Diameter, Perimeter and area)

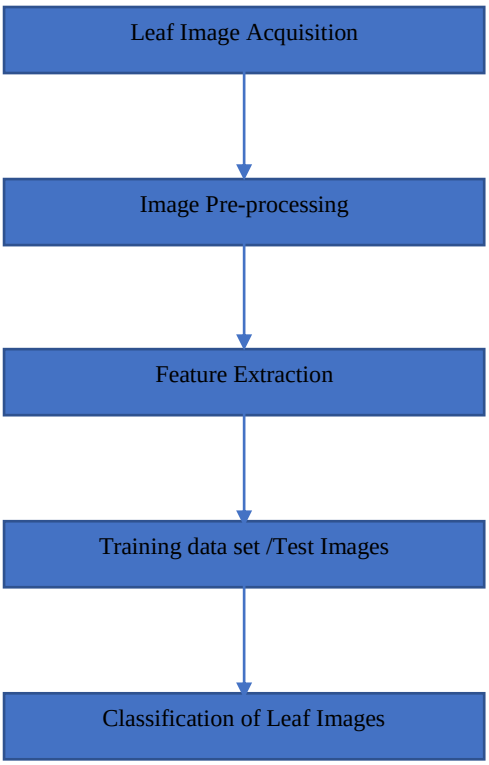

Figure 1. Steps involved in Leaf Identification

2.3.2 Basic feature extraction

(Aspect Ratio, form factor, Rectangularity, Narrow factor, perimeter ratio of diameter, perimeter ratio of length and width).

2.3.3 Derived Feature from the vein (vein feature).

The formula used to calculate all those parameters are as follows:

1. *Length*: It is the distance calculated between two extreme points in the main vein of the leaf.
2. *Width*: it is the distance calculated between two extreme points of minor axis of a leaf boundary.
3. *Perimeter*: It is calculated by counting number of pixels contributing margin of leaf.
4. *Diameter*: It is calculated as the longest distance between any two points of the margin of a leaf [22].
5. *Area*: It is calculated as counting number of pixels values having binary value 1 inside of leaf margin [22].
6. *Aspect ratio*: It is calculated from the ration of length to the width of the given leaf.
7. *Form factor*: It is calculated as follows:

   Form factor = (4 x π x area)/perimeter^2
8. *Rectangularity*: It is calculated as follows:

   Rectangularity = (length x width) /Area
9. *Narrow factor*: it is the ratio between diameter and length.
10. *Perimeter ratio of diameter*: it is the ratio between perimeter to diameter.
11. *Perimeter ratio of length to width*: it is calculated as follows:
12. Perimeter ratio of length to width = perimeter/ (length + width).
13. **Vein feature:** It is the ratio between number of white pixels to Area.

2.4 Model Creation

The next step is creating the model using classifier algorithms. Different classifiers can be applied and based on accuracy and other factors suitable classifiers can be used to improve the performance of leaf recognition system.

2.5 Test Image/Query Image

The main aim of the leaf recognition system is when the leaf image is given as input the corresponding class label and related information to be displayed as output. For this the steps ii and iii are repeated and matched with the training dataset. If the features match with the existing dataset then the corresponding information will be displayed.

3. SUMMARY OF DIFFERENT CLASSIFICATION TECHNIQUES USED FOR LEAF IDENTIFICATION

Table 1. Summary of techniques used by authors

Authors	Classification method	Algorithms used	Accuracy
Sachin D. Chothe , V.R.Ratnaparkhe[10]	Geometrical features, Vein features	Euclidean classifier, Median filtering	Dataset 1 - 78.12%% Dataset 2-85 %
Abdolvahab Ehsanirad et.al[11]	Texture features	PCA,GLCM	78%
D. Wijesingha and F.M.M.T. Marikar[12]	Morphological feature, Geometrical feature	PNN	85 %
Pavan et al. [13]	Color, Shape, Volume, Cell feature	Euclidian distance	85 %
Nidheesh p et al.[14]	Geometrical features and Morphological features	PNN,1-NN,kNN,RBPNN,GRNN	90.3%,93.2%,85.5%, 91.2%, 100 %
Kadir et al.[15]	Shape, Vein, Color and Texture features	PNN	93.75%
Sumathi et al.[16]	Edge based feature	CART, RBF	85.93%
Beghin, et al., [17]	Shape and Texture based feature	Incremental classification algorithms	81.1%
Arun, et al., [18]	Texture features	SGD, kNN, DT, SVM , ET, RF	94.7%

4. CONCLUSION

In this paper, different classification methods for leaf identification by different researchers are studied and it is observed that the feature extraction techniques like geometric, color, shape, vein, texture and morphological methods can be used. Different classifier algorithms are used to classify the leaf images. Further it is observed that using advanced neural network classifier, the accuracy obtained is better than the other classifiers. So, in future work different neural network classifiers can be used to classify the leaf images.

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