International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

A Review of Plant Species Identification Techniques

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Abstract: ***Plants identification process is rather problematical, time consuming so automated species identificationis important. In this paper a review on a various methods of plant species identification is presented. We focused on plants identification approaches that based on leaves, flowers, and fruits regardless seeds and style of branching. The main goal of this review is discussing different techniques of plantsidentification, features extraction methods and how it is mathematically represented. The overview will be beneficial for beginner researchers.***

Keywords: Plants identification, Leaf Recognition, Leaf Shape, Shape Features, Texture Features, Color Features

1. Introduction

Plants are pivotal part of our planet.Because ofthe existence of plants,earth is called a green planet. It plays a fundamental role in our life, to understand why we can imagine ourlife without oxygen which is provided by plants, in addition to the relation of plants to our "food", "medicines" and"furniture", so we can say plants was the basis of life.Plants are divided into smaller groups, according to shared attributes.Plants recognition is rather difficult because Plants are extremely complex.The recognition process of familiar plants was easy by experts, sometimes especially in medicine we need to identify prejudiced or toxic plants, botanists can do that facilely, but he must find a way to categorize the many different species when there are millions of various plant species which composed of similar parts(roots, stems, leaves, etc.).Designing plants recognition system is requiredin order to save time and decrease cost.Plant recognition or classification can be done based on parts of plant like:

- Leaves of Plant
- Flowers of Plant
- Fruits of Plant

Many research based on leaves in plant recognition, because the leaf was the most important part of plant carrying its characteristics compared with other plant parts,fruits and flowers are not available throughout the year, most plants are seasonalas well as shape, sizeand color of fruits and flowers arechanging during growth.Many studies used leaves to identify plant category based on shape,texture information, venation, and color. The process of identifying leaf was done using various methods [1]: chemical methods, instrumental methods, another method was used named optical method which was more advantage than other techniques.

2. Plants Recognition Approaches

In this section we will review approaches for plants classification and recognition:

a) Approaches based on leaves

Most of studies based on leaf shape or color to extract features, there are some important leaf features such that:"aspect ratio", "narrow factor", "compactness", "centroid", "eccentricity", "dispersion", "area", "equivalent diameter", "moments invariant", " etc. In[2] J.Chaki and R.Parekh presented a system based on leaf image to identify plants,two techniques were used moments-invariant and centroid-radii. N.Valliammal and S.N.Geethalakshmi [3] proposed a hybrid approach based on "contrast stretching" and "adaptive thresholding" that at the same time adjusts the intensity level of plant leaf image. The classification approach proposed by K. Gurpreet and K. Gurpinder [4]was based on leaf features: "isoperimetric quotient", "eccentricity", "aspect ratio", "leaf area", "leaf perimeter", "length of the major and minor axes", "solidity" and"upper and lower triangle area of the leaf".Tree identification system that presented by Itheriet al.[5]detected boundary then described the detected boundary by using the directional fragment histogram, geometric features such that: "rectangularity", "convexity and solidity", "circularity", "Sphericity" and "ellipse variance" are extracted. It was noted that most of the research based on geometric features of leaves as in [6] in which (8) geometric features were extracted with hypersphere classifier to classify more than 20 species of plants.

b) Approaches based on flowers or fruits

Some approaches recognize plants based on flowers, by focusing on the flower region as a whole or on parts of the flower [7, 8, 9,]. Tan et al. [10] proposed (4) flower shape descriptors: "area", "perimeter", " roundness", and "aspect ratio". Some studies extract features like color, texture, and shape[11,12]. Warisara et al.[13] presented a system for classifying flower, RGB histogram was used as a feature, (15) spices of input images were used which had good quality, for classification random forest algorithm was used. Diah et al. [14] presented a system for recognizing the orchid species based on image of flower, shape and color features were extracted, for segmentation maximal similarity based on region merging was used which was easy to use and more accurate than others, for classificationsupport vector machine method was used. As we know fruit images

may have similar color and shape, in[15] plants was Identified by using morphological features of fruits(shape and size). Arivazhagan et al.[16] presented a system based on intensity, color, shape and texture, 15 different types of fruit were used, minimum distance classifier was used, the good result of classification was obtained when used combined colour and texture features. Saurabh et al.[17] presented plant recognition system based on geometrical features(shape, size and orientation) by defining two classes: fruit and non-fruit, fifty images of fruit plants were collected, for classification support vector machine was used, artificial neural network, fuzzy set rules and image warping technique were used, the results were very satisfactory.

Moreover, some approaches based on two parts when recognize plants, Supapattranon P. and Siriwisesokul N.[18] presented a recognition system could recognize plants by either using leaf or flower image,features like: "height ratio", "area ratio", "width and height ratio", "roundness value"," ripple feature", "half leaf of flower area ratio", "color feature", "boundary feature"were extracted from leaf or flower,they used 30 kinds of flowers and 30 kinds of leaves, euclidean distance was used for recognition.

3. Features Extraction and Representation Techniques

Features extraction is an essential process in any recognition or classification system.Many techniques can be used to extract image attribute, divided into three types:

- **Shape**

Any object had a special shape, in other words had a contour, a good shape descriptor must beinvariant to scaling, rotation, translation, and reflection.Shape representation divided into two types: "boundary-based" and "region-based"[19,20]. Plants recognition system based on shape of leaf, flower and fruit to identify plant category. Shape features can be represented mathematically by the following techniques in table(1):

Table(1): Techniques of Representation Shape Features

Boundary-Based	Region-Based
Polygonal Models	Super Quadrics
Fourier Descriptors	Fourier Descriptors
Splines, Higher Order Constructs	Implicit Polynomials
Curvature Models	Blum's Skeletons

In [21] plants recognition was based on leaf boundary. Elliptic fourier and chain code were computed, the system used to identify (4) plants spices. AbdurrasyidHasim et al.[22] used centroid contour distance to recognize the leaf (boundary-based approach), it calculates the distance between the midpoint and each boundary point,(4) species of tropical plants were used, probabilistic neural network was used as a classifier,we observed that their approach assumed that the leaf shape is always symmetrical, so centroid contour distance was only done on one side of the leaf. Hu et al. [23] proposed a boundary-based shape descriptor named "multi-scale distance matrix" to extract the geometric features ,the approach was invariant to rotation, translation, and scaling. The approach used euclidean distances, it was more efficient compared to other boundary-based approaches. Ren et al. [24] proposed a region-based shape descriptor using "multi-scale local binary patterns" which provide a discriminative and robust leaf representation. Some methods cannot be classified as either boundary-based or region-based, it have been applied for plants identification methods for example the morphological shape descriptors which composed of "aspect ratio", "rectangularity measures", "circularity measures", and "the perimeter to area ratio", in [25] six features described "the morphological features" of the leaf's shape.

- **Texture**

There is no exceptional definition of texture, because it is extremely complex. We can recognize texture by our eyes, but we cannot be able to describe it.A simple definition of image texture is a surface attributes that can use to recognize objects.Texture wasdescribed by the number of "primitives" and the spatial layout of these "primitives".Texture is the most important technique used to quantify the patterns in images. It can describe the arrangement of the surface. Texture explains the spatial arrangement of "intensities" or "color" in an image. Mathematically three methods can be used for representation:

a) Structural: It provide effective description of image by using rules,it describes texture as a set ofarranged elements or texels. The extraction process of these texels is difficult.
b) Model based method. it is robust and requires less computation, It uses "fourier descriptor", "wavelet transform" and "gabor descriptor".
c) Statistical: it computes local features at each point in the image, it describes texture using "statistical proprieties" of the gray levels in image, the most common methods are: co-occurrence matrix and moment invariants.
d) In[26] texture features were extracted used gray level co-occurrence matrix, the database was contain 390 images, for testing 65 new image were used, the results showed that the gray level co-occurrence matrix was sensitive for any changes forimages.

- **Color**

Color is using every day to distinguish among objects.Color plays anessential role for flower analysis than for leaf analysis. Methods that used for color representation were: "color moments" which was simple, "color histograms" which was robust to translation and rotation, "color coherence vector", and "color correlogram", two kinds of histogram can be used "global" and "local". In[27] color histogram ,edge histogram and area were used for medicinal plant species identification.
as we mentioned, most studies based on leaf in plants identification, we found a specific leaf features namely, leaf venation which was used widelyin plants identification approaches.

- **Venation**

It means the pattern of veins in the leaf that can be classified as "arcuate", "cross-venulate" and "dichotomous", "longitudinal", "palmate", "parallel", "rotate", 'pinnate", "reticulate", see figure(1):

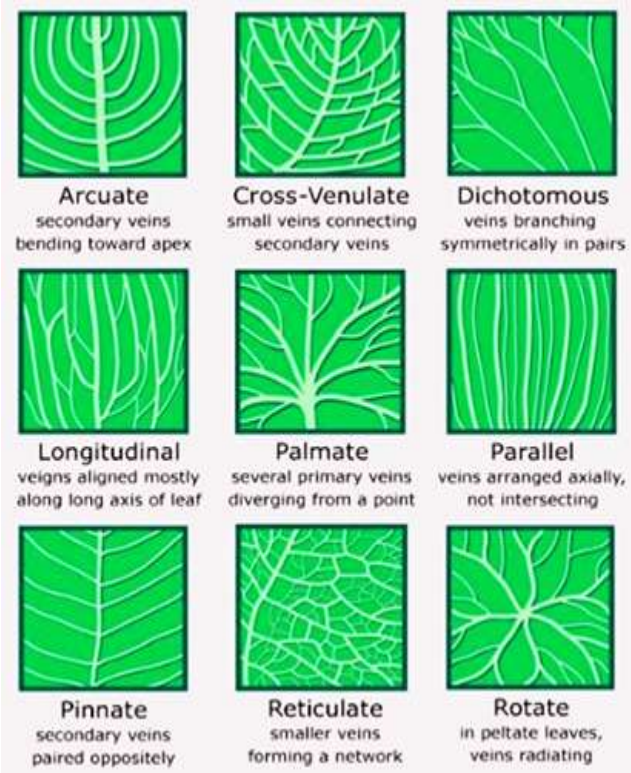

Figure 1: Leaves venation types

Veins features must extracted without effect on the shape of leaf, the usage of cleaned leaf image was necessary when image acquisition performed by using scanner.To improves the accuracy sometimes leaves need to be treated using chemical method. Monica et al. [28] ignored shape leaf or texture information and focused on the leaf vein. Gu et al. [29] used a gaussian interpolation and wavelet transforms to extract a vein of leaf imagethen compute run-length features,20 species dataset were used, the results showed that the accuracy was 91.2%.Projection histogram in the horizontal and vertical directions was using by kue-bum lee and kwang-seokhong[30] to measure leaf veins distribution as well as leaf features.

4. Conclusion

In this paper we reviewed the various systems of plants identification, techniques that were used to extract features and mathematical representation of it. We can summarize main results of this review by the following points:

1) Most researches avoid segmentation, images were used with plain background.
2) Most plant identification approaches focus on leaves.
3) Shape is the preeminent feature for plant identification, most studies based on leaf shape analysis.
4) Region-based description is less popular than boundary-based description.
5) For leaf analysis, shape and texture are consider more discriminative than color.
6) Cleaned leaves with good quality were used inleaves database, most researches ignoring crusty, distorted, uncleaned leaves.
7) Color is the paramount feature for flowers recognition and classification systems.

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