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A Survey on Various Leaf Identification Techniques for Medicinal Plants

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Abstract:Plants have been utilized as medicines since biblical times. All the traditional Indian medical systems namely Ayurveda, Siddha and Unani prominently use medicinal plants. It is necessary to classify these plants so that it would be easy to select the right plant for the medicinal preparation or to study more about its characteristics. The ability to identify plants is highly important. Automatic recognition of plant species recognition is a challenging made towards computer-based vision problem in the area of digital image processing. This paper reviews the works that have been systems for automatic identification of plant species.

Keywords:Medicinal plants, digital image processing, pre-processing, feature extraction, edge detection, pattern recognition.

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I. INTRODUCTION

Plants are the key factor for the survival of life on earth. As plants are essential for natural security, it is more vital to distinguish and characterize them precisely. Categorization of plants has a wide usage forthcoming in horticulture and medication, and is particularly critical to the science assorted qualities explore. Leaf image Classification method is the most preferred choice when compared to methods like Cell biology or Molecule Biology methods for leaf plant classification.

Earlier researchers have attempted to identify the plant based on image color histogram, edge features and its texture information. Research has been already done to classify the plants as trees, shrubs and herbs using neural networks. In this direction, a maiden attempt has been put forth by just considering the leaf details.

Leaf identification forms a vital part in plant classification. Plants can be regularly grouped based on different parts of plants. However, there are three dimensional objects that expands intricacy. Hence for the purpose of plant classification, recognizing its respective leaf image is a simple and easier way. Each leaf image is classified through a number of related processes. Initially a data base is created using sample images of all kinds of leaves. Each leaf image is linked to the corresponding plant details. When the leaf image is uploaded to system and then its essential features are identified and recorded using image processing methods.

This paper reviews work that has been utilized digital image processing techniques to automate identification or recognition of plant species by their leaf shapes. Different steps involving for leaf classification are:

- Image acquisition.
- Image pre-processing (noise removal, resize)
- Feature extractions
- Use of different techniques
- Identification/recognition

This paper presents survey of different plant species identification techniques. The rest of the paper is organized as follows. Section II describes related work done in this area. Section III explains the various leaf identification methods. Section IV shows the observations of previous experiments and finally Section V yields the conclusion.

II. RELATED WORK

Figure 1 illustrates the general framework of leaf identification system. The traditional steps followed in order to identify a plant from a given leaf image are as described below:

1. Foremost step in the Plant leaf classification is digitization. Leaf image is captured in a digital camera and it is termed as an input Image.
2. The input image is pre-processed to enhance the important features. Enhancing process includes images to be converted to grayscale, image segmentation i.e the procedure of partitioning a digital image to binary conversion, image smoothing and multiple segments. The objective of image pre-processing is to show signs of improvement in getting image information so that it can suppress unwanted information and it concentrates on enhancing the relevant image features for further processing.
3. In the next process, the significant attributes are drawn and mapped by the image in the database. The input image is classified to the plant whose leaf image comprises most extreme match score using some matching algorithm from which the information about the input image is obtained.

Till date many classification methods are created. They are picked based upon the extracted morphological elements. The shape, color and texture components are usually incorporated into numerous applications. Some researchers have utilized just part of these features. Few recent techniques that the researchers have developed involve vein and contour feature extraction methods too.

 ISSN: 2454-4248
38 – 42

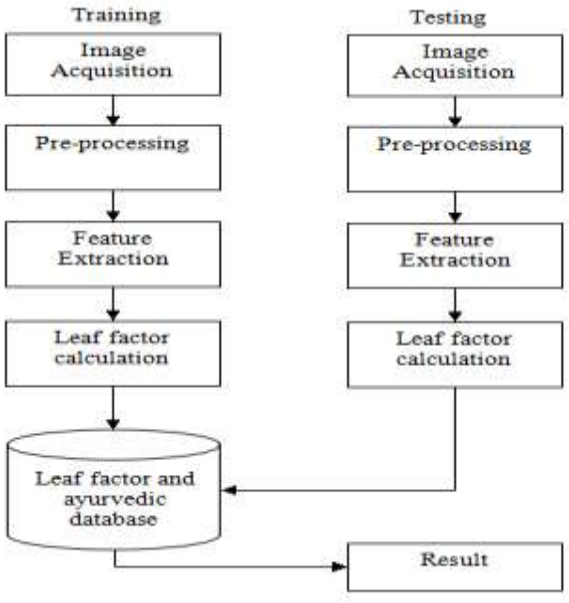


Fig. 1. Block Diagram for Leaf Recognition

III.SURVEY ON EXISTING METHODOLOGIES

Features Based Approach

Sandeep Kumar et. al. [1] presents a method for identification of medicinal plants based on some important features extracted from its leaf images. This paper presents an approach where the plant is identified based on its leaf features such as area, color histogram and edge histogram. Experimental analysis was conducted using some medicinal plant species. Example: Mentha, Ruta, Centella, Murraya, Vinca, Leucas, Ocimum, Betle and Hibiscus. The findings indicate that the aforesaid method is a simple and an efficient attempt.

The methodology here gives the identification of medicinal plants based on its edge features. The color image was converted to its corresponding grayscale equivalent image. From this grayscale image, the area of the leaf, color histogram and edge histogram using Canny edge detection algorithm are calculated.

First the images of leaves were obtained. Both the test image and the data base image were converted .intogray scale. The area of the leaf was calculated using pixel count and the difference in area was found. Then the Canny edge detection method was applied and the edge histogram was analysed for both the images. The red plane, blue plane and green plane were extracted from both the test image and the database image. The difference between the color histograms for the test and database image was observed. The average difference in area, edge histogram, and color histogram were found. Least value between the test and database image was the identified leaf.

The accuracy of the algorithm was detected by different leaf images such as Mentha species, Rutachalepensis, Centellaasiatica, Vincarosea, Piper betle, Leucas linifolia, Murrayakoenigii, Ocimum sanctum and Hibiscus rosa. The exceptional case was Tulsi which was wrongly identified as mint and vice-versa. The leaf characteristics vary widely from its tender stage to the mature stage. Therefore, the above algorithm is limited for images of mature leaves of a plant. Moreover, white background was maintained both for the database and test images.

Pattern Recognition Approach

Ananthi et.al [2] designed a way of identification and determination of the type of medicinal leaves is still being done manually and prone to human error. Leaves species is essential since this will improve medicinal species classification efficiency, the recognition approach identifies the shape and texture features of the medicinal leaves. After pre-processing the image data are applied to Neural Network and compared with several trained databases.

Image segmentation is applied to partition an image into meaningful regions with respect to a particular application. The segmentation was based on measurements taken from the image and that might be grey level, colour, texture, depth or motion. An edge based segmentation approach can be used to avoid a bias in the size of the segmented object without using a complex thresholding scheme. Edge-based segmentation is based on the fact that the position of an edge is given by an extreme of the first-order derivative or a zero crossing in the second-order derivative.

In order to smooth the image and to eliminate noise Canny edge detection algorithm was used. Further this helps the image gradient to emphasize regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum using non maximum suppression. The gradient array was further reduced by hysteresis so as to remove streaking and thinning the edges.

An individual leaf extraction computer program was developed based on grayscale, canny detector and Neural Network algorithm. After morphological processing the image data are applied to Neural Network. That should be compared with several leaf data trained in the neural network. The pattern recognition for different kinds of medicinal leaves data's was realized.

Authentication Approach

Vijayashree et. al [3] developed a work to classify and authenticate the medicinal plant materials and herbs widely used for Indian herbal medicinal preparation. The quality and authenticity of these leaves are to be ensured for the preparation of herbal medicines. The medicinal plant leaves were completely screened and then analysed. Finally, it was compared with the database to provide the exact measure of the texture and to which category the leaf belongs. This method is adopted due to the mistaken of lookalike leaves. Using image processing technique the mistaken of look-alike leaves can be authenticated by various parameters of the leaves.

Low level feature, curvature, image motion, shape, aspect ratio, compactness, entropy, skewness were some of the features that was extracted. For the second step initially preprocessing of the image is done.

Reprocessing of the image includes reduction of noise or distortion, image enhancement for better view and image sharpening for detecting the sharp edges of the leaf. The next step is pattern recognition which includes pixelization, linear

filtering, and quantization. A pattern is an arrangement of descriptors. Feature is often used in pattern recognition determines the descriptors. A pattern is of which has the common properties in the family pattern. Since here the leaf is used for authentication discriminant analysis can be used. The leaf varies with its size, length, width, texture and color it is better to go with discriminant analysis for the classic feature selection. One more technique of pattern recognition exists is known as pixelization that incorporates pixel by pixel operation in software. The next and final step is software implementation were the captured features are extracted and compared with the data base and the result is obtained. A database was initiated with 50 leaf samples. More samples were taken into consideration for identifying the parameters to get the exact match with the database. The parameters like aspect ratio, entropy, skewness, krutoksis, edge detection, shape, texture, uniformity, inverse element difference moment, maximum probability, element difference moment, vein features etc are calculated

Initially for the purpose of testing, single leaf was considered. The initial step done here is the preprocessing in which the color image is converted into gray scale, and then the edges are detected for determining the sharp features of the image. Histogram processing is done for better enhancement of the image. Sobel mask is used as it suppresses the noise compression characteristics. In order to form the database a minimum of 50 samples of leaves are to be considered and programmed. By the method of principal component analysis (PCA) the accuracy reached was 89.2% with considering six features of the leaf. Morphological operations are to be performed as it works well on plants for identifying the better continuity of edges. Considering the above facts, using morphological approach the exact shape of the leaf can be determined that will be beneficial for further identification/authentication.

Extracting Features Approach

Sachin et. al.[4] designed a computer based automatic plant identification system. Out of all available organs of plant, leaf is selected to obtain the features of plant. Five geometrical parameters were calculated using digital image processing techniques. On the basis of these geometrical parameters, six basic morphological features were extracted. On the basis of leaf structure, vein feature was extracted as a derived feature.

At the first stage leaf images are obtained using digital scanner. Then the morphological features are extracted which act as input to the classification stage. Recognition accuracy of the algorithm is tested. Accuracy of this algorithm is tested on two different databases and compared. False acceptance ratio and false rejection ratio for both databases is calculated. Total 12 kinds of plants are classified using this algorithm. Dataset consists of 92 images of total 12 plants. This method implements effective algorithm used for plant identification and classification as it is independent of leaf maturity.

Experiments have been done on two types of database. First database contains 32 samples of 6 plants. Second database contains 60 samples of 6 plants. From first database 2 leaf images per plant and from second database 3 leaf images per plant are used to obtain the accuracy of this algorithm. The accuracy obtained for first database is 78.12 % while for second database it is 85%. Some plants get less accuracy due to inter-species similarity and the intra-species variability and also due to the simplicity of algorithm. This method is easy to implement and fast in execution compared to other methods. Accuracy is moderate. Accuracy can be increased by adding more statistical features and using other advanced classifier. But due to this complexity of algorithm will increase and it will slow down the execution speed. So this method gives the optimum solution in between speed of recognition and accuracy.

Stastical Parameters Approach

Pushpa et. al. [5] proposes a simple and efficient methodology for Ayurvedic plant classification using digital image processing and machine vision technology. The three major phases in methodology are pre-processing, feature extraction and classification. Pre-processing is done in order to highlight the relevant features to be used in the methodology as well as to reduce unwanted noise from the input image, which reduces the chance of getting optimal feature values. In feature extraction phase, different morphologic features such as mean, standard deviation, convex hull ratio, isoperimetric quotient, eccentricity and entropy are extracted from the pre-processed leaf image. During the third phase, an innovative approach to categorize ayurvedic plant species was adopted to recognize plant species mainly by calculating the leaf factor of the input leaf by using the extracted feature values. Then it was compared with the trained values that were stored in the database.

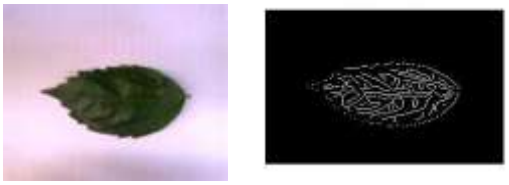
The images of leaves were obtained. The standard deviation and mean of the images were derived. The images were converted into gray scale. Entropy was calculated and the gray scale image was converted into binary image and convex hull was constructed. Then the Eccentricity, Isoperimetric Quotient and Convex hull ratio were calculated. Standard Deviation of convex hull and Leaf Factor were found. Finally, Minimum difference Leaf Factor from database was obtained.

This method was tested using 26 different species to the tune of 208 different sample leaf images and obtained positive response. To identify a medicinal plant there is a need for experienced taxonomists or a trained medicine practitioner. If the above method is utilized, human resources and time required to perform Ayurvedic species recognition can be significantly brought down. Thus this method can be extended to find the defected leaves to increase the accuracy.

IV. OBSERVATION

Sandeep Kumar et. Al [1] has adapted a method to identify medicinal plants depending on its edge features. The color image was converted into its grayscale equivalent image. Based on the grayscale image, the edge histogram was calculated by applying Canny edge detection algorithm [Fig 2 (a) & (b)].

 ISSN: 2454-4248
38 – 42



(a) (b)

Fig 2 (a). Leaf Image (b). Canny Edge Detection

The area of the leaf was calculated. Then the color of the image was extracted in the form of the histogram for the overall image. Then the findings were applied for both the test image and the database image and the difference in area, edge histogram and color histogram were calculated. The average values of these three parameters were obtained. This process was repeated for all the leaf images in the database the difference in the average value parameters between the test and database image were calculated. Based on the difference between the test image and database image pair the least value obtained gives the correct identity of the plant.

Ananthi et.al [2] developed a computer program to extract individual leaf feature based on grayscale, canny detector and Neural Network algorithm. After morphological processing the image data are applied to Neural Network. That should be compared with several leaf data trained in the neural network. The pattern recognition for different kinds of medicinal leaves realised and the recognition rate has been shown in the table 1. [2]

TABLE 1: THE RECOGNITION RATES

	Betel	Hibiscus	Castor	Manathakali
Hibiscus	66.8%	73.87%	69.4%	64.3%
	70.6%	73.4%	66.7%	70.1%
	69.4%	70.75	70.2%	64.2%
	65.5%	74.0%	68.2 %	66.0%
	69.8%	71.1%	67.7%	69.6%
	68.1%	66.4%	69.5 %	64.7%
	71.5%	71.15	74.2 %	67.7%
	69.8%	67.2%	64.3 %	70.4%
	74.5%	71.9%	71.1%	64.3%
	69.1%	69.1%	66.0%	69.9%
Total%	65.5%	70.87%	64.78%	68.57%

Vijayashree et. al [3] identified a methodology that the leaf [Fig 4]was classified and fed in to software which retrieves the related information about the leaf. For detecting the edge of the leaf 'Sobel' edge detection has been shown in Fig 3 (a) & (b). The advantage of sobel mask leads to better noise suppression characteristics. By the method of principal component analysis (PCA) the accuracy reached was 89.2% with considering six features of the leaf.

(a) (b)

Fig 3(a) Leaf Image (b) Sobel Edge Detection

Sachin et. al [4] introduced statistical method approach for plant identification. Five geometrical parameters (Length, width, diameter, Area and perimeter) of each leaf image were calculated. Using these geometrical parameters six basic features (Aspect ratio Form factor, Rectangularity, Narrow factor, Perimeter ratio of diameter, Perimeter ratio of length and width) is obtained. One derived feature which is vein feature is extracted. Euclidean classifier was used to classify the leaf images. Advantage of using Euclidean classifier is that it is fast and easy to implement. Experiments were done on two types of database and the accuracy obtained for first database is 78.12 % while for second database it is 85%.

Pushpa et. al. [5] developed a leaf recognition that was carried out through image processing techniques. The leaf image of a particular plant is fed into the system and the system will pre-process the image in order to reduce the noise present in it and to obtain gray scale, binary image and edge for future extraction. In the feature extraction phase, arithmetic mean on colour image, standard deviation on colour as well as convex hull of the leaf in the image, Entropy on gray scale image, convex hull ratio, isoperimetric quotient and eccentricity were calculated.

After the feature extraction phase, Laplacian filtering is applied for edge detection. Then the leaf factor of the particular leaf was calculated on eight different samples of that plant type and the average leaf factor was calculated which is unique for a particular leaf type and its value was stored in the database. When a new leaf is fed into the system for recognition, the leaf factor of that particular leaf is calculated and it is compared with the leaf factor which is stored in the database and the most matching leaf is returned as the output. This technique yield 93.7% of accuracy.

V. CONCLUSION

This survey paper focuses on various existing automated systems for plant classification and recognition. Recognition is a method designed for the assignment of every individual leaf image to its respective plants with regard to their regular traits. In computer vision, computer-aided plant recognition is still a testing errand because of deficiency of appropriate procedures or representation plans. An efficient feature extraction

 ISSN: 2454-4248
38 – 42

algorithm along with a robust classifier is required for achieving a good recognition rate.

In this paper various techniques for leaf identification have studied and explained. The study shows that the research for identification of medicinal plant is done mainly in image processing domain. Among all the five papers Pushpa et. al [5] gives the maximum accuracy in identifying the medicinal plants. Our future work will be focusing on an efficient algorithm for segmentation and recognition of herbal plant leaves.

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