LEAF COLOR, AREA AND EDGE FEATURES BASED APPROACH FOR IDENTIFICATION OF INDIAN MEDICINAL PLANTS

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Abstract

This paper presents a method for identification of medicinal plants based on some important features extracted from its leaf images. Medicinal plants are the essential aspects of ayurvedic system of medicine. The leaf extracts of many medicinal plants can cure various diseases and have become alternate for allopathic medicinal system now a days. Hence 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 with few medicinal plant species such as Hibiscus, Betle, Ocimum, Leucas, Vinca, Murraya, Centella, Ruta and Mentha. The result proves this method to be a simple and an efficient attempt.

Keywords— Medicinal plants; edge histogram; leaf area; ayurvedic medicinal system; allopathic medicinal system; color histogram.

1. Introduction

Medicinal plants form the backbone of a system of medicine called ayurveda and is useful in the treatment of certain chronic diseases. Ayurveda is considered a form of alternative to allopathic medicine in the world. This system of medicine has a rich history. Ancient epigraphic literature speaks of its strength. Ayurveda certainly brings substantial revenue to India by foreign exchange through export of ayurvedic medicines, because of many countries inclining towards this system of medicine. There is Considerable depletion in the population of certain species of medicinal plants. Hence we need to grow more of these plant species in India. This rejuvenation work requires easy recognition of medicinal plants. It is necessary to make people realize the importance of medicinal plants before their extinction. It is important for ayurveda practioners and also traditional botanists to know how to identify the medicinal plants through computers. The external features of plants are helpful in their identification. Hence here is a proposal of identification of these plants using leaf edge histogram, color histogram and leaf area.

2. Related work

Many researchers have made an attempt for plant identification. Where an approach identifies the plant based on plant image color histogram, edge features and its texture information. They also classify the plants as trees, shrubs and herbs using neural networks [1]. But this proposed paper work makes a simple approach by just considering leaf details without many complications. Lot of researchers has proposed many methods for finding out the area of the leaf in an image. Out of this my work uses a simple and a robust area calculation by using another object as reference [6]. Out of many edge detection techniques, this proposed work uses Canny edge detection algorithm [2] which extracts the boundary pattern and also the vein pattern successfully.

Hence this paper extracts maximum information possible from a leaf for the successful identification of the plant.

3. Proposed Methodology

3.1 *Image Acquisition*

The images of leaves of medicinal plants were obtained from a 5 mega pixel camera and it was resized later as per our requirement. The distance between camera and the leaf was maintained to be 15cms and the image was taken from the top view. All the images were taken in natural day light with white background.

3.2 *Image samples*

The samples were taken from few species of plants namely Hibiscus, Betle, Ocimum, Leucas, Vinca, Murraya, Centella Ruta and Mentha. The sample images are shown in figure 1.

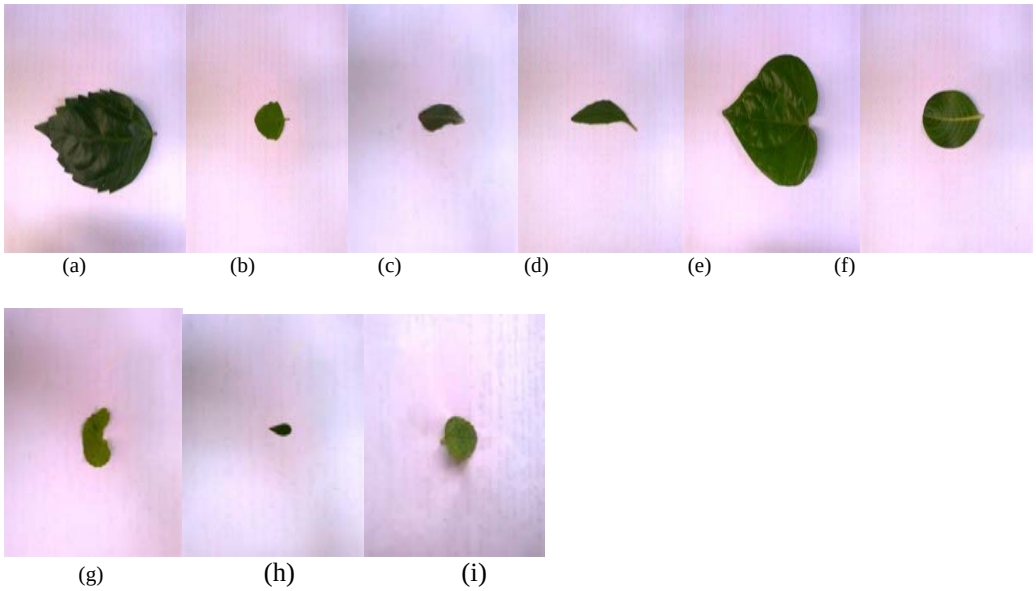

Figure 1: Leaf images of medicinal plants (a) Hibiscus rosa (b)Ocimum sanctum (Tulsi) (c) Murraya koenigii (Curry leaves) (d) Leucas linifolia (e) Piper betle (f) Vinca rosea (g) Centella asiatica (h) Ruta chalepensis (i) Mentha (Mint).

3.3 *Devised methodology*

The methodology here gives the identification of medicinal plants based on its edge features. The color image is converted to its grayscale equivalent image. From this grayscale image, calculate the edge histogram. Apply Canny edge detection algorithm for this purpose.

The next information i.e., the area is calculated by the proposed algorithm. The next information is the color of the image which is extracted in the form of the histogram for the overall image. These algorithms are applied for the test image and the database image and difference in area, edge histogram and color histogram is calculated. Obtain the average value of these three parameters. Repeat this process for all the leaf images in the database and calculate the difference in the average value parameter between the test and database image. The test image and database image pair which gives the least values is the correctly identified image in turn the plant. The system block diagram is shown in figure-2.

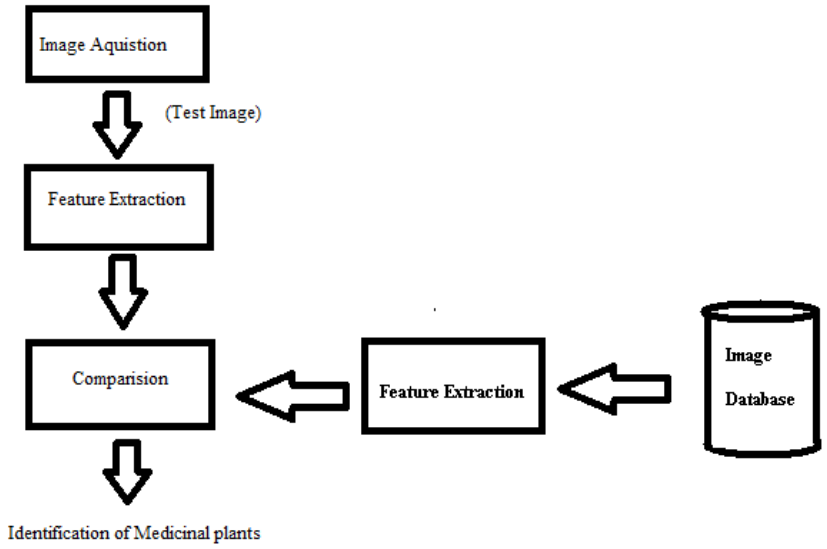

Figure-2: system block diagram

4. Feature Extraction

4.1 *Area of Leaf*

In this process, the area of coin is taken as the reference. Adjust the distance between the camera and the coin (nominal distance) and capture an image. Specifically one rupee coin is chosen as reference whose area is:
Area of coin= π (d/2) $^{2;}$ where'd' is diameter of the coin.
$= \pi$ (2.5 cm/2) ^{2}
$= 4.9063\ cm^2$

Convert this color image of coin to its grayscale and hence to its binary equivalent image. Calculate number of pixels occupying the vicinity of the coin. Suppose the pixel count of the coin from the image is 148 then:
1 pixel value= area of coin/pixel count
$= 4.9063/148$
$= 0.03315\ cm^2$

Consider the leaf case. Maintain the same nominal distance as for the case of coin. Convert the color image to its grayscale equivalent. Hence convert to binary and calculate the number of pixels occupying the area of the leaf. Suppose for leaf, the pixel count of the area is 3724 pixels, then:
Area of leaf= pixel count* 1 pixel value
$= 3724*0.03315$
$= 123.4506\ cm^2$

Algorithm:

Step 1: start
Step 2: acquire the leaf image
Step 3: convert color image to grayscale
Step 4: convert grayscale to binary
Step 5: count number of pixels in the leaf vicinity
Step 6: multiply pixel count with one pixel value
Step 7: compare with database image
Step 8: stop

4.2 *Edge histogram*

Every leaf is having its own edge features. Some leaf boundaries are saw tooth, some are smooth and some are wavy so on. Also midrib alignment and vein pattern of leaves are different. Hence this algorithm is used to extract this information. Here Canny edge detection algorithm is used.

Algorithm:

Step 1: start
Step 2: acquire the leaf image
Step 3: convert color image to grayscale
Step 4: apply Canny edge detection algorithm
Step 5: calculate histogram
Step 6: compare with edge histogram of the database image
Step 7: stop

4.3 *Color Histogram*

Every leaf is having its own color with varying intensity. Some are green; some are yellow, red so on. Even though we consider green colored leaf its intensity will be different. Hence this part of algorithm extracts this information from an input leaf as shown in figure 4.

Algorithm:

Step 1: start
Step 2: acquire the leaf image
Step 3: calculate the green histogram, blue histogram and red histogram separately of the image.
Step 4: calculate the difference with the database image
Step 5: stop

4.4 *System Algorithm*

Step 1: Read test image and database image.
Step 2: Resize the images
Step 3: Crop region of interest in both images.
Step 4: Convert both images into grayscale.
Step 5: Convert image to black and white respectively.
Step 6: Count the number of pixels i.e., in the vicinity of the area covered by the leaf respectively.
Step 7: Calculate the area of both images and find the difference in area.
Step 8: Apply the Canny edge detection method to the leaf grayscale images.
Step 9: Remove the background edges keeping only leaf edge details.
Step 10: Calculate the edge histogram of both the images.
Step 11: Calculate the difference in the edge histograms of both the images.
Step 12: Extract the red plane, blue plane and green plane from the un-cropped test image.
Step 13: Calculate red histogram, blue histogram and green histogram separately.
Step 14: Repeat Step 12 and Step 13 for the image in database.
Step 15: Find the difference in color histograms for the test and database image. Let this be value "**OVERALL**".
Step 16: Find the average of difference in area, difference in edge histogram and difference in the color histogram values.
Step 17: Repeat Step 1 to Step 15 for all the images in the database.
Step 18: Least value of "**OVERALL**" between the test and database image is the identified leaf.
Step 19: Stop.
The coin image used for calculating the leaf area and the example leaf image with its edge image is shown in figure 3 and color histogram extracted is shown in the figure 4.

(a) (b) (c)

Figure 3: (a) Coin image used as reference (b) Hibiscus leaf image (c) Edge image of Hibiscus leaf

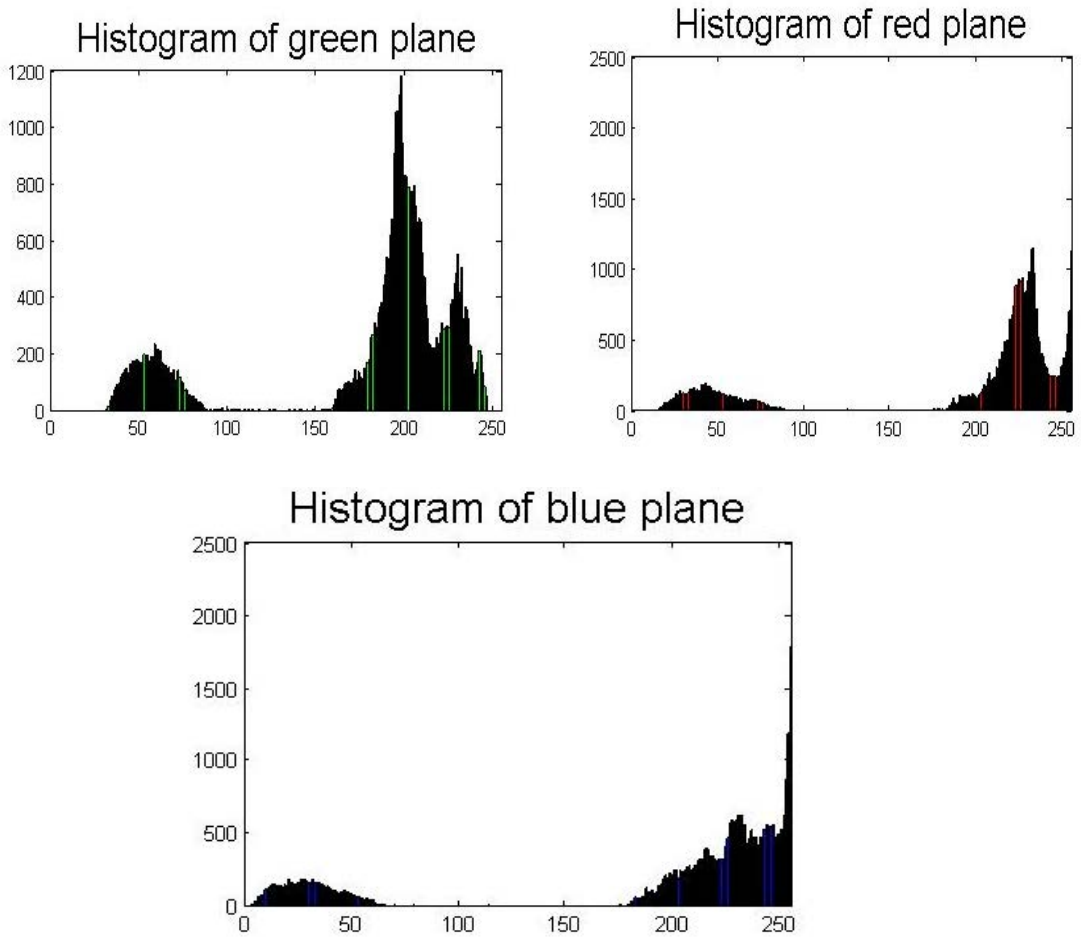

Figure 4: Green, Red and Blue Histograms of the Hibiscus leaf.

5. Results and Discussions

The accuracy of the proposed algorithm is tested by different leaf images like Hibiscus rosa, Ocimum sanctum, Murraya koenigii, Leucas linifolia, Piper betle, Vinca rosea, Centella asiatica, Ruta chalepensis and Mentha. With a group of samples of all these leaves kept in the database, following were the results obtained with test image input. The entire algorithm was implemented and tested using MATLAB 7.0.

Test leaf image	Data base leaf image	"OVERALL"
Hibiscus	**Hibiscus**	**0.0263**
	Betle	0.0523
	Ocimum	0.5374
	Murraya	0.5953
	Leucas	0.5264
	Vinca	0.4430
	Ruta	0.6503
	Centella	0.5649

	Mentha	0.5505
Betle	**Betle**	**0.0018**
	Hibiscus	0.0523
	Ocimum	0.5894
	Murraya	0.6455
	Leucas	0.5766
	Vinca	0.4934
	Ruta	0.7007
	Centella	0.6158
	Mentha	0.6041
Ocimum	Ocimum	0.0251
	Betle	0.5895
	Hibiscus	0.5381
	Murraya	0.0602
	Leucas	0.0298
	Vinca	0.0976
	Ruta	0.1156
	Centella	0.0287
	Mentha	**0.0145**
Murraya	**Murraya**	**0.0052**
	Betle	0.6458
	Ocimum	0.0603
	Hibiscus	0.5951
	Leucas	0.0867
	Vinca	0.1544
	Ruta	0.0568
	Centella	0.0320
	Mentha	0.0443
Leucas	**Leucas**	**0.0078**
	Betle	0.5765
	Ocimum	0.0285
	Murraya	0.0867
	Hibiscus	0.5266
	Vinca	0.0872
	Ruta	0.1403
	Centella	0.0588
	Mentha	0.0391
Vinca	**Vinca**	**0.0333**
	Betle	0.4934
	Ocimum	0.0976
	Murraya	0.1544
	Leucas	0.0872
	Hibiscus	0.4430
	Ruta	0.2090
	Centella	0.1236
	Mentha	0.1086
Ruta	**Ruta**	**0.0022**
	Betle	0.7014
	Ocimum	0.1168
	Murraya	0.0569
	Leucas	0.1404
	Vinca	0.2090
	Hibiscus	06505
	Centella	0.0877
	Mentha	0.1022
Centella	**Centella**	**0.0018**
	Betle	0.6160
	Ocimum	0.0287
	Murraya	0.0322
	Leucas	0.0588

	Vinca	0.1236
	Ruta	0.0873
	Hibiscus	0.5649
	Mentha	0.0158
Mentha	Mentha	0.0605
	Hibiscus	0.5491
	Betle	0.6040
	Ocimum	**0.0145**
	Murraya	0.0443
	Leucas	0.0391
	Vinca	0.1086
	Ruta	0.0996
	Centella	0.0173

Table 1: comparison of the result obtained

Statistics above show that the proposed methodology for identification of medicinal plants proven to be a successful method. In table 1 that when the test image and the database images are the same then the value of OVERALL variable is less compared to rest of the images in the database. The Exceptional case was Tulsi which was wrongly identified as mint and vice-versa. If we consider still more different types of samples this problem can also be overcome. Here cropping of the image was done to avoid the influence of varying intensity of sunlight on the background of the leaf image. To overcome this separate artificial environment can be set up; since in that case the intensity remains constant we can subtract the background from the image, but background subtraction cannot be applied for the image captured in natural light.

Hence having a leaf image, one can program a computer for the automatic identification of the plant by extracting its leaf area information, color histogram and edge histogram information.

6. Conclusion

The leaf characteristics vary widely from its tender stage to the mature stage. Hence this proposed algorithm is restricted for images of mature leaves of a plant. Also here white background is maintained both for the database and test images. With this constraint system achieved better accuracy.

Thus we can implement image processing technique for identification of Indian medicinal plants with less human induced errors.

Acknowledgements

I am thankful to the Principal, JNN college of Engineering and all staff members of Department of Telecommunication Engineering, JNN college of Engineering. Especially Mrs. Veena K.N, Asst. Professor, Dept. of Telecommunication Engineering for her valuable guidelines in preparing this paper. I am thankful to Mr. Pawan Kumar M.P, Lecturer, Dept. of Information Science & Engineering, JNN college of Engineering, Shimoga, who has supported me through out this work. My heart full thanks for Mr. Chethan K.R., Asst. Professor, Department of Computer science & Engineering, JNN college of Engineering, for his suggestions in making this paper a success.

Also I am thankful to my family members for their support and cooperation without whom this work would be incomplete.

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