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Plant's Leaf Identification using Normalized Radial Distance Transform and Support Vector Machine

Richa Sharma [1]
[1] Student, M. Tech. (ECE)
Ramgarhia Institute of Engineering and Technology,
Phagwara, Punjab (India)

Sukhwinder Kaur [2]
[2] Assistant Professor (ECE),
Ramgarhia Institute of Engineering and Technology,
Phagwara, Punjab (India)

Abstract:- **Plants are backbone of life on earth. Plant recognition is very demanding in agriculture for the management of huge number of plants species as well as for medicinal purposes. Now-a-days, many plant species are at the risk of extinction. A computerized automatic identification system should be developed to protect plant species, to use their medicinal properties and utilization as bio-fuel Automatic plant classification systems are essential for a wide range of applications including environment protection, plant resource survey, as well as for education purposes. This paper proposes a method of plant's identification based on analyzing the leaf patterns of plant species using normalized radial distance transform by extracting radial, shape, color, texture features. In this case, Support Vector Machine (SVM) classifier is used to classify the plants based on the extracted features. The experimental results show the average accuracy of 98% when tested on various leaf patterns.**

Keywords: Radial Transform, GLCM, Color Moments, Image Segmentation, SVM Classifier, Texture Features, Statistical Features, Centre of Mass, GLCM

1. INTRODUCTION

The leaf pattern analysis may be divided into two categories: visible range imaging and infra-red imaging. Visible range image processing includes the image processing operations like image de-nosing, enhancing and feature extraction. However, infra-red imaging involves the internal leaf structure and relates with the biological analysis of the leaf. However, the infrared imaging takes the off-line analysis as the leaf has to be analysed in controlled environment so as to undergo infrared imaging. Pattern recognition is the most potential domain in image processing and analysis research area. With each day exploration in pattern recognition, new possibilities of enabling the computer to look at and recognize are coming out; of course with application areas as well. The ultimate goal is to make machine so smart that they can see with logic at par with human. The image patterns are very well distinguished by their boundaries and therefore boundaries related features are used for feature vector for pattern recognition. It's but natural fact that human's approach in identifying or recognizing a pattern is a parallel process. Millions of neurons are stimulated in parallel when brain correlates a pattern to its possible class. The parallel approach of neuron's working gives strength to brain to quickly arrive at the suitable decision. When imparting pattern recognition algorithm to a machine vision system. Leaves contribute major role in food production in plants and therefore are termed as power house for plants. Respecting the same legacy, a leaf's pattern may lead to identify its source plant, manually and in automated manner. It becomes important to correlate leaves with respective plants to know the herb class. Automated collection of herbal leaves in forest may be achieved by using of plucking machine embedded with the leaves identification algorithm. The algorithm may be designed using the leaf's color feature, shape/morphological features and texture features etc. The presented work primarily emphases on radial features that are computed from the binary version of the plant's leaf.

Statistical analysis of radial features using standard deviation is used to correlate the leaf with the respective plant.

The proposed feature vector transform for patterns is an ideal case for image compression, where the given input image may be transformed into its feature vector and decompressed using inverse transform. The vectored feature transform is extremely useful in pattern recovery as well. A pattern can be save in form of its features rather than its pixel information in the form of an image that take the (row x column) number of bytes space in system memory.

2. RELATED WORKS

S. Bae Cho et al. stated that the hand written characters are also a class of patterns and can be identified using feature vector set. The feature vector set is unique for each of the hand written or typed fonts. [1]

Y. Abbas Alsultanny et al. proposed a hybrid approach between genetic algorithm and neural network was suggested here to classify the patterns into different class. The system consists of pattern segmentation, feature extraction and a classifier. [2]

R.C. Mureşan et al. suggested a pulse coded neural network (PCNN) for pattern classifier using different features when normalized with respect to pattern mean radius. Feature normalization was performed to range the features between 0 and 1. Further, the error analysis in pattern recovery was done on the basis of statistical parameters like standard deviation and variance. [3]

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B.S. Manjunathi et al. used Gabor wavelet features for input image texture classification and analysis that provided a comprehensive experimental evaluation. Based on textural properties, the patterns were classified into different classes using the minimum Euclidean distance. [4].

N.V. Boulgouris et al. presented a gait representation and recognition system with new feature extraction. Randon transform was taken as the basis for feature set generation. [5]

J. Hornegger et al. presented appearance-based approach for object recognition and pose estimation. non-linear image-to-image transform that is composed of linear mappings in order to reduce the feature vector size. [6]

D. Mudoi et al. suggested Histogram of oriented gradients (HOG) in classification of vehicles on road. Vehicle tracking system is designed around the features analysis based on HOG. The classifier is designed based on Support Vector Machine (SVM). [7]

Yu-Yao Wang et al. proposed a novel method was proposed for face recognition. Its basic idea was to use a coarse to fine strategy based on Scale Invariant Feature Transform (SIFT) feature. Extensive experiments on different public face databases confirm that our method obtains high recognition accuracy and has a good robustness. [8]

G. Savita et al. suggested a framework composed of HSV color histogram as a color feature, BDIP and BVLC texture feature for the image retrieval. The precision and recall value obtained from the proposed system showed significant improvements in image retrieval accuracy. [9]

Andre et al. proposed the recognition and retrieval of human gait profile using radius based features. As the human action may be clicked by just seeing the initial action or hand movement, therefore, they used a low profile features in order to get the estimate of hand gesture. [10]

3. SCOPE OF THE PROPOSED WORK

The proposed work finds application in plants identification based on their leaves analysis using image processing techniques. The presented algorithm is scalable i.e. the no. of plant's categories may be enhanced or added up for new varieties classification. However, during scaling up of the algorithm, the data base for leaves features should be enriched for proper classification and algorithm working. The new plant's class may be from herbs, wild plants or flowers etc.

4. ALGORITHM

The radial features are divided into radial coordinates from CoM to contour of the pattern, Sorted radii in descending order from CoM to contour of the pattern along with respective radial coordinates, Minimum radii in each quadrant, Maximum radii in each quadrant, Mean Radius, Variance of Radii, Standard Deviation of Radii, Perimeter and Area. Fig. 1 shows the radial transform.

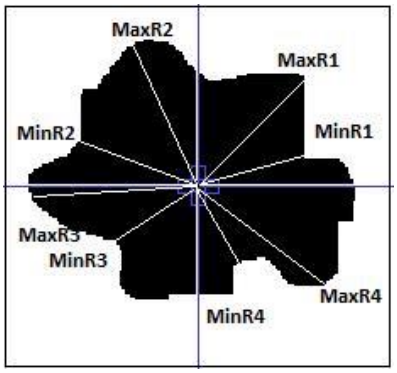


Fig. 1: Radial Profile around CoM

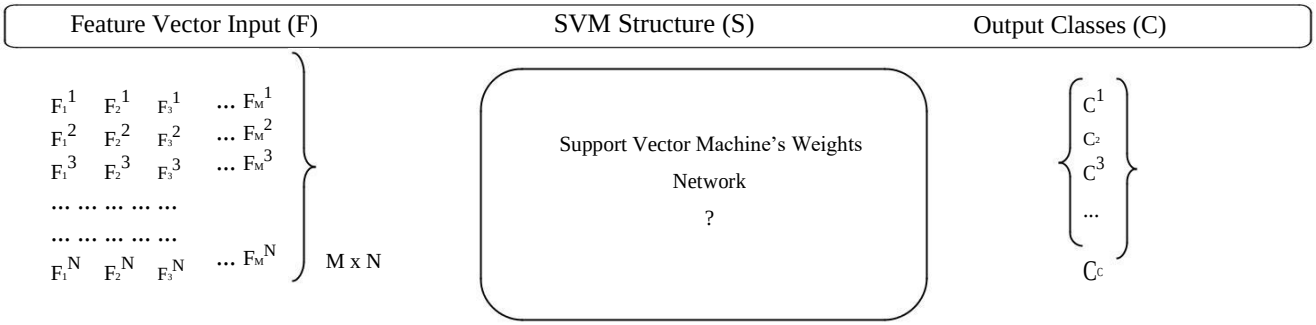
Further, the color moments and texture features are computed from RGB and gray images respectively. Texture features are computed using the GLCM matrix of the original image. For radial features, the leaf image is thresholded using the Otsu algorithm in orser to get the binary image i.e. monochrome image. Computation of radii from CoM in real order means that the radii are arranged and stored in the respective quadrants. If all the radii are plotted from CoM, the complete envelop of the pattern may be recovered. The algorithm implementation includes a subroutine that is called from the main program in order to compute the features.

5. SVM Training

SVM is trained using the known samples of leaf patterns in order to compute the weights of the SVM structure. In the training phase, input leaf feature vector and their respective class is know and weights network is unknown. Therefore, by training, the weight network is computed.

Support vector machine classifier is employed to classify the leaf patterns into their respective classes. The SVM structure is given below:

No. Leaves Classes = 10
No. of leaves in each class (C)= 5 No. of
Leaf patterns/samples (N) = 50
No. of test samples = 3 from each class
Total Features per leaf pattern (M) = 23
Output Classes (C)



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6. RESULTS AND DISCUSSION

The results in table-2 below are extracted using the algorithm developed in matlab for different plants leaves as discussed in table-1.

Table-1: Plant's Class and respective samples

Class No.	Class Name
1	Ficus religiosa (Peepal)
2	Azadirachta indica (Neem)
3	Ocimum tenuiflorum (Tulsi)
4	Ficus elastica (Rubber)
5	Mangifera indica (Mango)
6	Citrus limon
7	Saraca asoca
8	Ficus benghalensis
9	Murraya koenigii
10	Lactuca sativa

Table-3 shows the results of the SVM classifier when the features in table-2 are made input to the classifier.

may be compromised as the edge based features depend primarily upon the leaf size i.e. its perimeter.

Table-3: SVM Classification of Leaf Patterns

S. No.	No. of Image Samples	Expected Class	Correct No. of Images	Incorrect Images	% Accuracy
1	5	1	5	0	100
2	5	2	5	0	100
3	5	3	5	0	100
4	5	4	5	0	100
5	5	5	5	0	100
6	5	6	5	0	100
7	5	7	5	0	100
8	5	8	5	0	100
9	5	9	5	0	100
10	5	10	4	1	80
				Average Accuracy	98%

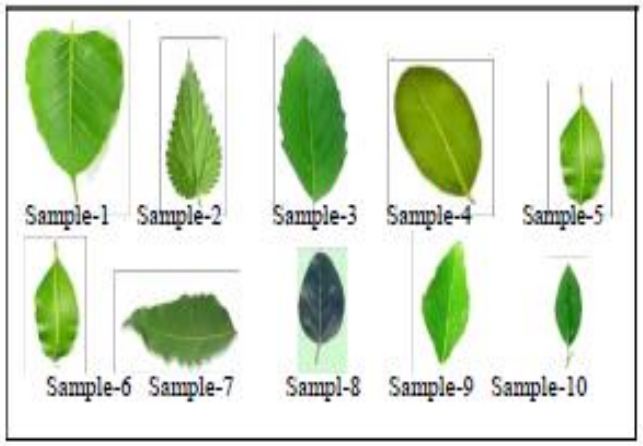

Table-2: Mean - Radial Features for Figures-2 to 11

S. No.	Feature	Samp-1	Samp-2	Samp-3	Samp-4	Samp-5	Samp-6	Samp-7	Samp-8	Samp-9	Samp-10
1	Min. R1	0.78	0.463	0.658	0.727	0.657	0.663	0.433	0.441	0.635	0.447
2	Min. R2	0.812	0.505	0.678	0.763	0.678	0.691	0.453	0.755	0.687	0.535
3	Min. R3	0.831	0.569	0.708	0.816	0.727	0.711	0.508	0.775	0.711	0.636
4	Min. R4	0.862	0.655	0.783	0.896	0.777	0.742	0.522	0.785	0.779	0.734
5	Max. R1	1.039	0.743	1.106	0.967	1.175	1.047	1.092	1.285	1.043	1.069
6	Max. R2	1.075	0.896	1.156	1.027	1.247	1.081	1.201	1.356	1.101	1.184
7	Max. R3	1.156	1.422	1.376	1.249	1.328	1.394	1.538	1.434	1.38	1.318
8	Max. R4	1.522	1.879	1.505	1.428	1.556	1.64	1.916	1.587	1.543	1.599
9	Intercept X1	0.836	0.532	0.707	0.8	0.681	0.706	0.479	0.444	0.685	0.839
10	Intercept X2	0.87	0.603	0.761	0.872	0.769	0.731	0.51	0.785	0.779	0.946
11	Intercept Y1	0.916	0.776	1.118	0.974	1.164	1.055	1.13	1.258	1.05	1.032
12	Intercept Y2	1.143	0.954	1.206	1.048	1.292	1.138	1.282	1.376	1.135	1.118

The leaves features as discussed above attributes the plant a unique identity as the accuracy in identifying the plant under test observe to be at fair accuracy level. This may further be enhanced if more features from other domain like edge or boundary moments are included. Also, as the edge moments are included, the algo speed

There may be a trade-off between the accuracy and speed of the algorithm when increasing the no. of features to enhance the accuracy level. The decision should be governed by the application where the accuracy level is adjustable.

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7. CONCLUSION

The radial features of plants leaves are shown in table-2 and are extracted for at least five samples in each category, A SVM classifier is trained using the training samples and tested using test sample. The accuracy in identifying the plants based on their leaf patterns and in turn radial features found to be up to 98%. The accuracy can further be enhanced if large no. of training samples are used for training in order to cover more variations in each class.

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