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A Review: Plant's Leaf Analysis based on Normalized Features Set using Image Processing

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Abstract: ***Leaf image patterns are the primary characteristics of a plant under the respective category. Pattern image features can be mapped to the respective plant category when made input to a SVM or ANN classifier. Pattern image features in different domains including radial, color, texture, morphological, statistical and ratio domains are extracted out. Image pattern features normalization with respect to size and rotation is an important aspect when made input to classifier. Mean radius is used to normalize the image features with respect to size. Largest chord of the leaf image is approximated to its mid rib, and, rotation aspect is covered by orienting the leaf image with respect to the largest chord i.e. mid rib. Computation of features like radii, area, perimeter and standard deviations in different quadrants contributes fair resolution at close level. Support vector machine classifier categorizes the features set into respective plant's class to an equal degree of high accuracy.***

Keywords: Image Segmentation, SVM Classifier, Texture Features, Statistical Features

1. Introduction

Image texture, defined as a function of the spatial variation in pixel intensities (gray values), is useful in a variety of applications and has been a subject of intense study by many researchers. Texture is the most important visual cue in identifying the types of homogeneous regions. This is called texture classification. The goal of texture classification then is to produce a classification map of the input image where each uniform textured region is identified with the texture class it belongs to. We could also find the texture boundaries even if we could not classify these textured surfaces. This is then the second type of problem that texture analysis research attempts to solve texture segmentation.

The goal of texture segmentation is to obtain the boundary map. Texture synthesis is often used for image compression applications. It is also important in computer graphics where the goal is to render object surfaces which are as realistic looking as possible. The goal is to extract three-dimensional shape information from various cues such as shading, stereo, and texture.

2. Related Works

Du, S. P. et. al. presented a model for solid figures extraction using the texture features by generating the grey level co-occurrence matrix from the grey image of the solid figures. High quality structures were recovered using the feature set. [1]

Hu, R et. al. proposed a multi-scale distance matrix using the novel contour-based shape descriptor. It captured the shape geometry that was invariant to translation, rotation, scaling, and bilateral symmetry. [2]

Fu, H. et. al. proposed a model for leaf patterns to correlate with their plant class. Segmentation of leaf from plants is presented here using different segmentation techniques. An artificial neural network (ANN) is discussed in length based on features. [3]

Barbedo J. discussed the plant's leaf analysis in geometric features domain and correlated the disease arising out in plants. The symptoms in plant were associated with geometric features in order to classify the plants with healthy condition and infected plants. [4]

Salve, P. et. al. presented the plant's leaf pattern based classification of plants using the shape, structure and texture features. The plant's class was correlated with the feature vector set as generated using the texture and shape model. [5]

V. Arulmoz et al. discussed the use of matlab neural tool box for pattern analysis in detail. Different patterns may be generated using the simple GUI and trained using the NN training provision. The same may be tested using the test option. [6]

G. Ou et al. presented neural network approach for multi class pattern. The neural network training features are extracted from the pattern after few image pre-processing operations applied on the pattern. The features are extracted from the binary image resulted out of threshold operation. [7]

A. Mirzaaghazadeh et al. proposed a gradient based neural network training using the pattern feature vector set. More are the features of a pattern, higher is the resolution at the output or more classes can be resolved. [8]

A.K. Jain et al. presented a review of pattern analysis using statistical analysis. The pattern was analyzed in different domains like spatial, frequency and wavelet domain for pattern recognition accuracy determination. [9]

A. Hassan et al. discussed statistical processing chart for pattern analysis. Patterns were represented by their normalized features. A feature vector set is generated using different radii around centre of mass. [10]

3. Leaf Structure

Plant's biodiversity is huge area to investigate and leaves are their characteristics identity. Plant's health and in turn of respective produce may be well judged by doing the leaf analysis. Further, 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.

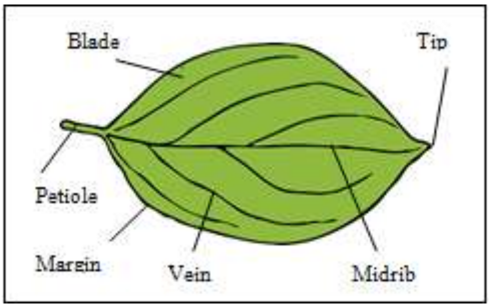

Figure 1: Basic Leaf Structure

4. Existing Techniques

Many feature extraction algorithms exist that give a feature vector sufficiently rich in parameters to identify the respective pattern among different classes of the patterns. The uniqueness of the feature vector s appreciable and the accuracy of the pattern recognition/identification can be tested by increasing the test data base of pattern. However, to what degree the feature vector is unique, the inverse is not true i.e., a pattern cannot be recovered back from its respective feature vector.

The feature transform like discrete cosine transform, wavelet transform or fast Fourier transform are rich in coefficients. But they are introvert in nature for a given pattern. However, if the feature vector consists of features from different domain, the degree of pattern recoverability/activeness from its feature vector improves. This proves to be of prime concern when working on content based image retrieval system using the features as the query vector. Following techniques are used in pattern features extraction and analysis in digital image processing:

- Edge/boundary based feature set
- Color moments based features
- Textural features using gray level co-occurrence matrix (GLCM)
- Wavelet transform based features
- Frequency Domain Features (FFT)

5. Features Uniqueness

Feature extraction and association of the same with respective pattern class is classical approach in pattern identification. In classical approach, the feature vector set is perfectly extracted using different algorithm either in spatial or frequency domain. More is the feature vector rich in parameters; better resolution is achieved in pattern classification.

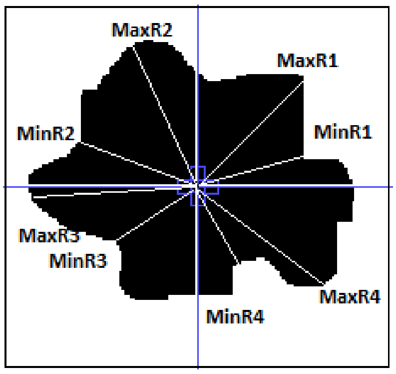

Figure 2: Radial Features of a Pattern

Extraction of a unique feature vector for a pattern is always a challenging research area in image processing ever. Pattern extraction in image processing is globally falls under the image mining category of research. Human brain's capability in parallel processing is beyond expectation in terms of speed and accuracy when compared with computer, but lacks in repetitive task when exposed to prolonged duration. This is why the humans can interpret an image in few seconds while a computer algorithm may have to work a lot for the same task. Table-1 describes the plant's class and respective samples for testing of the radial feature extraction algorithm.

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

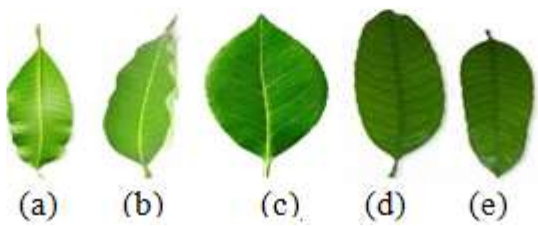

Figure 3: Leaf Images in RGB Color Format

6. Conclusion

The leaf pattern analysis using the existing techniques as discussed above suffers with the limitations of normalization of features with respect to size, location and orientation. In the proposed radial profile based features, the features are normalized with respect to size using mean radius, location using the centre of mass and orientation using the orthogonal transformation of coordinates. Using these normalization schemes, the feature set becomes unique for a given pattern and thereby increasing the accuracy in identifying the respective leaf pattern.

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