Plants Recognition using Leaf Image Pattern Analysis

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Abstract:
The features including shape and color profile can be covered up in image processing while evaluating a pattern under test. In image processing, a pattern is transformed from its shape to feature vector. Feature vector may include its perimeter, color profile, radii, area, edge features, moments and key points on pattern etc. While working or extracting features of a pattern, it is very much required that the features are invariant with respect to its size, orientation and location. Size invariance can be achieved via centre of mass of the pattern. Orientation invariance is obtained by using orthogonal transformation of features And size invariency is achieved using the mean radius of the pattern under test. In the existing techniques of pattern recognition, the features are dependent upon size, orientation and location. Therefore, a pattern recognition system lacks the faithfulness and repeatability for the same pattern if are resized or oriented at different angles. This issue of feature normalization has been taken care of by normalizing the features using different techniques. Size normalization is achieved by using mean radius.

Keywords: Image Segmentation, Support Vector Machine Classifier, Textural Features, Statistical Variances and Features

1. Introduction

Pattern recognition is an important activity in image processing applications. Patterns may be from different class/category like mechanical assemblies, alphabets, numerals, traffic signs and plant's leaves. Each class of patterns bear some common properties based on its appearance, shape, color profile and other features. The features including shape and color profile can be covered up in image processing while evaluating a pattern under test. In image processing, a pattern is transformed from its shape to feature vector. Feature vector may include its perimeter, color profile, radii, area, edge features, moments and key points on pattern etc.

Features vector is a set of features ($\mathbf{x} \in X$) extracted from the pattern. With the help of feature vector, a pattern may be defined as a point in feature space. While working or extracting features of a pattern, it is very much required that the features are invariant with respect to its size, orientation and location. Size invariance can be achieved via centre of mass of the pattern. Orientation invariance is obtained by using orthogonal transformation of features. And size invariency is achieved using the mean radius

of the pattern under test. Using the weighted score of unknown input pattern with trained set of parameters, the decision is deduced.
A RGB image stands for red, green and blue color combination image and hence is also termed as True colour. The true color images consists of all possible color combination from red, green and blue color channel. RGB image formats carries image information in form of pixels with color values from 0 to 2^{24}.. Where 0 represents the black and 2^{24} represents the white color and in between all colors in combination of red, green and blue color tones. As being only 24 bit color information, the RGB image format has 24 bit color resolution. RGB color combination image ranges in color from 0 to 255 in each color channel i.e. red, green and blue and their all possible combinations i.e. 256x256x256 = 2^8* 2^8*2^8 = 2^{24} = 16,777,216 possible no. of colors.

There are many different transform in either of spatial and frequency domains. Hough transform and distance transform falls under the spatial domain while wavelet, Fourier and discrete cosine transform cover the frequency domain. The Hough transform analyse the given pattern using the polar coordinates in terms of (r, θ). The distance transform uses the Euclidean distance for pattern classification. The frequency domain transform includes wavelet; Fourier and discrete cosine transform where the number of coefficients is high and varies according to image information/entropy.

2. Related Works

Plants leaf image pattern analysis has been in research for a long in past. It is very much demanded application for horticulturist that helps in identifying plants based on their leaf pattern.

Du S. P. et al emphasises on textural feature based pattern recognition system. texture feature includes contrast, entropy, homogeneity and correlation. [1]

Hu R et al highlights on multi-scale distance matrix that are based on the novel contour-based shape and feature descriptor. [2]

Fu H. et al gives an artificial neural network model (ANN). All features are normalised between 0 and 1 and are made as input neurons and leaf categories as output classes. [3]

Barbedo J. discussed about leaf's geometric features domain and identified the disease in plants. [4]

Salve P. **et al** also discussed about leaf's geometrical shape and size. Various edge based features were discussed to describe the leaf pattern.. [5]

Arulmoz V. et al uses Matlab neural tool box to describe various leaf classes based on leaf pattern featrures.. [6]

Ou G. et al proposed leaf features in neural network domain and binary classification of leaf pattern was discussed.. [7]

Mirzaaghazadeh A. et al discussed gradient based approach while identifying the leaf pattern into different classes.. [8]

Jain A.K. et al discussed statistical analysis of leaf pattern features using various statistical variance and standard deviation.. [9]

Hassan A. et al took the leaf pattern in statistical domain by using spss chart and

classifying the leaf patterns into respective classes.[10]

Bae Cho S. discussed the hand written shape features application over the leaf patterns using euler shapes. [11]

Abbas Alsultanny Y. et al took hybrid approach by combining features from different domain and in all together to classify into different classes. [12]

Mureşan R.C. described all leaf patterns features into binry class and used pulse coded neural network to identify leaf patterns. [13]

Manjunathi B.S. et al applied Gabor filters to leaf patterns in order to distinguish between different pattern classes.[14].

Boulgouris N.V. et al gave gait based approach in combination with random number theory. [15]

3. Features Normalization

While working or extracting features of a pattern, it is very much required that the features are invariant with respect to its size, orientation and location. Size invariance can be achieved via centre of mass of the pattern. Orientation invariance is obtained by using orthogonal transformation of features. And size invariency is achieved using the mean radius of the pattern under test [16-20].

In image entropy analysis, the feature vector for the pattern under study should include the features extracted in spatial, frequency, texture and statistical domain. Features in spatial domain includes radial feature including minimum radii in each quadrant band similarly maximum radii in each quadrant. along with perimeter, area and intercepts on axes and euler number. The features in frequency domain includes fft, dct and wavelet transform coefficients. The statistical features comprises of standard deviation (SD), variance (SD^2), histogram features, energy, power and correlation. The texture based features may include the contrast, homogeneity and autocorrelation [21-25].

4. Image Binarization (Thresholding)

Otsu Algorithm is thresholding algorithm that is based on computing the minimum within class variance. It is a repetitive algorithm that starts from 0 gray level intensity and goes till the 255 gray level intensity. At each gray level intensity, the image is divided into foreground and back ground parts and variance from each class is computed followed by within class variance. The gray level intensity at which a minimum of within class variance is obtained, is taken as the gray level threshold. Using the threshold value, the image is binarized into tow colors i.e. black and white [26-32].

5. Algorithm

Support vector machine is used for binary classification of data. The data set is made input to the support vector machine algorithm, where margins are computed from both classes and a virtual boundary is created between the classes of data. The image as acquired by using the digital camera are in jpeg format i.e. 24-bit color format and are converted to gray scale image. In the presented work, some images are acquired by using the digital camera and some are taken from online data base. The skin images are properly illuminated for image acquisition purposes so that the color artifact are eliminated and true picture of the skin image can be acquired. There may

be different linear or non-linear kernels creating a boundary between the two while processing the data that help in classes [33-40].

Say, X → is a set of vectors to e classified and is given by.

$$X = \begin{bmatrix} X^1, \\ X^2 \\ X^3 \\ \dots \\ \dots \\ \dots \\ X^M \end{bmatrix} = \begin{bmatrix} x_1^1, & x_2^1, & x_3^1, \dots & \dots & \dots & x_N^1 \\ x_1^2, & x_2^2, & x_3^2, \dots & \dots & \dots & x_N^2 \\ x_1^3, & x_2^3, & x_3^3, \dots & \dots & \dots & x_N^3 \\ & & \dots \dots \dots & & & \\ & & \dots \dots \dots & & & \\ & & \dots \dots \dots & & & \\ x_1^M, & x_2^M, & x_3^M, \dots & \dots & \dots & x_N^M \end{bmatrix}$$

From above, it can be seen that that there are ***M*** no. vectors of length N. Say ***X*** is to be divided into ***J*** no. of classes given by Y.

Say, Y = $[Y_1, Y_1, Y_1, \dots\ Y_J]$

Now, a weight matrix W is computed by taking the input sample X along with the outclass Y as follows:

$$Y_{r=1}^{M} = \sum_{c=1}^{M} \alpha_c \,.X_r \,.X_c$$

Where, α_1, α_2, α_3,

Upon expanding the above equation, we get,

$$\alpha_1.X_1\,.X_1 + \alpha_2.X_1\,.X_2 + \alpha_3.X_1\,.X_3 + \dots\ \alpha_M.X_1\,.X_M = Y_1$$
$$\alpha_1.X_2\,.X_1 + \alpha_2.X_2\,.X_2 + \alpha_3.X_2\,.X_3 + \dots\ \alpha_M.X_2\,.X_M = Y_2$$
$$\alpha_1.X_3\,.X_1 + \alpha_2.X_3\,.X_2 + \alpha_3.X_3\,.X_3 + \cdots\ \alpha_M.X_3\,.X_M = Y_3$$

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$$\alpha_1.X_M\,.X_1 + \alpha_2.X_M\,.X_2 + \alpha_3.X_M\,.X_3 + \dots\ \alpha_M.X_M\,.X_M = Y_M$$

After solving the above equations for α, following weight equation is derived:

$$W = \sum_{i=1}^{M} \alpha_i\,.X_i$$

A hyper plane with bias ***b*** is computed using the followings:

W. X + b = Y

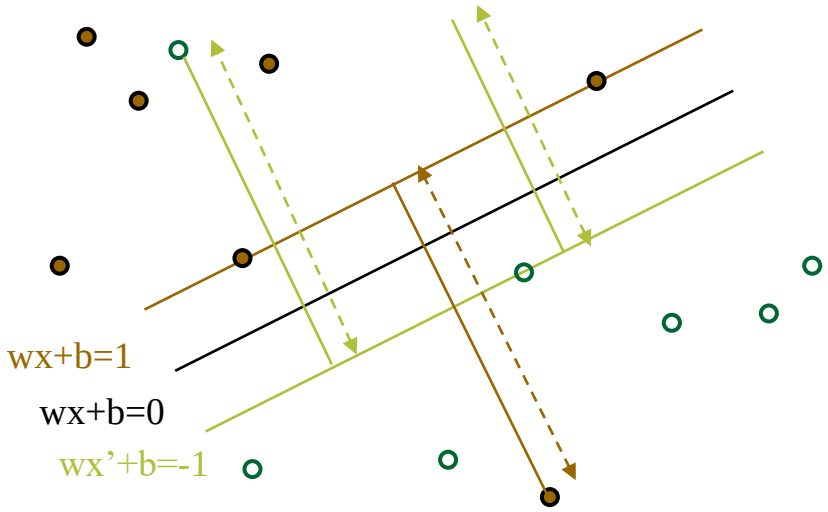

Figure 1: Diagram of SVM Classifier layer of the skin.

The image as acquired by using the digital camera are in jpeg format i.e. 24-bit color format and are converted to gray scale image. In the presented work, some images are acquired by using the digital camera and some are taken from online data base. The skin images are properly illuminated for image acquisition purposes so that the color artifact are eliminated and true picture of the skin image can be acquired.

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Image enhancement is an important step in image processing. And histogram equalization is one of the most popular method for image enhancement. A histogram is a graph between gray level intensity Vs. no. of pixels for each gray level. A poorly illuminated image may have a histogram either as of concave tpe or convex type. In each type of histogram, all pixels from gray level spectrum do not contribute and hence an image appears to be very blur. However, if good amount of pixels from each gray level intensity contribute in image formation, then the image is enhanced to a satisfactorily level.

Histogram equalization image enhancement technique is best suited for poorly illuminated images and brings out a well brightened image. Poorly illuminated image may have a histogram either as of concave type or convex type. In each type of histogram, all pixels from gray level spectrum do not contribute and hence an image appears to be very blur. However, if good amount of pixels from each gray level intensity contribute in image formation, then the image is enhanced to a satisfactorily level. Histogram equalization is used to enhance contrast. All pixel intensities are enabled to contribute in image and thereby resulting in a flat histogram. Either the input histogram is concave or convex, after histogram equalization, the histogram

becomes in a flat shape. Histogram equalization image enhancement technique is best suited for poorly illuminated images and brings out a well brightened image. Poorly illuminated image may have a histogram either as of concave type or covex type.

6. GLCM

GLCM stands for gray level co-occurance matrix. The GLCM matrix is primarily used for textural classification and analysis. It is governed by properties named as contrast, homogeneity, cross-correlation and energy. These four properties define well any of the texture either on any kind of surface or leaf. The pattern or texture may be colored or gray in color. The GLCM matrix a useful algorithm to distinguish between different texture patterns.

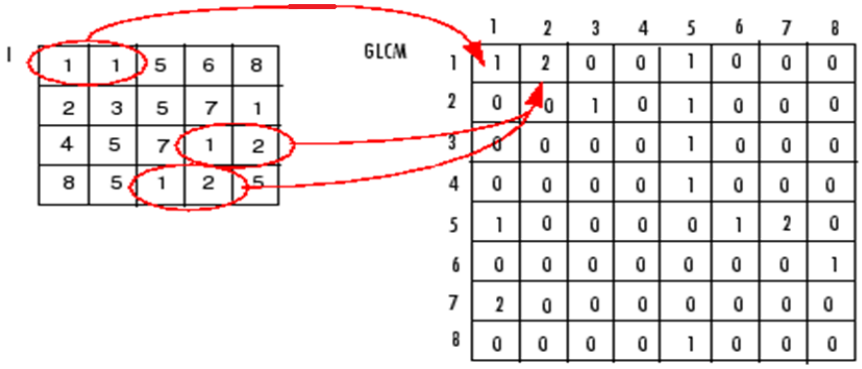

Figure 2: GLCM Matrix

7. Conclusion

The accuracy of the receptiveness can be observed in comparison table-11. In case of lettuce, the accuracy falls. This is attributed to noise present on boundary of the same. The boundary is not uniform due to color profile of the lettuce leaf image. For ore validation of the algorithm and feature vector, more leaf patterns of other classes other than those presented here were tested and recognition accuracy was to the satisfactory mark. Many researchers have used the features using Zernike moments, histogram of gradients and color domain and got the accuracy in the tune of 85-90%. Further, there is huge variety of plant's diversity in nature and all cannot be covered up in the in single slot, therefore, the accuracy issue is further open when more varieties of leaf patterns are included in data base. Leaf pattern's boundary is an important area where all radial features depend, therefore, boundary of the pattern must be extracted to a great accuracy ad faithfully.

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