Leaf Recognition – A Technical Review

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ABSTRACT

India is an agriculture based country, where 70% of the population depends on agriculture. Now-a-days the people of India wants to use some technology that make them work easier, faster and with more perfection and with less cost. Plant classification remains very useful and important task for scientist, field guides and others. Using computer vision this process can be automated. Here the reviews of different systems which are helpful to identify any leaf for automation in farming, gardening and in medicine developing from plants have been carried out.

Keywords/ Index Term— PNN, PCA, SVM-BDT, NN, BPNN, Leaf identification, leaf recognition

1. INTRODUCTION

Each leaf has its own features and carries significant information that can help people to recognise and classify the plant by looking at it. Leaf shape is a prominent feature that most people use to recognise and classify a plant **[17]**. Wu et al. **[18]** in had stated that diameter, physiological length, physiological width, leaf area and perimeter are basic geometry information can be extract from the leaf shape **[17]** . In addition, leaf color, textures and vein are also considered as features **[19]** . All these features are useful for recognition and classification of leaf image. Figure 1 illustrates the fundamental of recognition and classification process by computer using a leaf image in order to recognize and classify a plant.

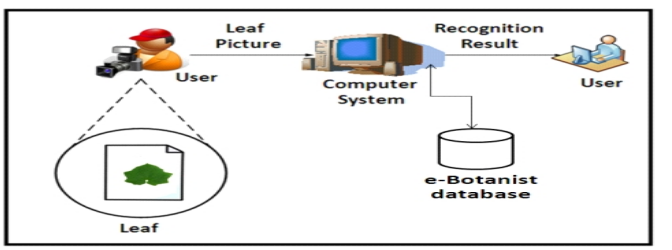

Fig 1 System Work Flow

Recognition of plant images is one of the research topics in computer science. The use of shape for recognizing objects has been actively studied since the beginning of object recognition in 1950s. Several authors suggest that object shape is more informative than its look properties such as texture, colour and shape.

Due to the availability of low cost camera and immense study of computer vision system, lots of methodologies are available for automatic leaf recognition. In this review paper we have studied different methods and compared it. Section 2 contains Literature Review, different classification methods are enclosed in section3 and finally section 4 contains conclusion of the literature review.

2. LITERATURE REVIEW

Flavia Dataset consists of 32 classes with 50-60 observation in each class. A 32 class of flavia database is used by the Stephen Gang Wu in their work for leaf recognition for plant classification, they achieved 90% accuracy **[1]**. The SVM-BDT has superior performance i.e. 96%, compare to PNN 91% and Fourier Moment 62%.

The experiments show that PCA can improve the accuracy of the system, from 93% to 95.7500% when dataset Foliage was used and from 93.4375% to 95% when dataset Flavia was used according to **[2]**.

A method for leaf classification has been developed. The method incorporates shape and vein, color, and texture features and uses PNN as a classifier **[3]**. The result gives 93.75% of accuracy, which is slightly better than the original work that gives 90,312% of accuracy.

Incorporating Zernike moments for feature descriptors is a feasible alternative for classifying structurally complex images. They offer exceptional invariance features and reveal enhanced performance than other moment based solutions. GLCM gives better texture approximations and hence makes classification easier **[4]**.

Advanced leaf recognition for plant classification based on leaf contour and centroid **[5]**. We extracted twenty leaf features for leaf recognition. From the experimental results, we can confirm that the recognition rate of the proposed advanced leaf recognition was better than that of the existed leaf recognition.

The computer can automatically recognize leaf by transferring the leaf sample to the computer. MLP is adopted for its fast training speed and simple structure. Ten features are extracted and later processed form the input vector of MLP. Experimental result indicates that algorithm is workable with an accuracy greater than 94% **[6]**. Compared with other methods, this algorithm is fast in execution, efficient in recognition and easy in implementation.

The system trains 25 kinds of leaves and 25 kinds of flowers with 1,250 images in the system database. The system tests its performance with 25 kinds of leaves and 25 kinds of flowers within 500 images for a training data set. The system tests another 5 kinds of leaves and 5 kinds of flowers within 50 images for an un-training data set. The precision rate is 71.9 % for the training dataset and 77.0 % for the un-training data set **[7]**.

The importance of leaf length, width, area and perimeter since the results obtained by the feature selection method selected these features as the most discriminant ones and combined them with other morphological features increased the results to 85 % **[8]**. As the automated system is a novel method of identification of plants from herbarium specimens, we believe that the performance, accuracy and results obtained are at least promising and have a potential in real plant identification application.

Leaf recognition lies in whether selected features are stable and have good ability to discriminate individual leaves **[9]**. From the view of plant morphology (such as shape, vein, dent and so on), domain-related visual features of plant leaf are analysed and extracted. On such a basis, an approach for recognizing plant leaf using artificial neural network is brought forward. Experiment results prove the effectiveness and superiority of our methods.

New robust & computationally efficient system is presented that takes into consideration the colour features and tooth features of the leaf in addition to the shape features. We finally used a combination of colour, shape, morphological and tooth features **[10]**. The system was tested on Flavia dataset by using two classifier and the results were admissible as can be seen in experimental results.

The leaf characteristics vary widely from its tender stage to the mature stage. Hence this algorithm is restricted for images of mature leaves of a plant. **[11]** white background is maintained both for the database and test images. With this constraint system achieved better accuracy.

A digital morphological feature based automatic recognition method for plant images was proposed and performed **[12]**. The fifteen features are used to classify 20 species of plant leaves. new moving median centres' hyper sphere classifier is adopted to perform the classification. The experimental results demonstrated that the proposed method is effective and efficient. By comparing with the 1-NN and k-NN classifiers, it can be found that the MMC classifier can not only save the storage space but also reduce the classification time under the case of no sacrificing the classification accuracy.

A Back propagation neural network (BPNN) for recognition of leaves is implemented in this project**[13]**. The training set contains minimum five spices for each type of leaf in each data file. Using more number of species in training set and no: of output nodes can enhance the recognition ability.

The classification based on the recognizing the leaves images with extracted texture features was proposed and performed **[14]**. The texture features have been extracted with using the Grey-Level Co-occurrences Matrix (GLCM) and the Principal Component Analysis (PCA) algorithms, on the 390 image in dataset and with 65 deformed or new leaf images for test. Different degrees for the GLCM method were used and it was found out to be more efficient in the degree 0° by 78.46 % accuracy. It was specified that the GLCM is very sensitive in any changes for images such as deforming or giving the new leaf image as a test. the PCA method comes out to be more efficient compare to the GLCM method by 98.46 % accuracy.

An automated system for plant identification using shape features of their leaves. Two shape modeling approaches are discussed: one technique based on invariant-moments model and the other on centroid-radii model, and the two are compared with regard to classification accuracies **[15]**. Such automated classification systems can prove extremely useful for quick and efficient classification of plant species. The accuracy of the current proposed approach is comparable to those reported in contemporary works. A salient feature of the current approach is the low-complexity data modeling scheme used whereby dimensionality of the feature vectors are typically below 40.

We have tested several types of features in a specific task - recognition of wooden species based on their leaves. We concluded that Fourier descriptors are the most appropriate features which can, when combined with the leaf size, achieve the recognition rate above 85% **[16]**. A crucial factor influencing the success rate is of course the quality of the input image. The system is not primarily designed to work with photographs of the leaves taken directly on the tree. The background segmentation and elimination of the perspective would have to be incorporated.

3. METHOD

In general, the leaf recognition follows some steps like Image capturing, image pre-processing, image-segmentation, feature extraction and finally classification leaf. Here some methods for feature extraction and methods for classification are explained in this section. Figure 2 shows preprocessing phase for leaf reorganization

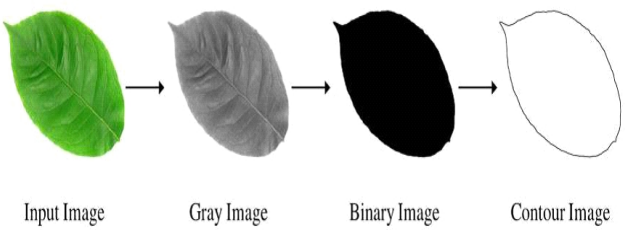

Fig 2 Image-Preprocessing steps

3.1. Feature Extraction Method

Feature extraction of leaf can be done on the bases of different features like color, shape and size. In this section we have described different methods for extracting features of leaf.

3.1.1 Color

For color feature extraction methods are available like Dominant color method, Intensity Distribution method, mean of color, nine color characteristic data, HIS color model technique, YES color model and many more [20].

3.1.2 Shape

For shape feature extraction different methods available which are mainly divided in to two parts: Contour-Based and Region Based. Again both the methods of shape feature extraction have two different approaches: Structural and Global. In contour based structural method have approaches like Chain code, Polygon, B-Spline and Invariants, Contour based Global

method have approaches like perimeter, shape signature and Fourier Descriptor and many more. In region based global method has area, gridmethod and euler method and many more approaches are available, and region based structural method have approaches like Convex hull, Core etc. [21]

3.1.3 Size

For size different methods are available like system based on measuring the volume of the gap between the fruit and an outer casing, Time of flight (TOF) range finding system, system based on the blocking of light and two dimensional machine vision systems. These are the main methods of size feature extraction and many more methods are available in that too.

Except above listed features there are other features like texture & veins of leaf available. [22]

3.2. Classification Method

In this section, different classification system is explained like Linear Discriminate Classifiers (LDC), Nearest neighbor classifiers (k-NN), Support vector machines, Artificial neural network (ANN), Rule based system (Fuzzy system).

3.2.1 Probabilistic Neural Network [23]

Probabilistic Neural Network (PNN) is derived from Radial Basis Function Network (RNF). PNN is an algorithm which can be used for classification problems. PNN has three layers the Input layer, Radial Basis Layer and Competitive Layer. When an input is given to the first layer, it matches the input with the training input. Then produces a vector whose elements the input is closest to a training input. Then second layer sums these contributions for each class of inputs to develop its net output of probabilities. And finally, a complete transfer function on the output of the second layer picks the maximum of these probabilities, and produces a 1 for that class and a 0 for the other classes. PNN training speed is many times faster than a BP network.

3.2.1 Principle Component Analysis [24]

Principal component analysis is a quantitatively difficult method for decreasing the dimension of input vector of neural network. The method generates a new set of variables it's called principal components. Component is a linear combination of original variables. And orthogonal to each other, so there is no redundant information. The principal components as a whole form an orthogonal basis for the space of the data. Mathematically, it transforms the data to a new coordinate system such that the greatest variance by any projection of the data comes to lie on the first coordinate, the second greatest variance on the second coordinate, and so on. Each coordinate is called a principal component.

3.2.3 Support Vector Machine [25]

SVMs are a relatively new machine-learning tool and have developed as a powerful technique for learning from data and in particular, for solving dual classification problems. SVMs is generated from Vapnik's statistical learning theory, and they formulated the learning problem as a quadratic optimization problem whose error surface is free of local minima and has global optimal, the aim is to find an optimal separating hyper plane (OSH) between the two data sets. SVM finds the OSH by maximizing the margin between the classes. The main concepts of SVM are first transform input data into a higher dimensional space and then construct an OSH between the two classes in the transformed space. Those data vectors nearest to the constructed line in the transformed space are called the support vectors. The SVM estimates a function for classifying data into two classes. Using a nonlinear transformation that depends on a regular parameter, the input vectors are placed into a high-dimensional feature space, where a linear separation is employed.

3.2.3 Fourier Method [26]

To calculate the Fourier moments of an image, you have to calculate first the centroid of the image. Rays are now drawn arising from the centroid toward the boundary. The distance of the centroid from the point of joining of the rays and the boundary of the image is calculated for each ray and stored. This sequence of lengths is periodic in nature, after every 2 radians the same ray is reached. For this periodic sequence Discrete Fourier Transform (DFT) is calculated. The sequence of radial distances for different images would return different periodic signals, and therefore different DFTs. Calculation of DFT of the sequence of radial distances makes these moments constant for rotating since shifting of a sequence or equivalently rotation of an image, corresponds to multiplication of the DFT by an imaginary exponential term, which does not affect its magnitude. The angle between two continuous rays can be mixed to increase or decrease number

of points in the sequence. By decreasing the angular step more number of points would be detached which would improve the resolving power of the Fourier moments.

4. CONCLUSION

From the above literature review we have concluded that lots of work had been done for foreign country's plant recognition but for Indian country's leaf very less work have been done. For classification many methods have been discussed in section 3.2, from that neural network give good accuracy but take more time. So in future we would like to work for Indian leaf recognition system using neural network.

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