Automated Leaf Recognition System for Plant Classification

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Introduction

A multitude of plants carry significant information for the development of human society from medical applications, natural product development, agricultural research purposes to daily household activities. An automated leaf recognition system is therefore immensely helpful in plant species recognition and classification giving reliable fast characterization of plant species without requiring the expertise of botanists. Therefore in this research we are focused on designing a leaf recognition system using Matlab and developing a user friendly mobile application based on it. We used a database provided by Flavia .

Objectives

1) Extracting geometrical and texture features for leaf recognition and comparing there discrimination performances

2) Applying feature selection to further improve recognition accuracy and reduce feature dimensionality

3) Developing a reliable leaf recognition system

4) Developing a user friendly mobile application for leaf recognition

Methodology

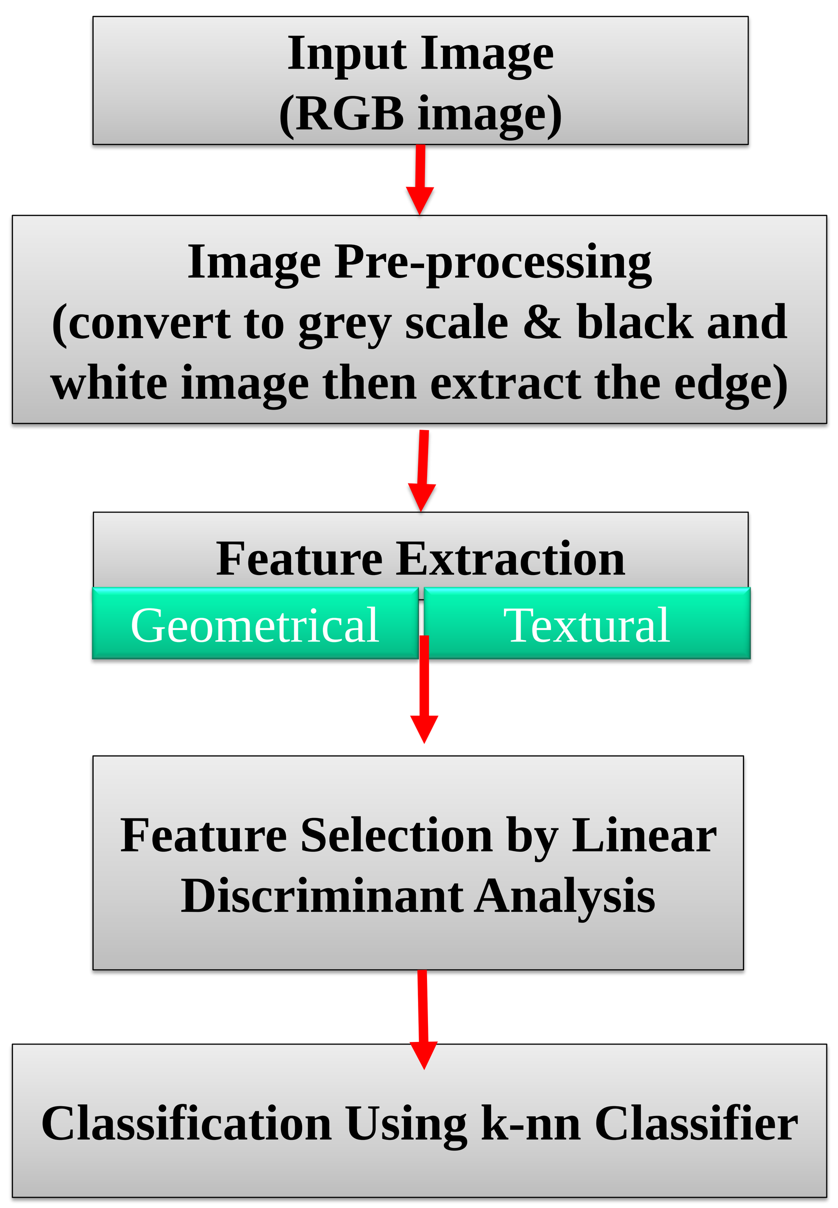

Figure 1: Flow diagram of the proposed method.

Dataset

To evaluate algorithm we use a dataset which consists of 1907 leaf images from 32 different classes of plants.

Figure 2: One representative leave from each 32 leaf classes.

Feature Extraction

Geometrical features

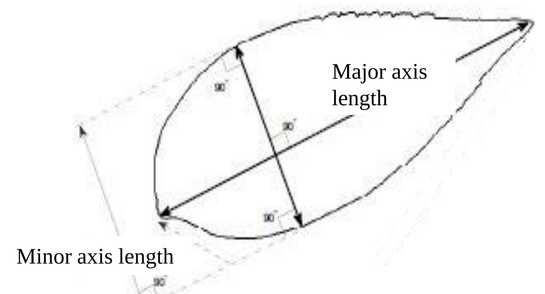

Figure 3: Computation of geometrical features

As Geometric features we extract major axis length, minor axis length, area of the leaf, form factor[1] smooth factor[1] from the leaf image and edge of the image. To achieve scale invariance we normalize the features.

Textural features

1) Local Binary Patterns (LBP)

LBP is a structural feature extraction method for textures. LBP is calculated by specifying the number of neighbors (P) and radius (R) followed by LBP histogram construction.

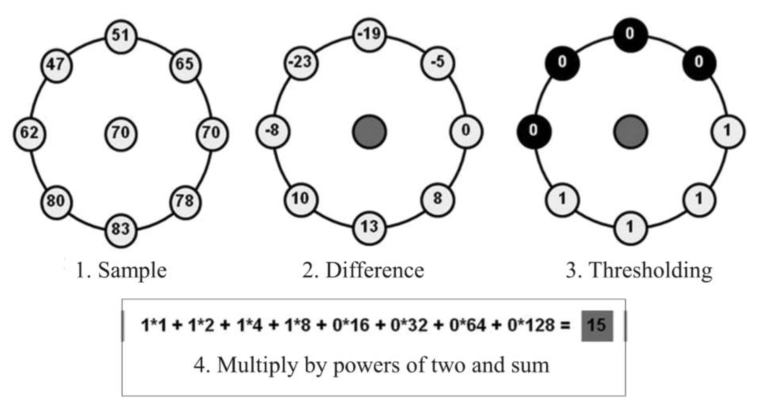

Figure 4: Local binary pattern computation

2) Features based on Co-occurrence Matrix

Here we extracted energy, entropy, homogeneity, correlation, weighted mean and variance as statistical texture features by using Grey Level Co-occurrence matrix.

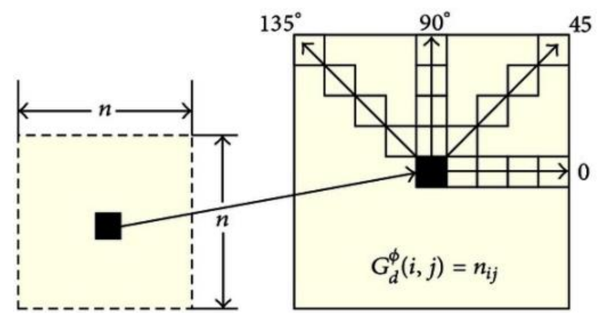

Figure 5: 2D Grey level co-occurrence matrix computation

Feature Selection

As a feature dimension reduction technique we use Linear Discriminat Analysis (LDA).

LDA selects the most dominant features which have a higher class discrimination power.

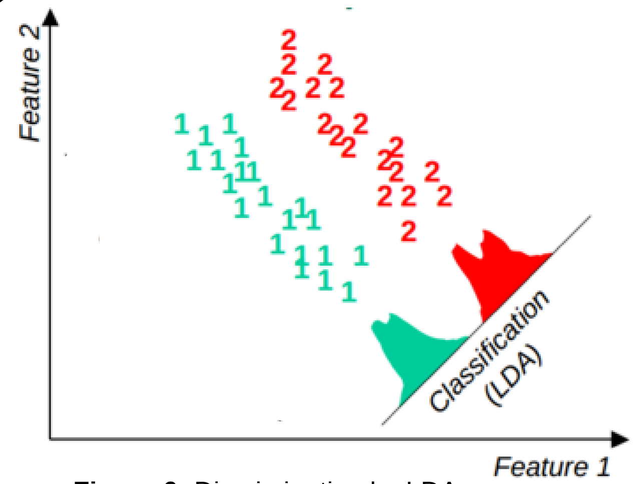

Figure 6: Discrimination by LDA

Classifier

In our algorithm to classify the leaves we use k-nearest neighbour (k-nn) classifier.

k-nn classifier assigns a class label to the new test sample based on k nearest neighbours.

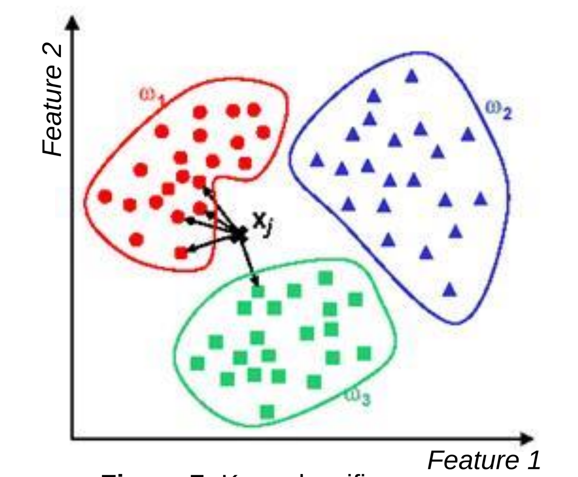

Figure 7: K-nn classifier

Results

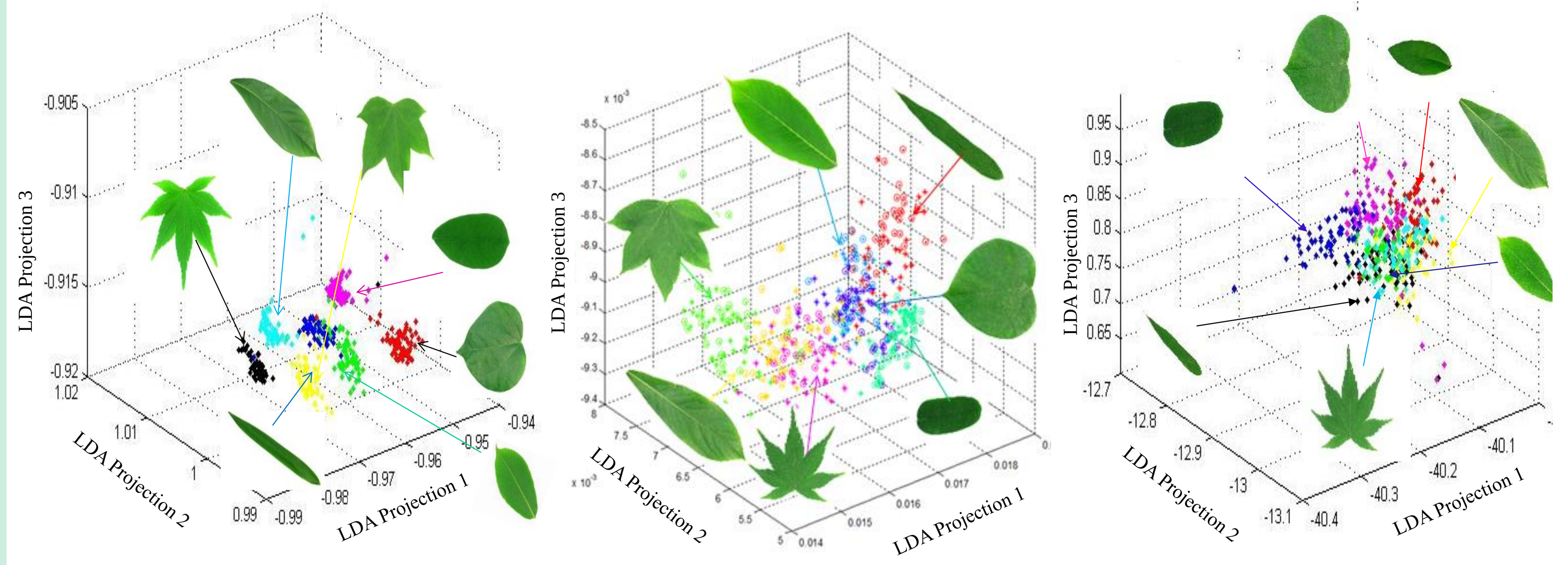

Figure 8 : 3D plot of geometric, LBP and Co-occurrence features for the 7 different classes of plants after feature selection by LDA for the first three dominant projected features.

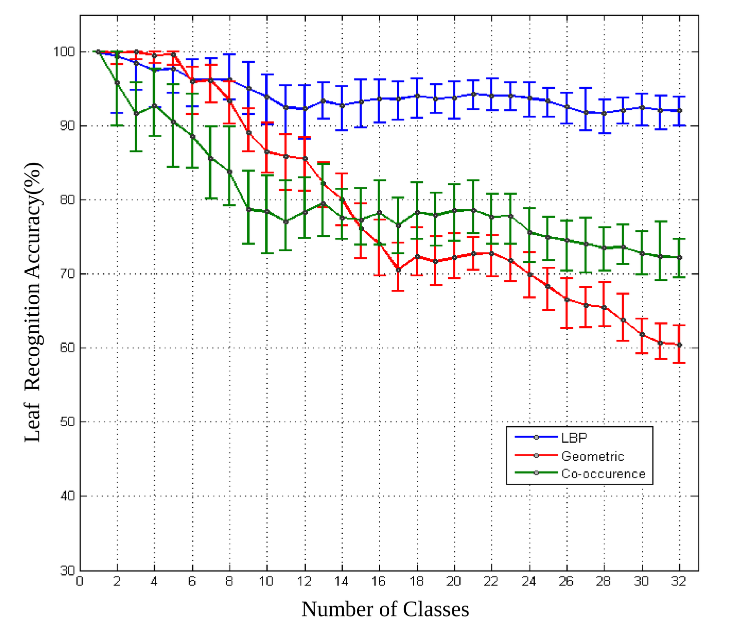

Figure 9: Accuracy with the number of classes for Geometric, LBP and Co-occurrence features.

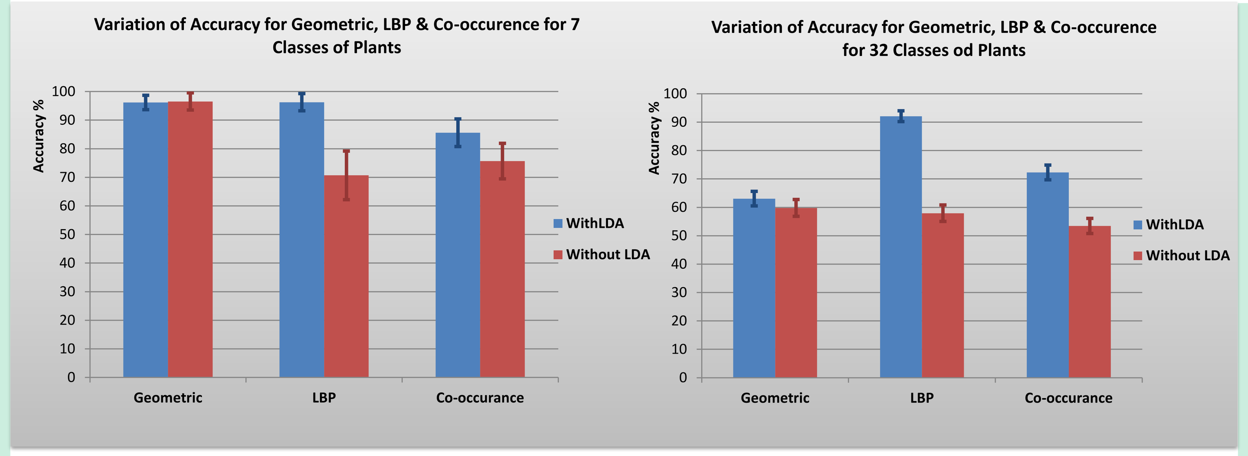

Figure 10: Accuracy using k-nn classifier for 7 & 32 classes of plants.

Table 1: Classification Accuracy for Geometric, LBP, Co-occurrence features with and without LDA for 32 different plant classes

Feature	Accuracy for 7 classes		Accuracy for 32 classes	
	With LDA	Without LDA	With LDA	Without LDA
Geometric	96.1±2.5%	96.5±3.0%	63.1±2.5%	59.8±2.9%
LBP	96.3±3.0%	70.7±8.5%	92.1±1.9%	57.9±3.2%
Co-occurrence	85.6±4.8%	75.7±6.2%	72.3±2.6%	53.4±3.2%

Conclusions & Future Work

- Here, we introduce a leaf recognition system for plant classification to classify 32 classes of plants.
- Texture features perform better than the geometrical features when a higher number of classes are associated.
- LDA improves the leaf recognition accuracy
- Leaf recognition accuracy based on other geometrical features and combined features are expected to be analysed.
- An application for smart phones which can identify the plant based on a leaf image is to be developed.

Acknowledgement

We wish to thank ***Dr. J. V. Wijayakulasooriya***, ***Dr. G. M. R. I. Godaliyadda***, ***Dr. M. P. B. Ekanayake*** and ***Dr. H. A. C. Dharmagunawardhana*** from the Department of Electrical & Electronic Engineering, Faculty of Engineering, University of Peradeniya, for their guidance and assistance for achieving a good outcome from our project.

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