Using Computer Vision to Cluster Plants based on Compound Leaf Morphology and Geometry

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Introduction

Recent advancements in computer technology opened new avenues in various life sciences including plant biology (Botany). Computer recognition of plant forms and discrimination between plants by computer feature extraction are gaining more attention among scientists [1].

Plants reflect significant information by their features for humans, these features can be observed from different plant parts such as fruits, flowers, roots, and leaves. Computer vision and further feature extraction could have many implications including plant taxonomy and the diagnosis of certain plant diseases [1].

Recently, some studies addressed plant type recognition depending on the morphology of the leaf. The plant leaf considered an obvious feature for recognition by implementing image processing techniques.

The previous work in literature showed the possibility of plant species identification depending on a simple leaf of different plant species [examples see 2, 3 and 4]. On the other hand, few studies have addressed plant identification based on a plant compound leaf, which is considered more complicated due to the higher variation in morphology compared to a simple leaf.

This study aims at proposing a methodology to group plants that have compound leaves according to the similarities and dissimilarities. The work will be based on implementing image processing techniques through features extracting from plant compound leaf.

The proposed methodology used image processing techniques to pre-process the images, and then to extract the proposed morphological and geometrical features from a plant compound leaf image. Hierarchal clustering will be used to do the clustering process.

The tomato leaf is suggested for the study because it appears in many types; the regular-leaf-type (RL) and the potato-leaf-type (PL) in addition to a clear variation in number and arrangement of leaflets within the same leaf [9].

This study implements a computer based feature extracting method with minimum user intervention, and gets benefits for the features from the previous works, such as the features have been proposed by Wu, et al. 2006 [3]. Our main improvements are on feature extraction from plants that have compound leaf and clustering them into similarity groups.

Methods

- Image Pre-processing

The proposed method is based on treating a plant leaf image through the pre-processing steps illustrated in figure 1.

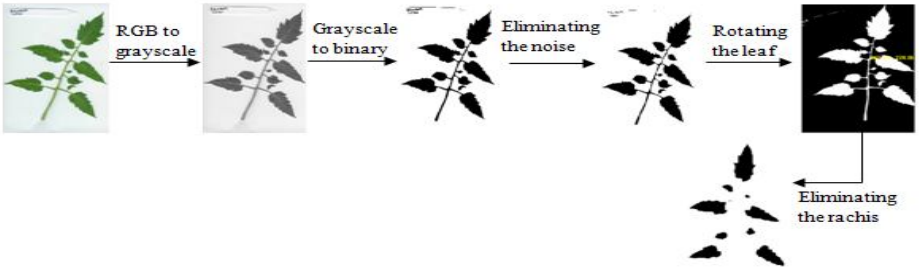

Figure 1. Steps implemented for image pre-processing

- Features Extraction: two types of features were defined and used for feature extraction
  1. Global features: which are extracted from the compound leaf as a whole, such as the number of leaflets and the general structure of the plant leaf.
  2. Local features: are extracted from each leaflet, such as area of each leaflet, perimeter, aspect ratio, form factor, angle and rectangularity [3].
- Hierarchal Clustering

Following to the feature extraction step, a hierarchal clustering using UPGMA algorithm was used to calculate the dendogram (figure 2).

By using images processing toolbox in MALAB[6], we applied a feature extraction methodology on 29 tomato variaty each was represented by a single compound leaf from online database [5]

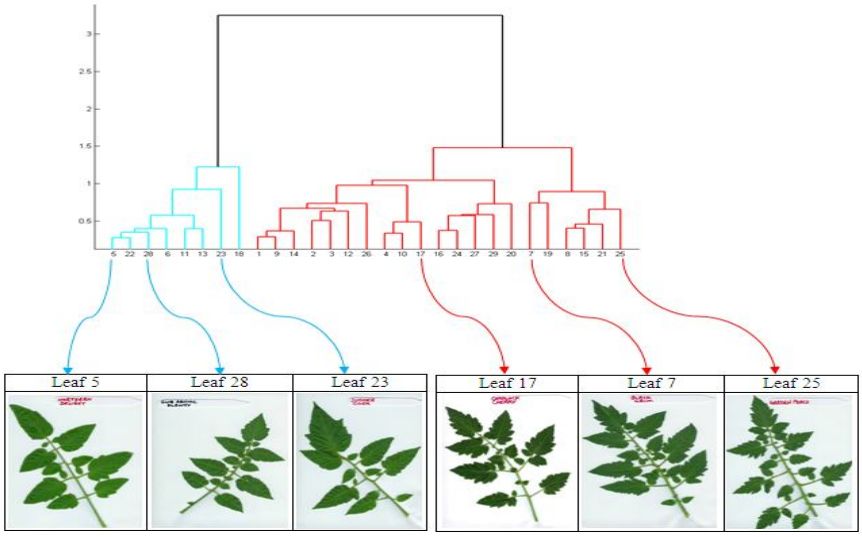

Figure 2 Dendogram The result of applying hierarchical clustering using UPGMA algorithm on sample leaves from the two main clusters revealed by dendrogram

Results

The hierarchical clustering of the sampled leaves with the UPGMA dendogram shows two main clusters (figure 2), the blue colored cluster represents the potato-leaf type (PL) and the red colored cluster represents the regular leaf type (RL). Samples within the same cluster shared other common features like leaflet dentation (serration) and leaflets number.

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