EE417 Project Final Report

Leaf Segmentation
Group05

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1. Introduction

In this project our goal was to extract leaf bodies from backgrounds of the given images. Our first approach was to set an optimal threshold so that the ratios of individual channels in bodies and background could differ within a specified value. This threshold value had to change for each image therefore we decided to compute this value within the images themselves. The problem of this approach was that it could not compute the ratios precise enough, some parts of the background could not be diverged from the bodies hence it reduced the accuracy. Second approach was to find a deterministic threshold for both grayscale and RGB densities and combine the produced output vector with an OR logic gate, this procedure improved the overall accuracy since both threshold mechanisms compensated each other's errors. The last method we used is based on K-Means and Lab color space, this approach is explained further in the next section.

2. The Algorithm

The workflow of the algorithm works in a sense that it does an evaluation between the mentioned approaches and picks the one that would produce best results. In most cases individual-thresholding performs best but the other cases improves the overall accuracy of the given validation set.

Individual thresholding works in a way that it optimizes itself within it's own scope. It computes the RGB ratios for each corner and compares with the maximum of the visited pixels ratios. If the ratio is greater than sum of the maximum value and difference between the previously visited pixel or less than the minimum value subtracted by the difference between the previously visited pixel's value, it marks it as an edge. The key point is that threshold can be less or greater than the leaf's ratio.

$$T > \max(r) + d_i - d_{i-1}$$

$$T < \min(r) + d_i - d_{i-1}$$

The obtained thresholds were processed with the logic operators to find the *true* threshold of the individual image. With this method, we managed to implement a generic threshold finding algorithm therefore it increased the accuracy for the whole set by re-calculating threshold of each sample image.

In K-means and Lab color space case, we observed that the given images contained noise and filtering operation could improve the accuracy hence we used a Gaussian Low Pass filter to get rid of the noise.

$$\underset{\mathbf{S}}{\arg\min} \sum_{i=1}^{k} \sum_{\mathbf{x} \in S_i} \left\| \mathbf{x} - \boldsymbol{\mu}_i \right\|^2$$

K-means clustering

Then we applied canny edge detection algorithm to color data in order to get an overall edge map from the image. *Lab* color is designed to approximate human vision, it does not blend the external sources for the perceptual unity. Therefore it improved the accuracy on the images with shadow and illumination when replacing RGB color space with L*a*b values.

$$\boldsymbol{X}_i^C = \begin{bmatrix} L(\boldsymbol{X_i}) \\ a(\boldsymbol{X_i}) \\ b(\boldsymbol{X_i}) \end{bmatrix}$$

After this conversion, the vectors had to be normalized in order to minimize the redundancy between data points. To do this, standard deviations were calculated and vectors were given into K-means as parameter.

After each and selected algorithm produces the segmented image, the morphological operations were applied to fill the holes and clear the noise that may occur during the segmentation phase. It’s well marked that the post-processing improves the accuracy drastically.