Has an image classification approach any chance at all (in plant classification)?...

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Abstract. ...somewhat. We extracted, partitioned and described contours, histogrammed their geometric parameters and concatenated the histograms to form a single image vector with which we classified the plant images using a Linear Discriminant Analysis (LDA); that is, no segmentation or saliency selection was performed. Despite the obvious simplicity of the LDA classification we reached the middle of the ranking for sheet-as-background images. While contour-based feature extraction is presently still a lone-some strategy in comparison to the prevailing gradient-based matching techniques (e.g. SIFT), it may soon be a viable alternative - once we developed appropriate classification methodology to deal with the descriptors.

Keywords: contour extraction, curve partitioning, grouping, image vector

1 Introduction

Whereas our classification was simple, our descriptor extraction is rather complex. We employed our method for curve partitioning and abstraction, which we previously introduced as part of an image classification study [Rasche, 2010]. Meanwhile the method has been improved and has also been applied in video indexing [Ionescu et al., 2012], image retrieval [Rasche and Vertan, 2010], gesture (posture) identification [Oprisescu et al., 2012] and in shape retrieval where we obtained the present benchmark [Rasche, 2013]. For reasons of time, we fell short of exploiting its full potential in the present plant classification task [Caputo et al., 2013,Goau et al., 2013]. Nevertheless, we obtain moderate results, with a simple classification of image vectors.

2 Method

We essentially pursued a structural description. Contours were extracted with the Canny algorithm [Canny, 1986] and then partitioned into (elementary) segments and geometrically described using a multi-resolution analysis. A contour is iterated with a fixed window which measures the amplitude for its contour subsegment. The resulting local/global space is analyzed for consistent 'segments', which are identified as elementary segments, namely smooth arcs and straight(er) segments. These segments are then geometrically described by several parameters such as orientation, length, 'bendness' ($\approx$ curvature), edginess, degree of alternating, etc.[Rasche, 2013]. The elementary segments were then grouped into a variety of pairs such as closure (2 curved segments facing each other as in '()'), ribbons (2 parallel, aligned, straight segments), hyperbola (2 curved segments facing away as in ')('), etc. To avoid a combinatorial explosion, we selected symmetric pairs, which exhibited a high degree of bilaterality along either the symmetric axis or the mid axis. The pairs were then also geometrically parameterized (various distances between segments, their degree of the 'structural biases', etc.). For (elementary) segment and pair descriptors we also extracted (image) appearance parameters (contrast, standard deviation of pixels values along the contour, etc.). In total 100 to 150 parameters are determined for both segment and pair descriptors.

These segment and pair descriptors represent a 'structural alternative' to the prevailing gradient-based features (e.g. SIFT), which typically excel at textural representation. However we could not capitalize on the structural specificity yet, and therefore report only on a statistical discrimination. That is, for each image, the parameters across descriptors were histogrammed with 10 bins - and the individual descriptors were thus not actually exploited. The image vector had so a dimensionality of 1000 to 1500.

3 Results

We applied the Principal Component Analysis to reduce the dimensionality to ca. 200-400 dimensions (depending on the classification task). A classical LDA was used, whereby we built a tree-like classification system. We firstly built a background classifier, which discriminated between natural and sheet background (99% on the training set). For natural-background images we then trained a type classifier discriminating between stem, leaf, entire, flower and fruit (ca. 70% on training set). Lastly, a (all-versus-all) species classifier was built to discriminate between the 250 species. For sheet-as-background images, we immediately applied a species classifier. For sheet-as-background images (species) classification reached the middle of the ranking (in comparison to the other approaches), and was also better than our performance for natural-sheet images.

4 Discussion and Conclusion

Classifying plant images with a 'whole-image' classification approach as presented here will certainly not be a serious alternative, but we hope to improve on exploiting the individual contour parameters better in the future - as we did in other image collections - and not just histogram them.

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