Leaf Image Classification Using SIFT Features and Bag of Visual Words

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Abstract

In the study of plant life, specifically trees, one important characteristic is the recognition of leaves. Due to the wide variety of shapes in which leafs appear, as well as their ease of transportation and photography, they have become one of the chief methods to visually determine the species of a tree or other plant. Modern software applications on smartphones provide a way of performing classification of a leaf, in the field, within minutes of it being photographed. For this assignment, we have developed a program with the goal of analyzing leaf images that were obtained from existing datasets of digitized leaf photographs. Features were extracted from each image using the scale- and rotation-invariant SIFT method, and were then filtered and clustered using a visual Bag of Words algorithm. The resulting feature sets were then classified using an artificial neural network to provide correct identification of the leaf's species. The performance of this system was gauged on accuracy, and then compared with other such implementations from the literature which differed in both classification method and dataset used.
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1 Introduction

Despite the advent of more precise methods, the use of leaves to identify trees and other plants persists. The variance of shapes between species with a general uniformity of shape within one species, combined with the portability and size of the leaves, has ensured their popularity for this usage. Whereas leaf identification used to require manual comparison of the leaf (or a photograph of it) to images of previous leaves (often involving large decision trees), advances in computer vison have made fast, large scale comparison of images feasible [1]. One example of the use of computer image classification for leafs is the Leaf Snap app [4]: a mobile app covering all 185 species of the northeast USA, it enables users to photograph leaves and immediately classify them, by transmitting the captures image to a server which houses the recognition system. After classification, the user is presented with a sorted list of identification results from which they can pick the one that most resembles their leaf. Total time to solution after uploading of the image is 5.4 seconds [4]. We decided to develop a system with a similar goal, to identify the species of a leaf by using Machine Learning techniques to compare it with a processed database of labeled examples. The resulting system is capable of performing the whole process: feature extraction from an image database and using the extracted features to train a classifier. We used two available datasets, one of which was part of the ImageClef 2012 leaf classification challenge, earlier installments of which have been used before in comparable efforts to make an image classification system [2].

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1.1 Instructions

1.1.1 Making the PDF

Run `makePDF.sh` (Linux, OS X) or `makePDF.bat` (Windows) in the terminal to make a pdf of the whole paper. This script also takes care of changes to the bibliography, so you only need to run it once.

1.1.2 Editing

Each section of the paper has its own `.tex` file that is imported into the main `ML_leaf_report.tex` file, so the sections can be worked on simultaneously without messing up the main file (hopefully).

1.1.3 Preamble

Finally, the file `preamble.sty` contains all package imports in one place.

1.2 Another subsection

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2 Methods

2.1 Data set

Images from the ImageCLEF2012 Plant Identification Task were used in this study [3]. The data set consists of high resolution colour images that are labelled with metadata such as the full taxon name of the plant, its common name, and the GPS coordinates of the observation. The images vary in resolution and aspect ratio but are scaled so that their longest axis is 800 pixels. The data set originally contains three types of images: *scans*, scan-like photographs (*pseudoscans*), and normal *photographs*. Examples of these three types are shown in Figure 1. They differ in the complexity of their backgrounds: *scans* have a purely white background and few shadows, whereas *pseudoscans*, while maintaining a uniform background, are more variable in the colour of their background and the lighting conditions. Finally, *photographs* have very diverse backgrounds, often with other plants visible, and vary strongly in their lighting conditions.

Figure 1: Examples of the three image types in the original ImageCLEF2012 data set. From left to right: *photograph*, *pseudoscan*, and *scan*.

Because of the complexity associated with extracting the leaf from its background, only *scan* images (57% of all images) were used in this study. This subset consisted of 6630 images of leaves from [??] classes. There were [??] images per class on average.

The images were divided into a training set of 4870 images ($\pm 73\%$) and a test set of 1760 images ($\pm 27\%$).

2.2 Feature extraction

Several image classification studies [6, 5], including at least one study into leaf image classification [7], have made use of Scale-Invariant Feature Transform (SIFT) descriptors. These descriptors are invariant

to changes in scale and rotation, and somewhat robust to variations in viewpoint and illumination. This makes them suitable for this task, since the leaves are photographed at varying scales and rotations.

2.3 Bag of visual words

2.4 Classifier

3 Results

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4 Discussion

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