

Fourier Descriptors

Properties and Utility in Leaf Classification

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Introduction

Now that large-scale data storage is feasible due to the large capacity and low cost of hard drives, huge image databases are becoming more prevalent. We need to be able to search these databases with a textual description of the image we desire in order for a large database to have any use. Manually entering this searchable information (metadata) is tedious and impractical when the number of images is large. One way to quickly extract and assign information contained in images is using Fourier descriptors to recognize shapes.

Fourier descriptors are a classical method to shape recognition and they have grown into a general method to encode various shape signatures. Previous experiments have used Fourier descriptors to recognize different types of marine life, product deformations, and tree leaves. I chose to implement a tree leaf identification program using Matlab because of a personal interest in nature and a database of leaf images is easy to create. There are many unique leaf shapes such as the oak tree leaf and the maple tree leaf. These leaves are easily recognized by any one who has grown up around these trees. But there are also more subtle differences between leaf shapes. A red maple leaf has notched lobes; a sugar maple leaf has smooth lobes. Because a good method for shape recognition needs to detect these subtleties, leaf shapes are a great example to test the limits of Fourier descriptor methods.

The general procedure begins with a color image containing a shape that we want to recognize. The color image is converted to a grayscale image. Then a threshold is applied to the grayscale image converting it into a black and white (ie. binary image). The threshold is applied so that the shape is enhanced and can easily be found. The shape

is located and its boundary is extracted. A shape signature is then used to describe the boundary. Several shape signatures exist such as the canonical complex boundary sequence or the centroid contour distance curve, which I apply here.

Approach

The database images are pictures of five different species of tree leaves and one type of shrub. Each leaf was placed on a white sheet of paper and labeled with the leaf type and a number for identification purposes. Over 200 pictures were taken of 59 different leaf samples in different orientations and places in the image. Once a database of leaf images was acquired, work began to extract the leaf boundary.

Before any processing takes place the image size is reduced from 3 Mega-pixels to 0.5 Mega-pixel. This speeds up all calculations by eliminating unnecessary precision in the image. The color image is then converted to a grayscale image. An appropriate grayscale threshold is obtained by locating the largest valley in the grayscale histogram. Due to the controlled environment during image acquisition, a single threshold clearly distinguishes the leaf and stem from the background in most cases.

The resulting binary image has a black background and the leaf and stem appear white. The image is then dilated by a small (3 pixel square) structuring element to remove any minor tears in the leaf boundary. Then the six longest boundaries are

