Recognizing Plant Species by Normalized Leaf Shapes

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Abstract

In order to recognize plant species from their shapes, contours of their leaves can be used. Leaves can be classified using their structural property that a leaf consists of triangular pieces that protrude around a polygon. However their shapes have variations even though they belong to the same species. Variations of leaf contours can be represented statistically. However there is variation caused by the large deformation of structural elements of leaves. Because tips of leaf veins can bend according to their environment, shapes of pieces can be deformed largely and influence the descriptions of leaves. It is desirable such deformed shapes be modified to the original undeformed shapes of the leaves in order to reduce the variation of the leaf shapes.

A leaf is considered to be composed of a number of overlapping leaflets which have a single apex and have symmetric shapes with respect to their veins basically. In this paper, a method that normalizes shapes of leaves is presented using the symmetry of each leaflet with respect to its vein. Recognition using normalized shapes of leaves shows improved results compared with the method using unnormalized leaves.

1 Introduction

Because there are a lot of plant species, it is helpful to search a database of plant species using the features of their shapes as indices. Leaves of plants have varieties of shapes. Therefore we can use the features of the leaf shapes in order to discriminate plant species.

We can consider that a leaf consists of leaflets that are overlapped by each other. A leaflet has a single apex which is a convex sharp corner and has a symmetric shape with respect to its vein basically. Therefore we can decompose a leaf into a number of triangular pieces that protrude around a polygon. Pieces of plant spices have varieties of shapes. On each piece, there are a number of teeth. In addition to such complexities of leaf contours, they have variations even though they belong to the same species. There are large variations caused by deformation of structural elements of leaves. Tips of leaf veins can be bent according to their environment and this influences shapes of pieces largely.

There are few methods for recognizing plant species which also use contours of leaves. Abassi [1] represents contours of leaves using curvature scale space images. However they use only peaks of curves in the upper part of the scale space images to compare contours of leaves. Such features can represent only global structures and ignore the detailed shapes of leaves. Tsukioka [5] represents leaf contours using critical points of curvature of them. However because of local variations of curvature of them, the method does not work well.

A method for detecting a detailed pattern on a curve is presented using wavelet local extrema[2]. They detect regular sequences of types of wavelet extrema of contour curvatures. However because shapes of teeth of leaves are not so regular, the method does not work well for detection of teeth.

Problems of the previous methods are lack of ability of representing detailed shapes and inefficiency of representing variations of shapes. Because previous methods described above do not assume any structural properties of leaf shapes, it is unclear which parts should be represented more in detail and which parts have small or large variations. The problem caused by deformation of leaf veins cannot be solved if the structural properties of leaves are not clarified.

In order to solve the problems, we have proposed a hierarchical method for representing leaf contours [3]. We represent detailed shapes of leaves in addition to global structures of leaves. We deal with relatively s-