Chapter 9

Categorization of Plant and Insect Species via Shape Analysis

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ABSTRACT

This chapter presents a graph-based approach to automatically categorize plant and insect species. In this approach, the plant leaf and insect objects are segmented from the background semi-automatically. For each object, the contour is then extracted, so that the contour points are used to form the vertices of a graph. We propose a vectorization method to recover clique histogram vectors from the graphs for classification. The clique histogram represents the distribution of one vertex with respect to its adjacent vertices. This treatment permits the use of a codebook approach to represent the graph in terms of a set of codewords that can be used for purposes of support vector machine classification. The experimental results show that the method is not only effective but also robust, and comparable with other methods in the literature for species recognition.

INTRODUCTION

Insects have one of the largest numbers of species in the world, which account for 3/4 of the total animal population (May, 1988). Since they are widely spread in every corner of the world, and mostly are very small, it is a challenging job to collect them. This makes a great many of them unknown to us. For insects, plants are not only their food, but also their home. The microclimate of the plant surfaces provides a variety of living environment. At the same time, insects can help to pollinate plants, and stimulus the

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plant differentiation and evolution. The interactions between insects and plants make their population grow very fast. In the meantime, the relationship between insects and plants are more complicated (Schoonhoven, Loon & Dicke, 1987).

Insects rely on plants. The competition between them seems to be an endless story. The relationship between insects and plants has long been a hot research topic in the community. To this end, one of the most important tasks is to recognize and classify these species. However, large number of insects and plants makes it a challenge job. The reasons are two-folds. On the one hand, it is tedious and time consuming for human to recognize insects and plants, especially for non-expert stakeholders, such as green hand gardeners, land owners, tourists, et al. On the other hand, human identification of these species becomes almost impossible in some environments, e.g., inaccessible rain forests. Therefore, an automatic recognition tool is essential, which not only can make the categorization task efficient but also help people to discover more insect and plant species and understand their interactions.

Recently, the use of computer vision method to automate species recognition has drawn much interest in the community. For tree classification, while the whole plant can be used for recognition, many researchers chose to use leaves. Kumar et al (Kumar, 2012) developed a vision system called Leafsnap for identifying plant leaves. Mouine et al (Mouine, 2013) developed a leaf retrieval system using leaf recognition by extracting the shape information of the plant leaves. Another automatic system was developed using a Zernike Moments (ZM) approach, (Tsakalidis et al, 2014) in which shape is used for the recognition. On the insect recognition, both artificial neural network and support vector machine have been used for classification (Wang et al, 2012). At the feature level, color and texture features are widely used (Kaya and Kayci, 2014).

In this chapter, we aim at categorizing leaf and butterfly species based on collected image datasets. The purpose of the research is to automatically recognize which category these species belong to. Some examples of leaves and butterflies are shown in Figure 1 and Figure 2. It can be observed from Figure 1 and Figure 2 that the leaves and butterflies have different shape representation for each category. Therefore, we propose a method to perform classification based on leaf and butterfly shapes. The method presented here starts from building a graph from the contour of targets. It then computes and clusters distance over the graph vertices. Thus, each vertex in the graph can be represented by an attribute vector. We construct a histogram from these vertex attributes to summarize their distribution. In this way, we can quantize the graph representation of the target into a codebook, and thus, make the representation

*Figure 1. Some images in the Swedish leaf. Images represent samples from different categories.*