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Leaf shape based plant species recognition ☆

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Abstract

Plant has plenty use in foodstuff, medicine and industry. And it is also vitally important for environmental protection. However, it is an important and difficult task to recognize plant species on earth. Designing a convenient and automatic recognition system of plants is necessary and useful since it can facilitate fast classifying plants, and understanding and managing them. In this paper, a leaf database from different plants is firstly constructed. Then, a new classification method, referred to as move median centers (MMC) hypersphere classifier, for the leaf database based on digital morphological feature is proposed. The proposed method is more robust than the one based on contour features since those significant curvature points are hard to find. Finally, the efficiency and effectiveness of the proposed method in recognizing different plants is demonstrated by experiments.

Keywords: Digital morphological feature; Plant recognition; Leaf database; Hypersphere classifier

1. Introduction

Plant, a biology existing everywhere, is a greatly significant thing for human's living and development. All over the world, there are currently about 310000–420000 known plant species, and many are still unknown yet.

At present, plant taxonomy usually adopts traditional classification method. And so far many other classification methods, such as morphologic anatomy, cell biology, molecule biology, phytochemistry, have also been used. These methods have great relation to do with biology and chemistry. Nevertheless, the acquisition of needed data from plant living body or specimen directly and automatically by computer has not been implemented [1].

With the deterioration of environments, more and more rare plant species are at the margin of extinction. Many of rare plants have died out. Nowadays, there are about 22–47% plant species of all known plants that

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are endangered, of which, there are about 100 000–150 000 plants that probably will die out in short time. So, it's necessary and urgent for us to establish bio-diversity database by information technology as soon as possible [2–7].

Since recent decades, digital image processing, image analysis and machine vision have been sharply developed, and they have become into a very important part of artificial intelligence and the interface between human and machine grounded theory and applied technology. These technologies have been applied widely in industry and medicine, but rarely in realm related to agriculture.

Our research work in this paper is introducing digital image processing theory into the numerical taxonomy in botany. Generally, the digital morphological features are most conventional and widely used. Thus, this efficient feature extraction method is adopted in this paper. By computing the digital morphological features of some kinds of plant species, plants can be classified automatically.

This paper is organized as follows: Section 2 introduces the image acquisition preprocessing method. In Section 3, digital morphological feature extraction method is described and discussed. Section 4 presents the fundamental principle of a new move median centers (MMC) hypersphere classifier. The experimental results are presented in Section 5, and Section 6 concludes the whole paper and gives related conclusions.

2. Image acquisition and preprocessing

In this section, we introduce how to acquire plant leaf and present the preprocessing procedure on the plant leaf. It's very necessary for later work of digital morphological feature extraction of plant leaf.

2.1. Acquisition of plant leaf

Plants can be usually identified according to the shapes, colors, textures and structures of their leaf, bark, flower, seedling and morph. However, it is very difficult for ones to analyze the shapes of flowers, seedling and morph of plants for their complex 3D structures if based on only 2D images. So in our research work, we will identify different plants by leaf features. Leaves are usually firstly clustered so that it is not easy for us to automatically extract features of leaves from the complex background. The leaf image database used in the following experiment is collected and built by ourselves in our lab. The procedure is that we pluck the leaf from plant, put it on the scanner, and then take the digital color image of the leaf directly, or put it on a panel, take digital color image of the leaf with a digital camera. In this way, we can get an image including only one leaf, and the background of the leaf image will be blurred.

This database includes 20 species of different plants. Each species includes 20 sample images. Hence there are totally 400 images with the database. The representative sample images for the 20 species in the database are shown in Figs. 1 and 2.

2.2. Leaf image preprocessing

The colors of plant leaves are usually green (as shown in Fig. 3(a)). Moreover, the shades and the variety of changes of water, nutrient, atmosphere and season can cause change of the color, so the color feature has low reliability. Thus, we decided to recognize various plants by the grey-level image of plant leaf (as shown in

Fig. 1. Different plant species in leaf database.