Chapter VII

Image Pattern Recognition–Based Morphological Structure and Applications

Donggang Yu
Bioinformatics Applications Research Centre, James Cook University, Australia

Tuan D. Pham
Bioinformatics Applications Research Centre, James Cook University, Australia

Hong Yan
City University of Hong Kong, Hong Kong

ABSTRACT

This chapter describes a new pattern recognition method: pattern recognition-based morphological structure. First, smooth following and linearization are introduced based on difference chain codes. Second, morphological structural points are described in terms of smooth followed contours and linearized lines, and then the patterns of morphological structural points and their properties are given. Morphological structural points are basic tools for pattern recognition-based morphological structure. Furthermore, we discuss how the morphological structure can be used to recognize and classify images. One application is document image processing and recognition, analysis and recognition of broken handwritten digits. Another one is dynamic analysis and recognition of cell-cycle screening based on morphological structures. Finally, a conclusion is given, including advantages, disadvantages, and future research.
INTRODUCTION

In intelligent information systems such as document and medical image processing, pattern recognition of images play an important role. The origin of character and shape recognition can be found as early as 1870, although it became a reality in the 1950s when computers were commonly used. For example, pattern recognition has wide applications in modern society: document reading and sorting, postal address reading, bank check reading, form recognition, writer recognition, signature verification, digital bar code reading, engineering drawing recognition, analysis and recognition of cells, face recognition, and shape recognition of various objects (e.g., ships, airplanes, etc.).

If postal codes can be recognized, then mail can be separated automatically in a processing system. In banks, a lot of checks need to be processed every day. One very hard task is that the dollar amount has to be input into computers by people. If these handwritten digits can be processed and recognized, one check processing system instead of people can do the job automatically.

One important problem is that there are broken and spurious segments caused by segmentation and threshold errors of noisy digits, the tools used or the writing style in handwritten digits in document images. In this case, it is difficult for most recognition methods to deal with them, including both structural and statistical approaches (Hu, 1998; Lee, 1996; Malaviya & Klette, 1996; Shi, 2002; Yan, 1993, 1994). In structural recognition method (Hu, 1998), it is difficult to describe the structure of the parts of broken segments of handwritten digits and spurious segments. If optimized nearest neighbor classifier (ONNC) (Yan, 1993) is used, the parts of broken segments of handwritten digits and spurious segments can influence training result. If the handwritten digits with broken and spurious parts belong to the test set, it is not easily recognized because there is a big difference between the digit shape and the normal digits.

In fact, it is based on the morphology structure of an object for a human to recognize an image. For example, if there are only two right-concave changes of one object skeleton, and the object is a digit based on prior knowledge, then the object is digit 3 for most of handwritten digit 3.

Morphological structure includes the morphology of lines, arcs, contours, and shapes. Also, all convex and concave changes have direction for each morphology change. Therefore, for the same shape of arcs, there are two directions: convex arc and concave arc. This chapter has made a new breakthrough in pattern recognition of images based on morphological structure. In this chapter, many new concepts of morphology description features are proposed; that is, contour smoothing following, smoothing of skeleton, linearization based on difference codes, structural points of contours, and description of morphological structures. Two applications, reconstruction and recognition of broken handwritten digits in document images and dynamic analysis and recognition of cell images, are described in detail.

SMOOTH FOLLOWING

Accurate representation and processing of the contour of a binary image play an important role in processing and recognition of images. For example, the result of thinning, curve fitting, contour following, polygon clipping, and mathematical morphology operations may depend on the contour shape of the image (Gonzalez & Woods, 1993; Freeman, 1961; Pavlidis, 1982; Rosenfeld, 1973).

In practical applications, the contour of a binary image is often corrupted by noise, which makes the recognition of the image unreliable. We propose an efficient method to smooth and linearize the contour of an image. Our method is developed based on a set of rules implemented