Chapter IV

Content-Based Trademark Recognition and Retrieval Based on Discrete Synergetic Neural Network

Tong Zhao
Carnegie Mellon University, USA

H. Lilian Tang
University of Surrey, United Kingdom

Horace H. S. Ip
City University of Hong Kong, Hong Kong

Feihu Qi
Shanghai Jiao Tong University, China

Synergetic Neural Network (SNN) as proposed by Hermann Haken is a novel top-down, self-organized system. In this chapter, its associated discrete SNN is proposed and the recognition stability and the convergence of a generalized discrete SNN is analyzed. We proposed an adaptive algorithm of iterative step length refinement for synergetic recognition, which can ensure fast convergence and network steadily for all kinds of input pattern. Additionally, we apply the SNN to trademark retrieval and study its ability to support affine invariant retrieval of 2D patterns. To this end, we propose an affine invariant input vector in the frequency domain for the SNN and evaluate the retrieval ability of such networks for different types of input queries, for example, query by complete trademark pattern and query by image components. We show experimentally that our proposed SNN method is noise

tolerant as well as able to support affine invariant retrieval. This led us to propose a novel paradigm for trademark retrieval based on visual keywords whereby trademark images can be queried in terms of simple geometric components.

INTRODUCTION

Image Retrieval

Image retrieval systems potentially find applications in areas such as engineering and architectural design, medical imaging (Lilian, Rudolf, and Ip, 1999), law enforcemant, journalism, fine art and fashion, and in trademark retrieval (Cheung, Ip, Lam, Hanka, Tang, and Fuller, 1999). At present, image retrieval techniques can be broadly classified into two categories based on the approach adopted for extracting the image attributes. *Spatial information-preserving* methods derive features that preserve the spatial information in the image. Representative techniques include polygonal approximation of the object of interest, deformable template matching (Del Bimbo and Pala, 1997) and shape modelling (Shen, Wong and Ip, 1999). *Nonspatial information-preserving* methods, on the other hand, extract statistical features that are used to discriminate among objects of interest. These include statistical approaches such as principal component analysis (Swets and Weng, 1996) and color histograms (Jain and Vailaya, 1996; Wu, Lam, Mehtre, Gao and Narasimhalu, 1996) and global features such as moment invariants (Ip, Cheung and Shen, 1998; Shen, Ip, Cheung, and Teoh, 1999).

Several content-based image retrieval systems have been recently proposed: QBIC (Flickner, et al., 1995), Photobook (Pentland, Picard and Sclaroff, 1996), STAR (Lam, Wu and Mehtre, 1995), MARS (Huang, Mehrota, and Ramchandran), etc. These systems follow the paradigm of representing images using a set of attributes, such as color, texture, shape, and layout, which are archived along with the images. Retrieval is performed by matching the features of a query image with those in the database. However, most of such existing techniques are either sensitive to occlusion and noise or computationally intensive. For querying a large image database, there are frequently tradeoffs between retrieval accuracy and speed. In this work, we investigate retrieval techniques based on synergetic neural networks that are both robust against noise and partial occlusions and capable of producing fast response to input queries.

Synergetic Neural Network

Neural network technology constitues a candidate that may offer effective solutions to image retrieval systems (Alwis and Austin, 1999). The incorporation of a neural network would provide several significant advantages over hardware implement, long-term memory, high degree fault-tolerance and learning and self-organizing capabilities, etc. As far as associative memory operations are concerned, a major drawback is that their capacity is a relatively small percentage of their size and their performance is sensitive to algebraic properties of stored patterns. And though this framework can capture perceptual similarity of trademark images to a certain extent, the high computational requirements creates the need for an efficient and low cost computational platform. Therefore, the scalability and the speed of computation of neural network would be the two main obstacles in its application to image retrieval.

Synergetics is an interdisciplinary field of research that is concerned with the spontaneous formation of macroscopic spatial, temporal, or functional structures of systems

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