

Chapter 20

Image Dimensionality Reduction Based on the Intrinsic Dimension and Parallel Genetic Algorithm

Liang Lei

Chongqing University, China

TongQing Wang

Chongqing University, China

Jun Peng

Chongqing University, China

Bo Yang

Chongqing University, China

ABSTRACT

In the research of Web content-based image retrieval, how to reduce more of the image dimensions without losing the main features of the image is highlighted. Many features of dimensional reduction schemes are determined by the breaking of higher dimensional general covariance associated with the selection of a particular subset of coordinates. This paper starts with analysis of commonly used methods for the dimension reduction of Web images, followed by a new algorithm for nonlinear dimensionality reduction based on the HSV image features. The approach obtains intrinsic dimension estimation by similarity calculation of two images. Finally, some improvements were made on the Parallel Genetic Algorithm (APGA) by use of the image similarity function as the self-adaptive judgment function to improve the genetic operators, thus achieving a Web image dimensionality reduction and similarity retrieval. Experimental results illustrate the validity of the algorithm.

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1. INTRODUCTION

The magnitude of the current Internet has already become huge, and it is still growing rapidly. The image set based on the Internet will be shown as a distributed image database in a striking size. Faced Web image retrieval, Internet users are usually reluctant to spend too much time to wait for search results. Rather, they are more in pursuit of image retrieval speed and accuracy. Therefore, Web image retrieval technology is focused on finding out a particularly efficient search algorithm in the premise of a considerable accuracy. Since image retrieval technology, as an application of artificial intelligence, play a pivotal role in a very important engineering application of computational Intelligence, i.e., pattern recognition and computer vision, the subject topic of this paper is within the broad scope of computational Intelligence.

In the content-based Web image retrieval, image dimension reduction is the key technology to improve retrieval efficiency. Under normal circumstances, the image feature vector has its dimensions in order of magnitude of 10^2 , while the performance of the index structure may rapidly decline as the number of dimensions increases. Especially in the higher dimension (>10), it is even less efficient than sequential scan. How to reduce more of the image dimensions without losing the main features of the image has become a hot spot in the research of Web content-based image retrieval. In this paper we focus on Similarity Calculation, between two images, by Adaptive Parallel Genetic Algorithm based on Random Operator (APGARO).

The paper is organized as follows. In Section 2, we described the commonly used methods for image dimension reduction. The dimensionality reduction method that is based on the HSV features was proposed in Section 3. We described in Section 4 parallel genetic algorithm. An Adaptive Genetic Operator based on Random Operator (AGORO) in Section 5 was used to achieve a Web image dimensionality reduction and similarity retrieval.

In Section 6, the results showed that this method has greatly improved the image retrieval in time and precision rates.

2. COMMONLY USED METHODS FOR IMAGE DIMENSION REDUCTION

Web Image Dimensional Reduction has a basic principle, that is, the sample is mapped to a low-dimensional space from the input space via a linear or nonlinear mode, and thus to obtain a compact low-dimensional expression on the original data sets. Traditional linear dimensionality reduction methods are featured with simplicity, easiness to explain and extendibility, etc., making it a major research direction in high-dimensional data processing. The existing linear dimension reduction methods include Principal Component Analysis (PCA) (Banerjee, 2009; Zhu, 2009; Zhang, 2009; Fan, 2008), Independent Component Analysis (ICA) (Rahman, 2009; Wang, 2009; Müller, 2009), Fisher Discriminated Analysis (FDA) (Zachary, 2000), Principal Curves, Projection Pursuit (PP), Local Linear Projection (LLP), as well as Self-Organizing Map (SOM) that is based on neural networks (Xiao, 2007). These methods are actually ways to find the best linear model under different optimization criteria, and this is also common to linear dimension reduction methods. However, with the advent of the information age, especially in the Web environment, a large number of high-dimensional nonlinear data will inevitably come along. Traditional linear dimension reduction methods are difficult to directly be used to analyze high-dimensional and non-linear data sourced from the real world. This may attribute to the following main reasons: the dimension of expansion leading to a rapid increase in computational complexity; high-dimensional may lead to a relatively small sample size, causing the statistical damage on some of the asymptotic properties; traditional methods in dealing with high dimensional data cannot meet the robustness requirements. There-

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