Vision Interface '99, Trois-Rivières, Canada, 19-21 May

Shape Retrieval from Image Databases through Structural Feature Indexing

Hirobumi Nishida
Software Research Center, Ricoh Co., Ltd.
1-1-17 Koishikawa, Bunkyo-ku, Tokyo 112-0002, Japan
hn@src.ricoh.co.jp

Abstract

Efficient and robust information retrieval from large image databases is an essential functionality for the reuse, manipulation, and editing of multimedia documents. Structural feature indexing is a potential approach to efficient shape retrieval from large databases, but it is sensitive to noise, scales of observation, and local shape deformations. To improve the robustness, shape feature generation techniques are incorporated into structural feature indexing. The feature transformation rules obtained by an analysis of some particular types of shape deformations are exploited to generate features that can be extracted from deformed patterns. Experimental trials with large image databases of boundary contours show that the feature generation significantly improves robustness and efficiency of shape retrieval.

1 Introduction

Efficient and robust information retrieval from large image databases is an essential functionality for the reuse, manipulation, and editing of multimedia documents [6, 15]. Images have several components in terms of information representation, such as color, texture, and shape [3]. Color and texture are mathematically and physically tractable, and their properties and variations can be represented in well-structured forms by some statistical methods [17]. On the other hand, shape is another essential component, but shape analysis and representation are still difficult research subjects in spite of intensive research carried out for decades. Feature indexing techniques [1, 5] are potential approaches to improving efficiency in shape classification and retrieval. However, they are known to be sensitive to noise and shape deformations, and their performance in terms of classification accuracy is degraded drastically even due to small changes of shapes [4].

Efficient and robust retrieval from large image databases by shape [8] is a challenging problem, and shape retrieval has been studied recently for improving efficiency and robustness. For structural organization of large image databases composed of boundary contours of objects, Del Bimbo [2] and Mokhtarian *et al.* [9, 10] apply the curvature scale-space approach to feature indexing, and Sclaroff [18] proposes a method for image indexing with the modal matching [20]. Furthermore, the structural indexing by Stein and Medioni [19] copes with noise and local shape deformations by extracting shape features from several versions of polygonal approximations of boundary contours. However, there are some technical questions against these approaches. The curvature scale-space method requires a large amount of computations for smoothing boundary contours with a number of different support sizes. Sclaroff's method requires the user to specify prototype shape sets spanning the shape space adequately, but this operation is obviously difficult for end-users. Stein-Medioni's method degrades the efficiency by generating a number of polygonal approximation from the boundary contours.

Efficiency and robustness are important, but sometimes incompatible criteria for performance evaluation. The improvement of robustness implies that the retrieval should tolerate certain types of variations and deformations for images. Obviously, it may lead to inefficiency if some brute-force methods are employed such as generating various images with a number of different parameters. A key to achieving both efficiency and robustness is through a compact and well-structured representation of images that tolerate variations and deformations.

In this paper, an efficient, robust method is presented for shape retrieval from image databases composed of boundary contours of objects. The method is mainly based on an indexing technique for structural features, along with a voting technique for ranking model images in terms of extracted features from the query image. In particular, shape feature generation techniques are incorporated into structural indexing to improve the accuracy and robustness of shape classification against noise and local shape transformations [14].