WATERSHED-DRIVEN REGION-BASED IMAGE RETRIEVAL

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Abstract This paper presents a strategy for content-based image retrieval. It is based on a meaningful segmentation procedure that can provide proper distributions for matching via the Earth mover's distance as a similarity metric. The segmentation procedure is based on a hierarchical watershed-driven algorithm that extracts automatically meaningful regions. In this framework, the proposed robust feature extraction plays a major role along with a novel region weighting for enhancing feature discrimination. Experimental results demonstrate the performance of the proposed strategy.

Keywords: content-based image retrieval, image segmentation, Earth Mover's distance, Region weighting

Introduction

Increasing amounts of imagery due to advances in computer technologies and the advent of World Wide Web (WWW) have made apparent the need for effective and efficient imagery indexing and search of not only the metadata associated with it (eg. captions and annotations) but also retrieval directly on the visual content. During the evolution period of Content-Based Image Retrieval (CBIR) research the major bottleneck in any system is the gap between low level features and high level semantic concepts. Therefore, the obvious effort toward improving a CBIR system is to focus on methodologies that will enable a reduction or even, in the best case, bridging of the aforementioned gap. Im-

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age segmentation always plays a key role toward the semantic description of an image since it provides the delineation of the objects that are present in an image. Although, contemporary algorithms can not provide a perfect segmentation, some can produce a rich set of meaningful regions upon which robust discriminant regional features can be computed. In this paper, we present a strategy for content-based image retrieval. It is based on a meaningful segmentation procedure that can provide proper distributions for matching via the Earth mover's distance as a similarity metric. In the underlying framework, a major role plays the proposed robust feature extraction along with a novel region weighting for enhancing feature discrimination. The segmentation procedure is based on a hierarchical watershed-driven algorithm that extracts automatically meaningful regions. This paper is organized as follows: In Section 1, we provide the state-of-the-art in the region-based CBIR approaches. Section 2 describes the proposed segmentation scheme that guides the image representation along with the proposed feature set which is extracted out of each region. Section 3 is dedicated to the description of the selected similarity metric and a novel region weighting factor while in Section 4 experimental results demonstrate the performance of the proposed CBIR strategy.

1. Related work

The fundamental aspects that characterize a region-based image retrieval system are the following : (i) the underlying segmentation scheme; (ii) the selected features for region representation; (iii) the region matching method and (iv) the user supervision.

In [8], the NeTra system is presented, where retrieval is based on segmented image regions. The segmentation scheme requires user supervision for parameter tuning and segmentation corrections. Furthermore, a one-to-one region matching is proposed after region selection by the user. In the same spirit, Blobworld system [1] is proposed, where a user is required to select important regions and features. As an extension to Blobworld, Greenspan *et al.* [4] compute blobs by using Gaussian mixture modeling and use Earth mover's distance (EMD) [12] to compute both the dissimilarity of the images and the flow-matrix of the blobs between the images. In [2], Fuh *et al.* use the idea of combining a color segmentation with relationship trees and a corresponding matching method. They use information concerning the hierarchical relationship of the regions along with the region features for a robust retrieval. In [16], an integrated matching algorithm is proposed that is based on region similarities with respect to a combination of color, shape and texture information. The proposed method enables one-to-many region matching. Hsieh and Grimson [5] propose a framework that supports a representation for a visual concept using regions of multiple images. They support one-to-many regions match-