Pattern Recognition 42 (2009) 386 – 394

Contents lists available at ScienceDirect

Pattern Recognition

journal homepage: www.elsevier.com/locate/pr

Trademark image retrieval using synthetic features for describing global shape and interior structure

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ARTICLE INFO

Article history:
Received 4 September 2007
Received in revised form 4 August 2008
Accepted 10 August 2008

Keywords:
Content-based image retrieval
Trademark image retrieval
Feature extraction
Zernike moments
Multimedia database

ABSTRACT

A trademark image retrieval (TIR) system is proposed in this work to deal with the vast number of trademark images in the trademark registration system. The proposed approach commences with the extraction of edges using the Canny edge detector, performs a shape normalisation procedure, and then extracts the global and local features. The global features capture the gross essence of the shapes while the local features describe the interior details of the trademarks. A two-component feature matching strategy is used to measure the similarity between the query and database images. The performance of the proposed algorithm is compared against four other algorithms.

1. Introduction

With the rapid increase in the amount of registered trademark images around the world, trademark image retrieval (TIR) has emerged to ensure that new trademarks do not repeat any of the vast number of trademark images stored in the trademark registration system. As the traditional classification of trademark images is based on their shape features and types of object depicted by employing manually assigned codes, faults or slips may appear because of different subjective perception of the trademark images. Evidence has been provided that the traditional classification is not feasible in dealing with a large fraction of trademark images with little or no representational meanings [1].

Trademarks can be categorised into a few different types. A trademark can be a word-only mark, a device-only mark or a device-and-word mark. For a word-only mark, the design of the trademark consists purely of text words or phrases. However, for a device-only mark, the trademark only contains symbols, icons or images. If a trademark comprises both words and any iconic symbols or images, it can be regarded as a device-and-word mark [2]. Since different algorithms have to be used in describing different kinds of trademark images, a trademark image retrieval system can only be designed to accommodate one of the types. Although several trademark image retrieval systems have been designed to handle all kinds of trademark images, the performance of these systems are rather unfavourable when compared to those systems that are specifically designed to handle only one kind of trademark. Another challenge in trademark image retrieval is the difficulty in modeling human perception about similarity between trademarks. As human perception of an image involves collaboration between different sensoria, it is in fact difficult to integrate such human perception mechanisms into a trademark image retrieval system.

The contributions of this paper are summarized as follows: (1) novel algorithms are proposed to describe the shape of device-only marks and device-and-word marks; (2) a two-component feature matching strategy is applied to compare global and local features; (3) this study not only evaluates the proposed method, but also investigates the retrieval performance of another four algorithms.

The rest of this paper is organized as follows. Section 2 reviews the related studies regarding the existing trademark image retrieval systems and techniques. Section 3 provides an overview of the proposed system architecture. Section 4 presents the algorithms proposed for extracting global and local features of trademarks. Section 5 describes a two-component matching strategy for measuring similarity between trademarks. Section 6 evaluates the performance and analyses the results. Finally, conclusions are drawn in Section 7.

2. Existing trademark retrieval systems

There are several remarkable trademark image retrieval systems that have been developed in recent years. TRADEMARK [3], STAR [4]

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doi:10.1016/j.patcog.2008.08.019

and ARTISAN [5] are three of the most prominent trademark image retrieval systems. Different methodologies have been employed in these trademark systems. The TRADEMARK system uses graphical feature vectors (GF-vector) to interpret the image content automatically and calculates the similarity based on human perception [3]. The STAR system adopts mainstream content-based image retrieval (CBIR) techniques. The techniques adopted in this system include the Fourier descriptors, grey level projection and moment invariants. The STAR system works by considering both shape components and the spatial layout of an image [4]. However, the recognition of some perceptually significant components has been considered to be too difficult to be done by an automated process [1]. Therefore, to a certain extent, manual operation is needed for the segmentation of some abstract trademark images. The ARTISAN system, however, introduces an innovative approach that incorporates principles derived from Gestalt psychology to cope with device-only marks which consist of some abstract geometric designs [5].

Apart from the TRADEMARK, STAR and ARTISAN trademark image retrieval systems, a significant amount of research work has also concentrated on trademark or logo image retrieval. Hussain and Eakins [6] employed the topological properties of the self-organising map for similarity retrieval from a trademark image database. Cerri et al. [7] utilised geometrical–topological tools for describing trademark shapes and matching their similarity based on size functions of the trademarks. Jiang et al. [8] presented a new approach by using the adaptive selection of visual features with different kinds of visual saliencies, including symmetry, continuity, proximity, parallelism and closure property of the trademark images. Hung et al. [9] exploited the contour and interior region for retrieving similar trademark images. Petrakis et al. [10] utilized relevance feedback for logo and trademark image retrieval on the web. Shen et al. [11] used block feature index to describe trademark shape. An enhanced normalisation technique for the wavelet shape description of trademarks was developed by Li and Edwards [12]. Kim and Kim [13] used Zernike moments as shape descriptor and conducted experiments based on the MPEG-7 core experiment procedure. Improved performance was reported when compared to other methods based on various shape descriptors; however, Zernike moments can only describe global shape. This leaves room for further improvement. Jain and Vailaya proposed another trademark retrieval system [14], using the histograms of edge directions as shape descriptor. Although the descriptor is invariant to translation, as the authors have indicated, it is not invariant to scaling and rotation. The performance in terms of accuracy and time complexity is also sensitive to the size of histogram bins. Moreover, like Ref. [13], the descriptor cannot represent local features. In addition to the aforementioned methods, the reader is referred to Ref. [15–24] for earlier studies on trademark image retrieval.

3. Overview of the proposed system

Our trademark image retrieval system consists of an *offline database construction* part and an *online image retrieval* part as shown in Fig. 1. The offline database construction part is intended to ensure high retrieval efficiency by extracting a feature set for each of the images in the database in an offline manner and storing the feature set along with its corresponding image in the database so that when a query image is presented to the system, the system does not have to perform online feature extraction on each database image.

To access the database, the user initiates the online image retrieval process by providing a query image as input, and then the system starts with extracting the features from the query image. Afterwards, the system measures the similarity between the feature set of the query image and those of the images stored in the database. Finally, the system ranks the relevance based on the similarity and returns the results to the user.

4. Feature extraction

As shown in Fig. 1, feature extraction has to be done in both offline database construction and online image retrieval processes. Feature extraction is about extracting from an image a set of attributes/features that can feasibly describe/represent the image in order to facilitate the ensuing feature matching and ranking processes. The feature extraction stage in the proposed algorithm involves image pre-processing and feature representation as shown in Fig. 2. The purpose of the image pre-processing module is to detect the edges in order to pave the way for the feature representation module. The task of the feature representation module is to extract a *set of feature descriptors* (also called *feature vector*) of the images from their corresponding edge maps generated by the image pre-processing module. In this work, we divide the feature descriptors into a subset of *local* features descriptors and a subset of *global* features descriptors. As tabulated in Table 1, the global feature vector is intended to capture the gross essence of the shape of the trademark while the local feature vector is meant for capturing the interior details of the trademark in the edge map. In this work, *curvature* and *distance to centroid* are used for describing the local features, whereas *Zernike moments* are employed to extract the global features of the images. Detailed descriptions regarding the image pre-processing procedure,

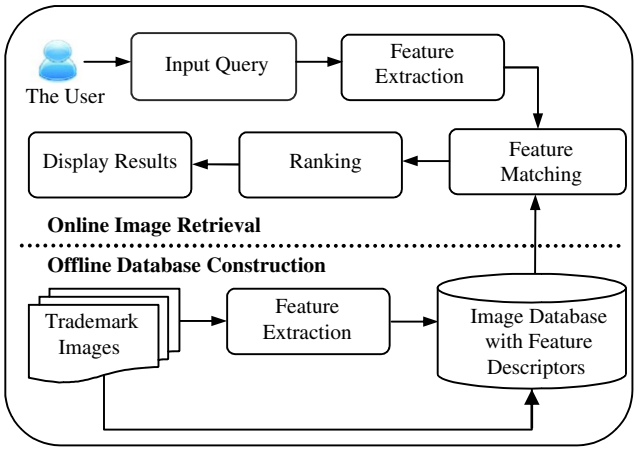

Fig. 1. The architecture of the proposed trademark image retrieval system.

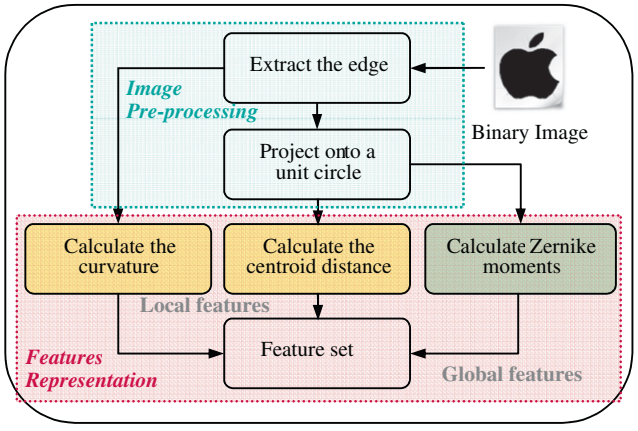

Fig. 2. The feature extraction stage of the proposed algorithm.