Cross-Checking-Based Trademark Image Retrieval for Hot Company Detection

Hao Wu, Beijing Normal University, China

Zhiyi Zhang, Beijing Normal University, China

Zhilin Zhu, Shandong Technology and Business University, China*

ABSTRACT

A trademark is an essential symbol of a company, consisting of a semantically rich image under ordinary circumstances. The popularity of a company can be measured by the frequency of its trademark being used. Therefore, efficiently retrieving trademark images would directly contribute to the detection of popular companies. However, most mainstream retrieval methods are not especially pertinent to trademark image retrieval. To solve this problem, a combination of the ResNet50 network and Autoencoder with local sensitive hashing (LSH) is used to conduct full cross-checking, which significantly improves the effectiveness of trademark image retrieval. Meanwhile, image super-resolution-based sparse coding is also proposed to achieve high-precision trademark image retrieval and its effect is particularly significant for challenging trademark images. Finally, the authors conduct extensive experiments on a high-quality database to demonstrate the substantial effectiveness of the proposed methods.

KEYWORDS

Autoencoder with LSH, hot company detection, image super-resolution, ResNet, sparse coding, trademark image retrieval

1. INTRODUCTION

With rapid changes occurring in the global economy and ways of doing business, the fortunes of companies and industries are also changing rapidly. Researchers, investors, and policy-makers are keen to face these changes proactively. They invest a great deal of resources to collect and analyse data to understand business performance and, more importantly, to predict the future of a company. One important measurement of a company's performance and its potential is its popularity with the general public. In particular, if a company's trademark appears frequently, it can indicate that the company is highly popular. Consequently, retrieving trademark images efficiently and accurately is becoming increasingly important.

Image retrieval technology has gone through three stages of development: text-based image retrieval (TBIR), content-based image retrieval (CBIR), and semantic-based image retrieval. TBIR is

known as "searching images by tags". This method is simple but time-consuming and labour-intensive because tags and indices such as titles, authors, and other metadata attributes are added by manual annotation. There were enormous amount of trademarks registered worldwide (World Intellectual Property Organization, 2018). Since the volume of digital image data on the internet has increased rapidly, along with the number of trademark images, TBIR is unsuitable for trademark retrieval from the internet where images lack annotation.

In contrast to TBIR, CBIR uses features that can be extracted automatically to retrieve images, avoiding the subjectivity of manual description, and improving retrieval efficiency. Low-level visual features include colour, texture, shape, etc., and different feature representations require different similarity measurement methods. Colour is the most intuitive physical feature of colour images; the methods available to describe colour include colour histograms (Swain & Ballard, 1991), colour correlograms (Huang et al., 1997), and colour coherence vectors (Pass et al., 1997). Texture is a measurement of the relationship between pixels in a local area; its purpose is to describe the spatial distribution of grey levels in the neighbourhood of pixels. Shape descriptors are even more important than colour or texture descriptors and can be grouped into contour-based and region-based approaches. The former uses image boundary information, while the latter uses information on the grey distribution in a certain area. The Fourier descriptor (Del Vecchio & Salvini, 2000) is one of the most commonly studied and used contour-based shape descriptors. It is characterized by good computational performance and is easy to normalize. However, it is unable to capture the local representation of shapes and is sensitive to boundary noise and variations, leading to the Gibbs phenomenon when used to reconstruct complex trademarks.

In addition to low-level features, images can be analysed according to their high-level semantic content, i.e., what they conceptually represent. Machine learning and neural network models such as AlexNet (Krizhevsky et al. 2017), VGGNet (Simonyan & Zisserman, 2014), Inception V4 (Szegedy et al., 2017), ResNet (He et al, 2016), and DenseNet (Huang et al., 2017) have been widely used due to their strength in extracting highly semantic and abstract features and realizing nonlinear feature mapping (Perez et al., 2018). Some methods achieve improved performance through deep learning. An end-to-end model (Mafla et al., 2021) combines text and visual features to achieve fine-grained classification and image retrieval through a multimodal inference module. Recently, more novel deep learning models have been proposed. CVNet (Lee et al., 2022) adopts geometric verification after a global search with global descriptor matching and local feature matching. Global search quickly performs a rough search across the entire database, and geometric validation reorders the results of a rough search by precisely assessing only the candidates identified by the global search. ViT-Slim (Chavan et al., 2022) replaces the convolutional neural network in network slimming with a transformer to realize more flexible and efficient visual retrieval and classification. Zhao et al. drew on the idea of dense retrieval, discretized images and texts into tokens, and aligned them across modalities, greatly improving the efficiency of large-scale graphic retrieval (2023).

In the retrieval of trademark images, the characteristics of the trademark image should be fully considered. Traditional image retrieval methods are difficult to apply directly to trademark image retrieval. Although the improved sparse coding-based method (Sun et al., 2019), spatial pyramid matching-based method (Lazebnik et al., 2006), and GIST-based similarity calculation method (Hays & Efros, 2007) can achieve image retrieval with relatively few reference images, there are still certain limitations in their application. Therefore, we are attempting to draw on the advantages of traditional methods as much as possible and optimize them according to actual needs. Many practical methods (Bao et al, 2021; Zou et al., 2022; Trappey et al., 2021) have been proposed by experts and applied to solve practical problems, achieving convincing results in their fields of application. Although the above methods cannot be directly used to solve our problem, their entire strategy can serve as a reference.

As a classic network model, ResNet performs well for image feature extraction. Its small parameter count makes model loading and weight training fast. In addition, the pretrained ResNet50 model, trained on a large set of open-source image data, is recognized as a high-performing feature extraction

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