

行政院國家科學委員會專題研究計畫成果報告

商標檢索系統

A New system for Trademark Images Segmentation and Retrieval

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中文摘要

隨著商標數量的大量增加，商標模倣的問題已變得日益嚴重。因此如何建立一個有效的商標檢索系統，讓使用者可以利用此一系統快速地找到在大型商標資料庫中相似的商標，是目前重要的研究方向。因此在這個計畫中我們將提出一個全自動的商標檢索系統，此系統將包含三個部份，商標分割(trademark segmentation)、特徵擷取(feature extraction)、和商標檢索(trademark retrieval)。

關鍵詞：商標檢索、商標分割、特徵擷取

Abstract

With the increasing of large number of trademarks, the problem of trademark imitation becomes serious. Thus, to build an efficient similar-trademark retrieval system is imperative. In this project, such a system will be presented. It will consist of three parts: segmentation, feature extraction, and retrieval.

Keywords: Trademark Retrieval, Trademark Segmentation, Feature Extraction

1. Introduction

There are some content-based trademark retrieval systems such as "Trademark Retrieval" of IBM's Query-by-Image-Content (QBIC) [1-3] and "Trademark and Art Museum Applications" from ETL [4-5]. A demonstration version of the QBIC system is available at <http://www.qbic.almaden.ibm.com>. In our experiments, we found that the QBIC system does not work very well, since in the query process some similar trademarks can not be retrieved properly. Kim also introduced a content-based trademark retrieval system [6]. The system uses the Zernike moment magnitudes (ZMMs), which are rotation invariant and robust to noise and shape deformation, of an image as the features. But the ZMMs are only suitable for circular symmetry shapes. Mehtre [7,14] proposed a color clustering algorithm and a shape clustering algorithm to find the connected components in a trademark and used some invariant moments as the features for trademark retrieval.

Some methods [8-9] use the histogram of the edge directions of the shape boundary in a trademark as the feature. However, the histogram does not contain the location information. Some boundary information is used for image retrieval, including the boundary matching algorithm [10], Fourier descriptor [11] and multiscale curve matching [12], etc. All of these depend on the accurate detection of the shape boundary. If there are some small cracks or overlap in the components of a trademark, the retrieving result will be much different. Moreover, the Fourier descriptor and curve matching method will not work well for those trademarks with complex boundary. To treat these problems, in this paper we will provide a new system for visually trademark retrieval. The system includes three phases including the trademark segmentation phase, the feature extraction phase, and the trademark retrieval phase.

2. Trademark Segmentation

In the trademark segmentation method, some primary functions including "Region-growing", "Region-delete", "Draw-black-line" and "Draw-white-line" are provided. In the functions of "Region-growing" and "Region-delete", a connected component can be found by the Region-Growing algorithm [13] while the seed of the Region-Growing algorithm is selected by the user.

3. Feature Extraction

In this paper, a composite feature set that is invariant to rotation, translation, scaling, and insensitive to deformation of the object will be used for trademark retrieval.

3.1 Invariant Moments

The seven invariant moments proposed by Hu[13] have been used as features to search for a similar mask. Note that the seven moments are invariant to rotation, scaling, and translation. For each mask s , the feature vector of the invariant moments is defined as $Mom_s^1, Mom_s^2, Mom_s^3, \dots, Mom_s^7$.

3.2 Polar-coordinate Transform, Edge detector, and Fourier Transform

First, through the polar-coordinate transform, the Cartesian coordinate of a pixel at (x, y) can be transformed to the polar coordinate $(\mathbf{r}; \mathbf{q})$. The Edge detector is then applied to get the one-pixel-width edges. Note that a scaling in the Cartesian coordinate plane becomes a translation along the \mathbf{r} -axis and a rotation becomes a translation along the \mathbf{q} -axis. Let $Lap_s(m, n)$ represent the edge detection result for mask s , $m = 0, 1, \dots, 63$, $n = 0, 1, \dots, 63$, and $Lap_s(m, n) = 0$ or 255 . Note that (m, n) is the sample point on $(\mathbf{r}; \mathbf{q})$ plane.

After performing the polar-coordinate transform and the edge detection, we will then find the first derivative of the extracted edge. For a mask s , a one-pixel-width white curve $\ell_s(n)$ in the edge detection result is defined as

$$\ell_s(n) = k,$$

$$\text{where } k = \min_m \{ m \mid Lap_s(m, n) = 255 \} \quad \text{and } n=0,$$

1, ..., 63. The first derivative of $\ell_s(n)$ is defined as

$$der_s[n] = (\ell_s(n) - \ell_s(n+1) + c_1) \times c_2,$$

where c_1 and c_2 are constants. Then, the first-derivative image can be represented by $Der_s(m, n)$, $m = 0, 1, \dots, 63$, $n = 0, 1, \dots, 63$, and

$$Der_s(m, n) = \begin{cases} 255 & \text{if } der_s[n] = m, \\ 0 & \text{otherwise.} \end{cases}$$

The Fourier transform[14] is then applied to $Lap_s(m, n)$ and $Der_s(m, n)$. The two resulted mages are expressed as $F_Lap_s(m, n)$ and $F_Der_s(m, n)$ that are used as the second and third feature vectors.

3.3 Histogram of Edge Directions

The histogram of edge directions as a feature vector to search for similar masks which may have different mass centers. The edge direction, \mathbf{a}_{w_0} , of each edge point \mathbf{w}_0 can be evaluated by

$$\mathbf{a}_{w_0} = \tan^{-1} \left(\frac{y' - y''}{x' - x''} \right),$$

where (x', y') and (x'', y'') are the coordinates of the two neighboring edge points of \mathbf{w}_0 . The edge direction histogram is defined as $Edge_His_s(h)$, $h = 0, 1, \dots, 7$, which is considered as the fourth feature vector.

4 Trademark Retrieval

The retrieving process will be time consuming for a very large trademark database. Thus, we will propose

a pruning process to get rid of those masks with very different shapes from the query one. In fact, the pruning process can reduce the searching time as well as the possibility of finding improper masks. Finally, based on the feature vectors described in the previous section to perform similar trademark retrieval.

4.1 The Pruning Process

In general, similar masks will have similar *OPM*. Thus, if the *OPM* difference, $OPM_dif_{q,s}$, between two masks q and s is very large, these two masks should have different density. By dividing EB_s into four enclosing subblocks, the occupying proportion of the mask s in each subblock can be defined as $OPS_{s,j}$, $0 \leq j \leq 3$. The *OPS* difference between two masks q and s is evaluated as $OPS_dif_{q,s}$. In additional, based on *OPS*, the correlation between two masks q and s also can be defined as $OPS_cor_{q,s}$.

4.2 The retrieval method

For a query mask q and any matching mask s , the distance for each feature vector can be defined as

$$Dis_Mom_{q,s}$$

$$= \sum_{j=1}^7 \mathbf{w}_{m_j} * \left| Mom_q^j - Mom_s^j \right|,$$

$$Dis_Lap_{q,s}$$

$$= \sum_{m=0}^{63} \sum_{n=0}^{63} \left| F_Lap_q(m, n) - F_Lap_s(m, n) \right|,$$

$$Dis_Der_{q,s}$$

$$= \sum_{m=0}^{63} \sum_{n=0}^{63} \left| F_Der_q(m, n) - F_Der_s(m, n) \right|,$$

$$Dis_Edge_His_{q,s}$$

$$= \sum_{h=0}^7 \left| Edge_His_q(h) - Edge_His_s(h) \right|$$

where \mathbf{w}_{m_j} , $j=1, 2, \dots, 7$, are the weights for the seven

moments. For each matching mask s , the sum of these distance is defined as

$$Dis_{q,s}^{total} = \mathbf{w}_1 Dis_Mom_{q,s} + \mathbf{w}_2 Dis_Lap_{q,s} + \mathbf{w}_3 Dis_Der_{q,s} + \mathbf{w}_4 Dis_Edge_His_{q,s},$$

where $\mathbf{w}_1, \mathbf{w}_2, \mathbf{w}_3$ and \mathbf{w}_4 are the weights and $\mathbf{w}_1 + \mathbf{w}_2 + \mathbf{w}_3 + \mathbf{w}_4 = 1$. A group of similar masks can be found using the value of $Dis_{q,s}^{total}$.

How to choose a set of proper weights will affect the retrieval results. Here, we will propose a feedback algorithm to automatically determine the weights depending on the user's response. Using these new weights, a user can get the second retrieval results.

The new retrieval results will be more similar to what the user really wants. Users can interactively search for similar masks until the retrieval results are satisfactory.

5. Experimental Results

In our experiments, there are 306 trademark images in our database, which is similar to the USPTO's trademark database used by IBM's QBIC system. For each query mask, four similar masks and their corresponding trademarks will be found. Then, users can select some similar masks from the recent retrieval results and query again. The interactive response will make the retrieval results more satisfactory to the users.

Since it is hard to decide what kinds of masks are similar by a single person, we do not calculate the recognition rate for each trademark. Here, we will show some retrieval result of query masks using our system and the QBIC system. In Fig. 1, the first column contains the indexing number. The second column shows the query masks. The third and fourth columns show four most similar marks retrieved by our system and the QBIC system, respectively. According to the grade of each mask, the first mask in the third column is the most similar mask, the second mask is the second similar mask, and so on. From the experiment results, we can see that the proposed system outperforms the QBIC system.

6. Conclusions

In this paper, an efficient and effective trademark retrieval system is proposed. In addition, we have proposed a semi-automatic trademark segmentation method to extract the desired masks from a trademark image. In order to accelerate the retrieval speed, a pruning process is provided. Next, a grade evaluation method is proposed to measure the similarity between two masks. Finally, we have introduced a feedback algorithm to interactively determine the weights of features. The experimental results show that the proposed system is very efficient and outperforms IBM's QBIC system.

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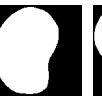
































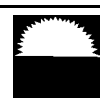



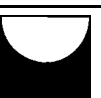
















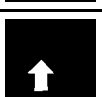



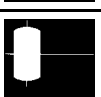

	Query mask	Similar mask (the proposed system)				Similar mask (QBIC system)			
1									
2									
3									
4									
5									
6									
7									

Fig. 1 Comparison the retrieval results by the proposed system and IBM's QBIC system.