A Method for Copyright Protection of Line Drawings

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Abstract

In this paper, we propose a method for copyright protection of line drawings using image retrieval. By matching local features, we achieve detecting not only printed but also handwritten partial copies of line drawings from complex backgrounds. We have proved the effectiveness of the proposed method based on a database of 11,600 line drawings.

1. Introduction

Line drawings, such as graphs, logos and comics, are an important part of image publications. Therefore, there is a great requirement for copyright protection of line drawings. Because of enormous volume of copyrighted line drawings, automatic copyright detection system is an ideal solution for the problem of illegal copies.

In practice, illegal users often utilize interest parts of the original images instead of using the whole ones, which are called partial copies. Since line drawings consist of distinct lines, they can be copied easily by handwriting. In addition, partial copies are sometimes embedded into unknown backgrounds. Therefore, an applicable copyright protection method should be available under all these conditions.

Since line drawings are with less color, digital watermarking is difficult to be applied in an unperceived way. Therefore, Sun et al. [1] have proposed using image retrieval by local feature matching to detect printed and handwritten partial copies of line drawings. Though the method achieved a high detection rate for both printed and handwritten partial copies of line drawings, it is time-consuming, which prevents it from being applied in practice.

In this paper, we propose a method to detect printed and handwritten partial copies of line drawings and proved that the proposed method can perform as good as the previous method on line drawings detections with less detection time.

2. Proposed Method

Using local feature matching we propose to detect the illegal copies of line drawings. As shown in Fig. 1, the process of local feature matching is divided into two parts. In the part of database processing, database feature vectors are extracted from database images using a region detector and a feature descriptor. The feature vectors are stored in the feature vector database with their image IDs. In the part of detection processing, using the same region detector and the feature descriptor, query feature vectors are extracted. By matching query feature vectors with the feature vectors in database, we obtain the votes for each image ID. The images with the IDs, which received more votes, are reported as copied images. For image copyright protection, copyrighted images are collected for database images, and suspicious images are treated as query images.

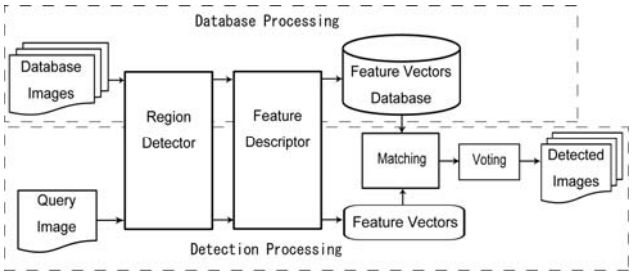

Figure 1: Process of local feature matching.

For detecting the handwritten copies of line drawings, we apply the method of using MSER (Maximally Stable Extremal Regions) [2] as a region detector and HOG (Histogram of Oriented Gradients) [3] as a feature descriptor, and obtain HOG feature vectors of 2,916 dimensions [1]. To reduce the memory and time for detection, first, we apply PCA (Principal Component Analysis) [4] to HOG feature vectors and obtain PCA-HOG feature vectors of 100 dimensions. Then, for matching the feature vectors, we apply a hash based method proposed by Kise et al. [5] for matching PCA-SIFT feature vectors, instead of ANN (Approximate Nearest Neighbor) [6], which is utilized in Sun's method.

3. Experimental Results

3.1 Condition

We utilized comic pages (about 650 x 100 pixels) as our

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database images, and made two kinds of partial copies: handwritten copies and printed copies with the size of 300 x 300 pixels. Also, we prepared comic pages (about 840 x 1200 pixels) as backgrounds for queries, which are not contained in database images. The top 5 images, which received more votes, are treated as results. The detection time is average time for detecting one image without extraction time of feature vectors. All the experiments were performed on a computer with AMD Opteron 2.8GHz and 64GB RAM.

3.2 Experiment 1

First, we compared the proposed method with Sun's method by detecting printed and handwritten partial copies without backgrounds based on a database of 1,000 comic pages. The results are shown in Tables 1 and 2.

We can see that the proposed method performed much faster than previous method with a similar detection rate.

3.3 Experiment 2

In this experiment, we tested the effectiveness of the proposed method based on a database of 11,600 comic pages. The queries are partial copies with and without backgrounds. The results are shown in Tables 3 and 4.

We can see that the proposed method is applicable for a larger database, and achieved 80% for detecting the partial copies from backgrounds as shown in Fig. 2.

4. Conclusions

In this paper we propose a method to detect the partial copies of line drawings. From the experimental results, we have proved the effectiveness of the proposed method.

Future work is to improve the detection rate.

Table 1: Detection results for printed copies based on a database of 1,000 images.

	Detection rate	Detection time
Proposed method	99%	90 ms
Previous method	99%	9,165 ms

Table 2: Detection results for handwritten copies based on a database of 1,000 comic images.

	Detection rate (%)	Detection time
Proposed method	94%	75 ms
Previous method	95%	6,013 ms

Table 3: Detection results for printed copies based on a database of 11,600 images.

	Detection rate	Detection time
No background	99%	930 ms
With background	98%	15,688 ms

Table 4: Detection results for handwritten copies based on a database of 11,600 images.

	Detection rate	Detection time
No background	93%	494 ms
With background	80%	8,846 ms

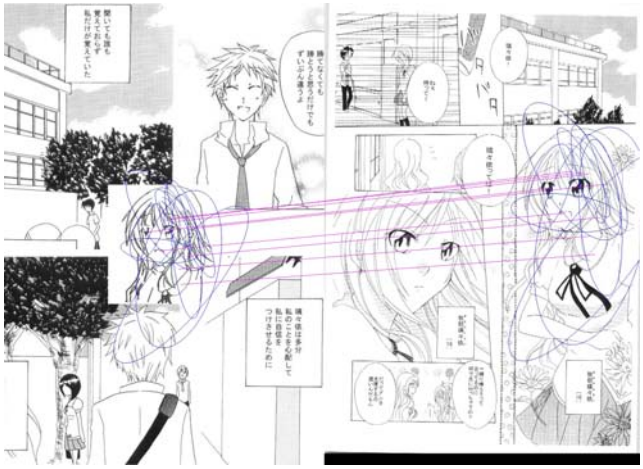

Figure 2: Sample of matching.

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