A citation-based review of study on image retrieval

Yuehua Zhao[1], Yanyan Wang[1], and Xin Cai[1]

[1] University of Wisconsin-Milwaukee, Milwaukee WI 53211, USA
`yuehua@uwm.edu`

Abstract. Driven by the development of the information retrieval technologies, image retrieval has been studied for more than several decades. This study centers on revealing the current status and future directions based on the review of previous studies on image retrieval. The citation-based analysis was applied to 2243 articles retrieved from Web of Science database. The time series plots of the citation relationships between the retrieved articles reveal a fundamental research article that lay the foundation for the study of image retrieval. Co-citation analysis identifies that the existing studies formed two clusters. Each cluster represents one of the two major areas in the field of image retrieval: the text-based image retrieval and the content-based image retrieval. The visualization map shows that the research of content-based image retrieval has received more attention than the area of text-based image retrieval. Relevance feedback was identified as a promising research direction for the future study.

Keywords: Image retrieval, Review, Visualization.

1 Introduction

Image retrieval has been a very active research area since the 1970s, with the thrust from two major research communities, database management and computer vision [1]. These two research communities study image retrieval from different angles: one being text-based and the other being visual-based [1]. Multiple image retrieval systems have been developed based on different approaches in recent years, e.g. QBIC (Query By Image Content), MARS (multimedia analysis and retrieval system), and RetrievalWare [2].

2 Methods

In order to approach the overview of the research on image retrieval, "(image* retriev*) or (retriev* image*)" was used as the search queries in the title field to be retrieved in the Web of Science database. The search time span was set as "from 1987 to present", which is the full coverage of the database. In total, 2243 articles were returned.

CitespaceII was employed to conduct the citation-based visualization analysis on the retrieved dataset. CiteSpaceII is a java application developed for analyzing and

visualizing emerging trends and changes in scientific literature based on citation analysis [3]. The nodes in the map represent the articles, while the size of the nodes shows the citation frequency and the lines between each node show the co-citation relationship between each paper.

3 Results

Image retrieval visualization has been studied for more than four decades [1]. Base on the retrieved dataset, the frequency of annual citation shows a continuing rapid growth since 1987, It suggests the overall research interests in the study of image retrieval has been continuing over the last 30 years.

3.1 Research foundation

Figure 1 shows the time-zone map that displays the time series plots of the citation relationships between the retrieved articles. The time zone map presents the research history or evolving path of the field of image retrieval. In Figure 1, the most important articles within each period are shown as the largest nodes in each time span.

Papers appearing in the first time span identified the fundamental research in this field. In the lower-left corner of Figure 1, we can find out that the study on image retrieval can be traced back to the article "Visual pattern recognition by moment invariants" written by Ming-Kuei Hu in 1962. In this paper, the theoretical formulation and practical models of visual pattern recognition are discussed [4]. The theorem of recognition of visual patterns and characters laid the foundation of the following research on the image retrieval.
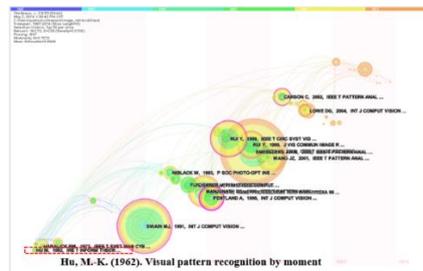

Fig. 1. The time-zone map of research on image retrieval

3.2 Current status

Figure 2 presents the articles cluster map between the papers in this field based on the co-citation relationship. Two clusters come up from the map represent the two primary areas in the study on image retrieval: text-based image retrieval and content-based image retrieval.

The cluster 1 in Figure 2 consists of the studies on the text-based image retrieval. Text-based image retrieval is conducted based on the manually added annotations (e.g. keywords, descriptions) to disclose the images [5]. A very popular framework of image retrieval then was to first annotate the images by text and then use text-based database management systems to perform image retrieval [5]. However, there exist two major limitations: (1) the large labor requirement in manual image annotation, and (2) the subjectivity of human perception towards the images.
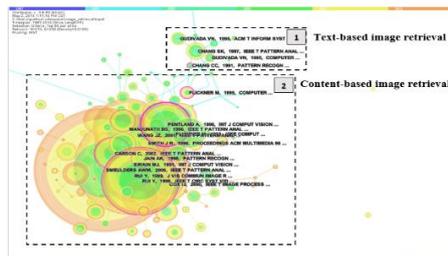
Fig. 2. The articles cluster map of the current research

As shown in Figure 2, cluster 2 consists of studies focusing on the content-based image retrieval. In the early 1990s, content-based image retrieval was proposed to overcome the two challenges faced by the text-based image retrieval with the emergence of large-scale image collections [5]. Content-based image retrieval systems index images by the visual content (e.g. color, texture) instead of the manually assigned text-based keywords. Since then, the development of visual feature representation techniques and systems contributed to the advance in content-based image retrieval area.

Each of the two clusters appears to be consistent with a research perspective pointed by Yong Rui and Thomas S. Huang [1]. As we can see from Figure 2, the colors of the nodes in cluster 1 are mainly green, which mains these studies are relatively old. The sizes of the nodes in cluster 2 are larger and the colors are more close to yellow, which mains much more dedications have been put into the research of content-based image retrieval rather than text-based image retrieval.

3.3 Promising directions

Figure 3 displays a keywords time-zone map of research history of image retrieval. The keyword "relevance feedback" was detected as the burst term by the software, which means the study related to the relevance feedback has been highly cited within a short time period and indicates this topic will be a hot topic in the future.

Relevance feedback is the process of automatically adjusting an existing query using the information feedback by the user about the relevance of previously retrieved objects such that the adjusted query is a better approximation to the user's information need [6]. Relevance feedback techniques have been one of the major advances in the user interaction techniques for image retrieval. In the relevance-feedback-based approach, the retrieval process is interactive between the computer and the human [6].
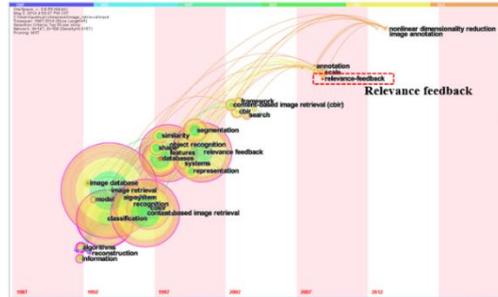
Fig. 3. The keywords time-zone map of research history

4 Conclusion

This study presents a review of the literature on image retrieval over the past 30 years. The research history and current status of image retrieval have been investigated and displayed through the visualization methods. Citation-based analysis unveils a fundamental research piece inspired the image retrieval research. The existing studies of image retrieval have been focused on two areas: text-based image retrieval and content-based image retrieval. Researchers moved from text-based image retrieval towards to content-based image retrieval. Relevance feedback is identified as a promising research direction. Ritenara Datta and his colleagues also suggested the relevance feedback as one of the merging interests for future research on image retrieval [7].

References

1. Rui, Y., Huang, T. S., & Chang, S.-F. (1999). Image Retrieval: Current Techniques, Promising Directions, and Open Issues. Journal of Visual Communication and Image Representation, 10(1), 39–62.
2. Rui, Y., Huang, T. S., Mehrotra, S., & Ortega, M. (1997). Automatic Matching Tool Selection Using Relevance Feedback. In: Proceedings of 2nd International Conference on Visual Information Systems.
3. Chen, C., Ibekwe-SanJuan, F., & Hou, J. (2010). The structure and dynamics of cocitation clusters: A multiple-perspective cocitation analysis. Journal of the American Society for Information Science and Technology, 61(7), 1386–1409.
4. Hu, M.-K. (1962). Visual pattern recognition by moment invariants. IRE Transactions on Information Theory, 8(2), 179–187.
5. Karthikeyan, T., Manikandaprabhu, P., & Nithya, S. (2014). A survey on text and content based image retrieval system for image mining. International journal of engineering research & Technology, 3(3), 509-512.
6. Rui, Y., Huang, T. S., Ortega, M., & Mehrotra, S. (1998). Relevance feedback: a power tool for interactive content-based image retrieval. IEEE Transactions on Circuits and Systems for Video Technology, 8(5), 644–655.
7. Datta, R., Joshi, D., Li, J., & Wang, J. Z. (2008). Image Retrieval: Ideas, Influences, and Trends of the New Age. ACM Computing Surveys, 40(2), 5:1–5:60.