

An Overview of Semantic-Based Visual Information Retrieval

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INTRODUCTION

Content-based image retrieval (CBIR) could be described as a process framework for efficiently retrieving images from a collection by similarity. The retrieval relies on extracting the appropriate characteristic quantities describing the desired contents of images. Content-based video retrieval (CBVR) made its appearance in treating video in the similar means as CBIR treating images. Content-based visual information retrieval (CBVIR) combines CBIR and CBVR together (Zhang, 2003).

With the progress of electronic equipments and computer techniques for visual information capturing and processing, a huge number of image and video records have been collected. Visual information becomes a well-known information format and a popular element in all aspects of our society. The large visual data make the dynamic research to be focused on the problem of how to efficiently capture, store, access, process, represent, describe, query, search, and retrieve their contents. In the last years, CBVIR has experienced significant growth and progress, resulting in a virtual explosion of published information. It has attracted many interests from image engineering, computer vision and the database community.

The current focus of CBVIR is around capturing high-level semantics, that is, the so-called Semantic-based Visual Information Retrieval (SBVIR). This article will first show

some statistics about the research publications on SBVIR in recent years to give an idea about its developments status. It then gives an overview on several current centers of attention, by summarizing results on subjects such as image and video annotation, human-computer interaction, models and tools for semantic retrieval, and miscellaneous techniques in applications. Finally, some future research directions, the domain knowledge and learning, relevance feedback and association feedback, as well as research at even high levels, such as cognitive level and affective level, are pointed out.

BACKGROUND

To get a general idea about the scale and progress of research on CBVIR and SBVIR for the past years, several searches in EI Compendex database (<http://www.ei.org>) for papers published in English from 1995 through 2005 have been made. In Table 1, the results of two searches in the title field for the numbers of English published papers (records) are listed: One term used is “image retrieval (IR)” and other term is “semantic image retrieval (SIR).” The papers found out by the second term should be a subset of the papers found out by the first term. Both numbers are increasing in that period, as seen from Table 1.

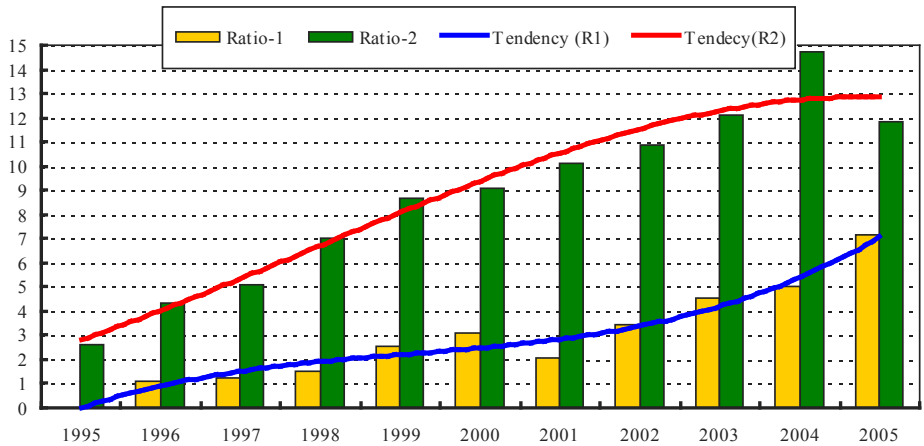
Table 1. List of English records found in the title field of EI Compendex

Searching Terms	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
(1) Image Retrieval	70	89	80	131	155	161	191	233	241	358	417	2126
(2) Semantic Image Retrieval	0	1	1	2	4	5	4	8	11	18	30	84
Ratio of (2) over (1)	0	1.12	1.25	1.53	2.58	3.11	2.09	3.43	4.56	5.03	7.19	3.95

Table 2. List of English records found in the subject/title/abstract field of EI Compendex

Searching Terms	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
(1) Image retrieval	421	580	531	640	718	871	1080	1203	1267	2196	2174	11681
(2) Semantic image retrieval	11	25	27	45	62	79	109	131	153	324	257	1223
Ratio of (2) over (1)	2.61	4.31	5.08	7.03	8.64	9.07	10.09	10.89	12.08	14.75	11.82	10.47

Figure 1. Comparison of two groups of ratios



Other searches take the same terms as used for Table 1, but are performed in the field of title/abstract/subject. The results are shown in Table 2.

The numbers of records in Table 2 for both terms are increasing in that period, too.

Comparing the ratios of SIR over IR in two tables, these ratios in Table 2 are much higher than those ratios in Table 1. This difference indicates that the research for SIR is still in an early stage (many papers have not put the word “semantic” in the title of papers) but this concept has started to get numerous considerations and attracts much attention (“semantic” appeared already in the abstract or subject parts of these papers).

To have a closer comparison, these ratios in Table 1 and Table 2 are plotted together in Figure 1. In Figure 1, light bars represent ratios from Table 1 and dark bars represent ratios from Table 2. In addition, the tendencies of ratio developments are approximated by a third order polynomial. It is clear that many papers have the “semantic” concept in mind although they do not always use the word “semantic” in the title.

MAIN FOCUS OF THE CHAPTER

Recently, a book specially contributing to SBVIR has been published (Zhang, 2007) from which, the current advancements on SBVIR on various topics can be perceived.

From Feature to Semantics

It is recognized that high-level research often relies on low-level investigation, so the development of feature-based techniques would considerably help semantic-based techniques.

A suitable start for going into the complex problem of content representation and description can be found in Konstantinidis, Gasteratos, and Andreadis (2007). Considering IR as a collection of techniques for retrieving images based on features (in its general sense), both low-level feature and high-level feature, and especially their relations, are discussed. An efficient way to present these features is by means of a statistical tool capable of bearing concrete information, such as the histogram. A number of IR systems using histograms is presented in a thorough manner and some experimental results are discussed. The steps in order to develop a custom IR system, along with modern techniques in image feature extraction, are also presented.

Among the existing CBIR techniques based on different perceptual features, shape-based ones are particularly challenging due to the intrinsic difficulties in dealing with shape localization and recognition problems. Nevertheless, there is no doubt that shape is one of the most important perceptual features, and successful shape-based techniques would significantly improve the spreading of general-purpose systems. A shape-based image retrieval approach, which is able to efficiently deal with domain independent images with



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