A User-Driven Ontology Guided Image Retrieval Model

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ABSTRACT

The demand for image retrieval and browsing online is growing dramatically. There are hundreds of millions of images available on the current World Wide Web. For multimedia documents, the typical keyword-based retrieval methods assume that the user has a specific goal in mind by using accurate query keywords in searching a set of images. Whereas the users may face with a repository of images whose domain is less known and content is semantically complicated, or the users may only generally know what they search for. In these cases it is difficult to decide what exact keywords to use for the query. In this article, we propose a user-centered image retrieval method that is based on the current Web, keyword-based annotation structure, and combining Ontology guided knowledge representation and probabilistic ranking. A prototype of web application for image retrieval using the proposed approach has been implemented. The model provides a recommendation subsystem to support and assist the user modifying the queries and reduces the user’s cognitive load with the searching space. Experimental results show that the image retrieval recall and precision rates increased and therefore demonstrates the effectiveness of the model. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: Image Retrieval; Ontology; User-Centered

INTRODUCTION

Image retrieval is a human centered task. Images are created by people and are ultimately retrieved and used by people for human related activities. Since the past decade, online image retrieval has been becoming one of the most popular topics on the Internet. The number of images available in online repositories is growing dramatically. For example, Flickr.com is hosting more than 50 million member-submitted images on their Web site (Terdiman, D.). And the giant search engine company Google claimed that they had indexed more than 880 millions images since 2004 (www.google.com). The typical method of image retrieval using mostly by the industry is to create a keyword-based query interface above the multimedia database (Agosti, M., & Smeaton, A., 1996). There are two major problems in keyword-based image retrieval. The first one is the retrieval quality problem from the search result. The keyword annotation of image documents has low capability to analyze semantic relations among keywords, such as synonym,
homonym and antonym. Taking the topics of images as an example, it is nearly impossible to include all the synonyms of the topic keywords in the annotation for every image. The reality is that if the images are annotated with keywords having same meanings with users input but in different terms, those images are not able to be retrieved by the keyword-based retrieval system. The second problem is that keyword-based search method always assumes that users have the exact searching goal in their mind (Hyvonen, E., Saarela, S., & Viljanen, K., 2003). However, in the real world application, the case is that most of them only hold a general interest to explore the images, and have a vague knowledge about the domain topic. They may not know what specific query keywords should use. As a result, a recommendation or a support subsystem helping users to modify their queries is needed.

Semantic Web technologies have been expected to improve the quality of information retrieval on the Web (Berners-Lee, T., Hendler, J., & Lassila, O., 2001; Berners-Lee, T.). In this article, we proposed a hybrid image retrieval model that uses a Web Ontology-based reasoning component and combining Bayesian Network model to improve the quality of image retrieval. Our proposed method returns more query keywords as recommendations that are semantically related to the user input keywords so that it can assist the users to explore more relevant images.

The rest of the article is organized as follows. In section 2, we reviewed the related research works in the area of image retrieval. In section 3, we present the proposed Ontology-guided model; precisely including the rules for Ontology reasoning and how to define the Bayesian Network model for ranking. In section 4, an image retrieval application for evaluating our model is presented in this implementation section. Section 5 is the conclusion and the future works.

**KEYWORD-BASED AND CONTENT-BASED IMAGE RETRIEVAL**

Traditionally, there are two main research approaches in the area of image retrieval. One is keyword-based image retrieval. This approach is to create a set of keywords as metadata to describe the images and then associate it to the image document. As a result, it is also called keyword annotation. Based on the keyword annotations, the system can apply keyword-based information retrieval techniques to search the images (Long, F., Zhang, H., Feng, D.D., 2003). Searchers try to analyze the text around image to improve the web image retrieval. However, huge amount of the images on Web, such as personal uploaded photo gallery, still lack of adequate text description.

The other approach is content-based image retrieval that mainly focuses on studying and analyzing the visual elements of the images. Through this approach, one is able to query the target images using criterions, such as color, shape and texture. A number of efficient content-based image retrieval systems have been presented in the last few years. For example, a database perspective of image annotation and retrieval has been studied by G. Carneiro and N. Vasconcelos (2005); a statistical approach of automatic linguistic indexing model was presented by J. Li and J. Z. Wang (2003); a machine learning approach is applied to study ancient art was presented by J. Li and J. Wang (2004). However, in the scenarios of the online Web image retrieval, content-based approach is still hard to meet the requirement of immediate response of retrieval result to users. Features input, such as color, shape and texture, is still not suitable and realistic for most of the online users. Furthermore, it is difficult for the systems to deal with the features such as human emotions and perceptions of the images. In our study, we realized that both keyword-based and content-based approach is hard to solve the semantic problem. A solution is to incorporate the Ontology technology into image retrieval.
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