Stéphane Marchand-Maillet Eric Bruno
Andreas Nürnberger Marcin Detyniecki (Eds.)

Adaptive Multimedia Retrieval: User, Context, and Feedback

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Revised Selected Papers

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Preface

This book is an extended collection of revised contributions that were initially submitted to the International Workshop on Adaptive Multimedia Retrieval (AMR 2006). This workshop was organized during July 27-28, 2006 at the University of Geneva, Switzerland.

AMR 2006 was the fourth workshop in the series, following AMR2005 organized at University of Glasgow (*Lecture Notes in Computer Science* volume 3877). The series started in 2003 with a workshop during the 26^{th} German Conference on Artificial Intelligence (KI 2003 – *Lecture Notes in Computer Science* volume 3094) and continued in 2004 as part of the 16^{th} European Conference on Artificial Intelligence (ECAI 2004).

This year, the AMR workshop kept its focus on accommodating user needs via adaptive processes. A number of contributions investigated the utility of segmentation in the query and retrieval process. Adaptive definitions of similarity were also proposed in the papers contained in this volume. The invited contributions were intended to open on less-addressed topics in the community. This is the case for music information retrieval and distributed information retrieval (e.g., on P2P networks). Other contributions looked at more applicative aspects of IR.

We think that this book provides a good and conclusive overview of the current research in the area of adaptive information retrieval. We would like to thank all members of the Program Committee for supporting us in the reviewing process, the workshop participants for their willingness to revise and extend their papers for this book and all staff at Springer for their support in publishing this book. We extend a special thanks to our supporting institutions.

December 2006

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A Method for Processing the Natural Language Query in Ontology-Based Image Retrieval System

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Abstract. There is a large amount of image data on the web because of the development of many image acquisition devices nowadays. Hence, many researchers have been focusing on the study how to manage and retrieve these huge images efficiently. In this paper, we use two kinds of ontologies in the image retrieval system for processing the natural language query. We use the domain ontology for describing objects in images and we newly build the spatial ontology for representing the relations between these objects. And then, we suggest the method for processing the user query formatted by the natural language in the ontology-based image retrieval system. Based on our study, we got the conclusion that the natural language query processing is the very important part for improving the efficiency of the image retrieval system.

1 Introduction

Nowadays, the study on the image retrieval has been actively progressing. Until now, the basic image retrieval methodologies are the *Text-Matching, Contents-based and Concept(Ontology)-based* methods.[2][3] In these methodologies, users generally use simple keywords as the user query. The Ontology-based image retrieval system uses the ontologies to understand the meaning of the user query, but the ontologies just solve the ambiguousness between words. Hence, the user query used in ontology-based system is also simple keywords. Nowadays, huge number of images has been creating through the various image acquisition devices such as the digital camera, scanner and phone-camera. Thus, we need more intelligent image retrieval techniques for searching the images efficiently. In present day, the users tend to use a descriptive sentence to find images because they want to search for images as fast as possible, they do not want to spend long time retrieving images. Thus, the user query is getting descriptive and natural language type. As a result, the method for processing the natural language query is demanded for improving the performance of the image retrieval system. In this paper, we use two kinds of ontologies in our proposed system to handle the natural language query. One is the domain ontology, which contains many concepts and represents the relations between these concepts. The other is the spatial ontology, which contains three basic relations and many words about the relations.

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We use some parts of the WordNet for building the domain ontology and we newly make the spatial ontology based on the survey paper, WordNet and OXFORD Dictionary for the purpose of processing the natural language queries. The basic idea of our study is that most user queries are including the words representing the spatial relationships. It is the significant feature of user queries for supporting our study. Therefore we use the features to design the newly proposed image retrieval system and try to process the natural language queries.

In the 2nd Section, we introduce the related works - the ontology-based image retrieval and the query processing methodologies. Then in Section 3, we explain the spatial ontology building steps and our system architecture based on the ontologies. And we describe the method for processing the natural language queries in the ontology-based system in details. We test and evaluate our system comparing with other systems in Section 4. At the end of this paper, we conclude our study and suggest the future works.

2 Related Works

2.1 Ontology-Based Image Retrieval

The traditional information retrieval systems have the mismatch problem among the terminologies. For solving the problem, many researchers have studied to apply the ontology theory to the system. Many works show that ontologies could be used not only for annotation and precise information retrieval, but also for helping the user in formulating the information need and the corresponding query. It is important especially in applications where the domain semantics are complicated and not necessarily known to the user. Furthermore, the ontology-enriched knowledge base of image metadata can be applied to construct more meaningful answers to queries than just hit-lists.

The major difficulty in the ontology-based approach is that the extra work is needed in creating the ontology and the detailed annotations.[5][6][7] We believe, however, that in many applications this price is justified due to the better accuracy obtained in information retrieval and to the new semantic browsing facilities offered to the end-user. We are trying to implement semantic techniques to avoid so much hard work with the ontology building the trade off between annotation work and quality of information retrieval can be balanced by using these less detailed ontologies and annotations. Although this approach could address the mismatch problem between the terms, it is still not suitable for image retrieval system because they did not consider the features of the image data. Therefore, we are not get the good results in the ontology-based image retrieval system.

2.2 User Query Processing

Due to the development of internet technology, infinite information is published in the web. And the volume is getting increase. So, most internet users depend on the information retrieval engines for searching information. The purpose of these information retrieval engines is efficient ranking for user who wants information in huge web documents.[9] And many ranking methods are introduced. For examples, through

clever term-based scoring, link analysis, evaluation of user traces and so on. But existing retrieval systems are mostly based on just word matching between query language and words in documents. Let's suppose someone who input a query, "tiger sits in the cage". So the systems are giving the results including 'tiger' or 'cage'. These methods show much information related to the user queries, but show the information of a little relevance even without relation. In result, the user must spend much time for additional work.

3 System Architecture and Spatial Ontology Building Process

In this Section, we introduce the background studies for processing the natural language query. The core studies are building the spatial ontology and designing the image retrieval system based on constructed ontologies.

3.1 Background Studies

3.1.1 Design of Ontology-Based Image Retrieval System

Our system uses the ontologies to describe the contents of images and search images. Especially, when users use natural language query for retrieving images in our system, our system is able to process the query based on the ontologies.

Our system consists of three parts.

- *Super User Interface Part : User can describe and manage the images.*
- *End User Interface Part : User can retrieve images using the natural language queries.*
- *Ontology Part : Domain and spatial ontologies exist in this part.*

Figure 1 illustrates the architecture of our system.

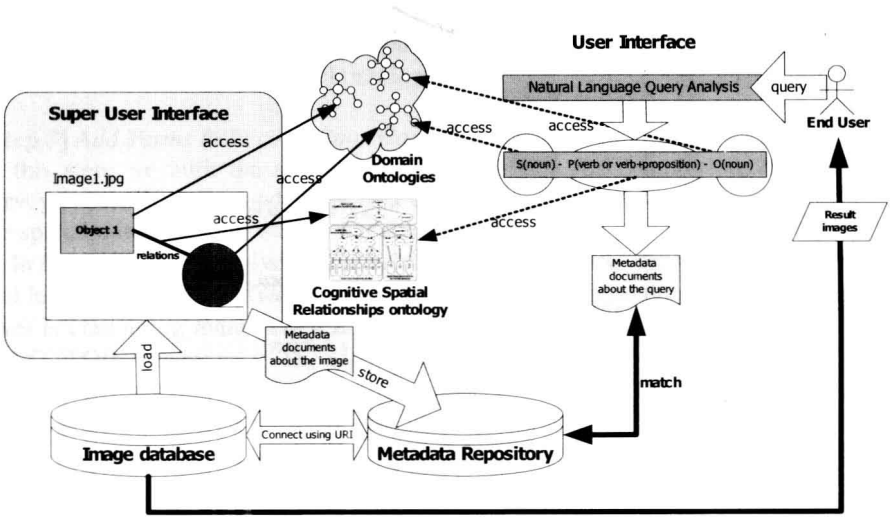

Fig. 1. The architecture of our proposed system

Our system has two significant features. First feature is to apply the spatial ontology for representing the relations between objects in images. Second feature is to apply the method for processing the natural language query. At result, we could expect the efficient image retrieval through our system. We explain two features used in our system by details in Section 3.1.2 and 3.1.3.

3.1.2 Spatial Ontology Building Steps

For processing the natural language query, the spatial ontology plays the core role in our study. So, we built the spatial ontology following as four steps. Figure 2 shows the spatial ontology building steps.

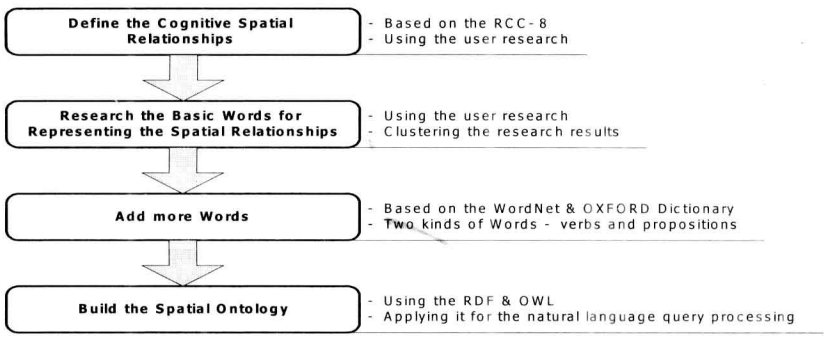

Fig. 2. The steps for building the spatial ontology

[Step 1] *Define the Cognitive Spatial Relations*

In the existing image retrieval system, if the system uses the spatial relations between objects, the system mostly use the region-based spatial relationships. In this case, the problems are either the spatial relations but not have the semantic meaning or system may define the spatial relations incorrectly. In this paper, we try to define the cognitive spatial relations newly. We used the survey for defining the cognitive spatial

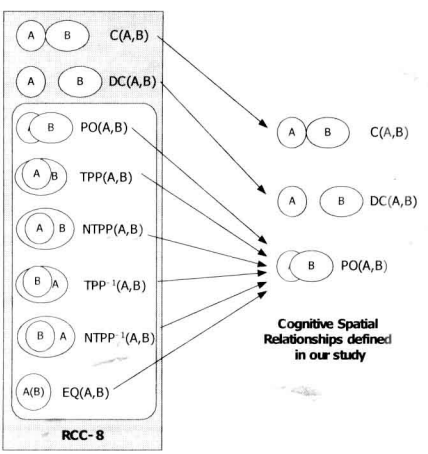

Fig. 3. The model of the cognitive spatial relations

relations. We prepare the 200 images containing the objects and spatial relations between objects. And then, we examine the spatial relations recognized by users when the users look at images. At the result of survey paper, the cognitive spatial relations are represented three basic relatons - 'connect', 'disconnect' and 'partOf'. Figure 3 illustrates the model of the cognitive spatial relations comparing with the RCC-8.[1]

[Step 2] *Examine the Root Words for Representing the Spatial Relations*
In step 1, we realized that three spatial relations are necessary for describing the contents of images in detail. In this step, for building the spatial ontology, firstly we get the terms about which words are used to describe images by the users through survey paper. And then, we build the spatial ontology based on the cognitive spatial relations with the results of survey paper. The lists showed in figure 4 are the results obtained from the process of replication concerning the representation of the spatial relations of each spatial verb.

image #3	image #33	image #40	image #55	image #59	image #141

Research results (spatial relationships 1)connect 2)partof 3)disconnect, C_SR:cognitive spatial relationships)

number	C_SR	Answers of the Researchers						
3	1	lying	lying	lie	lying	lying	lie	sit
33	2	swim	search	swim	swim	cross	look pretty	swim
40	1	kiss	kiss	kiss	kiss	kiss	love	play
55	3	on the left	bigger	beside	behind	left of	beside	beside
59	3	wait	in front	waiting	stand	in front	look	stand
141	2	fly	soars	fly	fly	fly	fly	fly

Fig. 4. The parts of the survey paper

Figure 4 shows the parts of survey paper. According to results of the survey, we realized that most users have similar feeling and use similar spatial verbs to describe images. After clustering the results, we select the root words from the results of survey paper for building the spatial ontology.

[Step 3] *Add Terms Related to Root Words based on WordNet and Dictionary*
In this step, we built the spatial ontology based on the cognitive spatial relations, survey paper, WordNet and OXFORD dictionary. Figure 5 shows the architecture of the spatial ontology proposed by our study.

In figure 5, the cognitive spatial relations are situated at the top level and the second level consists of the two parts – spatial verbs and spatial prepositions. The bottom level is containing many terms related to second level verbs based on the WordNet and OXFORD Dictionary. The significant fact through survey paper of the step 2 is that not only verbs but also prepositions are very important to represent the cognitive spatial relations. Therefore, we consist of the spatial verbs part based on the WordNet and the spatial postpositions part using the OXFORD Dictionary for building the more complete spatial ontology.