GraphOnto: A Component and a User Interface for the Definition and Use of Ontologies in Multimedia Information Systems

Chrisa Tsinaraki, Panagiotis Polydoros and Stavros Christodoulakis

Lab. Of Distributed Multimedia Information Systems,
Technical University of Crete (MUSIC/TUC)
University Campus, Kounoupidiana, Chania, Greece,
{chrisa, panpolyd,stavros}@ced.tuc.gr,
WWW home page: http://www.music.tuc.gr

Abstract. We propose here GraphOnto[1], a component that facilitates the generation and population of both standard-based and domain ontologies and their use in multimedia information system components. In our working environment, an Upper Ontology, which captures the MPEG-7 MDS, is utilized and OWL (imported and/or interactively created) domain ontologies extend the upper ontology with domain knowledge. Imported ontologies are parsed so that graphical ontology browsing and editing interfaces are automatically generated. The ontologies are used to guide the metadata definition in a standardized manner. Personalization of the GraphOnto interface on the application, task and user levels is provided.

1 Introduction

The advent of the Internet and the digital multimedia demonstrated the extreme importance of standards (like MPEG-7 [1]) for the multimedia industry. Interoperability among the well-accepted standards is needed in open environments, in order to allow multimedia content services built on top of different standards to communicate, exchange information, and co-operate. The interoperability support usually provided is based on ontologies [5], [3], [7], [8], [10], with the semantics of the standards captured in upper ontologies [5], [3].

In addition to the multimedia standards, domain knowledge is very useful for important functionality of multimedia information repositories (e.g. indexing, query specification, retrieval, filtering, etc.). Since the structures provided by the generic standards (like MPEG-7) are general-purpose, domain knowledge cannot be adequately represented using them. Thus, we have developed methodologies for extending the standard-based upper ontologies with domain ontologies [8].

However, the size and the complexity of the standards and the domain ontologies make them very difficult and time-consuming to use. We propose here

GraphOnto, a component that facilitates the generation and population of both standard-based and domain ontologies and their use in multimedia information system components.

Since ontologies may describe extremely complex concepts, the GraphOnto component provides mechanisms for information hiding, so that the metadata creators can concentrate only in the concepts they intend to use during their work. In addition, personalization of the GraphOnto interface on the application, task and user levels is provided. The GraphOnto component can be embedded in several applications where (part or all of) its functionality is needed (e.g. Semantic Indexing, Query Definition Interfaces etc.).

GraphOnto can be viewed as both a generic tool and as a specific tool for the multimedia domain. In the multimedia domain, an upper ontology is utilized [3], which captures the MPEG-7 MDS [2], and OWL [6] domain ontologies extend the upper ontology with domain knowledge.

The GraphOnto component is presented in section 2 and we conclude the paper in section 3.

2   The GraphOnto Component

We describe in this section the GraphOnto component, which allows creating and/or editing of OWL ontologies and supports personalised browsing and accessing OWL ontologies. The ontologies are used to guide the metadata definition and interaction with other multimedia information system components in a standardized manner. GraphOnto allows the user to distinguish two types of ontologies: Upper Ontologies, which usually capture ground truth and/or the semantics of well-accepted standards, and domain ontologies that extend the Upper Ontologies with domain knowledge. The functionality of the GraphOnto component is distinguished in three categories of operations:

- The *Ontology Management Operations*, which include:
    - *Ontology Import*, which allows importing OWL domain ontologies. The imported ontologies are parsed and displayed as a tree-like visualization, while graphical ontology browsing and editing interfaces are automatically generated for the ontologies.
    - *Ontology Creation*, allowing users to interatively specify new OWL domain ontologies.
    - *Editing (new and existing) domain Ontologies*. Ontology, class and property names may change, classes and/or properties may be added or removed, class and/or property hierarchies may be restructured and constraints may be added, deleted or modified. In addition, the definition of multiple annotations for classes and/or properties is allowed, including both conventional text annotations and multimedia annotations (e.g. images).
    - *Efficient Management for Upper Ontologies*. Given that Upper Ontologies are expected to be based on standards and/or ground truth, they are not expected to change on a frequent basis. Thus, their structure

is parsed once and then stored so that the overhead of parsing it every time it is used is avoided.

- *Ontology Browsing* using a tree-like visualization. Additional browsing support is provided for the Upper Ontologies, so that the end user decides if the concepts defined in the Upper Ontology are sufficient for the metadata (s)he wishes to produce or if (s)he should define domain-specific classes that specialize the Upper Ontology concepts for the domain (s)he works.

– The *Metadata Management Operations*, which include:

- *Metadata Import*, that allows importing metadata items expressed either in OWL/RDF format or in a well-accepted metadata description standard (MPEG-7 in our working environment).
- *Metadata Definition* based on the OWL ontologies. The metadata definition interface is automatically generated, based on the ranges and the constraints holding for the properties of the class where the metadata item being defined belongs.
- *Editing Metadata*, which supports addition/removal/change of metadata items and/or their property values.
- *Definition of Relationships among Metadata Items.* Definition of relationships among existing and new metadata items is supported by the GraphOnto component. As an example, consider a semantic indexing application, where the video segment of a goal in soccer game is related with the scorer.
- *Metadata Export* of the metadata items defined both in OWL/RDF and other standard metadata formats (e.g. MPEG-7 in the multimedia domain).

– The *Personalization Operations*, which include:

- *Definition of Templates for User Interface Specification.* Both domain and Upper ontologies may describe extremely complex concepts making it difficult for the end user to concentrate only on the properties (s)he will work with. In the GraphOnto component the end-user is allowed to define user interface templates where only the properties (s)he is going to work with are displayed for the selected classes.
- *Support for Multiple Personal Labels.* The user is allowed to define and use one or more labels for an ontology class, specify the preferred one (for him/her), and thus replace the RDF:ID of the class in the tree-like visualization for this user. In this case, the class name is displayed in a different colour, so as to indicate that it is the user's preferred name, while the RDF:ID of the class is displayed as a tool tip when the mouse is over the preferred name.
- *Application Configuration.* Configuration files allowing the adaptation of the GraphOnto component may be defined for specific applications, containing declarations of the upper and domain ontologies and the user interface templates used in each application. Different configuration files may be defined for the same application, based on different task requirements and user preferences. Thus, personalization of the GraphOnto interface on the application, task and user levels is provided.

The structure of the graphical editor is such that the task-oriented support of the user activities is provided. In addition, APIs allowing the use of parts of the functionality of the GraphOnto component in different tasks are provided. For example, in a query definition interface only the browsing functionality of the GraphOnto component is exported, while in a semantic indexing interface for power users performing audiovisual content annotation, all the GraphOnto functionality is exported.

Thus, the GraphOnto provides all the functionality of the existing graphical ontology editors (among which Protege [9] is the most advanced), together with personalization support. The GraphOnto component is being developed in Java Swing. Ontology parsing has been based on the OWL API [4].

3   Conclusions

We have presented GraphOnto, a component and a graphical user interface that facilitate the personalized generation and population of both standard-based and domain ontologies and their use in multimedia information system components.

In addition to the functionality provided by the existing ontology definition tools, the GraphOnto component recognizes upper ontologies usually based on standards (like MPEG-7) and domain ontologies and allows their integration into a single ontological structure and their use in applications. It also provides personalization and task-oriented support of the user activities.

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