Multimedia Processing on Multimedia Semantics and Multimedia Context

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Abstract. Context awareness and multimedia are observed together for multimedia retrieval. But multimedia semantics and multimedia context are often researched separately in applied multimedia information systems for communities of practice. As the information explosion on the Internet and different devices, we propose a model to identify the information flow of multimedia processing. We associate multimedia semantics with context information. This model can be further evaluated in mobile multimedia information systems which require context-awareness and multimedia retrieval with higher relevance.

1 Introduction

Context awareness and multimedia are important factors for multimedia retrieval in multimedia applications. But multimedia semantics and multimedia context are often researched separately in applied multimedia information systems for communities of practice. In computer science *context* can be understood as any situational or environmental information with an in depth definition survey in [1]. Multimedia semantics cannot be well processed directly by machines. So multimedia metadata is an crucial approach to computer-processing multimedia semantics [14].

Since the beginning of this century, amount and accessibility of multimedia data have been increased greatly. In comparison to textual information, multimedia information has higher richness. Multimedia creation has been becoming an online activity of everybody who has the Internet access. Meanwhile, handheld devices get more and more compact and multi-functional. The cost of mobile networks gets cheaper. Mobile users can take these advantages to create, process and share multimedia data everywhere and every time. The vision of ubiquitous computing [25] is being realized. With the current research advances, multimedia data accessibility can be enhanced by clear multimedia semantics rather than automatic image processing [19].

There is a great amount of multimedia context information generated together with multimedia creation processes. For example, various information about one image in Flickr on the Web 2.0 can be identified in Figure 1. The context information has its semantics, which can be used for multimedia search and retrieval.

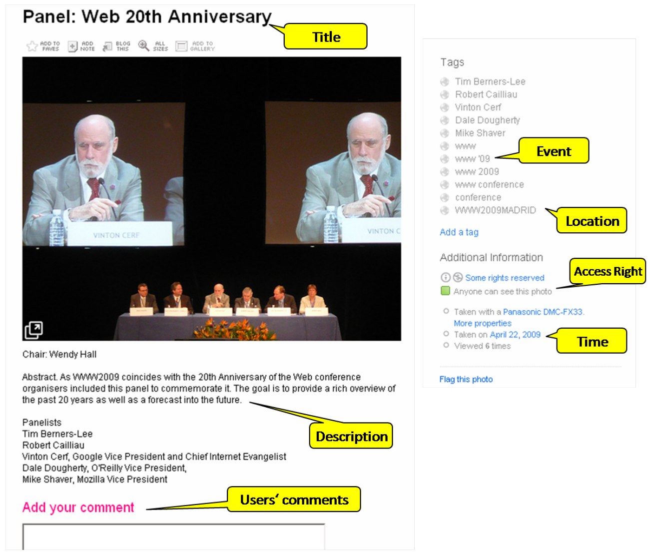

Fig. 1. Multimedia semantics for a photo in Flickr

The problems are obvious. Multimedia semantics and multimedia context are often observed and researched separately in research areas of multimedia information systems. Some of those multimedia information systems focus on multimedia adaptation and personalization, while some of them focus on context-awareness. In fact, both semantic and context have been working together well. An example is the search engine on the Web like Google, which provides suggestions in the search input field. When a song title is typed, often *lyrics* is attached which indicates the context. A further approach to application of context information for multimedia adaptation in the mobile environment is discussed in [15].

In our recent research we associate multimedia context information with multimedia semantics. Semantics information alone can be erroneous. So is context information. We propose a model to identify the information flow and to associate multimedia semantic and context information together, using ontology and impacts of communities of practices. This model can be further evaluated in mobile multimedia information systems which require context-awareness and multimedia retrieval with higher relevance.

Research questions are addressed: how is the complexity and correctness to extend multimedia metadata into ontology with regard to context information and domain information. How effective will it be to use different kinds of ontology?

The rest of this position paper is structured as follows. Section 2 introduces the relevant concepts of multimedia semantics and context. We propose a model for multimedia processing to deliver better multimedia search results by associating multimedia semantics and multimedia context in Section 3. Section 4 addresses open issues which could arise and need to be dealt with. We conclude the paper with an outlook at future work in Section 5.

2 Terminologies in the Related Work

Semantics is a concept in comparison to *syntax*. Any expression has the semantics so that information is passed. Thus, semantics can be expressed in various formats, under which the most clearly one is in text. In Semantic Web *semantics* is specified as degree of both machine-readability and human-readability. It is stated that machine readable content has quite low semantics [4].

In [9] context is categorized into four groups: *computing context* such as network connectivity, communication bandwidth, display size of the end devices; *user context* such as users' preferences, communities which users belong to; *physical context* such as lighting, location, noise levels, and temperature; and *time context* which can be used as timestamps to identify the records of a context history. Context is widely addressed to device profile, especially referred to those handheld devices with limited capacity. Hence, context-aware adaptation is related to device [23]. Dynamic aspects of context include environmental, spatial or location related, temporal, domain related, and even community related [6].

Le Grand et al. proposed that contextual and semantic information is used together to enrich ontology in order to enhance information retrieval [13]. They employed the concept of *context awareness* to express the relationships among different concepts to complete the ontology. Multimedia semantics and context information together can enhance *information richness*, which is defined as the capacity to clarify ambiguous issues of media communication [10].

Metadata is supposed to fulfill the tasks such as identifying items uniquely worldwide, describing collection items including their *contexts*, supporting retrieval and identification, grouping items into collections within a repository, recording authenticity evidence, facilitating information interchange between autonomous repositories etc. in the domain of digital objects preservation [12].

3 A Model for Multimedia Information Processing

We propose a model depicted in Figure 2 to represent the usage of multimedia semantics and multimedia context information in order to enhance multimedia retrieval. This model is based on the analysis of the impacts of multimedia, metadata, domain information, context, and communities of practice.

A great amount of multimedia information is available. Content description has proved to be an effective way to label or annotate multimedia information [19]. Two approaches are often used to annotate multimedia. One is the Web 2.0 prevalent tagging in free text. The other is adding meta information in line with certain multimedia metadata standards.

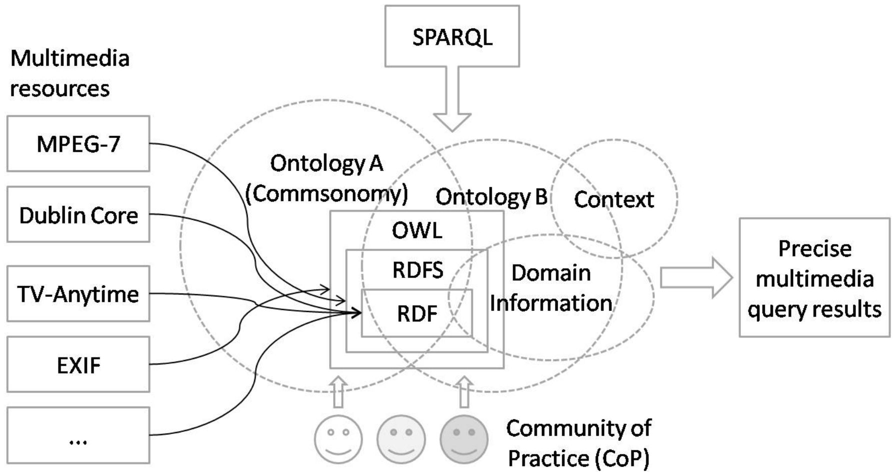

Fig. 2. A multimedia processing model combining multimedia semantics and context

3.1 Metadata Mapping

On the level of metadata standards, a large variability exists again. MPEG-7 standard [17] is one of the richest multimedia content description standards with a comprehensive schema. MPEG-7 is able to express multimedia content covering the most important media aspects including low-level technical information and high-level content semantics. The semantic information expressions may distinguish multimedia creators from the depicted people in a picture or a video clip. MPEG-7 can also be easily used with other metadata standards together, due to its flexible schema. Besides those advantages, MPEG-7 has limitations in semantic expression. Although it has defined many semantic tags, it is still impossible to cover semantic information across different domains. Thus, in different domains several metadata standards can be prevalent in use, such as Dublin Core for digital libraries or digital information preservation [12]. Metadata standards are also used for multimedia adaptation straightforwardly, such as TV-Anytime [11] for adaptive personalized TV programs. The widely spread metadata standard EXIF [21] describes the low-level technical, device, and semantic information such as creation information of images.

Employment of metadata standards aims at enabling data exchange with enhanced data interoperability. However, different metadata standards enhanced data interoperability to certain extent. Metadata standards facilitate data with an effective means to create, describe, search and retrieve multimedia data. Incompatibility and high variety still exist. Terms like *meta-metadata* was coined or crosswalks among different metadata standards have been attempted. It is trivial to specify crosswalks among different metadata standards. A mapping is needed in any two of metadata standards. A transitive mapping can be impossible theoretically. But information lost and imprecise mapping might lead to many other relevant problems or unexpected consequences.

3.2 Ontology to Bridge Multimedia Semantics and Context

Our approach is to use ontology models to avoid the complexity of mapping among different multimedia metadata standards. The goal is to enrich multimedia semantics with enhanced multimedia interoperability among different multimedia formats and diverse multimedia metadata standards. Ontology represented by a series of concepts which are tightly related to certain domain knowledge.

Context can be modeled by different approaches including key-value, markup scheme, graphical, object-oriented, logic-based, and ontology-based models [22]. Above all, the ontology-based context modeling approach is well evaluated for the purpose to describe context information clearly [6]. Different from the approach in [13], we use concepts specified in certain ontology to represent context information. This context information includes spatial, temporal, community and is modeled in ontology according to domain information.

On the metadata level, RDF, RDFS as well as OWL are proposed as Semantic Web technologies. Resource Description Framework (RDF) [3] provides data model specifications and XML-based serialization syntax. RDF Schema (RDFS) specifies RDF to simplify the process of using Web Ontology Language OWL [2] and also enables the definition of domain ontologies and sharing of domain vocabularies [24]. OWL can be used for the following purposes: (1) *domain formalization*, a domain can be formalized by defining classes and properties of those classes; (2) *property definition*, individuals and assert properties about them can be defined; (3) *reasoning*, one can reason about these classes and individuals. Thus, RDF together with RDFS and OWL can represent context with the information from a certain domain or communities of practice. The SPARQL Protocol and RDF Query Language (SPARQL) can be used for context reasoning [20].

3.3 Commsonomy

We propose *Commsonomy* which is community based folksonomy defined and used within and across communities of practice [16]. Folksonomy come into being as a kind of wide-spread taxonomy with unlimited concepts created by users on social network sites. Commsonomy is a sub set of folksonomy with certain community impacts. Concepts or labels in use could be limited to certain community context.

We employ the concept of *Community of practice*, when we refer to the term *community*. Community of practice is formed because users in communities of practice are engaged with tasks in a mutual way, share a common repertoire, and build up a jointly enterprise [26]. The results from our prior research show that the number of tags or keywords in use decreases as the users attain more expertise knowledge within a community of practice [8].

A suitable commsonomy can cover the knowledge gap which often occurs in Semantic Web. We try to supplement the background knowledge with commsonomy. Mika notifies that lack of background knowledge leads to knowledge gap greatly [18].

With the help of an ontology-based context model using OWL/RDF and the substantially enhanced interoperability, context information can be expressed and reasoned across systems. In summary, the reasoning with SPARQL is carried out on the data set of semantics, context even knowledge or information from communities. The goal is to use multiple dimensions of information to indentify, analyze and reduce the possible information errors.

4 Discussions on Open Issues

In our previous research, we have proposed an approach to multimedia adaptation with regard to context awareness and mobility [7]. Basic queries on context information have been conducted in SPARQL. As the next step proposed in this paper, context model will work together with the multimedia semantic models mapped from different metadata standards.

A potential benefit of this model is targeted for mobile communities. The goal is to deliver mobile users *right* multimedia information on demand on the fly. There might be a lot of scenarios for *Multimedia on the fly*. Users can generate different multimedia with their mobile devices en route. They would also like to search for multimedia for news, local news, and entertainment options etc. People like to contribute and to share information. Ontology is set up in order for multimedia information systems to define rules and apply reasoning on it. Furthermore, some business models should be interesting and useful. In order to get a large set of data, social network sites APIs can be used to collect getagged multimedia originally uploaded across those sites. The tags can be conveyed with the MPEG-7 metadata standards.

5 Conclusions

Semantics, context domain information with certain predefined ontology can help users get better multimedia search results. We analyze the multimedia information flow in community information systems. The information flow includes various multimedia data in different formats, diverse metadata for content or technical description, context information, and the community impacts. Based on this analyze, we propose a model to specify this information and relationships or impacts among these different categories of multimedia related information. In future research, the model can be validated and applied on context-aware mobile multimedia community information systems within the German Excellence Research Cluster UMIC [5].

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