4I (FOR EYE) MULTIMEDIA
Intelligent Semantically Enhanced and Context-ware Multimedia Browsing

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Abstract: Next generation of integration systems will utilize different methods and techniques to achieve the vision of ubiquitous knowledge: Semantic Web and Web Services, Agent Technologies and Mobility. Unlimited interoperability and collaboration are the important things for almost all the areas of people life. Development of a Global Understanding eNvironment (GUN) (Kaykova et al., 2005), which would support interoperation between all the resources and exchange of shared information, is a very profit-promising and challenging task. And as usually, a graphical user interface is one of the important parts in a process performing. Following the new technological trends, it is time to start a stage of semantic-based context-dependent multidimensional resource visualization and semantic metadata based browsing across resources. With a growing ubiquity of digital media content, whose management requires suitable annotation and systems able to use that annotation, the ability to combine continuous media data with its own multimedia specific content description into the one source brings the idea of a true multimedia semantic web one step closer. Thus, 4I (FOR EYE) technology (Khriyenko, 2007) is a perfect basis for elaboration of intelligent semantically enhanced and context-aware across multimedia content browsing.

1 INTRODUCTION

In recent years, the amount of digital multimedia information distributed over the Web has increased extremely because everyone can follow the production line of digital multimedia content. The discovery of "Web as platform", termed in some quarters as Web 2.0 (O'Reilly, 2005), and innovative websites like Flickr[1], Wikipedia[2], Google Map[3], Wikimapia[4] and Yahoo Maps[5] encourage social networking.

Accordingly to Lyndon J.B. Nixon work (Nixon, 2006), as the current trends develop we expect to experience a future Web which will be media rich, highly interactive and user oriented. The value of this Web will lie not only in the massive amount of information that will be stored within it, but the ability of Web technologies to organize, interpret and bring this information to the user. Media presentation is a key challenge for the emerging media-rich Web platforms.

The challenge of enabling computer systems to make better use of Web data by making that data machine-processable has been taken up by the Semantic Web effort, which proposes formal knowledge structures to represent concepts and their relations in a domain. These structures are known as ontologies and the World Wide Web Consortium (W3C)[6] has recommended two standards, the simpler Resource Description Framework (RDF)[7] and the more expressive Web Ontology Language (OWL)[8].

A number of vocabularies that deal at some level with multimedia content currently exist (Geurts et al., 2005): MPEG-7, Dublin Core Element Set, VRA, Media Streams, Art and Architecture Thesaurus (AAT), MIME, CSS, Composite Capabilities/Preference Profiles (CC/PP), PREMO,

[1] http://www.flickr.com/
[2] http://www.wikipedia.org/
[3] http://maps.google.com/
[4] http://www.wikimapia.org/
[5] http://maps.yahoo.com/

[6] http://www.w3c.org
[7] http://www.w3.org/RDF
[8] http://www.w3.org/TR/owl-absyn/

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Modality Theory, Web Content Accessibility Guidelines. Of course, it is very important to develop appropriate format for semantic annotation of multimedia content. But, from the other hand, it is more natural to find the way to build-in full semantics to the digital formants of multimedia (image, video, audio). Nowadays, production houses shoot high-quality video in digital format; organizations that hold multimedia content (such as TV channels, film archives, museums, and libraries) digitize analog material and use digital formats. Maybe it is a time to reach all the digital media formats with a Semantic Track, which will contain not just content structure, but full semantic content annotation including: content structure, concepts, objects, actions and etc.

Considering the main aspect of the discussions around a multimedia, Human is a main customer of multimedia services and an end-user of a multimedia content. With a sustainable multimedia content growing, Human/User needs new intelligent techniques for multimedia content browsing, search/retrieving and adapted representation. At the same time, the stated goal of the Semantic Web initiative is to enable machine understanding of web resources. However, it is not at all evident that such machine-readable semantic information will be clear and effective for human interpretation. Hence, in order to effectively harness the powers of the semantic web, it needs a “conceptual interface” (Naeve, 2005), that is more comprehensible for humans. Such conceptual interface can improve multimedia content retrieving process and together with well elaborated Semantic Track of the multimedia resources, can provide a unique basement for semantically enhanced across multimedia contents browsing.

The paper contains two main sections. Section #2 is related to the aspects of a browsing process across multimedia contents. The second section #3 describes a 4I (FOR EYE) technology based vision to groupware collaboration approach (Khriyenko, 2007), and a multimedia resource browsing case based on it.

2 SEMANTICALLY ENHANCED BROWSING ACROSS MULTIMEDIA CONTENTS

2.1 Resource Semantic Track

The sub-symbolic abstraction level covers the raw multimedia information represented in well-known formats for video, image, audio, text, metadata, and etc., which are typically binary formats, optimized for compression and streaming delivery. They aren’t well suited for further processing that uses, for example, the internal structure or other specific features of the media stream. A structural (symbolic) layer on top of the binary media stream provides this information. The standards that operate in this middle layer for the representation of multimedia document descriptions are: Dublin Core, MPEG-7, Visual Resource Association, and so on. The problem with this structural approach is that the semantics of the information encoded in the XML are only specified within each standard’s framework. MPEG-7 was not built specifically for web applications and thus does not facilitate embedding links to other resources and interoperability between them. A possible solution to resolve the interoperability conflict is to add a third layer (the logical abstraction level) that provides the semantics for the middle one, actually defining mappings between the structured information sources and the domain’s formal knowledge representation based on semantically enriched languages (RDF and OWL).

RDF-based languages and technologies provided by the W3C community is well suited to the formal, semantic descriptions of the terms in a multimedia document’s annotation. A combination of the existing standards seems to be the most promising path for multimedia document description in the near future. For these reasons, the W3C has started a Multimedia Annotation on the Semantic Web Task Force[9] as part of the Semantic Web Best Practices and Deployment Working Group. The new task force operates within the framework of the W3C Semantic Web Activity group[10]. One goal is to provide guidelines for using Semantic Web languages and technologies to create, store, manipulate, interchange, and process image metadata. Another is to study interoperability issues between multimedia annotation standardization and RDF- and OWL-based approaches. Hopefully, this

[9] http://www.w3.org/2001/sw/BestPractices/MM/
[10] http://www.w3.org/2001/sw/

effort will provide a unified framework of good practices for constructing interoperable multimedia annotations.

Research towards a multimedia content and content description bounding has been going during the last several years. Commonwealth Scientific and Industrial Research Organization have developed an open source family of technologies ANNODEX (Pfeiffer *et al.*, 2003) for embedding annotations and hyperlinks directly within digital audio and video files. Such embedding allows the combined resource to become just like any web document which has content and content description bound into one. Also, the idea of a media semantic track utilizing has been elaborated in another research (Khriyenko, 2005), which concerns issues of multimedia smart messaging in an environment of limited devices.

Semantic annotation of multimedia content is performed by using appropriate domain specific ontologies that model the multimedia content domain. Ontologies typically represent concepts by linguistic terms. However, also multimedia ontologies can be created, that assign multimedia objects to concepts. At the same time with semantic content metadata annotation, annotation of the concepts of: people (artist, owner, restorer, author, producer, etc.), art objects and representations (painting, sculptures, films, digital representations, etc.), events and activities, places, methods and techniques, and etc., we should provide a basis for multimedia content features to be presented in semantic annotation also. This gives a possibility for better automatic annotation of the multimedia content. Further we try to specify the features of the multimedia content that can be detected and presented in Semantic Track.

In (Bertini et al., 2005) authors present a list of systems of automatic semantic annotation, most of them in the application domain of sports video. Among these, there is an approach, where MPEG motion vectors, playfield shape and players position have been used with Hidden Markov Models to detect soccer highlights. Another approach has been aimed to detect the principal soccer highlights, such as shot on goal, placed kick, forward launch and turnover, from a few visual cues. Additionally, the ball trajectory also has been used in order to detect the main actions like touching and passing and compute ball possession by each team; a Kalman filter is used to check whether a detected trajectory can be recognized as a ball trajectory. But, in all these approaches a model based event classification is not associated with any ontology-based representation of the domain. However, although linguistic terms are appropriate to distinguish event and object categories, they are inadequate when they must describe specific patterns of events or video entities. In this case, high level concepts, expressed through linguistic terms, and pattern specifications represented instead through visual concepts, can be both organized into new extended ontologies, that will be referred to as pictorially enriched ontologies. Ontologies can be extended to multimedia enriched ontologies where concepts that cannot be expressed in linguistic terms are represented by prototypes/patterns of different media like video, audio, etc.

The audio features used to characterize the sound signal and classify the sample by instrument. The CUICADO project (Peeters, 2003), provided a set of 72 audio features, and research has shown that some of the features are more important in capturing the signal characteristics: temporal shape, temporal feature, energy features, special shape features, harmonic features, perceptual features and MPEG-7 Low Level Audio Descriptors (spectral flatness and crest factors).

Now we can see how many multimedia-specific features and properties can enrich a Semantic Track of multimedia resources.

2.2 Across Content Browsing in a Sense of Concept based Semantic Search

With the reference to the research (Marcos et al., 2005), there are a number of important criticisms that can be made of Classical Model of information search. On the one hand, this model does not adequately distinguish between the needs of a user and what a user must specify to get it. Very often, users may not know how to specify a good search query, even in Natural Language terms. Analyzing what is retrieved from the first attempt is used not so much to select useful results, as to find out what is there to be search over. A second important criticism of the Classical Model is that any knowledge generated during the process of formulation a query is not used later on in the sequence of search process steps, to influence the filtering step and presenting step of the search results, or to select the results. Finally, Classical Model provides an essentially context-free process. There is no proper way in which knowledge of the task context and situation, and user profile can have an influence on the information search process.

To address these criticisms, the WIDE Model of information retrieval (Marcos et al., 2005) treats the general task of information finding as a kind of design task, and not as a kind of search specification and results selection tasks. Information retrieval is understood as a kind of design task by first recognizing the difference between users stating needs and forming well specified requirements, and then properly supporting the incremental development of a complete and consistent requirements, and the re-use of the knowledge generated in this (sub) process to effectively support the subsequent steps in the process that concludes in a useful set of search results.

There are several projects that are aimed to somehow enhance the Classical Model of information retrieval. For example, a problem of search query uncertainty has been faced in one of the projects of Industrial Ontologies Group (IOG):"*Semantic Facilitators for Web Information Retrieval"*[11]. The main idea of the project is that Semantic Search Assistant/Facilitator (SSA) uses ontologically defined knowledge (WordNet[12]) about words from Google search request and provides possibility for user to specify right meaning of the words from available set of them. Further, based on description of a selected word meaning, SSA uses embedded support of advanced Google-search query features in order to construct more efficient queries from formal textual description of searched information (Kaykova et al., 2004).

Thus, we can see how much work is doing in the area of enhancement of the classical information retrieving model by adding some new useful features. And this gives us basis for creation of a fully ontology-based semantic query and search mechanisms, mechanisms, where search query is created based on ontological concepts specification. Together with a Resource Semantic Track, this gives us an opportunity to perform an across multimedia contents browsing. It is a browsing process that includes semi-automatic multimedia content based semantic search query creation and semantic search processes through Semantic Tracks of multimedia resources.

[11] http://www.cs.jyu.fi/ai/OntoGroup/SemanticFacilitator.htm

[12] http://wordnet.princeton.edu/

3 4I MULTIMEDIA: MULTIMEDIA BROWSING BASED ON 4I (FOR EYE) TECHNOLOGY

3.1 A New Human-centric Resource Visualization Techniques - 4i (FOR EYE) Technology

Nowadays, unlimited interoperability and collaboration are the important things for industry, business, education and research, health and wellness, and other areas of people life. In an emergency planning situation different agencies have to collaborate and share data as well as information about the actions they are performing. Thus, we need an open environment to allow different heterogeneous resources (software, data, devices, humans, organizations, processes and etc.) communicate and interoperate with each other. And as usually, graphical user interface, that helps to perform these interoperation and collaboration processes in handy and easy for human/expert way, is one of the important things in performing and creation of these processes.

Following new technological trends, it is time to start a new stage in user visual interface development – a stage of semantic-based resource visualization. We have a need somehow to visualize the resource properties (in specific way, different from "directed arc (vector) between objects" representation), various relations between the resources, inter-resource communication process and etc. And even more, we have a need to make visualization context dependent, to be able to represent information in handy and adequate to a certain case (context) way. Thus, the main focus will be directed to the resource visualization aspects. Now, we have a challenging task of semantic-based context-dependent multidimensional resource visualization.

Regarding to the core characteristics of Web 2.0, a website is no longer a static page to be viewed in the browser, but is a dynamic platform upon which users can generate their own experience. The richness of this experience is powered by the implicit threads of knowledge that can be derived from the content supplied by users and how they interact with the site. Another aspect of this Web as platform is sites which provide users with access to their data through well defined APIs and hence encourage new uses of that data, e.g. through its integration with other data sources.

Now it has become evident that we cannot separate the visual aspects of both data representation and graphical interface from the interaction mechanisms that help a user to browse and query a data set through its visual representation. Presented in (Khriyenko, 2007) semantic-based context-dependent multidimensional resource visualization approach provides an opportunity to create intelligent visual interface that presents relevant information in more suitable and personalized for user form. It can be considered as a new valuable extension of text-based Semantic MediaWiki to Context-based Visual Semantic MediaWiki with visual context-dependent information representation, browsing and editing. Context-awareness and intelligence of such interface brings a new feature that gives a possibility for user to get not just raw data, but required integrated information based on a specified context. 4i (FOR EYE) is a smart ensemble of Intelligent GUI-Shell (smart middleware for context dependent use and combination of a variety of different MetaProviders, depending on the user needs) and MetaProviders as graphical interfaces that visualise filtered integrated information (see Figure 1). GUI Shell allows user dynamic switching between MetaProviders for more suitable information representation depending on a context. From other side, MetaProvider provides API to specify information filtering context. Such switching and filtering process is a kind of semantic browsing based on semantic description of the context and resource properties.

3.2 Multimedia Semantic Browsing

We have to consider another developing trend on the Web – a growth in multimedia content. Technological progress has meant that we have never had access to so much media content as now. Future challenges for the Web will be the meaningful organization of this huge amount of online media content as well as its meaningful delivery to the user. However, the present state of the art of media and Web technologies prevents richer integration.

A multimedia semantic browsing, as a sub-class of general resources browsing is a complex process that combines a set of sub-processes. This process can be performed based on presented 4i (FOR EYE) technology. Figure 2 shows us an example of an across multimedia contents semantic browsing architecture. In the left center of the figure, a GUI-Shell is presented as a combination of the tools that take parts in the process: multimedia content player, Semantic Track visualization component, concept browser and semantic search query builder/creator.

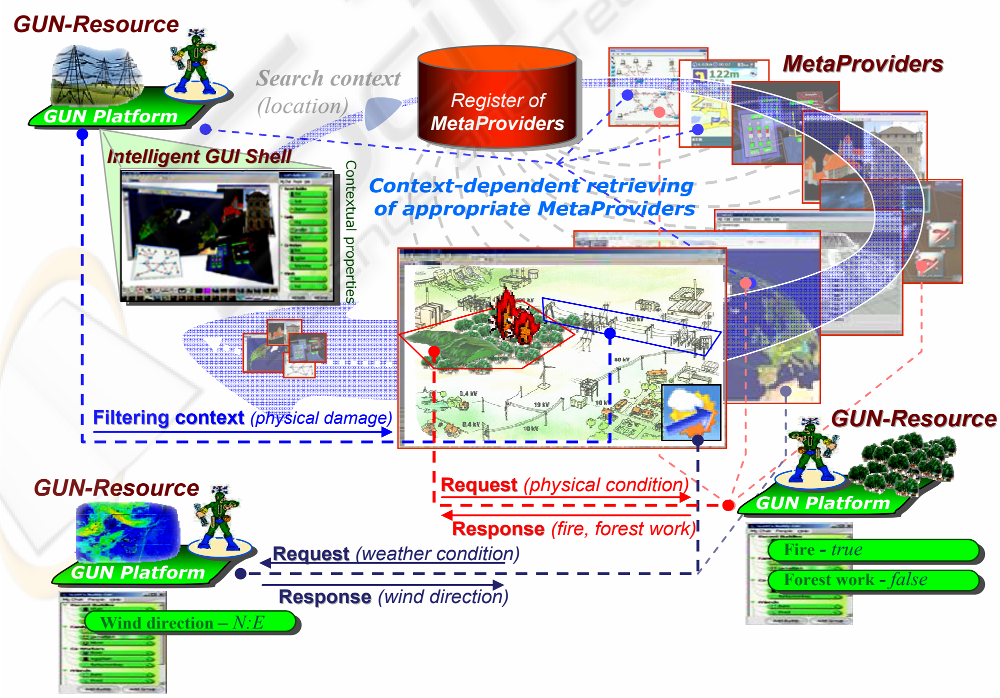

Figure 1: Intelligent Interface of Integrated Information (Khriyenko, 2007).

Let us consider an example, where user is watching an episode of a movie with some song (soundtrack) at the background. User likes this song/melody and would like to find more songs of this author (or even more complex goal – find similar songs to the initial one). To achieve the goal, user should browse Semantic Track of this video instance, which contains a structure of a video file, objects, actions, soundtracks, etc.; and find a reference to the searched song. Then, utilising a concept browsing tool, which is connected to remote ontology, user can specify a semantic query for a needed multimedia resource (in our case - a song). Such query specification can be considered as a creation/construction of a resource semantic pattern (virtual nested resource with specified properties). As a result of the search process, appropriate audio resource will be returned and even lyrics of the song can be displayed based on its' Semantic Track.

But it was just a simple case of semantic search/browsing process. Multimedia Resource Semantic Track usually contains just a structure of content and descriptions of multimedia content specific features (see the sub-chapter 2.1). And because of this, very often we can not specify direct linking between the contents of two Semantic Tracks of the different resources. The "glue" for these two semantic annotations is situated in Semantic Knowledge Bases (for example semantically-enhanced Wikipedia or different ontologies). It can be useful in the next example. Now we are looking for an image of the house of the first wife of some actor from a movie that we are watching. Firstly, we stop the movie on a scene where this actor is presented and, based on Semantic Track, find a link to this person. Then we browse a semantic knowledge base via the concept browser and find a link to his first wife and her house. After semantic search query generation we get the searched image on the browser.

At the same time, approach of instance based search via MetaProviders can be beneficially utilized in multimedia content searching/browsing. Let us consider a case, when we would like to see other houses, which are located nearby the house of the mentioned wife. We can use some MetaProvider – Wikimapia kind of service, which provide an access to the registered resources via showing them on a map. If the image is registered on this service/platform, then we easily can find other registered images in the same area (location), especially if final visualization will be filtered in a context that searched resource is an image of a house.

Figure 2: Multimedia semantic browsing.

Accordingly to the GUN approach, all the parts of searching/browsing process presented in GUI-Shell can be developed as separate functional modules (resource) and can be chosen by user to allow personalization of a browsing interface. In this particular use case of the OntoEnvironment, with resources of the real world (people, objects and etc.) we face new semantically-enhanced media-file resources. As was mentioned, these resources contain not just internal structure in their Semantic Tracks, but also links to other resources. Thus, with a purpose to be competitive in the open market of the media resources and have big rank of use, resources should be self-maintained and all the time should have up-to-date links in Semantic Track. Here we see the necessity of resource proactive behaviour. Supplied with an agent-based GUN Platform, behaviour of the resource can be configured in a way that gives resource a possibility to communicate with other resources and change/update own Semantic Track in real time (see Figure 3).

4 CONCLUSIONS

Presented 4i technology quite fits the demands of a new generation of integration systems. It can be very useful, especially if we have a deal with a Human-Computer interaction process. Now, when human becomes a very dynamic and proactive resource of a large integration environment with a huge amount of different heterogeneous data, it is quite necessary to provide a technology and tools for easy and handy human information access and manipulation.

Figure 3: Semantically enhanced multimedia resource infrastructure.

Presented semantic-based context-dependent multidimensional resource visualization approach provides an opportunity to create intelligent visual interface that presents relevant information in more suitable and personalized for user form. Context-awareness and intelligence of such interface brings a new feature that gives a possibility for user to get not just raw data, but required information based on a specified context.

There are already some developed domain-oriented software applications that try to visualize the data in domain specific and suitable for human way (one of the most popular is graphics software from SmartDraw® [13]). But it is standalone application without any functionality for interoperability. Subscribing to an opinion of (Nixon, 2006), bridging the gap between the emerging folksonomies of Web 2.0 and the formal semantics of Semantic Web ontologies would benefit the Semantic Web community with being able to leverage the content and knowledge that Web 2.0 is already generating from its users and making available over standardized APIs. This applies even more in the multimedia community, where e.g. collaborative user-contributed media annotation on a Web scale is an attractive (compromised) solution to the problem of extracting knowledge out of large multimedia data stores. In recognition of this, a Web 2.0 based scenario has been chosen for SWeMPs[14] ontology-based multimedia presentation system (one of the related works in this area).

With the idea of the GUN we come to the environment where all the resources are semantically interoperable and have own semantic description – Resource Semantic Track. With the growing ubiquity of digital media content, ability to combine continuous media data with its own multimedia specific content description into the one source brings the idea of a true multimedia semantic web one step closer.

Now, when environments with unlimited interoperability and collaboration demand data and information sharing, we need more open semantic-based applications that are able to interoperate and

[13] SmartDraw® - www.smartdraw.com

[14] http://swemps.ag-nbi.de/

collaborate with each other. Ability of the system to perform semantically enhanced resource search/browsing based on Resource Semantic Track brings a valuable benefit for today Web and for the Web of the future with unlimited amount of the resources. Proposed technology allows creation of a Human-centric open environment for resource collaboration with an enhanced semantic and context-based instance resource browsing. This is a good basis for the different business, production, maintenance, healthcare, social process models creation and multimedia content management as a one of the fastest growing area of the Web.

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