Multimedia Semantics and the Semantic Web

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• Motivation
• Multimedia annotation types
• Semantic Web Integration
• Semantic Web Integration Open Issues
• Multimedia Annotation Vocabularies
• Multimedia Annotation Tools
  ○ Common features
  ○ RDFPic, PhotoStuff, AKtiveMedia, M-OntoMat-Annotizer
  ○ Future Directions
• Conclusions
Motivation

- Growing amount of digital multimedia content available on the Web
- Multimedia content difficult to manage, search and reuse
- Multimedia annotations difficult, time-consuming, expensive
- Understanding and semantic representation of multimedia content - important step toward more efficient management of multimedia content
Multimedia Annotation Types

- **Fee-text annotation** - very expressive and the most natural for the human but provides least formal semantics and hence is very hard for computer processing.

- **Tagging** - tags have no formal semantics but could be useful for multimedia annotation if a fixed vocabulary is used.

- **Ontologies** - provide syntax and semantic to define complex domain vocabularies; inference of additional knowledge is possible; could be the solution of the interoperability problem.
Semantic Web Integration

- Recently, there has been an interest in applying Semantic Web technologies to represent multimedia semantics in a machine processable format.
- Semantic web proposes use of explicit background knowledge as a way to address the search problems.
- Semantic Web would simplify the integration of multiple vocabularies from different communities;
- Semantic Web tools could be used for multimedia annotation.
Semantic Web Integration Open Issues

- **Interoperability and tool support** - relates to the compatibility of Semantic Web tools and standards with the current multimedia standards and tools

- **Linking media data with metadata** — relates to the problem of a flexible attachment of metadata to media resources, it should be possible to link metadata to the appropriate part of the target media item and also a standard way to link a piece of metadata and its target media item should be developed. Another open problem is the distinction between metadata about a physical object and the metadata about a digital representation of that object

- **Vocabularies for multimedia annotations** - example multimedia vocabularies using Semantic Web languages should be collected and published; their practical use in the area of multimedia annotation should be demonstrated with the current multimedia metadata tools
Multimedia Annotation Vocabularies

- **Visual Resource Association (VRA)** - data standard for the cultural heritage community. The element set provides a categorical organization for the description of works of visual culture as well as the images that document them.

- **Exchangeable image file format (Exif)** - specification for the image file format used by digital cameras. The specification uses the existing JPEG, TIFF Rev. 6.0, and RIFF WAV file formats, with the addition of specific metadata tags. It is not supported in JPEG 2000, PNG, or GIF. The Exif header carries the metadata for the captured image or sound.

- **Multimedia Content Description Interface (MPEG-7)** - an ISO/IEC standard developed by MPEG (Moving Picture Experts Group). MPEG-7 offers a comprehensive set of audiovisual Description Tools (the metadata elements and their structure and relationships, that are defined by the standard in the form of Descriptors and Description Schemes) for the creation of modular descriptions on different levels of abstraction. Its XML-based syntax enables smooth interchange across applications and over the web, but the lack of precise semantics hinders metadata interoperability.

- **Others** - MPEG-21, Material Exchange Format (MXF), Synchronized Multimedia Integration Language (SMIL), Scalable Vector Graphics (SVG) ...
Multimedia Annotation Tools

**Common Features**

- Cross-media annotation
- Ontology visualization
- Metadata generation based on ontologies, storage, retrieval and reuse
- Metadata search
- Assistance in the annotation process
- Region-based annotation of image content
Multimedia Annotation Tools

**Common Features**

- Extraction of existing metadata embedded in image files and serialization of the information in the generated metadata
- Automatic generation of metadata
- Reusing existing knowledge and reasoning on existing knowledge
- Mechanism for content sharing
RDFpic

- supports only JPEG file format
- three domain specific RDF schemas are used to annotate digital images - Dublin Core Schema, Technical Schema and Content Schema
- manual annotation;
- resulting RDF/XML is embedded in the header of the JPEG
PhotoStuff (Mindswap)

- image regions annotation with custom defined ontologies;
- possible to load multiple ontologies at once and to mark-up images with concepts from any of the loaded ontology;
- reuse existing metadata definitions - existing instances can be loaded from any URI on the Web and thus depictions can reference existing instances;
- extraction of existing metadata embedded in image files and serialization of the information in the generated metadata;
- interaction with a Semantic Web portal - retrieving all instances that have been submitted to the portal, submitting generated RDF/XML, and uploading local images so they can be referenced by a URI;
- semantics based image browsing and searching is provided after the metadata of annotated images is submitted to the Semantic Web portal.
AKtiveMedia

- most of the functionality provided by PhotoStuff
- all types of image formats and import of multiple ontologies
- integration with web services, to find relevant images
- knowledge suggestion during annotation
- EXIF Metadata extraction
- batch annotation - users can annotate an entire collection of images at the same time
- export the annotated data to RDF for later access
M-OntoMat-Annotizer (aceMedia)

- ontology based image and video frame annotation at both the image and image-region level
- automatic, low-level MPEG-7-based feature extraction from annotated regions
- User can mark image regions manually or using an automatic segmentation tool
Future Directions

- **Automating portions of the annotation process** – automatic metadata extraction and presentation as formalized knowledge via ontologies;
- **Assistance in the annotation process** – for example knowledge suggestion during annotation;
- **Batch annotation** – users can annotate an entire collection of images at the same time;
- **Basic ontology editing functionalities** – allowing the user to customize the used ontologies;
- **Ontology based search in the created metadata stores**;
- **Interoperability support** – the issue of heterogeneity is addressed, functionality that provides mappings between different ontologies is missing in current multimedia annotation tools.
Conclusions

- Integration must be achieved in a way that decreases the complexity of the multimedia annotation and multimedia services development;
- Some work has to be done to achieve interoperability between different ontologies – ontology alignment techniques must be developed and applied;
- Multimedia annotation tools must be available and accessible to non-professional users;
- Tutorials, best practices and supporting tools for the creation of multimedia services are needed.
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