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Combining different access options for image databases

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Abstract

Living Memory is an interdisciplinary project running for two years, which is realised in cooperation of several institutions. It aims at developing an information system for a digital collection of different types of visual resources and will combine classical methods of image indexing and retrieval with innovative approaches like content-based image retrieval and the use of topic maps for semantic searching and browsing. This work-in-progress-report outlines the aims of the project and present first results after the period of fifteen months.

1. *Living Memory* – Aims of the Project

Living Memory is a cooperative project of applied research running for two years; it is in progress presently. Project partners include the University of Art and Design (HGK) Basel (Department of Visual Communications), the University of Applied Sciences (HTW) Chur (Department of Information Science), and the software company Interaktion, located in Zurich.

The aims are to set up an information system of visual resources and to explore new paths of image cataloguing and retrieval, including the investigation of how topic maps can be made fruitful for the image domain. A topic map representing index terms will be used both as a navigation tool for the user, allowing him to browse the image collection, and as a means to enable semantic searches, allowing the user to choose between precise and fuzzy results. Special emphasis is laid on the combination of different access options.

The visual resources at hand document a major project of urban planning – the structural alteration of an industrial area, located in Basel, into a research site.[1] In order to create a digital „living memory" of the site, Novartis mandated the HGK to document the process, and since 2003 HGK students have created some hundred visual resources in different media – photographs, drawings, graphics and videos – per year.[2] The images are grouped according to their creation and theme (see fig. 1).

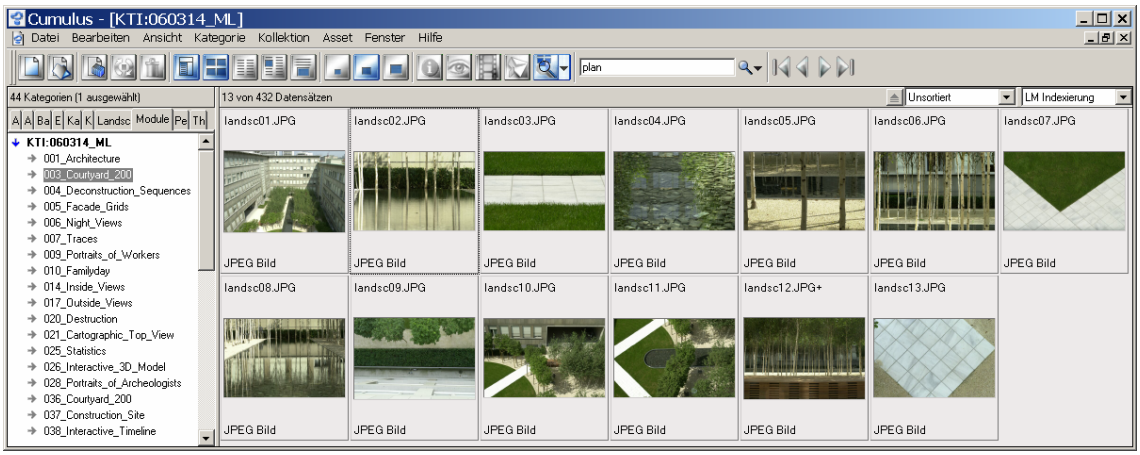

Fig. 1. Grouping of images with title "Courtyard 200"

The project *Living Memory* started in January 2005 and reached its first milestone after eleven months. The following results have been achieved: a database, implemented with the system Cumulus[3], ready for cataloguing; a first version of both

[1] The project has been initiated by the pharmaceutical company Novartis, the owner of the site. For more information about the emerging, so called Novartis Campus see http://www.novartis.ch/about_novartis/de/campus_2005/index.shtml

[2] These include architectural photographs as well as images of special events or everyday scenes like construction workers or Novartis employees at work.

[3] http://www.canto.de/pro/

a thesaurus and a topic map have been built; a concept of different access options has been set up as well as indexing guidelines. Since then, a sample of 432 images have been catalogued and the implementation of a protoype is going on.

2. The semantic structure of *Living Memory*

The semantic structure of the *Living Memory* information system is formed by three interlocking modules: metadata schema, thesaurus and topic map.

The basis for image description is a metadata schema especially designed for *Living Memory*. For that purpose, existing schemas such as the Dublin Core Metadata Element Set[4], the Categories for the Description of Works of Art[5] and the SEPIA Data Element Set[6] were consulted. Since we expect users of a *Living Memory* information system – mostly image professionals such as members of corporate communications, curators or architects – to search images by a variety of criteria, the schema combines formal metadata, index terms and visual properties. Formal metadata (such as author or medium) and index terms have to be assigned intellectually, visual features (such as contrast or luminance) can be extracted automatically.[7]

A thesaurus drawing mainly on the Art and Architecture Thesaurus (AAT)[8] has been designed; it will serve as a controlled vocabulary for image indexing.[9]

The thesaurus also served as a fundament for the construction of the topic map. Topic Maps as standardised by ISO are a powerful means for modelling semantic structures (associations) between any kind of things (topics), which are linked to any kind of documents (occurrences).[10] On the conceptual level, topic maps may be seen as an enlargement of thesauri, since they offer the possibility to express any kind of associations between terms. On the level of resources, they adopt the function of the traditional back-of-book indices for the realm of electronic resources. Just as an index points to occurrences of a topic within a book, the topic map points to occurrences which may be located internally (within the topic map itself) or externally (on the World Wide Web).

When converting a thesaurus to a topic map, the thesaurus provides the topics and some basic associations: the hierarchical super-/subclass association, synonyms and related terms. However, care must be applied with regard to the

[4] http://dublincore.org/
[5] http://www.getty.edu/research/conducting_research/standards/cdwa/index.html
[6] http://www.knaw.nl/ecpa/sepia/workinggroups/wp5/cataloguing.html
[7] Since the 1990ies, images can be searched for by their inherent features, i.e. colour, texture and form. This is called content-based image retrieval (CBIR). Although the technology has evolved into some commercial products, the results are not yet fully satisfactory. We limited this option to colour features.
[8] http://www.getty.edu/research/conducting_research/vocabularies/aat. This comprehensive and specialised thesaurus proved to be best suited for our project.
[9] The thesaurus in its present raw version contains ca. 1'000 terms ranging from concrete entities to abstract concepts, which are divided into several branches.
[10] Topics, associations and occurrences are the basic elements of the Topic Map paradigm (cf. [1]). The topic map was modelled with the software L4 Modeller by Moresophy (http://www.moresophy.com).

hierarchical composition of the thesaurus.[11] Since we did not follow the strict super-/subclass hierarchy of the AAT, but allowed part-of- and affiliated-with-relations[12], as well, every hierarchical relation had to be examined with regard to its semantics. Part-of- and affiliated-with-relations were therefore turned into association types of the topic map.

Accordingly, the topics of the topic map cover the index terms of the thesaurus.[13] The topic map will serve both as a navigation tool for the user (see fig. 2) and as an instrument to enable semantic searches (see sect. 3).

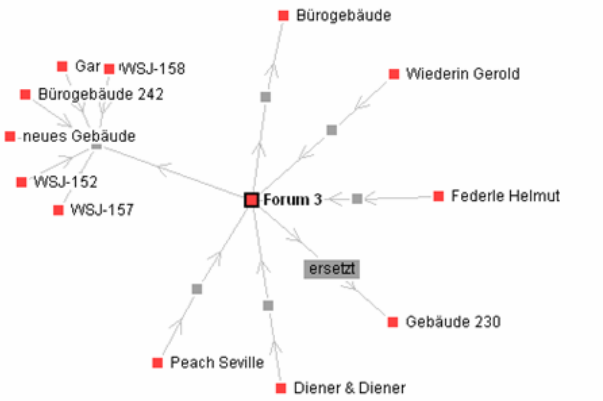

Fig. 2. Extract from the *Living Memory* topic map

Since the occurrences are stored in the database, every topic will be defined as a database query. This query may be simple; the topic „tree“ e.g. will initiate a query for „tree“ in the subject term data field of the database. Consequently, every relevant image of a tree will be an occurrence, provided the images have been properly indexed. But the query may also be combined; in fact, topics for image *expression* shall be defined in this way. The question „What makes an image express an idyll?“ may lead to answers like the following: colour feature A plus colour feature B plus subject term C.[14] By this mechanism, the topic map is connected to the database without redundancy.

3. Access options

Users will be able to combine different access options, which is supposed to be the most successful approach in image retrieval.[15] We therefore focused on the

[11] [3], p. 3.
[12] Examples are „tree – branch“ for the part-of-relation and „architecture – building“ for the affiliated-with-relation.
[13] The topic map will not, however, cover formal metadata like authors or formats of images. Formal search terms can only be found by traditional database queries.
[14] For the assignation of image expression, the images will have to be interpreted by image professionals. If the experts agree on a set of images to have the expression „idyllic“, these images can be analyzed with regard to visual features. If similarities can be found, combined queries can be defined accordingly.
[15] Cf. [2], p. 19ff.

combination of different levels of image description and methods of image retrieval, rather than pushing one method to extremes. The user will be presented an interface with a menu listing the different access options: a full-text search option, the thesaurus of index terms, a list of specific objects[16], the lists of authors and media, the groupings by title, a time axis, a map of the area and several colour features. The user may thus pick from this menu and put together his search by arbitrary combinations.

The following access scenarios are expected to correspond to user needs:

- *Traditional search* can be effected as text-based search (for formal metadata or index terms) or as visual search (for colour features, with the possibility to adjust a value on a scale). Given a set of images as a result, the user may then want to refine his search results, or he may continue the search based on a found image by selecting and combining allocated metadata of the image, including visual properties.
- *Semantic search* and *browsing* is effected with the aid of the topic map. The user can select the degree of precision (e. g. no related terms, exact match) or fuzziness (e. g. all related terms) of his search. But he may also browse the topic map guided by subject interests. The latter has several advantages for the user: He does not have to be familiar with the logic of the database or description language;[17] moreover, by navigating the topic map he will learn about the semantic context, in which a collection and its single items are embedded, and may find useful items he would not have expected to find in the beginning.

4. Conclusions and further work

These concepts of access options are being implemented presently. The use of topic maps for semantic searches is being worked out in detail: Given a search term, which are the different levels of related terms to be included in fuzzy searches? Indexing guidelines are improved and tested with students. Moreover, in the present stage of the project, the design of user interfaces occupies a central position. Finally, usability tests and an overall evaluation are due to optimise the emerging prototype of the information system.

A question still unresolved is the missing integration of topic map and thesaurus. Since the thesaurus is part of the Cumulus database, whereas the topic map is maintained with the L4 software package, this results in a double tracked solution. Because changes in either of the two always affect the other, an integrated solution is aspired.

References

1. Pepper, Steve (2000): The TAO of Topic Maps. Finding the Way in the Age of Infoglut. http://www.ontopia.net/topicmaps/materials/tao.html

[16] These include buildings, people, events, art objects and landscaping object.

[17] Topic maps may therefore be an appropriate solution for the increasing number of digital archives on the World Wide Web facing users without professional skills in information retrieval or databases.

2. Renz, Monika; Renz, Wolfgang: *Neue Verfahren im Bildretrieval. Perspektiven für die Anwendung*. (Contribution to 22th DGI-Online Conference, May 2-4 2000, Frankfurt a.M.) http://users.informatik.haw-hamburg.de/~wr/internFH/Renz_DGIonline.pdf
3. Wielinga, B. J. et al. (2001): *From Thesaurus to Ontology*. http://www.cs.vu.nl/~guus/papers/Wielinga01a.pdf