Content and concept-based retrieval and navigation tools in Sculpteur

(Semantic and Content-based mULtimedia exPloitation for EURopean benefit)[1]

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Abstract – The Sculpteur project provides an environment for intelligent retrieval and indexing of multimedia objects related to cultural collections stored in a set of networked databases. The paper gives an overview of the Sculpteur system and illustrates how the ontology developed in Sculpteur describing the application domains of the galleries and museums involved in the project, coupled to the content based analysis can be used to navigate the collections and enhance the content based retrieval.

INTRODUCTION

European cultural heritage collections are extensive and the museum community is investing time and resources creating pilot projects and applications ranging from 2D imaging, to 3D reconstruction. So cultural data is no longer limited to simple 2D images and metadata: it now includes movies, full texture mapped 3D models, quicktime VR and even tomographic data.

As a consequence, the possibility of easy and effective management of a large repository of more diverse multimedia types is becoming a vital objective for many cultural organisations.

Sculpteur is developing innovative solutions for extending digital library technology so that it can support storage and retrieval of diverse multimedia objects together with algorithms for content-based retrieval of high-resolution 2D and 3D objects. We believe that in the future researchers will expect to be able to find multimedia objects in terms of their properties as well as using metadata and other text.

Sculpteur will enable improved co-opera between teams of researches, historians and conservationists, and form the basis of new ways for the public to interact with information about exhibits.

[1] SCULPTEUR brings together five major European galleries (The Uffizi Gallery in Florence, The National Gallery and the Victoria and Albert Museum in London, the Louvre related restoration centre, Centre de Recherche et de Restauration des Musées de France and the Musee de Cherbourg in France) together with GIUNTI Interactive Labs (the Coordinator), IT Innovation, the Department of Electronics and Computer Science at the University of Southampton, Centrica, and Ecole Nationale Supérieure des Télécommunications. SCULPTEUR is co-funded by the European Commission under the Information Society Technologies Programme (IST).

The emergence of the Semantic Web [1] will allow museums and galleries to publish higher quality metadata about their collections. SCULPTEUR will use these new technologies to allow browsing by concepts and also across collections.

SYSTEM OVERVIEW

SCULPTEUR will provide integrated navigation and searching of gallery and museum collections using textual metadata, content-based analysis and ontological classification.
SCULPTEUR will include tools for importing data (new images and 3D models, data from gallery catalogues, information from the Web) and interoperating with external systems (remote SCULPTEUR installations, gallery legacy systems, or remote digital libraries supporting standard interfaces such as OAI [2]). These tools will include semi-automatic classification of collection content and searching the Web for information missing from the collection.
Finally, SCULPTEUR will provide an interface to allow multimedia content to be exported for use in eLearning tools. This will broaden the way in which museum and gallery information assets can be delivered to the users.
An overview of the Sculpteur system components is presented in the next figure.

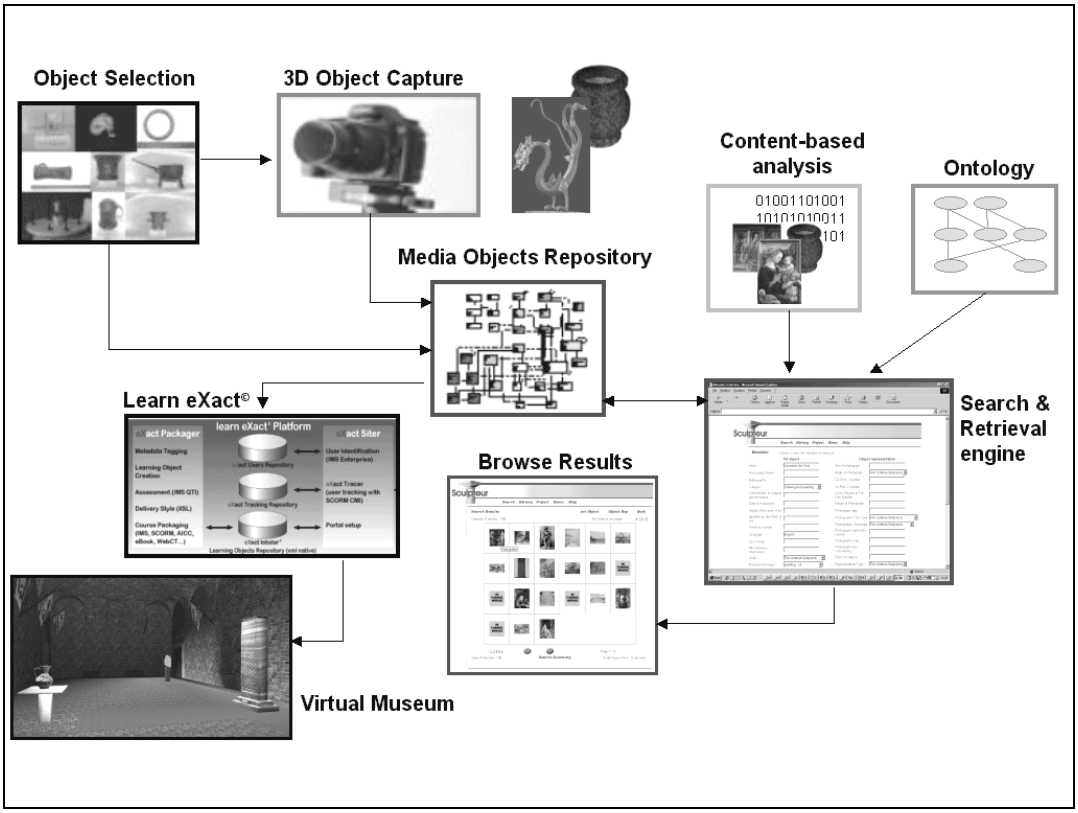

Fig. 1: Components of the SCULPTEUR system

One of the approaches to 3D object capture developed by the University of Paris uses a sequence of high-definition images. The 3D model reconstruction is achieved by applying two different and complementary methods: a silhouette method [3,4,5] and a multi-stereo method [6,7].
The media object repository (in part based on MySQL database) is used to store 3D models, media objects such as images, reports, audio, videos and metadata related to works of art

within the museums and galleries. The system provides services for executing image and 3D processing algorithms on the data. Algorithms are executed as a service while metadata queries are performed using SQL queries in the RDBMS (MySQL). The Sculpteur server will access the repository when executing search and retrieve queries from client applications. The adopted solution will give most flexibility to the algorithm developers as the interface between the Sculpteur server and image processing algorithms will be loosely coupled.
The Sculpteur server, the core of the search and retrieval engine, will provide querying services to the client applications to submit content-based and metadata queries on multimedia objects stored within the multimedia repository.
Client applications will access querying services using the Sculpteur Search and Retrieve Web Service (SRW). Queries will be constructed in XML messages using the Common Query Language (CQL) and transported using SOAP protocol on top of HTTP. The SRW is based on an evolving standard for querying digital libraries being developed by the ZING consortium. The protocol has its roots in Z39.50, a well established protocol for this purpose [8]. The Sculpteur server will be implemented as a Java (J2EE) application leveraging standard application services such as persistence management, security and concurrent multi-user access.
It is expected that eLearning applications (such as Learn eXact [9]) will access search and retrieval functionality of SCULPTEUR using one of the enhanced interoperability protocols such as OAI and SRW. Learn eXact is a learning content management system for authoring e-learning objects. It is native XML and compatible with the newly released IMS [10] and ADL SCORM 1.3 specifications [11], and pre-existing AICC standards for the creation, management and delivery of e-learning contents. Thanks to the integration of Learn eXact into Sculpteur, a user will be able to create cultural learning objects (LOs) by exploiting the multimedia objects returned from a query. Returned 3D models will also be used to create virtual museums or exhibitions as the example shown in the next figure.

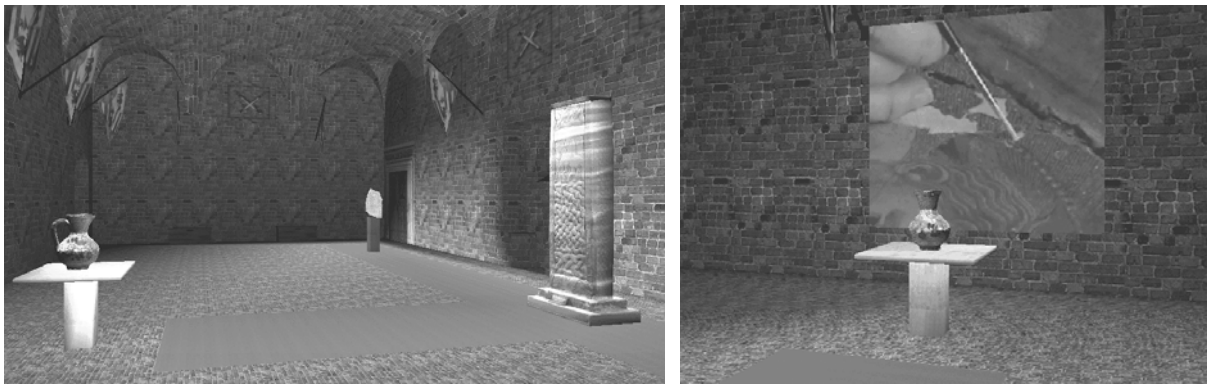

Fig. 2: An example a virtual museum in Sculpteur

Created learning objects (a virtual room is considered as a LO) could be packaged according to e-learning standards such as IEEE LTSC, IMS, ADL SCORM; this will guarantee maximum interoperability among learning objects creators.

CONTENT- AND CONCEPT-BASED RETRIEVAL

At the heart of the SCULPTEUR architecture is an ontology describing the application domains of the galleries and museums involved in the project. This is being developed from the CIDOC Conceptual Reference Model (CRM) [12] developed over the last 10 years by the CIDOC Documentation Standards Working Group. The CRM provides definitions and a

formal structure for describing the implicit and explicit concepts and relationships used in cultural heritage documentation.
These concepts and their relationships provide a semantic layer in the SCULPTEUR system and the multimedia objects and their metadata items provide instance information for populating the ontology. The approach builds on the multimedia thesaurus idea [13]. A graphical concept browser allows users to navigate through the concepts and retrieve instances of concepts in which they are interested. Thus a user could navigate to a particular sculptor and retrieve all figurines created by that sculptor in a particular period. This form of concept based navigation and retrieval may be combined with content based searching so that, for example, all objects created by a particular sculptor and similar in shape to a given query sculpture could be retrieved.
The associations between multimedia objects and concepts in the semantic layer can greatly enhance content based retrieval. A content-based query using shape matching on a figurine could retrieve other figurines which were not similar in shape but which are associated with the same concept in the ontology. (This is the multimedia equivalent of using a thesaurus to overcome the synonym problem in text retrieval). The associations between ontology and objects also means the scope of a search can be expanded or refined through the relationships in the semantic layer.

CONCLUSIONS

Sculpteur's purpose is the creation and management of distributed cultural multimedia repositories of images, videos, textual information, and 3D objects. Cultural information could be retrieved by metadata queries or query by example which uses content-based analysis. Data will be navigable by concept as well, which will bring more focused and accurate retrieval for researchers.
In this paper we provided an overview of the Sculpteur system and we described how the problem of 3D data retrieval based on content and concept will be faced in the project. Although the system is still under development the final system will be ready at the end of 2004. The current prototype already supports the acquisition of 3D objects, the storage of diverse multimedia objects and queries by metadata and 2D images.
It is expected that Semantic Web techniques will eventually be used by most major museums and galleries as it improves access to their collections. Perhaps search engines of the future will be able to answer the question "*find me a european vase this shape from the 17th century*".

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