

MILOS: A multimedia Content Management System for Multimedia Digital Library Applications

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Abstract

MILOS is a multimedia content management system specialised to support multimedia digital library applications. MILOS provides applications with functionalities for the storage of arbitrary multimedia documents and their content based retrieval using arbitrary metadata models represented in XML. MILOS is flexible in the management of documents containing different types of data and content descriptions; it is efficient and scalable in the storage and content based retrieval of these documents.

Keywords

Digital Library, Information Retrieval, Metadata, Multimedia

1. Introduction

Recently several digital library applications have been proposed able to manage multimedia digital documents in addition to the more traditional textual documents. However, these digital library applications are typically designed employing ad-hoc solutions to cope with specific applicative context, are limited to manage specific types of digital objects and specific metadata description models. This implies they can be hardly adapted to different application environments and to different metadata description models: all components of the digital library -- the data repository, the metadata manager, the search and retrieval components, etc. -- are specific to a given application and cannot be easily used in other environments. This is mainly due to the lack of standard general purpose basic building components tailored to multimedia digital library application design.

In contrast we propose an approach similar to that applied in the field of traditional database applications. In fact, database applications are generally built relying on a Database Management System (DBMS), a general purpose software module that offers all functions needed to build many different database applications (e.g., banking, corporate management, billing, etc.). The same should be done in the multimedia digital library field: we need a general purpose Multimedia Content Management System (MCMS) which offers functionalities specialized for multimedia digital library applications (see Figure 1). Different multimedia digital library applications, can be built on top of such an MCMS, each supporting the management of documents of any data type, described by using arbitrary metadata description models, searchable in many different modes. This MCMS should be able to manage not only formatted data, like in databases, but also textual data, using Information Retrieval technology, semi-structured data, typically encoded in XML, mixed-mode data, like structured presentations, and multimedia data, like images and audio/video.

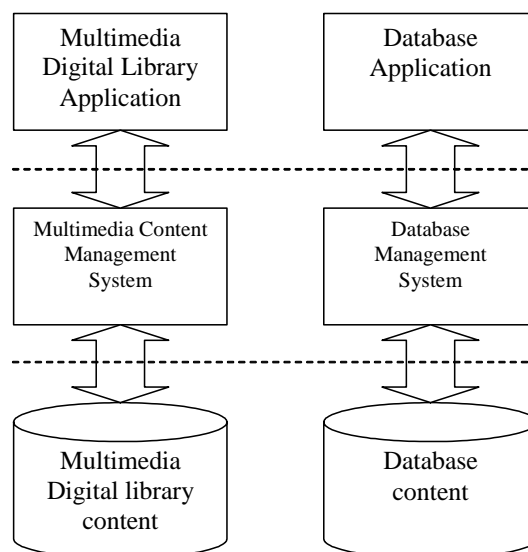


Figure 1: Layers of database and digital library applications

2. MILOS Functionalities and architecture

We believe that the basic functionalities of a MCMS can be summarized as:

1. capability of managing different documents embodied in different media and stored with different strategies;
2. capability of describing documents by means of arbitrary, and possibly heterogeneous, metadata;
3. capability of providing DL applications with custom/personalised views on the metadata schema actually handled.

Point 1) prescribes that no assumption should be made on the types of media and encoding used to represent documents, and especially on the specific strategy used to store them. This allows applications to be independent from the technical details related to multimedia document management.

Point 2) states that a content management system should be able to deal with arbitrary metadata. This is required by the fact that different digital library applications, according to their specific requirements, might need to use different metadata. These different metadata might be needed because the documents have redundant descriptions in terms of different metadata, or because the application is dealing with document collections described with heterogeneous metadata.

Point 3) makes it possible that the metadata schema seen by the DL application is different from the metadata schemas actually stored in the repository of the content management system. Suppose that an application was built to deal just with a specific metadata schema. The MCMS should be able to serve requests of such an application even if metadata stored in the repository comply with different schemas. In addition, this feature allows different applications, which require different metadata schemas, to share the same MCMS transparently.

Accordingly, we have designed and built MILOS (Multimedia dIgital Library Object Server) [2,3], a MCMS that satisfies the requirements and offers the functionalities discussed above. The MILOS MCMS has been developed by using the Web Service technology, which in many cases (e.g. .NET, EJB, CORBA, etc.) already provides very complex support for "standard" operations such as authentication, authorization management, encryption, replication, distribution, load balancing, etc. Thus, we do not further elaborate on these topics, but we will mainly concentrate on the aspects discussed above.

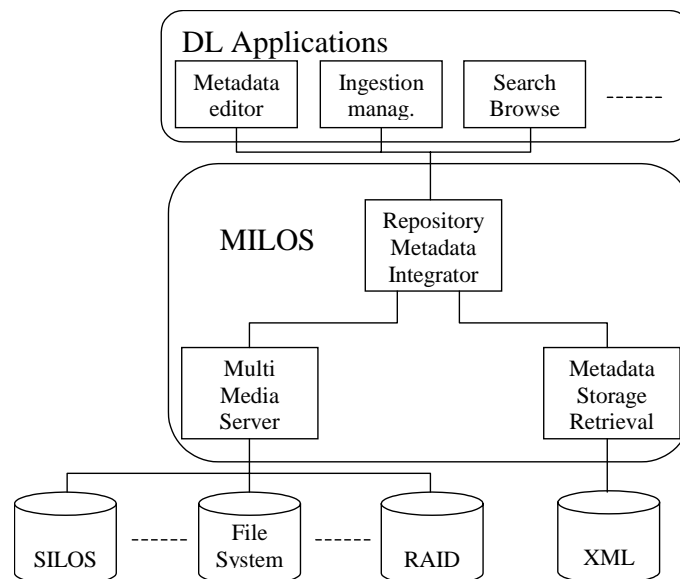


Figure 2: Architecture of Milos

MILOS is composed of three main components as depicted in Figure 2: the Metadata Storage and Retrieval (MSR) component, the Multi Media Server (MMS) component, and the Repository Metadata Integrator (RMI) component. All these components are implemented as Web Services and interact by using SOAP.

The MSR manages the metadata of the DL. It relies on our technology for native XML databases, and offers the functionality illustrated at point 2) above. It allows digital library applications to use arbitrary (XML encoded) metadata schemas and to deal with heterogeneous metadata, without schema design constraints and/or overhead due to metadata translation. Our XML database offers advanced search and indexing functionality. Consider that new generation of XML encoded metadata standards, such as MPEG-7 [1], include in their description also features automatically extracted from visual documents, such as color histograms, textures, shapes, etc. Thus, our XML database supports high

performance search and retrieval on heavily structured XML documents as well as full text search , automatic classification, and feature similarity search.

The MMS manages the multimedia documents used by the applications. MMS offers the functionality of point 1) above. Digital library applications might have different requirements concerning the strategy used to serve documents to the users. A small digital library dealing with relatively small textual documents, might serve documents using a normal web server, while heavily accessed digital libraries might need to use replication and load balancing strategies to guarantee high performance access to content. A video digital library might use high performance video servers for streaming their content in real time. The task of the MMS is to make the programmers of the applications free from all these issues. Specifically, the key idea here is that the application should deal with documents in a uniform way, independently of the specific strategy used to manage them.

The RMI implements the service logic of the repository providing developers of applications with a uniform and integrated way of accessing MMS and MRS. In addition, it supports the mapping of different metadata schemas as described at point 3) above. The mapping of application requests into requests compatible to the metadata schema actually managed by the MCMS is accomplished by defining a set of schema mapping rules. This mechanism allows the RMI to translate names of fields (such as Title, Author, etc.) known to the application, into correct requests to the MSR. When a new XML schema is introduced, the system administrator should define a mapping between the application perspective and the MCMS perspective on metadata.

3. Designing and building digital library application with MILOS

MILOS has been used to create several digital library applications with heterogeneous data. For example, we created DL applications based on the use of the Reuters data set [4], the ACM Sigmod Record dataset [5], the DBLP data set [6], and the ECHO data set [7].

Particularly interesting is the case of the ECHO data set which is composed of about 8,000 documents for 50 hours of video described by 43,000 XML files (36 Mb). This data set is composed of historical documentaries produced in different European countries from 1920 to 1970. The metadata associated to each audio-video document is based on the ECHO metadata model [7, 8] which is an extension of the IFLA-FRBR model [9]. The model allows a complete and detailed description of the entire video and of all its components (the audio part, the scenes that compose the video, the key frames associated to each scene, the transcript of the audio part, etc.). The Digital Library that has been developed supports powerful search capabilities that range from the simple free text on audio transcripts to searches on all metadata fields, on images, and on their combination. Furthermore, the Digital Library also supports multilingual searches.

The original ECHO DL application, as resulted from the ECHO project, was built using a relational database, and translating all metadata in a relational schema. Even simple searches required several (up to 10 or more) seconds to be processed. With MILOS we had a dramatic improvement of performance, being able to serve requests in less than one second even with several users accessing the system. A screen shot of the DL interface is shown in Figure 3.

4. Conclusion

This paper described the architecture of the MILOS Content Management System and the solutions adopted to obtain a system that is flexible in the management of documents with different types of content and descriptions, and that is efficient and scalable in the storage and content based retrieval of these documents. In particular, we described the approach adopted to support the management of different metadata descriptions of multimedia documents in the same repository. This goes towards the solution of the challenging problems of interoperability among different metadata descriptions. The proposed solution, based on the use of a mapping mechanism among the metadata fields of the different models, has been practically experimented by using the MILOS system to archive documents belonging to four different and heterogeneous collections which contain news agencies, scientific papers, and audio/video documentaries. The archiving of these documents was straightforward and it only required the creation of the mapping file and the development of the user interfaces to archive and to search the documents.

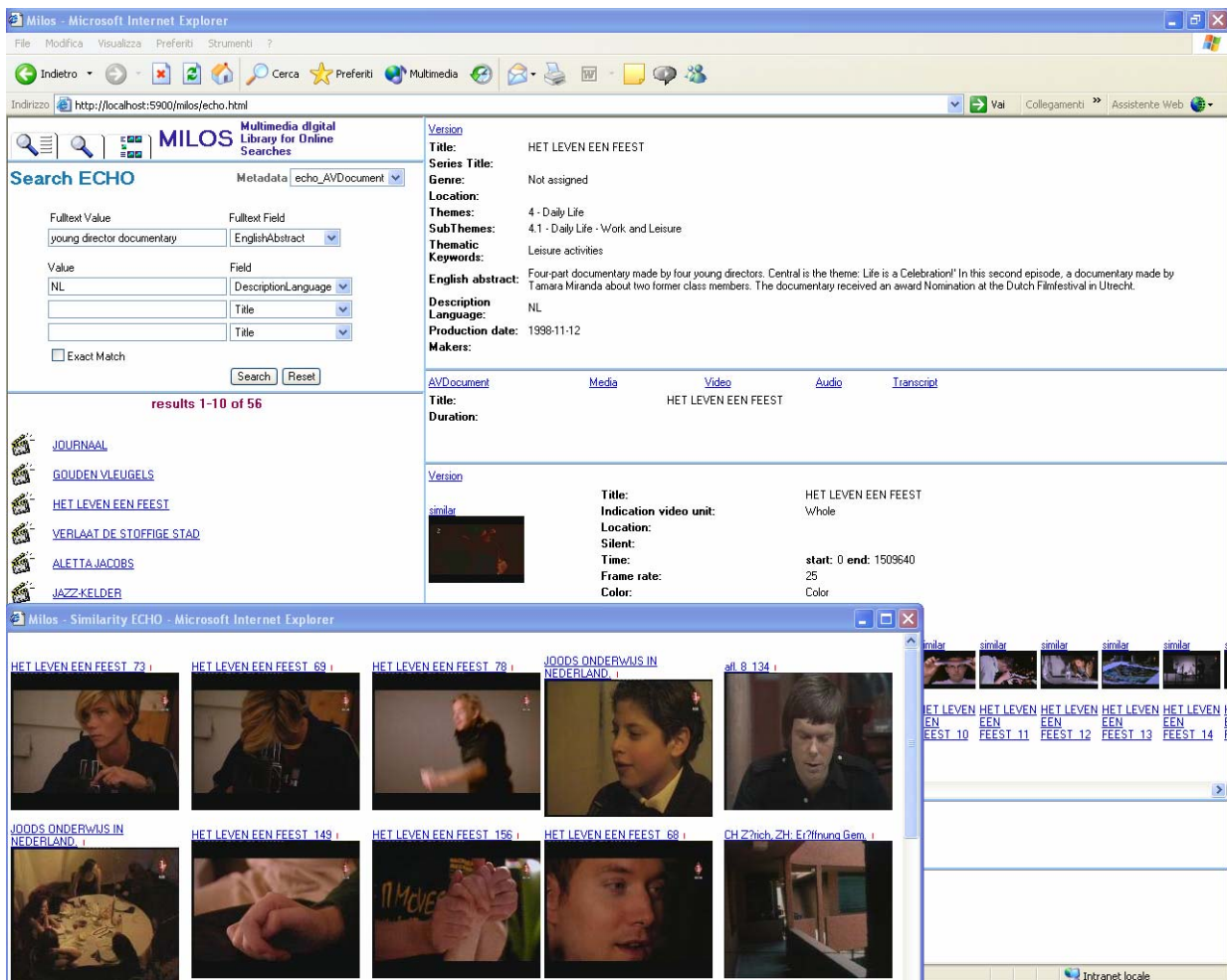


Figura 3: A screen shot of the ECHO Digital Library, based on the MILOS system.

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