International Journal

INFORMATION TECHNOLOGIES & KNOWLEDGE

2009 Volume 3 Number 1

International Journal
INFORMATION TECHNOLOGIES & KNOWLEDGE
Volume 3 / 2009, Number 1

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International Journal "INFORMATION TECHNOLOGIES & KNOWLEDGE" Vol.3, Number 1, 2009

Edited by the **Institute of Information Theories and Applications FOI ITHEA®**, Bulgaria,
in collaboration with the **V.M.Glushkov Institute of Cybernetics of NAS, Ukraine**,
and the **Institute of Mathematics and Informatics, BAS, Bulgaria**.

Publisher: **ITHEA®**
Sofia, 1000, P.O.B. 775, Bulgaria. www.ithea.org, e-mail: info@foibg.com
Printed in Bulgaria

ISSN 1313-0455 (printed) **ISSN 1313-048X (online)** **ISSN 1313-0501 (CD/DVD)**

TOWARDS AN INNOVATIVE PRESENTATION AND CREATIVE USAGE OF THE BULGARIAN FOLKLORE WEALTH

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***Abstract**: The "Knowledge Technologies for Creation of Digital Presentation and Significant Repositories of Folklore Heritage" research project uses the semantic-based and multimedia digital libraries technologies for innovative presentation, preservation and creative usage of the digitalized Bulgarian folklore knowledge. This paper presents the architecture of the Bulgarian folklore digital library, its main services and components, semantically described folklore objects, types of users, and their activities. The presented structure pursues the powerful and efficient functionalities for effective content structuring, storage, access, search, filtering, maintenance, metadata annotation, indexing, and dissemination.*

***Keywords**: Multimedia Digital Libraries – Functional Specification and Standardization, Multimedia Digital Libraries Architectures, Service-Based Architecture, Bulgarian Folklore*

***ACM Classification Keywords**: H.3.7 Digital Libraries – Collection, Dissemination, System issues.*

Introduction

The tendencies from the past few years in the development of digital libraries with multimedia content lean to transforming the static complex library structures to systems with a dynamic federation of services. This change resulted from the market needs, the emergence of new technologies and from the request for a more strict usage of the existing resources and adapting their content and services to the needs of different user groups. In relation to this, there are many architecture projects and their usage scenarios developed for multimedia digital libraries: service-oriented architecture, grid-based architecture, poor-to-peer architecture, which are presented in more detail in [Pavlov et al., '06] [Paneva et al., '05].

The "Technologies, Based on Knowledge of the Bulgarian Folklore Heritage" research project (FolkKnow) [Paneva et al., '07b] [Rangochev et al., '07a] aims to build a digital library of a selection of digitized multimedia objects, taken from fund of the Institute of Folklore of BAS. To achieve this goal, there is a need to research and analyze the variety of architectures, used for implementing the multimedia digital libraries, to evaluate their advantages and disadvantages and to choose the architecture that is most suitable for the specific case. Besides, there is a need for the folklore digital library that has been built for the project to adhere to the European and the world requirements for such an activity and to take into consideration the specifics of the artifacts that it presents.

This article presents the chosen type of architecture for a folklore multimedia digital library, its components, their functional specification, the tools used in the implementation process and the tests made on the system.

Choosing an Architecture for the Multimedia Digital Library of the Bulgarian Folklore

Every type of architecture for multimedia digital libraries [Pavlov&Paneva, '05] has a lot of advantages and disadvantages, which have to be considered both in the context of the intended library usage and having in mind the characteristics of the media resources, the necessary semantic and non-semantic descriptions, the resource

distribution (in one location or in multiple locations), the desired functionality, the complexity and the time needed to complete the project, the price parameters, etc. Besides, the following factors and characteristics were taken into consideration while choosing the architecture for the multimedia digital library in this project:

- according to the terminology, used in the project, every folklore object represents an aggregation of media objects (one or more), situated in one place;
- the rich internal semantics an the complex relations between the media objects within the folklore objects and between the folklore objects;
- the existence of a wide number of similar objects or objects with similarities in the semantic descriptions;
- the expected variety of the user audience – specialists and non-specialists in the target domain, etc.

Having these factors and features in mind and evaluating the available functionalities from each one of the architecture types, we can conclude that using the grid technologies as a basis for building the folklore digital library would provide optimized access and improved management of the digital resources with the availability of a virtual resource organization, but the complexity of creating a grid-based environment would not justify the results and the used tools. Also, this type of architecture expects to serve distributed computer resources, accessible through local or global networks, which make visualizations through an enormous virtual computer system. This is a condition, which is not needed in the current case, because the media objects are situated in a single location. On the other hand, using peer-to-peer technologies provides a freely-configurable integration of services for digital libraries and sharing of information, dynamic distribution and deployment of complex services and techniques for extracting specific details from multimedia documents, for searching support based on content similarity, etc. In the considered case, all these functionalities are a solution, which does not justify the complex technical implementation, price, effort and software/hardware resources. The limited number of the expected input data for the system on one hand and their rich internal semantics and complex relations between the media objects within the folklore objects on the other hand require the creation of a complex ontological structure for their semantic description. The semantic technologies enable the presentation of the knowledge about the digital objects and collections in the digital library storages via the usage of common classification schemes in the form of ontologies, via the coordination and ordering of the digital collection according to different semantically meaningful criteria, via provisioning of semantic access to them, the semantic-based services, the new ways to distribute resources, the semantic deductions, etc. Besides, in the future we expect the development of new semantics-based approaches, methods and techniques, used in digital libraries as well as improving the existing ones. With the creation of rich semantic descriptions for each folklore object, there emerges the need of improved visualization, accessibility upon request and optimized services for extracting a objects or collections of objects and the existence of a large number of similar objects or objects with similarities in their semantic descriptions requires services for reusing the same metadata and their fast selection.

Considering the prerequisites and the desired functionalities for the project's library and having in mind the specifics of the service-oriented architecture and its purpose to provide the functional modules that serve the main activities for building, provisioning and management of the library content and its semantic and non-semantic descriptions, we can conclude that this type of architecture is the optimum solution in this case. This type of architecture is decentralized, multi-functional, flexible, dynamic and easily-transformable [Rangochev et al., '08]. For the particular case, there is a need to:

- develop the services, which create and manage complex semantic descriptions of the folklore objects;
- provide access to the objects in a more effective and easy-to-use way;
- provide:

- services for diversity in searching by various semantic descriptors and combinations of theirs as well as optimized result visualization;
- services for object grouping by various semantic descriptors;
- services for file format conversion;
- exporting services for the objects to XML format.

- identify and personalize the users, manage the access permissions, monitor the user actions in the environment, etc.

The conclusions on the subject, made in this section, lead to the formulation of the specific components descriptions of a particular architecture for the folklore multimedia library, oriented towards the provisioning of diverse services.

Semantic Description of the Folklore Knowledge and its Place in the Service-based Architecture of the Bulgarian Folklore Digital Library

Ontology of Bulgarian folklore

Since one of the targets of the FolkKnow project is to present the valuable phenomena of the Bulgarian folklore in suitable virtual form using knowledge technologies, we have to observe and specify the experience that has been gained in the last 500 years in the area of traditional folklore *i.e.* to construct Bulgarian folklore domain ontology [Paneva et al., '07a] [Paneva et al., '07b] [Luchev et al., '08a] [Luchev et al., '08b].

FolkKnow annotator/indexers using this ontology will semantically describe and index the raw audiovisual content in order to create and maintain reusable digital objects. The ontology will be used also to realize semantic-based access to concrete digital objects, representing folklore objects, described by their main features, technical data or context. All this information is included within the Folklore Ontology Concept – the root concept for the ontology.

The process of building of the Bulgarian folklore ontology for the FolkKnow project is necessarily iterative. The first activity is the definition of the scope of the ontology. Scoping has been mainly based on several brainstorming sessions with folklorists and content providers. Having these brainstorming sessions allowed the production of most of the potentially relevant terms. At this stage, the terms alone represented the concept, thus concealing significant ambiguities and differences of opinion.

A clear issue that arose during these sessions was the difficulty in discovering of definite number of concepts and relations between these concepts. The concepts listed during the brainstorming sessions were grouped in areas of work corresponding naturally arising sub-groups. Most of the important concepts and many terms were identified. The main work of building the ontology was then to produce accurate definitions.

Description of the conceptions

The scientific classification and documentation of folklore objects provide folklorists and content generators with a rich knowledge background with plenty of multidimensional data and metadata. There is a special relation among the metadata, which reveals all the knowledge concerning the folklore object obtained from the classification procedure.

The folklore object is related to three levels of knowledge, enriched with a set of sub-levels of the data classification. All these levels of knowledge or "thematic entities" in the ontology conception are supported by the scientific diagnosis results and the related documentation.

The entity "Identification and description" consists of general historical data, identifying aspects such as title, language, archival signature, period, current location of the folklore object, annotation, first level description, second level description, *etc.*

The entity "Technical" includes technical information both revealing the technologies used for folklore object capturing and recording, record situation, record type, record place, record date, main participants in the process (record maker and informant), *etc.*

These main entities and their metadata are supported, documented and provided by the scientific diagnosis, which has been applied to the folklore objects.

Ontological model

We will present the Bulgarian folklore ontological model using classes of concepts, organized in taxonomy and able with properties. Taxonomies are used to organize ontological knowledge using generalization and specialization relationships through which simple and multiple inheritances could be applied. Properties are an interaction between individuals of the domain-classes and the range-classes.

The most representative concepts have been defined first and then they have been specified appropriately in order to get a representation of the knowledge stored in the databases. The Bulgarian folklore ontology is composed of 70 concepts and 82 properties.

Figure 1 depicts a scheme of some relationships between classes of objects in Bulgarian folklore ontology.

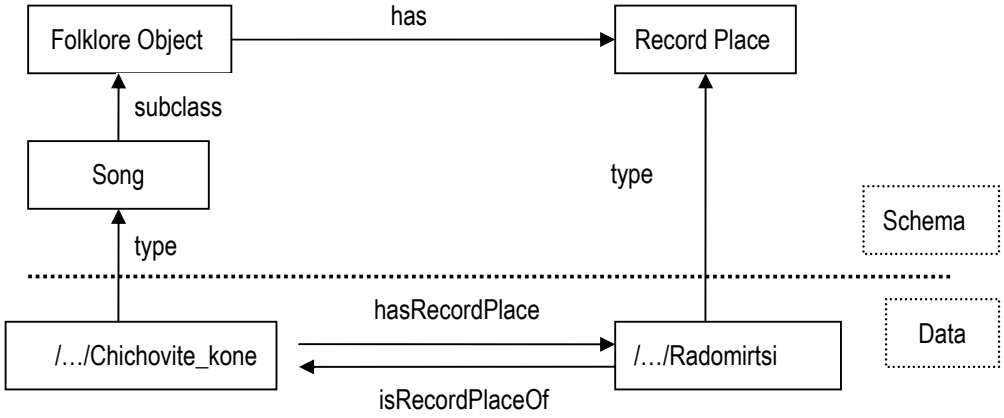

Figure 1: Scheme of relationships between classes of objects in Bulgarian folklore ontology

Main Components of the Bulgarian Folklore Multimedia Digital Library

Basic types of objects and their storage in the architecture of the folklore multimedia digital library

Following are the basic types of objects, which will be managed by the functional modules of the folklore multimedia digital library:

- Media objects (text, images, video, etc.) – they represent digital copies of folklore artifacts from a selected collection of the Institute of Folklore's fund at Bulgarian Academy of Sciences. Along with every media object, there is administrative/technical information about it, which is created in advance during

the object digitalization process. The administrative information includes fields like name, media object creator, description, date, type, format, identifier, permissions and source.

- Folklore objects (also known as library objects or digital objects) – the folklore objects represent digital objects, which are annotated and semantically indexed with proper metadata. These metadata show the object semantics according to the "Ontology for the Bulgarian folklore", developed according to module 3 of the project during its first stage. The semantic metadata is used most often in the requests for building information flows in the architecture, which is subject to description.
- User profiles – their purpose is to provide different access levels to different types of library users.

The media objects and the user profiles are kept into a storage of media objects and storage of user profiles, respectively. The metadata, which describe the folklore objects are kept in a storage of semantic metadata (also called data storage). The access and management of the storages, as well as the transition of the different types of objects is provided by a set of functional modules, which implement the library's services.

Main Types of Users of the Bulgarian Folklore Multimedia Digital Library

There are five types of users, defined in the system:

- Administrators – they can create, delete and modify users, as well as review the logs, kept by the tracing module. The administrators do not have access to the library content.
- Editors – this is the group of users with the greatest number of permissions in the library. They can edit all the objects, add and delete objects no matter who entered them.
- Users – the users in this group can view all the objects and can add new ones. They can also edit and delete objects, but only if they have created them.
- Viewers – users in this group can only review the library.
- Guests – the users, which belong to this group can review all the objects

Functional Specification of the Bulgarian Folklore Multimedia Digital Library

Following are the main functional modules of the folklore multimedia digital library [Paneva, '07a] [Rangochev et al., '07a] [Rangochev et al., '08]:

- A module for viewing the content of folklore objects according to their type / rubric, to which they belong;
- A module for creating and editing folklore objects;
- A module for viewing the objects, grouped by different descriptive characteristics (with the option to delete folklore objects);
- A module for searching by:
    - signature and archive number;
    - keywords of the following categories: name, language, annotation, type of the folklore object / rubric;
    - file type;
    - record information (simultaneously or one by one):
        - by situation;
        - by reporter name;
        - by recorder name;

        - by record date;
        - by recording location;
    - Extended search – it provides the option for searching through all the object characteristics;
- A module for managing the user data;
- A module for monitoring the user actions, which keeps track of the following actions:
    - actions, related to working with the system:
        - Registration;
        - Logging in the system;
        - Unsuccessful log-in attempts;
        - Logging out;
        - Changing of the user password;
        - E-mail address change;
        - etc.
    - Actions, related to the object manipulation:
        - Adding an object;
        - Editing an object;
        - Deleting an object;
        - Adding a file;
        - Deleting a file.
    - Actions, related to the content viewing:
        - Review of objects by their characteristics;
        - View of a single object;
        - Searching for objects by characteristics;
    - Other administrative actions:
        - Changing the user's level;
        - Deleting a user;
        - Generation of an XML copy of the data in the system;
- A module for file format conversion;
- A module for generation of XML copies of the objects in the system.

The module for viewing the content of folklore objects according to their type / rubric, to which they belong is available to all the users of the library, except the administrators. The reason is that the administrators of such systems are often people, who don't have any relation to their content. They only do support tasks. The module itself was implemented similar to the Windows OS file browser (Windows Explorer) and KDE (Konqueror), so that it is closer to the familiar user interfaces for viewing hierarchical information. The left side shows a tree of all classes, which inherit "Type of folklore object" and the right side shows a list of objects of the selected class in the tree.

The module for creating and editing folklore objects is used for adding new objects and modifying the information of already created objects. Through it, one can add more multimedia files to an object or delete existing ones.

Searching for information is the most frequent search and therefore the most important operation in a digital library. This is why, there are several different modules for searching by different criteria:

- Searching by a signature or archive number – This search module is useful for finding objects by their archive number (for example, AIF No 200, folder 1, page 57). In general, there is only one search result. In case of incorrect data, it is possible to have several objects as a result.
- Search by a keyword in the object properties – by name, language, annotation and type of the folklore object – Searching is performed simultaneously over all these properties. It is expected that this module is the most frequently used one. This is why special attention has been paid to its optimization.
- Searching by record information – This module is used to find all the objects, which cover some of the following conditions:
  - All the objects, recorded in a given situation, for example an interview, chat/conversation, etc.
  - All the objects, recorded by a given person.
  - All the objects, recorded by a given informer.
  - All the objects, recorded in a given period of time.
  - All the objects, recorded in a given location.
- Searching by file type – This module allows getting a list of all the objects, to which there is a multimedia file attached – audio, video or images. This type of searching uses the database, in which the administrative information is stored instead of the OWL file that contains the ontology.

Most types of searching use SPARQL (SPARQL Protocol and RDF Query Language). This is a language for requests to the RDF and OWL ontologies. The language is in a standardization process by RDF Data Access Working Group as an official recommendation of the World Wide Web Consortium. The SPARQL syntax is similar to the most widespread language for database requests – SQL.

The module for monitoring the user actions is intended to keep logs for the modified and deleted objects by the users, so that in case of deleted data by mistake or wrong entered data, the responsible user can be found. There is also a log for search requests, whose purpose is to enable statistical reports about the search types that are used least and most often. It would allow the removal of the rarely used search types and the priority optimization of the ones that are used most often.

The module for file format conversion was developed to provide the ability to present every file, which is unsuitable for internet preview in a “light” and convenient form for web preview. The module recognizes the “inconvenient” files, it tries to covert them and on success it replaces the original file with the new “lighter” file. On failure, the module keeps the original file in the library.

The module for generating an XML copy of the data is available only to the system administrators. The purpose behind this module is creating a copy, which can be used as an archive copy on one hand and on the other hand it may serve as raw data for other systems, using information from the library.

Implementation of Functional Components of the Architecture of the Bulgarian Folklore Digital Library

A module for adding objects to the FMDL – Adding objects to the FMDL is implemented through filling and sending a form to the web server. Because the great number of fields to fill, the form is not generated thoroughly. Only the necessary fields for the creation of the objects are generated, following the semantic descriptions, presented in the “Ontology of the Bulgarian folklore”, built in the first stage of module 3 of the project. The

technology, used for the implementation is AJAX. The user interface passes a request to the server, in which it requires only that part of the form, which according to the user is necessary to create the object. The server processes the request and returns the required fields as a result, which is visualized in the user interface. After all the fields are filled, the user submits the form. The server validates the data and if everything is correct, it adds the object to the data storage. If there is something wrong, it returns a message to the user, relative with the error (usually, an empty field or unacceptable field value). After the server adds the information from the form to the data storage, there follows a check for attached files in the user request. If there are attached files, the server checks if there are file formats, which are unsuitable for web presentation (for example, wav, .doc, .mpg, .avi, .mpeg, etc.) and if it finds such files, the system refers to the module for file format conversion to formats, suitable for web preview. For each of these files, the module for file format conversion tries to convert them. Upon success, it adds the converted file to the library. On failure (which can occur if the added file has some specifics, which the system cannot recognize), it adds the original file to the library. At the end of the object adding procedure, the system refers to the module for monitoring the user actions, where it adds an "object added" event and writes the author (the user, who created the object) and the event date.

A module for editing objects in a FMDL – The module for editing objects works almost in the same way as the module for adding objects. The difference is that the system doesn't add information about a new object, but replaces the existing information about an object with the new information, provided by the module for editing. Again, the system checks the form for errors, it processes the files (if there are new files added), it changes its data and finally adds an event for modified object through the module for monitoring the user's activity.

A module for viewing the content of folklore objects according to their type / rubric – This module takes a request from a user, in which the user specifies the property, by which folklore objects must be found. The module refers to the data storage and makes a request for selecting and sorting the objects by this property. The module for monitoring the users actions records the "view objects by" event and adds data about the date, the user and the property, by which objects are listed. The storage processes the request and returns a result, which the system processes and sends to the user. The user interface visualizes the result in a proper manner.

A module for searching – This module allows the user to set a property/properties, by which objects are found.

The algorithm for searching by a single property – The user interface sends a request to the data server specifying the property and its needed value. The module for searching refers to the data storage of semantic metadata with a query for selection and sorting the objects with the needed value of the specified property. The module for monitoring the user actions records the "search" event with the provided search parameters, the date and the user, who performs the search. The storage processes the request and returns a result, which is then processed by the search module and displayed in a proper manner by the user interface.

The algorithm for searching by more than a single property – - The algorithm is analogical to the one, described above with the only difference that the query to the data storage is more complicated – there are multiple selections of objects for each search property and the result is a sorted section of the selection results.

Testing the functional components of the architecture of the folklore multimedia digital library

After an analysis of the means and standards in the technological implementation of the library environment and the functional modules, the following software was chosen:

Operating system: Microsoft Windows Server 2008 x64 Standard

Web server: Apache HTTP Server v 2.2, PHP v 2.2.9

Database management system: MySQL v 5.1 Standard

Tools for the additional modules: FFMPEG, vwWare, HTML, JavaScript, AJAX

Database query language: SPARQL

The functional components of the architecture of the folklore multimedia digital library, described in [Rangochev et al., '07a] and [Rangochev et al., '08] were implemented and tested for errors and speed on a server platform with the following hardware configuration:

CPU: 2 x Intel QuadCore 2.8 GHz

RAM: 8GB DDR3

HDD: 4 x 500GB, RAID 10 SATA II

LAN: 2 x 1000Mbit

Objects: 220 test objects

Users: 1000 test users

Testing the functional module for adding/editing an object – server response time (average of 50 attempts): 0.0058 s, i.e. in theory, the functional module for adding/editing an object can process about 172 requests per second for each processor core, which makes 172*8=1376 requests.

Testing the module for selecting folklore objects according to their type/rubric – Time for server response: 0.009 seconds per request, i.e. 888 requests per second.

Testing the module for searching by a single property – Time for server response: 0.008 seconds per query, i.e. 1000 requests per second.

Testing the module for searching by several properties – The test was performed with 25 properties (it will happen very rarely). Time for server response: 0.01 seconds per query, i.e. 800 requests per second.

Testing the module for file format conversion – Converting video files: the server sends a response before it converts the video file, because the process is relatively slow. The average time of processing a video file is about 30 seconds, i.e. you can add about 16 video objects per minute. In this way, after adding a video object, its actual recording in the FMDL happens in 30 seconds.

Converting audio files: The server responds before the file is actually processed. The average time for processing an audio file is about 10 seconds, i.e. in theory, a system with such a configuration can process about 48 audio files per minute.

Converting MS Word (.doc) files: the conversion takes place in real time. The average server response time is 0.04 seconds per request, which is about 200 requests per second.

Conclusion

In this paper we presented the main components of the service-based architecture of a multimedia digital library of the Bulgarian folklore. The presented MDL structure is planned to be flexible and directed to the users. The library will be developed and modified to the new requirements and needs, *etc.* after the initial test. The library with its structural components is directed to two basics groups of users. The first group: scientists who make professional researches of Bulgarian folklore: this people need specialized information about the folklore objects

which they research – a genre characteristic of the folklore object, methods and location of the record, mode of the record, signature, a file-number, *etc.* ;the second group: users who are not specialists but they are interested in Bulgarian folklore and they want to get specialized information or just want to get to know to classic objects of the Bulgarian folklore. The structure of the digital library of the Bulgarian folklore described in this way gives universal character.

Acknowledgements

This work is supported by National Science Fund of the Bulgarian Ministry of Education and Science under grant No IO-03-03/2006 "Development of Digital Libraries and Information Portal with Virtual Exposition "Bulgarian Folklore Heritage"" from the project "Knowledge Technologies for Creation of Digital Presentation and Significant Repositories of Folklore Heritage".

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