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Digital Heritage

3rd International Conference dedicated on
Digital Heritage

Short Papers



Before July, 1974...



After July, 1974...

The Katholikon of the Monastery of Antiphonitis in Kalogrea, Cyprus (16th century)

DON'T MISS THE *Hi-tech*-STORY...

8th–13th of November 2010
Limassol, Cyprus

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Christ *Antifonitis* near *Kalogrea* in the Kyrenia district in Cyprus is another church, which was built and decorated with wall paintings in approximately 1200 AD. In the early 16th century, the north and south wall of the church proper and the northwestern squinch were decorated with wall paintings from the life of the Virgin, the Stem of Jesse, the Last Judgment and the standing saints, while the cupola was decorated with Christ Pantocrator, the Deesis-Supplication, the Apostles seated on thrones and the Prophets. Unfortunately, after the Turkish invasion in 1974 and the occupation of the area by the Turkish army, the systematic destruction and removal of the wall paintings from the monument began. The faces of Archangels Michael and Gabriel in the conch of the apse were barbarically destroyed, while the wall painting of the Birth of Christ was removed. These wall paintings are dated from the end of the 12th or early in the 13th century. The great wall paintings of the Stem of Jesse and the Last Judgment (early 16th century) were fragmented into small pieces and removed from the south and the north wall on which they were painted. Several *fragments from the wall paintings (in yellow outlined)*, which had been exported by Turkish smugglers to Germany from where they were repatriated, are on display on the second hall of the Byzantine-Museum (BM.321-356) in Nicosia, Cyprus. Others are in Germany and it is hoped they will be returned to Cyprus. When all the pieces which have been found are gathered, an effort will be made to restore these two large wall paintings using different modern applications from the area of Digital Heritage.

Photos: Eliades Ioannis, Curator, Byzantine Museum in Nicosia, Cyprus

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ON THE WIDER ACCESSIBILITY OF THE VALUABLE PHENOMENA OF THE ORTHODOX ICONOGRAPHY THROUGH A DIGITAL LIBRARY

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KEY WORDS: East Christian Iconographical Art, Multimedia Digital Libraries, Services, Domain Ontologies

ABSTRACT:

Over the last years several initiatives were carried out worldwide towards on-line documentation, exposure, storage and preservation of cultural heritage. In this framework, many valuable masterpieces of Orthodox iconography have been digitalized and appeared in the virtual space. However, rare specimens, private collections, icons from difficult-to-access storages, distant churches, chapels, and monasteries, objects in a risk environment or unstable conditions were almost “untouchable” for the e-user. In an attempt to answer these needs of wider iconographical objects accessibility, a team from the Institute of Mathematics and Informatics has developed a multimedia digital library called *Virtual Encyclopaedia of Bulgarian Iconography*. This Internet-based environment becomes a place where East Christian iconographical objects of different kinds and origins were documented, classified, and „exhibited” in front of professional researchers and the public. This paper does a complete description of this digital library, passing from the semantic description of the iconographical art content to the library architecture and functionalities.

1. INTRODUCTION

Orthodox (East Christian) iconographical art is recognised as one of the most significant areas of the art of painting. Until recently, it is being neglected in the digital documentation and the registry of the art of painting. But the accessibility to that valuable part of mankind's cultural and historical ancestry was enhanced greatly with the appearance of the “*Virtual Encyclopaedia of the Bulgarian Iconography*” multimedia digital library (also called Bulgarian Iconography Digital Library, BIDL) in the world virtual space (<http://mdl.cc.bas.bg/>). This Internet-based environment becomes a place where iconographical objects of different kinds and origins were documented, classified, and „exhibited” in order to be widely accessible to both professional researchers and the wide audience. Rare specimens, private collections, icons from difficult-to-access storages, distant churches, chapels, and monasteries, objects in a risk environment or unstable conditions, etc. are appearing for new e-exposition. The library provides services for registration, documentation, access and exploration of a practically unlimited number of Orthodox iconographical artefacts and knowledge (Pavlova-Draganova et al., 2007a; Pavlov et al., 2006) and the end users could use this rich knowledge base through its interactive preview, objects complex search, selection, and group. The first release of the BIDL was developed five years ago during the national project “*Digital Libraries with Multimedia Content and its Application in Bulgarian Cultural Heritage*” (contract 8/21.07.2005 between the Institute of Mathematics and Informatics, BAS, and the State Agency for Information Technologies and Communications). Until now, the library is used in several cross-media, ubiquitous and technology-enhanced learning applications (Paneva-Marinova et al., 2009).

The key for the current release of BIDL is the efficiency and the provision of strictly designed functionalities, powered by a

long-term observation of the users' preferences, cognitive goals, and needs, aiming to find an optimal functionality solution for the end users. A special attention was paid to content creation, preview, search and administrative services, trying to cover a wide range of possible solutions. Moreover, the BIDL semantic content description orders the specification of unique descriptive scheme for iconographical art content, covering the rich semantic, identification and technical features of the iconographical objects.

In this paper we make for the first time a complete presentation of the new release of “*Virtual Encyclopaedia of the Bulgarian Iconography*” multimedia digital library, passing from the semantic description of the iconographical art content to the BIDL architecture and functionalities, offered to the end users. During the BIDL development our main objectives are to give the users tool, providing opportunity to access, observe and compare valuable Orthodox iconographical specimens in their historic context, so that some yet undiscovered treasures of the Orthodox iconography be manifested.

2. SEMANTIC OF THE ICONOGRAPHICAL ART

The need for effective retrieval of the icons of East Christian Iconographical Art in BIDL is motivated by the increasing number of digitized iconographical objects. For the solution of this problem we develop *domain ontology for the East Christian Iconographical Art*. This ontology is used for the semantic metadata description and indexing of the iconographical art content. Similar work is done in (Tzouveli et al., 2008). It determined semantic classification for the Byzantine icons. This classification is used for icon separation on semantic regions in order to provide face detection, analysis of the facial characteristics and sacred figure recognition.

The conceptualization and formal presentation of the iconographical art semantic posed specific challenges for our team of ontologists, art domain specialists and DL content creators. Several problems in “Icons” domain formalization appeared. These challenges are mainly related with:

- Determining the set of separate ontological sub-structures of the iconographical object domain, the iconographic school, the author of iconographic objects, the iconographic character/scene, etc.;
- Determining in a unique way the descriptors of the different types of iconographical objects (icon, wall-painting, miniature, plastic iconographic object, etc.) according to accepted canons of the Orthodox painting;
- Reducing the complexity of the structures that describe different aspects of the iconographical object domain (especially for technological specifics, hierarchy of characters, descriptions of scenes, etc.) without loss of important content;
- Presenting relations between classes and constructing their complete network;
- Defining in a unique way the domain rules, axioms, constraints and facts (because of the incompleteness, inaccuracy or subjectivity of the existing information, presenting iconographical art domain);
- Creating standardized and consistent descriptions of iconographical objects following the available standards for cultural heritage content presentation.

In our ontological model the iconographical art world is described by three “thematic entities” (also called levels of knowledge). Every one of these entities is enriched with a set of sub-levels, covering wide range of characteristics. The first one is the “Identification” entity, which consists of general data identifying aspects such as IO title, type, author, its clan, iconographic school, period, dimensions, current location and source, and IO object identification notes, author’s clan and biography, and iconographic school description (see figure 1).

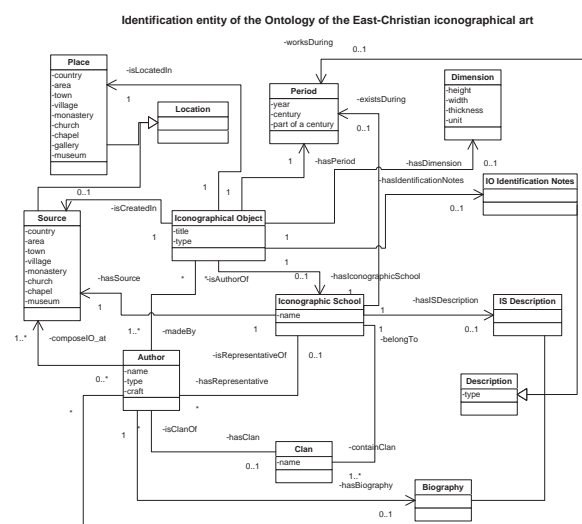


Figure 1: Identification entity of the Ontology of the East-Christian Iconographical Art

The second entity (see figure 2) covers information concerning the descriptive details of the theme and forms of representation, providing a better understanding of the content.

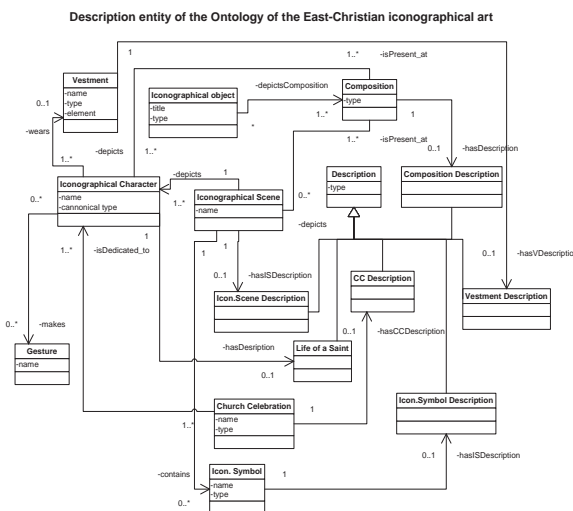


Figure 2: Description entity of the Ontology of the East-Christian Iconographical Art

The third entity (see figure 3) includes technical information revealing iconographic techniques, base materials, varnishes, gilding, etc., used in the creation of the iconographical object/collection, and also concerning examinations of the condition, such as diagnosis or history of the conservation treatment (Pavlova-Draganova et al., 2007b).

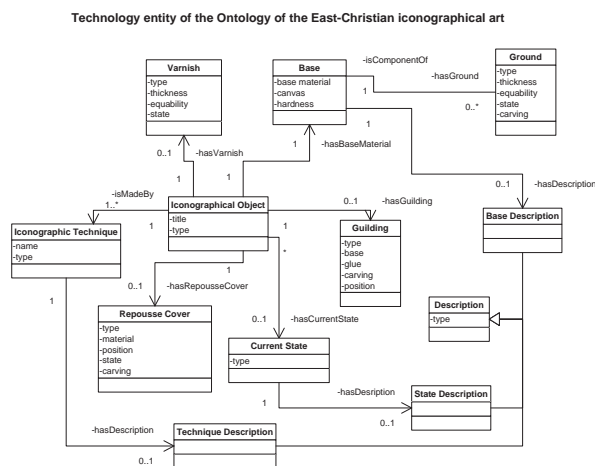


Figure 3: Technology entity of the Ontology of the East-Christian Iconographical Art

These main entities and their metadata values are supported, documented and provided by the scientific diagnosis, which has been applied to the iconographical objects and collections (Pavlova-Draganova et al., 2007b).

The interpretations of the iconographical knowledge are not considered isolated from the standards and specifications in the field of representation of cultural information because the goal is to maximize the reusability and portability of the designed ontological model. The most significant new development is the

CIDOC Conceptual Reference Model (CRM), “object-oriented domain ontology” for expressing implicit and explicit concepts in the documentation of cultural heritage. During the creation of the “East Christian iconographical art” ontology we observe the conceptualization approaches of CIDOC CRM ontology. We use part of its concepts and properties in our ontology. We extend another part in order to make it fit the iconography domain. For example, our “Iconographical Object” class is a sub-class of CIDOC CRM E22 -- Man-Made Object, our “IO Author” is CIDOC CRM E21 – Person, our “Clan” is CIDOC CRM E74 – Group, etc. The juxtaposing approach and a rich set of examples are included in (Paneva et al., 2007).

To represent efficiently the iconographical annotation framework and to integrate all the existing data representations into a standardized data specification, the “East Christian iconographical art” ontology need to be represented in a format (language) that not enforce semantic constraints on iconographic data, but can also facilitate reasoning tasks on this data using semantic query algebra. This motivates the representation of this ontological model in Web Ontology Language (OWL). OWL facilitates greater machine interpretability of Web content than that supported by XML, RDF, and RDF Schema by providing additional vocabulary along with a formal semantics. Knowledge captured from iconographic data using OWL is classified in a rich hierarchy of concepts and their inter-relationships. OWL is compositional and dynamic, relying on notions of classification, reasoning, consistency, retrieval and querying. We investigated the use of OWL for making our ontology using Protégé OWL Plug-in.

3. BIDL ARCHITECTURE

The architecture of the “Virtual encyclopaedia of Bulgarian Iconography” multimedia digital library contains two main service panels *Object data management* and *Administrative services* (see figure 4), jointed to a Media Repository and a User Profile Repository.

The *Object data management* panel refers to the activities related to content creation: add (annotate and semantic indexing), store, edit, preview, delete, group, and manage multimedia digital objects; manage metadata; search, select (filter), access and browse digital objects, collections and their descriptions.

The *Administrative services* panel mainly provides user data management, data export and tracking services. User data management covers the activities related to registration, data changes, level set, and tracking of the user. The export data services provide the transfer of information packages (for example, packages with BIDL objects/collections, user profiles, etc.) compatible with other data base systems. For example, with these services a package with objects could be transported in an XML-based structure for new external use in e-learning or e-commerce applications. The tracking services have two main branches: tracking of objects and tracking of users’ activities. The tracking of objects watch the activities of add, edit, preview, search, delete, selection, and group of objects/collections in order to provide a wide range of statistic data (for frequency of service use, failed requests, etc.) for internal use and generation of inferences about the stability and the flexibility of the work and the reliability of the environment. The tracking of users’ activities monitors user logs, personal

data changes, access level changes and user behaviour in the BIDL.

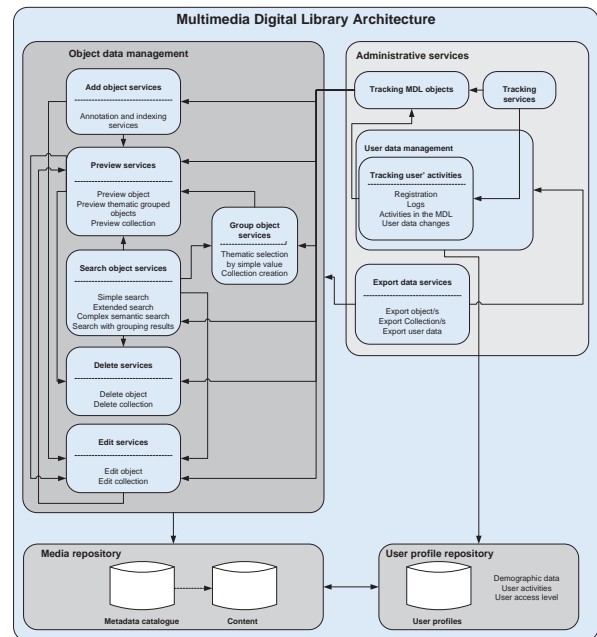


Figure 4: BIDL architecture

For every object all semantic and technical metadata are saved in the Media repository. These metadata are represented in catalogue records that point to the original media file/s associated to every object.

The User profile repository manages all user data and their changes.

4. BIDL FUNCTIONALITIES

4.1 Content Creation

The main part of the content creation process is the annotation and semantic indexing of digital objects in order to add them to the library repositories. The entering of technical and semantic metadata for a multimedia digital objects in the “Virtual encyclopaedia of Bulgarian Iconography” MDL is implemented through different automated annotation and indexing services (Pavlov et al., 2010).

The technical metadata, expressed in Dublin Core, are attached to every multimedia object automatically. They cover the general technical information, such as file type and format, identifier, date, provider, publisher, contributor, language, and rights.

An annotation template is implemented for the semantic description of iconographic objects. The template provides several options for easy and fast entering of metadata:

- Autocomplete services (All used (already entered) field values are available in a special panel for reuse.) (see fig. 5);

- Automated appearance of dependencies coming from the relations of the defined classes' (concepts) in the Ontology of East Christian iconographical art. (All main relations and rules expressed in the iconographical ontological structure are incorporated during the development of the annotation template);
- Example: If the value of the field **Region** is *Blagoevgrad*, when we start to complete the field **Town/Village**, all the available values in the MDL for towns/villages in the Blagoevgrad region will appear and can be selected by the annotator. All new field values are available for use after their first entering.

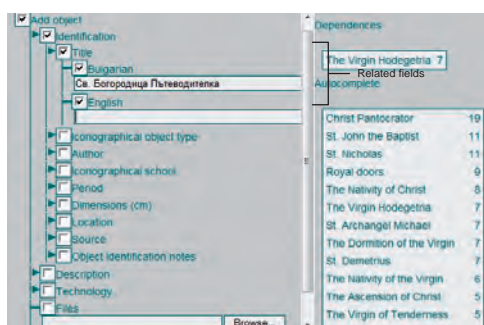


Figure 5: Part of the annotation template for an iconographical object

- Bilingual data entering with automated relation between the relevant values in different languages (see fig. 5);
- Automated appearance of the number of the used field value, providing regular data tracking (see fig. 5);
- A tree-based structure of the annotation template. Only checked fields are displayed for entering metadata (see fig. 5);
- Possibility for adding more than one media for one metadata description in order to create rich multimedia digital objects;
- Reuse of an already created annotation for new iconographical objects: the new media object has to replace the older one, the annotation is kept and the new iconographic object appears after saving;
- Automated watermarking of the image and video objects;
- Automated resizing of the image and video objects;
- Automated identification of file formats;
- Automated conversion of the audio, video and text objects in a format suitable for Web-preview.

After saving a new iconographical object, a special machine traces for the appearance of dictionary terms in the object data. If some terms are available the machine adds links to their explanations. In the case of entering a new dictionary term, its presence in the available objects is discovered automatically and a link is added.

In order to avoid duplicate image objects a service that checks the similarity between images is provided. It uses an algorithm

that caching images for optimizing their compare (see (Pavlov et al., 2010)). Similar works for similarities calculation is proposed in (Kushki et al., 2004).

4.2 Content Presentation

During the development of the content presentation services a profound analysis was made of content selection and preview possibilities in order to satisfy the user's needs. First we had to determine the preview possibilities of a separate iconographical object and its components and after that the preview of grouped objects (Pavlov et al., 2010). Figure 6 depicts the view of separate iconographical object.

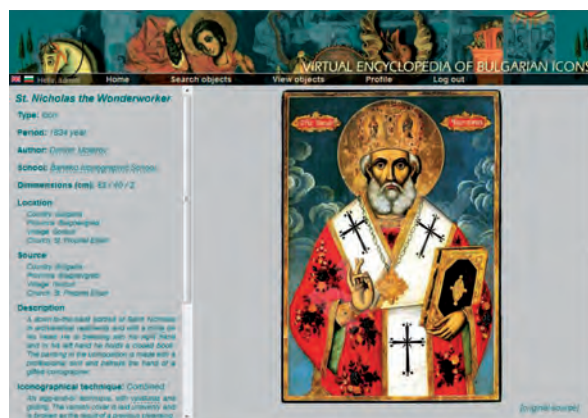


Figure 6: Saint Nicholas the Wonderworker, icon painted by Dimitar Molerov, Bansko Iconographic School

The visualization of the rich semantic description of the separate iconographical object is determined through hidden parts appearing in a new window after link selection. This possibility is used mainly for the long author's biography/school descriptions and for the dictionary terms. Parts of the descriptive data field are also hidden, but their values are available for searching in special forms.

The left frame of the preview window shows the description of the iconographical object. In the right frame the media/s object/s is/are situated. There appears a link to the original media source. The shown media object is stamped through watermarking technique.

During the development of object grouping services the main iconographic ontology classes are selected as object grouping criteria. For example, there can be a preview of the available iconographical objects, grouped according to their title, author, iconographic school, used technique or base material. Using another grouping option the user can see separately a list of all the iconographers (authors), and selecting one of them he can see additional biographic information and the collections of their work. A similar preview is available for the iconographic schools and regions/towns of physical object location.

The grouping option related to the presented content is implemented by the grouping of objects by depicted iconographic scenes, characters or canonical character types. Their presentation is based on the taxonomies of iconographical characters and iconographical scenes expressed in the ontology of East Christian iconographical art.

Every user can create his private collection of selected objects after search activity. Rich search possibilities are available in order to assist collection creation. The user can write the collection's title and short description. He can also select its status: private or shared with other users. New objects for a collection appear automatically after their entering.

4.3 Content Search

BIDL provides a wide range of search services, such as keyword search, extended keyword search, semantic-based search, complex search, and search with grouping results. Their realization was based on querying action to the BIDL knowledge base using mainly the structural branches of the "East Christian iconographical art" ontology. Moreover, five types of conditions for the results set are meant:

- "objects having value $= v$ for characteristic C "
- "objects having value $\neq v$ for characteristic C "
- "objects having numeric value $\geq, \leq, >, <, \text{or} = v$ for a characteristic C ". In the search templates you could search iconographical objects with precise date or period. The period could have concrete beginning and end date with a year's and/or century's (incl. parts of century as the beginning of century X, the middle of century X, the end of century X, the first half of century X, the second half of century X) values. In the Ontology of East Christian iconographical art the relations of year's and century's values (incl. its parts) are defined with rules.
- "objects having characteristic C "
- "objects NOT having characteristic C "

The search services support content request and delivery via index-based search and browse of managed content and its description.

4.4 Administrative Services

The *Administrative services* panel mainly provides user data management, data export, tracking services, and analysis services. The user data management covers the activities related to registration, data changes, level set, and tracking activities of the user. The tracking services have two main branches: tracking of objects, tracking of user's activities. Figure 7 depicts an example.

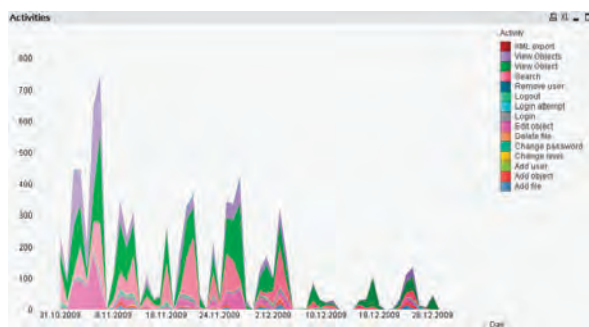


Figure 7: Users' activities during the period 10-12.2009

The tracking of objects spies on the activities of add, edit, preview, search, delete, selection, export to XML, and group of

BIDL objects/collections in order to provide a wide range of statistic data (for frequency of service usage, failed requests, etc.) for internal usage and generation of inferences about the stable work (stability), the flexibility, and the reliability of the environment. The tracking of user's activities spies user logs, personal data changes, access level changes and user behaviour in the BIDL.

The ClickTech® QlinView® Business Intelligence software is the analysis services provider. It is connected to the BIDL tracking services and objects data base by preliminary created data warehouse.

The ETL (Extract, Transform, Load) is completely automatic process and is performed by administrator request.

The ClickTech® QlinView® Business Intelligence Software is deployed in order to provide fast, powerful and visual in-memory analysis of the data in the warehouse. It is a data access solution that enables you to analyze and use information from different data sources. It is based on online analytical processing (OLAP), which provides an approach to quickly answer multi-dimensional analytical queries (Codd et al., 1993).

Figure 8 depicts an example of PIE diagram for canonical sub-types analysis.

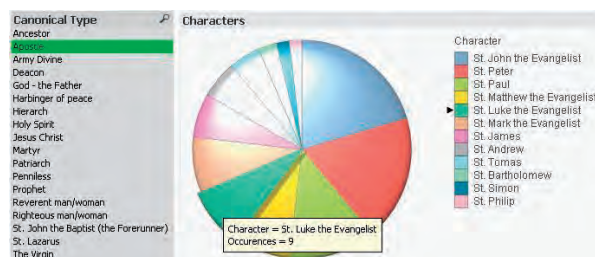


Figure 8: PIE diagram of canonical sub-types for *Apostle* canonical type

The variety of generated statistic information about BIDL data using ClickTech® QlinView® provides a rich extension of the tracking services and the base for profound analysis of extracted data.

The export data from the administrative services panel provides the transfer of information packages (for example, packages with BIDL objects/collections, user profiles, etc.) compatible with other systems managing data bases. For example, with these services a package with BIDL objects could be transported in a XML-based structure for a new external usage.

5. CONCLUSION AND FUTURE WORKS

Undoubtedly, the idiosyncratic art and exceptional values of the East Christian icon have to be made available in the global information medium. Its virtual presentation has to be executed through the best tools and techniques in order to continue to write traces in the history of the world fine arts. This paper presented the "Virtual Encyclopaedia of the Bulgarian Iconography" multimedia digital library and the developers' effort to build an applicable environment for cultural heritage exhibition.

Nowadays, BIDL includes several hundred specimens of Bulgarian iconographical objects from different artists, historical periods, and schools. There are also incorporated information objects, presenting iconographic techniques, authors' biographies, schools' history, terms vocabulary, etc. Several users created and driven collections are shown (for example, the unique collection of pencil-drawings of Zacharya Tsanyuv or the rich collection of icons from "Saint Trinity Church" in Bansko, etc.). The BIDL specimens are in the possession of the Bulgarian Orthodox church and the originals are currently exposed and freely accessible in acting Bulgarian churches and monastery.

The research in the field of iconographic art virtual presentation is supported by several international and national projects (for example, LOGOS project, SINUS project), mainly using the BIDL content for e-learning purposes (from formal and specialized professional education to self-training or personal cultural investigations). The SINUS project is 3-year national project that aims to demonstrate creative learning-by-doing through active learners' authoring of specific learning materials on Orthodox iconography, using multimedia and information resources delivered through BIDL. The main SINUS user groups are the developers of various learning resources and the consumers of those learning resources (i.e. academic users, researchers in the target learning domain, non-academic users). The users' group of BIDL is wider than defined in SINUS. BIDL functionality aims to serve iconographical art specialist and non-specialist. The group of specialists is composed by scientists who study Orthodox iconography professionally and search for specialized information on the observed iconographical objects. The group of non-specialists has interests and wants only to learn more about the iconographical objects. The current release of BIDL supports four users' levels: administrators, content editors, specialist viewers and non-specialists viewers with different privileges and access rights.

The future BIDL extensions are related to the content enrichment and the inclusion of wide range of artefacts of the Balkan countries and particularly Greece. In BIDL will also be included services for aggregating iconographical content for the European digital library EUROPEANA, thus providing possibilities for pan-European access to rich digitalised collections of East Christian iconographical heritage.

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