CultIS: Web-based Platform for Intelligent Cultural Content Management

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Abstract. The paper presents the research, development, and some of the major implementations to date of the web-based platform for intelligent cultural content management *CultIS*. It is an innovative environment providing descriptive cataloging, subject indexing, intelligent data retrieval, curation and collection development aimed at meeting the functional needs associated with the growing expectations of users of cultural institutions such as libraries, museums and other providers of cultural and historical heritage. Based on the implementations of *CultIS* for different purposes and contexts, not only its effectiveness, stability and reliability are tested, but the results also serve for its constant development and improvement.

Keywords: *CultIS*, Digital Humanities, Digital Content Management Systems, Intelligent Content Curation, CLaDA-BG, Research Infrastructure.

1 Introduction

The current research on the development and implementations of a web-based platform for intelligent cultural content management, called *CultIS*, fits into research aimed at creating software solutions for increasingly complete storage, management, preservation and presentation of diverse resources of cultural and historical heritage, and in particular for digital libraries to provide access and meet to the greatest extent the needs of learners and researchers in these scientific areas (Kuhar & Merčun, 2022; Barifah et al., 2020; Villanueva & Shiri, 2021, Paneva-Marinova et al., 2019). The development and implementations of *CultIS* concerns research in the areas of digital cultural heritage systems related to the development of detailed semantic structures representing the

knowledge of objects and standards, the improvement of the functionalities and architecture of digital libraries, the technological tools for personalization of services and content, the digital protection, management and resilience of such environments, *etc*. (Bogaard et al., 2019; Li et al., 2019; Li & Liu, 2019; Gartner, 2021; Candela et al., 2022; Liu, 2022; Wiedeman, 2023; Woolcott & Shiri, 2023; Chigbundu et al., 2023).

The web-based platform for intelligent cultural content management *CultIS* (https://cultis.math.bas.bg/en) represents a complex web-based humanities and social sciences data storage, retrieval and curation environment containing a rich set of technologies aiming to support a great variety of digital cultural units. Its powerful features and components providing flexible storing, interactive virtual presenting of objects and collections, standard and complex search and grouping in various intersections, flexible management and structuring of metadata, data, objects, multilayer indexing of data using dictionaries, *etc*., make it suitable for a number of diverse applications. The basic prototype of *CultIS* is able to store and manage different types of digitized copies of cultural heritage objects, including text, graphics, video, audio, 3D formats, or other media objects, as well as the relevant metadata.

The development of *CultIS* is aimed at achieving a high degree of adaptability in terms of building specific designs and user interfaces for the needs of specific environments. It has possibilities for implementation of additional modules and functionalities according to application areas and for importing data from various systems and formats. *CultIS* is based on some of the most advanced and established software technologies.

The platform is an infrastructure component of the CLaDA-BG, the Bulgarian National Interdisciplinary Research e-Infrastructure for Resources and Technologies in favour of the Bulgarian Language and Cultural Heritage, part of the EU infrastructures CLARIN and DARIAH (2018-2027), whose mission is to create a national technological infrastructure for resources and technologies for linguistic and cultural heritage.

Section 2 of this paper presents the *CultIS* architecture and main functionally. The technology used and the performance of the web-based platform for intelligent cultural content management is discussed in Section 3. In Section 4, the specifics of some of the main applications of the *CultIS* platform are demonstrated. In Conclusion, some future directions in the development of the presented digital environment are given.

2 *CultIS* Architecture and Main Functionally

The core *CultIS* platform is implemented using a 3-layered architecture.

- The data layer manages data structures (metadata), objects and their repositories, and communication with the logic layer.
- The logic layer contains all functional back-end features of the platform, together with security and account management features and integrations with third-party APIs.
- The presentation layer is responsible for all user interfaces and web access to the platform.

Each of these layers can be customized and extended as a separate component when implementing specific *CultIS* modifications. Thus, the core layers remain always the same, facilitating the development and maintenance of the platform.

The core *CultIS* layer includes the following modules:

- A module for managing objects metadata structure (Figure 1 presents the user interface of this module).
- A module for managing objects metadata.
- A module for presenting objects and their metadata.
- User and access management module.
- A module for bulk data management - different formats of data imports and exports, objects indexing and building in bulk.

The custom *CultIS* layer includes features specific for each *CultIS* implementation, depending on its concrete needs. Such features may include:

- Modules for language translation and transliteration.
- Extensions of the user interface, including specific screens, pages, UI components.
- Extensions to the access management module, including specific user permissions, objects statuses, object management flows, authentication mechanisms, *etc*.
- Specific data indexing features.
- Custom data conversions, optimizations for web, protection, watermarking.

The metadata of each individual object is created manually by the users-editors, or by automatically importing the cultural objects (presented in Figure 2) in the description form (also called metadata creation form).

By definition a digital library is a collection of digital items, however, they can be of different types and one item can be a combination of text and an image or video and audio (Liqiang & Quan, 2020). In the platform, every item's attribute (descriptor) may have a predefined type specification, determined by the object's metadata. The platform not only supports the standard user interface types (scalar and non-scalar, e.g., text, text area, text (multilingual), text area (multilingual), rich text area, form tags, number, date, time, array, dropdown, single and multiple-choice controls, files) but also allows customized (complex) types, such as domain-specific predefined non-scalar object types. The complex type provides the flexibility to describe all material and non-material cultural objects and eliminates the need for the redefinition of common descriptive items for each specific object type.

Items with similar attributes (descriptors) could be grouped in a separate general scheme, which combines the common elements of the objects. The specifics of the different types of objects are added as additional properties of their corresponding descriptive schemes. For example, the creation of a separate descriptive model of an object of type "Location", would save space in the database, reduce redundancies and create a traceable relation between the main objects sharing this common descriptive item.

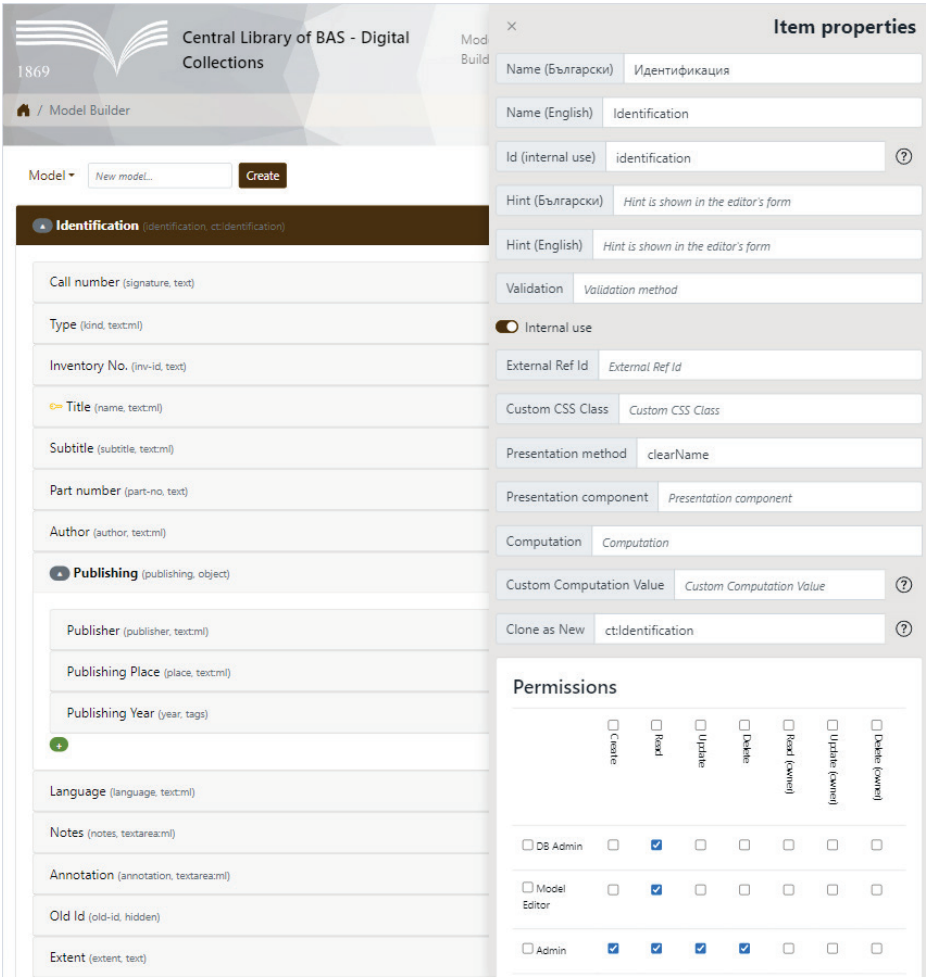

Fig. 1. Form for building metadata structures (descriptors).

This approach is also underlying for the efficient use of the platform's search engine, enabling, simplifying and boosting the performance of a unified search mechanism that allows the users to perform complex search queries within the whole content, using simple search operations.

The structure creation module could also manage relationships between objects, showing their complex or heterogeneous descriptive structure and support preliminary defined descriptive schemas and standards in the cultural heritage field, including Dublin core, CIDOC-CRM, *etc*.

The full metadata managing stack for creating, storing, editing, deleting metadata, backing up, and version control is covered by the functional module for managing and presenting metadata. The module is also responsible for user searches, data filtering, access management, and metadata presentation over a variety of user devices.

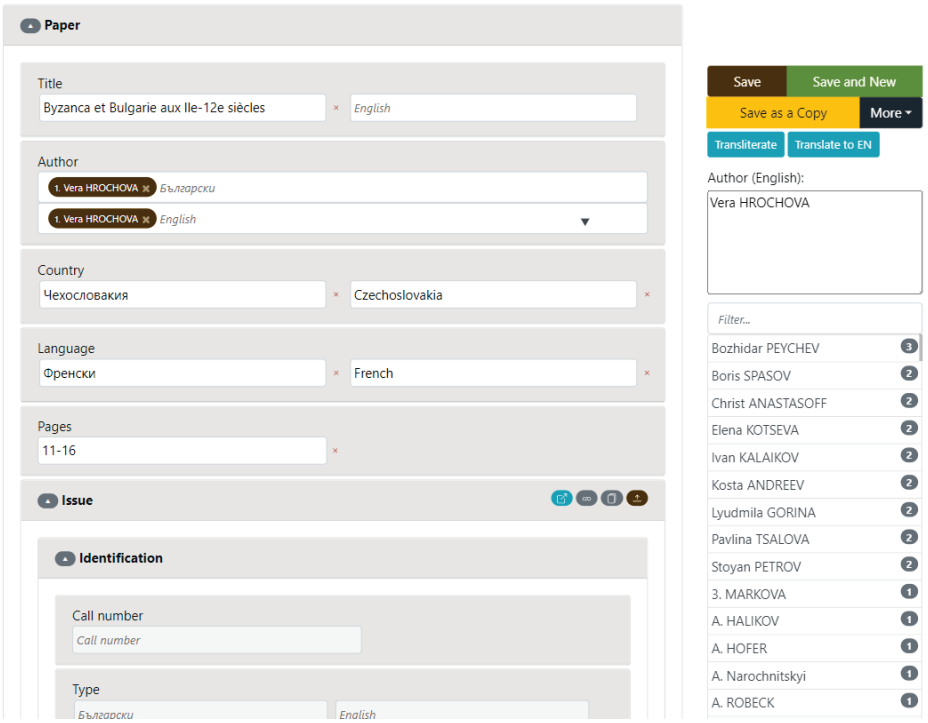

Fig. 2. Metadata creation form.

The fundamental purpose of the creation and editing features is to make user input as fast and efficient as possible. It is crucial to minimize user input errors and reduce the time for editing a single unit when there is a need for managing large volumes of data. For these specific goals, different features are implemented, including structuring of the annotation template using trees and tree-based sections, features for metadata re-usage, suggestions, autocomplete options based on previously entered metadata, partial/full import of data, and metadata, bulk data transformation. Services are specifically implemented to meet the content provider's needs, such as advanced collection creation, management and curation (thematic collections, time-dependent collections in a calendar structure, *etc*.), search in the text media objects, advanced objects preview and ordering, different device support, *etc*. Users with appropriate roles are able to define categories of metadata and the characteristic(s) of the objects to be used for aggregation and grouping. Object characteristics can vary according to the specific application domain. The module creates groups of objects, based on the given criteria and presents them to the users (Stoikov, 2021). The users are able to utilize this information directly or export it for further analysis in another system/tool.

For wider accessibility and usage, the *CultIS* implementations for research and e-learning are available on various devices (Figure 3) – PC, smart TV, tablet, smart phone and customized previews are supported.

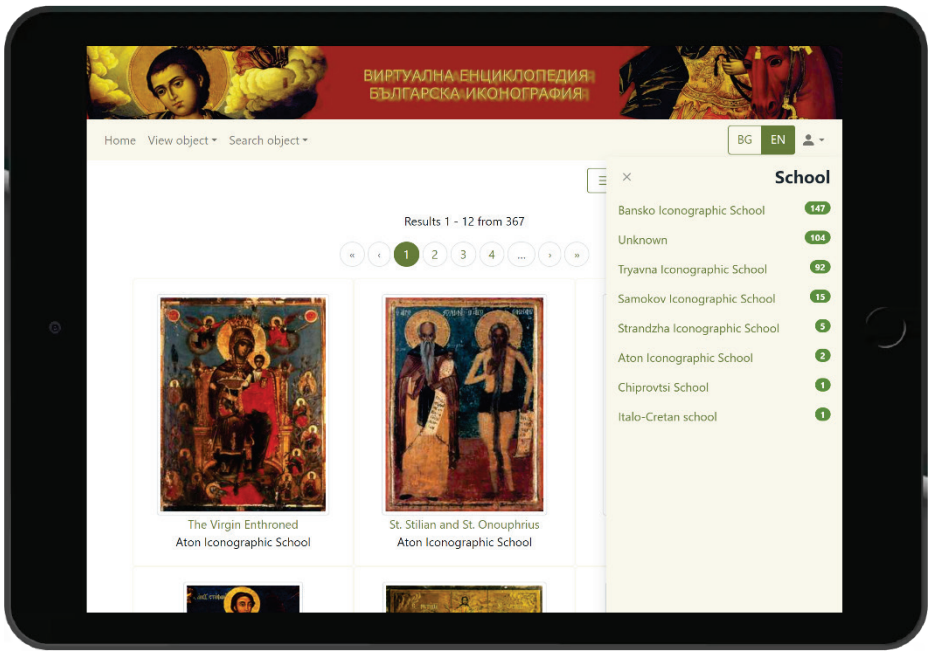

Fig. 3. Tablet view of *CultIS* UI.

3 Used Technology and Performance

CultIS is a platform built mainly using open-source software components. Back-end technologies used include NodeJS 20, Express 4, Apache or NGINX for proxying and load balancing user requests. As a database management system, we use the non-relational MongoDB Community Server 7.0. MongoDB offers management of complex data structures and high-performance queries over large volumes of structured data, making it a preferable solution (Mitreva & Kaloyanova, 2013).

The current front-end implementation is based on the MVVM design pattern. It is developed as a single page application (SPA), which reduces network loads and response times. Vue 2.7 and Bootstrap 4 frameworks are used for the implementation. Both frameworks aim to boost software development and reduce the time-to-market indicators, while providing great quality, performance, responsiveness, and accessibility of the developed user interfaces (UIs). Bundling of packages and releases was switched from WebPack 5 to Vite 5. Vite allows faster builds and HMR (hot module replacement) of the code modules during platform development. The codebase is managed in a Git version control system. Core functionality and specific customizations are separated into different git repositories, so management of the code, versions, and permissions is easier and more intuitive. Depending on the specific implementation, *CultIS* uses additional components for converting objects and making them web-friendly. Such components include ffmpeg, sharp, pdfjs, postscript utilities, *etc*. Indexing and querying of text content is performed by SphinxSearch.

4 *CultIS* Implementations

This section contains a presentation of several implementations of *CultIS* in different cultural heritage areas.

4.1 Digital Library "Virtual Encyclopedia of Bulgarian Iconography"

The "Virtual Encyclopedia of Bulgarian Iconography" (BIDL) utilizes the *CultIS* implementation for storing, retrieving and curating Bulgarian iconographic art data.

It is a web-based digital library, containing hundreds of Bulgarian iconographical artifacts from different authors, periods, iconographical schools, geographical locations, museums, churches, monasteries, *etc*.

Bulgaria is one of the first Slavic Eastern Orthodox countries in which icon painting became widespread. The great complexity and heterogeneity of knowledge about iconographic art is a motive for building rich semantically oriented structures for its descriptive presentation. In this regard, information technology can assist this process by providing means of description and digital storage and presentation in order to preserve the outstanding artistic heritage of Bulgarian icon painting and mural painting.

The BIDL illustrates the development of the Bulgarian iconography from the ninth to the nineteenth century, which reflects to a high degree the spiritual aspirations, the refined sensitivity, the high artistic taste, the great professionalism and the painterly gift of the Bulgarian artist. At BIDL, the user can familiarize oneself with the diversity which distinguishes Bulgarian icon painting in both technological and thematical aspects. The technology of creating the icons shows development, modifications, local features, striving for perfection, adaptation to the relevant modern means, materials and technologies, and the established canon did not prevent the stylistic and graphic development of the icon (Márkus et al., 2022).

The structure and implementation of BIDL aim to create flexible and context-sensitive access to multimedia content. The development of BIDL is aimed at providing complex services (heterogeneous, autonomous and distributed), processes and information flows. Flexibility, automatic adaptation, unlimited access, decentralization, a rich variety of digital objects and collections, information security, *etc*. are part of the library requirements (Paneva-Marinova et al., 2017).

The Digital Library "Virtual Encyclopedia of Bulgarian Iconography" is available at https://bidl.math.bas.bg/.

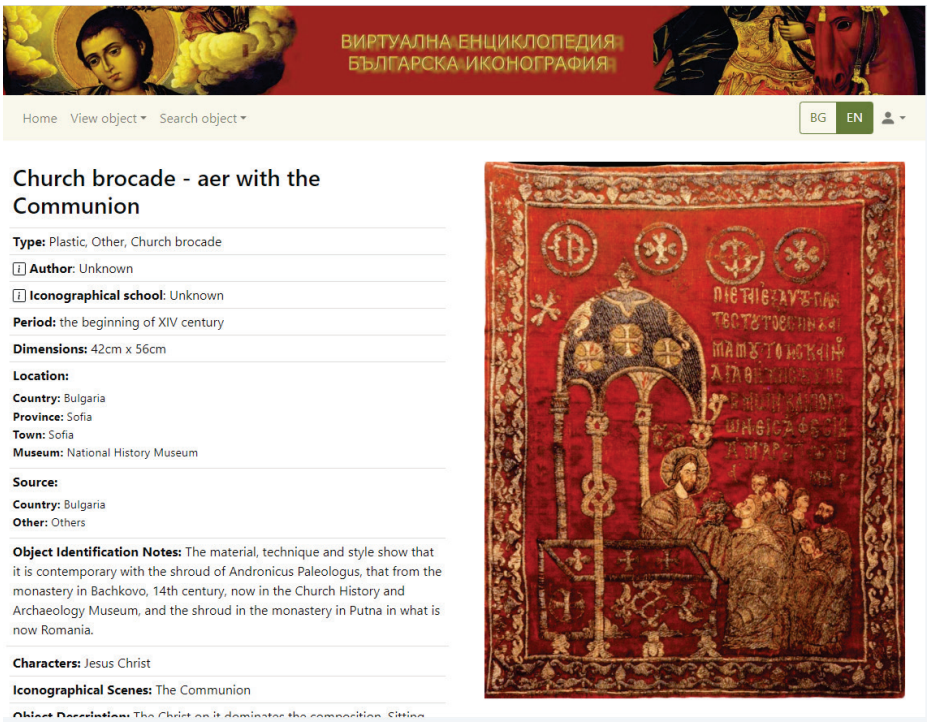

Fig. 4. Digital Library "Virtual Encyclopedia of Bulgarian Iconography", iconographical object.

4.2 Digital Library of the National Library "Ivan Vazov" in Plovdiv

The National Library "Ivan Vazov" – Plovdiv plays an essential role in the preservation of Bulgarian culture and history. It is the first cultural institution in Southern Bulgaria, established as a Regional Library and Museum of Eastern Rumelia in 1879, and has developed an archive of Bulgarian books and periodicals, a historical archive, a rich repository of manuscripts and Revival literature, and unique collections of rare and valuable publications. Today, the National Library "Ivan Vazov" – Plovdiv is a cultural institute that continues to dynamically enrich and develop the traditions of its prominent founders. Patrons annually realize over 120,000 visits and loan over 300,000 library documents. The library's holdings are comprehensive and amount to over 1,900,000 library units – scientific, fiction, manuscripts, old-printed, rare and valuable publications, Bulgarian and foreign periodicals, photographs, maps, audiovisual and electronic documents, original works of art, personal libraries (Paneva-Marinova et al., 2023).

The *CultIS* platform is implemented for the needs of the National Library "Ivan Vazov" – Plovdiv of storing, retrieving and curating data from the field of humanities and social sciences, considering the large volume of over 1,460,000 library The prototype produced to manage the digital collections of the National Library "Ivan Vazov" – Plovdiv is a web-based digital library. It supports a variety of digital cultural units

and rich functionality for interaction, with an accent on components providing storage, retrieval and intelligent curation of data and metadata (Paneva-Marinova et al. 2022).

The basic functional components are in the core of the services for intelligent content curation and context-based digital library content usage for research and e-learning: a metadata management and presentation functional module (incl. specific services), a metadata model management module, administrative services that are linked to a media repository and a user data repository (Luchev et al., 2021). The basic digital library prototype stores and manages the digital analogues of cultural heritage objects presented in text (via .pdf files, fully corresponding to book media), graphic, video, audio formats, or other media objects as well as the relevant metadata. Specific services for intelligent content curation and context-based digital library content usage for research and e-learning, as a part of this module, include functionalities closely related to the content provider needs, such as advanced collection creation, management and curation (thematic collections, time dependent collections in a calendar structure, *etc*.), search in the text media objects, advanced objects preview and ordering, different device support, *etc*. The National Library "Ivan Vazov" – Plovdiv prototype provides specific services for indexing Portable Document Format (PDF) objects, providing the opportunities for full-text search in the objects' content (Figure 5).

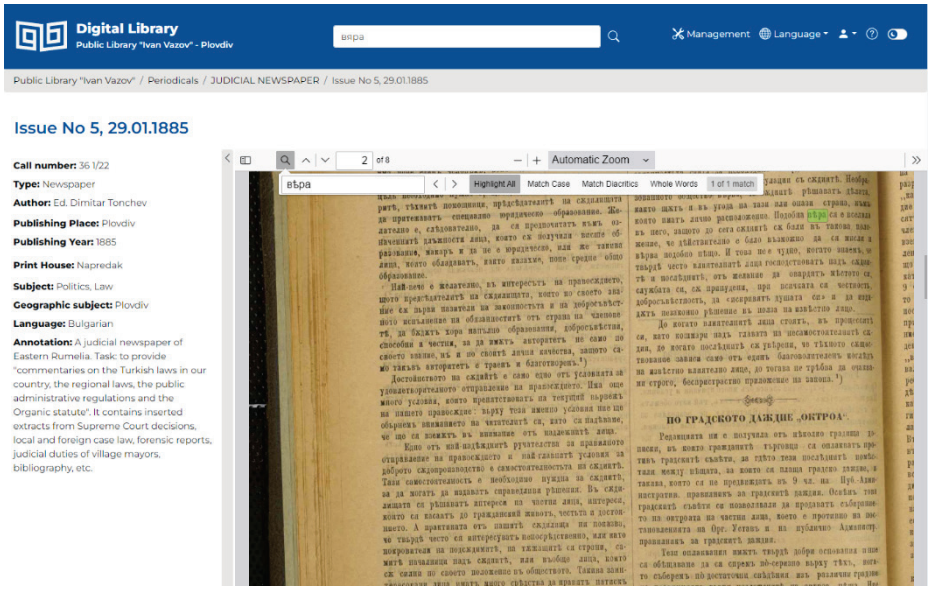

Fig. 5. Full text search screen for National Library "Ivan Vazov" digital library.

Functionalities for presentation of PDF objects in a web environment (without browser add-ons requirements), with options for search and visualization of the results in a certain document, are integrated in the system.

In order to get a higher level of data protection, a strong backup strategy was applied for the National Library "Ivan Vazov" – Plovdiv digital library. Both objects and metadata are backed up every week and stored in two backup repositories. Moreover,

data is stored in different geographical locations, thus greatly reducing the risk of data loss (Figure 6).

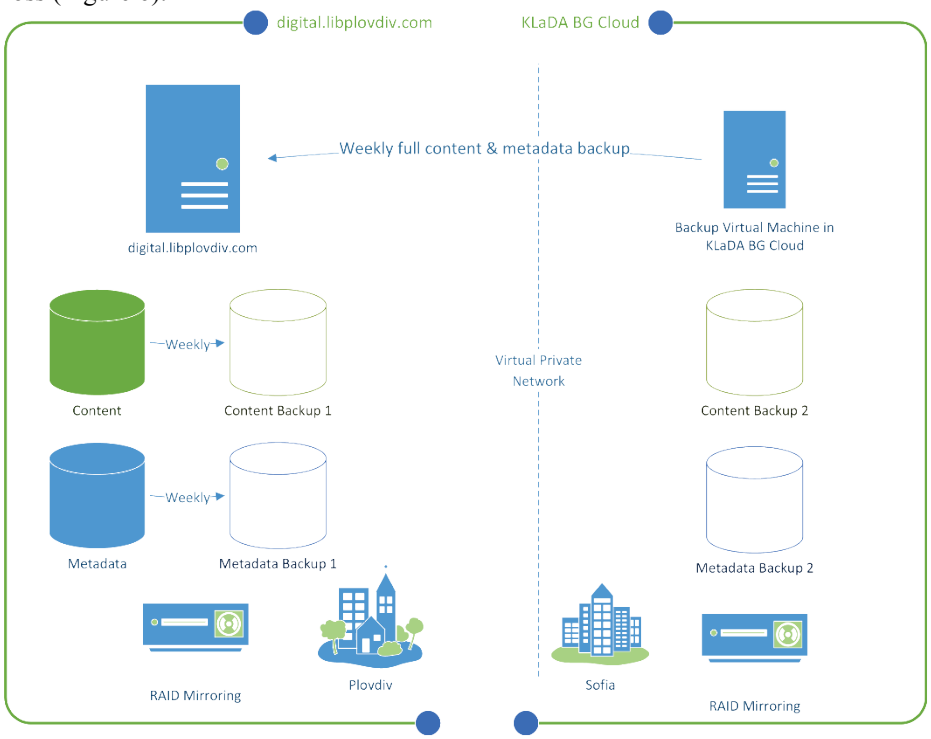

Fig. 6. Backup architecture of National Library "Ivan Vazov" – Plovdiv digital library.

Supporting the context-based digital library content usage for research and e-learning, there are also options for placing links to pop-ups with text and media files (images), basic data analysis/synthesis, *etc*. The aggregation of objects is achieved through common (one or more) characteristics, depending on the specific model and application domain. The system summarizes groups of objects based on the aggregated data to improve the organization of object representation in subsequent analysis.

Most of the digitised materials, those of high cultural and historical value and expired copyright in the collections of the National Library "Ivan Vazov" – Plovdiv, are predominantly from the period before the Bulgarian language's last Orthographic Reform of 1945, which poses a number of problems to the accuracy of OCR and which the platform's search algorithm must take into account in order to achieve results as accurate as possible. A very specific aspect of the platform's search function is that it must take into account the peculiarities of optical character recognition (OCR) applied to Cyrillic texts. This provides additional opportunities for intelligent content curation and context-based digital library content usage for research and e-learning, as not all researchers and students are familiar with Bulgarian spelling before the Orthographic Reform of 1945.

Digital Library of the National Library “Ivan Vazov” – Plovdiv is available at https://digital.libplovdiv.com/bg.

4.3 Digital Collections of the Regional Library "Peyo Yavorov" – Burgas

The work on the application of *CultIS* for the needs of Regional Library "Peyo Yavorov" – Burgas in connection with its association as a partner of CLaDA-BG, is in the late stage of development. Various collections of periodicals, printed materials, maps, manuscripts, *etc*. will be gradually included, while optimizing specialized functionality for the needs of library users. The library assets offered by the Burgas Library have a large volume – over 60,000 unique items, including 353 bibliographic objects such as periodicals published in the region since the beginning of the last century, books, photographs, postcards, posters, *etc*. The Burgas Library prioritizes the digitization of the most valuable and rare collections and prepares their descriptive metadata. The experimental research is aimed at demonstrating and testing the collection "Posters for events in the city of Burgas and the region".

The implementation of *CultIS* for managing the digital collections of the Regional Library "Peyo Yavorov" – Burgas also includes all the main modules of the system, expanded with several specific functionalities. The focus of these functionalities is on intelligent library units and metadata management. Regional Library "Peyo Yavorov" – Burgas owns rich and diverse digital catalogues of library units and cultural heritage that must be managed and presented in the best possible way, requiring well-defined search, sorting, flexible access and preview functionality, meeting the needs of librarians and readers. The prototype of *CiltIS* for the needs of the Burgas Library provides specific services both for managing objects and for creating sets of objects according to the needs of users, manually (according to the user's choice) and automatically grouping objects (according to predefined criteria) (Paneva-Marinova et al., 2023).

The collection of posters stored in the "Peyo Yavorov" Regional Library - Burgas is available at: https://plakati.bg73.net/bg.

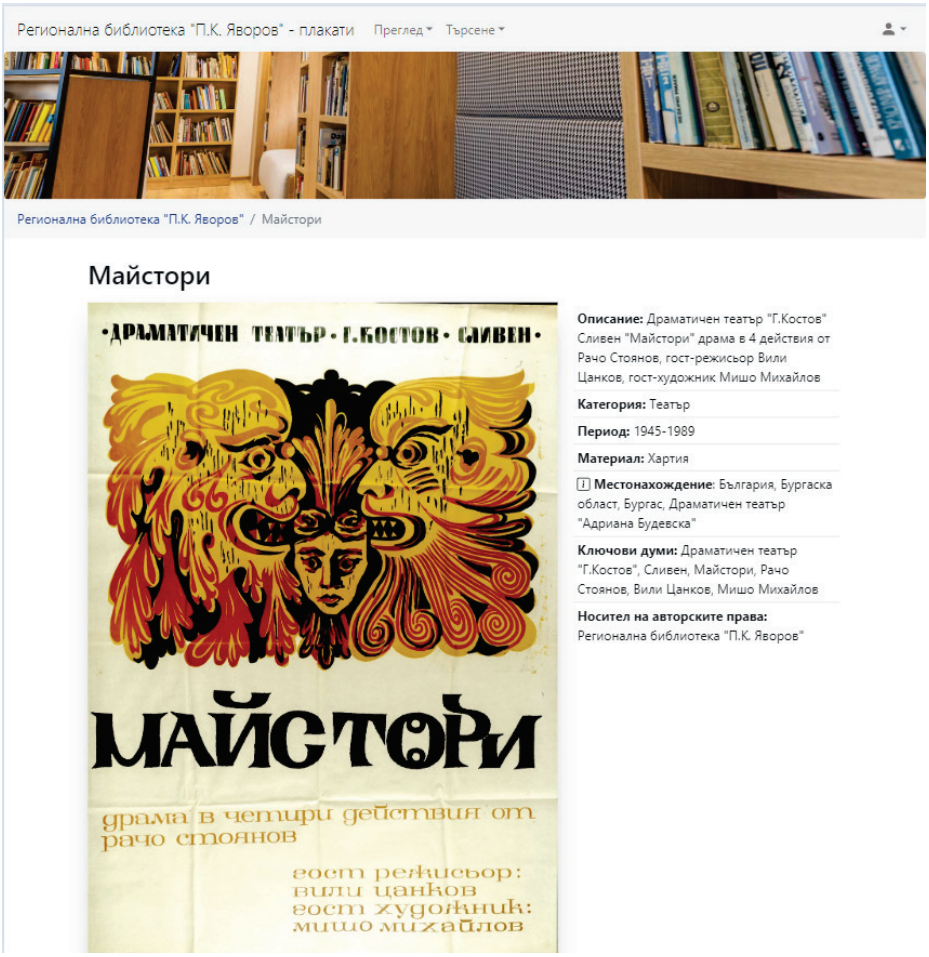

Fig. 7. Object from digital collection "Theater" of the "Peyo Yavorov" Regional Library – Burgas

4.4 Digital Collections of the Central Library of the Bulgarian Academy of Sciences

The Central Library of the Bulgarian Academy of Sciences is one of the most significant national centers for literary and documentary heritage, possessing over two million library documents and making a significant contribution to the development of national library and information resources. Over the past fifteen years, the digitization of significant collections from the library's repository has progressed and a number of digital datasets have been created.

The implementation of *CultIS* for the needs of the Central Library of BAS (CL-BAS) began with the work on one of the noteworthy collections of CL-BAS, associated with

the international congresses of Bulgarian studies from the 1980s (the Bulgarica Collection) and consisting of more than nine hundred scientific papers and reports. Because of the challenges during the implementation of *CultIS* for the needs of CL-BAS, related to the migration of data from an older platform used as a digital storage and from separate archive units, new modules were designed and implemented. The descriptive model of the Bulgarica Collection is based on performing a preliminary scientific and bibliographic analysis of the characteristics of the described objects in order to provide opportunities for a complete description of the objects and effective access to the presented knowledge. An extension of DublinCore is used for a description scheme reflecting the specifics of the target objects.

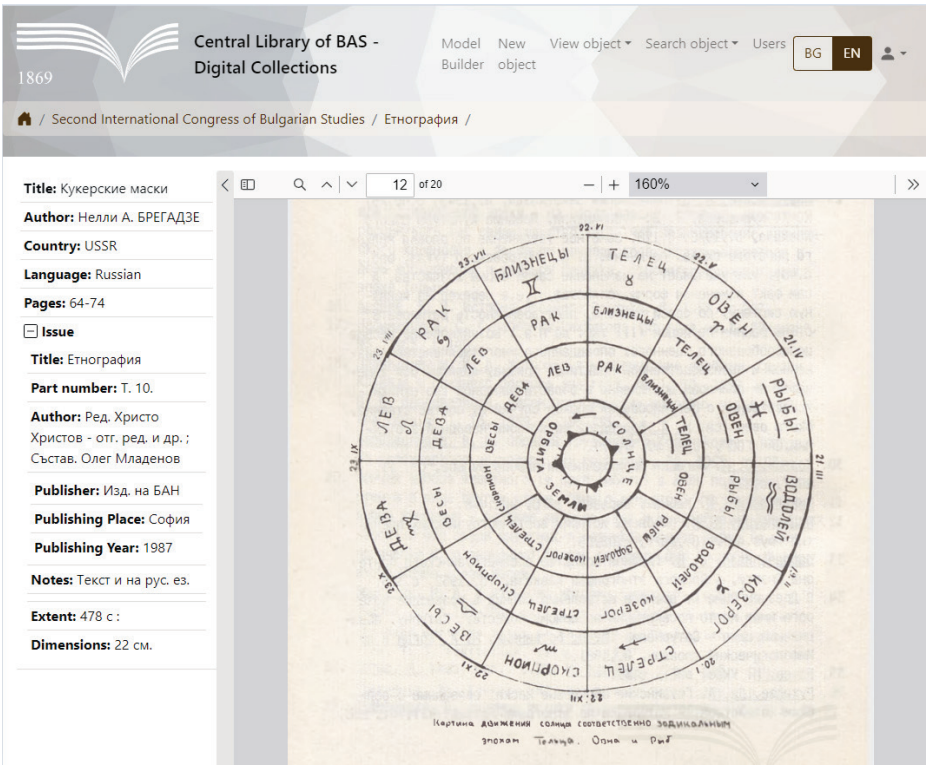

Fig. 8. Central Library of BAS, object of type "Paper".

In cases where the text indexes are relatively small and full-text search (FTS) is not the primary goal of the application, the MongoDB FTS engine is used in the standard version applications of the platform. Because the Bulgarica Collection contains huge amounts of textual data and the FTS function is in high demand, when implementing the prototype of *CiltIS*, the standard FTS was replaced by the SPHINX FTS engine, a high-performance, low-resource consumption engine, and tests prove its advantages in the application. On the basis of preliminary processing and curation of the objects, new modules (OAI-PMH, METS parser, MARC 21 metadata processor, TOC processor,

PDF paper builder, Metadata summarizer and importer, *etc.*) were also designed and implemented with a view to carrying out the migration of data from an older platform used as a digital repository, and due to the problems caused by the dispersion of ten years of photographing and preserving the individual pages of the congress collections and separating them into individual archival units (Goynov et al., 2023).

The digital collections of the paper of the First International Congress of Bulgarian Studies and the Second International Congress of Bulgarian Studies are available at https://clbas.bg73.net/.

4.5 Encyclopaedia Slavica Sanctorum

Work on the application of *CultIS* for the renewal and development of the electronic Encyclopedia Slavica Sanctorum (e-ESS) is in an advanced phase. The e-ESS was originally established in 2011. It is a calendar-oriented multimedia resource, aiming to present the reception of the cults of Christian saints and the Orthodox Christian tradition among Bulgarians from the Middle Ages to the present day (Goynov et al., 2011).

In the "Encyclopedia Slavica Sanctorum" electronic library, a corpus of memory for saints and Christian holidays - all-Christian and local - has been created, based on records of church calendars in different types of Bulgarian and more generally Slavic written sources from various historic periods. A number of field records (folklore texts) have been added to the data from the written sources, so that the complex interplay between written and oral culture can also be explored.

The electronic Encyclopedia Slavica Sanctorum brings together the following types of data: commemorations of saints on particular dates as attested in medieval Slavonic manuscripts (more than one hundred) containing church calendars or texts dedicated to saints; information on saints' lives, endeavors, and miracles according to medieval Greek and Slavonic writings; information on texts, both translations and original compositions, dedicated to saints that were available to the Bulgarian clergy in manuscripts and later in printed books; diplomatic editions of original texts dedicated to saints as identified in medieval and early modern Slavonic manuscripts; records of stories and believes about saints in popular Bulgarian culture; information on images and sacred places dedicated to popular saints, *etc*. All this information is structured by particular parameters and thus searching in the e-ESS can be made in different manners: by viewing a chosen date in the calendar given (if one chooses a date, one receives information about all the saints commemorated on this date according to numerous medieval manuscripts) (Figure 9), by viewing objects gathered in twelve lists of types of objects (*viz.* a list of all the names of saints in e-ESS and their days in the calendar; a list of the rulers and the saints who lived during their reigns, a lists by genres of texts dedicated to saints, *etc*.), by searching by different parameters, one or many, chosen by the user, *etc.* (Dimitrova et al., 2023).

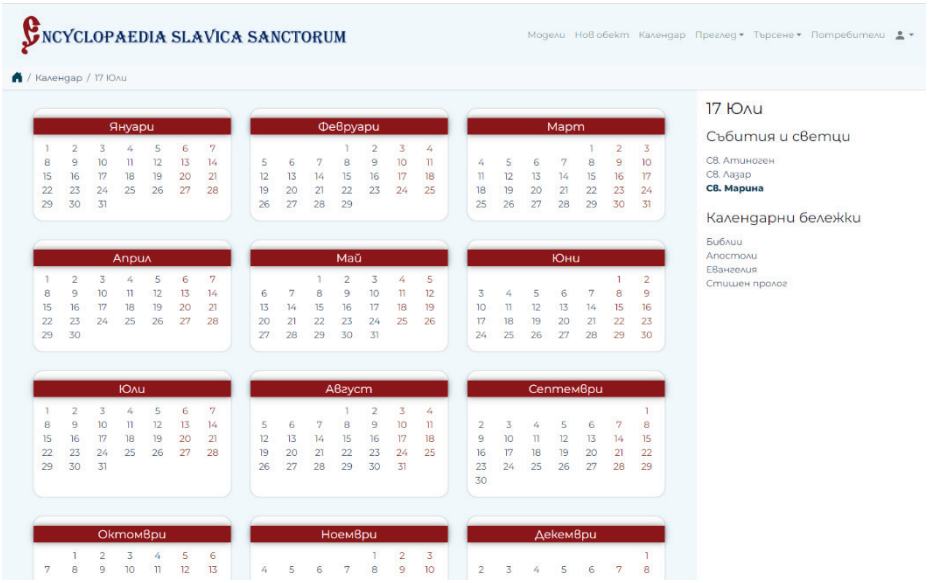

Fig. 9. Encyclopaedia Slavica Sanctorum, calendar of saints and events.

An important characteristic of the electronic Encyclopedia Slavica Sanctorum is its integration with another *CultIS* implementation presented in this paper – the Digital Library "Virtual Encyclopedia of Bulgarian Iconography", which gives opportunity to compare texts (written and oral) and images.

The test implementation of *CultIS* for electronic Encyclopedia Slavica Sanctorum is available at https://ess.bg73.net/.

5 Conclusions

Developed by the team of the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences (IMI-BAS), the web-based software platform for intelligent digital management and presentation of large data sets and knowledge in the field of culture, humanities and social sciences – *CultIS*, offers specific and individual solutions for the needs of different libraries and museums regarding the presentation of national heritage and the associated knowledge. The *CultIS* implementations demonstrate the possibilities and potential of the platform for its diverse use by different cultural institutions and their users, as well as its support to the work of researchers in the humanities and social sciences.

The challenges that *CultIS* faces in its implementations present the IMI-BAS team with new research problems and solutions and at the same time contribute to the constant development and improvement of the platform. Although the results of the research activity are primarily derived from the work with the network partners in CLaDA-BG, an interest in the platform is already present from institutions outside CLaDA-BG, both within and outside the borders of Bulgaria.

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