

# Virtual Walk in the Church of Nativity in Arbanasi

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**Abstract.** The paper presents the special features of the virtual walk developed in Bulgarian - Hungarian co-operation for the famous Bulgarian church named as Church of Nativity in Arbanasi. The virtual walk is created from high-resolution interactive spherical panorama pictures. The virtual walk is integrated with the Bulgarian Iconographical Digital Library, a rich repository of Bulgarian icons.

**Keywords:** Panorama Picture, Virtual Walk, Digital Library, Iconography.

## 1 Introduction

The Institute of Mathematics and Informatics at Bulgarian Academy of Sciences (IMI-BAS) and the Institute for Computer Science and Control (SZTAKI) conducts an extensive joint research and development work for presenting Bulgarian cultural and scientific assets (Márkus, et al., 2017). High-resolution spherical panorama pictures in Veliko Tarnovo and Arbanasi were created during the former Bulgarian-Hungarian academic co-operation. They proved to be an attractive way to present cultural and historical sites. The panorama pictures on Bulgarian churches were added to the Web site of the Bulgarian Iconographical Digital Library (BIDL) (Bulgarian Iconographical Digital Library, 2022) and the related mobile application (BOOK@HAND BIDL) (Márkus, Kaposi, Szkaliczki, Luchev, & Pavlov, 2015). A paper on this project was presented on the DIPP conference in 2017 (Luchev, et al., 2017).

As the continuation of the joint work, a virtual walk was prepared from the panorama pictures taken at outside and inside of the Church of Nativity in Arbanasi where the user can explore the church by moving from one section of the church to another. The virtual walks represent a service to present real spaces and special environments in an

attractive way and support virtual navigation and interactive discovery of various locations. The virtual walk is integrated with BIDL through hotspots. Hotspots were assigned to specific parts of the church in the virtual walk where users can get additional information. The information is available in multiple languages (Bulgarian and English). By clicking on a hotspot, the image and description of the icon at the hotspot is presented in BIDL. Furthermore, hotspots can provide additional information by showing icons from other churches in BIDL which are similar to the icon located at the hotspot.

The remainder of this paper is organized as follows. In Section 2, the Church of Nativity in Arbanasi is introduced. Section 3 provides an overview on the Bulgarian Iconographical Digital Library. Section 4 introduces the panorama pictures, describes the technology of creating panorama pictures and presents the panorama pictures created by SZTAKI. Section 5 provides an overview on virtual walks. Section 6 presents the integration of BIDL and the virtual walk on the Church of Nativity in Arbanasi. Section 7 evaluates the benefits of the virtual walk created by SZTAKI. Finally, Section 8 concludes the paper and presents some ideas for future work.

## **2 Church of Nativity in Arbanasi**

The village of Arbanasi is one of the most picturesque old settlements in Bulgaria. It is located on the rocky plateau of the same name, which is 4 kilometers northeast of Veliko Tarnovo. The village is known for the rich history and large number of historical monuments. With its unique 16th-17th century Revival architecture of houses and churches and its natural features, Arbanasi is a truly attractive place. The fortress houses make an impression with their appearance and high stone fences, which contrast with the pretty courtyards. Particularly beautiful are the preserved 7 churches from the 16th-17th century. With their strong high walls, small windows and impenetrable, iron-bound oak doors, they harmoniously fit into the general architectural appearance of the settlement.

The Nativity of Christ is the earliest and the most richly decorated church in the village of Arbanasi and has a complex and long history. In the second half of the 16th century, a temple was built, which occupied the volume of the present naos. Its painting was completed in 1597. During the second construction stage, a chapel from the north and a vestibule from the west were added to the existing church, united by an open, vaulted L-shaped gallery from the north and an exonartich from the west. Construction activities were carried out in the period between the 20s of the 17th century and 1632. During the third construction stage, the spaces between the arches of the vestibule, the gallery and the exonartich were walled with thin stone masonry. Window openings are formed, protected by metal bars. The chronological limits within which the walling is placed is the time after 1632 and before 1643.

The entire interior of the Nativity of Christ church is covered with painting, the execution of which took place in stages - 1597, 1632, 1638, 1643, 1649, 1681. Within these nearly nine decades, a unique mural ensemble emerged, which has no equal in the Bulgarian lands in terms of thematic breadth and encyclopedicity. Great care and

consistency, large-scale scope and generosity of spirit is put into writing. All the walls and vaults with a total area of over 2,000 square meters are covered with frescoes. Hundreds of compositions are painted, and the number of characters in them exceeds several thousand (Prashkov, 1979).

### 3 Digital Library "Virtual Encyclopedia of Bulgarian Iconography"

The Digital Library "Virtual Encyclopedia of Bulgarian Iconography" (<https://bidl.math.bas.bg/>, known also as *BIDL* – Bulgarian Iconographical Digital Library) was initially created within the project "Digital Libraries with Multimedia Content and Applications in Bulgarian Cultural Heritage", whose aim was to lay the foundations for the registration, documentation and virtual presentation of a potentially unlimited number of Bulgarian icons and iconographic objects.

The current version of BIDL is developed as an infrastructure component of CLaDA-BG, the Bulgarian National Interdisciplinary Research e-Infrastructure for Resources and Technologies in Favor of the Bulgarian Language and Cultural Heritage, Part of the EU Infrastructures CLARIN and DARIAH, whose mission is to create a national technological infrastructure for language, cultural and historical heritage resources and technologies (Luchev, et al., 2021).

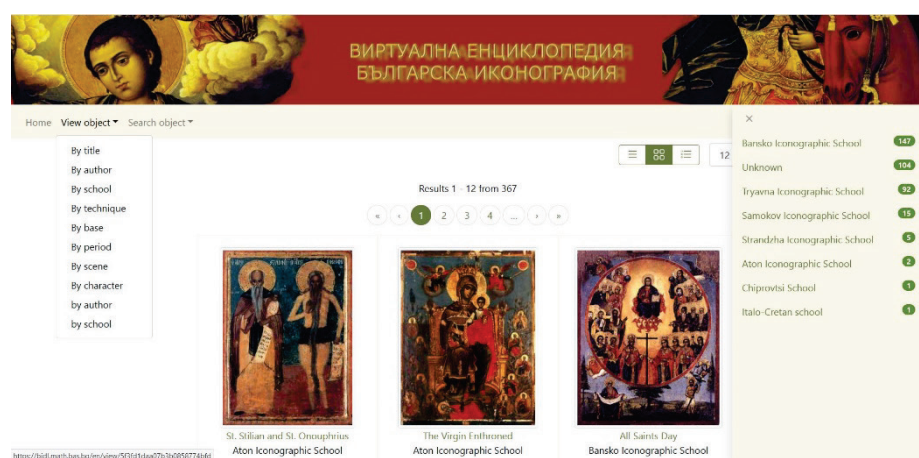


Fig. 1. Digital Library "Virtual Encyclopedia of Bulgarian Iconography" (BIDL)

The library contains several hundred specimens of Bulgarian icons from different artists, historical periods, and schools. It provides and manages complex services (heterogeneous, autonomous and distributed), processes and information workflows. The flexibility, the automatic adaptation, the universal access anywhere and anytime, the decentralization, the wide variety of digital objects and collections, the information security, etc. are some of the requirements considered in the library implementation.

The development of the Digital Library "Virtual Encyclopedia of Bulgarian Iconography" is complemented by other projects developed at IMI-BAS in the field of digitization and 3D scanning of historical and cultural artifacts, digital repositories and physical and digital accessibility in historical places and museums in the new reality (Bogdanova, et al., 2011; Bogdanova, et al., 2013; Bogdanova, et al., 2021).

## **4 Panorama Pictures**

### **4.1 An Overview of Panorama Pictures**

The interactive high-quality photo panorama pictures represent an attractive, impressive, and informative presentation technique to discover the details of a site and its surroundings. The users can explore both indoor and outdoor sites in an interactive way. The main benefit of using panoramas is that the details on the image can be easily explored without visiting the site. Visitor can look around in the presented environment with the help of panorama pictures. The panorama pictures can be arbitrarily rotated, zoomed in and out, or tilted up and down. The view direction and the zoom rate can be continuously adjusted in the dedicated viewer. The user may discover details by zooming which the visitors cannot see even on the site.

The panorama pictures can be classified from various aspects. They can be real (or photo) panoramas and virtual panoramas. The real panorama pictures are created from photos taken on the site. Virtual panoramas represent virtual environments. Two main categories of digital panorama pictures based on their geometry: cylindrical (2D) and spherical (3D) panoramas, are distinguishable. In case of cylindrical panoramas, the panorama picture covers a cylinder wall. The user can look around in the cylindrical environment but the top and the bottom is missing from the picture. In case of spherical panoramas, the user can look at any directions including upwards and downwards. The spherical panorama pictures have two main formats: equirectangular and cubic. The equirectangular projection is a standard method originated from cartography for mapping the surface of a sphere to a rectangle. The cubic panorama pictures consist of six cube faces containing images and the viewer can look around from the middle of the cube.

The panorama pictures can contain special areas so-called *hotspots* which can be selected by the users. The hotspot can load a different panorama picture simulating navigation between panoramas, open a description pane for the specified area of the panorama or start a game on a topic related to the specific area.

The panorama pictures can be used on various platforms including Web, mobile and Virtual Reality (VR) platforms. High-resolution photo panorama view provides an attractive way to present cultural and historical sites from a distance. The panorama pictures can be used on the site as well. For example, the panorama picture may represent a historical view from a site and the mobile device displays the segment of the historical view at the proper direction as the user turns around with the device.

## 4.2 The Technology of Preparing and Presenting Panorama Pictures

SZTAKI has the hardware and software tools and the know-how to create high-quality panorama pictures. There are several ways to create real panorama pictures:

- The panorama pictures are created from a series of photos. The photos are taken by using a high-resolution photo camera, high quality, special wide-angle photo lens, manual panoramic head, and heavy and stable tripod. To create spherical panorama, two more pictures are taken in upward and downward directions.
- In a more complex version of the above method, the series of pictures are taken in several rounds by using an advanced rotator, where the camera is tilted upwards or downwards with different angles in each round.
- Cameras with built-in panorama picture functionality can produce a panorama photo in one shot.

After taking the photo series, professional photo editing software tools can be used to stitch the images into one panorama picture. The result of stitching results in an equirectangular panorama picture. It can be transformed to a cubic panorama picture, which can be more efficiently displayed.

The panorama pictures can be presented on multiple platforms e.g., Web sites, Facebook, Google maps, own developed mobile applications, and VR glasses.

## 4.3 Panorama Pictures Created by SZTAKI

SZTAKI created a lot of panorama pictures on sites with touristic, cultural, religious, and scientific relevance in Hungary and other countries.

Panorama pictures were created in the following Bulgarian locations:

- Church of the Nativity in Arbanasi (SZTAKI, Church of the Nativity in Arbanasi - Panorama pictures, 2022);
- Peter Paul Ivan Rilski (Veliko Tarnovo);
- Church of Ss. Archangels Michael and Gabriel (Arbanasi);
- Church of St. George in Veliko Tarnovo;
- Holy Forty Martyr's church and the Great Laurel Monastic Complex (Veliko Tarnovo);
- Museum of the Bulgarian Revival and Constituent Assembly (Veliko Tarnovo);
- Bridges of Veliko Tarnovo;
- Touristic and cultural sites in Burgas;
- Ruins of ancient Roman baths in Aqua Calidae – Thermopolis (Vetren);
- Ostrusha mound, a Thracian burial tumulus (near Kazanlak).

SZTAKI implemented an own tool to present panorama pictures. SZTAKI panorama viewer has the following functions which are available on multiple platforms:

- *Display full 360° spherical panorama pictures.*
- *Offline panoramas.* The panorama pictures can be presented without any Internet connection.
- *Hotspots.* The user can set different viewing locations by selecting a hotspot within the panorama picture. The hotspot can load a different panorama picture

simulating navigation between panoramas or open a description pane for the specified area of the panorama.

- *Change panoramas from list.* The list is automatically built from the panoramas loaded to the device. The user can change between these panoramas anytime using the list.
- *Music.* Background music can be played while the user is watching the panorama picture.
- *High resolution offline images.* This allows compatibility for high resolution displays and supports zoom functionality.
- *Zoom.* The user can magnify the panorama picture to explore the details.

The panorama pictures are published on different platforms (Web, mobile and VR) and applications for different target groups (Table 1.).

**Table 1.** Platforms for publishing panorama pictures

| Platform                   | Target groups                  | Examples   |
|----------------------------|--------------------------------|--|
| <b>Web-based platforms</b> |                                |  |
| website of the location    | visitors                       | (Cave Bath of Miskolctapolca, 2022)  |
| website of BIDL            | researchers, artists, students | (Bulgarian Iconographical Digital Library, 2022)   |
| Facebook                   | friends                        | Film destination Budapest (Márkus Z. L., Facebook - View of Budapest from the top of Szechenyi Chain Bridge with marks of filming locations, 2022) |
| Google maps                | travellers                     | (Guide Hand, 2022)   |
| <b>Mobile platform</b>     |                                |  |
| GUIDE@HAND apps            | tourists, researchers          | BOOK@HAND BIDL, GUIDE@HAND Esztergomi Vármúzeum  |
| <b>VR platform</b>         |                                |  |
| VR glasses                 | visitors                       | tourist information office in Miskolc, DIPP conferences  |

Publishing panorama pictures on Google Maps could reach an especially wide audience. SZTAKI added more than 100 panorama pictures to the Google Maps which were viewed more than 3.6 million times.

## 5 Virtual Walks

A virtual walk can be created by assembling several panorama pictures taken on different locations of the same site. The eLearning Department of SZTAKI has created a new service to present virtually walk around and interactively explore real spaces and special environments. High-resolution, 2D or real 3D and 360° spherical panorama pictures are taken of the target indoor or outdoor spaces to be explored. These pictures are postprocessed by a content editor developed by SZTAKI and can be accessed via a multiplatform (Web, mobile, VR) player on various devices.

The creation of the service “Virtual walk” was preceded by a multi-stage research-development project. This novel service exploits the state-of-the-art capabilities of the latest IT devices and satisfies the user expectations at a high level. The service was evaluated within various areas (industry, economy, education, science, tourism, and knowledge dissemination) and target user groups (addressing both younger and older generations) during the development.

The new service can be used both with 2D and 3D display devices. Although 2D displays are more widespread the virtual tour is especially spectacular on 3D displays. Even 5-6 rooms/parts can be nested together to accommodate the virtual walk whereas an interactive map can facilitate the orientation. The movement between the rooms and the interaction within a room is determined by the control facilities of the applied display. In case of computers, the control is represented by the keyboard and the mouse.

The novel service can be applied for several purposes depending on the specific needs:

- presenting locations hard to reach;
- presenting environments requiring special clothing or imposing strict local rules;
- presenting locations where persistent work largely restricts visits;
- presenting temporarily available contents;
- adding multilingual, complementary multimedia contents to present real environments in a more detailed, diverse and novel way;
- exploring remote locations from a distance.

A virtual walk is created for the Church of Nativity (SZTAKI, Church of the Nativity - Virtual Walk, 2022). It contains panorama pictures both outside and inside of this church.

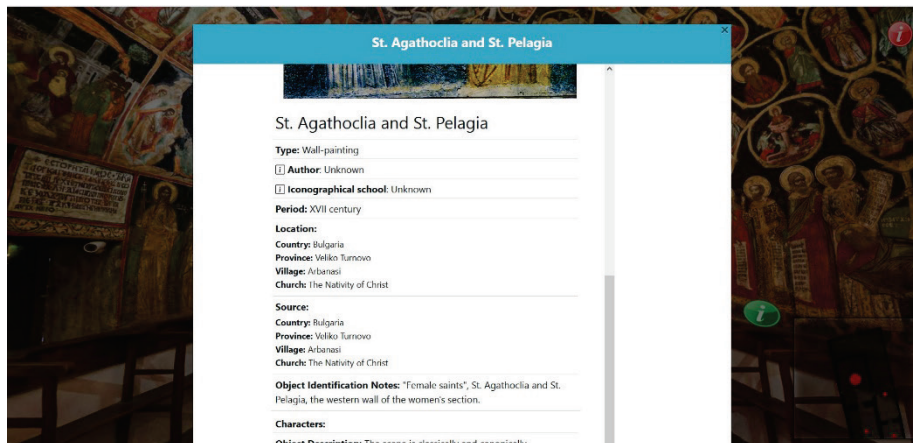
## 6 Integrating Virtual Walks with BIDL

The panorama pictures were integrated with the BIDL database with the help of hotspots. The hotspots are placed at the selected icons of the virtual walk.



**Fig. 2.** The green hotspots are placed at the selected icons which are existing in BIDL database

By clicking on a hotspot, the image and description of the icon in BIDL is online presented in Bulgarian and English.



**Fig. 3.** A presentation of the image and the description of the icon in BIDL by clicking on the hotspot

The virtual walk presents additional information not only on icons from the Church of Nativity in Arbanasi but on other icons stored in the BIDL with similar content from other churches. The icons selected from other churches represent the same characters or scenes as the icon at the hotspot in the virtual walk.

There are two kinds of hotspots with links to the BIDL:

- hotspot with one link to the icon in the BIDL;
- hotspot with one or more links to the additional information in BIDL.

BIDL contains a collection of twenty wall-paintings from the Church of the Nativity in Arbanasi.



## 7 Evaluation

Due to the cultural, touristic, and sacral significance of the location, several panorama pictures, and virtual tours (Arbanasi Nativity Church Virtual Tour, 2022) (Google, 2014) were created on the Church of Nativity in Arbanasi. Compared with the existing panorama pictures and virtual tours, the main benefits of our virtual tour solution are as follows:

- high quality panorama pictures;
- integration with BIDL;
- own player that can be customised and further extended;
- hotspots for various contents:
  - the icon located on the panorama picture; one icon description in BIDL for a hotspot;
  - icons with similar topic to the icon located on the panorama picture; multiple icon descriptions in BIDL for a hotspot.
- multilingual.

## 8 Conclusions and Future Plans

Virtual walk represents an attractive way to present cultural and historical sites which can be created by assembling multiple panorama pictures. Virtual walk in the Church of Nativity in Arbanasi is created and integrated with BIDL to provide detailed information on icons painted on the wall of the church. We have several plans in the future regarding virtual walks:

- We submitted a joint project proposal on the domain of gamification. In case of favourable decision, we are going to extend the virtual walks with minigames.
- We created panorama pictures for several Hungarian churches. We are going to integrate them with external information through hotspots.
- We prepared a virtual walk for the Roman baths in the town of Aqua Calidea located in the ancient region of Thrace. The virtual walk could be extended with additional information in a similar way like we did for the Church of Nativity in Arbanasi.
- Our plan is to provide personalised content through the hotspots based on the user profile.

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