

Selma Rizvić, Aida Sadžak

Faculty of Electrical Engineering Sarajevo
University of Sarajevo, Bosnia and Herzegovina

Mohamed El Zayat

Faculty of Information Technologies
University Džemal Bijedić Mostar, Bosnia and Herzegovina

Borut Žalik, Bojan Rupnik, Niko Lukač

Faculty of Electrical Engineering and Computer Science
University of Maribor, Slovenia

INTERACTIVE STORYTELLING ABOUT ISA BEY'S ENDOWMENT

Abstract: Isa bey Ishakovic built in 1462 a tekke, public kitchen and accommodation complex in Sarajevo. It was dedicated to travelers and Mevlevi dervishes. Today there is a road and gasoline station at this location. The goal of this paper is to bring these objects back to public memory using interactive storytelling. 3D models of objects are incorporated in a real-time virtual environment. The surrounding terrain is constructed using a fractal terrain generation method. The user is guided through the environment by interactive story. The story presents each object and its purpose. Dervish ritual that was performed inside the tekke is presented by interactive computer animation. User evaluation shows the levels of immersion and presence felt by the visitors through qualitative user experience methodology. The user study results will prove that the interactive storytelling is a better form of cultural heritage virtual presentation than the non-interactive form (movie).

Keywords: interactive storytelling, virtual cultural heritage, immersion and presence, real-time virtual environments, augmented reality

1. Introduction

Information and communication technologies (ICT), particularly computer graphics, offer a great potential in presentation and preservation of tangible and intangible cultural heritage. As every cultural heritage object or site has a story about its history, purpose or a related event, storytelling has to be incorporated in a virtual presentation. Scientific research is still looking for the best methodology to associate storytelling with virtual environments. This paper explores the interactive storytelling concepts and their influence to the users' perception of virtual cultural heritage.

Sarajevo Graphics Group (SGG) was founded in 2005 at the Faculty of Electrical Engineering in Sarajevo. Computer graphics researchers, together with colleagues from the University of Bristol, UK, and a team of historians and archaeologists, created the first laser scanned model of *stećak* (engraved medieval tombstone) from Donja Zgošća and made the first virtual reconstruction of the cultural heritage object from Bosnia and Herzegovina [14]. Since then they have been working on virtual presentations of cultural heritage objects and virtual museums. In the last two years they are a partner in the EU FP7 Network of Excellence Virtual Museum Transnational Network V-MusT.net [4].

In last five years SGG has been actively collaborating with the GeMMA Lab from the Faculty of Electrical Engineering and Computer Science in Maribor, Slovenia. Laboratory for Geometric Modelling and Multimedia Algorithms (GeMMA) was established in 2000, at the University of Maribor, Slovenia. The lab's main research fields include computational geometry, LiDAR data processing, and data compression.

Motivation for the Isa bey's endowment project was the fact that some of the most important cultural heritage objects in Sarajevo have disappeared not only physically, but also from the collective memory. Isa bey Ishakovic was the governor of Bosnian province inside the Ottoman Empire. The document about his endowment from 1462 is considered to be the oldest written source mentioning Sarajevo. This document describes the objects he built and left for the public benefit after his death. The complex consisted of a tekke (house where dervish were performing their prayers and rituals), musafirhana (free accommodation for travelers), imaret (soup kitchen) and water mills that provided self sustainability of the endowment, having their income distributed for the maintenance of the complex.



Figure 1: Appearance of the Isa bey's endowment complex through history:
a. assumed in 1462; b. 19th century; c. today

There is no trace of these objects at the physical location today (Figure 1c). Uncontrolled building and destruction completely changed the appearance of the place. Even the citizens of Sarajevo do not know about the complex. We hope that the virtual presentation will bring back the objects and story about them to the collective memory.

2. The project

The first virtual presentation of the complex was implemented by the SGG in 2009. They created a web site with materials and photos of the tekke object, together with interactive 3D model (Figure 2) of the exterior and two interior spaces (semahana – room for the zikr ritual) and divan room (for conversation and relaxation of dervishes after the ritual). The project was extremely well received by the Bosnian public. Many people remembered that they heard about this object from their grandparents. Younger generations learned about the history of their city. Museum of Sarajevo linked the digital content of the project to their web site.



Figure 2: Interactive 3D model of the tekke, 2009

Rekindled interest of the public for this object motivated us to offer the answer to the question what exactly was happening inside the object. Therefore we created the virtual presentation of the zikr ritual in the form of animated digital story (Figure 3).



Figure 3: Computer animation of the zikr ritual in Isa bey's tekke, 2011

In search of the best digital storytelling concept that will make the users “present” in the virtual environment, we created the interactive animation where the user is positioned in the middle of the ritual. Qualitative analysis of interviews with users showed that they preferred the interactive form over the movie [6]. Finally, we created the virtual presentation of the whole complex as a real time virtual environment that contains the audio stories about its parts and links the interactive animation of the zikr ritual [7].

3. Interactive digital storytelling

“Digital storytelling is narrative entertainment that reaches the audience via digital technology and media.” [10] Miller states that digital storytelling techniques can make a dry or difficult subject more alive and engaging to the viewers.

In order to improve the classical storytelling concept, Glassner defined interactive storytelling as a two-way experience [5], where “the audience member actually affects the story itself”. Manovich also introduces the possibility for audience to change the story and offers the concept of an interactive narrative as “a sum of multiple trajectories through a database” [8].

While introducing digital storytelling in our virtual cultural heritage applications, we explored various concepts of interactive stories. The first was the concept of “story guided virtual museum”, implemented in the Sarajevo Survival Tools project [12]. The digital story provides the user with the historical context of the siege of Sarajevo 1992-1996, guides him/her through the virtual museum of the objects created by the citizens during that time. These objects enabled them to survive 1425 days without running water, electricity, heating

and with very poor assortment of food. Virtual exhibition is divided in thematic clusters (Figure 4) and the story connected those clusters. The project achieved great success and since December 2010 the web site had over 300,000 views.

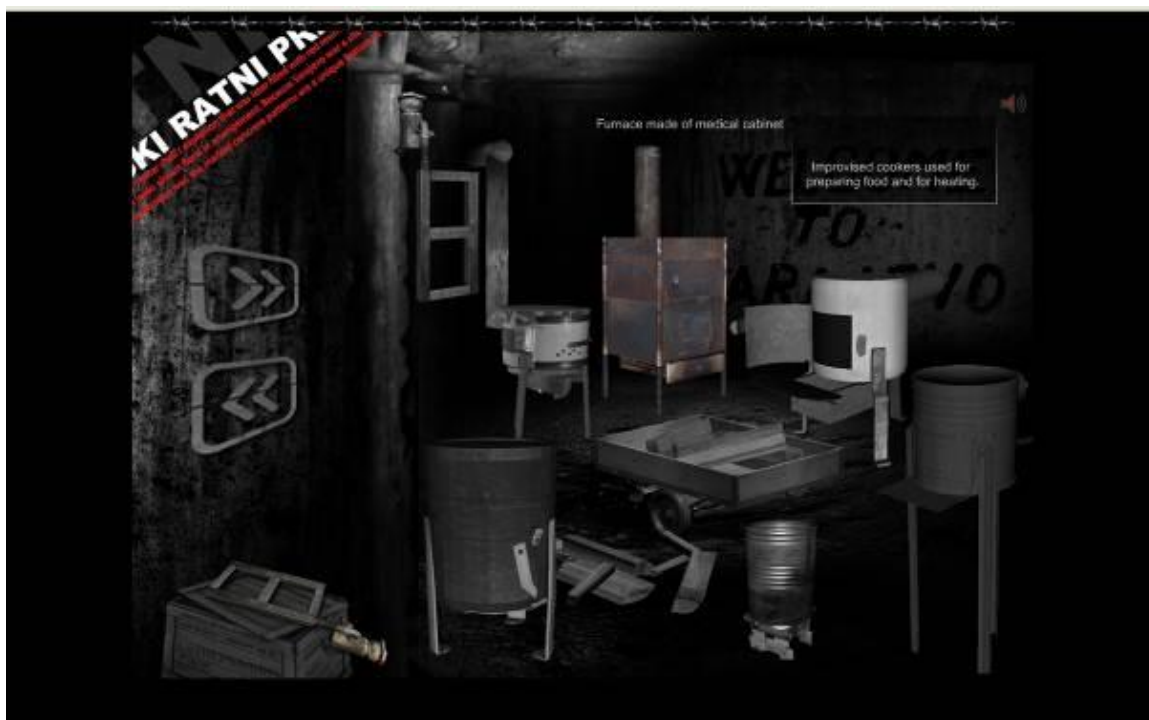


Figure 4: Virtual exhibition of improvised cookers, Sarajevo Survival Tools virtual museum



Figure 5: Audio guided virtual museum of the Bosniak Institute

The second concept we introduced and evaluated through user studies was the concept of audio guided virtual museum [13]. Here we implemented the audio stories to guide the visitor through the virtual collection of the Bosniak Institute exhibits (Figure 5). The user study has shown that visitors were so focused on the story that they have not noticed that movement through 3D environment was not enabled, but they could move only through clicking on hotspots in the pre-rendered images.

The third experiment with interactive digital storytelling was the computer animation of the zikr ritual in Isa bey's tekke [6]. The animated virtual environment was exported to Unity (a cross-platform game engine used to develop video games for web plug-ins, desktop platforms, consoles and mobile devices) and adjusted to place the user in the middle of the animation. The user observes the dervish ritual going on around him/her and has a possibility to explore in more detail the highlighted elements. Here the main story is happening in the ritual room semahana and sub stories are connected to highlighted elements and activated on mouse click (Figure 3). After the activation the sub story is implemented as a movie.

The last improvement of our interactive storytelling concept was implemented in the Isa bey's endowment project and united the interior animation of zikr ritual with the exterior virtual environment consisting of the tekke, musafirhana, imaret and water mills. The main story about the endowment and sub stories about particular objects are realized in the form of audio stories in the corresponding areas.

4. Case study – Isa bey's endowment

Based on the consultations with the expert historian and his sketch of the assumed appearance of the Isa bey's endowment complex (Figure 1a), we created the interactive virtual environment with storytelling. The goal of the project was to offer the visitor as much information as possible on cultural heritage objects that do not exist any more.

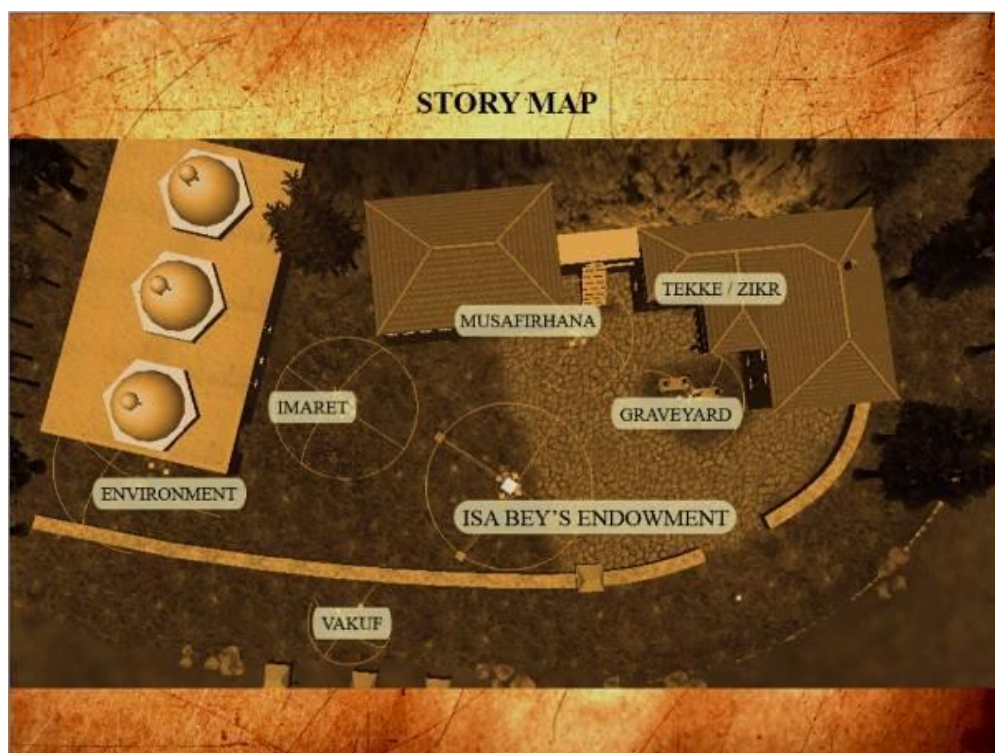


Figure 6: Story map of the exterior virtual environment

4.1. Digital storytelling concept. Digital storytelling in the exterior virtual environment consists of the main story, describing the history and purpose of the whole complex, and sub stories, describing in more detail the particular objects, such as musafirhana, imaret, watermills, natural environment, graveyard and the waqf institution. Sub stories are activated when the visitor approaches the info signs and they stop if the user moves away. In that case, the main story resumes from the point when it was interrupted for listening to sub story. All stories are audio files and they can be also activated using the story map (Figure 6).

When the visitor approaches the tekke object or selects it from the story map, interior virtual environment is loaded. It is the interactive computer animation of the zikr ritual, already mentioned in Sections 2 and 3, adjusted for this project. In this environment there is also the main story and sub stories, organized as presented in Figure 7a. This storytelling concept is different from the exterior one in the activation and implementation of sub stories. Here they are activated by mouse click on objects that are highlighted after being mentioned in the main story and implemented as movies. Figure 7b shows that the mihrab object is highlighted.

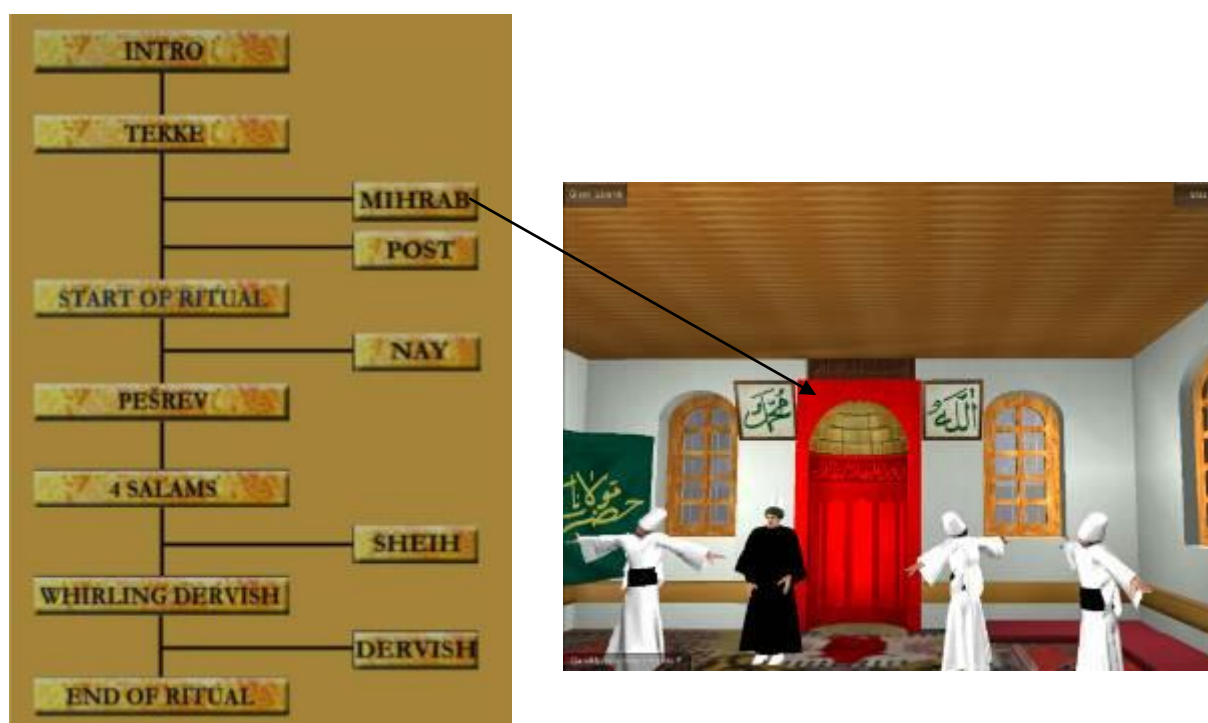


Figure 7: Digital storytelling structure in the interior virtual environment
a. Story map; b. Highlighted object mihrab

4.2. 3D modelling. The exterior virtual environment is mainly based on the concept art shown in Figure 1 and several reference images of different tekkes at different locations in Bosnia. After a careful study of the environment from the reference images and combining it with the concept art, it became possible to approximate environment's aesthetics. Autodesk Maya, Cinema4D were utilized in modelling and texturing, while Adobe Photoshop was used for creating and adjusting the textures.

4.3. Terrain generation. The terrain surrounding the model is mostly uneven, with a steep hill as well as a river. Fractal terrain generation provides a means for modelling mountainous surfaces [13], which is the case of this particular area.

The method is based in midpoint displacement [9], starting by selecting the central point of a flat surface, and displacing it on the height axis by a random value of a predetermined interval. By displacing the point, the initial surface is subdivided into four new surfaces, on which the procedure is then repeated in the same manner until the desired resolution is achieved. The final surface depends on the initial height displacement as well as on the smoothing in the next iterations, meaning that for each newly generated surface, the interval for selecting the random height displacement is reduced. A higher smoothing factor creates even terrains, while a lower one generates rougher surfaces. The riverbed is incorporated into the terrain model by manually lowering the height values at its position to the minimum. This also requires additional handling of the direct riverbed neighbourhood to repair overly steep walls that can appear. The height map of the generated terrain can be seen in Figure 8.



Figure 8: Terrain height map

4.4. Interactive virtual environment. The story about tekke is divided into seven separate yet connected stories. Each story tells about a certain location inside the endowment complex. As a consequence, each story is placed inside an activation area. Figure 6 shows the map of the exterior environment, including the radius of each activation area. Once the user starts the interactive environment, the main story starts; if the user is detected inside one of these activation areas, a trigger is launched to pause the main story and start the sub-story of the activated area.

Once the user leaves the activation area, a trigger is launched to resume the paused main story. Additionally, the sub-story pauses if the user left the area in the middle of the story, in case there is a need to continue the sub-story later.

5. Initial user evaluation

In order to start the user evaluation of the project, we selected 10 users, researchers from the GeMMA Lab in Maribor. It is important to note that these users are not Bosnian, so they are

not familiar with the historical facts about the complex. All of them are programmers and experienced in computer games.

For evaluation we used the qualitative user experience methodology and performed interviews after the users explored the project. Every participant was asked to measure the time spent in the virtual environment and write down his/her subjective perception of time. They were also asked to compare the storytelling implementations of exterior and interior environment.

The results of this user study have shown that all users appreciate this form of cultural heritage presentation. This way they were able to learn about Bosnian tangible and intangible cultural heritage, as well as the institution of waqf implemented all over the Islamic world at that time.

Most of them prefer the digital storytelling of the interior virtual environment. They claim to be confused by the exterior digital storytelling, as they would lose the context of the main story when interrupting it with sub story. The subjective time was for all participants longer than objective, so the virtual environment was not immersive enough. They found the story map very useful in both environments.

Here are some comments on the technical implementation of the project:

- looking directly down reveals a sphere instead of a model
- audio depends positionally on the info mark, it would be more appropriate to be positional depending on an environment
- in the interior it is not clear how to move from one event to another (“I am not sure if I discovered all things”)
- subtitles could be useful
- mouse was not working
- audio overlapping (multiple sources at the same time)
- mouse cursor slightly annoying
- unclear what info corresponds with which info sign
- mouse rotation oversensitive.

The initial evaluation shows us that we should modify the exterior storytelling concept. We plan to introduce the main story as intro that offers an overview of all presented content. That way the users would know what to expect and what to explore.

Next evaluation phases should be conducted on Bosnian users, users of various ages and backgrounds and users with no experience in computer games.

6. Augmented reality implementation of the project

The next step of the project is displaying the virtual environments on mobile devices using the technologies of augmented reality (AR). Augmented reality is a synonym for direct or indirect display of actual surroundings on portable computer devices, where computer generated contents such as text, images, sound, animation and 3D models are inserted [1]. Using advanced AR (computer vision, object recognition) the information of actual surroundings becomes interactive and usable in digital form. Information about the surroundings and objects in the vicinity can be displayed as layers over the actual world.

A possible way of using AR technologies represents mobile AR [3]. In this case we use a camera on the mobile device for selective access to virtual content. For a prototype application we will develop program support for an AR platform that will include:

- intelligent mobile device
- acquisition of location information by GPS, compass and accelerometer
- tracking and processing of the image acquired by the camera of the mobile device

- comparison to the original model
- generation of the virtual background
- display of virtual contents.

For the display of virtual content we will apply a suitable rendering engine [2]. Based on input data acquired by the AR platform, the rendering engine will display virtual content over the actual information. We will use it for automatic refreshing of the display during the movement of the user and camera.

7. Conclusion

Virtual cultural heritage applications contribute to preserving the past in collective memory. User evaluation shows interactive storytelling as efficient way to present cultural heritage. The best digital storytelling methodology that would enable users to feel “present” in the virtual environment and transferred to different time period still remains to be found. That form should offer information in an attractive way, so that interaction would enhance the immersion of the user. It should also be portable to all available platforms, from desktop, laptop and mobile devices to digital content installations in museums and AR applications on site.

References

- [1] Azuma, R. *The Challenge of Making Augmented Reality Work Outdoors*. In *Mixed Reality: Merging Real and Virtual*, 379-390. Springer-Verlag, 1999.
- [2] Bueno, M., Teichrieb, V., Kelner, J. *Illumination Techniques for Photorealistic Rendering in Augmented Reality*. SVR, 2008.
- [3] Chai, L., Hoff, W., Vincent, T. *3-D Motion and Structure Estimation Using Inertial Sensors and Computer Vision for Augmented Reality*. Teleoperators and Virtual Environments, 2005.
- [4] *EU FP7 Network of Excellence Virtual Museum Transnational Network V-MusT.net*, 2013. Available at: www.v-must.net
- [5] Glassner, A. *Interactive Storytelling*. A. K. Peters, 2004.
- [6] Huseinović, M., Turčinhodžić, R. *Interactive animated storytelling in presenting intangible cultural heritage*. Central European Seminar on Computer Graphics, Bratislava, Slovakia, 2013.
- [7] *Isa bey's endowment project*, 2013. Available at: <http://h.etf.unsa.ba/unity/TekijaProject/WebPlayer.html>
- [8] Manovich, L. *The Language of New Media*. 1st MIT Press pbk. ed, Cambridge, Mass., 2002.
- [9] Martz, P. *Generating Random Fractal Terrain*, 2008. Available at: <http://www.gameprogrammer.com/fractal.html>
- [10] Miller, C. *Digital Storytelling*. Elsevier, 2008.
- [11] Musgravet, F. K., Kolb, C. E., Mace, R. S. *The Synthesis and Rendering of Eroded Fractal Terrains*. Computer Graphics, vol. 23/3, 1989.
- [12] Rizvić, S., Sadžak, A., Hulusić, V., Karahasanović, A. *Interactive Digital Storytelling in the Sarajevo Survival Tools Virtual Environment*. SCCG 2012, ACM Digital Library.
- [13] Šljivo, S. *Audio Guided Virtual Museums*. Central European Seminar on Computer Graphics, Bratislava, Slovakia, 2012.
- [14] *Virtual 3D Reconstruction of Cultural Sites Heritage in Bosnia and Herzegovina*, 2005. Available at: <http://projects.etf.unsa.ba/~unesco/>