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Story Guided Virtual Cultural Heritage Applications

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Abstract

Virtual cultural heritage applications, particularly virtual museums, nowadays include various forms of storytelling. Every object, site or artifact is better perceived and understood through the adjoining story. Interactive applications naturally request the storytelling to become interactive as well. This paper describes the concepts of interactive digital storytelling in our virtual museums and cultural heritage presentations and discusses their advantages and drawbacks recognized through user evaluation. We used digital stories not only to introduce visitors with the context and information on the objects, but also to enhance their navigation through virtual environments with purpose of learning and perceiving maximum amount of offered information.

Key Words

Digital Storytelling, Virtual Cultural Heritage, Virtual Museums, Interactive Storytelling, Qualitative User Experience

I. INTRODUCTION

Tangible and intangible cultural heritage presentation and preservation is nowadays significantly enhanced using information and communication technologies (ICT), particularly computer graphics and multimedia. Applications range from virtual presentations of objects that do not exist any more or important archeological remains, to serious games for cultural heritage and virtual museums. Physical museum exhibitions are increasingly combined with digital content. Museums offer various installations for various groups of visitors, according to their age and interests. All of these applications are impossible without storytelling. The question is: what is the most appropriate form of storytelling to be used for this particular purpose, with the goal to immerse users in the past and enable them to learn the maximum amount of the presented information. This paper offers some answers concluded from our experience.

Most virtual cultural heritage applications are interactive. Practice has shown that users prefer to interact with digital content over being just passive observers/viewers of a movie or pre-rendered installation. We have been exploring whether digital storytelling could also be implemented as interactive,

and up to what amount of interactivity, without the user losing the context and thread of the story. In this paper we will chronologically present our work in this field through descriptions of the following projects and their user evaluation, showing how we adjusted our methodology in order to achieve the most satisfying user experience and convey the maximal amount of information about tangible and intangible cultural heritage.

In virtual museums many exhibits are offered to visitors. Our experience from the "Virtual Museum of Traditional Bosnian Objects" project has shown that they do not visit all exhibits, but after a certain number get tired and leave the virtual environment. Therefore, in the "Sarajevo Survival Tools" project, we introduced a digital story to guide visitors through the virtual museum, confirming the concept through user feedback. Even audio stories can guide the users through museum collections. If they are attractive enough, users will not notice the lack of 3D movement ability, as we have proven through the user evaluation of the "Bosniak Institute Virtual Museum" project.

Computer animation is a very appropriate technique for presenting intangible cultural heritage, such as crafts, rituals, dances etc. Our case study of Mevlevi dervish ritual in Isa bey's Tekke adds interactivity to this technique, placing the user inside the animated scene and enabling him/her to interact with certain objects and tailor the story according to his/her interest.

Interactive storytelling can also be implemented through the spatial movement of the user in the virtual environment, so that his/her position towards certain points of interest triggers corresponding parts of the story. This concept will be presented through description of the "Isa bey Endowment" project.

Finally, we will present the "Virtual Museum of Genocide upon Bosniaks" project, still under development. The concept of digital storytelling, implemented in this project, will implement all lessons learned in the previous projects through a recursive interactive story guided virtual cultural heritage application.

Two of the presented projects, "Sarajevo Survival Tools" and "Virtual Museum of Genocide upon Bosniaks" belong to a relatively new category of darker tourism VMs, a growing phenomenon which allows virtual visits to sites of death, disaster and tragedy, Kaelber (2007). We believe that our experience could contribute to the development of methodology appropriate for the efficient presentation of such topics.

II. RELATED WORK

Virtual Museum Transnational Network (see V-Must.net, 2013) defines a virtual museum (VM) through the following statement: "A virtual museum, in a real or virtual space, exists if there is a focus on tangible or intangible heritage, real or virtual, linked by a communication system, and it is used in various forms of interactivity and immersion, by the public for the purpose of education, research, enjoyment, enhancement of visitor experience or promotion", Ferdani et. al, (2013). In our search for the best implementation of interactivity and immersion we studied various implementations of virtual cultural heritage applications.

The VR museum of Inuit culture, see Ivory (2010), contains 2D images, 3D artifacts to view at 360 degree in QuickTime Virtual Reality (QTVR), video clips including archival film footage about how the exhibits were produced and used, video conversations with elders, narrations and transcriptions. The Virtual Hampson Museum offers

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a range of 3D presentations of artifacts available for download in VRML, 3D PDF and OBJ format in both high and low resolutions (Smallwood et al. 2006). In the virtual world of Eternal Egypt, see Tolva and Martin, (2004), visitors are offered different multimedia features for exploring, such as: a collection of high-resolution zoom-able pictures, virtual recreations of famous Egyptian sites, 3D views of artifacts, 360 degree interactive panoramic views of locations in Egypt, animations helping to illustrate and explain artifacts, and web cameras providing up-to-date interactive views from certain locations in Egypt.

The State Museum of Auschwitz-Birkenau offers a virtual tour of Auschwitz/Birkenau (Auschwitz, 2010) through either QTVR or Flash panoramas, with a textual explanation provided on the side. This website is an example of darker tourism VMs (Kaelber 2007). The "Siege of Sarajevo: Interactive chronology project" represents an "interactive timeline that depicts the most important events, experiences, personal stories and developments that occurred during the Siege of Sarajevo between March 1992 and March 1996. The user can scroll through a 3D timeline and engage with interactive content by clicking on one of 987 icons. Each icon represents a particular theme, event, topic and/or personal experience that occurred within a particular month/ year." (Fama Collection, 2005) However, navigation through this remarkable amount of content is, in our opinion, not solved in the most user friendly way. The content is cross-referenced so it is possible that the viewer will get lost and lose the thread of the story. Also, considering the enormous amount of material, it is very unlikely that anyone will see all the content presented in the project. Srebrenica-mapping genocide project (Srebrenica, 2012) is another example of the use of digital storytelling and multimedia in presenting horrific war events in Bosnia and Herzegovina, particularly genocide upon Bosniak Muslims in Srebrenica in July 1995, when over 8000 civilians were executed in the UN protected zone. The project contains 17 animated maps. The maps are organized in chronological order and in line with the methodologies adopted by institutions collecting and archiving documents related to Srebrenica genocide and genocide in general - as identified by a number of respectable studies. Each map has key points containing particular evidence (text files, photos, video clips). The authors of the project call this form of digital storytelling "a documentary animation".

There are several more examples of how some VMs have expanded their presentations with virtual environments. In addition to digital archives of paintings and calligraphies, antiquities, books and documents, the National Palace Museum holds a virtual replica of the exhibition hall containing virtual map presentations of the museum, digital stories and panoramic images with hotspots where the visitor can get more information on particular objects (sometimes including an audio guide), as well as a suggested virtual tour for children (Lai and Lin, 2006). The Virtual Museum of Iraq presents eight virtual thematic halls, set up in chronological order. It contains a selection of artifacts that are representative of the phase in question; each phase is presented through different formats: information sheets, three-dimensional models that can be rotated by the user, brief videos and films with animations and reconstructions (Cultraro et al, 2009). The Inuit 3D virtual museum (Canada et al, 2002) is an interactive VRML exhibition of Inuit art and objects, containing three exhibition rooms to navigate through, and twelve interactive 3D models of objects in VRML format. Introductory videos are presented at the entrance to each room. Pop-up text panels provide additional information on the objects. The Virtual Smithsonian tour (Jones, 2002) allows visitors with high bandwidth to take a virtual, audio

guided, room-by-room walking tour of the whole museum. The visitor can navigate from room to room and explore hotspots with artifacts that rotate in 3D and morph into other artifacts, high resolution images, video and audio clips, and more. A few more examples are: the Smithsonian Latino Virtual Museum (LVM) (LVM, 2010) with an avatar-guided 3D virtual learning environment and the Van Gogh Virtual Museum (Galani, 2003) with another unique opportunity of entering into a virtual conversation with other visitors.

In order to extend and evolve their relationship with visitors, museums need to develop a holistic view of the audience journey across both the physical and virtual spheres (Barry, 2006). From that point of view, what distinguishes our VM concept (Section 4) from those described is a story that helps visitors to learn about and explore exhibits in a carefully designed order and presentation style. We believe that this digital story guidance will increase their sense of immersion in virtual space and encourage them to explore more objects. The basis for this idea comes from a number of studies that showed how different forms of mediations (audio and visual) in virtual environments can increase the users' feeling of presence and make them more involved and interested in exploration (Murphy and Pitt 2001; Brown et al. 2002; Walker et al. 1999).

One of our concepts, described in Section 5, offers audio story guidance to the virtual museum visitors. The motivation for introducing such concept came from the "Anne Frank Secret Annex" virtual museum (Anne Frank Museum, 2010). Visitors of that museum are able to virtually walk and move around the panoramic 3D rendered photos of rooms in the house, where the Frank family and other Jews lived and hid during WWII. Beyond the ability to explore the house in detail and to click on various extras with additional information, such as text or films, visitors can hear a series of stories, accompanied with ambient sound and music, that explain what happened to the people in hiding. These audio narrations bring Anne Frank's life story to people's attention all over the world. They are based on the stories from Anna Frank's famous diary and reports of witnesses from the Anne Frank House archives. We also studied other virtual museums with audio stories such as The National Palace Museum (Lai et al, 2006). It has an exhibition hall guide for the antiquities in one of their permanent exhibition halls called "The Treasures of Eight Thousand Years". The exhibitions present antiquities from different historical periods (beginning from 6,200 B.C.) organized in a number of exhibition rooms. Each room has an audio guide and video story illustrated with old photographs and sometimes with 3D animations as well. The rooms are implemented as movable panoramic photographs of halls. The Virtual Smithsonian (Jones, 2002), mentioned before, also includes audio tours.

Finally, storytelling is also introduced in virtual cultural heritage applications that could not be classified as virtual museums. The main problems are how to make it interactive and how to trigger different parts of the narrative.

The research project "Virtual Heritage Tours: Developing Interactive Narrative-Based Environments for Historical Sites" is about Nottingham's cultural heritage (Tuck et al, 2009). Users can choose the road they will take and they feel as though they are a part of the examined environment and not just a passive audience. They can move around, view the action and sometimes interact with it. The story is not linear but a narrative coherence still exists. The narratives are triggered as the users approach an object.

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In (Pietroni and Antinnuci, 2010) a virtual environment was created from Giotto's scene "The Rule Confirmation". This scene is presented in 3D. Characters in the scene are mapped by Giotto's original fresco models. In this project, two virtual reality installations have been implemented. In the first one the visitor can virtually enter into Giotto's fresco. The characters are animated and shown while performing the actions painted by Giotto. The main goal is to involve the visitors in the 3D scene. In the second installation the user is able to interact inside the 3D scene, changing the view point in real time. The user can also directly compare the 3D scene and the 2D image by Giotto. When there is no visitor in the room, a simple animation shows Giotto's fresco in 2D with its translation in 3D. Then a short movie starts; when it ends the 3D scene becomes animated. Visitors are able to interact inside the virtual space by moving in the real space using a natural interface. We implemented the concept of placing the user inside a computer animation in the project described in Section 6.

III. WHY STORY GUIDED VIRTUAL MUSEUM?

The Virtual Museum of Traditional Bosnian Objects project (Rizvic and Sadzak, 2010) is a digital representation of the exhibition from the Museum of Sarajevo, dedicated to the history of the city and the different religions and cultures that have been living there for centuries, coexisting and preserving their unique identities. The virtual exhibition consists of a central virtual environment (Figure 1), where particular exhibits are presented in the form of panels. The user can move through this environment and select the desired panel. After that, a web site of each exhibit opens and offers information about the object, presented through text, photo gallery, digital story and interactive 3D model (Figure 2). The digital story introduces the visitor to the purpose and history of each exhibit and adds a dimension to the exhibition that is not achieved in the physical museum. The interactive 3D model enables the user to interact with the object, turning it around and exploring its details. This is also not possible in the physical museum.

The virtual museum contains 83 exhibits. User evaluation has shown that the project was appreciated and visitors learned a lot about the history of the city through this exhibition. However, we noticed that the majority of users visited only a small number of the presented artifacts. After some time they would get tired and leave the environment. Also, the objects were not classified into any particular groups within a common context, nor was the overall context of the exhibition explained through an introductory story. That was the reason we started to explore how to motivate the user to visit, if not all, at least most of the exhibits and to learn about their context and common background.

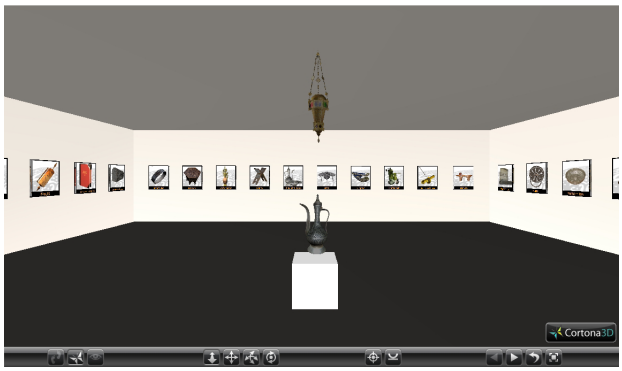

Fig. 1. Central virtual environment, Virtual Museum of Bosnian Traditional Objects

Fig. 2. Virtual Museum of BH Traditional Objects, presentation of Ibrik and Ledjen.
Left to right: text, photos (top); movie, interactive 3D models (bottom).

IV. STORY GUIDED VIRTUAL MUSEUM – SARAJEVO SURVIVAL TOOLS

The siege of Sarajevo started on 4th April 1992 and lasted for 1425 days. It was the longest siege in modern history. The Historical Museum of Bosnia and Herzegovina hosts an exhibition of objects created by citizens of Sarajevo in order to survive without running water, electricity, gas and with a reduced amount of food (Figure 3). As survivors of the siege, we noticed that some element was missing, something that would allow the visitors who come to this exhibition to perceive the real horror of these events. With the addition of the sounds of explosions, snipers, anti aircraft guns and the presentation of the historical context of the war in Bosnia and Herzegovina, as well as the stories told by each improvised object, the atmosphere of the daily life of Sarajevo citizens would be better understood and shared with the general public. Sarajevo Survival Tools Virtual Museum is able to combine all these elements through multimedia and reach not only the Historical Museum visitors, but any interested person through the Internet (Sarajevo Survival Tools, 2010). From December 2010 until now the web site of the project has had over 260 000 visits.

The first question asked by the majority of people who would like to learn about the siege of Sarajevo is: how did it all begin? Therefore we created a digital story to guide the visitor through the virtual museum and introduce him/her to the historical context. The story has an introduction and 11 thematic parts, ending with our message to the world and our wish that these events never happen to anybody again. The structure of the virtual museum is presented in Figure 4. After each part of the story, one of virtual exhibitions is displayed (Figure 5), where the user can select particular objects and view their photos, interactive 3D models and see the digital story about each of them.

The user can watch the stories and visit the virtual exhibitions sequentially or skip some parts, as well as activate them directly from the story map. The project and user evaluation is described in detail in (Rizvic et al, 2012). Here we will just point out some important inputs obtained through user studies.

Fig. 3. "Sarajevo Under the Siege" exhibition, Historical Museum of Bosnia and Herzegovina

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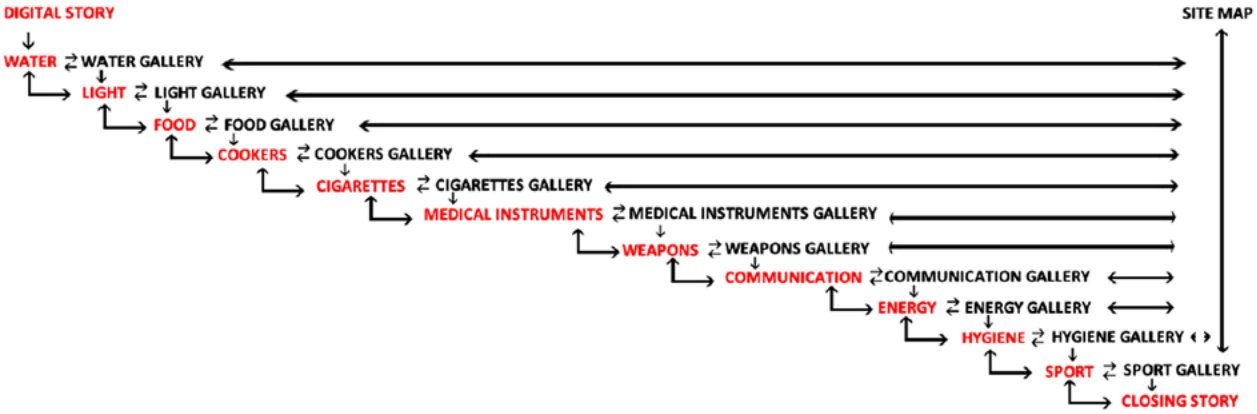

Fig. 4. Digital story segments and exhibitions in Sarajevo Survival Tools Virtual Museum

The project was evaluated through three studies with 63 participants in total (11 in the pilot study, 46 in the main study, while six participants were interviewed). In the pilot study the participants were asked to compare two virtual environments (the VM of Bosnian Traditional objects and Sarajevo Survival Tools VM) and fill in online questionnaires. In the main study, each participant evaluated only one VM. In this case, objective scores for both VMs were gained, allowing for further comparisons with other museums. In the third study the participants were interviewed after visiting the virtual environments, and the results were obtained using qualitative user experience methodology.

User studies focused on evaluation of the concept where the digital story guides visitors through the virtual museum, their feeling of immersion and information perception. The results of the pilot study indicated that interactive digital storytelling enhances the users' experience and motivates them to visit and explore more artifacts in the VM. One of the indicators of the efficiency of storytelling and users' engagement is given by the number of virtual objects visited in the VMs. Figure 6 shows that the visitors of the SST VM, containing a digital story, visited more objects than the users who visited the BTO VM without a story. This indicates that storytelling, used for guiding the user through a VM, motivates visitors to stay longer and see more exhibits.

Fig. 5. Cookers exhibit, Sarajevo Survival Tools Virtual Museum

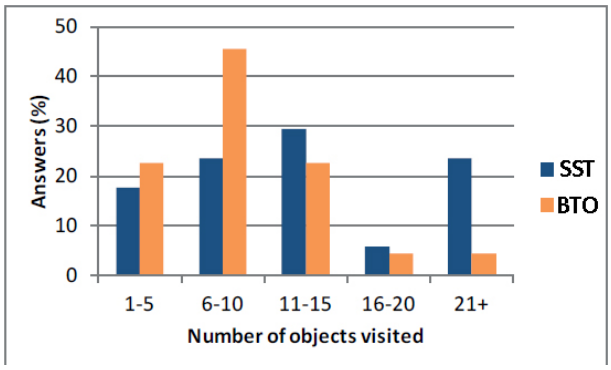

Fig. 6. Number of visited objects in both Sarajevo Survival Tools (SST) and Bosnian Traditional Objects (BTO) virtual museums

We support this thesis by the fact that the BTO and SST museums are similar in digital content, as they both present digitized physical exhibitions, with each exhibit presented through photos, interactive 3D model and a digital story. However, the main difference is that SST, through the story, offers the context of the exhibition and thematically guides the user through different sets of exhibits. Therefore, we believe that the story was the main distinguishing factor and its existence motivated users to visit more exhibits in the SST then in the BTO virtual museum.

The conducted open-ended interviews confirmed and enhanced these findings. The participants appreciated having the digital story to lead them through the museum but also advised the researchers to limit the amount of information and allow the user to easily "move" through the parts of the story.

V. STORY GUIDED VIRTUAL MUSEUM – BOSNIAK INSTITUTE

Our next step in exploring story guided virtual museums was implemented through the Bosniak Institute VM project (Šljivo, 2012). The motivation for this project was the Anne Frank Museum in Amsterdam, which has a virtual implementation, Anne Frank's 3D House (Anne Frank's 3D House, 2010). The audio stories in that museum were so engaging that we did not feel any need for moving around the environment. Therefore we decided to introduce an audio story guided virtual museum, where the environments will be implemented as pre-rendered images with hotspots, instead of real time 3D environments.

The Bosniak Institute in Sarajevo contains a library, an art centre, archive, collection of old manuscripts and old maps. There are also: a collection of Syrian furniture, a collection of furniture from the Safvet Bey Bašagić family (a Bosnian writer considered to be the father of the Bosnian Renaissance and one of Bosnia's most cherished poets from the turn of the 20th century), and also a collection of various items and furniture from Bosnian history and culture. The structure of the VM is displayed in Figure 7 and the virtual environment with hotspots representing the collection of virtual exhibits in Figure 8 (page 9).

The goal of our user evaluation was to explore whether audio storytelling can compensate movement limitations in a virtual environment. We conducted two user studies, one with questionnaires and one with in-depth interviews. The main goal of both user studies was to determine whether the audio storytelling was enough to guide the users through the VM collection, considering that they had no possibility to move through a 3D virtual environment.

The analysis of results was performed using qualitative analysis methodology and therefore no statistical calculations were used. Since practice has shown that 7 users will find approximately 80% of the problems in the graphics user interface (GUI) (Feng et al, 2010), we performed the user studies on 14 users in total.

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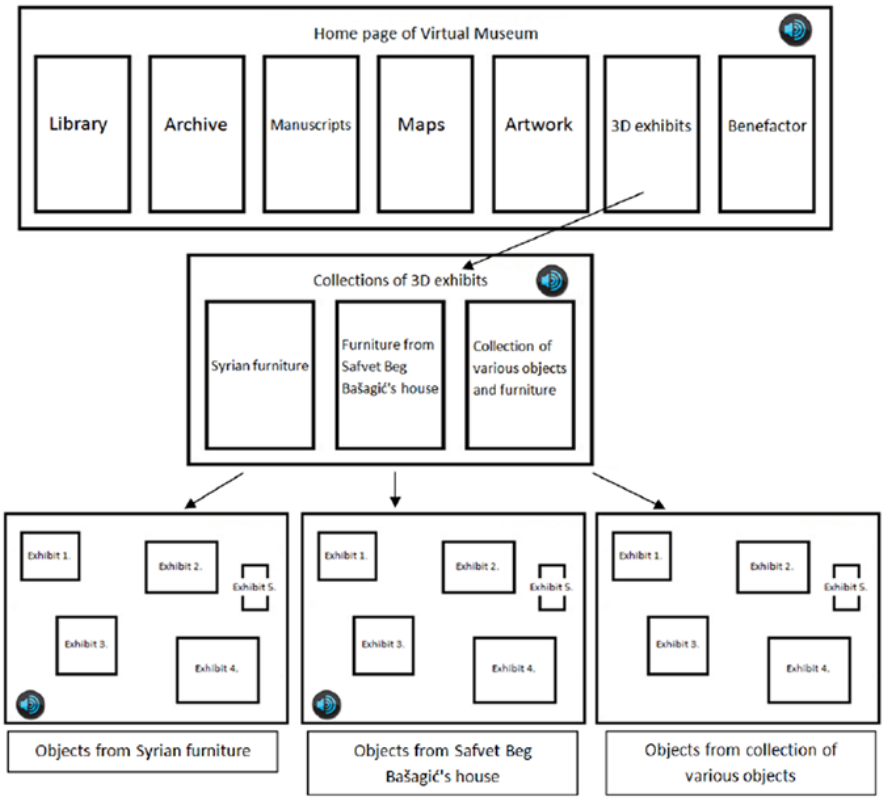

Fig. 7. Structure of Bosniak Institute Virtual Museum

Fig. 8. Virtual exhibits collection, Bosniak Institute Virtual Museum

The most important result of the study is that 11 out of 14 users did not notice that movement in the 3D environment was not enabled. To the specific question "Were you able to move in the 3D environment?" they answered positively. Most probably some of them considered movement to be changing the virtual environments using links, but however, they did not report problems with lack of movement abilities.

VI. INTERACTIVE ANIMATED STORYTELLING

Computer animation is a very suitable form for presenting intangible cultural heritage. There was a complex of objects in Sarajevo, that now do not exist any more and their historical value is in the fact that they are mentioned in the oldest preserved document about Sarajevo, the endowment document of Isa Bey Ishakovic, from 1462. The concept of endowment

was implemented in the Islamic world, enabling the rich and powerful to build and dedicate structures for public benefit. They would build mosques, schools, accommodation facilities, soup kitchens and similar buildings that would be free for the use of travelers, poor and common citizens. The sustainability of these structures would be secured by a percentage of the profit of the shops or water mills that would be also a part of endowment. Strict regulations about establishing, using and maintaining them would be written in the endowment document.

The previously mentioned complex contained a Tekke of the Mevlevi order where dervishes performed their rituals. We recreated the appearance of the Tekke in one of our projects (Rizvic et al, 2009), but users wanted to know what happened inside. Therefore we created a computer animation of a Sema dervish ritual and positioned the user inside the ritual room, with dervishes whirling around him/her. This interactive animation is described in detail in (Huseinovic and Turcinhodzic, 2013). Here we will just summarize the implemented interactive animated storytelling concept and user evaluation.

The story consists of the main story and sub stories. The main story is divided into parts playing sequentially one after another. Some objects related to the story are described in more detail through sub stories, activated when the user clicks on the object in question, higlighted by red color. After a substory is finished, the user is back to the current location in the main story. The structure of the interactive story is presented using the story map (Figure 9).

User evaluation was performed by comparing the interactive animation with its pre-rendered form. The materials viewed by the participants were divided into three categories. The first category included only the movie, the second only the interactive computer animation and the third category included both. Five people were involved in the first and second category and ten people in the third category. The evaluation was performed using qualitative user experience methods.

The results show that interactive form gives more participants the feeling of being inside of the observed object (immersion) than the movie. The participants preferred the interactive animation because (quoted from the answers):

- The participant can choose the direction of the story and can analyse the models from different angles.
- The participant can focus on certain details in the environment that the shots from the movie could not show (or only be briefly shown). The interactive form gives freedom to select certain parts of information the participant would like to listen to again.
- Active participation.

Fig. 9. Story map, interactive computer animation of dervish ritual

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The feeling of immersion is enhanced by the virtual characters, the participants in the ritual, twirling around the viewer. The ability to activate substories by clicking on a certain object or character from the virtual environment (Figure 10) made the users more comfortable with the exploration of the presented ritual.

Fig. 10. One of the clickable objects, highlighted red - mihrab

VII. SPATIAL INTERACTIVE STORYTELLING

Isa bey's endowment complex (Figure 11) mentioned in Section 6, which used to exist in Sarajevo, is virtually presented in a real time cultural heritage application (Rizvic et. al, 2013). The application contains two storytelling concepts, one described in the previous Section, and a spatial interactive story. The spatial concept is implemented for the exterior of the complex where the sub stories are triggered according to the position of the user. The story structure with proximity regions where sub stories are active is displayed in Figure 12.

Fig. 12. Spatial interactive story structure, Isa bey's endowment

During the initial user evaluation, the participants were requested to compare the interactive animation storytelling concept and spatial storytelling. The main difference between these two concepts is the way to trigger the start of the sub story. In the first one, the sub stories were triggered by clicking on the highlighted object in the scene, while in second one the user would start the sub story by approaching a particular object in the scene. The results showed that the users preferred the first concept. They found the second one quite confusing, would lose the thread of the story and had difficulties in navigation,

Fig. 11. . Appearance of Isa bey's endowment complex through history: a. assumed 1462;b. XIX century; c. today

as there were some spots in the scene where the stories almost overlapped. They also suggested adding a kind of summary of the presented content at the beginning, so the user would know what to expect and what to explore. They used the story map a lot in order to enhance the navigation and get the full picture of the offered content.

We plan to improve the spatial storytelling concept by introducing the mouse click activation of sub stories instead of proximity regions. The places where the sub stories can be activated will be marked by marker objects and those objects will be links to sub stories. We will also introduce an interactive introduction story, where the user will be able to see the content of the application and to choose what he/she wants to explore.

VIII. RECURSIVE INTERACTIVE STORY GUIDED VIRTUAL MUSEUM

Bosniaks are a nation of Slavic origin and Islamic religion. They live in the Western Balkan region, in the states of Bosnia and Herzegovina, Serbia, Montenegro, Kosovo and Macedonia. Some of them also live in Croatia and Slovenia and many of them in the worldwide Diaspora. The continuity of genocide over this small nation can be presented through 10 key time periods, from 1683-1992. The Virtual Museum project (Alispahic and Rizvic, 2013) aims to reveal these facts, covered up for many years by many regimes, to the general public and prevent such events from happening ever again to anybody.

The advantage of this form of presentation is the ability to show all kinds of documents (testimonies, movies, pictures, text, etc.) and the Internet visibility of the presentation. Later on, physical setups of the digital content will be built on the locations where genocide happened (if possible, considering the still unsolved political situation in the region) with exhibitions of physical artifacts about that particular location. This way we will build a network of physical museums connected by common digital content.

The core of the virtual museum will be organized as a set of interactive digital stories offering all types of users the corresponding level of detail (LOD) of the presented materials. Our user studies have shown that many users do not have enough time to spend in virtual museums and they sometimes come back to continue exploration. Therefore the content has to be structured in such a way that the initial LOD offers just a summary of the topic and enables the user to navigate deeper into the content by clicking on the offered links. The maximal LOD would support scientific researchers who are studying the topic and offer them links to libraries and books.

The draft structure of the digital storytelling concept is shown in Figure 13. The story starts with a brief presentation of the 10 key historic periods when genocide happened. The user will be able to go one LOD deeper by clicking on the links of each time period. Then a similar interactive story structure will be offered, related to the selected time period, describing in more detail the timeline of events. Every event can be accessed through its link, going one LOD deeper and offering materials such as testimonies, documents, images and videos of that particular event. At the bottom of the structure, every document will have references and meta-data about its source and origin and additional reading materials will be suggested to virtual museum visitors.

We named this concept recursive because every LOD of the virtual museum has the same structure. We are still working on the graphic user interface, considering the best multimedia technique to implement the concept. The main dilemma at the moment is between 3D real time environment and pseudo 3D, such as an image with hot spot

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hyperlinks. The drawbacks of navigation through real time environment were presented in the previous Section but we still think that for humans the 3D environment is more natural for navigation.

IX. CONCLUSIONS AND FUTURE WORK

The user feedback on the described projects shows that interactive digital storytelling represents a form with plenty of potential for virtual cultural heritage presentations. Users feel immersed in virtual environments and learn about the past. The key issues that should be taken into consideration are: not all users are ready to spend the same amount of time in virtual environments, so length of storytelling should be adjusted to several classes of users; virtual exhibitions should, in addition to artefacts, offer the historical context and common background of the exhibits; stories are a suitable form for guiding the viewer through the virtual environment, but they should be structured and triggered in a way which does not distract the user, make navigation problems or interrupt the thread of the topic; interactivity should be introduced in storytelling to an extent that does not prevent the user from grasping all the presented content.

In our future work, in addition to interactive storytelling concepts, we will also explore the methodology of creating the stories, from the narrative point of view, following up results presented in (Rizvic and Ferko, 2013), with the purpose to obtain the best narrative model for virtual cultural heritage and overcome the multiple limitations of back telling. We also plan to introduce non invasive methods in our user evaluation studies, such as virtual visit time measurement. Finally, we will explore the possibilities of translating traditionally 2D media such as novels into 3D, using a mix of different media together with web 3D tools and techniques.

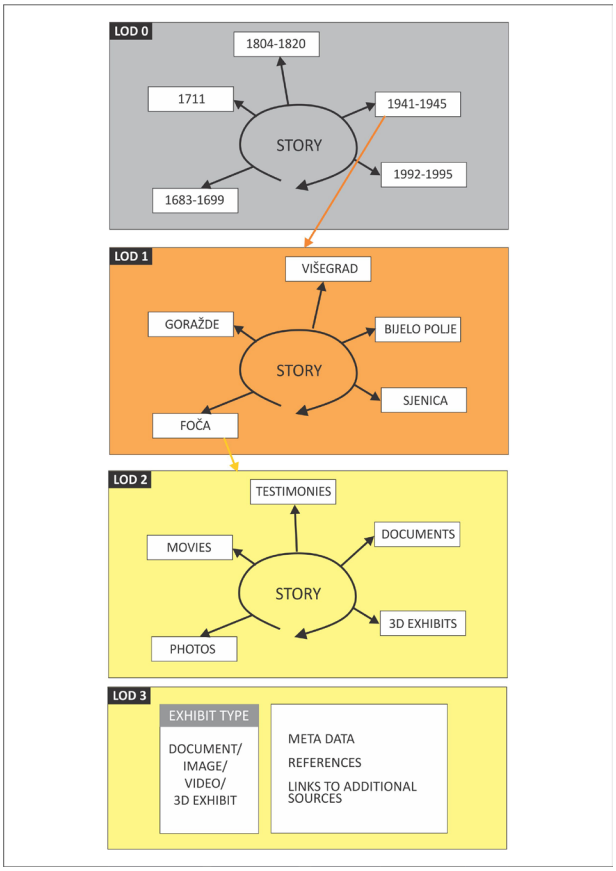

Fig. 13. Structure of the Virtual Museum of Genocide upon Bosniaks: LOD0 - intro with time periods; LOD1 – places of genocide 1941-1945; LOD2 – genocide in Foča, Eastern Bosnia; LOD3 – presentation of particular virtual exhibit

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