

Learning about prehistory through interactive digital storytelling

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Abstract— Archaeological sites from prehistory are very important for understanding humanity. However, they are very difficult to understand for common visitors. We see traces of excavations and fragments of archaeological findings, but we do not grasp their meaning. Interactive digital storytelling has potential to present the significance of these sites and make them attractive and educational at the same time. We will show this through the case study of Crvena stijena in Montenegro, presented in a Virtual Reality application. Through interactive stories, gameplay and digital replicas of archaeological findings the users obtain better perception of the physical site and are attracted to visit the museum.

Keywords— *interactive digital storytelling, digital cultural heritage, virtual reality, serious games*

I. INTRODUCTION

Since the beginning of mankind humans are telling stories. From gatherings around camp fires to modern internet media, storytelling was only changing form, not the essence. Social networks have provided every individual with opportunity to tell his/hers story using text, pictures, sounds, videos and all multimedia content combinations. Storytelling is considered to be a tool not only for entertaining, but also for learning, training and education [1]

As media became interactive, a new form of storytelling has become possible – Interactive Digital Storytelling (IDS). One of many definitions describes it as “use of digital media platforms and interactivity for narrative purposes, either for fictional or non-fiction stories” [2]. In IDS the user can influence the direction and outcome of the story. This kind of storytelling is characteristic for computer games. It also has ability to present a dry and large amount of information, such as historical text in a way that is suitable for modern receptors, with a very short attention span. We have followed the Guidelines for IDS [3] published on the free online knowledge exchange platform for interactive digital storytelling called Sarajevo Charter [4]. They contain a set of instructions for IDS creation in virtual cultural heritage applications, which elaborate the methodology for creating stories that will be educational and entertaining at the same time and introduce the viewers with cultural monuments in an attractive way adjusted to the modern media.

One of digital heritage projects we developed using IDS is Crvena Stijena VR. Motivation for this work was the fact that cultural heritage sites from prehistorical period are most difficult to understand for common visitors. Exploring the place where discoveries of paramount importance for

mankind have been made is often just roaming around excavations and browsing the small fragments of archaeological findings in a museum, without really grasping the life there in the past. In our research we want to show that the IDS and the Virtual Reality have a great potential to help users find out more about the cultural heritage, while being offered an entertaining and interesting user experience. We will demonstrate it on the example of Crvena Stijena VR application design, development and user experience evaluation.

The paper is organized as follows: in Related work we explore VR applications presenting prehistorical archaeological sites and discuss their advantages and drawbacks in comparison with our project. Section 3 describes the design of Crvena stijena VR application and considers the means to introduce the users with this important archaeological site. User experience section shows the experiment design and reports the results of a qualitative user experience evaluation we conducted. In Conclusions we present lessons learned and the path for future research.

II. RELATED WORK

The use of computer technology is not new in archaeology. The roots of the term “Virtual archaeology” can be traced to the beginning of 1990s. Digitalization of archaeological sites and monuments proved to be invaluable since it ensures long term preservation of those same sites and monuments [5] but can also help us understand how some objects were built [6] or sometimes show that we still cannot comprehend the level of engineering present in our past [7].

The potential for using Virtual Reality in digitalization of cultural heritage was recognized as soon as VR devices started appearing on consumer level. Different groups started making virtual environments for different locations [8] [9]. The level of immersion granted by these reconstructions is high and proves there is merit in furthering the research. Virtualization of places known to tourists [10] can enhance their visibility and broaden further research of cultural heritage. It also allows us to perceive objects that do not exist anymore in the most realistic way available to a viewer. As the author in [11] states “VR becomes a time machine and relies on visual realism”.

As we are aware, prehistoric sites are hardest for many people to visualise. Not many things are discovered and recognized from that time by archaeologists and for untrained

eye, lot of important things can be overlooked easily. Therefore, reconstruction of prehistoric sites is of great importance when talking about preserving cultural heritage [5] [12]. One must consider the limitations of the technology at our disposal in terms of computing power at the current time and that each year presents us with more and more possibilities. It is important however to document our steps for further research as shown in [13].

Exploiting the possibilities of VR can be enhanced by including the serious game component. This approach is still not massive but is showing potential in attracting users, especially younger ones, to play and learn about cultural heritage [14][15]. Combining presentational part with gameplay is something we strive to achieve. The third component that can be included are actors playing different roles related to cultural heritage sites to increase the level of amusement and improve storytelling [16].

III. APPLICATION DESIGN

Crvena stijena archaeological site is known to the public since 1950s. It is located in Petrovići village, near Nikšić, Montenegro. Crvena stijena contains 20 meters of archaeological strata originated from middle Paleolithic until the Bronze Age. Middle Palaeolithic strata, amazingly 10 meters thick, contain one of the largest and best-preserved Paleolithic sites in Europe. The site has been excavated since mid-20th century and it is extremely important for Balkans area.

Virtual Reality application (Fig. 1) aims to take the visitors to the past and introduce them with this important site in an amusing and educational way. Through digital stories told from the cave 3D model, the users find out about the most significant archaeological findings and life in prehistory. The

selected findings are digitized using photogrammetry and their 3D reconstructions have been created. They can be explored and turned around. After passing the quiz with questions from the stories, the user gets opportunity to experience the life in the past in the gameplay.

After language selection, the intro animation of historical development of our planet depicts creation of the rock formation where the site is located. The actress in the role of „Lara Croft“-like character introduces the user with the basic information about the site and its archaeological significance.

The user is then located in a virtual environment resembling a stylized cave and presented with a menu for selection of available application parts. Three digital stories cover the middle Paleolithic period and Neanderthals, younger Paleolithic and Mesolithic period, and Neolithic period with metal ages, respectively. The stories are VR video composites, with background image rendered from 3D reconstruction of the actual cave and the actress superimposed over it, together with related pictures and drawings.

After watching the stories, the user can visit the Tools virtual environment, where digitized archaeological findings are available for exploration. Unlike the physical museum exhibition, here the user can click on the finding and turn it into its 3D reconstruction, from which is understandable how the whole object used to look like. The objects can be grabbed and explored close by.

In order to access the gameplay (Fig. 2), the user has to correctly answer several questions related to the content of the stories. Then he/she gets the opportunity to hunt the deer at the lakeside below the cave using the spear found during excavations. User movement is conditioned by wind and if they move while wind blows the deer feels them and escapes. They need to reach the place where the spear is located, to

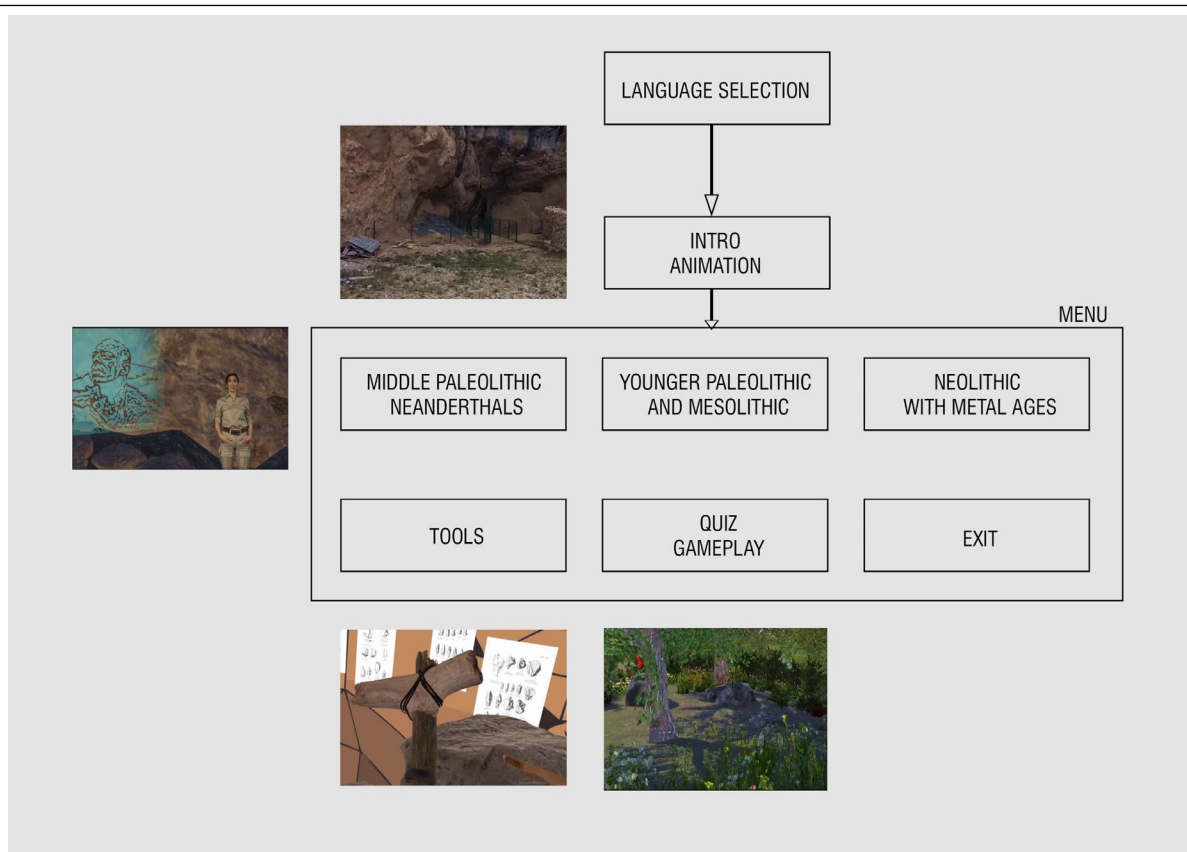


Fig. 1. Application structure

collect it and wait for the deer. The notification of deer approach triggers them to throw the spear and push the deer into a ravine. Failed attempts restart the gameplay.

IV. USER EXPERIENCE

This section describes the evaluation of the user experience conducted with objective to collect qualitative information on users' behaviour and to understand their specific behaviours, motivations, and attitudes.

The user research study included user engagement with all parts of the VR application but our focus was on exploring users': (1) interest in observing and interacting with exhibited prehistorical tools – otherwise out of reach when displayed in museums; and (2) behaviour and motivation during the deer hunting game.

Users were invited to engage with the Crvena Stijena VR application using the following setup: HTC VIVE headset connected through a cable to computer workstation. During the experiment, the users were expected to remain standing. Precautionary measures were taken to ensure participants' safety and wellbeing. Prior to engaging with the VR application participants were informed about the experiment procedure and tasks, and their demographic data were collected. The experiments were conducted by four teachers/TAs following the same procedure. During the experiment observing staff were available for additional instructions and assistance, and were making notes on users' interactions, emotions and attitudes. The participants were interviewed and answers were recorded immediately after the experiment.

Participants were recruited by invitation – total of 24 with roughly balanced gender (9 female, 15 male), background (16 – engineering and science; 8 – arts and humanities), and age (14 – less than 30; 10 – more than 30) composition. Experiments were conducted individually and duration of experiment varied depending on engagement with the tools and number of attempts to catch a deer. The following questions were asked in the interviews, and open answers were collected:

- Q1. What was your experience of navigation through Crvena stijena VR application?
- Q2. How would you grade your ability to interact and how guidelines and signs were helpful?
- Q3. What was the most impressive part to you?
- Q4. Can you describe your actions and feelings while engaged in hunting game?
- Q5. Could you describe difference of this experience when compared to visiting prehistoric museum exhibition?
- Q6. What would you recommend to change/improve?

It is interesting to note that users regardless of the age and background noted similar flaws in the interaction but were not much disturbed by them. An example is recognizing Exit button on the controller, and the fact that EXIT label was too high above to be noticed immediately. The users exhibited rather different behaviours when using the natural movements in the cave and the exhibition compared with the movements steered by the controller as during the deer hunting. Majority of the participants reflected on the difference, and reported some side effects as nausea and decrease of balance.

Observing the behaviour of participants while they were watching the content showed us how natural it is for users to be in this kind of virtual space. This was especially true during

the first cut scene of world creation. Participants were actively turning around and checking every part of the scene trying to capture as much information as they can. It is important to note that many of these users never used VR before or have used it only few times. Still it was completely natural for them to be “somewhere else” the moment application starts, and their amazement could be seen immediately.

Lesser exploration of space was observed during three parts of story inside the cave, probably because not many things happened around the space they were in. Again this shows that users react to actions around them in similar way they would in real life. If lots of things are happening around, people try to observe more information in shorter time.

The qualitative studies demand a lot of engagement and time, but provide valuable insights in different attitudes and capabilities of users. These insights may drive changes like customization of some effects depending on user behaviour. The slow reaction time on wind warnings for some users were prohibiting them to continue with the gameplay, and the VR application could adjust the penalty according to the measured reaction time, providing nice user abilities customization.

The most interesting part for the majority of participants were the tools exhibits and interaction with their 3D reconstruction as illustrated in Fig. 3.



Fig 3. User experience evaluation – interaction with the 3D tools

It is again demonstrated that the users like having freedom and being in control. The users were waving with the tools, building piles of tools, pushing tools around and hitting one tool with another. It was really amazing watching them and identifying different ways of interaction, and here is one answer recorded: “Tools that you can actually see in the state they were found and to compare them with the state they were in full shape and size when they were being used. That is the most impressive part of the application for me.”

V. CONCLUSIONS

In this work we explored how interactive digital storytelling can foster interest in prehistory and complement static exhibits in the museums. The archaeological sites difficult to understand by common visitors are enhanced with digital content improving both the educational and amusing part of the visit. Crvena stijena VR application [18] is set up in a Nikšić Museum pavilion close to the excavation site, as well as in the National Museum of Montenegro in Cetinje. Museum staff and archaeologists who were excavating the site are very pleased with virtual reconstruction, storytelling and gameplay.

The evaluation provided us with the relevant feedback to improve the interaction, and to better monitor user behaviour and adapt to different user profiles.



Fig 2. Gameplay – hunting the deer

Identified flaws in the interaction were easily improved, but feedback related to identification of different user behaviours and traits is more challenging issue. We encountered significant difference in movement experience between natural movements and movements steered by the controller. The discrepancy in visual and proprioceptive senses presents evident challenge in achieving high immersion with the VR applications. The lessons learned from this qualitative study will be used to improve our future designs and will be reflected in continually evolving Guidelines for interactive digital storytelling presentations of cultural heritage [3].

The most valuable result of the evaluation is insight in all possible activities users initiated playing with tools exhibits. VR environment enables 3D reconstruction of artefacts preserved just in fragments, and allows users to engage with those artefacts otherwise restricted and protected behind glass cabinets in the museums.

REFERENCES

- [1] Alterio, M. and McDrury, J., 2003. Learning through storytelling in higher education: Using reflection and experience to improve learning. Routledge.
- [2] Carolyn Handler Miller. Digital storytelling: a creators guide to interactive entertainment. Elsevier/Focal Press, Amsterdam Boston, 2014.
- [3] S. Rizvic, N. Djapo, F. Alispahic, B. Hadzihalilovic, F. Fejzic-Cengic, A. Imamovic, D. Boskovic, V. Okanovic, Guidelines for interactive digital storytelling presentations of cultural heritage, In Proceedings of 9th International Conference on Virtual Worlds and Games for Serious Applications (VS-Games 2017), pp 1-7, ISBN 978-1-5090-5812- 9 (Xplore)
- [4] Sarajevo Charter online platform, <http://h.etf.unsa.ba/sarajevocharter/>
- [5] Unger, Jiri & Květina, Petr. (2017). An On-Site Presentation of Invisible Prehistoric Landscapes. Internet Archaeology. 10.11141/ia.43.13.
- [6] V. DeLeon and R. Berry, "Bringing VR to the desktop: are you game?," in IEEE MultiMedia, vol. 7, no. 2, pp. 68-72, April-June 2000, doi: 10.1109/93.848433.
- [7] Chalmers, Alan & Debattista, Kurt. (2005). Investigating the Structural Validity of Virtual Reconstructions of Prehistoric Maltese Temples.. 107-112. 10.2312/VAST/VAST05/107-112.
- [8] Knabb, Kyle & Schulze, Jurgen & Kuester, Falko & DeFanti, Thomas & Levy, Thomas. (2014). Scientific Visualization, 3D Immersive Virtual Reality Environments, and Archaeology in Jordan and the Near East. Near Eastern Archaeology. 77. 228-232. 10.5615/neareastarch.77.3.0228.
- [9] Forte, Maurizio. (2014). 3D Archaeology. New Perspectives and Challenges. The example of Catalhoyuk.. Near Eastern Archaeology. 2. 10.13140/2.1.3285.0568.
- [10] Falconer, L. (2016, December). Interactive virtual archaeology: Constructing the prehistoric past at Avebury henge. Paper presented at Virtual Environments and Advanced Interfaces Workshop at IUCC 2016.
- [11] Pujol, Laia. (2011). Realism in Virtual Reality applications for Cultural Heritage. 10. 41.
- [12] R. P. C. J. Rajapakse, Y. Tokuyama and R. Somadeva, "Virtual Reconstruction and Visualization of Pre and Proto Historic Landscapes in Srilanka," 2011 International Conference on Biometrics and Kansei Engineering, 2011, pp. 198-203, doi: 10.1109/ICBAKE.2011.69.
- [13] Ch'ng, Eugene & Stone, Robert & Arvanitis, Theodoros. (2005). A Virtual Reality Archaeological Framework for the Investigation and Interpretation of Ancient Landscapes.. Proceedings of the IASTED International Conference on Internet and Multimedia Systems and Applications, EuroIMSA. 527-532.
- [14] Djaouti, Damien & Alvarez, Julian & Rampnoux, Olivier & Charvillat, Vincent & Jessel, Jean-Pierre. (2009). Serious Games & Cultural Heritage: A Case Study of Prehistoric Caves. 221 - 226. 10.1109/VSM2009.40.
- [15] Rizvić, Selma, Dušanka Bošković, Vensada Okanović, Ivona I. Kihic, Irfan Prazina, and Bojan Mijatović. 2021. "Time Travel to the Past of Bosnia and Herzegovina through Virtual and Augmented Reality" Applied Sciences 11, no. 8: 3711. <https://doi.org/10.3390/app11083711>
- [16] S. Rizvic, D. Boskovic, F. Bruno, B. D. Petriaggi, S. Sljivo and M. Cozza, "Actors in VR storytelling," 2019 11th International Conference on Virtual Worlds and Games for Serious Applications (VS-Games), 2019, pp. 1-8, doi: 10.1109/VSGames.2019.8864520.
- [17] Mušanović, Adnan & Mijatović, Bojan & Rizvić, Selma (2021) "3D Sound for Digital Cultural Heritage" GCH 2021 - Eurographics Workshop on Graphics and Cultural Heritage, <https://doi.org/10.2312/gch.20211415>
- [18] Crvena Stijena VR application landing page, <http://h.etf.unsa.ba/crvenastijena>