

# Advanced Interactive Digital Storytelling in Virtual Reality presentation of Austrian-Hungarian fortresses around Trebinje

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## Abstract

*Interactive Digital Storytelling (IDS) is a way of communicating information in the metaverse [BH22]. Gameplay elements added to these applications turn them into serious games that can offer unique immersive experiences of historical objects and events to museum visitors and online. In this paper, we describe this "Advanced IDS" methodology on a use case of the Trebinje Fortresses VR project. Austrian Hungarian Fortresses around Trebinje, Bosnia, and Herzegovina, are in decay, hardly accessible, and completely neglected. They can be explored in Virtual Reality through an application that combines Interactive Digital Storytelling narrated by officers who used to inhabit them with gameplays where the user becomes a carrier pigeon and carries the messages from one fortress to another while avoiding eagle attacks. After the first mission is successfully completed the user gets a task to accomplish in a fortress underground, and, if successful, gets the opportunity to explore digitized museum exhibits found in the fortress. The application is installed in the Trebinje Museum. The quality of user experience will be proven through an evaluation study.*

## CCS Concepts

• **Human-centered computing** → **User studies**; • **Computing methodologies** → **Virtual reality**; **Simulation types and techniques**;

## 1. Introduction

The appearance of the metaverse is finalizing the change in the way how we communicate information. The consumers' attention span is getting shorter and they expect the content to be offered on demand. Interactive Digital Storytelling (IDS), is defined as a hybrid form of game design and cinematic storytelling for the understanding and making of future learning and entertainment applications [Spi05]. The information is organized in short story snippets, interconnected in a hierarchy of stories and sub-stories. In IDS the user can influence the flow of the story and/or its outcome. The problem that researchers are facing in IDS is called "the narrative paradox". It is the conflict between the interactor's freedom of choice (or agency) and the author's control over the story world [SST\*19]. One of the solutions for this problem is introducing a motivation factor for the user to encourage him/her to watch all stories [RDA\*17].

In this paper, we will expand this solution by introducing Advanced IDS as a combination of storytelling and gameplays. This way we will turn a Virtual Reality cultural heritage presentation into a kind of serious game. In [dFL11] serious games are defined as computer games that have an educational and learning aspect and are not used just for entertainment purposes. The digital cul-

tural heritage domain is using serious games for presenting information about cultural monuments in an entertaining and attractive way, enabling users to experience cultural heritage.

The main contribution of this paper is to show how a cultural heritage topic can be presented in the museum using Advanced IDS. We will explain this methodology on the use case of Trebinje fortresses, cultural monuments from the Austrian Hungarian period scattered around a town in Bosnia and Herzegovina, neglected and hardly approachable in reality. The museum visitors will be able to explore them through a Virtual Reality application offering 3D reconstructions, storytelling, and gameplays. The users will first become carrier pigeons tasked to carry messages from one fortress to another and after that, they get a mission to prepare one of the fortresses for defense through a secret mechanism hidden in the underground. The user experience evaluation will show how much they learned about the history of the fortresses and how immersive and engaging was their visit.

The paper is structured in the following way: in the Related Work section, we present other approaches to presenting fortresses using digital technologies, their advantages, and their drawbacks compared to our approach. In Section 3 we briefly describe the Trebinje Fortresses VR application [DIG], its structure, and how Advanced

IDS was implemented. Section 4 summarizes our user evaluation study, and in the Conclusion, we offer lessons learned and directions for general use of described methodology.

## 2. Related work

Digitization has generally become a very important factor in cultural heritage (CH). It is not only used for preserving but also as author [BPF\*18] states: "Digitization enables the spread of knowledge, and the use of innovative immersive reality tools could further facilitate the access to CH in a more appealing and innovative way." This is true for all areas of cultural heritage and as authors [CSA05] point out: "These digital reconstructions have, to date, contributed significant awareness and interest among the general public, providing educational benefits to concerned parties and new research opportunities to archaeologists and conservationists." There are many projects where benefits of digitization in cultural heritage can be found. From digitizing the city [PDKP18] or using digital technology to help with the reconstructions [CD05] to creating serious games for learning and museums [DAR\*09] [GSA21]. Interactive Digital Storytelling play important role in development of digital cultural heritage [Fvv20], and gamification has much to offer [PFF\*20].

Digitizing fortresses from the past can prove to be both important for preservation of cultural heritage and as an important asset in creation of serious games. Different structures and fortresses from the past proved to always attract more admiration in accomplishments of our civilizations and as such can contribute to promoting tourism. Historical sites with fortresses attract tourists from all over the world who are interested in learning about local history and culture. Digital models of fortresses can provide tourists with a virtual tour of these historical sites, which can be used to promote tourism and increase visitor engagement.

This is why we can find many projects dealing with fortresses like Lost Bastion of C aceres Wall [FRMdIPCF20] or Famosa fortress in Malaysia [BS13], Russian Fortress Koporye [IBR\*10] and Catalhoyuk [For14]. We can even find teams of researchers tirelessly digitizing fortresses throughout the country [BMM\*20]. All of these projects use 3D scanners, photogrammetry and 3D modeling software for recreating these relics from the past.

However, even more interesting for the people would be the ability to visit locations or fortresses no longer existing, or which are not accessible because of the dangerous environment. And Virtual Reality technology allows just for that. How to execute the production of projects like these we can read in [EKW\*19] [AC22] [WK20]. All mentioned projects offer advantages and drawbacks that can be further elaborated. We will show that our Advanced IDS method will increase immersion and edutainment of digital heritage applications.

## 3. Trebinje fortresses VR application

Around Trebinje, Bosnia and Herzegovina, existed a system of 36 fortifications of different types, together with the accompanying infrastructure, close to 100 buildings of military purpose, distributed in two circles of defense - the inner one with the objects in the

city center and the outer one on the surrounding hills. During the Austro-Hungarian administration, the town contained several military barracks, so the Trebinje garrison usually numbered around 4,500 soldiers and officers. The construction of the system began in 1883 after the Austro-Hungarian military and political plans in Bosnia and Herzegovina were faced with unforeseen challenges: first of all, strong resistance to the occupation, and then the uprising of 1881-82 against the introduction of military service. When the Austro-Hungarian army conquered Bosnia and Herzegovina in 1878, most of the fortifications from the Ottoman period were in poor condition. The rebellion of 1875, which affected parts of southern Herzegovina, and finally the fighting during the summer and autumn of 1878, contributed to the fact that many towers and city walls were damaged. Today in the garrison building is located the Museum of Herzegovina, while the fortresses are in ruins, neglected, and hardly accessible.

### 3.1. Application structure

A VR headset Oculus Quest 2 has been set up in the basement of the Museum of Herzegovina, where users can virtually visit the Trebinje fortresses from the Austro-Hungarian period. The visit starts from the same room, only in its virtual model (Fig1.VE1), where a hologram of Baron Leightner appears, telling about what we can see in the VR experience. After that, the users go to the dovecote (Fig1.VE2) and after the story, they become carrier pigeons and fly above the fortresses Strac, Golo brdo, Petrina and Klicanj (Fig1.VE3). They can visit each of these forts and walk through its rooms, with the storytelling of Baron Leightner. When they visit all four fortresses (Fig1.VE4, VE5, VE6 and VE7), they return to the dovecote, where General Ferdinand Zahradnik asks them questions (Fig1.Quiz) and gives them the task of taking the message to the Strac fortress (Fig1.G1). An eagle can attack them during the flight. If they successfully avoid the eagle's attacks and deliver the message, they get another task in the basement of the Strac fortress (Fig1.G2). After successfully completing the mission, the users can virtually explore selected exhibits from the Museum, take them, and view them from all sides (Fig1.Exhibition). The application is implemented in Unity 3D game engine. Fortresses' 3D models were created in 3ds max based on the information and photos provided by historians.

### 3.2. Interactive digital storytelling

Interactive Digital Storytelling in Trebinje Fortresses VR application is performed by two historical characters: Engineer Baron Leightner and General Ferdinand Zahradnik, head of Strac construction site. These characters are played by the same actor, in two different costumes and with different make-up. Historical information is organized in short stories about fortresses and life of soldiers inside them. The narrators are guiding the user through the application, explaining its structure and communicating the "missions" to be performed in gameplays.

Fortresses Klicanj, Golo Brdo and Petrinja have only one adjoined story each, while in Strac we created five stories, located in different places around the fortress. Stories are annotated by "S" in Fig1. The user can skip stories and move around the virtual environments using a controller joystick. After visiting all fortresses

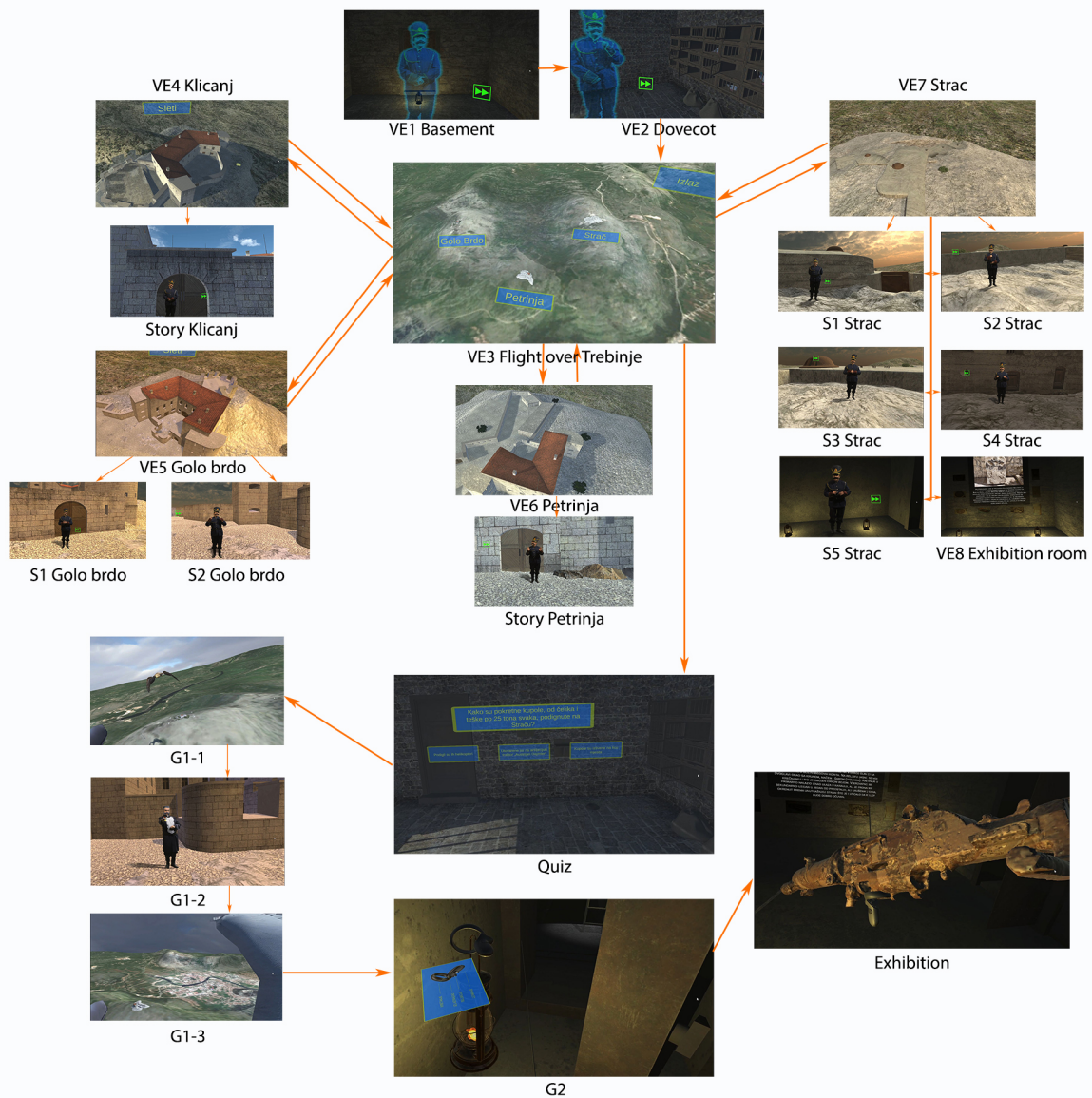


Figure 1: Application structure

users are placed in the dovecot again, where they should answer questions from the information presented in the storytelling. This is the way we motivate them to pay attention to the narration. After passing this test, they can continue to gameplays.

### 3.3. Gameplays

In this application, we implemented two gameplays. In the first one (Fig.1.G1), users become carrier pigeons. They get a message from Gen. Zahradnik to carry to the Strac fortress. On the way there they are attacked by an eagle and have to avoid it to survive. After they

arrive to Strac, they get another message to carry back to the garrison. Again, the eagle needs to be avoided during the flight back.

After completing the first gameplay, the users are located in the underground of Strac Fortress. The "mission" is written on a parchment they need to retrieve and read using the lantern, as the space is very dark. They are ordered to find the key of the secret room and activate the mechanism for opening the cupolas with machine guns, so the fortress can prepare for defense from the enemy. After finding and unlocking the secret room, they should place the ladder in the correct position to activate the cupolas (Fig.1.G2).

**Table 1:** Summary statistics

Item	Range of means	Mean	SD
Immersion	3.89 to 4.41	4.20	0.91
Edutainment	4.15 to 4.63	4.36	0.75
Easy of Use	2.70 to 4.30	3.78	1.08

### 3.4. Digital exhibition

After the mission is accomplished, users are awarded the possibility to visit the Exhibition room (Fig.1. Exhibition), where they can find and explore the digitized museum exhibits. Interaction with digitized exhibits is very appreciated by the users, as they can interact in a way they cannot do in the physical museum, e.g. taking the exhibits and turning them around. The exhibition also contains photos of important artifacts that could not be digitized. For each exhibit, the user can open the info text with basic information.

### 4. User experience

The quality of the overall user experience of Advanced IDS for Trebinje fortresses VR application is evaluated by a quantitative study designed according to our benchmarking framework [BRO\*17]. In addition to measuring levels of users' performance and effort, employing a standardized evaluation tool enables comparison between the VR solutions and identification of users' preferences. The evaluated measures are Performance Expectancy (PE) linked to immersion and edutainment; and Effort Expectancy (EE) linked to perceived ease of use [VTX12]. The experiment was conducted at the Sarajevo Graphics Group Lab at the University of Sarajevo. Participants were recruited by invitation, and users were invited so as to represent different groups and user types. There were also participants in the survey among museum visitors. Respective summary statistics are shown per specific measure: Range, Mean, and Standard Deviation (SD) Table 1. Results presented are in line with our previous findings [SRH\*20]: issues linked to ease of use will affect immersion, but not significantly, and edutainment is receiving the highest grading.

### 5. Conclusions

Presented research and results of User Evaluation show that Advanced IDS concept brings user satisfaction and appreciation as a tool to present and preserve cultural heritage. Museum exhibition has been enriched with digital content that enabled the visitors to explore places difficult to reach in reality and learn about their original appearances and historical importance. IDS based on two narrator characters was successfully improved by gameplays and digital exhibition, offering interaction with museum exhibits otherwise impossible in physical exhibition. This concept can be applied to any historical topic, cultural heritage object or site, as well as intangible cultural heritage.

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