

Bridges of Sarajevo

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Abstract

With the fast growth of technology, interactive digital storytelling has become a very popular mean to convey the information, especially in virtual cultural heritage applications. Although it has many advantages, there is a challenge to be solved - the narrative paradox. It is a situation when the application tries to mediate the story to the user and aims to maintain control over the order of events, but at the same time tries to give the user full freedom of choice and movement. In this paper, the authors did a case study in accordance to already proposed narrative paradox solution, the user motivation. The case study is an interactive digital story about 7 popular Sarajevo bridges. Afterwards, a user evaluation was performed. This paper presents the results of the application of the narrative paradox solution.

Keywords: Interactive Digital Storytelling, Virtual Cultural Heritage, Narrative Paradox, 360-degree video, VR, bridge, Sarajevo

1 Introduction

While the storytelling is widely spread and commonly used for education and cultural preservation, as Peinado and Gervas [9] evaluate, interactive digital storytelling is still a relatively new field and there are no direct guidelines that show the way to correctly create this kind of art. The main challenge is to give the user the power of choice and free will, while the author must keep holding the strings of the story.

Throughout human history, there were many ways to preserve the past. In modern times, with great development in computer technologies, realistic replicas of almost everything considering cultural heritage can be made. However, mere replicas are not enough. In archeology, context is very important. Joining virtual replicas with

stories about them is a complete job of preserving cultural heritage. Is there a better way to preserve the past? Nowadays most of the people live too fast and are overloaded with information. Consequently, people have a short attention span and need an optimized input of information. Unfortunately, very few people read books and are willing to spend time on detailed browsing of websites. Therefore, we can say that the hypertext principle has become a dominating factor in everyday lives of people. Athena Plus [10] recommendations for cultural institutions highly encourage conveying cultural heritage information through digital storytelling.

Interactive Digital Storytelling (IDS) cultural heritage applications are usually combinations of stories, interactive 3D models of cultural heritage artifacts and/or interactive virtual environments with reconstructions of cultural monuments original appearance. The practice has shown that users prefer to interact with digital content over being just passive observers/viewers of a movie or pre-rendered installation. In Rizvic et al. [13], the authors concluded that users prefer a combination of digital stories and models because models contained additional information displayed through stories and users prefer interactive virtual cultural heritage presentation over a sequential presentation in the form of a documentary movie.

The purpose of this paper is to verify the solution to the narrative paradox problem proposed in Rizvic et al. [13], through the group of actions offered to the user, thus giving him the motivation to explore the whole story presented. The key goal of this project is to present one part of the cultural heritage of Bosnia and Herzegovina, explaining not just the historical background of observed bridges, but also the soul of Sarajevo through its legends.

This paper is structured in the following way: *The Related work section 2* offers a brief overview of similar projects in this field. In *The Narrative Paradox 2.1* subsection, a big challenge in IDS applications, the narrative paradox is described. In the *360-degree video 2.2* subsection, basic information about the 360-degree video is given. In *Case study Bridges of Sarajevo section 3*, we are explaining the aim of this paper and the project structure. Then in *Work process subsection 3.1*, the process of

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making this application is described in detail. In *Evaluation and Results section 4* the process of user evaluation and results are presented. In the end, there is *Conclusions and future work section 5* where our conclusions are given.

2 Related work

There are many interesting projects that have similar approach and implementation to this paper. In this section are briefly mentioned some of them. Also, the term narrative paradox and 360-degree video are explained in more detail.

2.1 Narrative paradox

Narrative Paradox challenge subtly emerges as a recurring problem in most interactive digital storytelling applications for cultural heritage. Schoenau-Fog [14] describes this challenge as a problem of implementation of an open sandbox-like 3D story world application where the user may roam freely, while the same application simultaneously aims to maintain control over the order of the events or to mediate the story.

Interactive virtual environments as parts of IDS encounter this problem when stories are linked to objects in these environments. Users could miss finding those triggers and consequently not perceive important information. Therefore, solutions for narrative paradox are important contributions to IDS methodology.

There are many interesting approaches to solve this challenge. Some of them use emergent narratives like Louchart and Aylett [8], Aylett [2], Temte and Schoenau-Fog [15], others like Hargood et al. [5] propose a solution in the form of modelling the narrative as multiple threads, woven together to create a braid, thus managing the narrative paradox by separating logical cohesion within threads from thematic cohesion across the whole braid. The researchers in Kyrenia project [13] have tried to find a way to overcome the narrative paradox challenge through the motivation factor. There is also a lot of literature that suggests implosive stories as one of the solutions to the narrative paradox.

2.2 360-degree video

A tremendous development of immersive technologies (Lee et al. [7] define these technologies as technologies that blur the line between real and simulated world, thus creating the sense of immersion) has been accomplished as a result of a desire for better immersion and presence in computer simulated environments.

As an example of promising immersive technology, a 360-degree video has to be pointed out as it offers enhanced realism.

When combined with other technologies, this enhanced realism has considerable potential leading to VR experience at a higher level.

In traditional video productions, the viewpoint is chosen by the director, unlike in 360-degree video, where viewers are allowed to interactively change their viewpoint in the scene using options like clicking and dragging, or if users use a head mounted display (HMD), moving their heads in desired direction, and thus move around the video. All of this is due to the fact that 360-degree video applications are based on free viewpoint videos and resemble navigation in virtual worlds of 3D computer graphics.

Special rig of multiple cameras (for example 6 GoPro Cameras) or dedicated camera that contains multiple camera lenses which are embedded into the device such as Samsung Gear 360 are typically used for recording 360-degree video.

Another popular purpose of the 360-degree video is an ability to experience historically significant places. Namely, the user can experience this kind of places without being present there, as well as interact with them.

In next part of this section, we will describe some of the similar works in detail.

A project that is most similar to ours, which uses user motivation and game elements, is *Kyrenia* in Rizvic et al. [13]. Actually, we have taken the proposed solution to narrative paradox from this web application and applied it to our case study. In this web application, users have to watch all the videos, so they can be awarded the interactive virtual environment of the sunken ancient ship *Kyrenia*.

In *After the Storm* (Beck Grace [3]) which is also a web application, there is an interactive story similar to turning the pages of a photo album with interactive videos and pictures. The user can watch the video, or choose to see in detail some offered pictures or videos inside of the main video. The reasons why we find this application interesting are the usage of video and user's freedom of choice. Another similar web application made by National Geographic Channel that uses interactive video and info-graphics is *Killing Kennedy* [4] which through split-screen format, simultaneously tells the stories of Lee Harvey Oswald and JFK. This application is interesting because it uses video and also gives the user freedom of choice. *The Virtual Museum of Bosnian Traditional Objects* (Rizvic [12]) is another web application which enables the user to explore an interactive digital exhibition of Bosnian traditional objects in the form of the virtual exhibition. By clicking on the object, the user can see the information about it, photo gallery, movie about the use of the object and an interactive virtual 3D model. In these projects, the main advantage is that user can freely choose what to click and see, but at the same time this can be a big disadvantage because if the user does not click on some part of the story, they miss out on information and story overall.

A web application that uses the 360-degree video as an interactive environment is *Walking New York* [16] which follows the creation of a 150-foot-tall portrait of an Azerbaijani immigrant that was pasted onto a sidewalk across from New York's Flatiron building. In this web applica-

tion, there is the use of 360-degree video just like in our case study, but the main difference is that in our application, there are 7 360-degree videos and here, there is only one. a disadvantage of this approach is that to get all the information, the user has to see this only once, so we could say that this approach is kind of boring if its seen multiple times.

Heart of Stone (Dvorko [11]) is a project where a Khakas heroic folk-epic *Tas Churek* is made into interactive digital storytelling application through a combination of interactive pictures and video with the simple game elements. This project, just like ours, besides interactive environment, has also simple game elements which motivate the user to explore more.

Another similar project to ours is Argyriou et al. [1] which is immersive application based on the 360-degree video where users learn about the city of Rethymno, Greece with game elements. The main advantage of this approach is that user is motivated to find all the information and see the whole story but at their own pace. The disadvantage of this approach could lie in an overall cognitive load of the user, so they could give up on the application before seeing all the stories and information.

3 Case study - Bridges of Sarajevo

Bridges over river Miljacka do not only represent a mere connection of two riverbanks but a connection between people and different cultures. It can be said that they represent a soul of Sarajevo and people living there. In this paper, bridges, as one of the many jewels of the city, are presented through different technologies, combining pictures, video, and sound.

Bridges presented through the project are as follows:

- Goat's Bridge (orig. Kozija Cuprija)
- Sehercehaja's Bridge (orig. Seher-Cehajina Cuprija)
- Tsar's bridge (orig. Careva Cuprija)
- Latin bridge (orig. Latinska Cuprija)
- Drvenija bridge
- Festina-Lente bridge
- Suada and Olga bridge (orig. Most Suade i Olge)

The main reason why we have chosen this bridges over many more is that these bridges have an interesting historical background.

We have created a web application with seven short 360-degree videos of the bridges with the stories about them. Stories are meant to be interesting and to tickle the user's attention. There is no straight storyline, instead, every story is a piece of itself and user can choose stories from the map with clickable models representing bridges. The user has all the freedom to explore the story at their own

pace and manner. After watching a video, the user gets a puzzle piece. When all of the videos are watched, and all puzzle pieces collected, the user gets the reward in form of a final story about Sarajevo. In this manner, we wanted to verify the proposed solution in a paper by Rizvic et al. [13] (motivational factor where the user can watch all the stories, but at the same time they are not restricted and they have freedom of choice).

3.1 Work process

The project structure is presented in Figure 1.

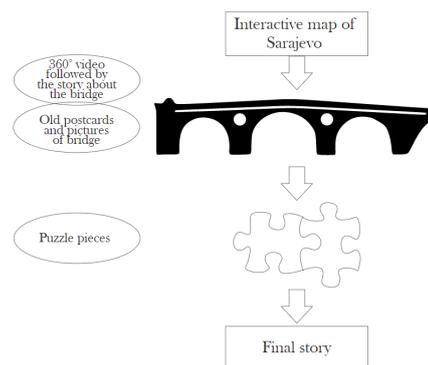


Figure 1: Structure of the project

Key elements of the project:

- Hand drawn map of the area where the bridges are located
- Clickable models of the bridges made in Blender located on the map
- 360-degree videos with stories about the bridges
- Puzzle made out of seven pieces that need to be collected
- Final video about bridges recorded with drone

The project was developed in the following steps as shown in Figure 2.

First, we chose the bridges with the most interesting history and background, then we have collected the detailed information about them so we could make stories. We have found the information about the bridges on the Internet and in our local library. Afterwards, we have written the stories, and we have asked our colleagues to read them for us and we have recorded them using the mobile phone voice recorder application. A male colleague has read the stories in English, and the female colleague has read the stories in the Bosnian language. We have decided that our web application should be bilingual (in English and Bosnian), so the locals can also enjoy our stories as tourists and others interested in bridges of Sarajevo. After the recording of the stories, we have recorded the videos

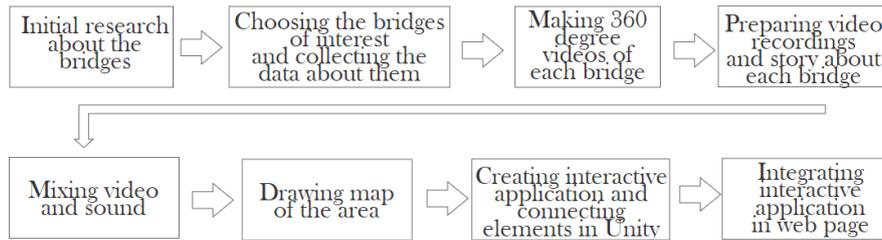


Figure 2: Workflow

of each bridge, using the Samsung Gear 360 video camera. A screenshot of 360-video of Tsar's Bridge can be seen in Figure 3.



Figure 3: Tsar's bridge

After this, we have obtained raw video recordings which were needed to be merged into one spherical video of each bridge. This was performed with the usage of a method called video stitching, where the contrast of each shot is calibrated. This can be performed by a camera itself or by specialized video editing software. We have performed the video stitching using Gear 360 ActionDirector (as can be seen in Figure 4).

Also, we have recorded the final video of the bridges of Sarajevo using a drone. When we have completed both the voice and video recording, we have joined them in Adobe After Effects video editing software. After video editing, we made models of the bridges in Blender. We have used the photographs of the bridges for the reference. Then we have drawn the cartoonish map of Sarajevo with river Miljacka in focus using Adobe Photoshop software. This picture is used as background for the application. We have split the other picture of Sarajevo into 7 pieces of a puzzle, also using the Adobe Photoshop program. This picture was used later in the application.

Next step was creation of the Unity application. All Unity scripts were written in C#. The application was made of several scenes. The main scene has central cartoon map on it and clickable places representing bridges as can be seen in Figure 5.

When the user clicks on a bridge, it triggers the menu and user can choose which content will be shown, the 360-degree video or puzzle progress (Figure 6).

A script then starts another scene which contains 360-degree video or a scene with puzzles depending on the

user's choice. The first time video is shown, a counter for that video is incremented, and the user is rewarded with one piece of the puzzle. When a 360-degree video is finished, or a user closes it, a scene with puzzle progress is shown (Figure 7).

After collecting all the pieces, a script with the final video is triggered, and the user is shown the scene with the final video of bridges and Sarajevo with an extra story as a reward. We have built the application as WebGL and uploaded to the website.

4 Evaluation and results

When the web application was finished and online, we have shared the link [6] on our social networks profiles such as Facebook and asked our friends to visit the website and to fill out an online questionnaire after their visit. For the questionnaire, we have used free Google forms. In order to ensure that the responses represent a diverse cross-section of respondents and to establish the validity of survey responses, we have included questions for relevant demographic data: age, education and computer skills.

The evaluation involved 96 participants, most of them were in an age range of 18-30 years (43.8%). Also, most of them were students (22), and software developers and engineers (18).

The questionnaire contained seven sections: (1) introductory part with data for user profiling, (2) and (3) with questions addressing usability and immersion; containing 11 Likert items defined as straightforward statements following positive logic, (4) section where users were asked to grade the story and video about every bridge individually, (5) with questions have the user seen the bridges in real life and are they faithfully represented in the application, (6) with question if the user has not been to Sarajevo before, are they interested in visit and (7) open questions where users could express their opinion about the application and their the most favorable and the least favorite part of it.

Example Likert items:

- "I like the 360-degree video"
- "The application loading was fast and simple"
- "I like the idea with the puzzle pieces"



Figure 4: Gear 360 ActionDirector

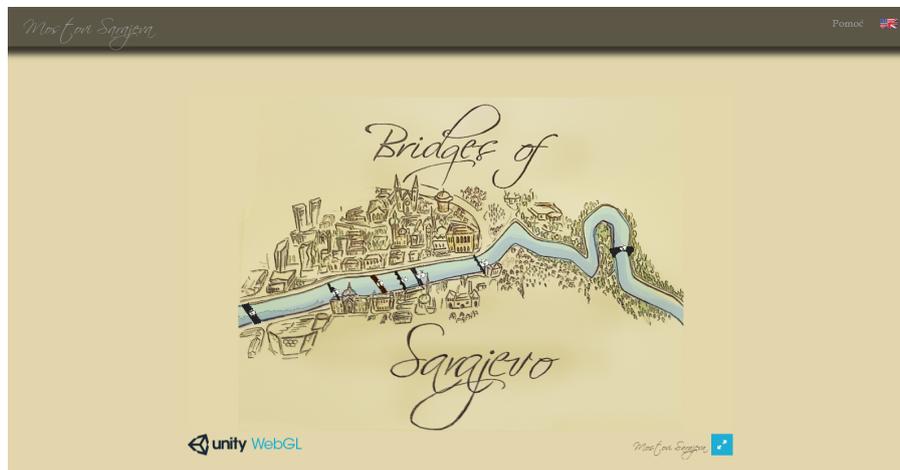


Figure 5: Map of Sarajevo



Figure 6: Bridge's menu



Figure 7: Scene with puzzle pieces

- "I felt like walking over the real bridge"
- "I like the background picture"
- "I like that I can choose the order of watching the videos"

The participants have given mostly positive feedback, they liked the usage of 360-degree videos, and they have found both stories about bridges and the final story very

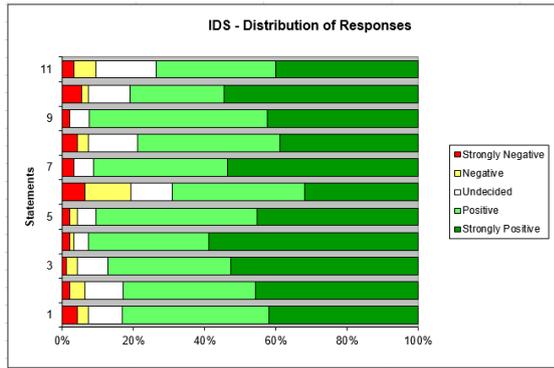


Figure 8: Results

interesting and entertaining. Most of them (65.6%) have watched all the videos and 71.9% did not have any technical difficulties. Also, a very important thing that should be mentioned is that they were very positive about pieces of puzzles as motivation for the further exploration.

The Likert scale question results can be seen in Figure 8.

5 Conclusions and future work

Recently, methods in interactive digital storytelling have improved greatly, but they are still developing with the advancement of technology. With Virtual Reality (VR) systems, storytelling is experiencing a form of revolution. Users can not only experience stories with eyes and ears, but they can now have a whole-body experience, they can feel like they are part of that story.

Considering the results of the user evaluation, we can conclude that we have verified the approach used in the Kyrenia project [13] which uses the motivational factor. This approach can be considered as a solution to the narrative paradox problem. Users were very positive about it and they liked the freedom given in choosing the order of the stories. Most of them have decided to see all the 360-degree videos and stories so they could see the last story about old Sarajevo.

For future work, we can apply other immersive technologies in combination with 360-video and see the results of that approach.

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