Multi-touch Rocks: Playing with Tangible Virtual Heritage in the Museum –First User Tests

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Abstract
More than 50.000 petroglyphs are engraved in rock panels on the flanks of the UNESCO world heritage site Val Camonica (Northern Italy). The engravings are not always visible and are often on steep slopes on which it is forbidden to walk for conservation reasons. To overcome these problems, and to be able to transfer the rock art experience to other places, we designed a collaborative computer game for a multi-touch tabletop display. The game contains the image of a full rock panel and several mini games to be played on the panel. This short paper describes the game design as well as the interface and interaction design. We focus on the evaluation of the user interface as an important step in the user centered design approach. Consequently, we perform first user tests on the game in order to evaluate effectivity and efficiency of the user interface. The tests achieve largely good results.

Categories and Subject Descriptors (according to ACM CCS): H.5.2 [Information Interfaces and Presentation]: User Interfaces—Input devices and strategies; K.8.0 [Personal Computing]: General—Games

1. Introduction

Around 5000 years ago members of the Camunian tribe started to use quartzite hammers to smash images out of the flanks of the Val Camonica in the Lombard Alps of northern Italy. The images of houses, warriors, carts and ploughs are a UNESCO world heritage site and have resisted the extremes of summer and winter since the Copper Age. The engraved rock panels contain over 50,000 Pitoti. The "Pitoti" (a local dialect word for small puppet) allow us a unique entry point into the life and times of a prehistoric tribe who where over thrown by the Romans in 15BC [FC02].

Our goal is to create a collaborative educational computer game for children, that can be used in public space (e.g. in museums). The computer game is needed for three reasons: one it allows the art to come to the audience, since the rock cannot be transported. Second, it allows the audience to interact with the Pitoti, which are not always visible and are often on steep slopes on which it is forbidden to walk for conservation reasons. Finally the game allows the visitors to explore the interactions between the engravings, by playing the games. The graphic simplicity of the images is close to children's drawings and so leads to an instant identification for young visitors. James Joyce said that the difference between a space and a place is that "Places remember events" i.e. tell stories. The aim of this video game is to help the audience to turn prehistoric spaces into interesting places, in which the Pitoti act out past events.

We acquired a digital image of a complete rock panel in the Val Camonica (Seradina I rock 12). Figure 1 shows a part of the rock panel and its surroundings, Figure 2 depicts a detail. The image with a size of three gigapixels has been stitched of more than two hundred single images. It is the basis for our game, which will be placed in public space. Computers in public space have to be easily usable and robust. Therefore, we use a multi-touch tabletop display for the implementation of our game. Tabletops have been widely used for over a decade now. We expect a continuing increase in usage of these systems, as new technologies (e.g. Microsoft Surface 2) allow less expensive multi-touch setups.

In this paper, we describe the game design and the user interface of our game. We focus on the interface and interaction design. Our contribution is the evaluation methodology and a first user test of the interface and interaction design. This short paper is organized as follows: We summarize related work in Section 2. Section 3 contains the description of our game and its user interface. In Section 4, we describe the first usability evaluation of our game and its results. In Section 5 we draw conclusions and line out future work.

Figure 1: *A part of the rock panel we use (Seradina I rock 12) and its surroundings. Pitoti are in the lower right part of the image.*

Figure 2: *A detail of the rock panel we use (Seradina I rock 12) showing a Pitoti.*

2. Related Work

We consider related work in the fields of game design and human computer interaction (HCI), as both fields are relevant to our approach.

Salen and Zimmermann [SZ03] define game design as *".. the process, by which a game designer creates a game, to be encountered by a player, from which meaningful play emerges."*. We focus on game design work related to ad-hoc games on public displays and to games on multi-touch table top computers. Cao et al. [CMB08] state five requirements, that the game design for a public game should fulfill: a) casual and lightweight; b) simple to understand and operate; c) suitable for various populations; d) ad-hoc joining and leaving and e) encouraging group play and communication. Schild and Masuch [SM10] describe the creation of the multi-touch game "magic garden", that allows continuous ad-hoc group game play. Their proposal for an approach for the creation of such games includes self-contained mini games put into one game scenario. Antle et al. [ABT*11] present a collaborative learning game on a multi-touch digital tabletop. They evaluate it in a field study with hundreds of users, and identify several key design features. Among these key features is the usage of multi-touch interaction on a large surface to allow collaborative play, and the usage of discrete events to pause fast paced multi-touch interaction in order to facilitate reflection and self-regulation.

Interface and interaction design aims at efficiency and simplicity of the human computer interface. A reduction of functionality in the interface as well as the product decreases

the cognitive workload for the user [Nie94]. Hence, the user has more cognitive capacity for playing and learning. Colborne [Col10] states four strategies to simplify interfaces and gain better usability: Remove, organize, hide and displace. Saffer [Saf08] proposes seven gestures for touchscreens: tap, drag/slide, flick, nudge, pinch, spread and hold.

The evaluation of the interface and interaction design is an important step in the user centered design approach. For the interface design of Office 2007, Microsoft used comprehensive evaluation results in an iterative process [Har08]. They collected large amounts of usage data from the previous version Office 2003 and from several steps in the design process of Office 2007. The usage data consists of usability metrics. Tullis and Albert [TA08] propose an extensive list of metrics, e.g. task time, assists, errors, success rate, etc. Software for the automatic collection of such usage data exists for conventional point-and-click interfaces. However, the metrics-based evaluation of multi-touch multi-user software is an emerging field. One example is presented by Chow et al. [CHG11]. They evaluate the usability of multi-touch control of a virtual environment compared to mouse-based control.

3. Game Concept & Interface and Interaction Design

Our game concept contains several types of mini games embedded in a complete scenario. The scenario is the full-scale image of a rock panel (see Section 1). Players can explore the three gigapixel image by zooming and panning. The zoom levels range from a detailed view at 200% of the real size of the stone to a total view of the rock panel. On the rock panel,

graphical variants of the Rosa Camuna mark entry points to the mini games (see Figure 3). The mini games are simple games dealing with the environment of the Camuni, e.g. with hunting, building a house, catching run away oxes, etc. The mini games can be played in any order, i.e. it is possible to enter and leave the game at any time. Furthermore, each of the mini games can be played by one, two, three or four players. The players can enter and leave a mini game at any time. When a mini game is finished, the game changes back to the surrounding scenario, rock panel exploration. Some

Figure 3: *A Rosa Camuna on the panel serves as entry point to a mini game.*

of the mini games deliberately contradict the archaeological state of the art. In this case, the game is stopped at some point of the game, and the character *Archeologist Chris* explains the archaeological point of view on the current game state. Additionally to this automatic context-dependent appearance, the character of the archeologist can be accessed throughout the whole game. Besides this archaeological information, general help can be accessed at any game state.

Our game will be placed in public space. The interface and interaction design aim at easy access for our target group, 10-18 years old students. The attention span for a motivated use is short. We have to involve the players quickly. Therefore, we reduce the number of utilized gestures as much as possible. Four gestures are sufficient to control the functionality of our game.

4. First Usability Evaluation

4.1. Test Plan and Setup

For the first user test, we implemented the rock panel with its zoom and pan functionality and one mini game. The panel persistently shows a navigator and a help button in the menu bar. The navigator shows the zoom level and position of the current viewpoint on the panel in relation to the full panel. The mini game "Put the clothes on" (see Figure 4) is a puzzle. The players move, scale and rotate scattered parts of a

Pitoti to re-assemble the figure. Help is implemented for the panel and the game.

Figure 4: *Evaluation of the game "Put the clothes on".*

We evaluate the functions of the panel and the game. Questions we want to answer with our test are:

- Are the functions "zoom" and "pan" usable intuitively?
- Are the entry points to the games found easily?
- Are the functions of the games usable intuitively?
- Is the rock panel perceived as rock panel?
- Are the engraved figures (Pitoti) found on the panel?
- Is the navigator self-explanatory?
- Is the help function usable and understandable?

We test effectivity, efficiency and satisfaction. We use markers for

- *Begin* and *end* of the test.
- *Errors:* usage of not supported gestures; usage of non-interactive spots; unwanted interaction results.
- *Task success:* Rosa Camuna is found and game is started; helmet of the Pitoti is in the right spot.
- *Assists:* User asks for help.

Our hardware setup consists of three video cameras and one photo camera. We evaluate the synchronized video recordings and take notes during the tests. The test takes place in a room. Only the test participants and one observer are in this room. We ensure, that students who already did the test do not meet other students.

After the test, we ask each test participant to fill out a questionnaire. The questions deal with the previous knowledge of touchscreen usage and the satisfaction resulting from the game used in the test.

4.2. Results

We performed a first user test with eleven students (age: 14yrs), six of them male and five of them female. We tested three groups, one with three participants, and two with four participants. Prior to the test, the test participants got a short

briefing about the Val Camonica. They did not get any briefing about the type of interface or the type of software on the tabletop computer.

The evaluation of the video recordings and our notes show, that two of three groups found the entry point to the mini games adequately quick. The interaction with the system was smooth in two of three groups. In one group, errors occured frequently. In the game "Put the clothes on", the test participants unintentionally took away parts of the puzzle from other test persons. Furthermore, the help function was frequently opened unintentionally. After a while, the group realized, that the scarf of one person touched the screen frequently and caused the unwanted interaction results. Two of the three groups asked the observer a question ("Is this a touch screen?","Is it bad, if we all touch it simultaneously?"). All three groups understood the help function as well as all four gestures intuitively. All the groups spent more time in the mini game than for exploring the panel and the Pitoti on it. The navigator is tapped although it is not an interaction element. Furthermore, we observe, that the mini game "Put the clothes on" is attractive for our target group.

The post-test questionnaire shows, that all of the test persons had the impression, that they could use the functionality of the table either "very good" or "good". Only three of eleven had used a multi-touch table before. Ten of eleven test persons identified the Rosa Camuna as entry point to the mini games. Ten of eleven found the help function immediately, but only four of eleven read the help text.

Analyzing the results, we identified four problems in our current design. We discuss possible solutions:

- *The test persons do not notice the Pitoti on the panel.* When the table is not used for a certain time, the view on the rock panel should change automatically to a zoom level and viewpoint where Pitoti can be seen on the rock surface. Furthermore, an animated help screen for the gestures to zoom and pan should be shown in the idle state of the game.
- *The test persons find the help screen, but the help text besides the depicted gestures is not read.* The gesture pictures on the help screen should be animated, and the amount of text reduced further.
- *The users seldomely find the total view of the rock panel.* An additional gesture, "double tap", could be implemented to zoom out to the total view from any other zoom level.
- *The testpersons want to activate the navigator by the gesture "tap".* The graphical design of the navigator should be changed in a way, that it is no longer confusable with an interaction element. We assume that this is a challenge, as with touch interfaces everything is perceived as a potential interaction element.

5. Conclusions and Future Work

In this short paper, we presented a game concept for an educational archaeology game. We implemented a part of the game, and performed first user tests with largely good results. In our current design, we identified four problems and possible solutions. Future work will include a) the implementation of the design improvements the results of the first user test suggest; b) the implementation of further mini games; c) the implementation of automatic data gathering for some usability metrics (task completion, etc.); d) further user tests and e) at least one large-scale public user test.

6. Acknowledgements

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