

Cultural Heritage, User Interfaces and Serious Games at CTU Prague

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Abstract — Cultural heritage presentation is a topic we at CTU Prague deal with for more than ten years. In this paper we present our experience with user interface design where serious games paradigm has been utilized. The survey of selected projects represents various technologies and approaches for cultural heritage data handling that includes data acquisition, presentation, interaction and educational issues. The aim of our activities was to develop a systematic approach to the user interface design for the given class of applications.

Keywords – cultural heritage; user interface; serious games

I. INTRODUCTION

One of fields where new information technologies can be used with a big impact is cultural heritage. By means of these technologies the cultural heritage can be presented to wide audience in a form that was not possible without these technologies. The user can e.g. experience an immersion into environment of historical buildings or part of historical cities. Such an experience helps the user to get specific knowledge about particular buildings or even about particular events throughout the history. In other words it is possible to say that new information technologies possess an important educational potential. This potential can be used in several ways when presenting historical data of various kind to the audience.

In this paper we will deal with the survey of technologies used at DCGI (Department of Computer Graphics and Interaction) at CTU Prague during the work on various projects dealing with Czech cultural heritage. Moreover besides results achieved some ideas that were used in pilot solutions will be presented as well. This concerns mainly ideas about data handling and interaction in environment of various technologies used in projects performed at DCGI. The main issue discussed in this paper is the approach to user interface design. An average user that is interested in cultural heritage (we assume the educational framework of such an interest) is a person with average knowledge (or even less than average knowledge) how to deal with computers – especially from the point of sophisticated interaction in 3D environment etc.

The following text describes selected projects that were realized at DCGI in last five years. Experience with development of user interfaces (including serious games interfaces) will be briefly described. At the end of each chapter

dedicated to particular project (chapters 3 to 7) the lessons learnt about user interface design are summarized.

II. STATE OF ART

When using information technologies for education of any kind, an important problem always arises “How to improve the process of acquiring information?”. The proper way is to increase the user involvement into learning process by means of introducing some kind of feedback from the user – and in such a way to check whether the knowledge the user had to acquire was really acquired. One of relatively new approaches in this field are serious games. These games can be used in various contexts what influences the way the serious games can be exploited. In the following text we will give an overview of experience (related to some topics that are linked up with serious games) we obtained in last years at DCGI in the framework of several projects where DCGI was a solely actor or in projects where DCGI participated in some extent.

There exist several definitions of the term “serious game”. Probably the widest acceptance has the definition given in [7]: Serious game: “a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives”.

One of aspects that has to be discussed is the form of mental contest. In our work we considered large variety of the meaning of this term – beginning with the “low end” meaning what comprises score obtained from some kind of test (e.g. performed after the learning phase that includes presentation of some information) and ending up with “high end” meaning where the user actively reacts to stimuli or questions during the learning phase (the user reacts “on the fly”).

Of course it is possible to discuss what is entertaining and what is not entertaining (where the threshold lies). For our purposes we limited ourselves to statement that the user should enjoy (level of satisfaction) the work with the product that mediates him/her some kind of information that should be acquired by the user. The level of satisfaction is in most cases influenced by the way the information is presented to the user. The presentation should be as natural as possible. That is why the virtual reality (in some cases accompanied by video or other multimedia material) is used for this kind of education. In the following text we will describe our experience with the

presentation techniques we used in our projects. The nature of data that are presented influences the data acquisition process that will be briefly described as well.

III. CELTIC CULTURAL HERITAGE IN THE CZECH REPUBLIC

The very first project in the field of cultural heritage performed at our department was reconstruction of Celtic oppidum Zavist near Prague. Celtic oppidum Zavist was established in the first half of the 6th century B.C. For almost two centuries this oppidum was an important location both of social and economic life on the territory of present Czech Republic. The size of the oppidum area was quite large – about 0,27 km². This area was surrounded by complex fortifications. Besides buildings of various purposes a very important part of the oppidum was created by acropolis with sacral function.



Figure 1. Model of Celtic Oppidum

The virtual reconstruction resulted in VRML based model [8], [9]. Such a model allows the user (virtual visitor) to make virtual walkthroughs in the site. In general the user is not limited in the time – the user can investigate both the overall structure of the oppidum and the individual details. After the walkthrough is over the user (who had to learn something about the oppidum) can be asked several questions in form of a test. There can be given some kind of minimal threshold the user should pass in order to succeed in the test. In the time when the project was done such a form of interaction with user (interactive walkthrough in the oppidum) was more or less acceptable.

Initially, there was no special user interface developed. The users had to use standard user interface in Cortona VRML browser. As it has been stated above the users with no or small experience in navigation in 3D encountered certain problems when using such an interface. The initial users of the model developed were mostly archeologists with limited experience with 3D applications it took some time before they are able to perform proper walkthrough in the oppidum model. We have utilized the user experience with archeologists (who deal with Celtic culture) in the next project aimed to a historical site reconstruction and presentation. When creating a 3D model of another Celtic site – Svrzno (in Western Bohemia) - we have successfully combined VRML geometry and texture data with additional information provided to both experts and ordinary users. Such supplementary information has been available in form of textual legends, 2D maps and schemes, and photos of archeological objects and locations (see Figure 2.). This rich and multi-modal stream of information has been appreciated by majority of users, although some of them were a little bit confused by too many options available.



Figure 2. Snapshots of reconstructed Celtic site Svrzno

IV. VIRTUAL OLD PRAGUE – VOP

The VOP project [5] is the web application that allows walking through a virtual city stored in a remote database. The data are progressively transferred from the server according to a visitor's position. A high frame rate is achieved by rendering visible city parts only. The system has been tuned considering various characteristics – network capacity, computing power on client side, quality of graphics hardware used. Although the overall amount of data describing a virtual city could theoretically grow up to hundreds of megabytes, fine granularity of the city objects (building facades, streets, and other components) helps to achieve smooth and high speed rendering during a walk through the city.



Figure 3. Snapshots from virtual walkthrough in VOP project

The interactive investigation of the virtual city is supported by three navigation modes that gives a possibility to formulate various sets of questions (in form of tests that is given to the user when the walkthrough is over) that are appropriate to the amount of information the user acquired during individual walkthrough modes. As it has been mentioned the VOP application offers three kinds of navigations. The simplest one is a guided-tour. A user selects predefined tour and the application runs without any further user navigation input (3D navigation input is redirected and is taken from the server instead of a mouse/keyboard). It reminds of replaying movie but all VR data are loaded and rendered in a real-time. A user can interrupt the guided tour anytime. The second kind of navigation is based on selecting one of predefined viewpoints. Such viewpoints are shown on sensitive 2D map that can be displayed when clicking on left textual menu. The last navigation mode is interactive walking mode suitable for users experienced in navigation in 3D virtual space.

Advanced menu contains a lot of settings that help to tune the application performance and to adapt it to user's needs. The VRML window can be enlarged to several predefined resolutions and some frames can be hidden. An appropriate VRML browser is able to render the scene in stereoscopic views thus allowing spatial and highly impressive perception transmitted via Internet.

One of lessons learned from the VOP project was the experience with complex user interfaces used to control the walkthrough in the virtual city. As the majority of common users have no (or just little) experience in interaction in 3D – new techniques had to be developed in order to ease the interaction. Situations when the users are not able to get to proper place in the virtual city can negatively influence the results of tests as the users do not possess some particular information in question. In this project an experience from the previous project (Celtic oppidum) was used where the users had problems with navigation in 3D without any further support. In the VOP project the users had e.g. the possibility to choose some predefined walkthroughs. In this case the movement in 3D scene was rather limited and thus the users had „no opportunity“ to get in some undesirable positions. The experience in the field of user interfaces gained was used in the next project – VHCE.

V. VIRTUAL HEART OF CENTRAL EUROPE – VHCE

In this very project [6] DCGI was one of partners. The project was funded by EC in the framework of Culture 2000 Program. The main idea behind that project is to present historical architectural gems of four selected cities from different countries – Prague, Graz, Maribor, and Bratislava. Instead of showing well-known tourist attractions only, the project concentrates on vertical solitaires – Towers and Wells. The aim is to digitally preserve carefully selected buildings, to reconstruct them virtually, to prepare a suitable digital storytelling and to publish results on the web using rich hyperlinked structures and multi-modal approach.



Figure 4. User interface for 3D navigation and interaction in VHCE project

A big attention has been paid to utilizing a wide range of presentation techniques. While the standard combination of textual and image information creates a solid base for the final web application, three-dimensional models are shown in a number of ways. This approach required a complex handling of data of various types and thus various formats. Also user interaction with data of various nature was very demanding. It was necessary to develop new interaction techniques that allow

the user to access information of various kind in various presentations that use different data formats.

As an example we can give navigation in a 3D virtual space that is sometimes a nightmare for users accustomed to window based GUI where point-and-click is the major interaction technique. Moreover, web pages with hyperlinks are based on similar interaction techniques: click-and-go. To the contrary, virtual reality offers several navigation paradigms – walk, fly, examine. Each of them usually contains additional navigation elements like turn head, rotate object of interest, go ahead/back, pan, change camera optics, jump to another viewpoint, etc. – see Figure 4.

A user interface for 3D is not yet standardized. Even VRML browsers complying ISO standard differ in a number of control elements and their arrangement on a screen. This fact increases skepticism of ordinary users. To achieve platform independent behavior in VR applications, one has to create a user interface as an integral part of the virtual scene. One such interface is shown in Figure 4. It has a function of so called *head-up display*, since it stays at the same position on a screen while user navigates through the virtual scene. The user interface in the example consists of control buttons represented by semitransparent spheres with 3D icons and textual description. The outermost spheres allow choosing previous/next viewpoint. The other buttons manipulate with a 3D object of interest. This interface is suitable for exploration of one object rather than for a large virtual space, since it does not allow free walking/flying. An animated walk-through started by selecting a proper viewpoint is used instead.

VI. DIGITALIZATION OF LANGWEIL MODEL – VIRTUALIZATION OF OLD PRAGUE

This large scale project was lead by Visual Connection company from Prague and DCGI was one of partners in the project. What is unique in comparison with other projects mentioned above is data acquisition. There exists a physical paper model that was digitized. Just to mention some facts:

Paper model of Prague was created in years 1826-1837. The author of the model was Antonin Langweil and it is 20 sq meters large in scale 1:480 [13]. The model comprises more than 2 500 numbered buildings. About 960 buildings do not exist in present days due to the building activities in the time that passed between the model creation and present time. This means that we have detailed information about appearance of Prague – how it looked like almost 200 years ago. The digital model contains about 13 400 roofs, 9 100 chimneys, 5 400 bushes and trees. For digitalization it was necessary to use 48 powerful computers and disk space 20 TB. More than 170 operators and more than 200 other collaborators participated in the project. The data obtained by means of 3D photogrammetry had to be optimized. In the optimization phase more than 8100 hours were spent.

The digital model will be at disposal to visitors of Museum of Prague in form of virtual walkthrough available on information kiosks placed in the museum. Also 3D projection will be available and the visitors will get a real feeling „of being there 200 years ago“. Another output of the project is DVD where the user can perform arbitrary walkthroughs in the

virtual model having possibility to fly over the model and thus getting non traditional views on the parts of Prague.

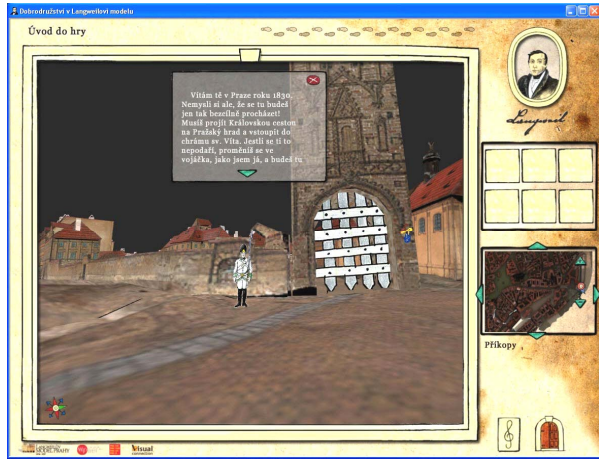


Figure 5. Serious game “Adventure in Langweil model” provides enjoyable cultural heritage experience

For kids there will be a possibility to play a "serious game" where the user as a virtual visitor to Prague has to fulfill 16 tasks. The tasks are related to issues dealing with the history of certain locations in Prague. During the game the user is both instructed (and thus the user gets a lot of new and interesting information about old Prague) and tested – and in such a way the user gets evaluation how successful he/she was when learning a new stuff about Prague history. A user interface had to cover several requirements – navigation in a large virtual city environment, presentation of tasks and supporting information, game control and selection of proper artifacts, choosing answers from quizzes, etc. All these components were integrated in a 3D space (and implemented using VRML and JavaScript). The whole 3D model (consisting of more than 20 GB of texture and geometry data) has been simplified, stylized to a cartoon look, and converted into a computer game targeted to children audience (Figure 5.).

Although this project is still running some lessons dealing with user interfaces have been learnt. The knowledge acquired is based on the fact that the user uses different interaction methods for interaction with the same data (3D digital model). While for museum kiosks equipped with the touchscreens the interaction is strictly limited (navigation mediated by means of buttons similarly to VHCE project), the interaction in the game environment is much richer. The user interface design had to take into consideration the context in which the interaction took place. The experience gained will be used for user interface design for planned web-based application, where the users can perform walkthrough in the model.

VII. ENHANCED LEARNING UNLIMITED – ELU PROJECT

One of the recent projects DCGI was involved in, was the ELU project [12]. It was and research project funded by EC - the 6th Framework Programme. The goal of this project was to develop educational content [4] for a specific interactive environment – iTV (interactive digital TV) [1], [2] – in

further we will speak about t-learning . This particular environment represented itself a significant challenge as it differs from computer environment where interaction styles have been developed for decades. In the case of iTV all control has to be done by means of remote controller [3]. A general screen template was developed (together with standardized meaning of buttons on remote controller) for all applications developed in the framework of the ELU project.

DCGI developed a learning module dealing with the Czech history (and thus it dealt with cultural heritage – specifically in Prague). The target group for the learning process were seniors. The aim of the sample module was to provide the learner information about the most important buildings in Prague and also information about historical events linked up with these buildings (or in some cases with certain monuments). Most of historically important events in the Czech history happened in places where our t-learning course leads the learner through – so called Royal route. The authors of the module are convinced that in such a way the learners will get a sort of crash course of the Czech history. Due to the fact that t-learning should be rather entertaining the authors can assume that the learners will be in certain way immersed in the course when watching it.

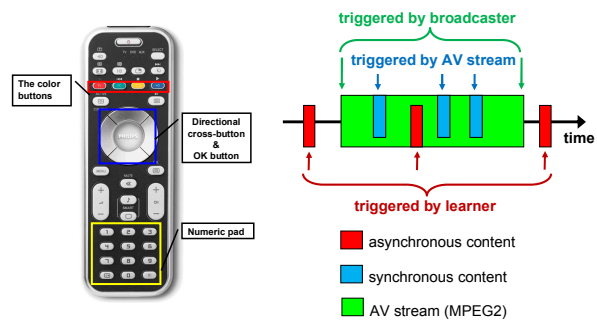


Figure 6. Remote control for iTV and the structure of the iTV course

As the target audience were seniors – specific problems when designing user interface (in addition to specific features of TV remote controllers) had to be considered. There are three main characteristics of the target group that had to be taken into account:

The first characteristic is that a typical learner from our target group has no experience with computers and Internet, high-end mobile phones, and other electronic devices with complicated user interfaces. Therefore it is expected that the learner will not be familiar with complicated user interfaces and that controlling electronic devices using such user interfaces may cause her/him problems.

The second characteristic is the health of our target audience. There are visual or/and hearing impairments that are consequence of higher age.

The third characteristic includes problems with cognition. Elderly people have problems to follow several tasks in parallel.

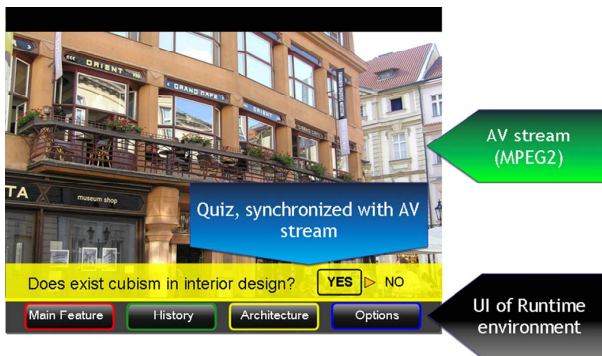


Figure 7. Example of quiz in ELU project. The quiz is synchronized with the AV stream

The first two characteristics concern mainly design and implementation of the user interface. The third characteristic concerns the distribution of additional information that is synchronized with the AV stream in time (see Figure 6.). The distribution of the information in time has to be done very carefully otherwise the learner could be overloaded with information and thus stressed.



Figure 8. Example of object highlighting in ELU project

Especially in this very project considerable attention was paid both to the design of user interfaces and to their testing [10], [11]. The method of user interface development was based on the user centered design approach. Besides gathering information about users in the early stage of the project also intensive user interface prototyping took place in all stages of the user interface design. This approach resulted in the design of the user interface for the given application the users were satisfied with.

The user interface design also considered user interaction during the learning process. After some stuff was delivered the users were asked to answer a short test dealing with topics delivered few seconds (or minutes) ago – see Figure 7. The answers were evaluated and at the end of the session the users were informed about their performance.



Figure 9. Participant of the ELU course test answering the quiz

As the way of interaction with our Cultural heritage education module in iDTV environment should be acceptable for common users, there were made usability tests throughout the whole process of development of the user interface for this course. One of first tests was performed by means of a prototype (written in Adobe Flash). The test setup was a TV set with ordinary remote controller (see Figure 6.). In the usability test participated 7 persons (all above 60 years of age). The findings from this usability test helped to modify the original user interface design. Participants appreciated the usage of the directional cross (arrows) control as it was intuitive for them. Also highlighting of important objects during the course was found as very convenient (see Figure 8.). During the next tests (where participated more than 30 seniors) some problems when dealing with quizzes were identified – the participants had due the time pressure a problem with using the directional cross (see Figure 9.). The movement of the cursor by means of pressing arrow buttons is in the case of elderly users too slow. Based on this observation the selection of the right answer in the quiz was changed to pressing the number on the numerical pad (see Figure 6.). Interaction in the final test was considered as rather demanding for the users with little experience with information technology.

Each learning module was accompanied by bonus material where an additional knowledge about particular topics mentioned in the learning module can be obtained. Also in this part some additional tests are an integral part of the bonus material. Specific entertaining feature – game “Find the Phantom of Prague” was designed (see Figure 10.). In this game the user should find the Phantom that is hidden in 7 various locations on the route. Each successful action of the user (the Phantom was found) results in obtaining one key. As the Czech coronation jewels are locked in cathedral and the number of locks is seven – the successful user can “unlock” the treasure chamber and can see the coronation jewels. The process of the Phantom finding is based on answering questions related to the learning course. The correct answer helps to find Phantom location (and thus obtaining one key).

Since the user interface for iDTV environment in combination with specific target group (seniors) was a complex issue it was necessary to deal with the user interface design in a systematic way. Firstly an extensive user research had to be performed. Secondly high-fidelity prototypes (Adobe Flash)

were developed and design concepts were tested with our target group. The findings were finally synthesized in a form of guidelines for user interface design in iDTV environment.

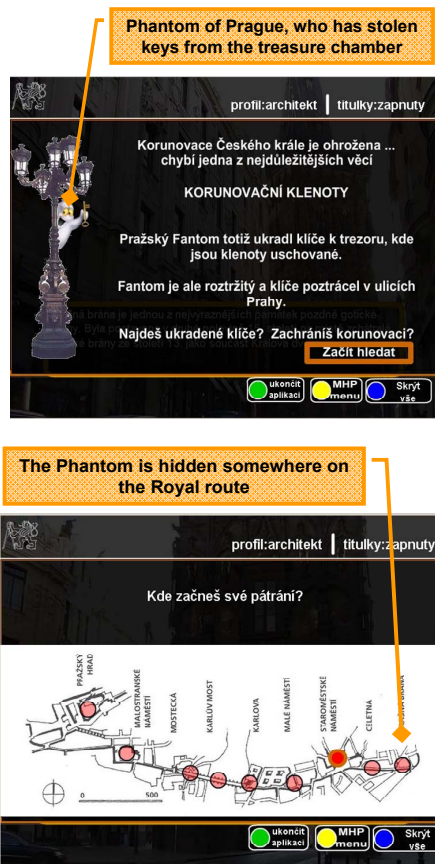


Figure 10. Serious game "Find the Phantom of Prague"

VIII. CONCLUSION AND FUTURE WORK

The paper summarizes experience gained with Cultural Heritage projects at DCGI. The main goal of these projects was presentation of Czech Cultural Heritage by means of information technologies of various kind. As these technologies mutually differ many specific problems had to be solved. Our focus was primarily put on user interfaces as the high quality user interface allows the user to interact easily with the learning module. Such a feature (easy interaction) is necessary both during the navigation in the learning stuff (it can have various forms: 3D walkthrough, navigation in the course structure etc...) and when answering questions (either in form of classical test or in the form of some kind of game).

Conclusion can be made that serious games accompanying learning modules can hardly be successful without proper user interface. An overview of experience in the field of user interface design in various applications was given in the paper. The main problem we encountered during our work was absence of a systematic method for designing and evaluation of

user interfaces. In some cases (namely in the ELU project) we succeeded to develop our own approach to the user interface design that was successfully used for our particular application (Cultural Heritage plus seniors as a target group).

Future work in this field should be dedicated to the design of methods applicable for the design and evaluation of user interfaces for specific class of applications. We namely feel the absence of such a method in case of user interfaces used in 3D environment. In future research a big effort should be dedicated to the creation of methods for design and usability testing of 3D based applications.

ACKNOWLEDGEMENTS

This research has been partially supported by MSMT under research program MSM 6840770014 and by the MSMT under the research program LC-06008 (Center for Computer Graphics).

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