Realism vs. Reality: Creating Virtual Reconstructions of Architectural Artifacts

Abstract

Virtual representations of architectural artifacts present spatial properties of particular objects. It is not sufficient to provide visual accuracy of the model without broader context. Structure, backgrounds, scenarios and narratives are necessary to immerse the viewer into virtual re-creations of the artifacts and to understand their original function. The concept of immersion has been explored by researchers in VR. The concept of recognizable place is closely related to the concept of immersion. Mixed reality systems, involving real objects, images and synthesized ones deliver the most convincing sensory input to the viewer. The paper discusses different case studies of virtual representations delivering the sense of place and function of the reconstructed artifact pointing out what problems are addressed during the reconstruction process.

Keywords-**Virtual heritage, VRML/X3D, 3D modeling**

1. Introduction

Two-dimensional drawings and three-dimensional models have been the traditional medium for description, visualization and documentation of architectonic objects. Understanding spatial relations of different buildings and public places leading to recognition of their specific style are vital to the researcher when trying to study the evolution of architecture. Documentary resources provide partial evidences of changes that took place in the past. The mass of documents is constantly growing, thus offering more space for combinations and possible scenarios of reconstruction. Two-dimensional representation of data has found its valuable place in online community through Geographical Information Systems and data repositories offering high resolution image scans and QTVR object movies [1,2,3]. On the other hand, 3D visualization remains in close relation with perception of space. Virtual renderings present intuitively information about spatial properties of the building and its surrounding. A viewer instantly recognize the form and the style of particular building as long as its representation is not oversimplified. Geometrical complexity of the virtual model is usually a result of trial-and-error process of reconstruction. Extensive consultations with various experts is 'a must to' in order to deliver accurate and credible models of no longer existing buildings. Off-line

visualization either in a form of still images or digital video is usually meticulous but well documented and can be done after some training [4,5]. The problem of visual accuracy in virtual models arises in cases when interactive 'walk-through' environments are the main goal of reconstruction. In order to meet real-time criteria the models must be simplified. Simplification of geometry is a primary methodology in game programming, online 3d repositories and low-cost visualizations [6,7]. It is also possible to replace some geometry details with their flat renderings – 'baked' image textures. This way almost photo realistic visualizations can be created [8]. To convey information with context and in appealing way, it is necessary to presented as much background information to the viewer as it is possible. Textual and image documentary is relatively easy to present with the help of hyper links and WWW (images, drawings). Environmental context, giving visual background to the presented virtual objects is more demanding. Several authors discussed the topic of accurate reproduction of complex visual environments [9,10] but they aim mostly at dedicated high-end solutions. In the paper, the author presents his experience with creation of accurate virtual reconstructions representing existing and destroyed architectural artifacts with their environmental context. They are targeted at end-users with low-cost PCs connected to the Internet. A case studies of three different reconstructions is presented: The Castle in Chojnik (surrounded by Sudety mountains), the Synagogue in Zielona Góra presented within the cityscape and the City Hall in Poznań (in the old market square).

2. Virtual Reconstructions

2.1. Conceptualization

The interdependence between the documentation, analysis and visualization has a history that originates in renaissance and now is one of the key issues in architectural visualization [11,12,13]. It is assumed that visual results are in no way the elements of information in a research when they are not accompanied by documentation that validates their content. On the other hand, documentation analysis would be far more complicated without visual clues obtained by rapid prototyping that enhance understanding. This is particularly visible in education and edutainment, where visual models may be a first step to understand function of buildings and its changes. This may invoke the need to go

deeper in fact and document analysis in order to reveal the historical facts.

Documents and visualization of historical processes that are reflected by the cityscape are closely related to the scale of analysis. Each scale needs appropriate representation that matches the complexity of the objects considered. For the whole city, 2D GIS (Geographical Information System) is the best solution to illustrate changes in parcels, streets etc. [2,3]. If separate buildings are considered, three-dimensional visualization is far more appropriate to describe spatial relations between the object elements. The details and sculptures should rather be represented as 3D structures [10, 14,15,16,17,18].

2.2. Visualization

The main goal of visualization is to bring understanding of data. The task is to present complex information in the most comprehensive manner. Considering architectural artifacts, the visualization process is mostly focused on the understanding of spatial relations and on the recognition of particular style and form. The most natural way to convey this information is to build a three dimensional model. The construction should be seen as an intentional activity based on thoughtful well informed and inventive decision-making. Such construction is best seen as the construction of meaningful forms and experiences close to the real world impressions. Unfortunately, most of the visualizations depict static environments without context, i.e. atmospheric effects (weather, seasons) and very often without context (pedestrians-humanoids and foliage). In order to give the spectator feeling of immersive environment one should support the viewer with visual cues such as shadows, photorealistic rendering, texturing that mimics natural materials and physical based motion. Unfortunately photorealism is based on powerful yet demanding technologies such as ray tracing and radiosity that are too slow to apply straightforward in internet-based real-time applications. Physical modeling plays important role in the animation process, motion of the models should be coordinated and give impression of their weight and behavior (for instance a wrought iron gate should open slowly with some inertia). There is also a problem of illustration of changes in the cityscape (refurbishments, destruction, …).

2.3. VR interfaces

Applications of the VR (VRML and X3D, Xj3D) standards in architecture have often been discussed [19]. The web-based VR languages provides features that represent both geometry of 3D objects, they appearance and make possible to assign actions and events to introduce 'walk-through' interactive manipulation and modification of the scene content. The virtual scene can be built and assembled off-line in any of the modeling environment, as long as the modeler remember about mesh optimization before the model is ported to the Web3D. It is possible to create visually correct scene that supports comparative analysis and understanding of different aspects of architecture. It is also possible to re-create appearance of the building in different periods in history.

Much harder problem appears if one wants to swap some elements in real-time, where user choices trigger animation sequences and changes in reconstruction. VR usually provide human-view of the content that fits the human scale of the observer-pedestrian wandering on the streets of a virtual city. There have been many examples of the 2D and 3D interface applied to time-related visualizations [4,18]. There is also a number methods than can help with the process of optimization of user actions while accessing a multimodal data [19]. They include highlights of selected buildings, transparency triggers (switching on/off visibility of selected buildings) and view-point controlled actions (through proximity sensors, triggering visualization process when the observer approximates the location). The most popular for stratigraphic applications in VR is a global scene control, usually placed as a separate 2D GUI control slider, that provide a client-side control over the whole scene [18]. The slider usually marks certain periods in a building morphology and triggers download of several virtual scenes representing different stages of the object development.
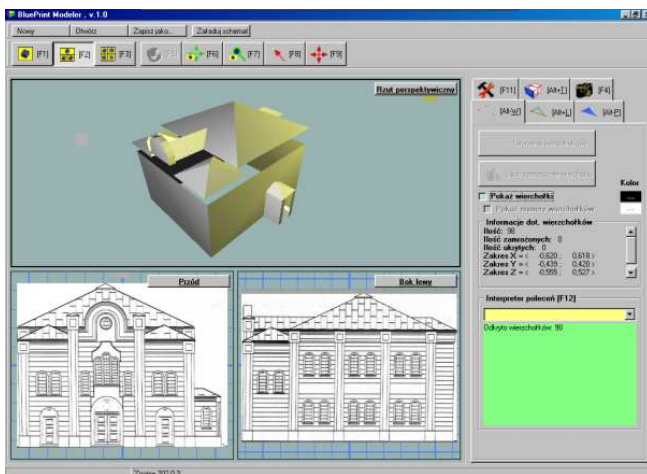
2.4. Case studies

By exploring the technologies typical in the computer games industry it is possible to provide end-user with better sensory experience. Characters, animations and scene construction, while borrowed from game programming offer cost –effective solutions targeted both at proprietary museum display systems and at low-cot PCs with broadband internet access. Based on low-count polygon modelers, scene assembly editors and image editing systems three environments depicting different artifacts have been constructed. The castle in Chojnik is a ruin of medieval fortifications in Sudety mountains, enchanting tourists with its history and prominent views from the tower.
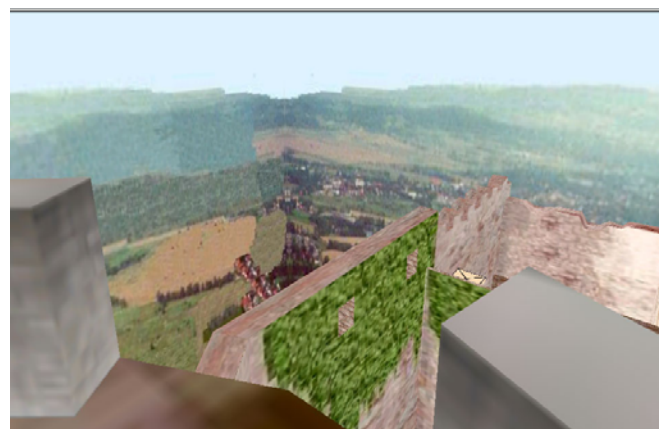
Figure 1 A view from virtual Castle of Chojnik

Figure 4 The virtual Synagogue in Zielona Góra (a night view with the cityscape)

Figure 2 The Synagogue in Zielona Góra (an old photograph)

Figure 5 The virtual city-hall in Poznań

Figure 3 The virtual Synagogue in Zielona Góra (construction of the 3D model)

The synagogue in Zielona Góra was burnt in the 30's but before it had been one of central buildings in the cityscape. The city hall in Poznań was chosen to demonstrate a stratigraphic visualization. The city hall has a long history and several refurbishments over the past époques, till the currently recognized complex renaissance form.

Three 'context' objectives were selected. To re-create the panorama of Sudety as seen from the castle (Fig. 1). To re-create the mood of Glasser Platz, that originally hosted the synagogue in Zielona Góra (Fig. 2, 3, 4)and to illustrate changes that took place in the city hall in Poznań before and after World War 2 (Fig. 4). To meet the objectives extensive image rendering techniques were applied, including photogrammetry correction of the panoramic views and adjustment of lights and shadows. The web-based VR representation usually does not support active shadows. During the reconstruction process it was decided to represent the mountains in a shadow-less bright cloudy day. For the synagogue project, the shadows were faked by textures. The objects were put in a winter night scenery, hiding flaws in the re-constructions of the surrounding buildings. The most complex model of city hall in Poznań presents user some key elements of the building and surrounding environment.

Figure 6 The changes depicted in virtual city-hall in Poznań

User can choose three modes of navigation: browse web pages with embedded VR visualization accompanied by other digital documents giving credibility to the reconstruction, switch a few events that change reconstruction of the object or choose the "guided tour" to navigate surrounding of the city hall and observe changes that were made to the object in real-time (Fig. 6).

Conclusions

The architectural visualization presents several challenges in the field of virtual heritage. To the artifacts have always been made with some cultural and environmental context. It is not sufficient then to provide only visually accurate model without broader analysis and information support. Structure, backgrounds, scenarios and narratives can help to immerse the viewer into virtual re-creations of the artifacts. Mixed reality systems, involving real objects, images and synthesized ones deliver the most convincing sensory input to the viewer. The paper discussed different case studies of virtual representations delivering the sense of place and function of the reconstructed artifacts.

Acknowledgements [1]

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