Virtual reconstruction of medieval Zielona Góra- a case study

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Abstract

Virtually reconstructed architectural artifacts and cityscapes are becoming a crucial factor in promotion organized by cultural and art-oriented institutions. The paper presents issues related to digital reconstruction and modeling of architecture, considering the multimedia capabilities of currently available systems. The tradeoff between realism and real-time modeling will be discussed along with technologies enabling better user engagement in the 3D scene. Finally, we present the 3D model of the old-town of Zielona Góra ready for free exploration to prospective virtual tourists.

Keywords: interactive 3d graphics, virtual reality, digital cultural heritage.

1. Introduction

Architecture examines and creates environment and objects with the human context. There is important advantage of virtual representation of architecture – it shows spatial relation of models and environments in a natural way. It also helps to present objects that do not exist any more with photorealistic precision. It is relatively easy to integrate virtual objects into static photographs. Virtual environment might be the next stage in development of visualization systems and 3-dimensional computer graphics. The main difference between traditional 3D graphics and virtual reality system is interaction and immersion (giving feeling of presence in a virtual world). A user has direct contact with computer-generated models and can directly manipulate them. One adequate definition says virtual reality is applying information technology to create interactive 3-dimensional world effect, in which every object has presence property. Since the beginning of 3D graphics people have been trying to develop tools, that would generate virtual reality according to rules of real world. First attempts had failed to deliver planned effects, though. Computers had been simply too slow to cope with complex 3D models. The internet contributed to fast information exchange and development of 3-dimensional graphics. At first, web sites could contain image and sound, but that was not enough to present spatial complexity of architectural objects. With the technological progress, computers have become more and more powerful and can generate more and more complex 3D models. VR systems can help with visualization of architectural objects, that do not exist in real world. It is possible to create single objects, virtual museums or even the whole virtual cities (ex. Virtual Rome – www.vroma.org).

Fully interactive 3D reconstructions for cultural heritage raise many questions:

- 3D models are only an approximation, they are a metaphor of real objects. 3D models hardly resemble old artisan work on artifacts. Nevertheless when carefully designed, manually constructed objects are the closest approximations to real objects.

- There is a problem of reliability of historical source data. The older and more destroyed documentation is, the more possible is 'over-interpretation' of virtual reconstruction. In similar way to artists in the 17th century we just use available tools to give the 'subjective' image.

- 3D objects are perceived to be 'finished' and objective. In opposition to pictures, that are kind of symbolic, they have features of physical objects (including surface, material, lighting). Furthermore, cinematic quality of 3D graphics is now expected, but the more detailed image the more probable is that it does not show the reality correctly.

Despite this limitations, using many tools and techniques of modeling, it was possible to create virtual model of old-town of Zielona Góra. To describe the model VRML (Virtual Reality Modeling Language) was used (Ames 1997, Dąbkowski 1998, Lea 1996). We chose this technology because there are many editing tools and the Internet browsers interactive viewer plug-ins available. Currently we are working on more advanced technologies (X3D).

2. VR Techniques

Growing popularity of virtual reality has resulted in a number of open standards for describing virtual worlds (3D models). The most popular technology is VRML (Virtual Reality Modeling Language). It is a file standard for describing interactive 3D vector graphics. VRML was mainly developed for World Wide Web. In 1997 a new version of the format was proposed, called VRML97, also known as VRML 2. It was accepted as international standard by ISO (International Organization for Standardization). Vertices can be described, apart from coordinates, by additional information like color, UV mapped textures, lighting properties, transparency and others. The format supports lighting, cameras, sounds, animations, interactions and so on. It's well recognized and still widely used. There are many tools available as open source applications. The successor of VRML is X3D, which also is ISO standard file format. It's based on XML and used for describing 3D vector computer graphics. It extends functionality of its predecessor among others by such features like Humanoid Animation and NURBS.

There are many techniques improving presence of user. One of them is stereoscopy. Stereoscopic image provides two pictures showing reality from two viewpoints. The difference between the points is usually similar to distance between eyes. Looking at this pictures by right and left eye separately makes illusion of 3D view. Unfortunately, it requires special hardware. Probably the most popular are VR glasses with two LCD screens. Orientation sensors are often attached to such kind of glasses. They make looking around in virtual world as natural as possible. Another device, special gloves, makes the user can move virtual hand in visualization by moving real hand in real world. Thanks that, he or she can more naturally interact with virtual environment, touch, grab, throw virtual object and even feel it. The interaction between user and the virtual environment becomes one of the main feature of enaging simulation.

3. The history of old-town of Zielona Góra

To these days not much left from medieval fortifications. Probably the only proofs of its existence are: a fragment of defense wall in the north part of the city, a fountain placed where the old moat was and Bath (Łazienna) Tower in the south part of the city. In early Middle Ages, Zielona Góra was protected by earth embankments, which surrounded market with buildings. It is not known much about shape of earthworks, gates, drawbridges, watchtowers, etc. No thorough archeological research was made in the city. If done, it could explain many doubts. The fortifications did not work well probably. At the beginning of the 15th century it was decided to build new ones, made of new more durable materials: brick and stone. The decision was made by prince Henryk IX in 1429. Medieval protection circle contained defense wall, Hunger (Głodowa) Tower, Bath (Łazienna) Tower, The Upper, Lower and New Gate, Bastei and moat around whole city. Since the beginning a town hall was the central point of the city. It has very rich history and it "remembers" every important for

the city events. At first it was made of timber. Then, in the 15th century construction was replaced with bricks. Next to it, there was a market place. In that place craftsmen sold their goods. Arrangement of roads, in comparison to current one, have not changed much either. All merchant streets were localized around the town hall, as they are to nowadays. The defense system had not changed until middle of the 18th century when few parts of it was demolished.

In our project we have presented all buildings of the medieval town. Additionally, some objects built in 18th century (i.e. Matki Boskiej Częstochowskiej Church) have been included. The projects gives chance to user to see the old-town of Zielona Góra from the 18th century, when all parts of the fortifications existed. For these days not much left after the defense system (Dąbrowska 2005, Kowalski 2002). In a book by Wojciech Eckert „Fortyfikacje Zielonej Góry" („Fortifications of Zielona Góra") there are many pieces of information used to reconstruction of the most important buildings of the defense system of the old-town (Eckert 2003).

Rest of objects were created based on a scale model of Zielona Gora from the middle of the 18th century. It is placed in Muzeum Ziemi Lubuskiej (Lubuska Land Museum). The main streets with buildings are shown on the scale model (Ciesielski). Thanks that it was possible to create virtual city centre according to both aspects, architectural and historical.

4. The virtual old-town of Zielona Góra

Virtual model of Zielona Góra with all divers architecture, citizens and objects like moat, trees, grass needed considering hardware requirements. The whole scene was very complicated and the visualization should work in real-time. It was necessary to find right balance between realism of the objects and their computation complexity. Many optimization techniques was used to improve efficiency of virtual world. First of all, the number of displayed triangles is limited to current needs. If a user stay close to object, he or she can see its structure clearly, since it is more detailed. With rising distance the resolution of models lowers, but the user do not see the difference because it is too far. The number of levels of resolution for each object is dependent on complexity of the object. That highly improved efficiency of virtual city and did not lower the quality of image. Textures used to show architectural details and facture of the objects are high resolution according to keeping good quality. Cinema4D was used to texture models.

During building virtual old-town of Zielona Góra, the important part was expanding it of interaction objects. In the scene there were placed special interactive spots where user can hear an information about particular place. They give historical knowledge about the town. The City coat, cemetery or whipping post are only few examples of many. They cause better understanding of historical background of the old-town of Zielona Góra.

Important aspect of visualization was providing similar condition to natural ones in real world. Including gravity allows user exploring the scene only in walking mode. Sever vantage points connected with the most important objects have been added. Few of them are not available from ground level (ex. view from inside of the Lower Gate or view of city panorama). Because of perspective projection there are optical distortions. That is the reason why small angle of view is used (45 degrees in comparison to 160x110 degrees in human eye). It causes problems with reading virtual space. Objects look smaller than in real world. There is also problem with assessing altitude differences. The next part of the project was expanding visualization by animated sky, trees with branches which moving slightly on the wind, and waving grass and flags. Model of the moat surrounded the whole old-town was also created and added into scene. Finally, to enliven the virtual world, background music was attached.

Fig. 1. The scale model of Zielona Góra in 18th century from Lubusky Land Museum

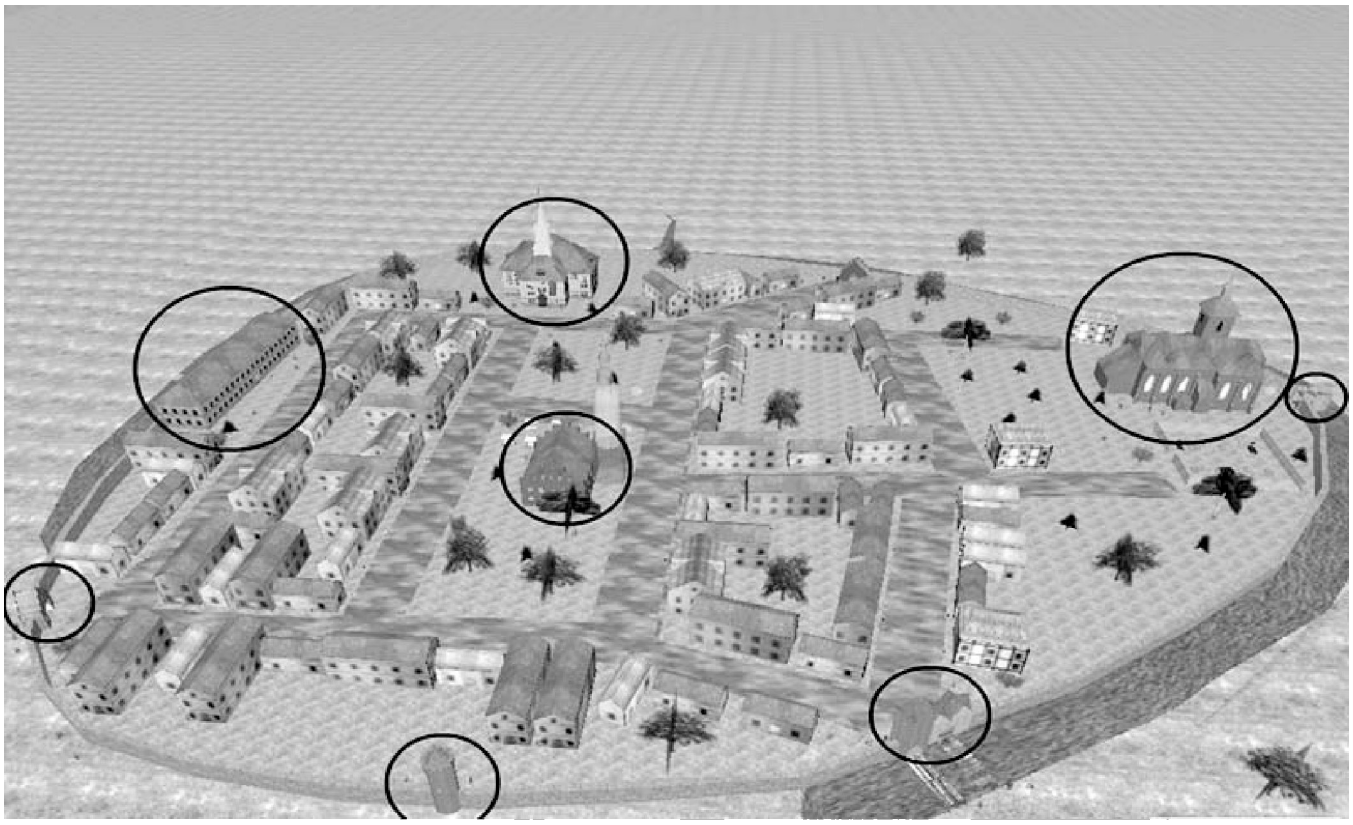

Fig. 2. Virtual reconstruction of the old-town of Zielona Góra and some viewpoints

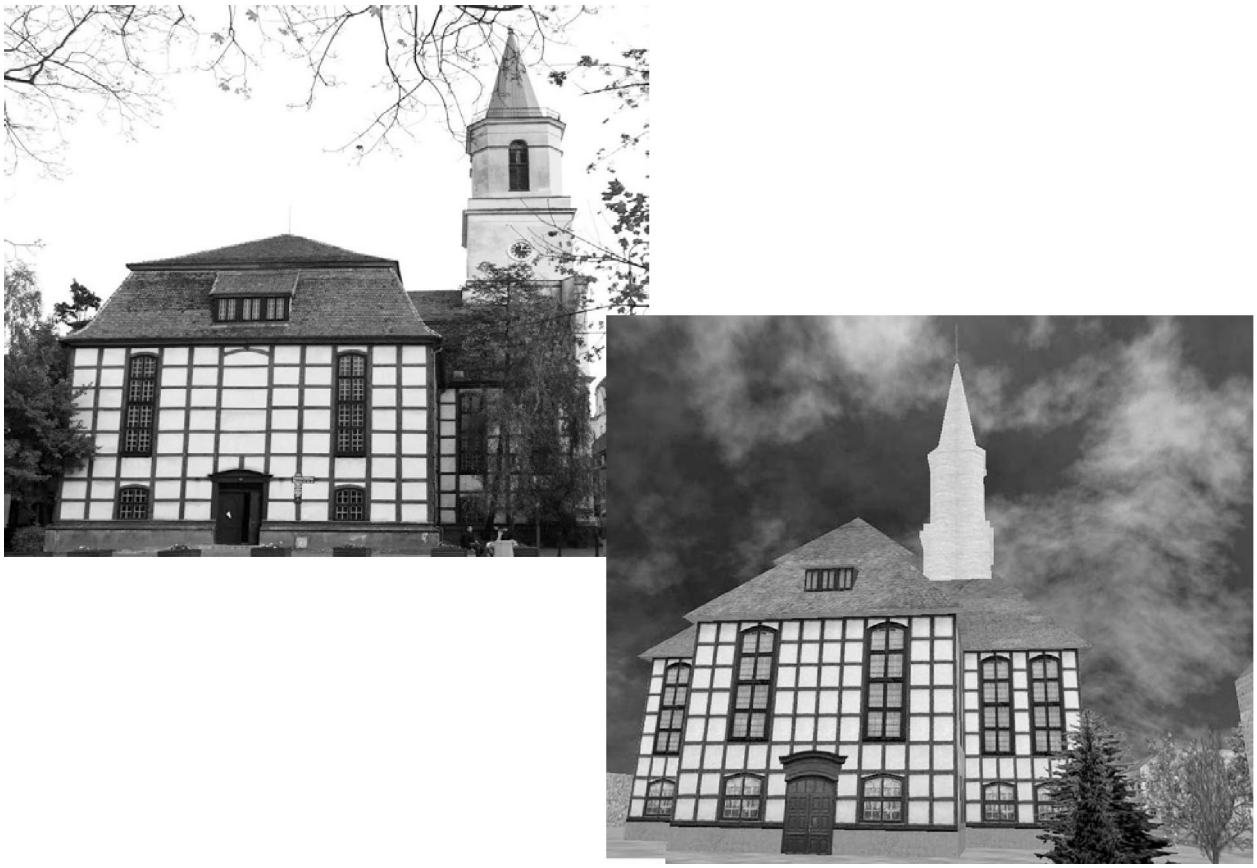

Fig. 3. Matka Boska Częstochowska Church in Zielona Góra and its virtual reconstruction

Fig. 4. St. Jadwiga Cathedral in Zielona Góra and its virtual reconstruction

Fig. 5. Reconstruction of the Lower Gate from 15th century and a photograph of ornamental paving fixed in promenade where the gate was originally located

5. Conclusion

Building a compelling VR environment based on visualization of architectural objects is a time-consuming process. The goal of the project was a virtual reconstruction of the old-town of Zielona Góra in VRML. Prototype application enables user to explore and sightsee places, which he or she would never see in real world. The success of the project required effective using of tools. Available sourcebooks, the scale model and other material made the work easier. Another important aspect was finding right balance between complexity of models and their realism. The goal is achieved. Virtual models are very similar to real objects: the landmarks can be found in the old-town. The application is optimized enough to work in real-time. The final effect is the educational application with historically-correct content. It shows possibility of adaptation 3D graphics to modeling architectural objects. It can be also used as a showpiece of monuments of Zielona Góra by Digital Cultural Heritage (Yastıklı 2003). Our system is efficient enough to be presented on multi-screen VR systems (Teo 2000). Current dynamic technological progress lets us think optimistic about the future of virtual reality systems, which will not be so limited by hardware and they will be more and more realistic.

6. Literature:

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