Modellierung der Struktur von architektonischen Artefakten – Polnische Kirche in Zielona Góra

Modeling structure of architectural artefacts - Polnische Kirche in Zielona Góra

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Zusammenfassung:

Die Analyse der baulichen Struktur ist bei der Betrachtung von Artefakten der Architektur einer der Kernpunkte. Bauingenieure benötigen detaillierte Spezifikationen über Materialien und Technologien, die beim Bau und bei der Rekonstruktion verschiedenster Objekte verwendet wurden. Die architektonische Gestaltung basiert bei Rekonstruktion und Modernisierung auf räumlichen und strukturellen Informationen. Es gibt zahlreiche Tools für derartige Prozesse, darunter ArchiCAD, ihre Verwendung ist gewöhnlich beschränkt auf die Applikationsumgebung. Andererseits bieten die weit verbreiteten VR- und 3D-Spiele-Technologien eine leistungsstarkes Rendering und die Möglichkeit eines virtuellen Rundgangs. Sie sind visuell realistisch, die Bildgebung ist aber zumeist begrenzt auf die Oberfläche der Objekte und vernachlässigt deren Konstruktion. Der Vortrag präsentiert Ergebnisse eines Projektes, in dem VR-Techniken zur Rekonstruktion der Gebäudestruktur zur Aus- und Weiterbildung in den Bereichen Architektur und Geschichte genutzt werden.

Abstract:

Considering architectural artefacts, analysis of their building structure is one of the key issues. Civil engineering requires detailed specification of the material and technologies used to build and reconstruct certain types of objects. Architectural design is focused rather on spatial and structural information to handle reconstruction and modernisation of the artefact. There are a number of tools dedicated to those processes, including ArchiCAD, however their usage is usually restricted to the native application environments. On the other hand, popular VR and 3D gaming technologies offer high performance rendering and walk-through capabilities of visualizations. They are visually realistic, but the imaging is usually limited to the surface of the object, neglecting its construction. The paper presents results of the joint project, where the VR engineering is used to reconstruct structure of the building for the purposes of education and training in architecture and history.

1. Introduction

Students of architecture needs training both in history and in currently available technologies. Understanding structural engineering, physical construction and spatial relations is necessary to educate people that, in future, will develop city infrastructures. Visualization of old techniques through the recent technologies is one of the most demanding tasks. Rapid development in ArchiCAD contrasts with mundane manual works of an artisan several decades ago. Old buildings were built manually without CAD models, however 3D real-time models of such buildings can help to understand their function and construction [1,2,3,4].

A number of techniques have been developed to preserve information on architectural artefacts. One of these methods is to store digitally reconstructed models of monuments with possibility of their further display. Commonly used techniques (i.e. laser scanning) help to preserve detailed spatial information about real-life objects. Object geometry can be acquired with help of various

scanning techniques that rely on telemetry and remote sensing. The problem is how to choose the method that can be more efficient and better fitted to depict not only appearance but also structure of the object. Moreover, the usage of laser beam or automatic photogrammetric systems gives in output large amount of data, which causes problems with storage and visualization of the reconstructed models. Still, the outer 'shell' of the object is captured. The other way is to take some shots of the target objects – but static photographs aren't valuable since they give little or no spatial information. Sometimes it is better to rely simply on manual photogrammetric and 'blue-print' based reconstructions [5,6]. That is particularly useful in reconstruction of destroyed buildings.[7]

Manual reconstructions exploit a great thing – human knowledge that is used in the reconstruction process. User decides what details are to be reconstructed and can personally supervise modelling process. Of course it involves some difficulties like analysis and manual processing of the data. Typically photogrammetric reconstructions are based on the perspective photographs and drawings, 'blue-prints'. Results are usually unsatisfactory – user has to manually correct structure of the model. The paper focuses on such technologies applied to virtual reconstruction of both structure and appearance of no longer existing artefact.

2. 3D Modeling based on the orthogonal views

Modeling based on the orthogonal views is used to visualize artifacts for architecture. The process usually can be split to three fundamental phases:

- processing data – the orthophotos are made from perspective photographs;
- calibration of the virtual orthogonal cameras;
- main reconstruction of the object.

Orthogonal/parallel views are very helpful in modeling (calculations in reconstruction process are simpler than for perspective photographs) but require pre-processing phase that consists of:

- removal of lens distortion from perspective photographs,
- removal of perspective with use of the perspective correction algorithm.

For blueprints (technical drafts/orthogonal views) the problem is simpler: it relies only on correction (translation, rotation and scaling) of the blueprint. Such blueprints are usually delivered by civil engineers and are based on historical drawings and on the knowledge on technology.

3. Virtual reconstructions - visualization of the Polnische Kirche in Zielona Góra

Virtual reality systems can convey the sense of actual objects within the place reconstructed. By exploring the technologies from the computer games industry, it is possible to provide low-cost end-user experience usually reserved to high-end dedicated systems. Objects and scene construction, typical to game programming, offer cost–effective solutions targeted both at educational applications and at low-cost PCs with broadband Internet access. Similar techniques have been used in the joint project (architecture and computer graphics). Based on low-count polygon modelers, scene assembly editors and image editing systems the virtual model of the destroyed church in Zielona Góra has been constructed.

The 'Polnische Kirche' was destroyed in 1850. It has gained attention of historians and architectures because of its construction. The original half-timbered construction was efficient and durable, however at the cost of mundane hand-works during the building process. It took several years of research to agree upon the structure of reconstructed artifact. There are only few drawings from XVIII century depicting the building and its placement in the cityscape of Zielona Góra (Fig. 1). Based on them, on historical knowledge and on rules of construction, the architectural drawings of the 'Polnische Kirche' were prepared at the Faculty of Civil and Environmental Engineering, University of Zielona Góra (Fig. 2). They are an approximation to the real building and the discussion on this particular artifact is not yet closed. The structure of the virtual model is very accurate and follows the rules of civil engineering. Each beam in the timber framework has its own function. Its position and shape is by no way accidental. A virtual model depicting both inner structure and completed building was optimized for web 3D applications (VRML/X3D) (Fig. 3).

5. Conclusions

Handling very complex and detailed models is not always the main goal of 3D visualization. The low-count polygon models with limited geometry can offer something different. The idea of rapid development systems for architecture should be treated as a fast 3D sketching tool that can describe both the outer look of the building and its inner structure. With use of limited geometry, details still might appear – on the texture that can be easily prepared. Final effect will depend only on user's work – automatic systems usually deliver too much complexity – only human might create the optimised and spatially accurate virtual model. The reconstruction shows that the process with very accurate results might be completed only manually. It can serve as a mean of education to the students of architecture and history. Resulting model can be used as a part of a complex scene, even for real-time purposes due to its low complexity. Reconstruction from the drawings and image planes helps with better analysis of the geometry of artifacts comparing to the automatic process. User can decide what is to be reconstructed and this helps to create optimal polygon model (a 3D sketch). There is a number methods than can help with the process of optimization of user actions while accessing multimodal data [8]. With the technique, it has been proven that satisfactory results are obtained even if source materials are of low quality. Therefore it is possible to include it in the process of architectural reconstruction, adding new possibility of on-site 3D visualization and direct porting/ distribution of the model in the Internet [9].

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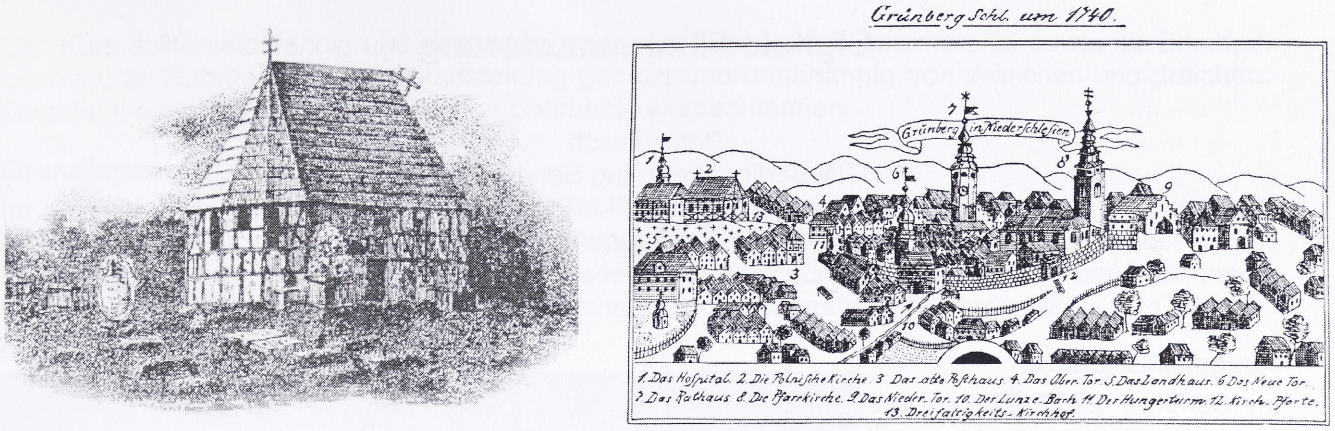

Fig. 1 The 'Polnische Kirche' and the cityscape of Zielona Góra (1740)

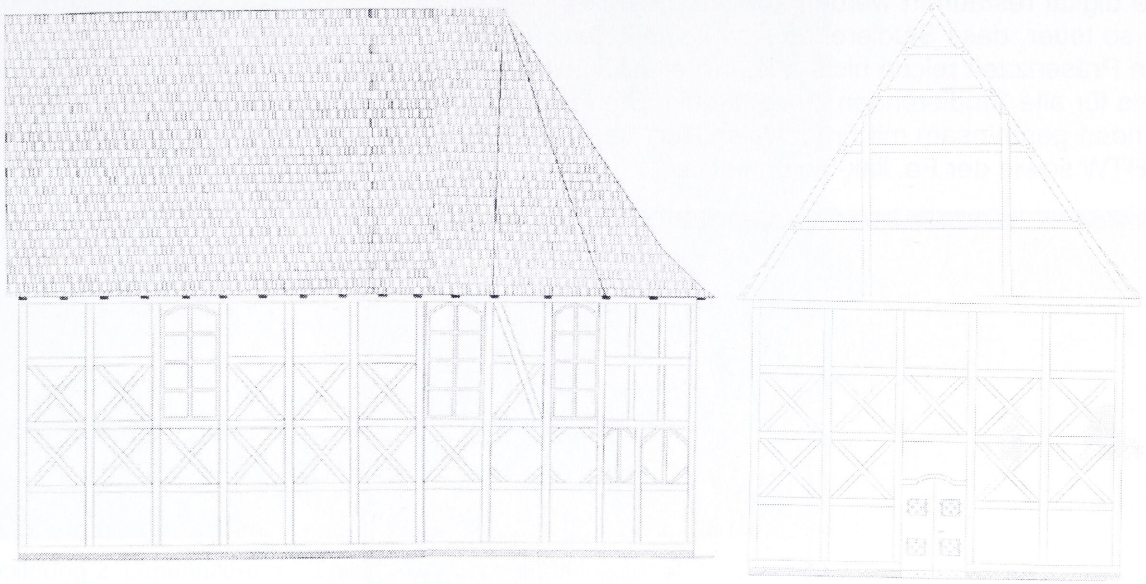

Fig. 2 Blue-print drawing of the church (side and front views)

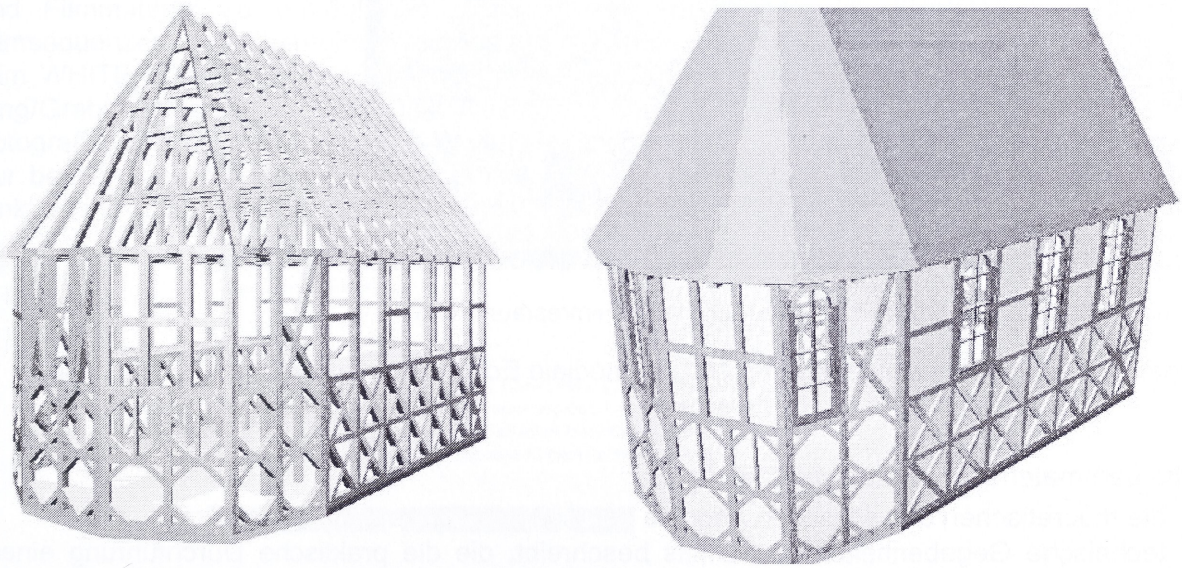

Fig. 3 Virtual reconstructions of the church (structure and complete building)