Digital 3D Reconstruction and Visualisation of Architectural Cultural Heritage – Review of definitions, terminology and requirements.

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Theoretical requirements meet the practical approaches.

Introduction

Theoretical framework for computer-based modelling and visualization in cultural heritage studies is currently reported as an invincible. The general principles were outlined by the London Charter (2009), demonstrating the need for diverse communities to develop their own guidelines implementation covered by their aims, objectives and methods. In response to this call, the Sevilla Principles (2017), defining the implementation of the London Charter in the field of virtual archaeology, were framed. For other disciplines, no official documents of this kind have emerged, leaving the entire community of computer-based heritage visualisation research in debate about terminology and definitions of basic concepts. The following paper is intended to look at existing standards, guidelines, recommendations and also practical approaches in order to outline the theoretical background from the perspective of a member of the architecture community.

Definitions

The foundation of any scientific field is its definition, which allows the identification of the covered research issues and the establishment of a specific terminology among the professional community. Visualisation-based cultural heritage field does not seem to have a uniform terminology, while a variety of expressions is used depending on the profession of the person conducting the research (Cazzaro, 2023). Therefore, it is crucial to classify the scientific disciplines which are concern with the topic of visualization of cultural heritage. The London Charter gives general definition of ***cultural heritage*** and defines ***computer-based visualisation***. The Sevilla Principles declare the first scientific discipline in favour of the computer-aided visualisation methods - ***virtual archaeology***, and introducing four types of possible archaeological interventions based on acquired the virtual model: ***virtual anastylosis*** (virtual restructuring existing but dismembered parts in a model), ***virtual restoration*** (virtual reordering available material remains in order to visually recreate something that existed in the past), ***virtual reconstruction*** (virtual recovering a building or object made by humans at a given moment in the past from available physical evidence) and ***virtual recreation*** (virtual recovering an archaeological site at a given moment in the past, including material culture, environment, landscape, customs, and general cultural significance).

Other scientific fields that make extensive use of computer-aided visualisation methods are ***art and architectural history studies***, ***museology*** and ***heritage studies*** (Münster, 2022, pp. 5).

None of these disciplines have developed broadly approved guidelines and definitions for their communities based on the London Charter. However, there are two important concepts broadly used in cultural heritage fields worth mentioning: **digitisation** understood as "*transfer of a physically existing object to a digital copy and 3D models derived from it*" (Altenhöner et al., 2023, pp. 23) and **digital 3D reconstruction** which refers to a process of creation a hypothetical visualization of a past object based on the human interpretation of data (Münster, 2022, pp. 8). The definitions of these terms have not been standardised yet and remain flexible. In addition, in some domains they appear under other names, such as **reality-** and **virtual-based modelling** (Münster, 2022, pp. 8), **geometrical** and **manual modelling** (De Francesco and D'Andrea, 2008), **raw** and **informative model** (Apollonio et al., 2023) or **source-based reconstruction** (Kuroczyński et al., 2021) and **retrodigitisation** (Altenhöner et al., 2023, pp. 23).

Requirements

The main objective of the London Charter and Sevilla Principles was to define guidelines on how to prepare computer-based visualisation projects of cultural heritage in a way that allows the study of used methods, sources, analyses or interpretations and the verification of final results. In other words, these documents outline the rigour required to recognise a computer-based visualization of cultural heritage as a scientific discipline. Among this rigour factors are:

1. The need to distinguish between authentic and hypothetical elements on the visual materials, introducing several levels of hypothesis if necessary.

2. Reliable documentation based on existing standards and ontologies including:

   - the aim and initial assumptions;

   - the research methods used;

   - the techniques used;

   - the source materials used, including their provenance;

   - paradata including evaluation, analysis, interpretation and deduction of source material;

   - the final result;

   - conclusions.

The omission of any of these factors results in questioning the scientific nature of the presented work. This topic is problematic due to the frequent restriction to the visual presentation of the final results in multimedia form. It makes inclusion of the full scientific documentation nearly impossible. That is why, it is important to present the most relevant elements of the documentation in a synthetic way together with final results and to include information where full documentation of the project could be find.

Evaluation

Accurate documentation of the digital reconstruction process can be an extremely time-consuming task. Practice has shown that most well-documented projects have required the development of their own documentation tools and systems, which has been resource-intensive (Kuroczyński et al, 2021; Nevola et al., 2022). As a result, almost every visualization-based project has its own evaluation

criteria and ways of presenting the final results. The lack of standardization of these methods and their complexity makes it difficult to quickly assess the value of the work, even if it meets the criteria required by the London Charter.

The first steps have been made towards inventing a simple method of assessing the scientific value of digital reconstruction projects by presenting this task to students at a seminar on digital reconstruction of wooden synagogues in Warsaw University of Technology and Lodz University of Technology. The students, after reviewing the professional literature, presented their own proposals for estimating the value of reconstructions as number using such parameters as the level of source reliability, the level of used detail development, the level of applied hypothesis, or level of reconstruction uncertainty. Their work was concluded with a graphic synthesis explaining the functionality of the invented method. (see Figure 1).

The results were unexpectedly intriguing. The fresh and innovative approach to the subject resulted in interesting proposals for evaluating reconstruction projects, along with easy-to-understand graphic visualizations illustrating the level of hypothesis and inaccuracy of the work. Due to the simplicity of the information delivery, this type of solution should be considered when creating a standard solution for assessing the scientific value of computer-aided visualization of cultural heritage.

Conclusion

Developing an appropriate theoretical background for the modelling and visualization of architectural heritage requires careful examination of existing general guidelines and discussion with representatives of all involved disciplines in order to collaborate in defining differences and similarities in terminology, methods and goals. A computer-based visualization field is still the lacking of elaborated and well-established methods for evaluating the value of work, which would allow fast and accurate assessment of reliability and utility of the work. The conducted assignment with students showed that the development of these methods is possible and allows to graphically present the scientific value of the work complementing the visual results of the reconstruction. As a result, it is recommended for development of the future recommendations for computer-aided visualisation of cultural heritage to prepare complementary documentation in graphical form that synthesises the requirements of the London Charter or the Seville Principles.

References

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