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The use of 3D computer graphics to preserve, reproduce and obtain information relating to a historically valuable object

Zastosowanie komputerowej grafiki 3D do zachowania, odtwarzania i pozyskiwania informacji oraz wizerunku historycznie cennego obiektu architektury

Abstract

This paper provides a summary of the benefits of 3D computer graphics for preserving, reconstructing and obtaining information pertaining to historically valuable architectural objects. The current technology is discussed including its most common applications and examples of solutions as well as the creative process of three-dimensional architectural modelling.

Keywords: 3D modelling, 3D graphics, digital reconstruction

Streszczenie

W artykule przedstawiono zastosowanie modelowania przy pomocy komputerowej grafiki 3D w celu pokazania korzyści płynących z wykorzystania tej metody w zachowywaniu, odtwarzania i pozyskiwaniu informacji wraz z wizerunkiem w kontekście historycznie cennych obiektów architektury. Omówiono aktualną technologię z jej najczęstszym zastosowaniem wraz z przykładami rozwiązań i procesem twórczym trójwymiarowych modeli architektury.

Słowa kluczowe: modelowanie 3D, grafika 3D, rekonstrukcja cyfrowa

Technological developments in the field of 3D graphics and computer-aided design have increasingly provided us with new tools for creating virtual representations of real-world objects. The ongoing nature of these technological developments continues to present us with new opportunities in almost every area of everyday life. The dramatic increase in the quality and quantity of knowledge available to us creates new potential with regard to artistic creativity, industry and science.

While discussing 3D modelling, we must regard it as a creative activity which can essentially be described as a mathematical representation of an object's surface in three dimensions by means of an appropriate software program. Depending on the software and what the given material is intended for, the current array of options is very wide. Many opportunities are available, but there are also limitations at the expense of the enhanced efficiency. This is related to the problem of the specific skill-set specialisation for a given task. Each program, like any other tool, requires a different approach and competence to operate it. The technique of creating models by sculpting, spatial drawing, manipulating forms, and generation by the means of parameters or any other aid from which the models are created requires a proper file format. This, in turn, introduces the problem of the accessibility of records for prospective recipients, and how a given digital material may be used in the future. With the constantly changing reality and technological progress, the creation of digital data records in a universal format, along with the accessibility to materials, may require either the implementation of certain rigid outlines or the establishment of specially designed projects. There is the possibility of transmitting data between different programs, but it is done with a certain amount of effort and sometimes it causes a loss in the value of the material. Despite these slight deficiencies, the ongoing process of program specialization has immensely contributed to the incredible achievement in the field of three-dimensional modelling.

How exactly does 3D modelling serve architects, historians, archaeologists and other researchers? It is an undeniable fact that spatial changes are taking place over time and are inevitable and indeed natural, whether it is due to natural, random, deliberate or human activity. Recognition of existing changes and the ability to understand them in the best way to excel in digital reproduction. At present, new potential is brought in the field of archiving and reconstructive projects with regard to monuments conceived in an alternative virtual space. It is what can be defined as a kind of timeless protection or preservation of information regarding the state in which the object was situated at a given time, or a way to obtain that kind of information.

There are numerous methods of creating copies of an object. They differ in the details and information resources they contain and each method has its own advantages and disadvantages. Depending on the established work organisation and the technological method, the digital record can be executed as either a comprehensive form which reflects the main parameters and substantial information about the object or a one-to-one virtual copy. The latter is achieved by using a highly detailed information recording process, which requires a sequence of diverse virtual replication techniques such as precise analytical research of the subject, this in turn enables creation of an almost perfect copy. Of course, the more information and quality is incorporated, the greater the expenses are, including the time required and the usage of hardware resources.

The basic of 3D modelling of existing buildings relies mainly on the transfer of a given object's reference points from the real world to the virtual world. The mapping of these points and their

coordinates in the Cartesian scale occurs in numerous ways; from old-fashioned walking with a measure and noting down measurements, through to the simultaneous work of reading an object's data, creating a spatial model and then applying methods of tacheometry, photogrammetry and algorithms which are able to generate a virtual object based upon the received visual material.

Work based on BIM deserves proper recognition. Building information modeling involves the work based on parameters, blocks, values, attributes and other important information. All data are collected together in a single file which allows to generate up-to-date information after any changes are applied to 3D model. Moreover, a digital entity created in this way becomes a valuable tool for use in other types of work. An example can be a scan made with the aid of the BIM method for an inventory. The scanned object was the front elevation of the Cadet School in Krakow made by the academic staff of the Cracow University of Technology and a representative of the BIMPOINT company [8].

The protection of architectural heritage through 3D modelling does not have to rely solely on the process of transferring the reality that surrounds us as it can also be used as a tool to acquire knowledge about the past and attempt to better understand it. In order to create the virtual speculative duplicate as accurately as possible, the digital reconstruction of a previous state of building or a building that no longer exists, requires an appropriate approach and suitable research procedures. The mere transfer of monument to a virtual space is not sufficient, what is required is reference to the relevant critical discourse present in the field of history. Sometimes, however, it calls for the aid of a wider range of scientific tools. The studied historical materials should, and even must, be regarded in terms of contextual, historical processes, which is broadly understood as a methodology of history. The theoretical aspect of this topic had been extensively discussed in the book of the Polish historian Jerzy Topolski entitled *Methodology of History*. The skills of decoding are of key importance in this situation. In every field, relevant knowledge and expertise of the 'symbol system' and the 'language' of the transcribed material is essential. In architecture, this is knowledge of reading plans, drawings, illustrations and descriptions that use building terminology, although it may not be sufficient itself when in contact with the form of 'old language'[5].

Depending on the available material, reconstructions differ. During 3D modelling process, the very method of analysing source material can evolve. Thus the whole process in the manner of asking questions about information in material changes. The analysis of visual materials for decoding information requires not only skills, but a variety of methods. For example, getting the proportions right can be achieved simply by measuring the length of the given building in a visual material and next by mathematical calculations convert the dimensions to the appropriate scale. However, the process can sometimes be considerably more complex. For example, one can identify the correlation between the length of the shadow, or by means of descriptive geometry, a common denominator on the scale of perspective depth. As has already been discussed, in the case of an existing object, methods including photogarmmetry, which allow determination of the coordinates of points that include a great number of different pictures of the architecture in development, provides the opportunity to not only reproduce but even generate a model with help of appropriate software. It often happens that there is no access to sufficient visual materials, which forces one to use a wider range of information and supplement

it with identical cases or corresponding realities in the context of the location and architectural history. This may often lead to a kind of historical narration. For example, in the case of the Palace of the Vatican Ambassador in Valencia, where the task was reconstructing the now non--existent building in the Gothic and Renaissance style, researchers used assembled historical, literary and graphic materials, as well as information obtained from archaeological remains. The basic materials were preserved demolition records along with old drawings and a map of Valencia. This served as a means of determining the exact location of the object and helped identify its architectural features. Unidentified components had been determined and inserted on the basis of information obtained from other similar buildings by the means of analytical deduction. Consequently, the historical object was recreated and 'preserved' in two styles [4].

For archaeologists, 3D modelling has become one of the most important tools for working on substance of momentous significance. Digital equivalents enable the conducting of research without interference to the original substance and even run virtual simulations that aim to resolve queries or pose new questions. Just as in other cases, works of ancient architecture which are based upon digital reconstruction are rooted in original sources as well as derivative sources and educated guesswork. Despite, the greatest effort and desire, some things remain the subject of speculation with regard to their actual state. This only confirms the key statement that the obtained image is not an absolute fact. This notion was most accurately described by the English archaeologist and historian Simon James who said: "Every reconstruction is wrong. The only real question is, how wrong is it?".

Another example where 3D modelling was employed is the reconstruction of the Royal Palace in Lobzow. The building functioned as the Cadet Institute for the Austro-Hungarian Army. Currently, it serves the Cracow University of Technology. The state of this object prior to the Austrian reconstruction is little known. By consulting the surviving records of reconstruction and depictions drafted by contemporary artists, an image of this historical object was created. By analysing all data and subjecting them to the comparative process along side with the model, it was possible to find issues never before considered. Currently the model serves as the basis for comparison in further research regarding the appearance of the building in earlier times [6].

The practical application of materials in the form of virtual models of architecture can already be observed. They are incorporated in museum exhibitions, which in turn affects education, tourism and increases social awareness on issues such as transience and cultural identity by means of 'architecture in time'. Cultural improvements have global scale impact and are groundwork for further progress. According to Professor Jerzy Topolski, all endeavours of this sort are meant to contribute to the advancement of humanity, which would not have been possible without social organization. Organization which is built upon insight in social reality and the awareness of the history. An example is the Virtual Archaeological Museum of Herculaneum. The CyArk organisation is worth mentioning here as its volunteers are creating a library of three-dimensional models of forms which are invaluable not only for posterity but also as an aid for conducting comparative studies concerning the visual aspects of buildings.

The creation of 3D computer-generated models is an efficient way to understand the state of a given monument, and the process of its ongoing changes over time. The discussed creative process aided by the means of digital modelling techniques is in fact, a constant

decision-making process. One must make decisions regarding each aspect of the building and its surroundings. The search for co-dependencies in construction opens up a vast array of possible solutions and poses new thought-provoking challenges. Even the rudimentary reconstruction of an object provides a new perspective for the already collected previous data. It helps in a distinct process of analysis and the deduction of a speculative form of the given monument in a specific time period. The constant development of technology offers increasingly compelling means of experiencing virtual objects and the prospect of realising them at a reduced scale through the use of three-dimensional printing. The advancement of the field of printing technology now makes it possible to print buildings at a micro-scale. In the future, this will facilitate the reconstruction and reproduction of objects at their original size. Moreover, products developed by the means of 3D modelling can serve as a valid source of information for the next generations and be a reliable tool of 'eternal protection'.

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