Cost Effective 3D Architectural Visualisation

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Abstract – **Visualization is any technique for creating images, diagrams, or animations to communicate a message. Visualization through visual imagery has been an effective way to communicate both abstract and concrete ideas since the dawn of man. Architectural Visualization involves visualization software technology for the viewing and manipulation of 3D models, technical drawing and other related documentation of architectural buildings. Architectural visualization software typically provides high levels of photorealism so that a building can be viewed before it is actually manufactured.**

Keywords – **Visualization, 3D modeling, Analysis, 3D laser scanning, Photogrametry, Hybrid method.**

I. INTRODUCTION

The primary goal of research in the field of 3D graphics is exact representation of the 3D real world. One of the possibilities for precise 3D representation of the real world is to create an interactive 3D model where the user could move into a simulated environment. This feature of 3D graphics software is used in many areas, from architecture, automotive, and ending with marketing and 3D catalogs of products.

For architectural visualization, is important to say that computer graphics is widely used in architectural visualization. First, for better presentation of new projects, then the restoration of old buildings and ruins, in the area of spatial planning, interior elements, the very arrangement of the interior or exterior of the building and ultimately of course for leaving a better impression on investor in the facility or the public.

But despite all these benefits allows our 3D architectural visualization, it must be noted (highlighted) that this is usually an expensive operation, requiring construction of complex models with many details, high quality rendering, long time, and expensive hardware.

Also classical architectural visualization is based on movement along a path, without the possibility of free virtual tours and interaction with the user.

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Therefore aim of this paper is analysis of existing methods for 3D architectural visualization, and demonstration of hybrid methods and tools that will satisfy the quality of the finished product (3D interactive visualization of architectural structure), which will be cheap, simple and will not require much time.

II. METHODS FOR 3D ARCHITECTURAL VISUALISATION

In the world of architectural visualization, there are three standard methods, they are:
1. 3D laser scanning
2. Photogrametry, and
3. 3D modeling.

Each of these methods has its field of application, has its advantages and disadvantages. In this section we explain the methods with examples of models made by each of the methods. Also in this section we analyze advanteges (benefits) and disadvantages of these methods.

A. Method of 3D Laser scanning

3D scanner is a device that analyzes the real object or the natural environment in order to gather data on its shape and possibly for his outward (exterior) appearance. The collected information are used for the construction of digital 3D models that have broad application. These devices are used mostly in the entertainment industry in the production of films and video games. Another similar application of this technology include industrial design, prothetics, and of course most in architecture for testing, documentation, and reproduction of objects of cultural heritage.

The method for obtaining the 3D model using 3D scanner comprises three stages, as follows:
1. Scanning (often multiple)
2. Aligment, and
3. Reconstruction

In most situations, the singular scan does not produce a complete model of the scanned object. Often multiple scans are needed, often hundreds, of different directions to obtain full information about the scanned object. This information should be brought into a common coordinate system and then be drawn in order to obtain a complete model. This process is usually called alignment.

A classic example of this is digitalization of the temple of Angkor in Cambodia and it is of exceptional importance. An example of this visualization is given in the Figure 1.
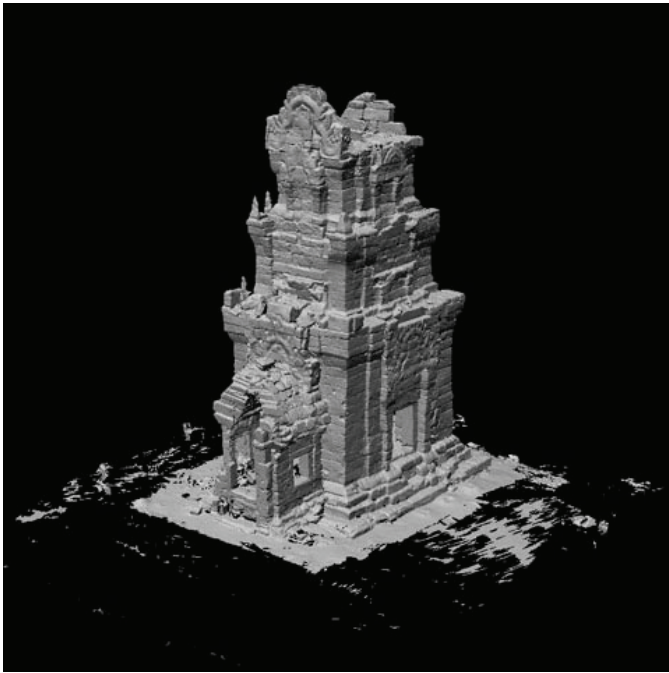
Fig. 1. Digitalization of the temple of Angkor in Cambodia with method of 3D laser scanning.

The largest advantage of this method is precision with which the final model is obtained. So its use is limited in projects of digitalization of cultural heritage and the model then is used for further examinations. But despite the high quality models that are obtained using this method should be noted that the method is very expensive and also the equipment. Average 3D scanner costs about U.S. $ 30 000, plus the method is expensive, requires engagement of many people who also need to pay. So if the use of that model is not for scientific research purposes, use of this method is unnecessary.

B. Method of Photogrametry

Photogrametry is the first technology in which geometric properties of objects are determined from the photos. The principle of photogrametry can simply be explained as follows, the distance between two points which lie on a plane parallel to the plane of the photograph can be determined by measuring their distance if scaling of the photograph is known.

More sophisticated technique is stereogrametry. With this technique it is possible to obtain 3D coordinates of object points. They are determined by measurements made on two or more photos taken from different positions. The common points are identified on each image. The line of sight (or ray) can be constructed from the location of the camera to the point of the object. The intersection of three beams determines the exact location of the point in 3D coordinates. For this purpose are used very sophisticated algorithms that can determine the 3D coordinates of the point from just one photograph.

Photogrametry process can be divided into three basic stages as follows:

1. Taking pictures of the facility,
2. Metrology (measurement object), and
3. Reconstruction of the object (obtaining the model).

Photographing the facility is the first stage of this method. There are two ways of photographing Aerial photogrametry, and Close-range photogrametry. These methods have their use depending on field of use.

Measurement is an integral part of photogrametry. Namely this is the phase in which are obtained real dimensions of the object from the images. So the use of more photos from different sides are recomended. Then the rays are projected and we determine the common points of the images, from wich we can reconstruct the required model.

This method is often used in architectural visualization, especially if it is a digitalization of existing facilities. Compared to the 3D scanning, models are not as detailed but would satisfy the needs of a digital tour guide or a 3D map for a city. It should also be noted that Close-range photogrametry is often used in hybrid technologies. classic example of photogrametry is visualization of North-German castles, figure 2.

Fig. 2. Digitalization of the North-German castles with method of Photogrametry.

Unlike the method of 3D scanning, Photogrametry is used often due to economic reasons. In terms of quality, models are simple and could not be used for scientific purposes as was the case with 3D scanning. Therefore, this method is widely used in hybrid technologies. There is a technology based on photogrametry and is called Image - based modeling (modeling based on the picture) which is often used in hybrid methods. As disadvantage of this technology can be mentioned expensive computer hardware and software, and also aerial photogrametry is very expencive As for photography equipment should say that the professional photographic equipment does not come in cheap products. Another important problem that arises in this method is digitalization of art and natural forms (such as decorations on walls with images of animals, people, plants, irregular shapes, etc.). However photogrametry is often used for architectural visualization and gives satisfaying results.

C. Method of 3D modeling

In 3D computer graphics, 3D modeling is the process of creating mathematical (string) representation of any three-dimensional object, using special software. Popular softwares in the world of 3D modeling are 3D `s MAX, Maya, Blender and so on. The product is called a 3D model. It can be shown as two-dimensional image through a process called rendering, or be used for computer simulation of physical phenomena. The model can also be physically created with device called 3D printer.

Although programs for 3D geometric modeling may seem very complex, mainly any modeling is based on six tasks (steps):

1. Creation of simple elements of the model,
2. Their assembly into complex structures,
3. Order of objects in 3D scene,
4. Selecting materialsAdjust the lights,
5. Selecting a views and methods for rendering.

In the architectural visualization 3D modeling is widely used. We should note that these models usually do not represent real objects with their real dimensions, but are widely used in many fields.

3D modeling is often used for the design of new buildings and their presentation to the public, which was not the case with the previous techniques. In figure 3 is given example of architectural 3D visualisation made with this method.

Fig. 3. Example of architectural visualization of a new facility developed in 3D `s MAX.

The method of 3D modeling is the most popular method in the world of architectural visualization, because of it`s economic feasibility. Models have high quality. They are very widely used in industry with games, also in the film industry. Disadvantage of this method is long time of modeling, of course depending on complexity of the model. It`s not excluded the application of 3D modeling in hybrid methods.

III. HYBRID METHOD FOR 3D ARCHITECTURAL VISUALISATION

Hybrid method involves using several methods and software that are simple to learn, require low or average hardware, and of course are cheap or free.

For this method we use combination of previous methods (3d modeling, and close range photogrametry). It is a mixture of three cost free softwares. Google Sketch Up for polygonal modeling, Gimp for image processing and SUBDO, software used for interactivity, lights and shadows of the model that allows real-time rendering.

This hybrid method consists of the following steps:

1. Taking pictures of the model
2. Measurement
3. Selection of photos
4. Processing of the images,
5. Modeling from photos,
6. Texture mapping,
7. Render in real time and interactivity.

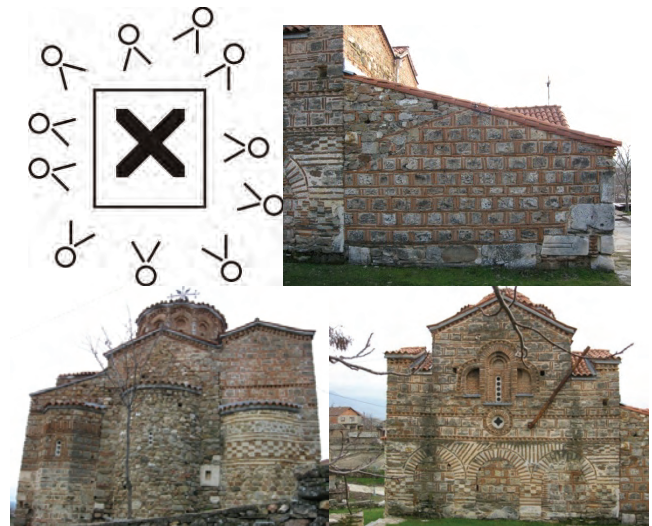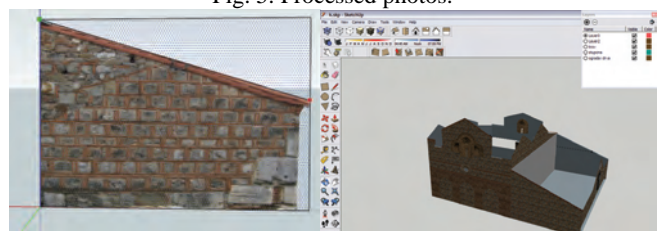Below in figures 4, 5, and 6 are given steps of this method.

Fig. 4. Taking pictures of the model (close range photogrametry).
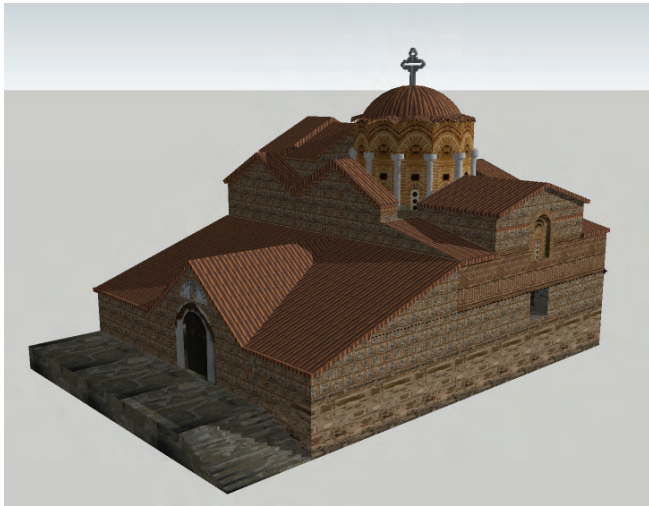

Fig. 5. Processed photos.

Fig. 6. Modeling.

After modeling follows the phase of setting lights, and interactivity in SUBDO. In the end of the process we choose the format and export the interactive architectural 3D visualization.

The hybrid method is cheap, needs short time for developing. Disadvantages of this method is deficit of natural effects. Quality of the interactive 3D architectural visualization developed with this hybrid method can`t be compared with traditional methods like 3D modeling or 3D scanning, but it`s on the same level with other very expensive hybrid technologies. This method can be used in spatial planning, also for presentation of new architectural designs, documenting of architectural heritage, presenting the tourist attractions on the Internet and multimedia presentations, navigation systems and so on.

IV. CONCLUSION

3D architectural visualization is process for creating models of existing or new architectural structures with different methods. There are few conventional methods for 3D architectural visualization depending for what purpose is visualization you can use different methods and software.

In this paper we analyze existing methods with their advantages and disadvantages. Also we demonstrated low cost hybrid method for creating satisfying 3D architectural visualization that can be used in many fields. Further research will continue toward improving the real time rendering, exploring new combinations of software, and application of this method in navigation systems.

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