THE DEVELOPMENT OF VIRTUAL MUSEUMS IN IRAN PRESENTING HISTORIC BUILDINGS OF AZERBAIJAN PROVINCE, IRAN, IN 8 HISTORIC COMPLEXES, COMBINATION OF DIFFERENT MODELS AND MATERIALS

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ABSTRACT:

Digital technology has offered new approaches in gathering, presentation and transferring the information of historic complexes. The approach is expanding through the passing time and the development of hardware and software capabilities. Today, using the information technology for presentation and introduction of historic buildings has exceeded the development of text and image website and benefits more capabilities. One of the methods is 3-dimentional modeling and rendering and digital animating. This project aims to: 1-look for the possible methods in gathering, presentation and documentation of the information of historic buildings by advanced modeling, rendering and animating techniques, and 2-compare the methods in presenting and simulating of these buildings in terms of volume, material, geometry, etc. To do this, 8 complexes of Azerbaijan historic buildings has been chosen as case study. Each has characterized by unique features for computer modeling and presentation which this project tries to deal with each in the same realistic manner. This paper investigates current simulation systems implemented with purpose of documentation of historic or new sites and complexes and it identifies how we can use these systems for better understanding of sites either for conservation or introduction purposes. This paper researches on the one hand the conditions for data collection, the state of data, its documentation and the production of the 3D model and on the other a theoretical framework of simulation and reproduction of the model of the ‘‘historical complex ’’ based on reality. In this project what we seek is the creation of a model with the qualities of reality. Through the excellent possibilities that digital technology has made available for the production of a photo-real model, we have managed to make the model of the mentioned above historical complexes come alive. The conclusion results from studying different approaches of digital simulation and leveraging them into 8 historic complexes. The color, material, texture, etc are the key elements studied for this purpose.

1 Introduction

Digital technology has offered new approaches in gathering, presentation and transferring the information of historic complexes. The approach is expanding through the passing time and the development of hardware and software capabilities. Today, using the information technology for presentation and introduction of historic buildings has exceeded the development of text and image website and benefits more capabilities. One of the methods is 3-dimentional modeling and rendering and digital animating. Modern virtual reconstruction [1] is quite realistic due to improved computer systems and visualization peripherals, and a better understanding and implementation of geometric and visual modeling techniques.

In this paper, visualization is based on blended methods, evidence found during surveying, and accurate and documented historical information. Each reconstruction involves a multidisciplinary team with architects, archaeologists, historians, computer scientists and scriptwriters.

Azerbaijan province, placed on the northern east of Iran, is one of most important historical parts of Ancient Iran and history of it back to more than 5000 years ago. It has experienced varied periods of civilizations either before or after commence of Islam. In this project, using facilities that advanced technology made, we experienced varied methods to simulate 8 of numerous complexes of Azerbaijan and we managed to generate some methods help us facilitate simulation of historical buildings in Iran, according to current limitations in hardware and software. We chose our complexes according some factors, some of them relate to their historical characters, some relate to geographical distribution, and the rests are related to capabilities of them for simulation and visualization. Each of them has some distinctions in volume, ornamental details, surrounding natural terrain, and size.

Consequently we used varied methods for simulation of each of them. The chosen complexes include: **1- Sheikh Safialdin Ardebili complex:** The complex has unique tiling and exclusive geometric volumes (refer to Figure 1). The methods of assigning materials and adjusting UVW mapping are of great importance. In

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addition, constructing the components of Islamic Architecture such as Moqarnas, Karbandi and so on are emphasized (refer to Figure 15).

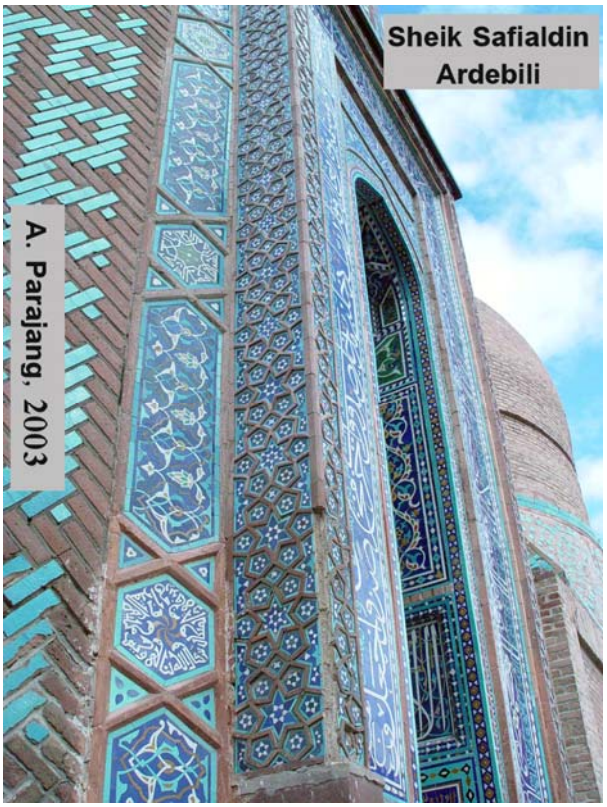

Fig. 1: Exclusive Tiling of Shekh Safialdin, Ardebil, Iran

2- Sheikh Shahbaldin Ahari complex: In this complex, the special carvings and the unique beautiful garden surrounding it are significant (refer to Fig. 2).

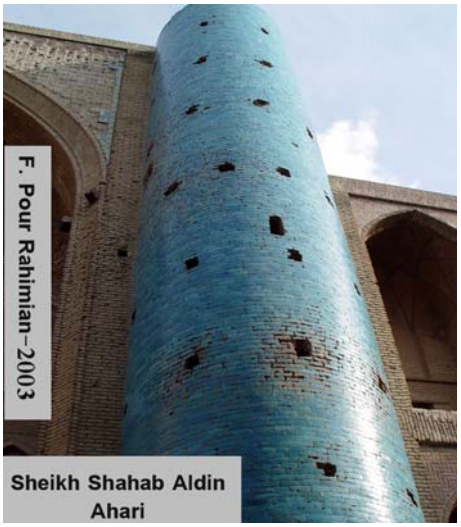

Fig. 2: Minarah, Sheikh Shahab Aldin Ahari, Ahar, Iran

Therefore, the experience of heavy-weight modeling, XRef and data compressing methods occurs in this method and replacing modeling with all details with Bump assigning materials have been experienced.

3- Quadric towers of Maragheh: The towers have exceptional innovative bricking patterns. The project tries experience the methods of simulating bricking patterns (refer to Fig. 3).

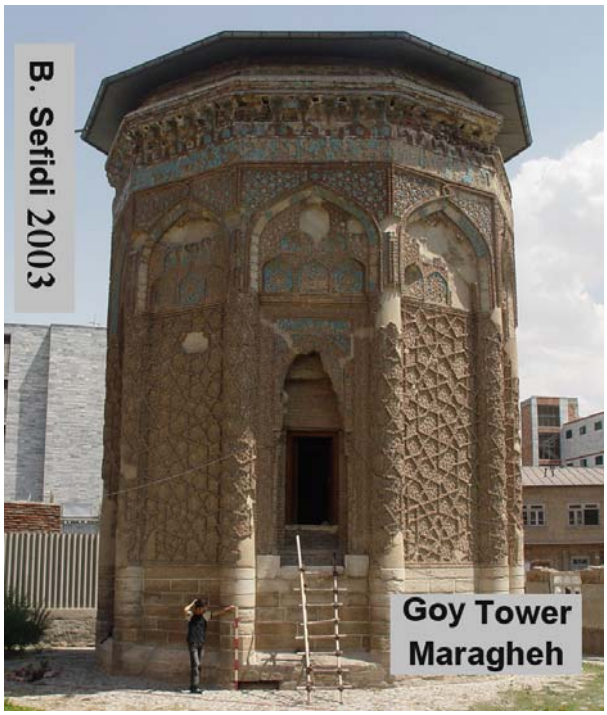

Fig. 3: Goy Tower, Maragheh, Iran

4- Marand Congregational Mosque: This mosque has a distinctive gypsum Mihrab and the assigning materials methods and placing it by UVW mapping have been studied and experienced (refer to Fig. 4).

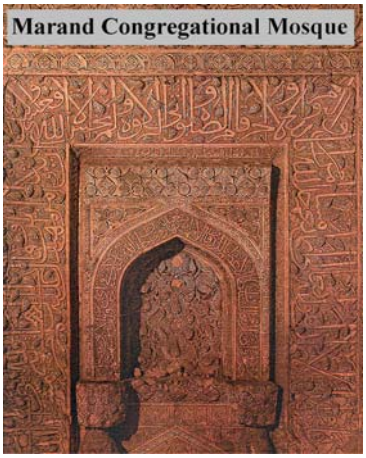

Fig. 4: gypsum Mihrab, Marand Congregational Mosque

5- Saint Stepanus Church: The church has surrounding natural terrain and vegetation as well as special stone decoration (refer to Figs. 5, 6). Since the ambient topography has had a key role in developing the form, simulating the topography and studying its different methods has been of great importance.

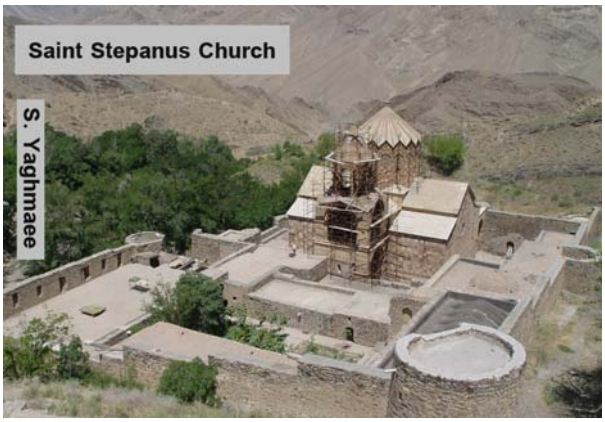

Fig. 5: Saint Stepanus Church and Its Surroundings

Fig. 6: Fig. 5: Saint Stepanus Church and Its Stone Decorations

This paper examines the framework of the problem of realistic visualization through specific work plans that deal with the historic complex.

2 Background literature review

In this section we present some literature on simulation and 3D visualization and explain how it can support the documentation of historical complexes either for introductive or conservative purposes.

2.1 3D virtual reconstruction

3D modeling of a site falls within the framework of large or medium scale cartography. Cartographic representation used to be conventional. Using two-dimensional maps (conventional maps); the relief was designed with techniques that represented the third dimension in two dimensions wherever it was imperative. The needs for additional coverage were satisfied employing axonometric and architectural plans.

The subsequent introduction of digital technology in cartography, at first, radically transformed the processing of analogical maps, as it developed. It changed the form of the produced work, making it animated, interactive and three dimensional [2]. There are different methods in the realm of virtual reconstruction. This is depended upon the tools and technologies the group uses and the purposes it has. Sinha and Liang classify several general-purpose simulation modeling paradigms and languages. The classification is according to the following criteria [3]: graph-based versus language-based paradigms, procedural versus declarative models, multi-domain versus single-domain models, continuous versus discrete models, and functional versus object-oriented paradigms. Gutierrez and Seron [1] describe the 3D digital reconstruction of Sinhaya, an X–XIIth century Muslim suburb in the city of Zaragoza. Accurate models and textures were obtained that capture all the wear and tear of a real suburb populated by real characters. The visualization is based on archaeological evidence from excavations and accurate historical documents. Callieria and Cignonia [4] use a methodology which a pre-requisite of it is the acquisition of an accurate digital 3D model of the artifact, which is now possible at affordable costs using 3D scanning technology. They discuss the specific needs that a drafting system oriented to the cultural heritage domain should satisfy and they present the design, features and performances of a computer-aided drafting system, called Cavalieri. Cavalieri allows to manage the huge digital models produced with 3D scanning devices and supports easy specification of orthographic drawings and cut-through sections, which are given in output as very high-resolution images (with user-selected reproduction scale and printer resolution). Andre´ G.P. Brown uses visualization to solve fundamental problem in the building design process, how best to represent the designed object at different stages in the design process, and how best to interact with the partly designed object to refine and optimize satisfaction and performance [5]. Finally Sidiropoulosa and Vasilakos [2] research on the one hand the conditions for data collection, the state of data, its documentation and the production of the 3D model and on the other a theoretical framework of simulation and reproduction of the model of the ‘‘city’’ based on reality. They conclude from applications used employing popular software programs (AutoCAD, Arc-VIEW (3D analyst), and 3D Studio MAX). This experience led to the formulation of a 3D model creation framework which allows for a greater degree of realistic re-creation without coming into conflict with scientific ethics, but in fact, demonstrating them.

Through all of above mentioned methods scale of case and degree of expected reality play a big role in simulation of a site or a building.

2.2 Degree of realism and the size of complex

First degree of realism was of initial demands of simulators. Recently, developments in the ICT made it possible for simulation teams. There are varied guidelines help us measure the degree of realism. Bill Fleming divides the guidelines that ensure that an image is photo-real into 10 points that he calls Principles of Photo-real 3D. The mentioned 10 guidelines are: clutter and chaos, personality and expectations, believability, surface texture, specularity, dirt, dust and rust, flaws, scratches and dings, beveled edges, object material depth, radiosity.

Fleming answers to the question that what can make an image photo-real, by saying that "there are thousands of things that make an image photo-real, but I place them into 10 categories." According to Fleming if an image conforms to at least 8 categories it is to be considered truly photo-real. Fleming refers to areas, objects and environments of a smaller scale [6].

In the case of the large-scales, the size is such that the rules must be modified. Others become inactive, such as Flaws–Dust–Rust, and others are required to be modified in order to deal with the sizes of urban and geographical scales. One such principle is the principle of object material depth [2]. Sidiropoulos and Vasilakos believe that we have to use a different method if we want to apply this to a glass board or a lustrous wall and a different method if we want to use it on the sea's transparent surface. They believe that we can shape the application fields of the principles of photorealism, regarding medium and large visualization scales, as follows:

_ the geometry of buildings and installations (deterioration to building materials, etc.),
_ materials (concrete, glass, brick, etc.),
_ lighting (natural or ''theatrical'' lighting),
_ weather conditions,
_ background (terrain), and
_ animation (camera on eye level, ''theatrical'' camera, a camera resembling the flight of a bird, etc.).

3 The virtual reconstruction process

The main goal of the virtual reconstruction is to convey the sensation of a populated complex with imperfections in the buildings and objects and years of deterioration. Ironically, it is far more difficult to create imperfections with a computer than perfect worlds, so this goal implied additional work at every step.

3.1 The surveying and drawing

To do excellent and photo-real simulation works we were to gather perfect information, plans, elevations and sections of mentioned complexes. Since we didn't have high-technology tools for surveying such as 3D scanners and photo geometry tools, we implemented an inventory and blended method to control our surveying. We used both manual measurement and photography to create almost accurate drawings of complexes. On the other hand we measured dimensions of complexes in general and recovered details through deliberately taken photographs. We used our made ruler-like rods as indicators (refer to Fig. 7). These rods helped us correct declinations of photographs in the computer software, PhotoShop, and then after final corrections of drawing in the AutoCAD, finally we managed to have almost accurate drawings that in the stage of 3D modeling we used those as the base of our work (refer to Fig. 8). Random checks and walkthroughs acknowledged that our drawings are more than 90% correct and it was excellent range for our purpose.

Fig. 7: The Method for Surveying, Using the Indicators

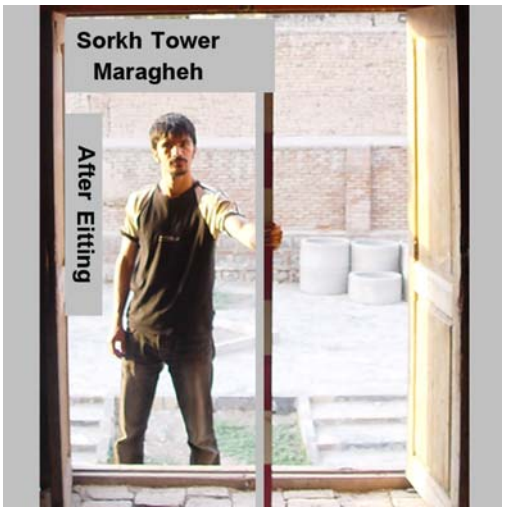

Fig. 8: Declinations Corrected Photograph in Photoshop

We made our drawings after all of corrections. Indeed documentation of plans, elevations, and sections of complexes was byproduct of our project (refer to Fig. 9). Finally we took photographs of details and ornamental parts of buildings and edited them to use in 3D Studio Max as directly sticker maps to surfaces or which help us to define opacity maps of elements (refer to Fig. 10,11).

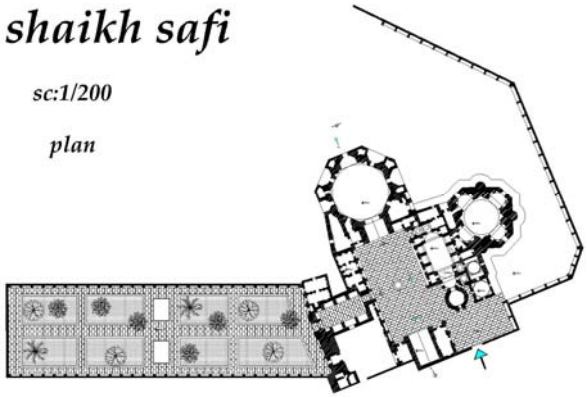

Fig. 9: Almost Accurate Plan of Sheikh Safialdin Ardebili

Fig. 10: Edited Photograph, Details of Ornamental Parts of Sheikh Safialdin Ardebili

Fig. 11: an Opacity map Used in 3D-Studio Max

3.2 3D modeling

Using information and drawings made in previous stage of project we prepared accurate 3D models of complexes in the computer software, Auto CAD (refer to Fig. 12). The main problem was heavy weight of the files and we used XRefs to solve the problem. We made varied parts of the complexes in the separate files and called them by proxies of them when they were needed. Using this method we managed to make detailed and completed models of the complexes in the Auto CAD. We learned construction methods of the components of Islamic Architecture such as Moqarnas, Karbandi and so on by asking of traditional mentors and virtually emulated the methods in the virtual reality space. After all we exported the models into 3D Studio Max and rendered them in mud-like methods. These pure forms helped up gain better understanding of models and correct the errors.

Fig. 12: Accurate 3D Models of Sheik Safialdin Ardebili, Including All of details, created in AutoCAD

3.3 Rendering and Animation

In this stage we used created models and adjusted the prepared maps on the faces and completed the Photo-Reality of the renders. Since we used the natural maps, we caught majority of guidelines stated by Fleming (refer to Figs. 13, 14, 15).

Fig. 13: 3D simulation of Court Yard of Sheikh Safialdin

The accuracy of models and prepared maps helped us have maps adjusted on the all of the faces. In some cases we used PhotoShop to re-edit the maps and to correct inconveniencies. We used inventory methods of geometrical lighting, rather than photometrical lighting, to decrease the amount of computation. We used a big sphere as sky dome. In the creation of animations we used both path-constraints and manual

movements of the cameras. It helped us have our animations alive (refer to Figs. 13, 14, 15).

Fig. 14: 3D simulation of Chini Khaneh, Sheikh Safialdin

Fig. 15: 3D simulation of Chini Khaneh, Sheikh Safialdin

4 Results

8 historic complexes of Azerbaijan Province of Iran were successfully reconstructed in the digital realm. Final outputs were CLS format animations and those are going to be presented in a website as Virtual Museum of Historical Buildings of Azerbaijan. The whole story takes about 30 minutes of animation which introduces the historical heritage of Azerbaijan. These animations are almost full introduction of mentioned complexes. The historic buildings of Tabriz, the most important city of the province and the Original Garden-of-Eden by David Rohi's idea [7], were absent in this project and it was because those buildings were introduced in our prior project, Virtual Museum of Historical Building of Tabriz. You can visit this museum in the following site: http://www.tabriziau.ac.ir/vmhbt/index.htm

5 Conclusions

This paper describes the complete digital 3D reconstruction of 8 historic complexes of Azerbaijan Province of Iran, including realistic interiors and exteriors of complexes. Accurate models and textures were needed to capture all the wear and tear of a real historic populated by real characters as well as a multidisciplinary team composed of architects, archaeologists, historians, computer scientists and scriptwriters. Precise lighting methods give the images a photo-real look and were used to specify the date, the time of the day and various atmospheric conditions. A complete sun and sky model was prepared to light the scene. Only simulated natural light was used, although at very different times of the day (from dawn to midday, to sunset and night). The virtual reconstruction was quite successful and will help to preserve part of the city's archaeological and cultural heritage, breathing life into a long-gone past. Visitors can experience what was life like in the historical sites, from morning to sunset, and archaeologists and historians can study and analyze it in a whole new way.

6 Future Works

For more interaction pictures and animations can be viewed in a low-cost Cave-like system. These immersive views can help visitors have better understanding of the space and hopefully in the future projects we will try to do that. Moreover, this 3D documentation procedure can be used as a guide to streamline the design documentation process during the actual design process. More studies will be required in order to facilitate the design and construction integration using 3D documentation process. Additionally, the 3D documentation procedures have illustrated some challenges during the case studies' documentation. More studies are planned to improve how future design studios would operate if this methodology is being implemented for architectural design integration purposes.

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