3Dimensional Reconstitution and Virtual Reality, Bam and its Cultural Landscape

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Introduction

After the earthquake of the 26th December 2003 and the immense destruction of the Bam heritage in Iran, the reconstruction of the ruins especially of the citadel of Bam has become an important task for those experts, institutions or organizations who are concerning about the cultural heritage safe keeping. As one of the first steps of the world wide concerns, the Bam Citadel was added to UNESCO's World Heritage in Danger List during the 28th session of the organization's World Heritage Committee on Friday 02/07/2004 in the Chinese city of Suzhou under the name of "Bam and its cultural landscape [7].

As part of the National Institutes of Informatics endeavour for digital documentation and advanced recording of cultural heritages of the Silk Roads, after a set of meetings and discussions started from March 2004 between NII, Iranian Cultural Heritage and Tourism Organization, Waseda University and University of Tehran with cooperation of Prof. Adle from CNRS, the joint research project of a 3 Dimensional Reconstitution and Virtual Reality of Bam and its Cultural Landscape has started in January 2005.The main tasks for the

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[7] http://whc.unesco.org/en/list/1208

first phase of the project were to develop the 3Dimensional models of 7 case studies inside the citadel of Bam (Main gate, Bazaar, Tekkiyeh (religious plaza), Mosque, Sistani house, barrack, stable, four season reception room) in a collaborative research work by the team of computer science experts and architects.

Target of the project

Due to the complexity of physical restoration and several problems ahead of it, we strongly believe it is curtail to start a virtual reconstitution of the heritage which is destroyed specially in citadel of Bam after the earthquake. The main benefits are as follows:

1- The fast process of virtual reconstitution comparing to physical one
2- The possibility to check completely the documents in order to build the 3Dimensional models and specifying the shortcomings
3- The possibility to save and demonstrate the digital virtual reconstitution as a Virtual Reality of Bam regardless of the location of demonstration in order to make the citadel of Bam alive again in virtual world.
4- The importance of the 3D models as a reference document for physical reconstruction
5- The possibility of revival of the original building in virtual world for those spaces which are very difficult or impossible to reconstruct

Challenges of the project

The main challenge of the project was the lack of data. We confronted with several problems regarding the quantity and quality of necessary data during the process of building the 3D model. To build a 3D model inside the tools such as 3D studio max software it is important to have precise and complete data of maps as sections, facades and plans of all the target spaces. The data provided for this purpose by ICHTO[8], NCC[9], CNRS[10], NII[11] and other resources were as below:

1- Maps surveyed before earthquake
2- Maps surveyed after earthquake
3- Photos taken before the earthquake
4- Photos taken after the earthquake from those parts which are still remaining
5- 3D Cartography data built from Arial photo (that after preliminary completion of 7 case studies has reached to us) as IFCA[12] project

The main challenges ahead are listed as below:

1- Error on maps surveyed before earthquake (Figure 1).
2- Lack of maps from most of the interior or some exterior facades
3- Lack of photos from many interior or exterior spaces
4- Destruction of the target buildings

[8] Iranian Cultural Heritage and Tourism Organization
[9] National Cartography Center (Iran)
[10] Centre Nationale de la Recherche Scientifique
[11] National Institute of Informatics
[12] Irano -French 3D Cartographic Agreement

The process of the project

The processes of developing the 3D models—concerning all the necessities and problems—are defined as follows:

1- To provide metadata inventory of the available data resources
2- To do a comparative analysis on the data resources (maps, photos, etc.)
3- To specify the errors on maps
4- To specify the spaces with no available data
5- To try to build the 3D model using all the analysed resources
6- To develop a technical guideline of drawing the 3D models inside the 3D studio Max tool to reach to a homogeneous 3D model built by different groups specially for systematic naming of the layers of the 3D model.
7- To validate the 3D models in several evaluation process by the team of supervisory (consisting of architects, historical architecture experts, local experts in Bam and computer graphics) regarding the technical drawing quality of the 3D model, architectural details and historical architectural specifications
8- To examine the validity of the 3D models in frequent meetings and discussions with experts
9- To develop the first trial of the Virtual Reality of the model of 3 case studies (main gate, bazaar, 4 season reception room)

The results of the project

A set of snapshots of the developed models are shown as the results of the project until the current date (June 2006)[13].

Note

The team of drawing the 3D models consisting of N. Abe and A. Ito in Japan from Waseda University and the team of Raaz Ahang architectural firm in Iran from University of Tehran has made a tremendous effort to build the 3D models with all these challenges. Prof. Kinji Ono has made his constant support and leadership for the project definition, financial and technical support. Dr. Elham Andaroodi has had the central role of assisting in preparation and signing process of the Framework Agreements, coordination between the Iranian team and Japanese team, ICHTO and NII as well as technical quality control of the 3D models. Mr. M. Matini (Ph.D. student) has contributed in developing the technical guideline and technical evaluation of the 3D models.
The process was done under technical supervision of Prof. Ono, Assoc. Prof. Kawai, and Assoc. Prof. Einifar and under direct cooperation of Dr. Mokhtari, Mr. Beheshti, Mr. Talebian, Mr. Taghizadeh asl from ICHTO and Prof. Adle from CNRS.
Assoc. Prof. Kitamoto and Assoc. Prof. Andres gave their valuable comments during the process of the project. Mr. M. Naito gave his great support for the process of data exchange.

[13] These photos are under the copy right of National Institutes of informatics, Iranian cultural Heritage and Tourism Organization, Waseda University and University of Tehran.

Acknowledgment

The support of Iranian National Commission of UNESCO especially Ms. F. Farahani is highly appreciated from the process of the project and for the missions to Bam city.
The project was also reflected in the NHK television program and also was precisely sowed in a virtual studio (as a walking through process of the narrator inside the virtual main gate and bazaar) in the program with the name of "World heritage S.O.S." directed by Mr. OHGANE in 4th April 2006. The attention and support of NHK is also appreciated.

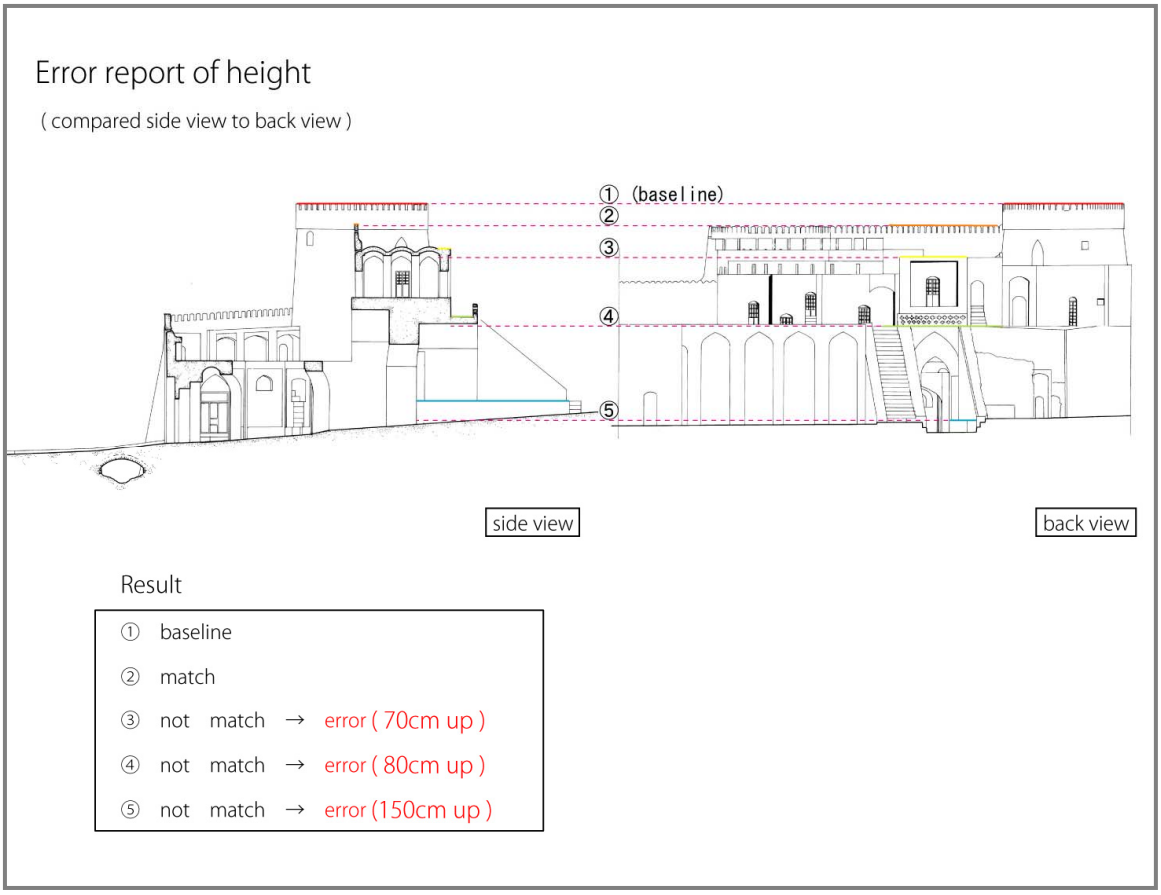
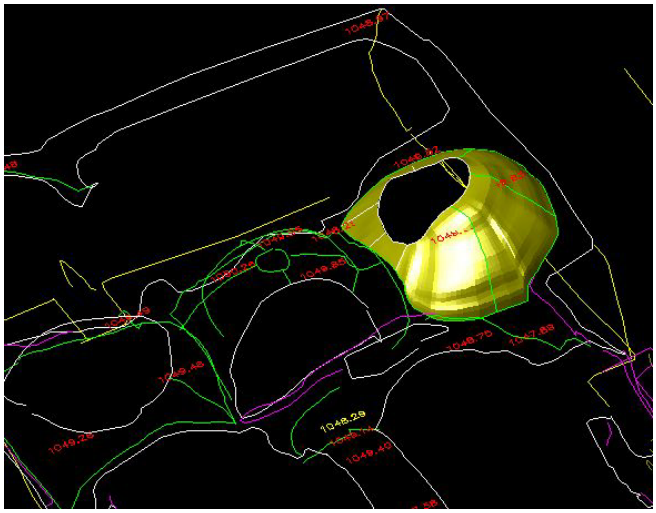


Figure 1: Analysis of the sections that are surveyed before earthquake and some errors on maps



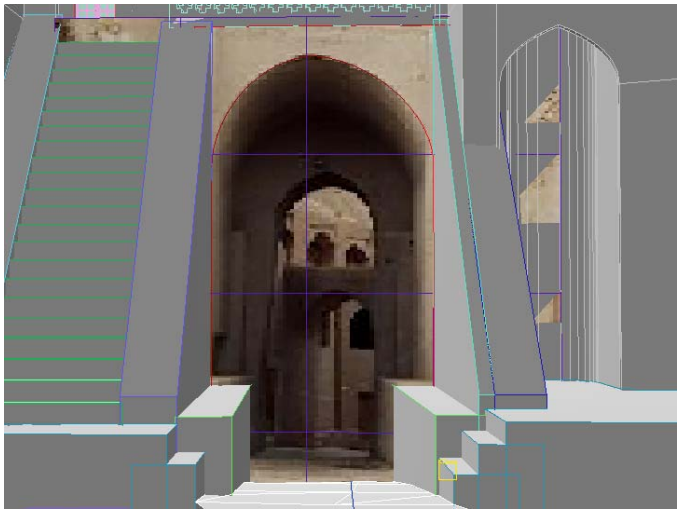


Figure 2 : Completing the roof and domes using cartography data, case of caravanserai (in the process)
Figure 3 : Using photos in order to complete the 3D model, example of the main gate entrance arch

Figure 4 : 3D model of the main gate (completed by Japanese team)

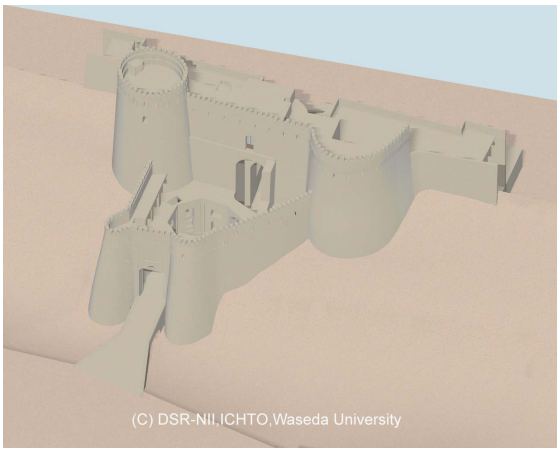


Figure 5 : 3D model of the main gate (completed by Japanese team)

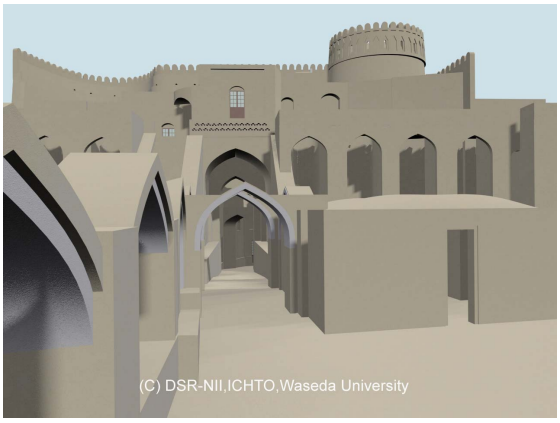


Figure 6 : 3D model of the main gate (completed by Japanese team)

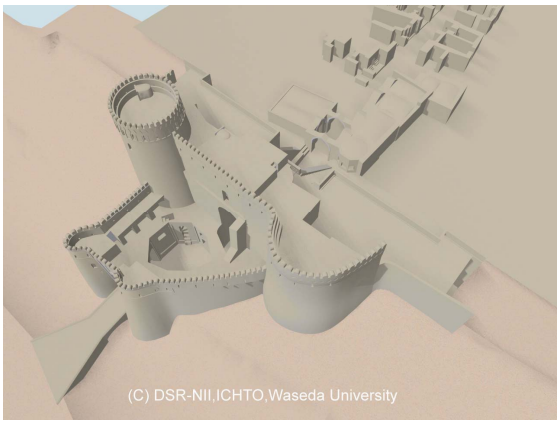


Figure 7 : 3D model of the main gate (completed by Japanese team)

Figure 8 : 3D model of the bazaar (in the process by Japanese team)

Figure 9 : 3D model of the bazaar (in the process by Japanese team)

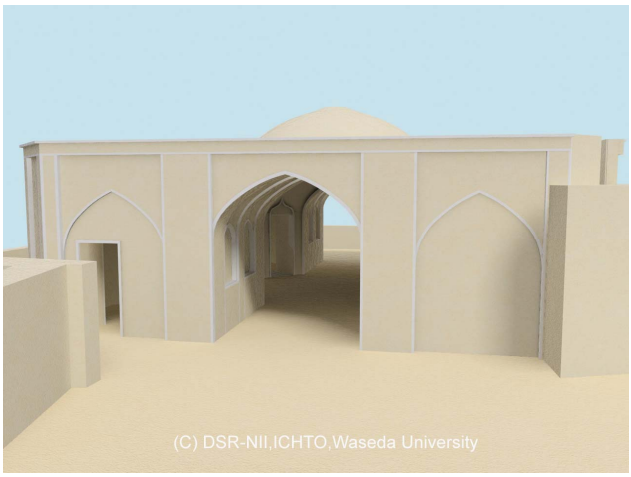


Figure 10 : 3D model of the four season reception room (in the process by Japanese team)

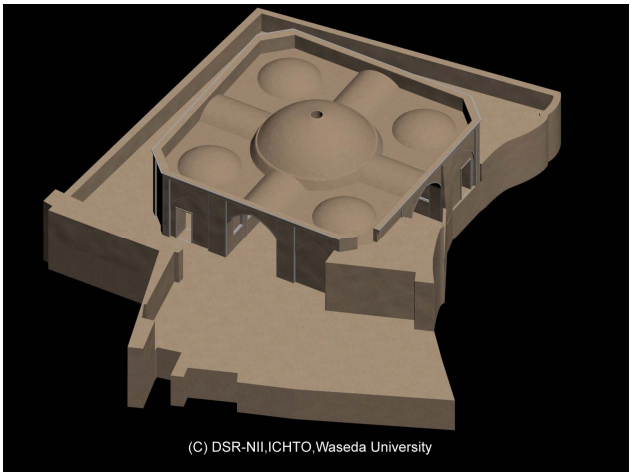


Figure 11: 3D model of the four season reception room (in the process by Japanese team)

Figure 12: 3D model of the four season reception room (in the process by Japanese team)

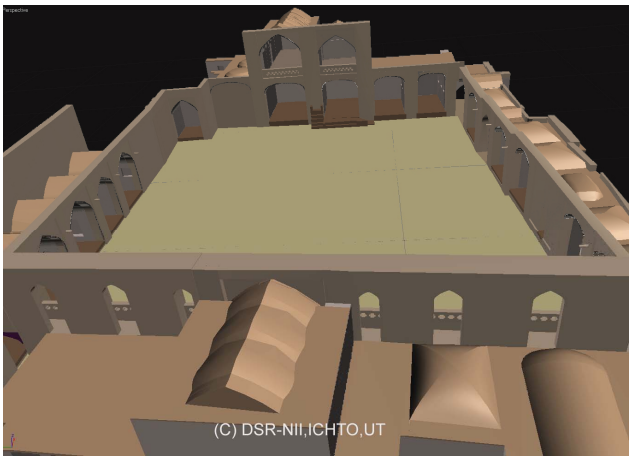


Figure 13: 3D model of the Tekkiyeh (in the process by Iranian team)

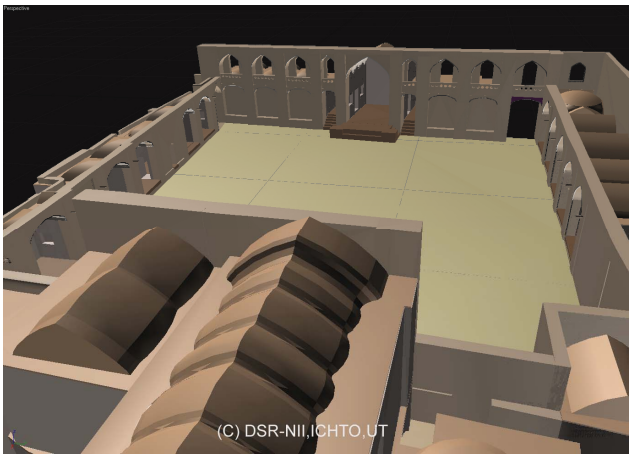


Figure 14: 3D model of the Tekkiyeh (in the process by Iranian team)

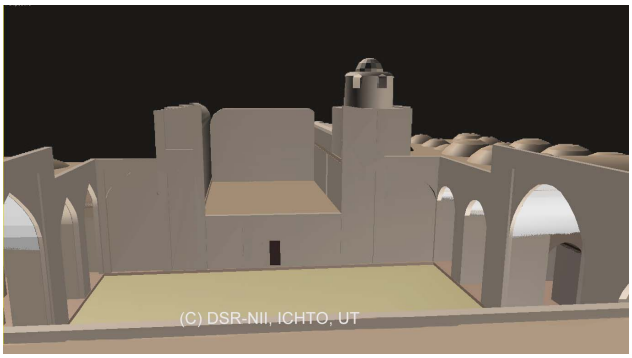


Figure 15: 3D model of the mosque (in the process by Iranian team)

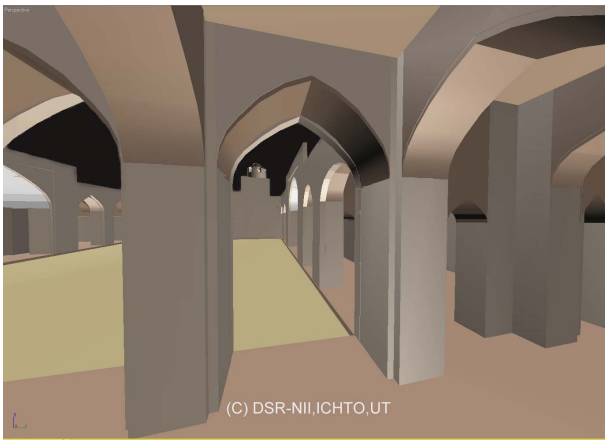


Figure 16: 3D model of the mosque (in the process by Iranian team)

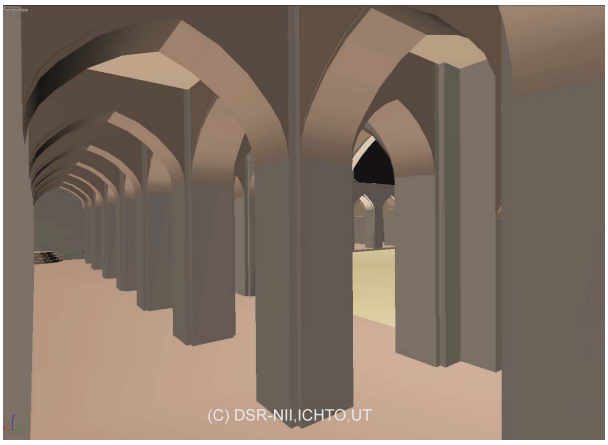


Figure 17: 3D model of the mosque (in the process by Iranian team)

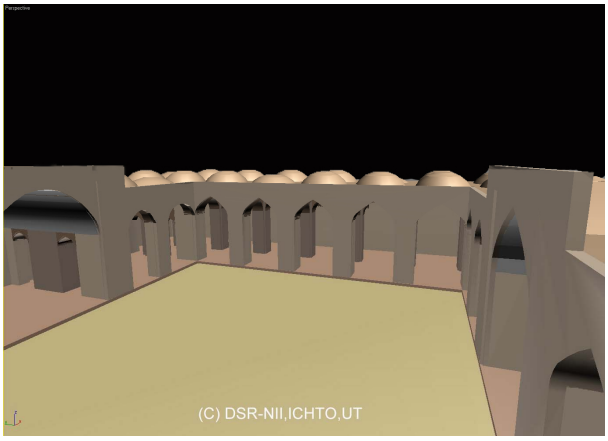


Figure 18: 3D model of the mosque (in the process by Iranian team)

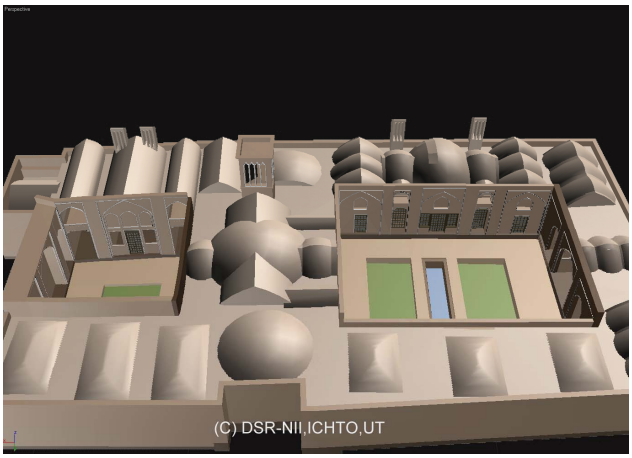


Figure 19: 3D model of the Sistani house (in the process by Iranian team)

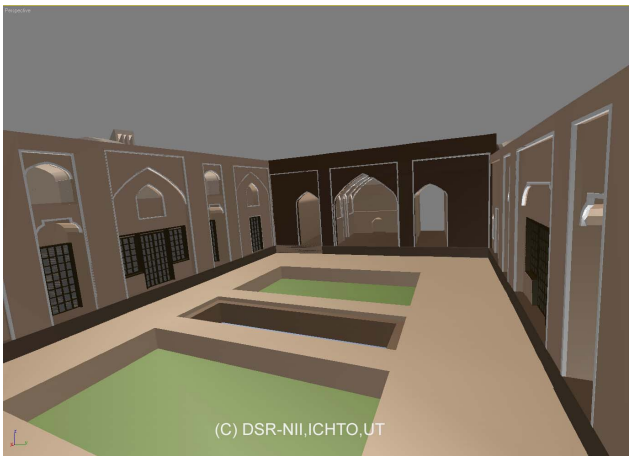


Figure 20 : 3D model of the Sistani house (in the process by Iranian team)

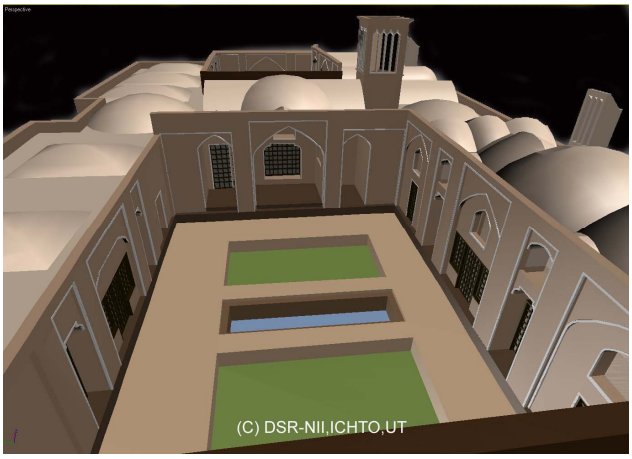


Figure 21: 3D model of the Sistani house (in the process by Iranian team)

Figure 22: 3D model of the Sistani house (in the process by Iranian team)

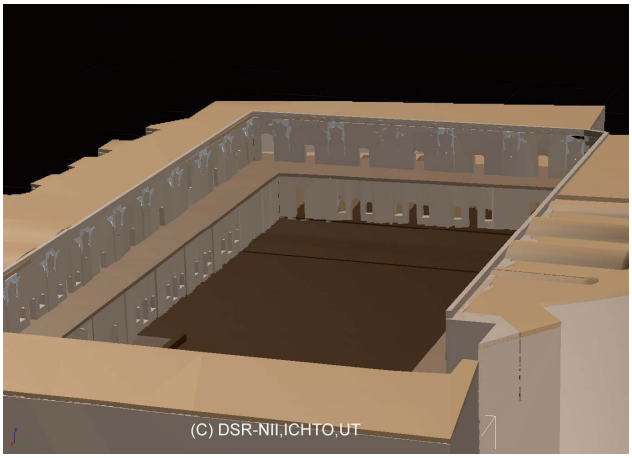


Figure 23: 3D model of the Barrack (in the process by Iranian team)