

DETAILED DOCUMENTATION AND 3D MODEL CREATION OF DALAL BRIDGE USING TERRESTRIAL PHOTOGRAMMETRY IN ZAKHU, NORTHERN IRAQI KURDISTAN

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ABSTRACT:

Photogrammetric and geodetic measurements were the first step of all the activities in historical monuments documentation. In the period 2006-2009, many Czech – Iraq projects have been carried out for the reconstruction of monuments in northern Iraq with the aim of primary monument documentation, archaeological investigation, finding appropriate technology for documented objects restoration and final restoration of selected objects. Among the major projects, the Choli minaret documentation and restoration in Erbil, primary mapping and documentation of the Al-Qala citadel in Erbil and detailed documentation of the Dalal Bridge in Zakhu by the Turkish border in northern Iraqi Kurdistan can be mentioned. This bridge is erected over the Khabur River. It consists of a wide and high arch in the middle and other smaller arches on the sides. Totally there are five arches; the length of the bridge is about 115m, the width is less than 5m and the maximal height is about 16m. The state of the bridge is poor; it was many times repaired regardless of its historical price. In 2008, the Dalal Bridge was documented by terrestrial digital photogrammetry using a calibrated digital camera Canon 20D and necessary geodetic measurement. Photomodeler ver.6 and AutoCAD software were used for creating a 3D model. The aim of this project is creating of necessary basic documentation of this valuable cultural heritage as a 3D model with all curved stones and other parts. This model will be used for future restoration of the bridge, which is now only under planning.

1. INTRODUCTION

1.1 Czech projects in Kurdistan

In the period 2006-2009, many Czech – Iraq projects have been carried out for the reconstruction of monuments in northern Iraq with the aim of primary monument documentation, archaeological investigation, finding appropriate technology for documented objects restoration and final restoration of selected objects. Photogrammetric and geodetic measurements were the first step of all the activities. Among the major projects, the Choli minaret documentation and restoration in Erbil, primary mapping and documentation of the Al-Qala citadel in Erbil and detailed documentation of the Dalal Bridge in Zakhu by the Turkish border in northern Iraqi Kurdistan can be mentioned

1.2 Dalal Bridge

In 2008, a project “Documentation of the Dalal Bridge” has been started. This bridge is erected over the Khabur (or Little Khabur, Turkish Habur) River. This river begins in Sirnak, Turkey, flows through Zakho, Iraq and empties into the River Tigris at the tripoint between Turkey, Iraq and Syria. The origin of the Dalal Bridge is not clear; probably it is from the Roman period, but there are other theories, which assign it to the Greek

period or the period of Alexander the Great. However, the legendary battle field at Gaugamel, where Alexander the Great beat Dareios III. in 331 B.C. is located in Iraq near Erbil.



Figure 1: Zakhu city in Dahuk province in northern Iraqi
The city Zakhu is in the northern part of Iraq/Kurdistan on the Turkish border). Some of the archaeologists in the Iraqi think it might be erected by one of the Badinan Sultans (Badinan Emirate, a Kurdish principality from the 13th century to the mid-19th century; it was centred in the present-day Dahuk province in Iraqi Kurdistan.) but it is certain that the bridge was erected on the remains of an ancient one. It is possible that one of the Badinan princes repaired the old partly destroyed bridge. There is a famous epic in the Kurdish language about the construction of the bridge.

The bridge consists of a wide and high arch in the middle and other smaller arches on the sides. Totally there are five arches; the length of the bridge is about 115m, the width is less than 5m and the maximal height is about 16m. Carved limestone is the material used; the central span has clearly been rebuilt many times after the Roman period, smaller spans are fine Roman arches. The state of the bridge is poor; it was many times repaired regardless of its historical price.

2. PHOTOGRAMMETRIC DOCUMENTATION

2.1 Measurement

During only 2 days, in September 2008, the Dalal Bridge was documented by terrestrial digital photogrammetry using a calibrated digital camera Canon 20D. A total station Trimble with self-reflecting distance meter was used for necessary geodetic measurement. Achieved accuracy of about 1-2cm in position was good enough for basic documentation, however by non-signalized points (block edges, small details on blocks) was the accuracy of course not so good. Photomodeler ver.6, AutoCAD and 3D Max software were used for creating a 3D model. About 120 digital images were originally taken, including vaults. 69 images and about 100 control points were used as a background for a 3D model in vector format. More than 1100 object points and hundreds of edges were evaluated from the images. A raw model was created using Potomodeler and exported to the AutoCAD software. Using AutoCAD, the model was adapted and edited; and after this, a rendered model from original photos was created. Achieved accuracy of control points was approximately 1-2cm, in the case of processed non-signalised object points about 2-5cm. However, after all processing steps the absolute accuracy is below 10cm.



Figure 2: The Dalal Bridge in Zakhu

Both sides of the bridge are approximately flat, but for arches it was necessary to use a special process - particular arch rings represented a special case where it was necessary to divide the arch surface to more flat surfaces which substituted the arch.

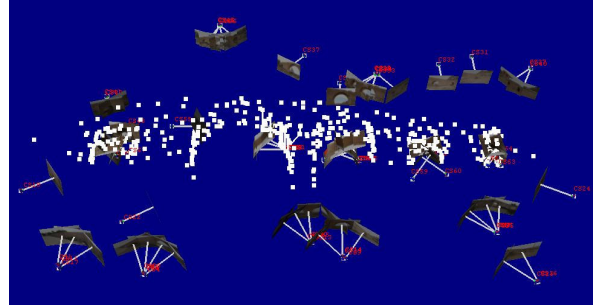


Figure 3: Creation of 3D model by using Photomodeler 6

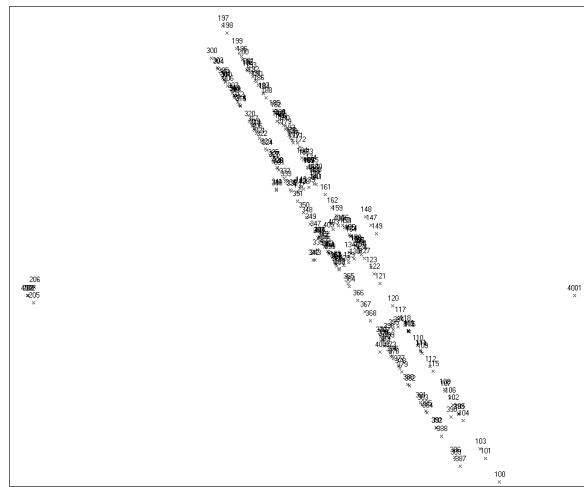


Figure 4: Geodetically measured control and object points

2.2 Outputs

The detailed 3D model with all necessary details and stones was planned. Both software AutoCAD and 3D Max Studio were used for construction and visualization. The model is now under final construction updating and after finishing (October 2009) it will be used for future restoration of the bridge, which is now only under planning.



Figure 5: Vectorising of joints between the stones

As the second step, a special database for information about stones (quality, material, exposition, damage ...) will be created,

which can be useful for planned restoration. Mouse clicking on a stone in the model will depict the related data. Similar system has been developed at the Czech Technical University in Prague and used for the Charles Bridge (Prague, UNESCO heritage).

3. CONCLUSION

This paper is focused on documentation of the Dalal Bridge in Zakho in northern Kurdistan in Iraq by using easy and non-expensive technology. Geodetical measurement, terrestrial photogrammetry and 3D documentation and visualisation techniques were used for the final 3D model. The aim of this project is creating a basic documentation of the bridge for planned bridge restoration and displaying of a rendered 3D model visualisation on the web. We hope that our project can help to save and restore this valuable historical monument.

4. ACKNOWLEDGEMENTS

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Figure 6: The Dalal Bridge in Zakhu

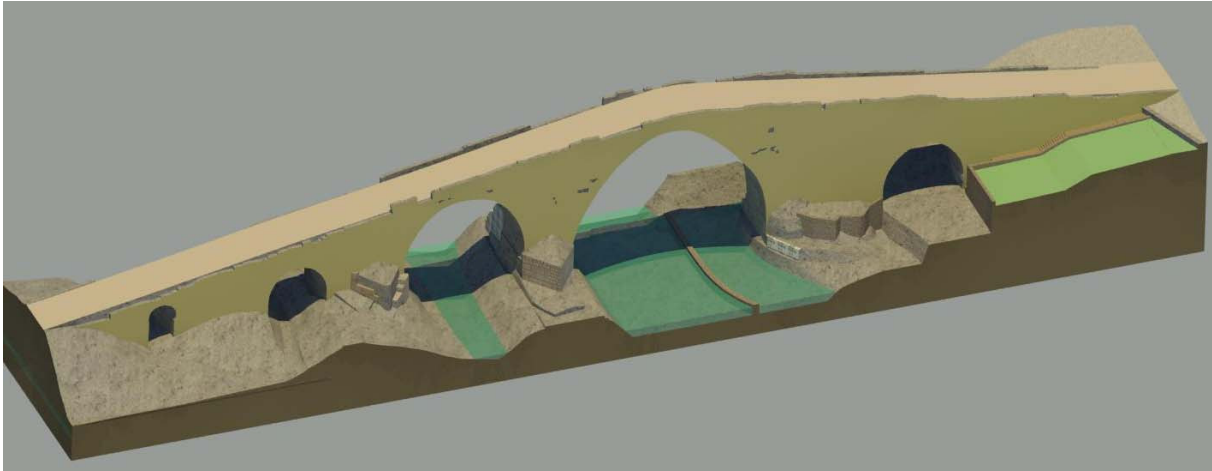


Figure 7: 3D Model of the Dalal Bridge in 3D Max Studio

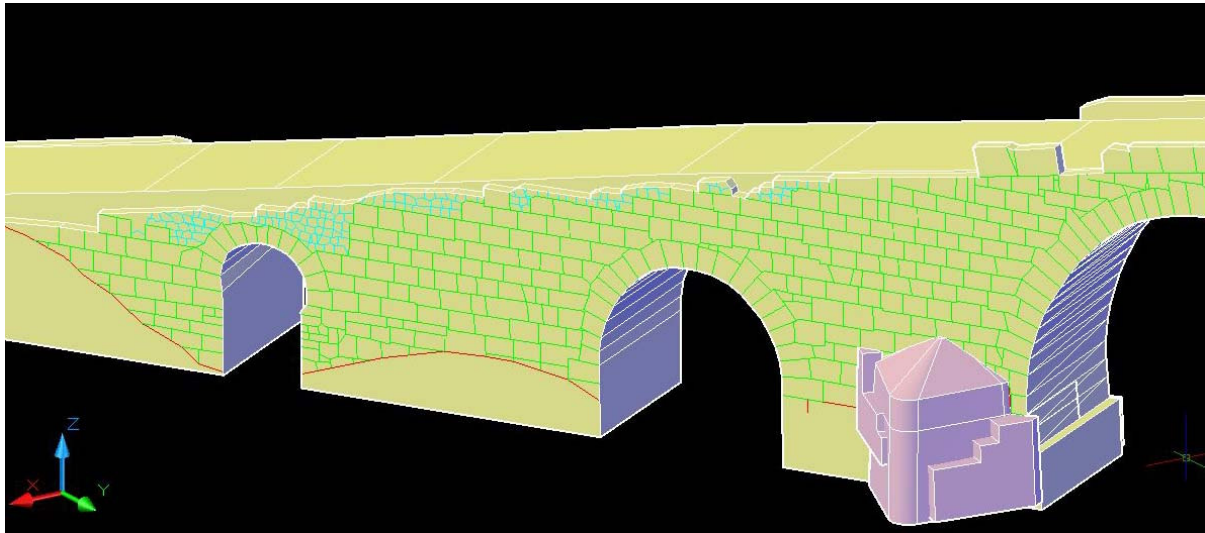


Figure 8: The Dalal Bridge model with detailed stones

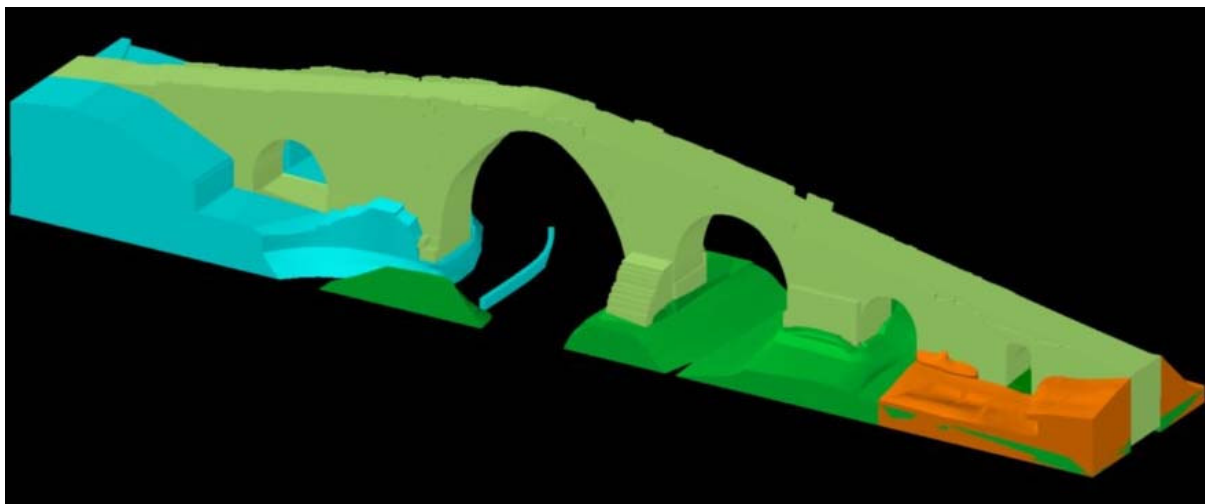


Figure 9: 3D model of the Dalal Bridge in AutoCAD