"3D LASER" VERSUS "STEREO PHOTOGRAMMETRY" FOR DOCUMENTATION AND DIAGNOSIS OF BUILDINGS AND MONUMENTS (PRO AND CONTRA)

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ABSTRACT

Our company from Austria is specialized in surveying, scanning and photogrammetry for more than 30 years and offers documentation of cultural heritages with highest precision. We have done more than 400 projects throughout Europe. Since several years we are looking at the different developments in the scanner industry and the purposes these instruments are used for. First of all we have to differentiate the basic techniques of this two methods regarding time, costs and quality. Secondly we compare a 3D laser scanner (range 10-100 meter) with a topometric close range scanner (distance 0.3-2 meter) in respect to accuracy, quality and time. For these purposes we present three different examples which are realised by our company and partners. The first project is Neuschwanstein Castle in Germany. This project is done 2002-2005 in classic stereo photogrammetry. The result was a 3D model and orthophotos for the whole facades. Each stone (more then 170.000) is displayed with a closed polyline (Autocad) and an orthophoto. Behind this AutoCad layers is a large database attached where each stone has a number for the stone deteoriation. The second project is done with a topometric close range scanner (distance 0.3-2 meter) from Breuckmann. The twelve meter huge "Residenzbrunnen" in front of the Dome in Salzburg was modeled with 2700 scans in a very high accuracy (0.5 mm). The aim of this paper should describe the strengths and weaknesses of each method and how you can make the right decision for the right project.

1. INTRODUCTION

Our company, which is placed in St. Johann in Salzburg (Austria), is specialist in documentation of cultural heritage. In this 30 years of work experience we have realised more than 400 projects throughout Europe for different organisations.
Here are some examples from our projects:
• Residence, Munich / Germany
• Neuschwanstein Castle / Germany
• Kufstein Castle, Tyrol / Austria
• St. Stephans Cathedral / Austria
• Water castle, De Haar/ Netherlands
• Palace and castles / Luxembourg
• Engelberg Church/ Switzerland
• Sigmundskron Castle,/ Italy

2. HISTORY FROM THE ANALOG PHOTOGRAMMETRY TILL HIGH TECH 3D SCANNING

Albrecht Meydenbauer (1834-1924) was the pioneer of the analog photogrammetry for architecture and still a lot of the mathematic theories in this area results from his developments. Later during the time when the computers were established it changed from analog to analytic stereo photogrammetry which made the whole process much faster and easier. So the black gravurplans were replaced by the computer. But since year 2000 there is coming up a new technology for structural recording old buildings with laser. During the last five years we saw a lot of different scanners for different application areas.

3. THE MAIN POINTS BETWEEN SCANNER AND STEREO PHOTOGRAMMETRY

Stereo Photogrammetry
"The strengths of stereo photogrammetry is the 3D line and the 3D edge "
Laserscanning
"The strengths of laser scanning is the 3D surface".

And here starts normally the discussion about what you need and what should be the result. A 3D model with surfaces where later the lines were drawn inside or the classic lines out of stereo photogrammetry ? The result of the scanner is the pointcloud and out of this millions of points it is very hard to define an exact line. It is easy to make a 3D model, but do not look at the details and accuracy. For archaeological topics it is a perfect feature. Here I will present two different typs of surveying of objects. The objective of this comparison is to look at the strengths and the weakness of each technology.

3.1 Stereo Photogrammetry (Neuschwanstein Castle/Germany)

The first project is Neuschwanstein Castle in Germany. This project is done from 2002 till 2005 by classic stereo photogrammetry with a 3D model and orthophotos for the whole facades. Parts of the facades where done by a scanning-company, but the results were not satisfactory. Because of the fact that it was not possible to generate orthophotos with right closed polylines and a high accuracy for each stone on the facade out of the pointclouds we hade to repeat this facades with stereo photogrammetry. The final result of this project was a 3D model and orthophotos from the whole facade (scale 1:20). This was the basis for the large database for the stone deterioration where each stone gets a number (more then 170.000 stones) with texture and polylines. The modeling of the inside of the castle especially the throne-hall now is done by Zoller&Fröhlich GmbH and DLR with laser-technology and photo-mapping.

3.2 3D Closerange-Lightscanner

This kind of scanner we use for very high accuracy. We are using this scanner for objects with a lot of details and with an unsteady surface. The distance we need to the object is max. 2 meter and the accuracy is between 0,8 mm and 0,1 mm. We have done several projects with this scanner. One of them is the Residenz Fountain in Salzburg, 12 meter high. During 2 months we have done more 2.700 Scanns with a final database of about 27 GB.

The object was measured with a topometric close range scanner. Topometric metrologies are based on the principle of optical triangulation by means of structured illumination: A pattern of well defined periodic fringes is projected onto the object, recorded by a high resolution camera and transfered to a powerful imageprocessing system for data analysis. At the end you get a 3D model of the surface. Further the model has been textured. The 3D-sensors of these systems are based on the patented Miniature Projection Technique (MPT), combining Phaseshift- and GrayCode-method, which guarantees high accuracy of data. About 2700 single shots of the fountain have been taken and at the end they have been processed and merged to one model with a deviation of 0,5 mm at every point. The complete model consists of about 26 Mio. triangles and the texture was created of about 200 digital pictures.
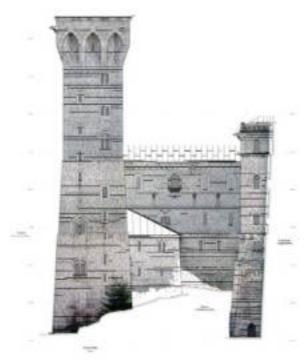

Figure 3. Residenzfountain in Salzburg with 2.700 scans

Figure 4. 3D model of one horse of the fountain section

Figure 1. Orthophoto Neuschwanstein Castle / Germany

Figure 5. 3D model and stone determination

CONCLUSION

With this new technique is was possible to give the restorer digital 3D data primary for the 3D deterioration mapping but also for the documentation. With the data it was possible to make some copies in different size and different materials from parts of the fountain but also for reconstruction for some missing parts. The 3D model was also used for an internet performance. But in order to receive the most suitable product in the end it is often necessary to combine scanning and threedimensional photogrammetry. This is the product we offer most of our clients.

Figure 2. Photo Neuschwanstein Castle / Germany