LASER SCANNING FOR TERRESTRIAL PHOTOGRAMMETRY, ALTERNATIVE SYSTEM OR COMBINED WITH TRADITIONAL SYSTEM?

N. Demir [a, *], B. Bayram [a], Z. Alkış [a], C.Helvaci [a], I. Çetin [a], T. Vögtle [b], K. Ringle [b], E. Steinle [b]

[a] YTU, Civil Engineering Faculty, 34349 Beşiktaş Istanbul, Turkey - (demir, bayram, zubeyde, chelvaci, icetin)@yildiz.edu.tr

[b] Institut für Photogrammetrie und Fernerkundung, Universitat Karlsruhe, Englerstr. 7, 76128 Karlsruhe , Germany – (voegtle, ringle, steinle)@ipf.uni-karlsruhe.de

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ABSTRACT:

Traditional photogrammetric method has been a system for documentation, 3D modelling for long years. After the development of digital photogrammetrical systems, map products can be monitored in CAD platforms. Placing models in CAD had verified flexibility for getting information from model and easy editing for modelling. Terrestrial Laser Scanning Systems provide modelling of objects without scale and complexness. Likewise the combination of laser scanning method and photogrammetric method or taking in the consideration of the laser scanning method as an alternative method has been become a discussing topic. In this study, the study area has modelled with both systems and after completed the comparison and combination of the both systems. 3D Model of the building of University of Karlsruhe, Institute of Photogrammetry and Remote Sensing in Germany had been evaluated by photogrammetric method. The 3D model of same scenery had been created by terrestrial laser scanning method. Then the comparison of results from both systems had been done. To fusion the elevation data had been taken from laser scanning and the spatial data from photogrammetric evaluation. The process steps had been explained and the results given.

1. INTRODUCTION

Architectural photogrammetry has a big role for correct, scaled documentation of buildings. By development of photogrammetric and laser scanning systems, creating of orthophoto, digital terrain models and monitoring has been become rapid, correct and economical.

In last years terrestrial laser scanning systems have been got usefulness for modelling processes. Processes may be done without scale and complexness factor in laser scanning Systems. Modelling of complex shaped objects is created by point clouds in this system. All points of cloud have 3d coordinates. Another superiority of laser scanning system is having tolls of data export at a file format. (Barber,2001)

The ability of ground based laser scanners to generate thousands of 3D points over surface of interest in just a few minutes is an appealing concept.(Gordon, 2001)

Stereo Close Range photogrammetry has been the main tool in the field of 3D modelling for many decades. Hence it is well established technique , whereas laser scanning is a rather new method for three dimensional object modelling. Since both methods have their advantages and disadvantages, the goal is to extract the positive aspects of each, in order to decade which is suitable for certain application.(Vozikis, 2004)

Differentiations of laser scanners in a technical way concern

- The way of scanning (360^o scans, scanning specific sections because of limited fields of view ,scanning of profiles)
- The deflection system(sweeping or rotation mirrors)
- The combination with other devices, mounted on the laser scanner.
- etc. (Schulz, 2004)

When the laser scanner operates, all points are referenced to internal coordinate system. If the object that has been modelled is complex shaped, a series of scans will be necessary. The multiplying scan series is be done by target points. 3d model is produced by laser software and the data may be exported in data export formats.(Bornaz, 2002)

Compared to the photogrammetric approaches the use of the laser scanners has some advantages:

- Direct acquisition of 3D points
- This systems deliver an enormous amount of 3D points on surfaces
- Excellent technique for the description of irregular surfaces(relieves, sculptures, pillar capitals)
- Results are avaible in a very short term

* Corresponding author.

On the other side, photogrammetry has some advantages:

- Colored information avaible
- Unlimited range
- Shorter data acquisition times at the site
- Higher resolutions are avaible
- Low price of the images
- Possibility to use historical imagery (Wehr, 1999)

2. USED HARDWARE, SOFTWARE AND STUDY AREA:

2.1 Used Hardware

2.1.1 Cyrax Laser Scanner

In this study Cyrax 2500 Laser Scanning System had been used. Cyrax 2500 Laser Scanning System can get 1000 points per second and its point diameter is 6mm.

The most important technical details of the used scanner are given below:

- Range up to 150 m
- Field scanning width of 40^o x 40^o
- Hundred of thousand points in 5-15 min.
- 6mm point accuracy @ 50m
- <15 mm resolution(point cloud density) @50 m
- 6 mm point diameter @ 50 m.(Vozikis, 2004)

2.1.2 Pentax PAMS645 Terrestrial Metric Camera

In this study the stereo photographs had been taken by using Pentax PAMS645 metric camera. Focal length of camera is 45 mm.

2.1.3 PHODIS Digital Photogrammetric System:

Digital photogrammetry requires that if conventional photographs are being used the diapositives must be scanned to create digital files. (Bailiy, 2002). In this study the photographs had been scanned by using UMAX Powerlook II scanner with 2400 dpi (10 microns) resolution.

The PHODIS System had been used for photogrammetrical evaluation in this study. PHODIS is a UNIX based digital photogrammetrical system.

2.2 Used Software:

2.2.1 Cyclone Software:

Cyclone software is a Cyrax scanner solution for data processing and modelling. This software has data completion, meshing, 3D modelling tolls.

2.2.2 Microstation SE / V8 Software:

Microstation is a classic CAD Software. The model that had been done for photogrammetric system had been produced by Microstation SE/ V8 .

2.3 Study Area:

The building of Karlsruhe University Photogrammetry and Remote Sensing Institute No: 8 had been modelled by laser scanning method and close range photogrammetric method.

3. USED METHODS

3.1 Photogrammetrical Evaluation

Modelling of study area had been done by stereo evaluation. Stereo photographs pairs had been taken by metric camera at 18m. range (Figure 1).

Figure 1.Stereo photograph pairs.

Interior orientation process had been done with error of 13 microns. The accuracy of exterior orientation is shown in Table 1.

dx	dy	dz
0.045	0.041	0.031

Table 2. The accuracy of exterior orientation

The coordinate system of laser scanned study area had been used as a reference coordinate system. (Figure 2)

Figure 2.Measured Control Points for exterior orientation

3D drawing of study object had been created interactively. Figure 3. shows 3D design of the object.

Figure 3. 3D design of the object.

3.2 Laser Scanning Method:

The study area had been scanned by using local coordinate system. During scanning process with control points each different parts side of building had been located for registration process. Cyrax HSD2500 sensitive specific targets had been used. The three side of building was scanned with 6 mm point diameter. All scanned sides of building registered with 1,4 mm. accuracy and 3D point cloud model of the building was generated (Figure 4).

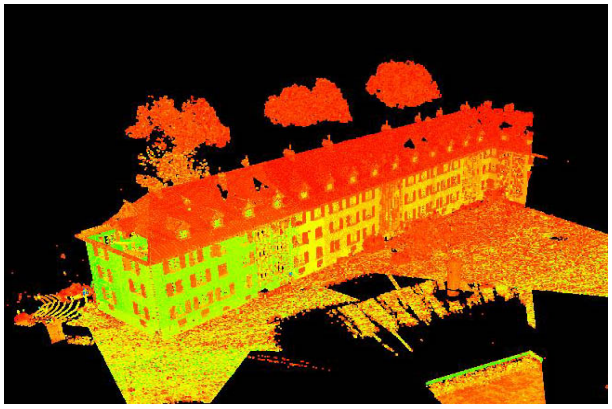

Figure 4. Point clouds of whole building

3D modelling of the laser scanned study area has been done by using Cyclone software. Single patches of surfaces have been created for modelling. This process had been completed by selecting point clouds and creating fitting patches of them. If the modelling of the big surfaces made from small patches, because of the fitting problems some error can arise. The patches have to be edited by user to solve this problem, and then the patches can be fitted on their true surface. The 3D editing possibility of software makes that easier. However this process could be done with automatically mesh generation process, but in this study the 3D modelling has been realised only by using interactive method (Figure 5,6). Only the side evaluated by photogrammetric method had been modelled.

Figure 5: 3D model by laser scanning method.

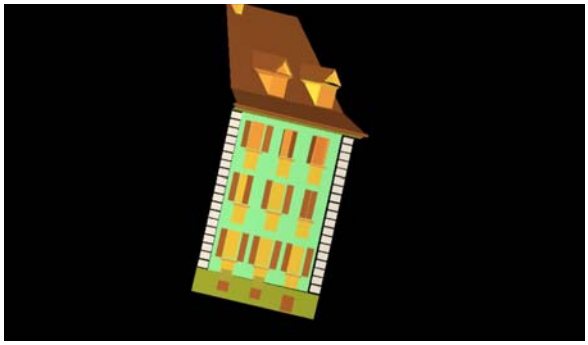

Figure 6: different perspective of 3D model

3.3 Comparing two methods

The 3D outlines created by photogrammetric system and 3D modelling created by evaluating laser scanned data had been overlapped (Figure 7).

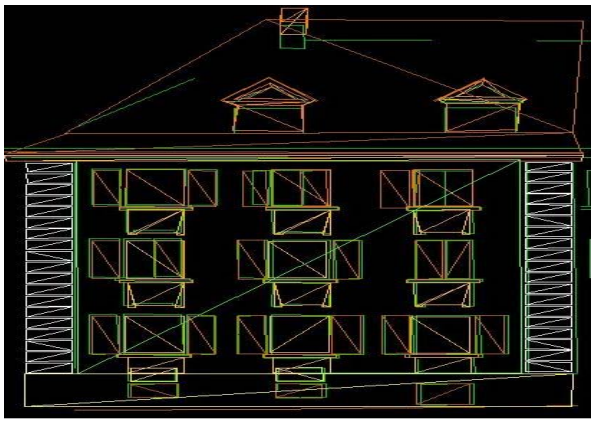

Figure 7 : Overlapped models

Coordinates of 60 specific points as corners had been measured from two products. Residuals vx, vy, vz had been calculated by difference of coordinates (Table 2).

σvx (m)	σvy (m)	σvz (m)
0.0145	0.049	0.069

Table 2.Standart deviations of residuals

3.4 Fusion of two methods

Through the combined use of photogrammetric and scanning data, the geometry of any kind of object can be fully captured. Moreover, new products can be available, such as the production of '3D orthophotos', which is the orthoprojection of photos onto a unified dense DTM of the whole object derived from laser scanner data (Ionnidis , 2003).

Ortohophotos that had been created by photogrammetric systems, represent 3D coordinates of an image. Orthophotos contain texture information also. The model had been created by laser scanning data may not contain texture information of object. This problem can be solved by fusion of laser datas and single photograph that had been taken by metric camera.

For fusion of laser scanning data and the rectificated photograph of study area has been overlapped and formed at coordinate system of local laser scanning data (Figure 8).

Figure 8: Reftificated single photograph.

The last years laser scanning has become a reliable and economic technology to build up high class DEM (Knabenschuh, 1999).

The DEM file was created by using point clouds. At the beginning the TINs had been created, after the mesh of study area had been generated. (Figure 9)

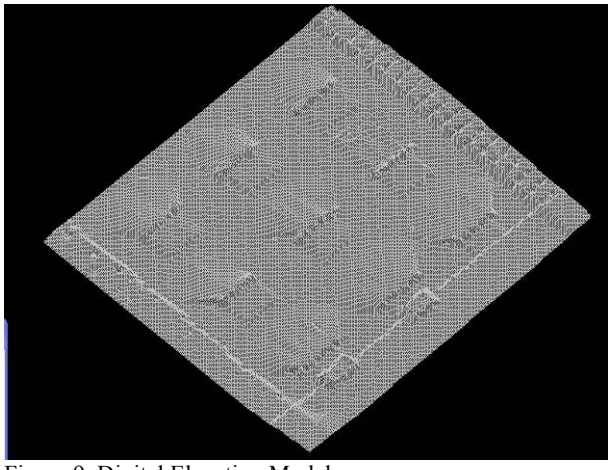

Figure 9. Digital Elevation Model.

After this process the DEM and the rectified photograph had been overlapped and the result product (orthophoto) created (Figure 10, 11, 12).

Figure 10 :Orthophoto of study object

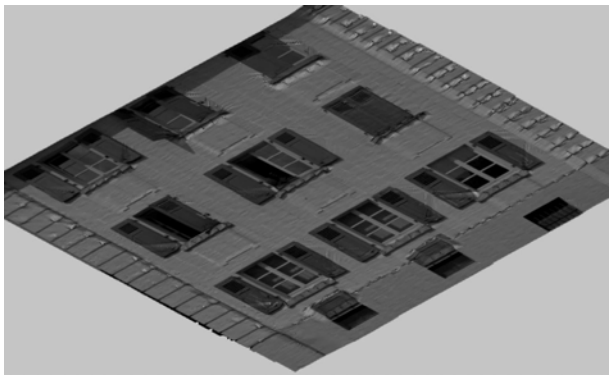

Figure 11. Different perspective of orthophoto

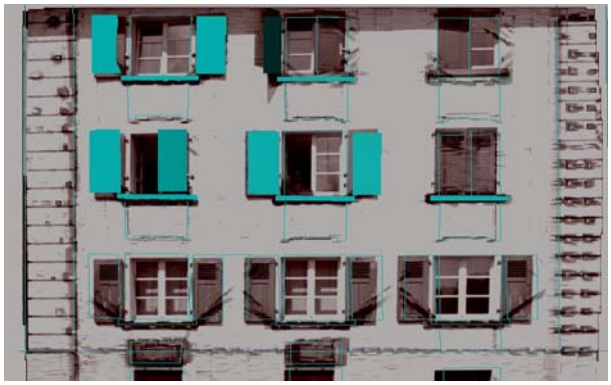

Figure 12. Overlapping orthophoto and 3D photogrammetrical design

4. CONCLUSIONS

Nowadays, the usage of laser scanning systems has an important role for data acquisition and being realized easily.

Interactive modelling at laser scanning systems is easier than photogrammetric systems. Operator does photogrammetric evaluation on the plane at this method. Namely operator can't rotate in 3D space. Whereas model could be done by operator in 3D space. This occurrence is become because of concept differences of two methods.

In this study, our experiences showed that the laser scanning data process softwares need more developing and user friendly tools. Especially automatic mesh generation algorithms aren't efficiently to create 3D models. Because of false created triangles, different surfaces that have different elevation could not be modelled in 3D. Therefore it requires more editing after the mesh generation.

In this study, because of the used camera, the laser scanner data were taken a basic system to compare both methods. By comparing two methods, we may say that the laser scanning systems may be used in 3D modelling applications instead of close range photogrammetry but texture information is an important topic for architectural projects By fusion of single photograph that had been taken by photogrammetric method and laser scanning data; the model that contains texture information had been generated.

We suggest that in the future, using terrestrial scanning systems will be more effective by developing of user softwares.

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