

**Assoc. Prof.Dr. Murat YAKAR
Instructor Ali ULVI
(TURKEY)**

USING OF LASER SCANNING TECHNIQUE TO CULTURE HERITAGE: THE SAMPLE OF KIZKALESİ

1.INTRODUCTION

Mersin is very touristic city in TURKEY. Mersin is at the Mediterranean Sea. There are a lot of beaches at Mersin. Kızkalesi is the most popular holiday centre in TURKEY –Mersin province..



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Image1: Location of Kızkalesi



This castle is in the sea and 500 m far away from land. Kizkalesi has $36^{\circ} 27' 24.47''$ North, $34^{\circ} 08' 54.1''$ East coordinates.



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Kizkalesi have eight towers. The external peripheral length of castle is 192 meter. Kizkalesi, which is important tourism centre of Erdemli, is 23 km far away from Erdemli and 60 km far away from Mersin.



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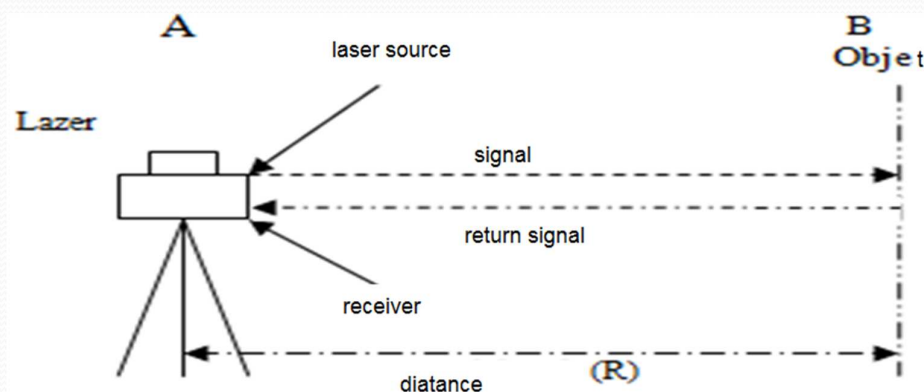


Cultural heritages requires developed measuring tool and technique to measure in detail an documented because of having different natural features, dimensions and complicate construction. In recent years, 3D laser scanning technique has come to as a standard tool i documenting works of cultural heritage and historical structures in terms of acquiring 3 dimension: data and modeling. This technique gives the opportunity to obtain millions of 3 dimensional poir datas, so it gives opportunity to get surface geometries of cultural properties effectively and densel [1].



2. 3D LASER SCANNING TECHNOLOGY

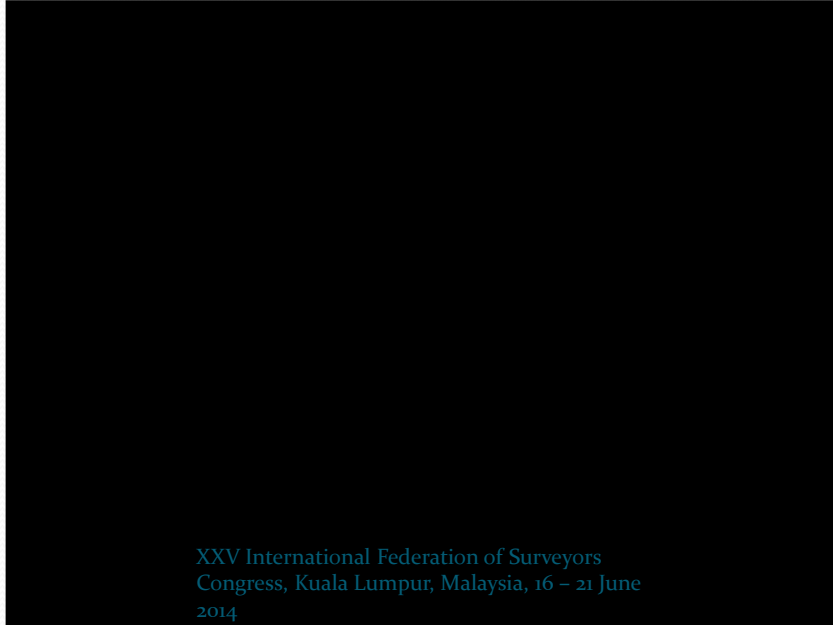
Laser scanning is a technology which provides to get 3 dimensional coordinations of objects directly, accurately and automatically [5]. It has an application area in registration procedures of cultural heritage and especially in the engineering projects[4]. This technology can be used in the work of cultural heritage and archeological areas for different purposes to form 3 dimensional models with high precision, to have high incidence of detail about the object and coupling[3].





2. 3D LASER SCANNING TECHNOLOGY

In the works of documentation, cultural properties to scan small sculptures, objects, close-range scanings, which work with the method of triangulation, are used. The scanings which is used with phase comparing method and with stream-arrival time of laser beam, is used in the works of documenting of historical building, archeological areas and big areas[7].



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3. STUDY AREA

The castle formed on a small island that is 500m far away from coast, is called Kızkalesi. It has eight towers. The external peripheral length of the castle is 192 meter. Kızkalesi, which is important tourism centre of Erdemli, is 23 km far away from Erdemli and 60 km far away from Mersin.



Image 3: Interior and external apperance of Kızkalesi

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This project was completed in two steps

1) Field work

- setting of the control points
- coordinate measurement with total station
- laser scanning procedures

2) Bureau work

combining point clouds and registration



- Distance Measuring Operation 200m without reflector
- It provides high data recording area with 10.000 points internal memory capacity
- Measurement precision $\pm 2\text{mm} \pm 2\text{ppm}$
- Reading aspect 2cc

Image 5: Total Station used in work (Geomax ZTS 605)



Image 6: Paper target sign in A4 size



Image 7: Attachment of paper targets to wall (Ulvi A. ,2012)



Device Type	Long range Laser Scanning System
User Interface	PC, WindowsNT/2000
Ideal usage range	2-100 m
Maximum Scanning Rate	5000 point/second
Standard Deviation	6.5mm in 200m
Scan Resolution	3mm in 50 metric distance
Distance Measuring Method	Time of Flight
Camera Zoom Factor	Up to 5.5x
Accuracy in Modelled Surface	+/-2mm
Accuracy of Single-point	7 mm in 100m
Point of view; Continuous monadic scanning	360°x60°
Dot pitch	Under 3.2 mm in 100



Image 4: Laser Scanning (Trimble GX 3D) used in work



Measuring of Check Points in the Working Area

Angle and distance measures: Vertical angle, horizontal angle, distance was measured by Total Station Geomax ZTS 605 device which measures reflectorless

3.1.2. Modeling by Using Point Clouds With Topographic Laser Scanning

Documentation working used in laser scanning method, was carried out at 4 operation phases. These operation phases are planning before scanning, scanning, data processing and evaluation.

Planning Before Scanning	Defined of station positions and numbers
Scanning Operation	- Placement of Targets - Scanning of general area
Processing of Datas	- Computerized of Datas - Forming 3 dimensional point clouds of structure
Evaluation	Planning and transecting of the structure from 3 dimensional point cloud

Image 8: Phase of Topographic Laser Scanning Operation



Scanning operation has to be planned before doing scanning in the terrain. In the phase of planning, positions and numbers of stations have to be defined. To be scanned stations' positions have to be defined in sufficient number by involving the whole structure and all details.

While defining positions of these stations, unscanned areas by keeping them in a background in a station have to be defined from other stations to scan them and it has to be made a point of setting out in full. In the scanning operation plan, with which coordinate system it will be combined with point cloud have to be defined. This reference system could be a geodetic coordinate system or a scanner based local coordinate system. If the reference system of scanning is a geodetic coordinate system, coordinates of target points used as linkup have to be defined according to this coordinate system.



Topographic Laser Scanning Operation



Topographic Laser Scanning Operation



4. RESULTS OF SCANNING

Laser scanning was done with Trimble GX 3D laser scanning from 25 different station

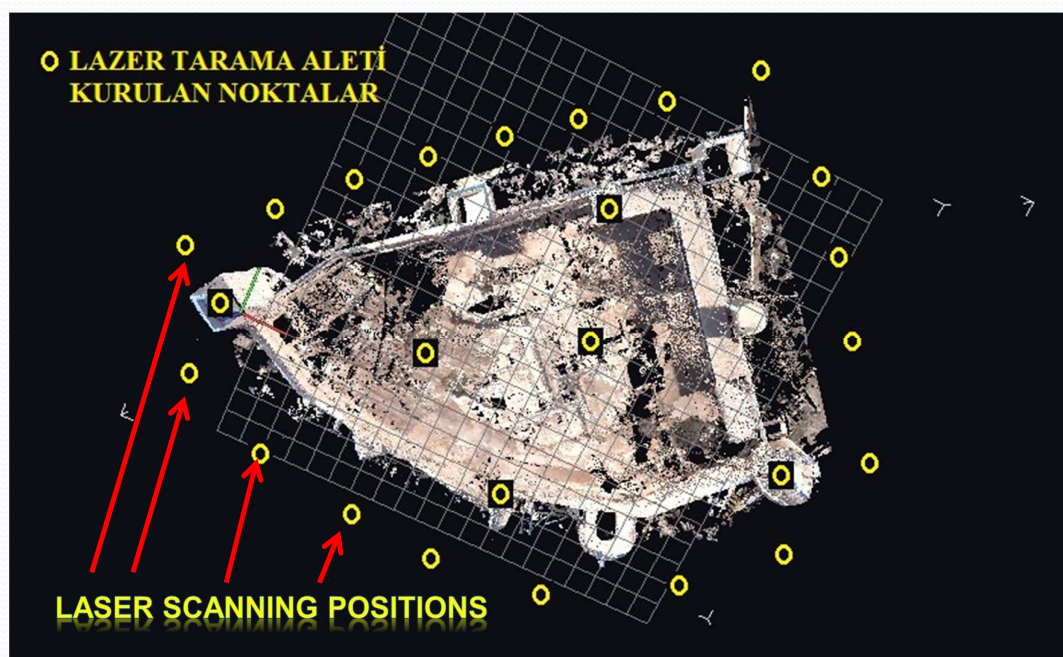


Image 12: Scanned Stations of laser scanning Trimble GX 3D
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After scanning process
finished, obtained point clouds have
been combined at same coordinate
system

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Coordinates of points (30.374.829 adet) obtained from scanning, were transformed general coordinate system. Coordinates obtained from Total Station, and gained apparent 30 points is given in table1.

N.N	Total Station (Local)			Manüel Combination (Scanner)		
	x	y	z	x	y	z
200	1062.869	1001.8	106.452	1062.852	1001.81	106.461
201	1066.371	990.579	106.926	1066.356	990.592	106.917
204	1057.593	1019.234	103.36	1057.605	1019.225	103.368
205	1054.075	1028.673	103.419	1054.065	1028.677	103.424
207	1041.188	1044.834	103.061	1041.199	1044.832	103.046
215	978.213	1076.558	103.887	978.22	1076.563	103.873
210	1036.657	1055.185	102.957	1036.669	1055.19	102.965
227	976.975	1071.362	102.642	976.98	1071.377	102.656
231	993.271	1006.046	97.445	993.282	1006.036	97.458
233	1000.696	979.175	103.245	1000.678	979.17	103.257
244	1033.941	996.184	96.047	1033.95	996.18	96.052
246	1059.401	1000.627	100.78	1059.407	1000.632	100.763
251	1041.983	1042.934	97.55	1041.992	1042.949	97.541
254	1019.25	1063.525	95.603	1019.262	1063.512	95.619
256	990.776	1074.938	96.083	990.761	1074.948	96.093
316	998.873	973.44	99.774	998.858	973.452	99.765
320	1033.904	983.151	94.607	1033.916	983.142	94.615
322	1047.489	992.073	95.013	1047.48	992.078	95.016
325	1065.944	1001.945	93.436	1065.954	1001.943	93.421
330	1053.376	1039.015	95.83	1053.383	1039.02	95.817
343	976.738	1079.785	96.669	976.75	1079.79	96.679
350	979.804	1040.886	94.338	979.811	1040.901	94.348
357	992.962	1000.645	94.647	992.971	1000.635	94.658
360	997.959	976.37	93.776	997.941	976.365	93.788
363	1005.918	971.492	93.32	1005.926	971.487	93.325
367	1019.654	984.318	95.773	1019.66	984.323	95.758
377	982.252	1033.606	101.016	982.261	1033.622	101.007
383	1002.674	1073.688	102.134	1002.685	1073.674	102.15
387	1037.373	1056.449	102.738	1037.354	1056.444	102.726
394	1053.986	1038.941	103.845	1053.995	1038.936	103.819

Table 1: Coordinates obtained with Total Station and Manual Combination

CONCLUSION

As a measurement device, widely used of 3D laser scanning technology have been making progress in recent years. Laser beam used in scanning is used for both length measuring and screening. Nowadays, it is very important to have fast and in full 3 dimensional model and visual knowledge with minimum cost. To use 3 dimensional knowledge for different purposes, alot of data have to be collect fast . When it is needed to get knowledge fastly about an object, traditional geodetic and numeric photogrammetric methods remain incapable. In this situations, 3D laser scanning method,which allows 3D measurement of object geometry fast at high accuracy, can be used.

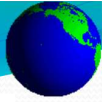
Especially, usage of this method, which begins to have an important place at the engineering field, become widespread gradually, and provides good advantages in terms of time, cost and labour for users.

In this work, the position alterations in characteristic points of Kizkalesi is defined. Points on the surface of this structure are measured with **Geomax ZTS 605** Total station device and coordinates were obtained in general system. As a result of 3D laser scanning, within oriented point cloud, which were obtained from manual combination, were created identical point masses by defning coordinates of same points. Comparison between identical point coordinates defined manual and coordinates defined with Total Station, is done.

Conclusion

Differences between coordinates obtained from Total station and - 16mm and 17mm in manual method was found. Benefit from difference between characteristic points obtained from Total station and Laser scanning, for every coordinate combination, precision criterion is defined. Benefit from results found nominally, alteration of point position is defined. Accuracy of point position is found ± 20 mm . For every point, accuracy of position is found between ± 14 mm and ± 26 mm .

Considering calculation of the coordination differences and standard deviation of them, t—test was applied whether coordinate differences which is obtained from total station and laser scanner, is meaningful or not. When t-test results are analysed, all test values are seen under limit value.



THANK YOU FOR YOUR PATIANCE

CONTACTS

Murat YAKAR

Selcuk University, The Faculty of geomatic engineering, Selçuklu/Konya/TURKEY

yakar@selcuk.edu.tr

Ali ULVI

Selcuk University, The Vocational School Of Hadim,

aliulvi@selcuk.edu.tr

