

## **The Problems and Solution Offers, Faced During The 3d Modeling Process Of Sekiliyurt Underground Shelters With Terrestrial Laser Scanning Method**

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### **Abstract**

The aim of this research is, to find out the practicality of using terrestrial laser scanners in the area of 3D modeling of underground cities and underground shelters and to offer a suggestion for possible problems. Our research concluded that the terrestrial laser scanners are suitable for mapping and modeling the underground shelters and cities and terrestrial laser scanning is a useful technique to obtain sensitive and detailed results for hastily scanned objects. Generated maps and measurements can be used as a base for future restoration and recreation works of the scanned objects.

**Keywords:** 3D Modeling, Terrestrial Laser Scanning,

### **Introduction**

The cultural heritages has different natural features because of their complex structures, they have to be measured in details, and therefore the task requires advanced measuring equipment and techniques. In recent years, terrestrial scanning technique has become a standard facility on the study of 3D modeling, obtaining 3D data for cultural heritages and documenting historical structures. This method allows to obtain millions of fast and reliable data for measured object. Thus it enables to obtain the surface geometries of cultural heritages with an effective and intense way (Alshawabkeh, 2006; Comert et al., 2012).

The point cloud data which is as a result of laser scanning obtains base data for one to one 3D modeling and plan, section and facade which are needed for relievio plans. It' s relievio, which is measuring planning and transacting in details while rebuilding of a building after it damaged or collapsed.( Ulvi,2008; Comert et al.,2012)

This research has aimed to; search the availability of using the terrestrial laser scanners within process of mapping the underground shelters etc., figure out the problems and offer solutions about these problems.

After area studies; the obtained data from the scanned area, are processed on computers and the study area's excavated parts dimensions, shapes, plans and of are 3D modeled. With the experiences acquired by this study we are able to get the most detailed information about point clouds which are collected with the help of terrestrial laser scanners. This shows us that laser scanners are the most efficient method to work with on this field.

### **Terrestrial Laser Scanning Technology**

Terrestrial laser scanning is a technology that provides direct sensitive and automatic 3D coordinates (Reshetyuk,2009;Comert et al.,2012).Terrestrial Laser Scanning Technology are especially used in fields like engineering

projects and registering cultural heritages (Lichti, and Gordon,2004; Comert et al.,2012). This technology is used in different fields like , 3D modeling of cultural heritages with high sensibility, Including high detail about the object, pairing high definition , as it has monitoring the alteration and presentation features it can be used in archaeology and cultural heritages .(Fabris et al.,2009; Comert et al.,2012)

*Laser telemeter*

One laser telemeter consists of:

- Transmitter transistorized laser or semi permeable laser diode
- Receiver channel (automatic detection control, detection amplifier)
- Time measurement unit (digital convertor)

Transmitter and receiver optics

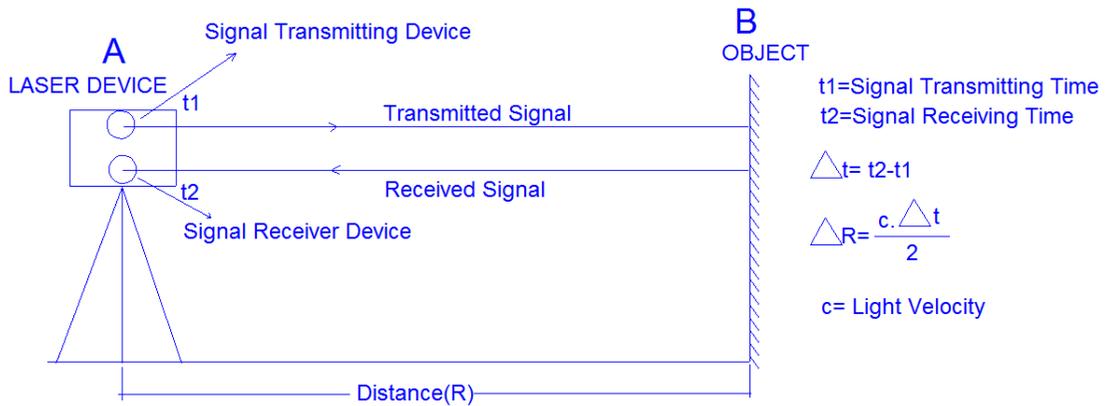


Figure 1: The working principle of typical laser sender.

Laser transmitter transmits laser starting waves which is divided into two waves, one is sent to the receiver which starts the time measuring unit, and the other one is sent to the object. Detector is used to detect the waves which are reflected from the surface of the object. When it is reached on the surface of scanned object, laser beam reflects and some returns to the detector. The bright power of the laser beam is converted into electric current.

As the amount of receiving power affects the value of sounded distance sensibility, the analysis of this relation is very crucial. As it is said some of the laser beams which are transmitted, returns to detector. Received laser power is very tiny part of the transmitted laser and relates to the reflections from the target.

With the help of automatic detection control time measurement is set, the dynamics of the received beams can be noticed by the optic or electrical dimmer. The reflected laser beam part, after it is noticed it is sent to the time separator which starts and ends the time measurement unit.

The differences between terrestrial laser scanners and traditional measurement techniques.

The most important aspect of the terrestrial laser scanners are that, they can reflect the 3D object geometry directly fast and detailed.

The other advantages are (Reshetyuk, 2009):

1. Significant reduction on the cost of outgoing
2. Completion of the projects is much faster. A project can be completed in few days.
3. Complex, dangerous and inaccessible areas, where traditional techniques fail to measure, can be measured.
4. Scanning process doesn't require any sort of environmental lighting.
5. The full and accurate scanning it can reflect everything at one time .Thus ,if new information is needed ,you don't have to turn back to the area .This also gains the confidences of the user over result.
6. Now and in the future, multipurpose usage

### *The Application Areas of terrestrial laser technology*

In recent years, the needs for the 3D data, like most of research areas, the usage of terrestrial laser scanners are also essential on speleology. Especially, because of the unlevelled geometrical and complicated shape; the visualization 3D data and 3D modeling of the area is very advantageous with the use of terrestrial laser scanners. (Avdan et al., 2013)

Terrestrial laser scanning technology is almost used in every area of 3D modeling .This technology is intensively used in below listed areas. (Alshawabkeh and Haala, 2004; Bitelli et al., 2004; Bornaz et al., 2004)

- Mining industry
- Documenting of industrial buildings

- Archaeology
- Architecture
- Archiving and preserving of historical and cultural heritages
- Car industry and robotics applications.
- Measuring and CIS applications
- Determination of coast line
- Volcanic observations
- Forestry studies
- deformation studies
- Environmental studies

### **Study Area**

The cave that was modeled with terrestrial laser scanning technology is located 20 km from Seydişehir, Konya and placed in Çavuş town Karatepe mount .Its coordinates are 37° 37'00.27'' north and 39°55'56.51'' east.(figure 2)



Figure 2: Sekiliyurt shelter main outlook

### **The Application of Laser Scanning Method in Underground Shelter.**

The conducted study is Preparation for field work; marking the central points on the area and scanning the area with the laser scanning device. Office work; the data which are obtained from field work are processed on computers and transferred the information on the useful devices. Area work has taken 1day and office work has taken 3 days.

### *Devices used on the study*

Faro focus 3D laser scanning device is used in this scanning study (figure 3)



Figure 3: The laser scanning device which is used in the study. (Faro Focus 3D, measuring distance is 0.6-120 m, measuring speed is 976000 point of seconds, 2mm distance accuracy and 3mm location accuracy.)

### Scanning Process

During the planning process of scanning, the point cloud which is obtained during the scanning process, should be clearly defined that which reference system it belongs to. This reference system can belong to either a geodesic coordinate system or a scanner centered local coordinate system.

If the reference system of the scanning belongs to a geodesic coordinate system, the target

signals coordinates which are used as the connection point in scanning process should be defined according to this coordinate system. In this study, the tool centered coordinate system of first scanning station is defined as the project coordination system.

Laser scanning process is made in 10 different stations with 6 mm sensibility (Figure 4). Each scanning is made in order to have at least 3 connection points within the mutual area



Figure 4: General view of the laser scanning

The laser scanner is situated in order not to have any missing area in the scanned area



Figure 5: The plan view of underground shelter and scanning stations

*Processing of the data*

Processing of data includes a combination different from scanning station data and coloring the point clouds. The combination and coloring of the point clouds are made with the FARO

“Scene” software. After integration of the point cloud, the data are evaluated on different software and explorations about the excavated area are obtained (Figure 7).Also, inside shelter, the excavated areas are accurately achieved.



Figure 6: a) Outdoor and b)Indoor side images which are gathered from the point clouds of the underground shelter.

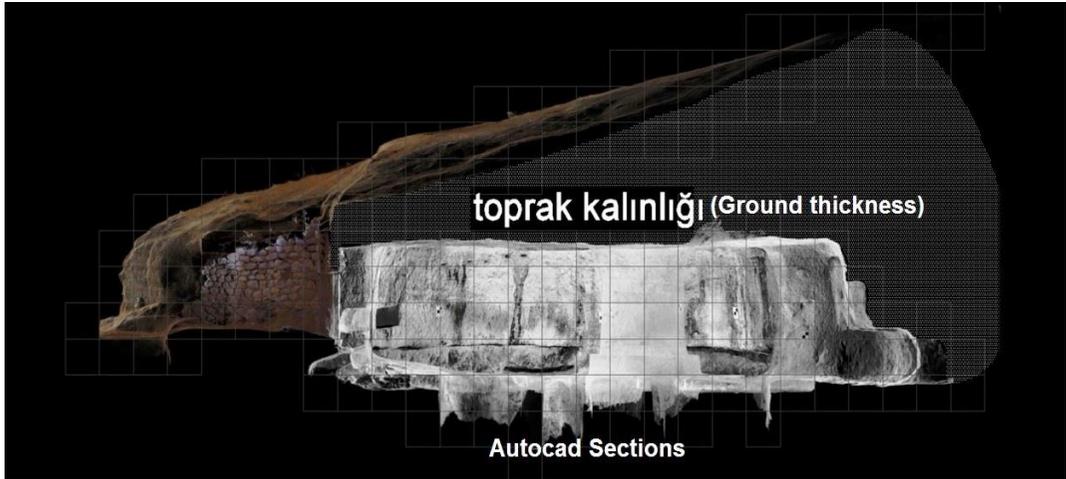


Figure 7: Sections about the study area

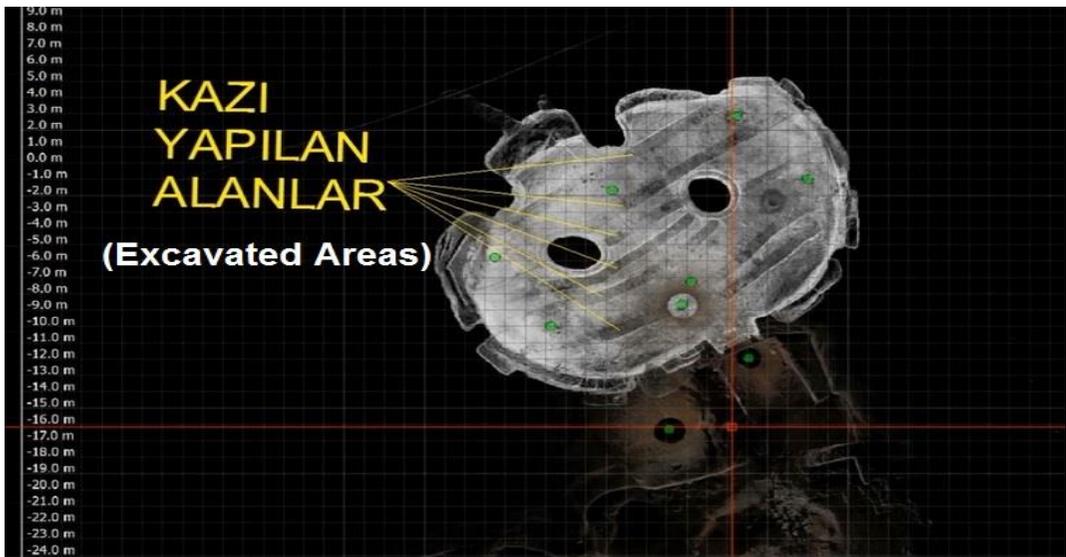


Figure 8: The excavated areas in the shelter

## Conclusion

*At the end of this research;*

The terrestrial scanning of an underground shelter is a specific work. Before the start of the scanning work, the tools and the equipment which are going to be used, should be selected by taking into account of their technical features.

- The prepared 3D model will help the geologist about age estimation of the underground shelter.
- The sections and the plans of the cause can be referenced from the 3D models.
- The modeled 3D work will be a base on geographical information system and will help the gaining process of the area to tourism.

When 3D modeling of the underground shelters, caves, etc., and like these kind of structures are requested, before starting the measuring process, the physical conditions of the area should be evaluated

As each laser scanning device has different features the selection of the appropriate device should be made carefully. Because, the device which has the nearest scanning feature is the most suitable one (For ex: 30 mm). If this situation doesn't considered in order to model the physical condition of the cave accurately. We should need more scanning process and this causes waste of time.

Before the scanning process, lighting the cause will help to obtain the colorful point clouds and this will be the base for visualization of the 3D modeling of the cave.

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