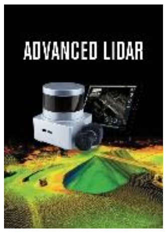
Advanced LiDAR

http://publish.mersin.edu.tr/index.php/lidar/index

e-ISSN 2791-8572



Survey Process of Gesi Pigeonry with Ground Laser by (Point Cloud) Scanning Method

Mahmut Albayrak [*1], **Gonca Büyükmıhcı** [2]

[1]*Master Architect, Turkey*
[2]*Erciyes University, Faculty of Architecture, Department of Architecture, Kayseri, Turkey*

Keywords
Lidar
Gesi Pigeonry
Laser Scanning
Point Cloud

ABSTRACT

The pigeons, which are accepted as the symbol of peace and love, are one of the first domesticated birds by people. Pigeons have been bred up for 6000 years since they are used in postal services, feeding as a hobby, benefiting from meat, manure, and egg for different purposes. There are special pigeon nests made for pigeons in the world. The nests in the Kayseri Gesi Region, which are described as a dovecote, are special structures that are unique in the world and are designed to obtain the pigeon manure used in agriculture. The unique feature of the gothic cavern is that the main nest is made of carved chambers under the ground and on the ground a dovetail chimney, a dovecote or a dovecote tower. As it is seen in this study which is related to dovecotes, it has the function, form, and organization of each other with its unique local artifacts. However, in the globalizing world, the necessity of adding the original identity of the dovecotes to the world cultural heritage is determined. Preserving cultural heritage is an imperative task for all civilizations in the world. In order to keep the traces of civilizations alive, it is extremely necessary to transfer historical and cultural artifacts from generation to generation. Terrestrial laser scanning method has become the reason of choice for many disciplines with its potential to obtain cost-effective, high-accuracy data in a short time. Laser scanners, which ensure that architectural documentation works are carried out in a healthy way and in accordance with the determined standards, have become preferred by users in our country and in the world. Different from traditional methods, terrestrial laser scanning method was preferred for the preparation of survey projects of Gesi dovecotes. Terrestrial scanning device has replaced traditional measurement methods with the rapidly developing technology. The laser scanning method has advantages over traditional methods in terms of speed, workflow and workforce. Using a laser scanner for accurate measurement allows accurate preparation of survey projects. By using local laser scanning technologies, thousands of points reflecting the object or object surface are obtained. With the help of these points, realistic 3D models are obtained. According to the models created, area, volume and surface dimensions can be reached according to the size information of the object or structure. 3D point cloud data about the plan scheme, sections and facades of Gesi dovecotes, which are of historical importance, were obtained by using Faro Focus 3d laser scanning device.

1. INTRODUCTION

Cultural heritage is one of the most important links between the past and the future of humanity. It has an important place in the individual and social development of human beings. It is also an important issue for humanity to leave these heritages to future generations in accordance with their original form. UNESCO (United Nations Educational, Scientific and Cultural Organization), ICOMOS (International Council for Monuments and Sites), ISPRS (International Society for Photogrammetry & Remote Sensing), ICOM (International Council for Museums), ICCROM (International Center for the Conservation and Restoration) of Monuments) and UIA (International Union of Architects) have undertaken duties related to the protection of world cultural heritage (Calegari, 2003; (www.unesco.org.tr, 2021).

The current situation and problems of cultural heritage are determined by metric, written and visual

* **Corresponding Author**

*(mahmutalbayrak38@gmail.com) ORCID ID 0000-0003-1953-6342
(bmgonca@erciyes.edu.tr) ORCID ID 0000-0002-4894-9421

Cite this article;

Albayrak M & Büyükmıhcı G (2021). Survey Process of Gesi Pigeonry with Ground Laser by (Point Cloud) Scanning Method. Advanced LiDAR, 1(1), 06-17

Research Article

Received: 01/09/2021; Accepted: 26/09/2021

documentation. Documentation is one of the most important ways of transmitting cultural heritage to future generations and introducing it to the society, as well as providing basic data in all conservation studies aimed at solving the problems of cultural heritage. Today, different techniques are used in the documentation of Cultural Heritage, and these techniques are developing rapidly in the light of technological developments. The production of physical, social, economic, cultural and historical information of cultural heritage in various qualities and scales, and the processing of large amounts of data produced and transforming them into usable information are indispensable in terms of protection (Yakar et al., 2015).

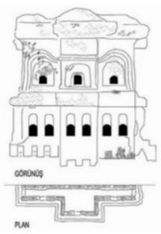
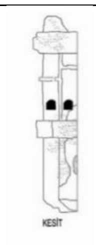
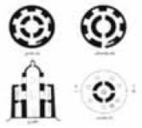
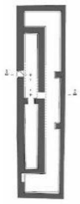
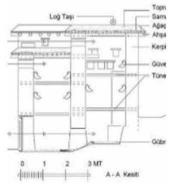
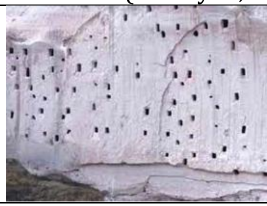
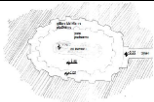
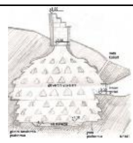
Terrestrial laser scanning method has become a more effective and up-to-date method than traditional measurement methods for architectural documentation studies. Terrestrial laser scanning technique is basically evaluated within the LIDAR (Light Detection and Range) system (Yakaret al., 2020; Ulvi & Yakar, 2014) is the name given to remote sensing technology (Sevgen, 2018). Using the 3D point cloud data obtained by the laser scanning method, the following studies can be carried out on CAD applications; basic measurement data, orthophoto image extraction, 2D or 3D drawings, solid surface models, 3D animations, texture covered 3D model extraction (Karasaka & Ulutaş, 2021; Yılmaz & Yakar, 2006).

In this study, the survey studies of Gesi Pigeonries, one of the historical and cultural monuments of Kayseri province, with terrestrial photogrammetry technique were examined. With laser scanning, 3D CAD drawings were created from high-resolution 3D point cloud data, and it was seen that measurements that can be a base for architecture, restoration, restitution, historical artifact documentation and registration are much more efficient, more advantageous in terms of graphics, and more sensitive in terms of accuracy than classical methods.

2. BIRD CULTURE, BIRD HOUSES and PIGEONS

Pigeons, one of the first domesticated birds by humans, have been bred for different purposes for 6000 years, primarily for use in postal works, as a hobby, and to benefit from their meat, manure and eggs. There are many nests and structures built for birds in the world, and most of them seem to have been built by humans as above-ground structures. According to the published literature, there are special pigeon nests in Iran and in our country in Cappadocia, Diyarbakir and Kayseri.

Table 1. Bird Lodge, Kebûterhâne, Boranhane, Rock Carved dovecotes and Kayseri dovecotes.

		
Bird Lodge Fatih Bali Pasha Mosque Bird Pavilion/ Plan, section, view drawings (Avunduk,2008)		
		
Iranian Kebûterhouses (Gavart Tower) (Amirkhani, Okhovat, & Zamani, 2010)		
		
Diyarbakir Boran Houses (Bekleyen, 2007)		
		
Nevshehir Cappadocia rock carved dovecotes (Berkmen, 2015)		
		
Kayseri Dovecotes (Büyükmıhcı, 2006)		

The formations defined as dovecotes in Kayseri Gesi Region, which is the subject of this research, are special structures in terms of their architectural features and are designed to be used in agricultural areas by obtaining pigeon manure. The feature that distinguishes the dovecotes in Gesi from their counterparts is; it is a stone-built structure form that creates the main nest by transforming the rocks into carved rooms in the underground part and forming the nest door called the dovecote chimney/pigeon bush or pigeon tower seen above the ground (Figure 1-Figure 2).

Figure 1. Pigeon bush and underground nest (Albayrak, 2019)

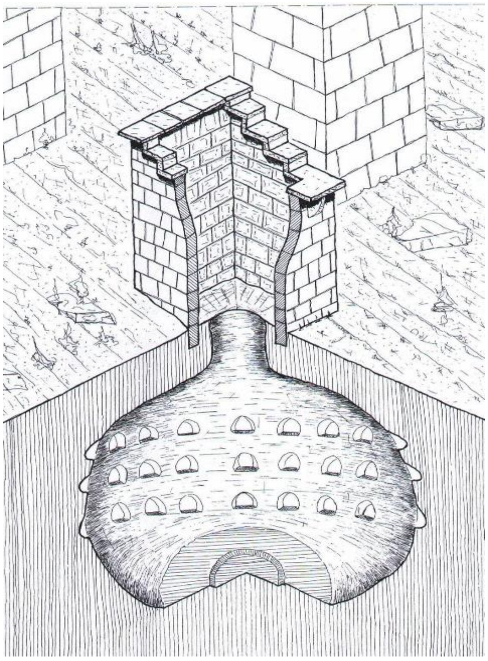


Figure 2. Cross-sectional perspective (Dr. Lecturer Mustafa Korumaz Personal Archive, 2002)

Along the roads leading from Gesi to Kayabağ (Darsiyak) and Güzelköy (Nize), dovecote bastions can be seen in different forms, first sporadically and intermittently, then lined up one after the other. These bastions, which are positioned according to the slope of the land and sprinkled on both sides of the valley, on the right and left, under the roads, exhibit an impressive appearance. The visible upper part of the pigeonry is called a chimney/bush or tower, and it is kept high in order to protect the pigeons from the environment factors (the chimneys are kept high to protect the pigeons from reptiles and insects that can harm the pigeons (Büyükmıhcı, 2006) and that can harm the birds (marten, fox, wolf, bear) is the part that protects from all kinds of creatures. Pigeon house chimneys are the mouth part that sits on these nests and allows the birds to enter and leave their nests (Büyükmıhcı, 2006) (Figure 3). The dovecotes, whose nest part is not perceived from the outside, have only towers in the landscape, and the towers are in harmony with the slope of the valley (Özkul & Özkul, 2021; Alptekin et al., 2019) (Figure 4).

Figure 3. Bushes and birds (Albayrak, 2019)

Figure 4. Harmony of the valley and the dovecotes (Albayrak, 2019)

The parts of the masonry forms rising on the land today, which connect the pigeons with the building and are designed to function as a door, are raised above the ground like a chimney to illuminate and ventilate the interior, and their roofs are raised approximately 3.00-5.00 meters from the ground level and are aligned with the valley slope. Their angling in the plane is obviously intended to facilitate the entry of birds.

In very few examples, the heights are approximately 6.00-7.00 m. has also been found. The underground sections, which are designed for the purpose of the pigeons living safely and for the easy collection of their manure, which is a very important commercial tool for the period, can be descended into and, according to the remaining examples, a water pool in the center of the ground, a bait platform around it and a pigeon manure accumulation on it. The other consists of a platform and niches where pigeons nest; This section under the ground can be reached by a narrow tunnel that a person can easily enter and exit through, and in some examples, the presence of an inclined bait channel can be detected on the soil surface. In the few examples that can be entered, the depth of the main nest section is 5.00-7.00 m. between them was found. In some examples, it is understood that the original plastic masonry walls, which were destroyed over time, were made later in the form of period additions made of rubble stone.

There are pigeon nests at a depth of 20-30 cm on the walls of the main nest. These cavities are also called slots and swaps. Slots and swaps are used for laying and sheltering pigeons (Özkul & Özkul, 2021).

'These individually carved nests are quite safe for pigeons. The geometrical connection between these slots is really interesting. So much so that no pigeon nest is located on the axis of the other nest. In the settlement, the axis has been shifted in the nests and care has been taken that no pigeon contaminates the other pigeon or its nest. The slots that catch the same axis in the second row do not harm each other due to the concave slope created on the wall' (Büyükmıhcı, 2006) (Figure 5).

Figure 5. Slots and swaps (Albayrak,2019)

'Although these nests are used for laying and sheltering pigeons, the main purpose of the building is to collect pigeon manure, which is very valuable for the commercial conditions of the period. When we examine the nest structure, the association of this geometric chain and its design were made in accordance with this purpose. Pigeon manure is collected on the platform that surrounds the building. The relationship between the people who enter the building and collect these fertilizers in necessary periods is provided through a narrow tunnel (Büyükmıhcı, 2006)(Figure 6).

Figure 6. Nest entrance tunnel (Albayrak,2019)

The necessity of adding pigeon houses, which have unique local characteristics in terms of function, form, material, context and organizational relationship with each other, to the world cultural heritage with their unique identity in the globalizing world has determined the purpose of the study. Fieldwork was carried out in the valley where 147 dovecote entrance structures (bastions) and an accessible nest section (cave) are located.

2.1. The Purpose, Importance and Method of the Study on Gesi Pigeonries

The cloud method is used in the survey, restitution and restoration projects of historical buildings of various scales that need to be protected, or in the documentation of cultural and natural heritage sites, and is a method widely used by many architectural offices in Turkey and around the world (Uzun & Spor, 2019). Laser scanning technologies are used in engineering applications (Larsson & Kjellander, 2006), in the examination of changes in structures, in deformation measurements (Riveiro etal., 2011), in documenting cultural heritage structures such as mosques, baths, churches (Allen, Troccoli, Benjamin, & Murray, 2003), (Yastıklı, 2007), (Ergincan et al., 2010), measuring castles (Grussenmeyer et al., 2008), creating street silhouettes on an urban scale and street rehabilitation (Varlık, et al., 2016), bridge (Varol et al, 2018), geographical and geological applications such as caves and land surveying (Dunning, Massey, & Rosser, 2009), determination of forest and woodland parameters (Akgül et al., 2016) etc. appear in the fields.

Gesi dovecotes consist of 147 independent dovecote bastions and nests, and it has been concluded that laser scanning is the most suitable method for the survey and restitution projects of those bastions and nests. With the use of this method, the actual location of the current situation of the pigeonries, depending on the geographical coordinates, was obtained by the point capture method and transferred to the digital environment. It is ensured that the most intricate, complex and intricate geometries of the nests that can be entered are revealed exactly, and this method adds a positive value in terms of acceleration and accuracy of the process-result relationship, especially in the preparation of the restoration projects of the dovecotes. The technical objectives of the project are to take the surveys of the nest sections of the dovecotes, which are under the ground, to reveal the unknown features about the structure, and to prepare the original plan scheme. The main functional purpose of the project is to bring the historical richness of the region to light, to bring the region to country and world tourism, to integrate the people with the historical texture and to ensure the sustainability of the conservation awareness.

The first laser was developed by Theodore Maiman in 1960, and air and ground laser scanning was developed in the 1970s, and these scans are based on the Lidar4 technique (Reshetyuk, 2006). Commercial use of terrestrial laser scanners coincides with the end of the 1990s (Karasaka, 2012). Terrestrial laser scanning method scans the object and acquires millions of 3D point data quickly and reliably. Thanks to this scanning method, the surface geometries of cultural assets can be obtained no matter how complex they are (Alshawabkeh, 2006). The point cloud is obtained by scanning the structure as a series of points horizontally and vertically at a targeted angle (Altuntaş & Yıldız, 2008).

The beam coming out of laser scanners with horizontal and vertical rotating mechanism comes out of the electronic unit of the instrument and hits the optical part that rotates at a great speed (Figure 7)

Figure 7. Scanner, Optical and laser

The beam on the surface of this optical unit, which acts like a mirror, is reflected and exits the instrument at a special angle. Immediately after the laser scanner achieves this angle, it rotates around the vertical axis with a very small angle to obtain the next angle (Kuçak et al., 2014). The system converts the 3D point coordinates obtained through laser beams sent to the object to be scanned into digital data. The obtained digital data is transferred to the computerized drawing environment. Point data is converted into digital data by transferring the point image records obtained with 360 degree rotating camera angles to microstation and similar programs. It is then transferred to the CAD environment to be drawn in the drawing environment. Thanks to the views obtained through the photographic image recorded in the digital environment, floor plans, facades and sections of the whole building can be obtained.

2.2. Documentation Method of Gesi Pigeons with 3D Laser Scanning

The preparation of the survey-restitution-restoration projects of Gesi dovecotes started with 3D laser scanning. In the process of preparing precision plan and section drawings and documenting them with technical drawings, the following methods were used, respectively, in the Cad environment.

2.3. Relief Measurement Method with Laser Scanning and Structural Findings

Horizontal and vertical laser scanning measurements of the dovecotes were made to reveal the plan, section and facades. While drawing the plan, facade and sections, the walls of the dovecote bastions, nest entrances, swaps in the nests, human entrance gates, manure storage platforms, feed platforms, feed tunnels, water pools, all stone patterns and spaces of the tower walls, planted areas, scanning results were obtained. It has been drawn in full using the 3D point cloud data obtained. It is very difficult to take measurements with traditional methods in both the bushes and nest sections of the pigeon houses, and even if a superposition measurement is made after manual measurement, the manual method of working has been abandoned due to the difficulty of testing the accuracy margin and the laser scanning method has been preferred.

2.4. Laser Scanner and Equipment Used in the Study

Thanks to the technical possibilities of the laser scanning system, manpower was used to a minimum. Within the scope of the study, measurement and documentation processes were carried out with the Faro Focus 3d 120 brand terrestrial laser scanning device. Faro Focus 3d 120 brand terrestrial laser scanning device has the technical features of scanning and processing 976,000 points per second between 0,6-120 m distances up to a distance error of ±2mm (Figure 8).

Figure 8. Faro Focus 3d 120 terrestrial laser scanning device

The device was installed in 815 different stations in the building area and the structure was scanned with the Faro Focus 3d laser scanning device. Device measurements took 32 days with simultaneous use of two laser scanners. In these measurements, the laser scanner also took the photograph. The bastions of all 147 dovecotes were scanned, and about 20 nests were entered and scanned. Other slots could not be entered. (Gesi Kayabağ Pigeonry repair and Valley Arrangement Project was carried out by Demirhanlı Agricultural Products Tec. Project Service Industry and Trade Ltd. (Master Architect Hatice Filiz SEZER and her team) under the control of Kayseri Cultural Heritage Preservation Regional Board.)

2.5. Measuring Technique and Process of Gesi Pigeon Houses with 3D Laser Scanning

The conversion of the digital data obtained as a result of the laser scanning process and laser scanning into survey drawings took place in 6 stages. In the first stage; in the planning phase of scanning positions; the number and position of scanning positions, the resolution and the project coordinate system of the scanning were determined. The position and number of scanning positions vary according to the position of the dovecote bush, the form of the bush, and the slope of the land. By installing devices in 815 different stations in the building area, the structure was scanned with the Faro Focus 3d laser scanning device and a point cloud was obtained (Figure 9). In the second stage; Thanks to the point cloud data obtained as a result of laser scanning, exact measurements of the dovecotes were obtained. The raw scan data obtained after the scanning process in the field were combined with the Scene 5.4 program, which was specially produced for the Faro Focus 3d laser scanning device. After the merging process was completed, the color was assigned to the point data in each coordinate from the photographs obtained with the integrated camera of the device. (For the processing of scan data, users have unlimited freedom of choice to leverage the software tools most useful for their workflow. Point cloud data captured with FARO Laser Scanners, FARO SCENE, FARO As-Built, FARO-BuildIT Construction, FARO Zone 2D, FARO Zone 3D or with various software packages, including 3rd party software such as Autodesk ReCap (paksoyteknik.com.tr, 2021). The point cloud data obtained in the third stage was exported in .pod and .rcp formats and converted into a format that can be used in Cad programs. In the fourth stage; The point cloud data obtained by using the PointCab 3.3 Program was transferred to the dwg environment as a 2D orthophoto. The purpose of laser scanning is to obtain orthophotos. "Orthophoto image; They are digital images in which errors caused by curvature, rotation and height difference are corrected and transformed into vertical projections (Yastıklı, 2007). In the fifth stage; 2 or 3 dimensional technical drawings, solid surface 3 dimensional models or material coated 3 dimensional models and animations are obtained from orthophotos.

Figure 9. Pigeon houses and established stations (Albayrak,2021)

Since the data was transferred to the digital environment correctly, there were no deviations from the drawings and measurements, and when viewed from the plan, sectional facade and directions, all the measurements were provided in the diagram. Since these exact measurements were obtained by scanning and overlapping the entire structure 360 degrees in all directions, one-to-one data were obtained for all stone bricks used in the building and their unit measurements. In the sixth stage; All original drawings are mapped with techniques suitable for the project, and the work is completed. The dimensional differences of the bastions and nests, which have different geometric forms, were analyzed separately, and two and three-dimensional original measurements of each space were obtained.

2.6. Point Cloud Model Data Collection

Point cloud is the digital points data obtained by sending the laser beams to the target in a structure or geographical area with a laser scanning device and sending millions of points to each m^2 by scanning the point cloud. An object or field is formed through linear surfaces that are formed by combining these points, whose coordinates are known in the x-y and z planes in the digital environment. The raw scan data obtained after the scanning process in the field were combined with the Scene 5.4 program, which was specially produced for the Faro Focus 3d laser scanning device. After the merging process was completed, the color was assigned to the point data in each coordinate from the photographs obtained with the integrated camera of the device.

2.7. Converting 3D Point Cloud Model to Technical Drawings in Cad Environment

The obtained point cloud data was exported in .pod and .rcp formats and converted into a format that can be used in Cad programs (Figure 10-Figure 11). (In addition, the point cloud data obtained by using the PointCab 3.3 Program can be transferred to the dwg environment as a 2D orthophoto.(Table 2)) By combining the 3D data from the orthophoto obtained by laser scanning, all structural components such as occupied empty spaces, material patterns, plaster voids are stored in the device memory visually and numerically. Three-dimensional data taken from piece by piece and from different points are combined with the registration method to create a 3-dimensional point cloud model of the area. Any number of sections, views and plans can be taken from this model at the desired elevation. Thanks to other utilities, models are converted to vector drawing. Numerous intermediate plans and sections of the building can be drawn by cutting the three-dimensional model obtained from orthographic photographs transferred to the computer environment at the desired elevation, both horizontally and vertically. By transferring these cross-sections to the Cad environment, plan sections and views can be drawn as technical drawings.

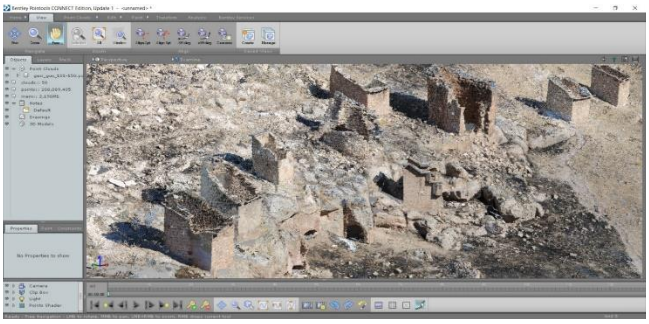


Figure 10. 3D point cloud model (Albayrak,2021)

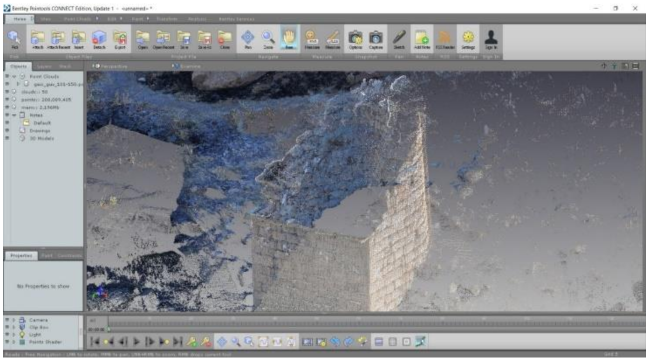


Figure 11. 3D point cloud model dovecote sign

Table 2. 2D point cloud model dovecote sign (the pigeonry number 141) (Albayrak,2021)

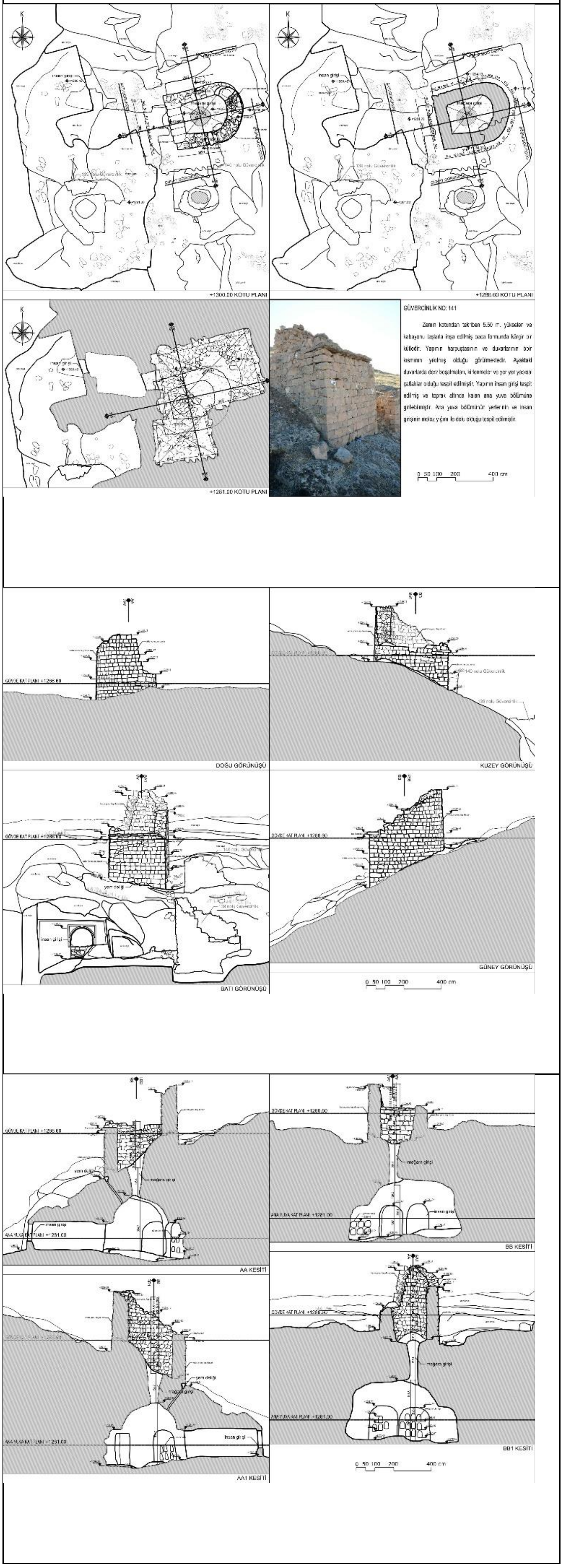
Obtaining these comprehensive images gives the technical drawing team the opportunity to process all stone pavement patterns, full-empty sections, existing texture and missing structural distortions, if any (Table 3).

2.8. Converting Data to Architectural Project

Based on the available data, a damage assessment plan, a damage assessment of the views, and a damage assessment map based on the sections were created. In the current damage assessment phase, digital damage assessment sheets were used in order to make accurate damage evaluation.

In CAD drawings where color separations due to full, empty and material differences are processed, differences due to material aging can be clearly seen in the colored areas on the layouts.

TABLE 3. The Survey of The Pigeonry Number 141 (Albayrak,2021)



3. GESI PIGEONRY MEASUREMENT DRAWING RESTORATION RESTITUTION PROCESS

3.1. Damage Determination and Architectural Deterioration

The main purpose of the preservation of historical artifacts is to protect the structural integrity of the artifact and to ensure its safe transfer to the future. The main aim should be not to spoil the original qualities of the historical artifact and to try to protect it without reducing the value of the document. I. Group Buildings, which are cultural assets, are generally large-scale public buildings owned by the state. The state protects such structures and makes the necessary interventions meticulously. But most of them are privately owned II. Grup Yapılar cannot be protected due to legal infrastructure deficiencies and various reasons (Örmecioğlu, 2010). Gesi dovecotes are privately owned, as stated before, and they were built during the Second World War. It is in Group Structures class. The deteriorations of these structures have been examined in situ and unfortunately some wear, damage and deterioration have been detected in these structures. Basically, it has been tried to analyze what kinds of destructions caused by various deterioration mechanisms, which are caused by natural causes and human effects, cause to the elements, sections and material types that make up the structure, and how these forms of destruction affect the protection status of the structure. As a result of the examinations made specifically for pigeons, it is possible to collect the factors causing deterioration under two main headings (Table 4);

1. Natural Factors
2. Human Factors

Table 4. Deterioration Factors in Pigeonries

1. Natural Factors	2. Human Deterioration
1.1.Mechanical Release and Discharges in the Joints	2.1. Faulty Repairs and Integrations
1.2. Material Deterioration	2.2. Human Caused Destructions/ Vandalism
1.3. Biodegradations	

3.1.1. Effect of Natural Factors on Deterioration

3.1.1.1. Mechanical Release and Joint Loosening

Fluctuations between night and day temperatures are the main cause of mechanical thaw. At high temperatures the material expands and at low temperatures it contracts. When this process repeatedly continues, the expansion and contraction movements begin to dissolve and crumble in the structure of the materials (Öcal & Dal, 2012). This mechanism can be seen in almost all inorganic materials used in the construction of dovecotes. Mechanical disintegration, which is especially effective in stone materials, causes physical destructions such as crumbling, shedding, rupture, and loss of parts following breakage. The number of pigeonries that encountered the problem of mechanical dissolution as a result of analyzing such deteriorations, which are seen intensively in Gesi pigeonries, is 130.

Of the 65 dovecotes, of which deterioration was detected on the tower wall, 49 of which were found to be damaged due to stone collapse, it is necessary to complete the demolished walls in accordance with their forms by using the traces from the building.

Discharges were observed in the joint material between the stones. It is likely that these micro spills have increased over time. Wind and climatic factors can cause this. Plant formation also causes joint discharge. It was observed that clefts were formed as a result of joint fall. These joint gaps and collapses, which can cause serious problems in the above-ground parts of the pigeon houses, were observed in 44 of the pigeonries, 6 of them require major repairs, the loose joints should be strengthened in accordance with their originality.

Joint discharge can also accelerate other deteriorations, as it will also affect the floor and ceiling surfaces of the stones to be exposed. In addition, the formation of salt crystals on the surface during the evaporation of water and the transportion of salts contained in porous materials to the surface with water is called salinization (Hasbay & Hattap, 2017). Salts cause damage to the joint filling and deterioration of the visuality of the towers.

3.1.1.2.Material Deterioration

As with all building materials made of rock, pigeon houses are also affected by water when they come into contact with it. For this reason, color change and salinization were observed in the materials. Particularly, such degradation was observed in the capstones exposed to rain. Pigeons cause melting of the materials in the capstones with their acidic feces. There are 140 dovecotes with discoloration in the material, 45 of which require major repairs. Color change, dirt accumulations should be cleaned with low pressure atomized hot water (nebulization), washing should be supported with a bristle brush. Where this technique is not sufficient, cleaning should be done with controlled sandblasting.

3.1.1.3. Biodegradations

Particularly, biological degradation has a great impact on the degradation of the stones of pigeonries. While lichens often form crusts and pits in the stone, bacteria-fungi cause exfoliation, animals-insects-birds cause typical shaped holes, rust and cracks. Biological deterioration of the stone may develop due to the pressure created by the growth of the organism and its progression to the inner surfaces (Hasbay & Hattap, 2017). In particular, the growth of the roots of advanced plants in the cracks by penetrating the stone can cause physical damage to the stone surface. During the succession of humid and dry seasons, fragmentation and crumbling may occur. Thus, the stone surface becomes susceptible to further colonization and biological growth.

In some cases, the organism may choose the stone surface as a feeding area and damage the stone and a chemical reaction may occur. Moisture occurs on damp surfaces. This causes accumulation and contamination on the stone surface (Öcal & Dal, 2012).

Contamination from algae, mold, fungus and algae on the building surfaces due to humidity was observed in 78 of the dovecotes. Algae, which cause more superficial damage to the stones, can in some cases crack the stone by wrapping their roots deep into the stone through cracks. Many algae require light for photosynthesis and therefore thrive where both light and water are present. Plants can develop by growing inside the structure with their roots. It causes cracks and crevices in the structure. Plant roots also cause chemical dissolution with the secretions they produce. Grass or perennial plants adapt into the pore system of the stone and cause mechanical cracks and ruptures in the stone over time (Hasbay & Hattap, 2017).

There are 30 dovecotes in pigeon-hole towers, especially in the coping, that need to be repaired depending on the biological deterioration and this type of deterioration. Cleaning is recommended for plants and biological formations in joints or on building surfaces, and chemical intervention is required for contamination from algae, mold, fungus and algae on building surfaces.

3.1.2. Human Caused Deterioration

People can damage structures consciously or unconsciously. They can cause deterioration in historical buildings and materials in various ways such as abuse, faulty repair, neglect, abandonment.

3.1.2.1 Faulty Repairs and Integrations

It has been observed that cement-containing mortar is used in the repair of pigeon houses. Compounds such as silica and calcium carbonate in the cement-added mortars used in the repair penetrate into the original materials of the building, causing crust formation on the surface, with the effect of water and humidity (Hasbay & Hattap, 2017). Atmospheric pollutants also support this process, facilitating the formation of crusts. The dovecote owners who wanted to repair the towers whose dovecotes were destroyed or partially damaged, unconsciously used cement-added mortar in 25 dovecotes. Cement applications should be removed from the pigeonholes.

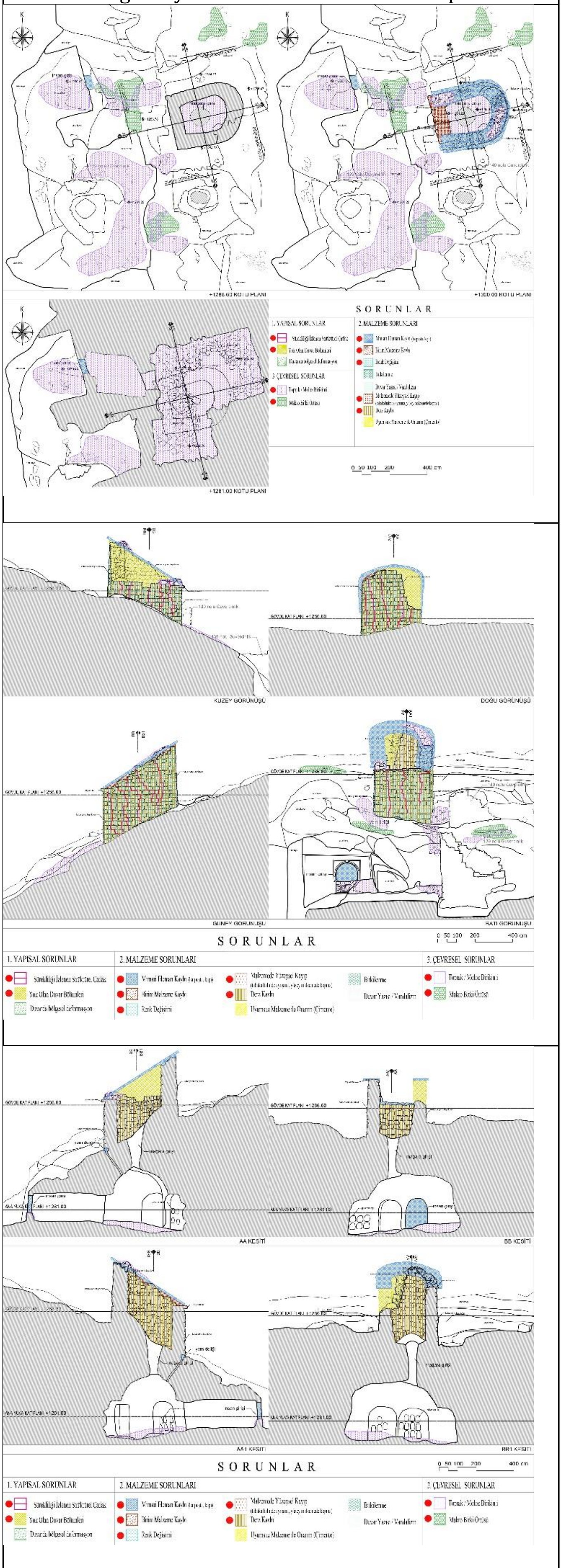
3.1.2.2. Human Caused Destructions/ Vandalism

In some of the dovecotes, collapses on the stone walls were detected. The biggest factor causing damage in pigeonries is human. The majority of the collapses are caused by people. Significant deterioration has been observed due to reasons such as misuse and neglect, vandalism. Some dovecote bastions were destroyed by man for theft, and the stone walls were partially or completely destroyed. Pigeon bushes have been subjected to vandalism, deliberately destroyed by people. Some villagers opened the door to the nest section and turned it into a barn, put their cows in the nest, and demolished the dovecote bush to do this. Most of the destroyed bastions created rubble filling in the nest part, and approximately 65 pigeon-holes are in this form and 49 of them require major repairs.

Table 5. Some examples of distortions (Albayrak,2021)

	
Collapses on Tower Walls (57 units)	Discharge in Joints (44 units)
	
Color Change in Material (140 units)	Breakage and Loss in Stone Material (130 units)
	
Biodegradations (78 units)	Wrong Repairs and Interventions (25 units)
	
Rubble Fill (22 units)	

Table 6: Pigeonry no. 141 Deterioration examples



4. EVALUATION

Gesi dovecotes differ from other bird houses with their towers, nest sections, and alignment in harmony with the topography. Since it would be very difficult to measure these unique structures manually, the laser method was preferred. By combining all the point data of the structures obtained by data acquisition with a laser scanning device and scanning of the emerging point cloud, the dovecote towers and nests were revealed. All parameters that could be overlooked in the documentation to be made with manual measurements and photographs in the field have been eliminated by laser scanning. For example, since the spatial measurement of the slots that can be entered, depending on the special geometry, is made by laser scanning, the accuracy has increased. Again, measurement errors that may arise in dovecote towers exceeding human height are disabled.

As a result of the preparation of the survey, restoration and restitution projects of Gesi dovecotes with laser scanning technology, the following technical achievements have been achieved;

- A rich archive has been gained as a result of visualization studies for the protection of pigeon houses with the details of the current situation of the cultural heritage, damage assessment and evaluation.
- Thanks to the 3D point cloud data obtained with the laser scanning device, an infinite number of drawable models were obtained from every corner of the dovecotes and from different viewpoints by taking the plans, sections and facades of the dovecotes from any desired elevation.
- The time spent in repetitive measurements and registration processes made with traditional methods is not lost in laser measurements. Compared to traditional methods, laser measurements provided fast results in terms of work performance.
- Thanks to the laser scanning technology, it can work in dark environments such as the slot where daylight is low, just like in daylight. Thanks to this feature of the machine, measurements can be made without the need for artificial lighting.
- The accuracy of the data obtained with the point cloud method scans obtained as a result of laser scanning was determined as 99.9% (+- 2 mm) by the digital measurement team.
- Obtained 3D point cloud, orthophoto images, drawn plans, sections and facades can be easily archived in computer environment. Thus, thanks to the practicality of filing, space saving was achieved in offices from volumetric areas.
- Transfer and sharing of digitally archived documents in the office e-mail environment is a faster and more practical way. Thus, the processes gained in the fields of workflow and project management shorten the delivery period in the conclusion of the project and make a positive contribution in terms of project management.
- By classifying and transferring the structural findings obtained during the preparation of the survey and restoration project to digital media, the technical findings of the past periods in the field of construction technologies were brought to light.
- Since there is no contact with the objects to be scanned during the laser scanning phase, the historical texture is not damaged.

5. CONCLUSION

Preserving cultural heritage is an imperative task for all civilizations in the world. In order to keep the traces of civilizations alive, it is extremely necessary to transfer historical and cultural artifacts from generation to generation. Terrestrial laser scanning method has become the reason of choice for many disciplines with its potential to obtain cost-effective, high-accuracy data in a short time (Okuyucu & Çoban, 2019). Laser scanners, which ensure that architectural documentation works are carried out in a healthy way and in accordance with the determined standards, have become preferred by users in our country and in the world.

Different from traditional methods, terrestrial laser scanning method was preferred for the preparation of survey projects of Gesi dovecotes. Terrestrial scanning device has replaced traditional measurement methods with the rapidly developing technology. The laser scanning method has advantages over traditional methods in terms of speed, workflow and workforce. Using a laser scanner for accurate measurement allows accurate preparation of survey projects. By using local laser scanning technologies, thousands of points reflecting the object or object surface are obtained. With the help of these points, realistic 3D models are obtained. According to the models created, area, volume and surface dimensions can be reached according to the size information of the object or structure. 3D point cloud data about the plan scheme, sections and facades of Gesi dovecotes, which are of historical importance, were obtained by using Faro Focus 3d laser scanning device. By installing devices in 815 different stations in the building area, the scans of the structure were made in 32 days and a point cloud was obtained. For each of the 147 dovecotes, the plan scheme of the towers and the plan of the 20 slots that can be entered were measured using the terrestrial laser method. For each of the 147 dovecotes, at least 2 cross-sections and four frontal views were produced. Numerical survey with the help of 3D point cloud data obtained by using Focus 3d laser scanning device.

With the help of 3D point cloud data obtained by using Focus 3d laser scanning device, it was converted into numerical survey measurements and survey drawings were created in the computer environment. By using this method, since the scans performed can be combined in the computer environment, images giving information about the whole building can be obtained. Removing the survey of Gesi dovecotes by laser scanning method, apart from traditional methods, had a positive effect on the study in terms of time, quality and accuracy. The use of laser scanning technology has provided the opportunity to reach digital surveys and visual documents about the entire dovecote. In this study, the usability of terrestrial laser scanning Focus 3d laser scanning and Scene 5.4 software in architectural documentation studies was investigated. It was concluded that terrestrial laser scanning is a suitable method for documenting the heritage structure. Thanks to the CAD software developed in recent years, 2D representation of historical and cultural heritage and 3D modeling studies have accelerated the design processes.

Technical drawings, analyzes and simulations can be obtained with the CAD software, which includes many modules that allow 2D and 3D work. Thanks to the point cloud function that comes with the AutoCAD software used within the scope of the study, 3D visualization can be made by capturing the points in the point cloud. It is extremely important that the software allows 3D drawing over the point cloud. Autodesk Revit program is as useful as AutoCad in converting a 3D point cloud into a survey project.

In our country, 3D modeling studies are preferred in documenting our historical and cultural heritage values. With the constantly developing CAD software possibilities, it will be easier to work on 3D point cloud data and the details of complex objects such as dovecotes will be drawn more easily. In this way, studies on point clouds can provide different dimensions and new gains to heritage documentation studies.

In the study, intervention plans, damage assessment sheets, survey, restitution plans, restoration sheets were obtained for 147 pigeonries. When digital data acquisition is compared with traditional method data collection, it is observed that the process is shortened and there is a deviation close to zero with 99% accuracy. In line with these results, it is a study that reveals the priority of the laser measurement technique as the reason for preference and the validity of the preference, especially for the example of preparing the survey of Gesi pigeonries with terrestrial laser scanning method.

When the data obtained with laser scanning technology is compared with traditional methods, it has been seen that the Laser scanning method is more advantageous in terms of process / performance / accuracy and cost analysis.

ACKNOWLEDGEMENT

This article, extracted from the Master's thesis paper named "Typological Analysis and Documentation Proposal on Gesi Pigeonries", was prepared by Mahmut ALBAYRAK under the supervision of Prof. Dr. Gonca BÜYÜKMIHCI. The before mentioned thesis work was approved on 20/09/2019 at Erciyes University, Institute of Science and Technology, Department of Architecture.

Author contributions

Mahmut ALBAYRAK**:** Case Study Survey, Software, Data curation, Writing-Original, Field Examinations
Gonca BÜYÜKMIHCI**:** Conceptualization, Methodology, Writing-Reviewing and Editing, Investigation, References Provide.

Conflicts of interest

The authors declare no conflicts of interest.

Statement of Research and Publication Ethics

The authors declare that this study complies with Research and Publication Ethics

REFERENCES

Akgül M, Yurtseven H, Akburak S & Çoban S (2016). Yersel lazer tarayıcı sistemler ile kentsel yeşil alanlarda bazı ağaç parametrelerinin belirlenmesi. İstanbul Üniversitesi Journal of the Faculty of Forestry Istanbul University dergisi, 445-458.

Allen P K, Troccoli A, Benjamin S & Murray S (2003). New Methods for Digital Modeling of Historic Sites 3D Reconstruction and Visualization. IEEE Computer Society, 32-41.

Alptekin A, Fidan Ş, Karabacak A, Çelik M Ö & Yakar M (2019). Üçayak Örenyeri'nin yersel lazer tarayıcı kullanılarak modellenmesi. Turkey Lidar Journal, 1(1), 16-20.

Alshawabkeh Y (2006). Integration of Lazer Scanning and Photogrammetry for Heritage Documentation. Stuttgart.

Altuntaş C & Yıldız F (2008). Yersel Lazer Tarayıcı Ölçme Prensipleri ve Nokta Bulutlarının Birleştirilmesi. HKM, Jeodezi, Jeoinformasyon ve Arazi Yönetimi Dergisi, 20-27.

Amirkhani A, Okhovat H & Zamani E (2010, July). Ancient pigeon houses: Remarkable example of the Asian culture crystallized in the architecture of Iran and Central Anatolia. Asian Culture and History, ss: 45-57.

Avunduk A (2010). Şefkat Estetiği Kuşevleri. İstanbul Zeytinburnu Belediyesi Kültür Yayınları, 181-193.

Bekleyen A (2007). Diyarbakır Kırsalındaki Güvercin Evleri: Boranhaneler, Karaçalı (Tilalo) Köyü. Trakya Univ J Sci, 99-107.

Büyükmıhcı G (2006). 19. Yüzyıl Anadolu'sundan Günümüze Yansıyan Özgün Bir Tarımsal Ticaret Yapısı: Güvercinlikler. 35.

Büyükmıhçı, G. (2006). 19. Yüzyıl Anadolu'sundan Günümüze Yansıyan Özgün Bir Tarımsal T Erciyes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 35.

Büyükmıhçı, G. (2006). 19. Yüzyıl Anadolu'sundan Günümüze Yansıyan Özgün Bir Tarımsal Ti97-119.

Calegari F (2003). Sustainable development prospects for Italian coastal cultural heritage: a Ligurian case study. Journal of Cultural Heritage, 49-56.

Dunning S A, Massey C I & Rosser N J (2009). Structural and geomorphological features of landslides in the Bhutan Himalaya derived from Terrestrial Laser Scanning. Geomorphology, 17-29.

Ergincan F, Çabuk A, Avdan U & Tün M (2010). Advanced technologies for rchaeological documentation:Patara case. Scientific Research and Essays Vol., 2615-2629.

Grussenmeyer P, Landes T, Voegtle T & Ringle K (2008). Comparıson Methods Of Terrestrial Laser Scannıng, Photogrammetry And Tacheometry Data For Recording of Cultural Heritage Buildings. The International Archives of the photogrammetry, Remote Sensing and Spatial Information Sciences. Beijing.

Hasbay U & Hattap S (2017). Doğal Taşlardaki Bozunma (Ayrışma) Türleri ve Nedenleri. Bilim Ve Gençlik Dergisi, 23-45.

Karasaka L & Ulutaş N (2021). CAD-Based Modeling Using Three Dimensional Point Cloud Data. Türkiye LİDAR Dergisi, 25-30.

Karasaka L (2012). Mobil yersel lazer tarama sistemlerinin fotogrametrik rölöve projelerinde kullanılabilirliği üzerine bir çalışma. Konya.

Kuçak R A, Kılıç F & Kısa A (2014). Tarihi Eserlerin Dokümantasyonunda Çeşitli Veri Toplama Yöntemlerinin İncelenmesi. 5. Uzaktan Algılama-Cbs Sempozyumu (UZAL-CBS 2014). İstanbul.

Larsson S & Kjellander J (2006). Motion control and data capturing for laser scanning with an industrial robot. Robotics and Autonomous Systems, 453–460.

Okuyucu Ş E & Çoban G (2019). Afyonkarahisar Dinar Bademli Köyü Cami Röleve Projesinin Lazer Tarama Yöntemiyle Hazırlanması. The Turkish Online Journal of Design, Art and Communication, 249-262.

Öcal A & Dal M (2012). Doğal Taşlardaki Bozunmalar. Kırklareli: Mimarlık Vakfı İktisadi İşletmesi.

Örmecioğlu H (2010). Tarihi Yapıların Yapısal Güçlendirilmesinde Ana İlkeler ve Yaklaşımlar. Politeknik Dergisi, 233-237.

Özkul I F & Özkul A (2021, 09 24). https://gesivakfi.org/egitim-faaliyetlerimiz/96-gesi/tarihi-ve-kulturel-yapisi/guvercinlikler. https://gesivakfi.org/egitim-faaliyetlerimiz/96-gesi/tarihi-ve-kulturel-yapisi/guvercinlikler.

Reshetyuk Y (2006). Investigation and calibration of pulsed time of flight terrestrial laser scanners. 1-55. Stockholm.

Riveiro B, Morer P, Arias P & De Arteaga I (2011). Terrestrial laser scanning and limit analysis of masonry arch bridges. Construction and Building Materials, 1726-1735.

Sevgen S C (2018). LiDAR VERİLERİNDEN BİNA ÇATI DÜZLEMİ OTOMATİK ÇIKARIM MODELİ GELİŞTİRME. Trabzon.

Ulvi A & Yakar M (2014). Yersel Lazer Tarama Tekniği Kullanarak Kızkalesi'nin Nokta Bulutunun Elde Edilmesi ve Lazer Tarama Noktalarının Hassasiyet Araştırması. Harita Teknolojileri Elektronik Dergisi, 6(1), 25-36.

Uzun T İ & Spor Y (2019). Yersel Lazer (Nokta Bulut) Tarama Yöntemi ile Rölöve-Restitüsyon-Restorasyon Projesi Hazırlama Süreci ve Bir Örnek: Elazığ Harput Kale Hamamı. Tasarım Kuram, 1-26.

Varlık A, Uray F & Metin A (2016). Sokak Sağlıklaştırma Projelerinde Yersel Lazer Tarayıcı İle Mimari Rölöve Alımı: Afyonkarahisar Kentsel Sit Alanı Örneği. Harita Teknolojileri Elektronik Dergisi, 141-150.

Varol F, Ulvi A & Yakar M (2018). Kültürel Mirasın Dokümantasyonunda Yersel Fotogrametri Tekniğinin Kullanılması: Sazak Köprüsü Örneği. Uluslararası Sosyal Araştırmalar Dergisi, 986-991.

www.unesco.org.tr. (2021).

Yakar M, Bünyan Ünel F & Kuşak L (2020). Ölçme Bilgisi 2. Atlas Akademi.

Yakar M, Orhan O, Ulvi A, Yiğit A Y & Yüzer M M (2015). Sahip Ata Külliyesi Rölöve Örneği. TMMOB Harita ve Kadastro Mühendisleri Odası 15. Türkiye Harita Bilimsel ve Teknik Kurultayı. Ankara.

Yastıklı N (2007). Documentation of cultural heritage using digital photogrammetry and laser scanning. Journal of Cultural Heritage, 423-427.

Yılmaz H M & Yakar M (2006). Lidar (Light Detection And Ranging) Tarama Sistemi. Yapı Teknolojileri Elektronik Dergisi, 2(2), 23-33.