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Research paper

Use photogrammetry program to document the blue dome tower as a part of conservation requirement for the historical buildings in Kirkuk castle

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Abstract

The heritage buildings are considered witnesses for city memory and its cultural legacy. Recently the attention increased concerning this legacy in accordance to informational revolution which the world observes in the field of computer technology and its role in all life fields. The computer role became clear to reserve Cultural heritage properties especially in the aspect of documentation and performance through three dimension type.
Iraq is one of Middle East country which is rich of Cultural heritage treasure that extended to thousand years.
Kirkuk is one of outstanding historical city, the most eminent rain is the ancient Kirkuk castle. It includes distinguished remains such as houses, the Blue Dome tower.
These buildings subjected to collapses during the time periods for many different factors, so they are in sore need for documentation according to modern methods.
The research pays attention to documental the blue dome mine rate which subjected to deterioration. To explain this we need acknowledge to trace the scientific and practical styles for documentation process concerning historical building by using photogrammetry program.
The importance of the research appeared in necessity to find a conception about architectural documentation process use computer scientifically to get benefit of photogrammetry technology that employed to keep cultural heritage buildings. The research problem appeared at this respect ambiguity of using photogrammetry process ways to document ate cultural legacy as a part of keeping work generally and ascertainment of theological accuracy through the documentation and achievement of three dimensional photogrammetry of Blue Dome tower of Kirkuk castle in particular.
The aim of the research showed 3 parts , first the study of historical and architectural features of Kirkuk Blue Dome tower and its classification as ancient historical building. Second study of the technology and its role in documentation of historical buildings. Third includes the practical application through fulfilling photogrammetry of Kirkuk Blue Dome tower, by using the instruments of software, hardware to accomplish the process. The last parts dedicated the analysis and discussion the consequences to define the final conclusions that presented to obtain coordinates of Kirkuk Blue Dome tower and its typicalization on three dimensions, keeping the information's and coordinates as documented main source and to preserve original characteristics for ancient buildings then to the new generation if they subjected to collapses.

Keywords: *Cultural Heritage Buildings; Photogrammetry Program; Kirkuk Castle; Blue Dome Tower.*

1. Introduction

The historical and ancient building are considered as true wealth for any country, for it's their significance in cultural social and tourishcal fields, thus there is a necessity to research the advanced technology to keep ancient buildings and documentation is regarded as the most important method since it associates to reservation conception such as rebuilding, reconstruction and maintenance. Each one of these principles restore to data and documental photos for architectural legacy which required to be rebuilt and reserved.
The development of documentation technologies ways that they used to be in previous time connected to the development of programmers and photogrammetry devices which they provided accurate graphics and embodied three dimensions for architectural legacy.
The research focuses on documentation process through typicalization of three dimensions for Kirkuk Blue Dome tower that situated on Kirkuk castle. The documentation process includes two basic stages; first stags to make use of multi angles photos technology and to restore to total (comprehensive) station device to specify coordinates of taken photos. The second stage includes the tackle of photos through the photo modeler program.

2. Kirkuk city

Kirkuk city locates in north of Iraq which is one of Arab land countries in Asia contenant and it is the fourth country in Iraq

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(Bakır,T.,Sefer,F,(1965). It characterizes with its architectural buildings and historical tissue, the city form on the banks of khasa so river which clearly indicated by its ruins that return back to 2600 years B.C.

The most important remains that discovered was the oldest map on a clay gets back to Akadian regin 2300 year B.C. Kirkuk for the first time was formed of protected fort surrounded by historical walls that can be seen till now that returned to mid third century B.C included ancient and historical buildings (Saatci , 2014).see Figure (1)

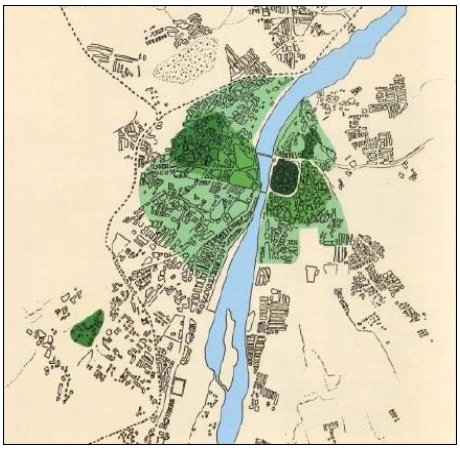
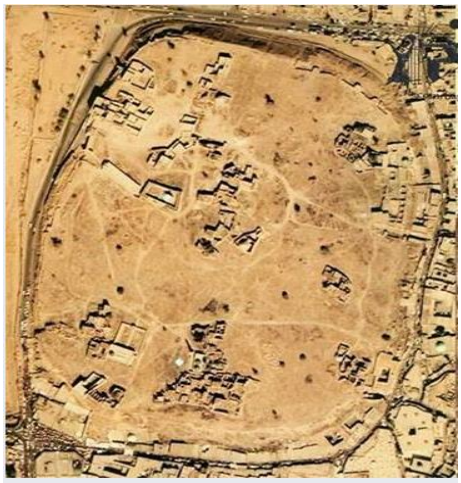


Fig. 1: Kirkuk.City Development, the Darker Places Represents the Older Parts of the City. (Saatci, 2014).



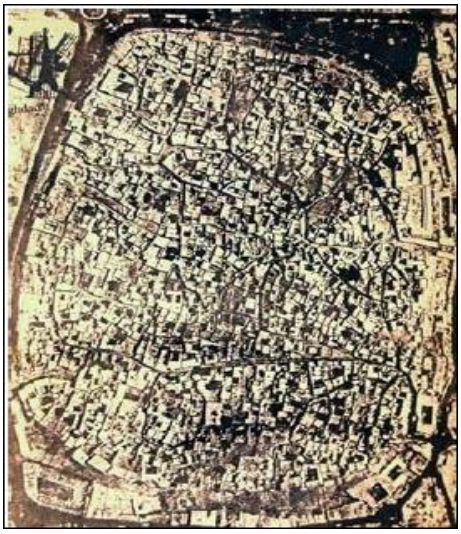


Fig. 2: First Image Google Earth Record in 2010 and Second One Is Aerial Photo of Area before Demolishing. (Saatci, 2014).

1.1. Historical kirkuk castle

Kirkuk castle is regarded the oldest domiciliary center we can observe the obvious features of architecture city in it such as living and residential building, religious and ancient houses with distinguished architectural impressions (Saatci , 2014). Kirkuk castle was established on aplatue its area is 62500 m2 includes historical building surrounded by ancient wall which recently discovered, but the campaign of destruction and negligence that took place in the castle resulted to lose a lot of buildings without registration them or documentation properly the a few remained numbers of buildings are warfiay their fate to be collapsed too, because of continuous negligence(Al-Jameel, Al-Yaqoobi, Sulaiman, 2015).see Figure (2).



Fig. 3: The Blue Dome Tower (Researchers).

1.2. The blue dome tower (kook kumpat)

It is an ancient historical light house locates in Kirkuk castle encircled by a gallery, its entrance includes prominent manuscript its text is "Afraid of God is a high wisdom" 1280 Hajj. The green dome distinguished by eight angles building with many ornaments in a beautiful architectural model, and it ornate with colorful kashanic and decorated by manuscript bar at the top outside building beneath the Dome there is a shrine of Saljuqic girl her name "Bughdai Khatoon" goes back to 762 Hijri, 1361 A.D. Bayat, (Fadel, 2016). See Figure (3)

1.3. The architectural description of green dome

The dome building is eight angles form, its diameter is 5m total height 10m, the height of its wall 6m was built of brick and gypsum, inside building consists of two floors(Fadel, 2016).

a) Ground floor of square diagram inside contains three windows for enlightment and entrance, its ceiling consists of two domes they were built one above the other. The first dome has corners based on four arches half circular the second dome is the floor of second dome. The first floor includes rectangular ditch, its length 3.20m, wide 2.5m, depth 2m which represents the shrine of (bughdai khatoon) ,(Hirmizi, 2005).
b) The second floor in a square shape inside includes four arches of acuminate shape has blue color of plant ornament, dome and extends to the forth window arches which a simple feature appear to the witness, outside there are four windows with half circular arches that are acuminated in side pillars that the dome had based on them and the corner of the end of second floors,(Hirmizi, 2005).
c) Dome building shape; its eight angles of outside depends on a base its height is 1.5m was made of stone and gypsum, above it is arrow of brick surrounded the dome its length 20m, it stands for outside circumference, at the top there is

arrow of red stone in organized shape, the measurement of each one is (30*35.5) cm. this sort of stones are resistant against natural factors (rains) above it there is a brick its height 5m, there is another row of bricks were built horizontally its height 285m.

d) Then cornices edges start, its number is eight, its measure 80*181cm. the length of trapezium ornament 140cm the above these rows there are carved bricks its height is 28cm horizontally, above it there are eight ornamental units, consist of trapezium shapes frame, inside it there is a quadrilateral star, on the other side there are trapezium shapes of blue kashanic, there is a second frame be hand the first frame, in it there is an ornament consist of eight side rose made of carved and sculpted bricks. This ornament extends to the beginning of dome base. Worthy to mentioned the light house threatened by demolition the evidences of collapses appeared at the top of the dome well as the falling some of its parts which led to deform of the ornaments and the decorated Manu scripts disappeared. , (Hirmizi, 2005).

3. Theoretical background

3.1. Photogrammetry prgrams technology

It is a measurement technology wich is used to find out points and three dimensions coordinates of photos by usage of devices, such as hard ware and specialized computer programs, soft were through three dimension types, using the found out data without direct measurements relating to historical building .(Dowajy,2017)

Kinds of photogrammetry process:

Photogrammetry to achieve geometrical surveys for architectural establishments, there are ways according to the detained accuracy of documented elements as following, see Figure (4);

a) Air photo: it's called long rang photo used for serving cities, locations, historical parks, structural survey and general establishment and for building roofs surveys, outside spaces and huge completes, it works on conclusion of measured information includes; coordinates and distance aiming to know the locates of historical buildings. A photo camera used for this purpose in an infinitive dimension situation above 300m or more in a detailed photo for documented elements, we can realize the details on 5meatures depending on used lens. (USLU,2016)

b) Land photogrammetry: It is called photo of short rang used in historical and independent edifice buildings document, and natural ruins and elements that need close survey to specify the details within document element. This kind used to obtain high accurate results which leads to find out delicate measurements that can be found of depicted closely. A certain camera of specified dimensions used in this purpose, the distance between the camera and the element will be 300m. (USLU,2016)

c) Satellites image: used to cover vast or wide areas to make use of a few depicted pictures which are economically cheap. This kind of photo can be done in any sort of circumstances, there is ability to regain photos in other time of the year. (USLU,2016)







Fig. 4: Various Imaging Tech-Niques (https://I1.wp.com/www.bonah.org).

3.2. Programmes roles in photogrammetry to document historical and ancient buildings

The architectural documentation focuses on providing accurate and enough information to place rehabilitation and rebuilding plans; in additions to its main roles to achieve and documentable historical buildings and to use special data in case of building falling or disappearing the main features because deterioration and extinction (Remondino, 2011). see Figure (5).

The architectural photos have great values to obtain reliable graphics and can be considered a good reference for researchers. These programmers are the most sophisticated and delicate methods which were used for documentation. They have the capacity to submit accurate geometrical information which necessary to typicalize the historical buildings depending on taken photos coordinates that relate to the building, preparation the virtual three dimension model that bears details and ornaments used for touristical performances, are also used for documentation of cracks and constructional state of the historical buildings during the different periods of time, the information are used for rebuilding and maintenance, (Lucia, Baptista, 2013).

In many countries the photo technology were used rapidly and general in sectors like (Federal Service for Historic Monuments) (Bundesdenkmalamt) in Austria, (geographic natural institute) in France, and (survey team of English heritage) in UK(Remondino, 2011).

The world council for ruin and (ICOMOS) organization recommended to use photogrammetry to register ate historical buildings since 1961 as well as the international committee for cultural documentation which is one of these committees supported this technology to keep me moral monuments by publishing pamphlets, holding seminaries and meeting with experts and doing field studies and other activities. Uresco had organized training activities concerning photos in various fields (ICOMOS1996).





Fig. 5: Documentation of One of the Archaeological Buildings (Remondino, 2011).

4. Material and methods

In this stage the practical steps will be shown to documented the ancient Blue Dome tower by the programmer of photogrammetry and to follow several steps as below:-

1) To find out the area topographic and explore the place or the building for study.
2) The exploratory the situation (location) of installation the total station device by one of closed way of polygonal.
3) Preparation diagram (picture) for demanded building that relates to the study.
4) Adhesion the specialized papers on building sides.
5) Supplying the needed devices and tools for work.
6) Providing photo devices and to localize the places for taking photos.
7) Specifying the kind of programme for estimation and documentation by computer.

3.1. The tools and instruments that used in the field of application

a) Total station instrument its sort is LEICATS06

The total station instrument is considered more perfect and accurate in this time it includes (EDM) device to measure the distances and digital thud, light to measure distances and vertical and horizontal angles. Recently the tow devices total station and world system device were combined to limit the situation of (GIS) to observe location coordinates to associate the land area to the space one together. the total station instrument generates a bundle of unseen ultraviolet or seen Lizzie rays get out of telescope lens to control the as result of the used reflective sort and the distance to required point to be observed. After arrival this radiation to the reflective then it reflect to the device, this instrument will account the time of radiation to pass the distance between device Centre and reflective center going and returning . Knowing this distance and height reflective and height of known device and the central point of the device, then device the device accounts the coordinates of reflective point and the floated, slanted distance between device center and reflective center. https://leica-geosystems.com

Characteristics of total station device:

1) 1-Accuracy of distance measure, the fault is Millimeters.
2) Long distance observation many kilometer .
3) The high accuracy to measure horizontal and vertical angles.
4) The capacity of points measurement without reflective by using laser technology to serve 100m or more.
5) Easiness of transferring data from and to device to use flash are cable or Bluetooth.
6) Bearing the rude circumstance for more 50 temperature percentage.
7) The light weight and easiness for conveying and transport.
8) The velocity to measure distance in shorter than two seconds.



Fig. 6: The Terminal Device Used to Document the Blue Dome (Researchers).

b) Digital camera sony2:

The technical specification must be taken in consideration the photo tool used to take pictures of the site and it has to change the places every setting photo taking. The photos must be taken widely to coverall building area without changing the numbers of cameras through the process of minimizing or maximizing the photos.



Fig. 7: The Camera Used in the Blue Dome Imaging Scan (https://www.sony.com).

c) Adhesive papers and iron pieces:

Adhesive papers are used dimension 21*28.5 cm to be adhered to building walls can be made used it definition and modulation and to find polygonal sites that total station can be put in or installed. https://www.sony.com

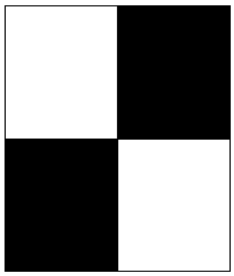


Fig. 8: Calibration and Identification Papers (Researchers).

3.2. Action way

First of all we found out the area and to acquaint to the field of study and application, then determine the installation location of the device on the shape of closed polygonal on condition that every polygonal can be shown as two polygons to gather when we install ate the device after that we make adhesion of dedicated papers on the margins of the legacy wall to facilitate the definition process between the points, then we started to take the coordinates in different places. After finishing the field work, we put in order the control points we obtained of total station device on the shape of the formula that supported by programmer. It means on shape of (txt) which can be seen in diagrams (9, 10 and 11). After transferring the graphics from total station we transfer the taken picture by digital camera then to the computer, thus we regulate the pictures in volumes finally we select a group of pictures to be done

photo modeler program, before we start using the pictures we have to modulate the used camera instrument in this application, then all the pictures are defined together and adding the control points. I mean coordinates points which were taken by total station and documental the legacy shown in table (1).

Table 1: Specifications of LEICA TS06, Total Station

ANGLE MEASUREMENT (HZ, V)	
Accuracy	1” (0.3 mgon) / 2” (0.6 mgon) 3” (1 mgon) / 5” (1.5 mgon) 7” (2 mgon)
Method	Absolute, continuous, diametrical: at all models
Compensation	Quadruple axis compensation: at all models
Compensator setting accuracy	0.5” / 0.5” / 1” / 1.5” / 2”
Compensator range	0.07 gon
Endless drives	Smooth movements with no delayed response tim
DISTANCE MEASUREMENT WITH REFLECTOR	
Range 2) Round prism (Leica GPR1)	3,500 m
Range 2) Reflective tape (60 mm x 60 mm)	>500 m 9) >10,000 m
Range 2) Prism-Long (Leica GPR1, R500/R1000)	>1000 m
Accuracy 3	Precise+: 1.5 mm + 2.0 ppm Precise Fast: 2.0 mm + 2.0 ppm Tracking: 3.0 mm + 2.0 ppm
Typical measurement time 4)	1.0 s
Measurement time while in "Precise+" mode	2.4s
DISTANCE MEASUREMENT WITHOUT REFLECTOR 8)	
Range 5) PinPoint R500 / R1000	> 500 m / > 1000 m
Laser dot size	At 30 m: approx. 7 x 10 mm At 50 m: approx. 8 x 20 mm
DATA STORAGE / COMMUNICATION	
Internal memory	Max.: 100,000 fixpoints, Max.: 60,000 measurements
nterfaces	– Serial (Baudrate up to 115’200) – USB Type A and mini B, – Bluetooth® Wireless, class 1,150 m – TCPS29 (non-EU) > 1000 m – TCPS30 (EU) > 500 m
Data formats	GSI / DXF / LandXML / CSV / user definable ASCII formats
BATTERY	
Type	Lithium-Ion
Operating time 7)	Approx. 30 hours
Battery charging time	2.3 hours
WEIGHT	
Total station including GEB211 and tribrach	5.1 kg
TELESCOPE	
Magnification	30 x
Resolving power	3”
Field of View	1° 30’ (1.66 gon) 2.7 m at 100 m
Focusing range	1.7 m to infinity
Reticle	Illuminated, 10 brightness levels
KEYBOARD AND DISPLAY	
Keyboard and display	Full Alpha-numerical keyboard with high resolution, Black & white display, Graphics, 160 x 288 pixels, Display illuminated, 5 brightness levels
Position	Face I, Face II
OPERATING SYSTEM	
Windows CE	5.0 Core
LASERPLUMMET	
Type	Laser point, 5 brightness levels
Centring accuracy	1.5 mm at 1.5 m instrument height
ENVIRONMENTA	
Temperature range (operation)	–20° C to +50° C (–4° F to +122° F) Arctic Version –35° C to 50° C (–31° F to +122° F)
Dust / Water (IEC 60529) Humidity	IP55, 95%, non condensing
GUIDE LIGHT (EGL)	
Working Range (average atmospheric conditions)	5 m – 150 m
Positioning accuracy	5 cm at 100 m

Table 2: Specifications of A SONY Camera

(Basic information)	
accuracy	4320x3240Px
(Effective pixels)	14.1MP
(ISO)	Auto, 80, 100, 200, 400, 800, 1600, 3200
(Processor)	
Screen size	2.7 inch
(Multimedia)	
Shutter Speed)	1/1600sec
(Focal length)	26–104mm
(Auto focus)	yes
(focus points)	9
(Optical Zoom)	4
(Digital Zoom)	6.7
(Flash)	yes
(Exposure compensation)	Yes
(Exposure)	±2EV(at 1/3 EV steps)

(Scene modes)	9
(White balance)	7
(Aperture)	F/2.7-5.7
(Sensor size)	1/2.3inch



Fig. 9: The Effect Pattern Documented by the Photo Modular Program) Researchers).

5. Results

Table 1: Points and Coordinates That Have Been Monitored by the Station (Researchers)

NO. nodes	X unit	Y unit	Z unit
1	100	100	100
2	89.775	105.5912	100.6556
3	88.1126	104.5573	102.0137
4	86.8903	103.8082	100.6781
5	85.7876	104.2877	101.7369
6	89.3996	106.0495	101.8976
7	89.4299	106.0323	102.978
8	88.2028	104.6085	102.9635
9	88.2057	104.6408	107.8056
10	89.4225	106.026	107.8134
11	87.7132	104.4201	107.8136
12	85.8776	104.3198	107.8198
13	85.8833	104.3112	102.9734
14	87.6769	104.399	102.9506
15	87.6989	104.3993	102.9603
16	90.1182	107.1002	100.6607
17	89.573	108.2409	101.7366
18	89.6036	106.5598	101.8968
19	89.6008	106.565	102.6822
20	89.6007	106.565	102.9747
21	89.6194	106.5771	107.8132
22	89.5304	108.3733	107.8106
23	87.6199	121.345	100.2383
24	87.6199	121.345	100.2151
25	86.8029	110.7486	100.6661
26	89.0222	109.7706	100.5744
27	89.0181	109.063	102.2097
28	85.4674	110.1489	101.7226

29	85.5622	110.1387	107.7987
30	87.3703	110.2617	107.798
31	87.9087	110.0954	107.7937
32	89.3231	108.838	107.8075
33	85.0355	109.8774	107.8035
34	83.8661	108.4815	107.8066
35	83.8073	108.536	102.9746
36	85.036	109.8561	102.9718
37	84.6204	109.3946	101.7257
38	83.9423	109.4837	100.6719
39	85.5287	110.1095	102.9639
40	87.2636	110.212	102.9531
41	89.3227	108.8668	102.9511
42	78.911	105.2299	100.2144
43	78.911	105.2299	100.2221
44	83.7285	106.2007	101.8891
45	83.743	106.2038	102.6636
46	83.6353	107.966	102.6755
47	83.6579	108.0012	101.9011
48	83.7382	106.1928	102.9695
49	83.6393	107.9702	102.9885
50	83.7035	107.9432	107.8387
51	83.773	106.1981	107.8275
52	83.986	105.6755	107.8271
53	85.3813	104.4766	107.8272
54	85.3611	104.4622	102.9699
55	83.9792	105.6977	102.9596
56	84.3347	104.6184	101.9555
57	83.848	105.0417	101.1155
58	84.803	104.1952	101.0461

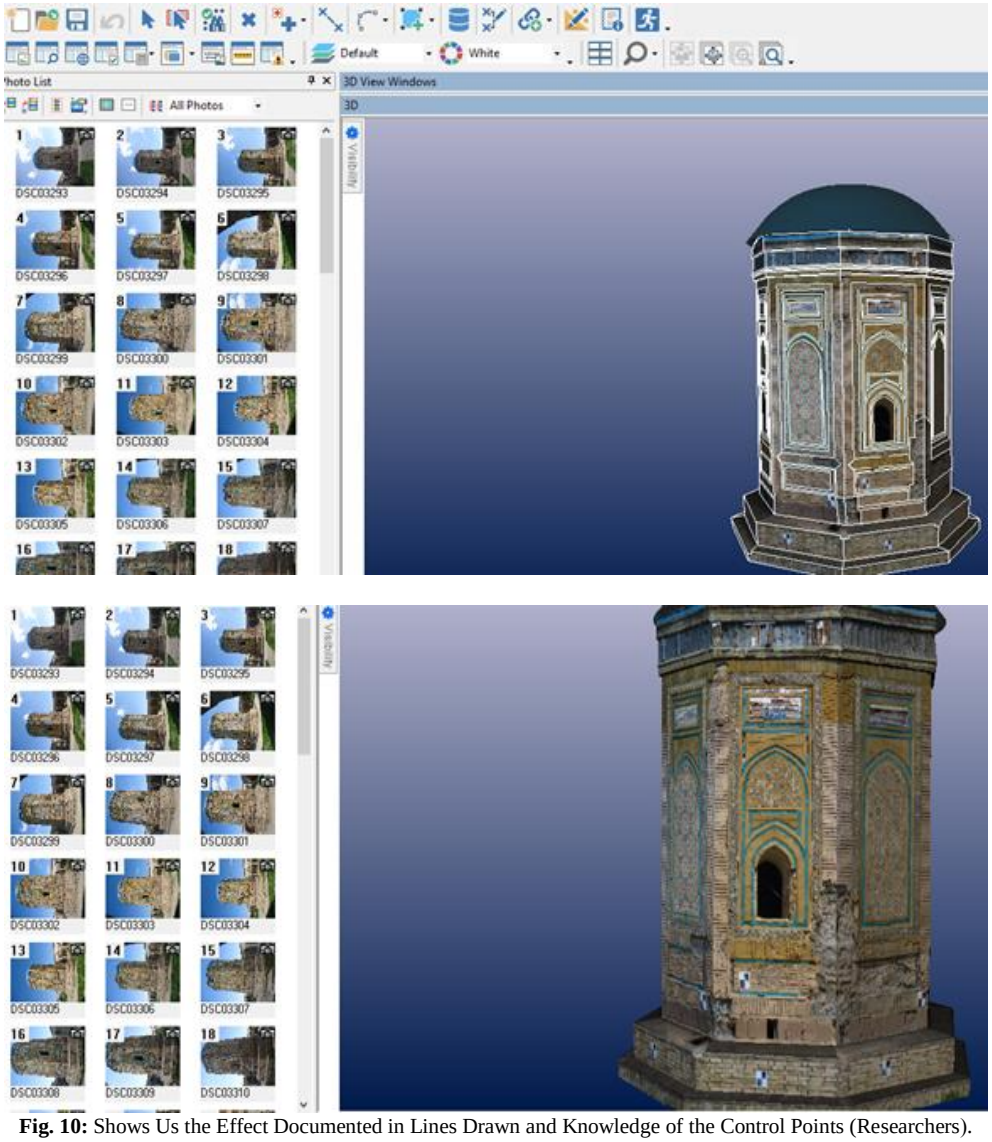


Fig. 10: Shows Us the Effect Documented in Lines Drawn and Knowledge of the Control Points (Researchers).

6. Conclusion and recommendation

- The documentation is important for ancient buildings in Kirkuk castle which subjected to discontinuance and disappearance of main features, therefore to obtain information before its collapsing will enrich culture and to provide data base for past living and the style of previous building.
- Fifty eight points registered for coordinates of different sides of light house to ensure accurate results for photogrammetry on one side and stressed details on other side of Blue Dome tower which include ornaments and different windows and paving style in addition to various using of cover materials of bricks and blue mosaic and using manuscripts and Islamic ornaments especially at the entrance.
- The reliable registered coordinates in the research can be considered a basic source if the light house subjects to collapse or demolition, these can be good for rebuilding or reconstruction.
- This research as the first action which documented the Blue Dome tower in regard of coordinates and measured points and embodied picture on photogrammetry and can be used in performance and touristic publishing for the legacy

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