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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 8 (2): 202-207, 2009
ISSN 1812-5638

Advantage of Digital Close Range Photogrammetry in Drawing of Muqarnas in Architecture

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Abstract: In this study, conventional method and digital close range photogrammetry is compared in sample study for measuring and drawing of muqarnas which is common in architecture. One of the most significant advantages of close range photogrammetry in documentation is giving opportunity to measure buildings or part of the buildings especially very high, very low, dangerous, not accessible or very detailed like muqarnas or damaged. It is a big facility to measure required measurement of the parts of the building from the photograph. Its another important thing in documentation that these data can be used in the future again and they can be shared with other users and they are easy to store in computer.

Key words: Documenting, close range photogrammetry, architecture, muqarnas

INTRODUCTION

Heritage and culture are two important components in life of societies. Monuments and monumental groups are constructions of great value because they represent the history and memory of the communities where they are placed. The view of cultural heritage is closely consistent with that of UNESCO, enunciated in the 1972 Convention for the protection of the world cultural and natural heritage (Callegari, 2003; Carbonnell and Dallas, 1985; Dallas, 1990).

UNESCO (1946) and the Council of Europe have formed specialized organizations for conservation of cultural heritages. ICOMOS (International Council for Monuments and Sites) is the most important one, but also CIPA (International Committee for Architectural Photogrammetry), ISPRS (International Society for Photogrammetry and Remote Sensing), ICOM (International Council for Museums), ICCROM (International Centre for the Conservation and Restoration of Monuments) and UIA (International Union of Architects) are all involved in conservation task of cultural heritages.

It is an indisputable reality that the most important thing for transmitting cultural heritage to posterity is a sensitive documentation. Nowadays, there have been many developments in documentation of cultural heritage by developing technology and contemporary documentation techniques have been progressed speedily such as photogrammetric laser scanning. Today's technology gives possibility to authenticate of historical and conserved edifices more sensitively and more speedily.

By the time, modern methods are preferred to conventional methods in architecture generally in existent state and determination of deformations and preparing measured drawing projects of historical edifices (Hamamcıoğlu, 2004).

Photogrammetry is a method which used frequently to document cultural heritages. Photogrammetric techniques, measuring objects from photographs, have been utilized since the late 1800s. Digital close range photogrammetry is a technique for accurately measuring objects directly from photographs or digital images captured with a camera at close range. Multiple, overlapping images taken from different perspectives, produces measurements that can be used to create accurate as-built 3D models. Knowing the position of camera is not necessary because the geometry of the object is established directly from the images. Close-range photogrammetric methods have been successfully applied to projects in archaeology, architecture, automotive and aerospace engineering and accident reconstruction (Atkinson, 1996; Cooper and Robson, 1996; Slama, 1980). In conventional method, to measure and draw complicated details, a big scaffold is constructed and by force of it, measurements and projection of all details and face obtained by plumb. All these traditional methods are slow,

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time-consuming and present a number of evident limitations (Pieraccini *et al*., 2001). After that complicated details of the edifice are drawn by photographs. But in this way, measurements are not very correct. But with photogrammetric methods, these are not problem.

Turkey hosted many diverse civilizations and cultures during the history. Hence, Turkey is the rich country from the view of cultural subsistence like others country of the world. This cultural subsistence has diverse and different architectural peculiarities of their own civilization. Settlements from the first eras of history, Rome, Seljukian and Ottoman are the most significant and the most widespread ones. There are considerably many monumental edifices like mosques, tombs, madrahs, baths etc., in Turkey. Generally, one of the most prominent characteristic of these edifices is their maindoors. These maindoors are elevated conveniently to the monumental of the construction, generally made in stone and adorned with many geometric motif compositions and they have enchanting architectural appearance and perspective. They emphasize the main entrance not only the point of the rational, but also the visuality. These main doors are named portal. Muqarnas is a transition entity on the high level of the portal shaped as half-cupola. It gives a shape like a funnel to the its part of the portal and constituted from actuations curved vault part. This part of the portal is named kavsara in architecture.

In the study, the conventional and photogrammetric drawings of a muqarnas are compared and differences between their methodologies are defined. In drawings of detailed surfaces, what kind of advantages close range photogrammetry has from the view oft the methodology when it is compared with conventional method.

THE STUDY OBJECT: MUQARNAS

Muqarnas is the term given to an architectural device unique to Islamic architecture. Its purpose is to provide a transition between, for example, a square base and a dome. Muqarnas is also frequently used to create a concave semi-vault above an entrance to a building or to provide a decorative cornice along the perimeters of a ceiling or beneath a balcony. Different regions in the Islamic world have used different styles of construction techniques in their history.

In the same way, muqarnas is name of stone prismatic carbels arranged abreastly and imbricately and supplies to transcend from a vertical surface to more salient vertical surface on portals. It is a kind of Islamic ornament technique. It is considerably used as a transition entity in different geometric regularization of the wall surfaces and their different levels. Also it is mostly seen in cornices, column capitals, niches, portals, mosque minarets, geometric transition of vaults and cupolas. Muqarnas is seemed not only in our country but also in nearly each Islam countries (Hasol, 1998).

Muqarnas compositions are very suitable for contemporary interpretations. They can be designed as ornaments for modern interiors and can be given new functions, such lamps or display cabinets. It is possible to make a plaster muqarnas coving for an interior. They have a unique beauty quite distinct from traditional two-dimensional geometry.

In Turkish Architecture before Ottoman, the portals are fairly nominative and elementary indented. In later years, especially in portals in Anatolian, they are comparatively decorative, ornamental and striking. Whatever, the roof construction system is, the portal plan is immutable and its plan is rectangle. Half cupola of portal for the roof system is preferred. Prismatic elements which are arranged abreastly and overlapped are combined in the intersection point of the outside wall on the definite level. In these combinations many different geometric arrangements affect the users. Projecting of these mass geometric arrangements is a difficult design required good geometry knowledge.

Figure 1 is a model that is made using the style that is typical for North Africa and Anatolia. It uses triangular elements of wood or plaster into which the downward curve of the element is carved out. The elements have different angles (for example 30° or 60°). There are two versions of each element: they will either have a flat surface of the section facing forward or facing backward.

If it faces forward, the curve will move down and recede and taper until it reaches the bottom of the element. If it faces backward, the curve will recede but will get wider as it goes down.

The muqarnas is on the Sahibata Medressah. It was built in 1283 by one of the Seljukian vezirs, Sahibata Fahrettin Ali. It provides a mescid, tomb and a bath in its constitution. Many parts of this stone construction are demolished and destroyed by the time. But in the past they were renovated. Although many parts of the edifice destroyed by the time, from the couple minaret, only one minaret and portal is extant. Portal is an important part of Sahibata Medressa, with geometric ornaments, stone works and muqarnas with diverse perspectives. This edifice had been restorated many times in the past but prepared projects were'nt suitable for application and they were insufficient (Fig. 1).

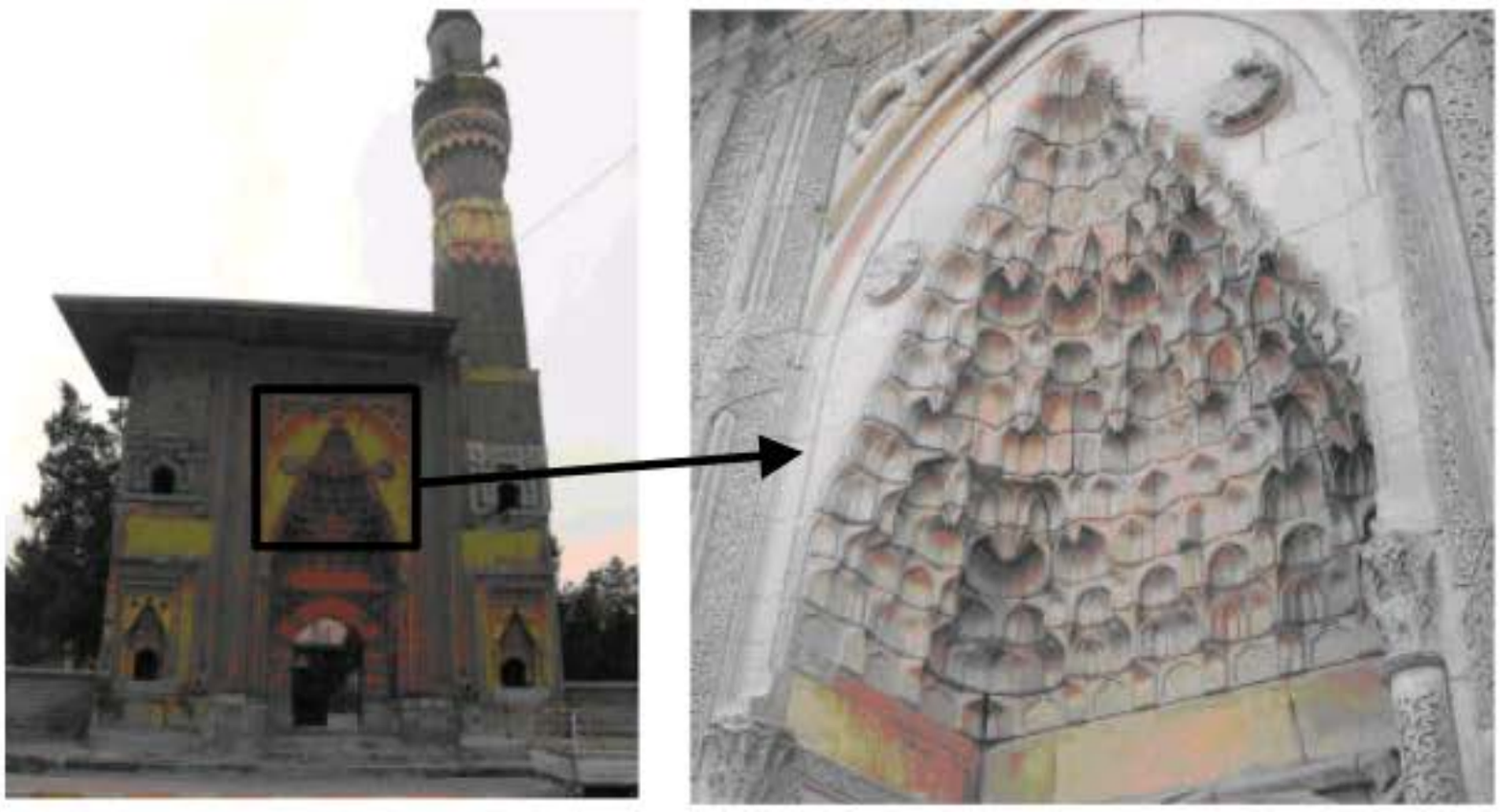

Fig. 1: Muqarnas and front façade of Sahibata Medressah

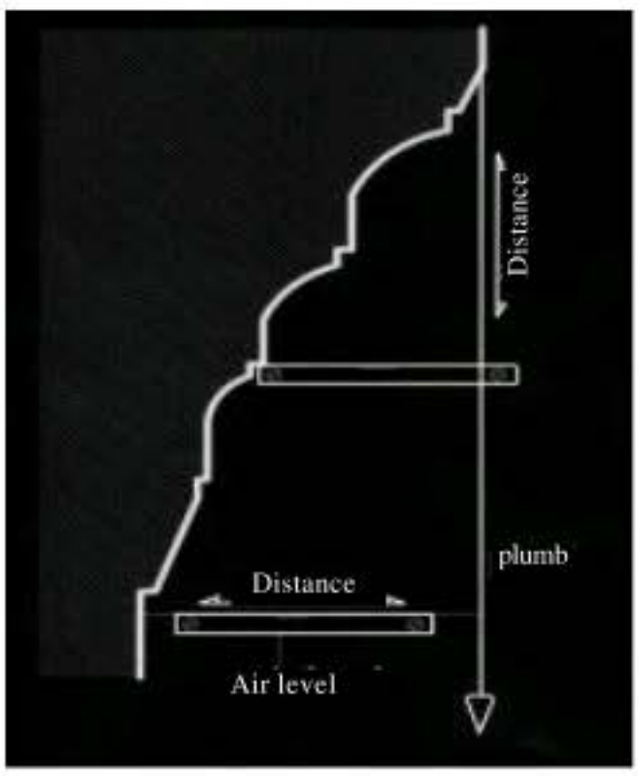

Fig. 2: Conventional measurement method

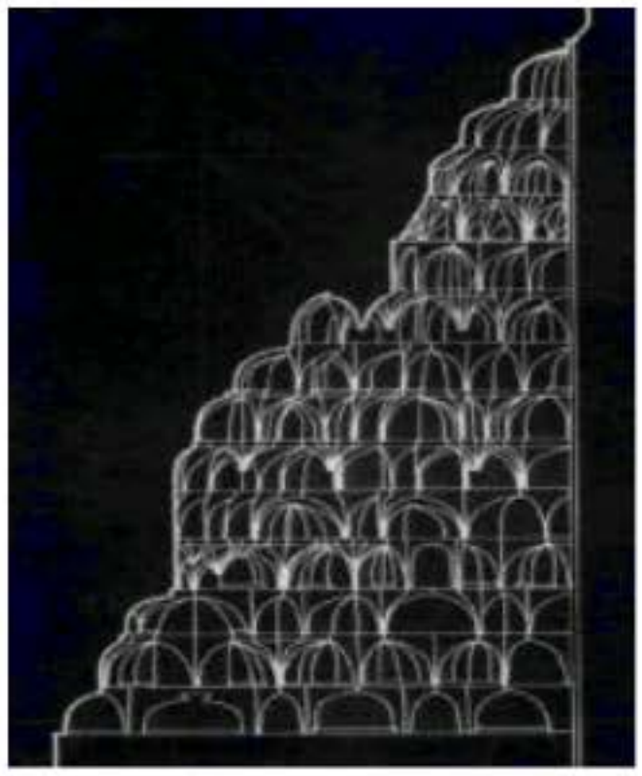

Fig. 3: Conventional drawing

MEASURING MUQARNAS BY CONVENTIONAL METHOD

In conventional method, muqarnas is measured by fundamental tools; meter, plumb and air level (Fig. 2, 3). Fundamental though muqarnas has considerable difficult geometry, it is drawn by repeating or alternation of basic geometric model. Main aim of conventional method is, to acquire the plan, section and façade of this basic geometric model and to repeat this. Later, muqarnas project completed with copying measured geometric modules in the plan, section and facade. Shortly, it is drawn by the principle of the repeating the basic models in traditional methods. For the plan drawings, measurements are obtained by plumb and meter. At first, a reference point must be predicated on the portal. Then, for finding projection of the detail, a plumb is lolled from the module and horizontal and vertical distance from reference point is measured.

But for them, at first it is necessary to reach the details and modules of the portal. In order to reach them, elevators or scaffolds are used in conventional methods. They constructed a suitable place front of the portal and measures are taken. As it can be shown in Fig. 4, measurement studies conducted by conventianal methods have major risks for human lives.

Fig. 4: Views of a measurement study by conventional method

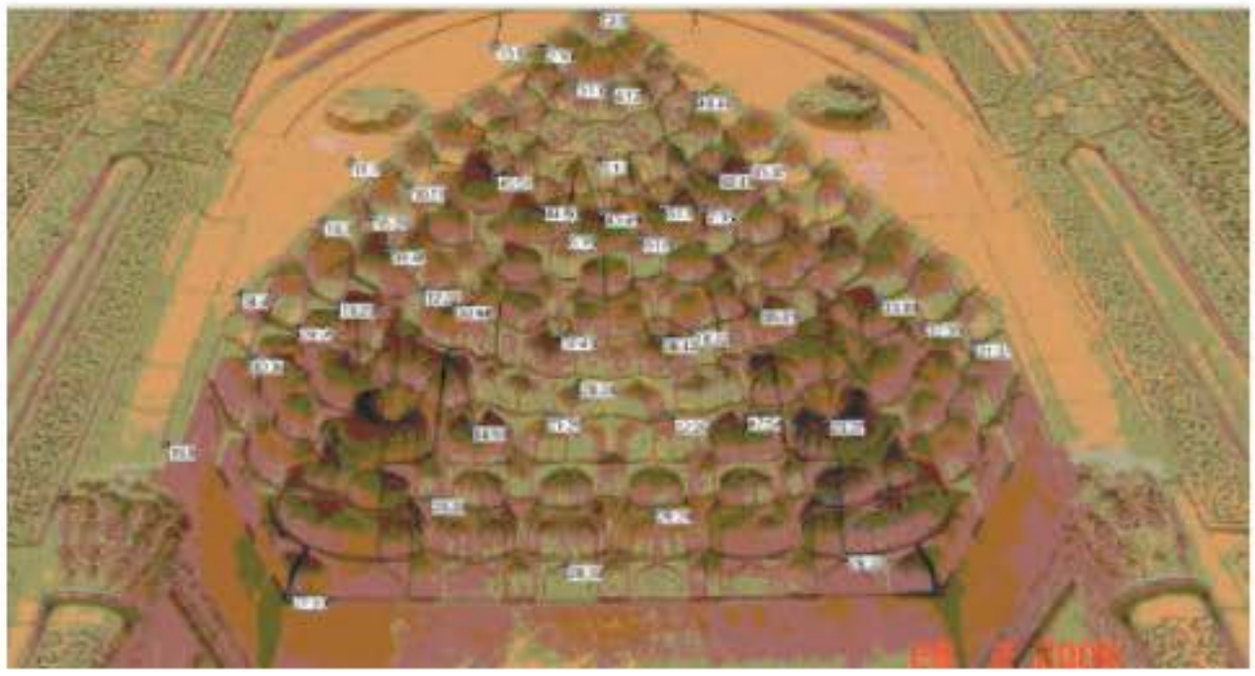

Fig. 5: The control points in object

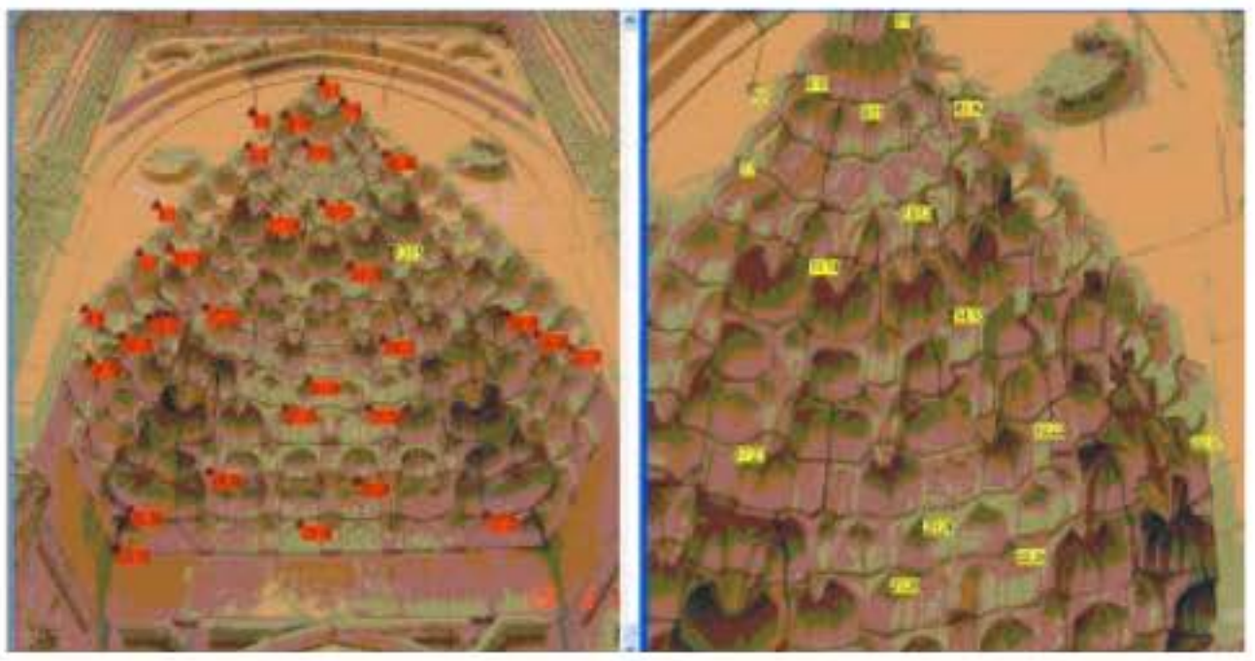

Fig. 6: Referencing of control points

MEASURING MUQARNAS BY CLOSE RANGE PHOTOGRAMMETRY

When drawing detailed surfaces by close range photogrammetry, elevators, cranks or scaffolds and also tools like meter or plumb are not needed to use. With intersecting control points in taken photos, it is easy to draw. For this portal, Topcon 3007 Total Station is used. Photographs are taken with Sony F828 8 mega pixel camera from different perspectives. Control points were chosen only on muqarnas. Deformations and all modules on muqarnas are determined. Drawings is carry out by photogrammetric software. It is important for future restoration projects. Measuring and evaluation process in digital close arrange photogrammetry are fairly easy. Evaluation process is shown in Fig. 5-8.

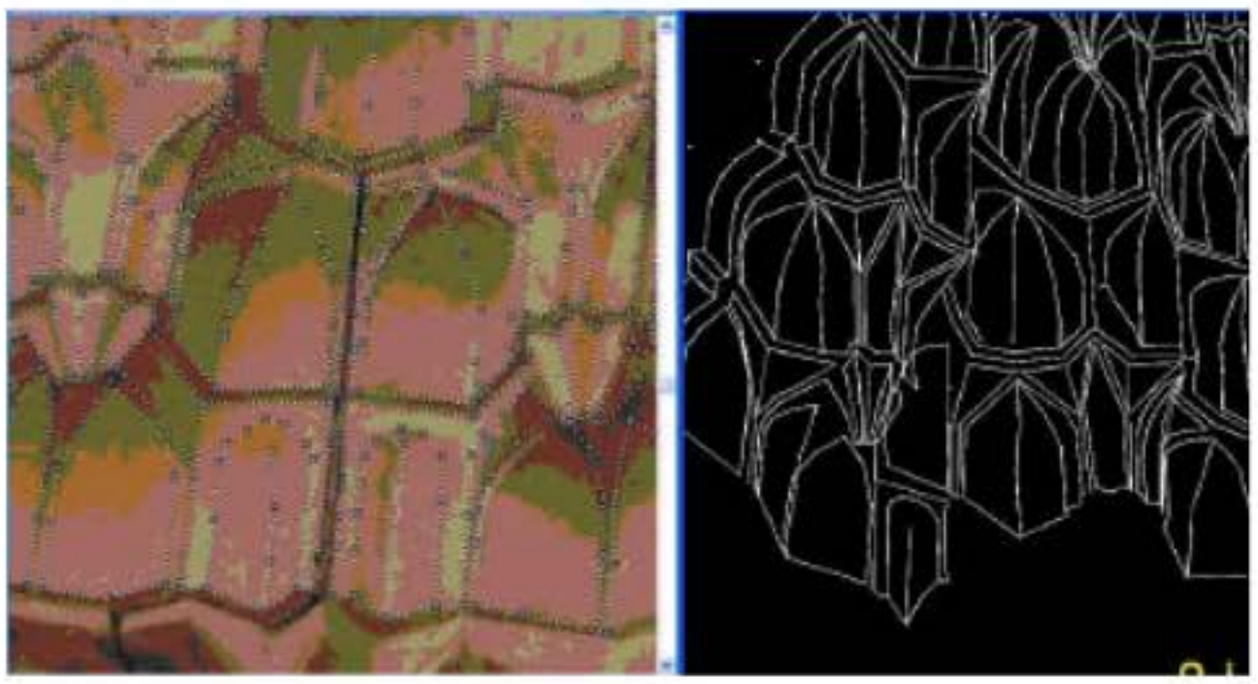

Fig. 7: Drawing of object in software

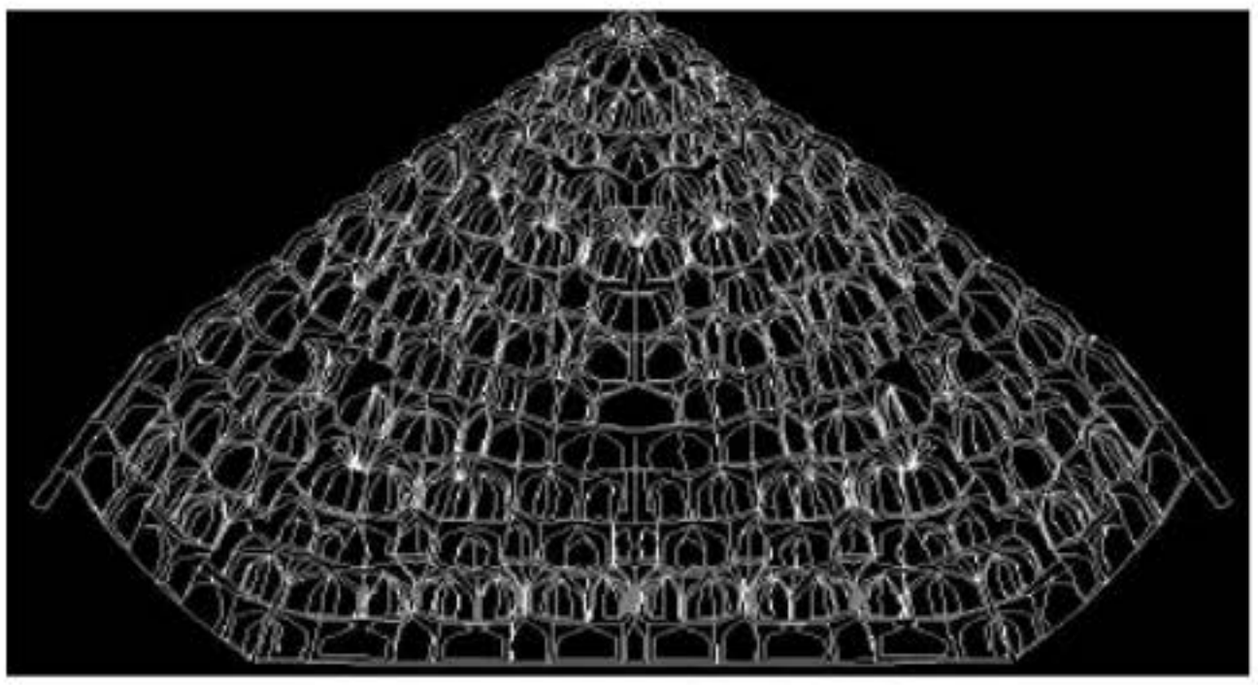

Fig. 8: 3D of object

COMPARISON OF USED METHODS

Digital close range photogrammetry has many advantages when it compared with conventional methods.

Results of digital close range photogrammetry are straighter than conventional method results. It is defined that in a research in Austria with the equal number of worker is done and all measurements are taken in traditional and also in photogrammetric method. And at the end of the research, it is concluded that photogrammetric method is more efficient than conventional methods 100-130 times, 2-5 times in graphically and also accuracy 10 times more than traditional methods (Sağıroğlu, 2004).

All deformations on these parts can not be in traditional method projects completely. But in photogrammetric method, it is possible to measure section wherever wanted and to acquire 3D model of these sections.

Photogrammetric method is a safety measuring method when it is impossible to access the building because of yields, decays, deformations. With taken photographs, vital risk is avoided. It is also useful in situations that the building is not stable (Warden and Woodcock, 2005).

Using photogrammetric technique, documentation can be completed in a short time in many buildings. Because field survey embraced taking photo, determining control points and coordinates are completed in a short time (Bedate *et al*., 2004).

If needed control points are correctly measured in the field, field survey is made only in one time. It means field work, time and financial saving. From the point of required equipage, it considerably reduces manpower and expense.

Correctness is one the most important and useful input for architects. And also sensitiveness can be inspected when it is necessary. Another advantage is that documentation gives possibility to study in CAD and GIS systems.

CONCLUSIONS

In documentation of cultural heritage, methodological evaluation has opened new possibilities and innovative techniques opening new and wider horizons. By improving digital techniques, digital photogrammetry has become more efficient and more economic method. In the field of architecture, the method of close range photogrammetry has become more used techniques for several purposes like determination of existing state, evaluation of damages and especially for preparing measured drawing projects for the purpose of conservation because of many advantages. Documentation is necessary for transmitting cultural heritage to next generation like muqarnas.

The method of close range photogrammetry shepherds to projects which will be repaired for documentation and conservation of historical buildings and architects. Besides its sensitivity and speedy, another important advantage is ensuring immediate consult ability of this method. Obtained 3D drawings help to understand complex and detailed surfaces more easily. Because, two dimensional drawings may be insufficient to understand the building or detailed parts of the building in some situations. Although drawing deformations in the parts like muqarnas is very difficult and dangerous by conventional methods, it is easy with digital close range photogrammetry. Because, photogrammetry use only photographs and mathematical equations. It is a noncontact method and so, there is no dangerous in the field works. 3D informations and drawings can be the most important input for architects and for reconstruction, restoration projects for the complex surfaces like muqarnas. In conventional methods, various techniques are used for measuring them. As mentioned before they are very laborious, time-consuming and dangerous methods. Actually it is not possible to measure. But, thanks to photogrammetry, it is easy to measure them.

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