

Image Based Documentation of Cultural Heritage: The Case of Alqosh Town, Iraq

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ABSTRACT

Preservation of cultural heritage is of great importance due to its historical, tourism, educational, and spiritual significance. Unfortunately, many cultural heritage sites, particularly those in Iraq, are at risk of deterioration from natural disasters, pollution, and neglect. This research shows a cost-effective photogrammetric modeling approach for documenting cultural heritage sites, with a focus on the historic town of Alqosh in northern Iraq. Through digital methods, orthophotos and 3D models of selected historic buildings in the town were generated. This study assesses the practicality of this approach and thoroughly examines the 3D modeling process for heritage conservation, including visualization, reconstruction, and the encountered advantages and limitations.

Keywords: Photogrammetry, heritage, Alqosh, documentation

INTRODUCTION

Historic structures possess architectural features that encapsulate the shared cultural heritage of particular societies during specific historical periods. The documentation of these locations is vital for safeguarding heritage against threats such as damage, destruction, and changes. This process encompasses not merely scientific advancements and technologies but also the lifestyle elements pertinent to the examined society, complementing historical records, archives, illustrations, and contemporary accounts. Such historical documentation significantly aids in recognizing the attributes defining a specific region. This process is essential for effectively preserving the shared architectural heritage. Furthermore, the creation of 3D architectural models enhances the widespread sharing of this heritage and fosters greater understanding of it. Utilizing advanced technologies, including specialized imaging devices, drones, and terrestrial laser scanning systems, has made it possible to gather high-quality data that facilitates thorough documentation with minimal requirements for data alignment.

Among various innovative documentation techniques, the approach of photogrammetry not only records the current condition of architectural features but also allows for the generation of precise 3D models, which support extensive analysis and restoration initiatives. By employing sophisticated digital algorithms, scholars can create accurate depictions of structures, thereby enabling well-informed choices regarding heritage conservation. This investigation underscores the importance of incorporating photogrammetry into heritage studies, showing its effectiveness in protecting cultural heritage while increasing public participation and awareness. Ultimately, embracing these approaches lays the groundwork for a more sustainable and informed strategy for heritage management amid a rapidly evolving modern context.

Photogrammetry plays a significant role in safeguarding cultural heritage by generating intricate 3D models that can be utilized for restoration initiatives. These models act as precise records that can be consulted in the event of damage or loss, allowing for the faithful restoration of heritage sites to their original conditions. The global recognition of the importance of documentation underscores the necessity of imaging techniques, especially photogrammetry, in the preservation of heritage. This approach not only captures the current condition of architectural features but also facilitates the development of highly detailed 3D models, which support thorough analysis and restoration activities. Ultimately, these methods promote a more sustainable and informed strategy for managing heritage within contemporary contexts.

Alqosh is located in the Nineveh Plains, situated roughly 45 km north of Mosul, Iraq (Fig.1). It is positioned at the base of Alqosh Mountain, also referred to as Ba'aidhre Mountain. The surrounding area features numerous caves and valleys, including the red cave, the dripping cave, the water cave, the cave of Satan, the thundering cave, and an extensive valley.

The town is an ancient Assyrian settlement, likely dating back to before 800 B.C. It gained recognition partly due to its mention in the Old Testament with respect to the Prophet Nahum, who preached in the region between 697 and 726 B.C.[1]. The Monastery of Saint Hormizd houses valuable original manuscripts and documents concerning the history of the Church. Additionally, behind the mountain of Alqosh is the site of Bezqin, which features remnants of an orchard and a Syriac Orthodox monastery that may have also been part of the Church of the East.

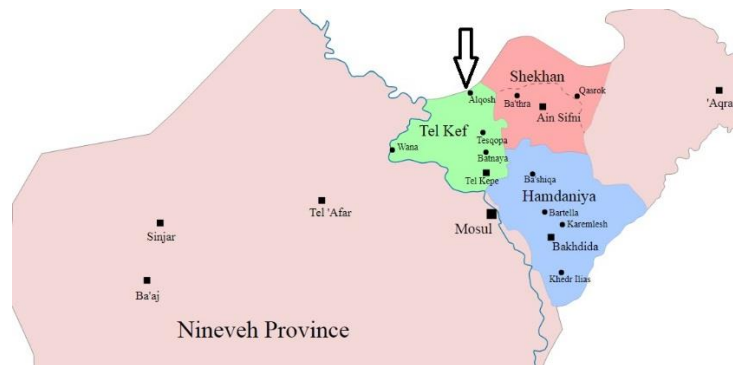


Figure 1. The location of Alqosh town, north of Iraq.

In recent years, Alqosh's cultural heritage has been threatened by urban development and the effects of aging (Fig.2, 3, 4). Additional threats stem from natural hazards, including heavy rainfall, earthquakes, mudflow and landslides [2].

The current study focuses on Alqosh town in Iraq, and emphasizes the challenges confronting its cultural heritage alongside the growing necessity to document and safeguard this heritage.



Figure 2. A wall on the verge of collapsing.

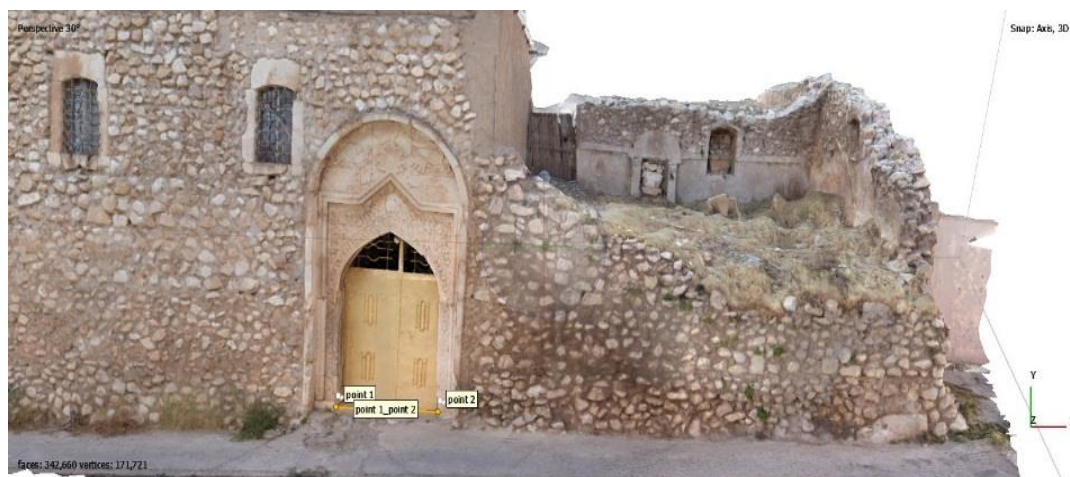


Figure 3. The ancient house of (Elias Pola).



Figure 4. Heritage demolition for new construction.

Objectives of the research:

The primary goal of this study is to explore an imaging technique for documenting selected heritage structures in Alqosh, which will provide a foundational reference for developing a pilot heritage database.

The principal findings of this research are presented alongside a discussion of the key associated issues.

REVIEW OF LITERATURE

The archaeological sites in Alqosh are experiencing considerable deterioration. To ensure their preservation and maintain their cultural and urban significance, it is essential to undertake comprehensive documentation.

Regarding the spatial documentation of heritage, there has been limited scholarly work and literature pertaining to Alqosh town. A recent investigation into the restoration of the ancient tomb of Prophet Nahum within Alqosh utilized photogrammetry and UAV techniques, as referenced in the study of (Pavelka, K et al) [3]. Natural disasters can inflict severe damage on structures representing human heritage. Geological hazards are commonplace in the Alqosh region. Sissakian and Ibrahim [2] identified the zonation of a considerable landslide situated near the town in their research. They confirm that Alqosh town lies within an area marked by active mass movements.

The combination of photogrammetry with other surveying methodologies, such as laser scanning, has proven vital, especially in intricate settings like urban heritage locations. Architectural surveys conducted in Italy highlight the necessity of a comprehensive strategy that integrates GPS networks, aerial assessments, and close-range photogrammetry [4]. The ongoing dialogue surrounding digital cultural heritage illustrates the shared challenges and goals of photogrammetry and digital humanities, emphasizing the synergy between these domains in furthering heritage conservation [5]. The digital models produced through photogrammetry are applicable for virtual reality initiatives, enhancing the visualization and commemoration of heritage sites. This digital conservation is paramount for protecting cultural heritage from natural threats [6]. Photogrammetric techniques are both economical and efficient in terms of time, particularly due to the advancements in digital photography and versatile software. They facilitate the swift processing of images to create precise models, which are beneficial for subsequent analysis and interpretation.

Photogrammetric documentation is particularly valuable for documenting complex and inaccessible structures, reducing logistical costs and survey time compared to traditional techniques. By utilizing photogrammetry, anomalies and structural deformations can be meticulously analyzed, aiding in the identification of potential causes and necessary interventions. The technique is adaptable and can be utilized in various challenging environments, supporting the use of low-cost equipment and making it accessible for broader applications, including contributions from non-experts and tourists. Additionally, photogrammetry can be complemented with other technologies such as terrestrial laser scanning (TLS) to enhance the quality and accuracy of documentation. In summary, photogrammetric documentation is an indispensable tool in the field of heritage conservation, offering high accuracy, flexibility, and cost-effectiveness while enabling detailed analysis and digital preservation of cultural heritage structures. The architectural sites in Alqosh are experiencing significant deterioration, highlighting the urgent need for comprehensive architectural documentation.

The decline in documentation can be attributed to various factors, including the lack of expertise in the field, limited resources and references, and the absence of a comprehensive strategy for heritage preservation. Furthermore, insufficient financial support and institutional backing for preservation projects pose additional challenges. A further reason is the deficit of proper administration efforts with insufficient institutional interest in the conservation. For

example, a study, originally planned for Alqosh historical town, was relocated to another historic area to avoid administrative hurdles [7].

HERITAGE SPATIAL DOCUMENTATION: TOOLS AND METHODS

Traditional methods of documenting heritage, such as in-situ direct measurement of structural elements using tapes are being replaced by more advanced and efficient techniques. Modern tools, including cameras, scanners, and computer programs, are now utilized to convert data, information, and paper images into electronic form.

Photogrammetry, which involves using a digital camera to capture images and videos of archaeological sites and buildings. These images can be easily transmitted worldwide and used directly in archaeological excavations. This method is crucial for its accuracy, simplicity, and speed, as it combines photographic and metric documentation simultaneously. Common methods include UAV, terrestrial, and close-range photogrammetry.

Another technique is documentation using total stations, which utilizes laser distance measurements to determine coordinates of points within and around a building. Results can be drafted using specialized computer software.

3D laser scanning is a rapid and precise technique that can capture minute details of a building, recording up to one million points per second to create dense point clouds.

Radar and GPR methods are also utilized to gather geometric information using microwave energy, particularly for buried and underground objects.

These modern tools and techniques have revolutionized the process of architectural documentation, providing faster, more accurate, and more detailed results than traditional methods.

DIFFERENT TYPES OF HERITAGE DOCUMENTATION

Heritage documentation plays a crucial role in promoting and advancing the techniques used to record cultural heritage. Architectural documentation encompasses various aspects, including shape and spatial considerations, which are determined through surveying measurements. To ensure accuracy in lifting, the building must be geometrically lifted on the plan, connecting all geometric entities. Another important aspect of documentation involves recording the construction materials used in the structure [8]. This type of documentation is essential for preserving the structural integrity of the site, as it provides detailed information on the archaeological elements present, such as wood, stone, metal, cement, lime, and gypsum.

Decoration documentation is also a significant part of the process, with one common method involving placing transparent paper over the ornament to be documented and carefully drawing it. More recently, advancements in technology have allowed for the use of computers and precise scanning and photogrammetric methods to document decorations accurately.

MATERIALS AND METHODS

The photographs were taken using a Canon EOS M50 digital mirrorless camera equipped with a 15–45 mm lens (Fig.5). The camera settings were manually adjusted to f 7.1 aperture, 1/250 shutter speed, and ISO 100, and the original files were saved in JPEG format. In addition, supplementary images were captured with a mobile phone to provide additional information and documentation for easier interpretation and analysis.



Figure 5. The camera (Canon EOS M50) mainly used in the study.

Photogrammetric software (Agisoft) was employed to generate 3D and ortho representations. Further data was gathered through interviews with knowledgeable elderly individuals well-versed in building construction and materials used in heritage buildings.

This research work went on despite of encountering several challenges, such as unavoidable shadow effects on a hot summer day and dense vegetation obstructing parts of the buildings. The presence of intense foliage made it difficult to find suitable camera locations, compounded by the leaves swaying in the wind, affecting the stability required for automatic data processing (Fig.6). Nevertheless, photogrammetric software was utilized to create textured, 3D, and ortho representations.



Figure 6. Tree leaves problems in automatic processing of images.

RESULTS AND RECOMMENDATIONS

This work represents a significant addition to the limited studies previously conducted on Alqosh heritage. Fortunately, this study has been carried out in a critical time, as some heritage buildings are being rapidly demolished. (Fig.7, 8) show part of the results of this work.



Figure 7. Selected scenes of old houses.



Figure 8. processed orthophoto of the ancient house of Elias Pola.

A major outcome from photogrammetric processing is the point cloud representing thousands of points with relative coordinates. Accordingly, lines were drawn to follow up boundary edges of various building entities. The new created drawing is used as a basic autocad file that is ready for accurate documentation or restoration. More related software

can be used to create real 3D representations or walk through animations. Figure 9 shows the extracted door shape from the point cloud of an old building.

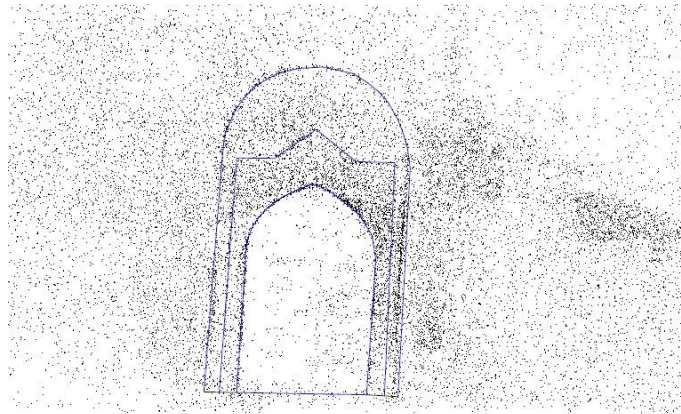


Figure 9. Converting point cloud into a 3D autocad representation of Elias Pola house.

The town museum have several artifacts of the past. A processed 3D shape is shown (Fig.10).



Figure 10. Digitally processed old artifact demonstrated in the Alqosh museum.

1. The process of documentation should stem from the understanding that these monuments are not only remnants of the past but also evidence of previous civilizations.
2. It is imperative to enhance the national project aimed at documenting and archiving all historical buildings by fostering greater cooperation and coordination among relevant bodies, institutions, centers, and individuals.
3. Increasing public awareness and educating those responsible about the importance of preserving architectural heritage is crucial.
4. Securing financial support from government agencies and charitable institutions is essential for advancing the certification process in all its forms.
5. Engaging individuals with valuable knowledge and expertise in conservation and documentation is key.
6. Other surveying methods are essential for more accurate, detailed, and fast ocumenation such as UAV, TLS, GPR. Etc.

In conclusion, photogrammetric documentation plays a vital role in safeguarding the rich heritage by capturing intricate details often overlooked by traditional methods. By leveraging advanced technology, we not only preserve architectural narratives and cultural identities for future generations but also enhance historical research and restoration efforts while fostering public appreciation for our shared heritage.

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