Using Drones to Fix GPS Coordinates of Holy Shrines: Imam Hussein and Imam Abbas

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Abstract

Mapping religious sites will allow a better understanding of the religious landscape of the participating countries. Maps connect you to the matter at hand. They are functional tools to compile, display and share information, and support spatial thinking and planning. The geographically referenced information displayed provide context as they are visualized at a large scale. This mapping effort is made possible thanks to the engagement of relevant networks of government and religious organizations in-country and builds on existing information. UNAOC launched a global Call to Action for Safe Worship to support the UN Plan of Action to Safeguard Religious Sites.

This paper explores the application of drone technology in accurately determining and fixing GPS coordinates of the Holy shrines of Imam Hussein and Imam Abbas in Karbala, Iraq. With millions of visitors annually, precise geospatial data is essential for security, navigation, urban planning, and crowd management. This study examines the use of advanced drone mapping techniques, including RTK (Real-Time Kinematic) and PPK (Post-Processed Kinematic) GPS, to enhance the accuracy of spatial data. Case studies of successful drone-based mapping projects worldwide are included to highlight best practices and potential applications in Karbala. By leveraging aerial photogrammetry and geospatial mapping, this approach enhances precision in shrine documentation, facilitates pilgrimage planning, and contributes to heritage preservation. The paper outlines the methodology used, results obtained, and potential implications for urban planning, security, and tourism.

Keywords: Drones, GPS, Imam Hussein, Karbala, Geospatial Mapping, Holy Shrines, Photogrammetry, UAV.

Introduction

The United Nations Plan of Action to safeguard religious sites is a framework for action containing concrete recommendations for all relevant stakeholders to better prepare, prevent and respond to attacks against religious sites.

One of the main recommendations of the Plan is the development of a mapping of religious sites around the world, which will capture the universality of religious sites and contribute to fostering respect and understanding of their significance for individuals and communities in every continent.

The United Nations Alliance of Civilizations (UNAOC), which the UN Secretary-General entrusted with the elaboration of the Plan of Action and is the lead in its implementation, and the United Nations Satellite Centre (UNOSAT) are working together on the mapping of religious sites, initially in several pilot countries around the world. Argentina and Burkina Faso are the first countries to join this initiative and engage in the mapping effort.

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The United Nations Alliance of Civilizations (UNAOC) was established in 2005, as a political initiative of the UN Secretary-General for conflict prevention and resolution. In January 2019, H.E. Mr. Miguel Ángel Moratinos, assumed the position of High Representative for UNAOC. UNAOC aims at bridging divides and overcoming prejudice, misconceptions and polarization through its projects and initiatives on its five pillars: Education, Youth, Migration, Media, and the Role of Women as Peacemakers in situations with a sociocultural and interreligious dimension. UNAOC benefits from the political support of its Group of Friends which currently includes 156 Members of which are 127 UN Member States, 1 non-member state, and 28 international organizations. The Group of Friends provides input, advice and support to UNAOC's activities. UNAOC leads in the implementation of the UN Plan Action to Safeguard Religious Sites that UNAOC elaborated at the request of the UN Secretary-General in 2019. The Plan of Action is a framework for action containing a number of recommendations for all relevant stakeholders to better prevent, prepare and respond to attacks against religious)sites (UNITAR,n,d.).

Figure 1: Aerial Image of Karbala

UNAOC launched a global Call to Action for Safe Worship to support the UN Plan of Action to Safeguard Religious Sites, inviting people around the world to submit multimedia stories about their personal, emotional connections to religious sites. This communications campaign is meant to engage the global youth and faith communities in celebrating the universality of religious sites as symbols of our shared humanity, history, and traditions. To date, UNAOC has received and featured multimedia stories from Afghanistan, Bahrain, Brazil, Canada, Egypt, France, India, Indonesia, Iraq, Nepal, Portugal, Spain, the United Kingdom, the United States, and more! In addition, the campaign has reached 320,000+ people on social media.

The Arbaeen pilgrimage attracts millions of visitors to Karbala annually, creating logistical challenges for security, navigation, and infrastructure management . Traditional methods of mapping and surveying require significant manpower and time.See Fig.1

With advancements in drone technology, high-precision GPS mapping has become feasible, providing accurate data for authorities and planners (Alghamdi et al.,2022), (Karbovskii et al. ,2021). This paper presents the methodology and benefits of using drones to fix the GPS coordinates of the Holy Shrines of Imam Hussein and Imam Abbas.

Case Studies

1 .Drone-Based Mapping in Mecca & Medina :

- High-accuracy GPS mapping was used to guide pilgrims and improve infrastructure.
- Similar techniques can be applied in Karbala for better crowd control (Sharma et al.,2018).

2 .UNESCO Site Mapping Using Drones :

- Drones have been used to map historical sites with extreme accuracy, ensuring preservation and accurate documentation (UNESCO,2020).
- The methodology can be adapted for Karbala's holy shrines to assist in heritage conservation.

3. Importance of Accurate GPS Mapping for Holy Shrines

Accurate spatial data is essential for:

- **Security & Surveillance:** Enhanced monitoring and crowd management.as shown in Fig.2 .
- **I**nfrastructure Planning: Precise urban development around the shrines.
- Religious and Historical Preservation: Documenting sacred sites.

Navigation & Pilgrim Guidance: Assisting pilgrims with real-time positioni .

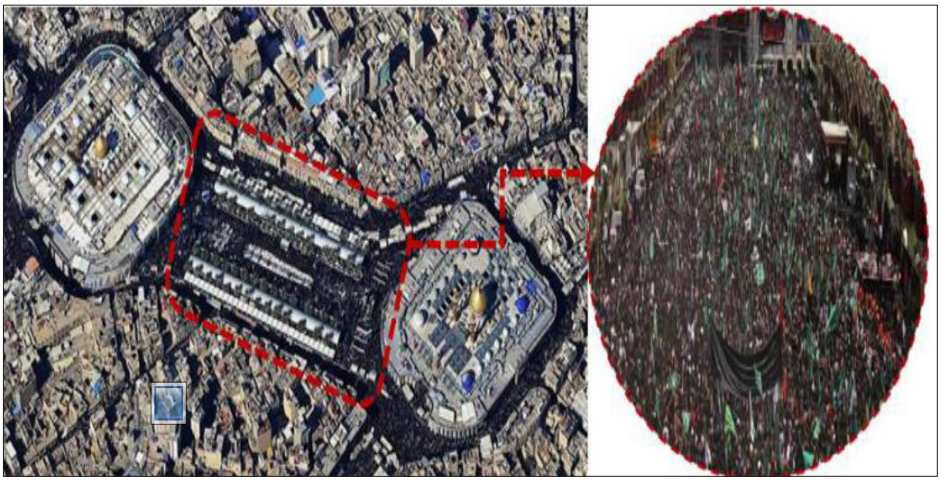

Figure 2: An overhead picture of the Bayn Al-Haramayn zone and the crowd around the holy monuments (Abbas, Naji, Zainab, & Muneer) (Discover QBase 3D,n.d.).

As mentioned above the problem of protect visitors represent a serious challenge ,and need to use the most novel technology to guide them in cases of emergency.

Figure.3 Matrice 350 RTK(DJI,n.d.)

3. Methodology: Drone-Based GPS Mapping

1.Drone Selection

- **Matrice 350 RTK:** Ideal for high-precision mapping.see Fig.3 .An upgraded flagship drone
- platform, the Matrice 350 RTK sets a new benchmark for the industry.

This next-generation drone platform features an all-new video transmission system and control experience, a more efficient battery system, and more comprehensive safety features, as well as robust payload and expansion capabilities. It is fully powered to inject innovative strength into any aerial operation.The payload curve w.r.t can be shown in Fig.4.

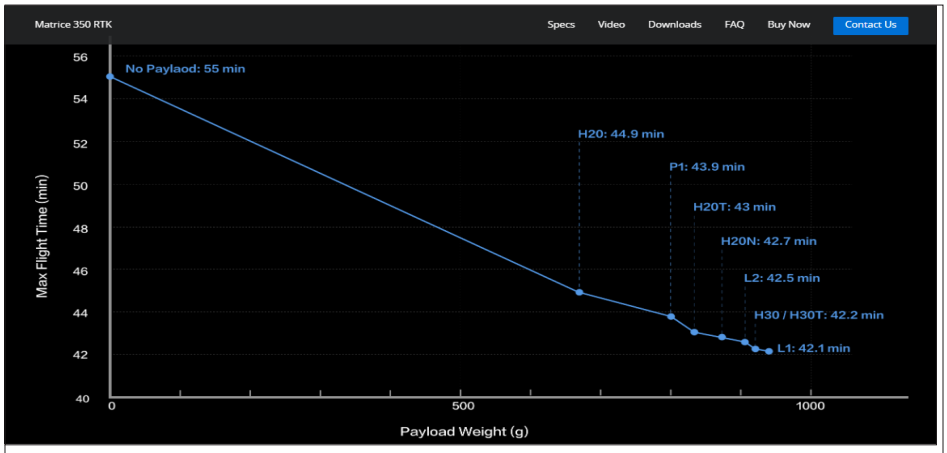

Figure.4 Payload-Flight time curve for Matrice 350 RTK

• **Fixed-Wing Drones:** Suitable for large-scale mapping.

Figure.5 Fixed-Wing drone (UNESCO,2020)

The fixed wing drone is optimized for scanning large areas. With an average autonomy of 90 minutes, it can cover over 3km² in a single flight at 2.5cm resolution flying for over 70km in a single flight. The mission trajectory is pre-programmed in order to achieve the best

coverage, this also ensures that all future visits to the site cover exactly the same area. This

allows for 3D models to be compared over time and assess changes, be it stock piles, land abuse or renovation work on an asset. See Fig.6.The suitable choice for Karbala city using quad-copter type .

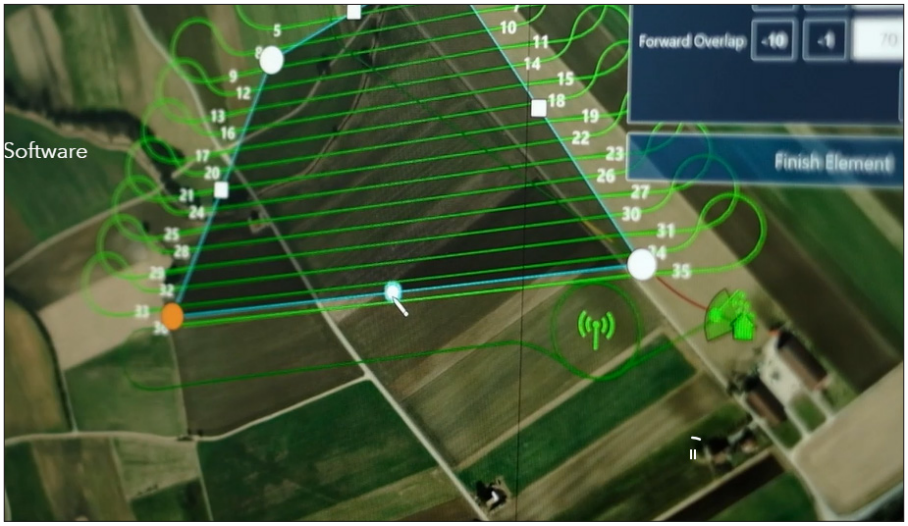

Figure.6 building 3D model by Fixed wing drone . (UNESCO, 2020).

2 . Data Collection Techniques

- **RTK (Real-Time Kinematic):** Provides centimeter-level accuracy using base stations.Fig.7. Real-time kinematic GPS is a type of GPS technology that uses a combination of GPS signals and a local base station to provide highly accurate positioning data. Unlike traditional GPS systems, which rely on data from satellites alone, RTK GPS systems use

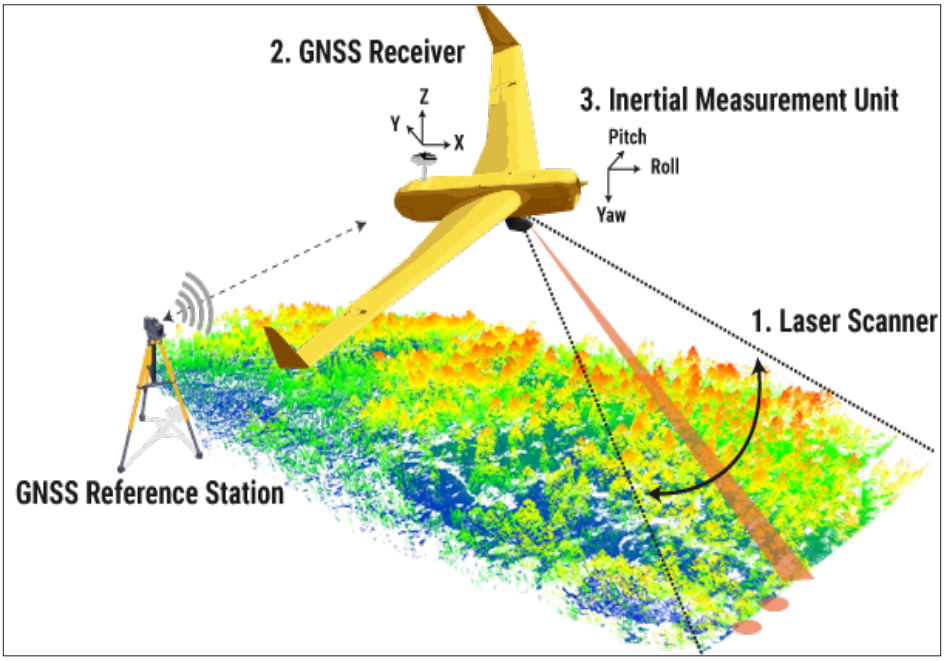

Figure 7: Image how lidar for drone works

- additional data from a nearby base station to improve the accuracy of the GPS data. This can provide positioning data that is accurate to within centimeters, making it ideal for a wide range of applications.
- PPPK (Post-Processed Kinematic): Enhances accuracy by post-processing GPS data.
- LiDAR works in Karbala by using drones equipped with LiDAR sensors to create highly accurate 3D maps of the holy shrines and surrounding areas. Here's how it functions in this context:

1. Data Collection – The drone flies over Karbala, emitting laser pulses that bounce back from the ground and structures. These pulses measure distances with high precision.
2. 3D Terrain Modeling – The reflected data points are processed to create a high-resolution 3D elevation model of the shrines, roads, and surrounding areas.

3. Structural Analysis – LiDAR helps in detecting minor deformations or changes in historical structures, aiding in preservation.
4. Crowd Flow Optimization – The data can be used to identify congestion-prone areas and improve movement planning for pilgrims.
5. Urban Planning & Navigation – Government and religious authorities can use LiDAR-generated maps for better infrastructure development and real-time navigation assistance (Colomina & Molina, 2014) , (Iraqi Civil Aviation Authority,n.d.).

Figure 8: image depicting an aerial drone view of the holy shrines of Imam Hussein and Imam Abbas, overlaid with a GPS coordinate grid and a LiDAR point cloud representation.

- **Multispectral Imaging:** Captures additional data for structural analysis.See an example of these Geo-Image taken by author in 2022 as clear in Fig.9.

Semi-Annual Scientific Journal
www.arbnj.com
Ramadan 1447 A.H, March 2026 A.D

Figure.9 Four corners of Holly Shreen Imam Abbas labelled red colour

Table 1

32.616680, 44.036563	**32.616680, 44.036563**
32.616680, 44.036563	**32.617473, 44.036106**

Suggested 4 corners coordinates of Imam Abbas Holly Shreen as checked control points to fix the by Drone map .

3 . Data Processing & Accuracy Enhancement

- Use of GNSS (Global Navigation Satellite Systems) corrections.
- Integration with Geographic Information Systems (GIS).
- AI-based feature recognition for mapping intricate structures.

Potential Applications in Karbala

- Digital Maps for Pilgrims: Real-time guidance and navigation.
- Disaster Management: Improved evacuation planning during large gatherings.
- Infrastructure Monitoring: Early detection of wear and tear in sacred sites.
- The experimental work: can be done during the Arbeen pilgrimage.
- All the recorded: coordinates can be send to World Heritage Interactive Map (Iraqi Civil Aviation Authority,(n.d.).

Sorry to know that Imam Hussein and Imam Abass holly shreins until now not mentioned within this world map, see Fig.7.


https://whc.unesco.org/ar/list/

- (2015) مواقع توسي
- (2016) غابات شينونجيا في هوبي
- (2016) مواقع فن النحت الصخري في زوجيانج هواشان
- Kulangsu, a Historic International Settlement (2017)
- Qinghai Hoh Xil (2017)
- (2018) جبل فان جينغ شان
- (2019) الأطلال الأثرية في مدينة ليانغتشو
- (2019, 2024) محميات الطيور المهاجرة على طول ساحل البحر الأصفر في خليج بوهاي الصيني (المرحلة الثانية)
- (2021) تشوانتشو: مركز العالم التجاري في سونغ تشوان بالصين
- (2023) المنظر الطبيعي الثقافي لغابات الشاي القديمة على جبل جينغماي في بوير
- (2024) المحور المركزي في بيجين: مجمّع من المباني يبيّن الترتيب النموذجي للعاصمة الصينية
- (2024) صحراء باداين جاران- أبراج الرمال والبحيرات

العراق

- (1985) الحضر
- (2003) آشور (قلعة الشرقاط)
- (2007) مدينة سامراء الأثرية
- Erbil Citadel (2014)
- (2016) الأهوار جنوب العراق: تعد هذه المسطحات المائية مثالاً على التنوّع البيولوجي والمناظر الخلّابة لمدن بلاد الرافدين
- (2019) بابل

الفلبين

- (1993) الكنائس الباروكيّة في الفلبين

Figure.7 The Iraqi places recorded by UNISCO (UNESCO,2015).

Conclusion & Recommendations

The use of drones in fixing GPS coordinates for the Holy Shrines of Imam Hussein and Imam Abbas presents a cutting-edge solution for religious site management. By leveraging RTK and PPK-based drone surveys, authorities can enhance security, navigation, and infrastructure planning. Future research should focus on AI integration and automation in geospatial analysis to further improve the precision and usability of mapped data.Any future improvement of site and re-building service for visitors will be concern with this real 3D measuring and the will help decision's people .All the experimental results will be corrected at Al-Arbeen pilgrimage period in real time and in co-operation with Karbala Center for Studies and Research, it is the right of the Holy Shrine of Imam Hussein.

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