

CBL4UAV Photogrammetry

Phase 1

Engagement

2022

Assignment-1, part-1: Essential Questions

1- Develop/choose an/some essential question as a group.

Outcome- a

A list of stakeholders, distinguishing between external and internal stakeholders and between direct and indirect influence.

Stakeholders	Responsibilities in CH Context
Ministry of Cultural Heritage Tourism & Handicrafts (MCTH) (Central Government)	Establishing the policies and specifications & supervising the implementation
Administration of Cultural Heritage in Provinces (Local Government)	Implementing the policies of architectural heritage protection
Cultural Heritage Department of Cities	Identification, documentation, registration, preservation, restoration, conservation of artifacts, etc.
Local Community / Local Residents	Participating in the protection of architectural heritage and understanding the policy in the architectural heritage protection
Expert group	Providing intellectual support for the protection of architectural heritage
Media	Reporting and disseminating news, events, and information about the state of conservation of architectural heritages
Consulting Engineer Companys for the Restoration of Architectural Heritages	Proposing and executing architectural heritage restoration projects according to the condition of the artifact, budget, and requirements of quality and time
Visitors/ Tourists	Providing feedback and suggestion for the architectural heritage protection

Stakeholders	Internal	External
Direct Influence	<ul style="list-style-type: none"> ○ Local Residents ○ Consulting Engineer Companys for the Restoration of Architectural Heritages 	
Indirect Influence	<ul style="list-style-type: none"> ○ Ministry of Cultural Heritage Tourism & Handicrafts (MCTH) (Central Government) ○ Administration of Cultural Heritage in Provinces (Local Government) ○ Expert Group ○ Cultural Heritage Department of Cities 	<ul style="list-style-type: none"> ○ Visitors/ Tourists ○ Media

Outcome- b

A brief overview of the perspectives of the stakeholders that were spoken with.

The central government cares about the protocols, considerations, and security issues of UAV photogrammetry when it will be used for civil and cultural projects. While the necessity and costs of applying this technique are more likely to be exposed to the discussion by the local government.

Cultural property experts were addressing the technical matters of interior space data capturing by UAV and parametric 3D modeling challenges when they use point cloud data obtained from processing UAV-captured Pictures.

The local community has the most positive attitude toward using UAV photogrammetry for architectural heritage surveying. From their point of view, UAV photogrammetry surveying gathers abundant precise data that can be used for introducing architectural heritage. This may get the needed attention of Architectural Heritage enthusiasts and different communities that effecting the state of the conservation of the artifacts.

From the viewpoint of Consulting Engineer Companys data gathered by UAV photogrammetry survey provides the essential geometric information that they need for the identification, documentation, restoration, and monitoring of Architectural Heritage in an accurate, precise, and time-efficient manner.

2- Develop/choose individually at least five more essential questions

Outcome a: At least one essential question

- 1- How to use UAV photogrammetry for the conservation of Architectural heritage?
- 2- How to generate a complete 3D model of Architectural heritage using a UAV Photogrammetry Survey?
- 3- How to accelerate the parametric modeling process of complex Architectural Heritage surveyed by UAV photogrammetry?

Outcome b: A list of resources (people, books, etc.)

Papers

1. Bakirman, T., Bayram, B., Akpınar, B., Karabulut, M. F., Bayrak, O. C., Yigitoglu, A., & Seker, D. Z. (2020). Implementation of ultra-light UAV systems for cultural heritage documentation. *Journal of Cultural Heritage*, 44, 174-184. doi:10.1016/j.culher.2020.01.006.
2. Chen, X., Jia, D., & Zhang, W. (2021). *Integrating UAV photogrammetry and terrestrial laser scanning for three-dimensional geometrical modeling of post-earthquake county of Beichuan* doi:10.1007/978-3-030-51295-8_75.
3. Frodella, W., Elashvili, M., Spizzichino, D., Gigli, G., Adikashvili, L., Vacheishvili, N., . . . Casagli, N. (2020). Combining infrared thermography and UAV digital photogrammetry for the protection and conservation of rupestrian cultural heritage sites in Georgia: A methodological application. *Remote Sensing*, 12(5) doi:10.3390/rs12050892.

4. Germanese, D., Leone, G. R., Moroni, D., Pascali, M. A., & Tampucci, M. (2019). *Towards structural monitoring and 3D documentation of architectural heritage using UAV* doi:10.1007/978-3-319-98678-4_34.
5. Guo, M., Fu, Z., Pan, D., Zhou, Y., Huang, M., & Guo, K. (2022). 3D digital protection and representation of burial ruins based on LiDAR and UAV survey. *Measurement and Control (United Kingdom)*, 55(7-8), 555-566. doi:10.1177/00202940221110949.
6. Luhmann, T., Chizhova, M., & Gorkovchuk, D. (2020). Fusion of UAV and terrestrial photogrammetry with laser scanning for 3D reconstruction of historic churches in Georgia. *Drones*, 4(3), 1-18. doi:10.3390/drones4030053.
7. Adami, A., Fregonese, L., Gallo, M., Helder, J., Pepe, M., & Treccani, D. (2019). Ultra-light UAV systems for the metrical documentation of cultural heritage: Applications for architecture and archaeology. Paper presented at the *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, 42(2/W17) 15-21. doi:10.5194/isprs-archives-XLII-2-W17-15-2019.
8. Aicardi, I., Chiabrandò, F., Grasso, N., Lingua, A. M., Noardo, F., & Spanó, A. (2016). UAV photogrammetry with oblique images: First analysis on data acquisition and processing. Paper presented at the *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, 2016-January 835-842. doi:10.5194/isprsarchives-XLI-B1-835-2016.
9. Alicandro, M., & Rotilio, M. (2019). Uav photogrammetry for resilience management in reconstruction plan of urban historical centers after seismic events. A case study. Paper presented at the *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42(2/W11) 55-61. doi:10.5194/isprs-Archives-XLII-2-W11-55-2019.
10. Álvarez Larrain, A., Greco, C., & Tarragó, M. (2021). Participatory mapping and UAV photogrammetry as complementary techniques for landscape archaeology studies: An example from north-western Argentina. *Archaeological Prospection*, 28(1), 47-61. doi:10.1002/arp.1794.

People

- Intentionally removed

Outcome c: Reflect on whether certain perspectives have changed your perspective.

Assignment 1 part 2: Challenge Proposal

Write your Challenge proposal. Please submit a brief text with:

- Your names/group
 - Intentionally removed
- The problem you want to address (resulting in an actionable challenge)

Conservation of Architectural Heritage using UAV Photogrammetry

- How the problem is unique or why has the problem been not addressed yet (within the UT)

Identification and documentation are the first steps in the conservation of Cultural Heritage. Traditional survey and 3D documentation methods of Architectural Heritage are challenging, tedious, time-consuming, and error-prone due to the special geometry, ornament, and texture complexity in most of these structures. Aiming to solve the problem of difficult data collection and modeling, many researchers proposed and evaluated using unmanned aerial vehicle photogrammetry for identifying, documentation, digital restoration, and monitoring immovable cultural heritage. The results of mentioned researches show the capability of UAV photogrammetry as a rapid, accurate, time-efficient, and flexible method for data acquisition, modeling, and monitoring of complex, extended, hard-to-access, and high-rise architectural heritage.

In recent years, the extensive usage of UAVs in academic and commercial applications has encouraged their expansion, putting forward the challenge of identifying common procedures and feasibilities of UAVs, along with benchmarks for researchers. While in the high-ranked universities the manual and traditional methods still are used by the experts and students of conservation for identification and documentation of cultural properties. So, there is an essential need for learning UAV photogrammetry as a multidisciplinary method for acquiring and processing required data for Architectural Heritage conservation purposes.

- How the problem connects to the five competencies

Architectural Heritage surveys carry out to respond to different data requirements and purposes such as identification, documentation, 3D modeling, pathology, 3D virtual reconstruction, restoration, monitoring, and management of these cultural properties. UAV photogrammetry of Architectural heritage as one of the surveying methods requires acquisition planning and parameter determining using interdisciplinary knowledge of Cultural Heritage, mapping, photogrammetry, and UAV technology.

Determining Ground Sampling Distance (GSD), mapping scale, Ground Control Points, Check Points, and optimal trajectory configurations are the conjunction points that photogrammetry and

architectural heritage knowledge meet each other. On the other hand, designing the flight plan requires consultation and cooperation between photogrammetry specialists and the UAV operational team.

Processing the gathered data at the first step is a photogrammetric process when it produces a point cloud or even a textured 3d surface model. Whenever the obtained architectural heritage's point cloud needs further processing to create a 3D parametric model or Building Information Model, there will appear a need for a group of other knowledge fields. IT, Computer Science, and Software Programming are the main knowledge fields needed to employ for the 3D modeling of architectural heritage according to the complex and unique geometry of these artifacts.

- The need (for the community) that justifies this Challenge (the problem being solved)

Today the world is losing its architectural and archaeological cultural heritage even faster than it can be documented. Human-caused disasters, such as war and uncontrolled development, are major culprits. Natural disasters, neglect, and inappropriate conservation are also among the reasons our heritage is vanishing. Considering the existence of numerous architectural heritages across the world and countries, there has to be knowledge of implementing UAV photogrammetry as a quick and cost-effective same time accurate, and flexible method to acquire this artifacts data.

- Sources of information consulted
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 - Murtiyoso, Arnadi & Grussenmeyer, Pierre. (2017). Documentation of heritage buildings using close-range UAV images: dense matching issues, comparison and case studies. *The Photogrammetric Record*. 32. 10.1111/phor.12197.
 - F. Noardo, Architectural heritage semantic 3D documentation in multi-scale standard maps, *Journal of Cultural Heritage* (2017), <https://doi.org/10.1016/j.culher.2018.02.009>.
 - Previtali, M., Brumana, R., & Banfi, F. (2022). Existing infrastructure cost-effective informative modelling with multisource sensed data: TLS, MMS and photogrammetry. *Applied Geomatics*, 14, 21-40. doi:10.1007/s12518-020-00326-3.
 - Alsadik, B. (2022). Crowdsourced drone imagery—A powerful source for the 3D documentation of cultural heritage at risk. *International Journal of Architectural Heritage*, 16(7), 977-987. doi:10.1080/15583058.2020.1853851.
 - Chiabrandoa, F., D'Andriab, F., Sammartanoa, G., & Spanòa, A. (2018). UAV photogrammetry for archaeological site survey. 3d models at the hierapolis in phrygia (turkey). *Virtual Archaeology Review*, 9(18), 28-43. doi:10.4995/var.2018.5958.