LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

FAKULTÄT FÜR KULTURWISSENSCHAFTEN

INSTITUT FÜR DIGITALE KULTURERBE STUDIEN

Institute for Digital Cultural Heritage Studies (IDCHS)
Winter School Methods in Digital Heritage
Syllabus 2025
(4.0 ECTS or 6.0 ECTS)

Instructors: Prof. Dr. Nicola Lercari and Dr. Dario Calderone

Instructor Emails: n.lercari@lmu.de; dario.calderone@lmu.de

Time and Location: Monday, March 17, to Friday, March 28 (see details in section VI. Schedule).

Classroom/Computer Lab: CIP Pool 02 - Akademiestr. 7 (internal courtyard).

Moodle Self-enrollment: find the course e-learning webpage at https://moodle.lmu.de, sign in with the LMU credentials you receive upon enrollment, find the course (MDH Winter School 2025), then use the code WS-MDH25.

Course Description

Heritage professionals and archaeologists have long employed digital imaging and laser scanning techniques to document, analyze, and digitize museum collections, historic buildings, and archaeological sites. In this course, students will develop competencies in digital photogrammetry and laser scanning applications related to cultural heritage and archaeology through fieldwork and computer lab activities. These experiences will introduce essential principles and toolsets. The exercises will cover a range of workflows, including image acquisition and processing (digital photogrammetry), object digitization planning, site planning, scanning, processing of raw data (laser scanning), creating derived products (such as digital drawings, 3D mesh models, and digital elevation models), and data visualization for analysis and dissemination purposes. Students will compile their work into a portfolio, which will be graded as their final exam, and present their projects at the Institute for Digital Cultural Heritage (IDCHS) VR Lab. Two data acquisition sessions will take place at partner museums in Munich: the Museum für Abgüsse Klassischer Bildwerke München and the Staatliche Museum Ägyptischer Kunst. Additionally, there will be a laser scanning session in the city center of Munich. These activities will complement the laboratory work and expose students to a real case study.

I.Topics:

The first week of this intensive course covers key concepts and toolsets in digital photogrammetry applications for cultural heritage and archaeology. The topics include: digital photography (e.g., focus; focal length; depth of field; shutter speed; color calibration; framing; sensors; image resolution; lighting; file formats; storage); drone photography; digital photogrammetry image acquisition techniques (e.g., accuracy and precision; calibrated versus non-calibrated cameras; recommended lenses; collinearity; image orientation; image matching; control points; point-source lighting with constant radius from subject, light probes, common mistakes); data preparation (e.g., file batch renaming; format conversion; color profiles; image-enhancing); data processing (e.g., dense stereo matching, structure from motion; desktop versus cloud digital photogrammetry processing; proprietary versus open-source software; georeferencing); basic considerations on data analysis for research-driven applications (e.g., segmentation, filtering,

transforming, and enhancing various photogrammetric products for further study in a Geographic Information System (GIS); basic visualization principles and tools.

The second week of this intensive course covers key concepts and toolsets in laser scanning and mapping applications for cultural heritage and archaeology. The topics include: laser scanning technology (e.g., different types of scanners and applications, proprietary versus open-source scanning software, processing workstations); planning (e.g., analyze site/collection conditions; workflow planning; site planning; data management; end products); data capture (e.g., laser safety; operational safety; calibration; range and coverage; resolution and accuracy; intensity and color; control and georeferencing; common mistakes); data processing (e.g., raw vs. pre-processed; cleaning; noise and distance filtering; segmentation; sectioning; classification; meshing; rendering; vectorization for CAD/BIM; exporting and file formats; image-based output); basic considerations on data analysis for research-driven applications (e.g., data fusion, data integration with BIM and CAD, further analysis in GIS; cloud integration); basic visualization principles and tools (e.g., GIS visualization tools; rendering; animation).

II.Format, Procedures, and Workload:

The course structure is: (2) intensive weekly exercise sessions.

Format 4.0 ECTS: assigned readings, tutorials, digital assignments, hands-on sessions at our partner museums, and data capture practica in Munich city center, LMU Moodle. The final exam is structured as follows: 1) a portfolio compiling all the digital material and written reports produced during the winter school and 2) a final presentation at the Institute for Digital Cultural Heritage VR Lab.

Format 6.0 ECTS: assigned readings, tutorials, digital assignments, hands-on sessions at our partner museums, and data capture practica in Munich city center, LMU Moodle. The final exam is structured as follows: 1) a portfolio compiling all the digital material and written reports produced during the winter school, 2) a final presentation at the Institute for Digital Cultural Heritage VR Lab, and 3) a 10-15-page term paper reflecting on one of the digital techniques learned during the winter school and its applications. The term paper is due twenty days after the end of the winter school and must be submitted electronically through the LMU Moodle page for the course.

Certificate of completion:

Students who select the 4.0 ECTS format will receive a printed certificate before they return home.

Students who opt for the 6.0 ECTS format will receive a digital copy (PDF) of their certificate after their term paper is evaluated.

III. Tutorials

Tutorials and digital assignments for this course are complex. They require a lot of commitment and a good understanding of the course methods. This is why you must complete the assigned tutorials according to schedule and submit your digital assignments on time.

In each exercise, you will read and follow step-by-step tutorials, create digital material, and a three-page written report.

You will also receive freely accessible online discussions (on Moodle) to share comments, ideas, and reflections with your classmates and instructors.

IV. Mandatory Readings (please read text one before the beginning of the Winter School and text two before the start of the second course week):

1. Bedford, Jon. 2017. Photogrammetric Applications for Cultural Heritage: Guidance for Good Practice. Swindon: Historic England. http://historicengland.org.uk/images-books/publications/photogrammetric-applications-for-cultural-heritage/.

2. Boardman, Clive, and Paul Bryan. 2018. *3D Laser Scanning for Heritage: Advice and Guidance to Users on Laser Scanning in Archaeology and Architecture*. 3rd ed. Guidance. Swindon: Historic England Publishing. https://historicengland.org.uk/images-books/publications/3d-laser-scanning-heritage/.

V. Optional Readings:

Digital Imaging Techniques:

- MacDonald, Lindsay W., ed. 2006. Digital Heritage: Applying Digital Imaging to Cultural Heritage. Oxford: Elsevier Butterworth-Heinemann.
- Mudge, Mark, Carla Schroer, Graeme Earl, Kirk Martinez, Hembo Pagi, Corey Toler-Franklin, Szymon Rusinkiewicz, et al. 2010. "Principles and Practices of Robust Photography-Based Digital Imaging Techniques for Museums." http://repository.si.edu/xmlui/handle/10088/67710.
- Mudge, Mark, Tom Malzbender, Alan Chalmers, Roberto Scopigno, James Davis, Oliver Wang, Prabath Gunawardane, Michael Ashley, Martin Doerr, and Alberto Proenca. 2008. "Image-Based Empirical Information Acquisition, Scientific Reliability, and Long-Term Digital Preservation for the Natural Sciences and Cultural Heritage." Eurographics (Tutorials) 2 (4). https://www.academia.edu/download/35007938/EG-mudge-tutorial-notes-final.pdf

Laser Scanning:

- Crutchley, Simon, and Peter Crow. 2018. *Using Airborne Lidar in Archaeological Survey: The Light Fantastic*. Swindon: Historic England. https://historicengland.org.uk/images-books/publications/using-airborne-lidar-in-archaeological-survey/.
- Lercari, Nicola. 2016. "Terrestrial Laser Scanning in the Age of Sensing." In *Digital Methods and Remote Sensing in Archaeology*, edited by Maurizio Forte and Stefano Campana, 3–33. Quantitative Methods in the Humanities and Social Sciences. Cham, Switzerland: Springer.
- Lercari, Nicola. 2019. "Monitoring Earthen Archaeological Heritage Using Multi-Temporal Terrestrial Laser Scanning and Surface Change Detection." *Journal of Cultural Heritage* 39: 152–65.

A complete list of readings, tutorials, and exercises will be posted on Moodle during the workshop.

VI. Schedule*

Friday, March 14	Arrival in Munich & Registration at accommodation	Staff
Saturday, March 15 11:00 (Meet at LMU Main building – Geschwister-Scholl-Platz 1 – in front of main entrance)	Meet & Greet at LMU Main Building. Tour the Institute for Digital Cultural Heritage and LMU Main Mensa (where you can lunch at the end of the tour)	Tutors 1&2
Sunday, March 16	Optional excursion to Schloss Neuschwanstein	MISU
Monday, March 17		
9-11 (Meet at Akademiestr. 7, CIP Pool 02)	Welcome address by Prof. Dr. Nicola Lercari and presentation "Cultural Heritage in the Digital Age and introduction to the IDCHS"	Prof. Lercari
11-13	Tour of the IDCHS & Presentation of current research projects	IDCHS staff
14-18	Lessons & supervised exercises (complete DigImag lab assignment 1)	Prof. Lercari, Dr. Calderone (Tutors 1 & 2 bring photo equipment to MfA)
Tuesday, March 18		
9-14	Visit to partner Museum 1 (Meet at Plastercast Museum, Katharina von Bora Str. 10) (complete lab 1 assignment)	Prof. Lercari, Dr. Calderone, Tutors 1 & 2
15-18	Lessons & supervised exercises (complete lab assignment 2 MfA statue reconstruction)	Prof. Lercari, Dr. Calderone
Wednesday, March 19 to Friday, March 21		
9-13	Lessons & supervised exercises (complete lab assignments 3 (arch. Context) and 4 (drone)	Prof. Lercari, Dr. Calderone
14-18	CIP pool of institute available for group work projects	Tutor 1
Monday, March 24		
9-14	Visit to partner Museum 2 (Meet at SMAEK, Gabelsbergerstraße 35, 80333 München)	Prof. Lercari, Dr. Calderone, Tutors 1 & 2
15-18	Lessons & supervised exercises	
Tuesday, March 25		
9-14	Scanning session at LMU Alte Aula (Meet at CIP Pool)	Prof. Lercari, Dr. Calderone, Tutors 2
15-18	Lessons & supervised exercises	
Wednesday, March 26 to Thursday, March 27		
9-18	CIP pool of institute available for group work projects	Tutor 2
Friday, March 28		
10-12 and 14-16	Final presentation and discussion of participants' projects, delivery of the certificates	Tutors 1 & 2 help setup VR Lab
Saturday, March 29	Departure	

*To ensure we can resume sessions on time and reduce your meal costs, we recommend having lunch at the LMU cafeterias on Adalbertstraße 5 or Leopoldstraße 13a.