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Doctoral Dissertation
Doctoral Program in Architectural and Landscape Heritage
XXXV Cycle

Geomatic techniques for the documentation of the Underwater Cultural Heritage

By

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Abstract

Underwater Cultural Heritage (UCH) needs to be preserved, documented, and safeguarded due to their intrinsic values. The documentation is a fundamental tool for increasing the resilience of UCH. Therefore, the study, the communication and the protection of this Heritage are supported by many processes and require specific data to be collected, stored, and pre-processed, before performing the actual data processing and quality certification steps that are essentials for the documentation of the Heritage. In addition, these activities involve many disciplines, actors, and stakeholders, leading to the need to establish fruitful collaborations among scientists, professionals, and institutions.

The research presented in this PhD thesis focuses on one of the research fields of **Geomatics**, discussing 3D metric techniques for underwater surveys and addressing the need to document the UCH via a **Photogrammetric approach**, by studying and applying geomatic sensors and methods in real scenarios, with the aim of documenting and promoting the Underwater Cultural Heritage and the Coastal Landscape.

This thesis is targeted to fill some gaps present in the current knowledge of underwater photogrammetry data processing. The core of this research focuses on the study and the design of a workflow to enhance photogrammetric datasets, boosting the performance of the final results (3D models and 2D products) in terms of reliability of the delivered metric and colourimetric data. Specifically, the thesis focuses on the possibility of enhancing **legacy datasets** or any kind of underwater photographic datasets not acquired with the purpose of a photogrammetric reconstruction.

The methodology is developed around 3 main collaborations with national and international universities and provides an establishment of a methodological protocol specifically designed for I) **enhancing sub-optimal datasets** (i.e. exploiting the metric and radiometric content of less-than-ideal image datasets by adopting pre-processing strategies, to achieve acceptable results) II) **restoring colour information** and III) providing a novelty strategy for **georeferentiation in very shallow water** (< 4 m depth). For each use case different solutions are proposed and evaluated and, finally, challenges, success and drawbacks faced during the development of the methodological protocol are applied in the real case of a metric survey of an underwater archaeological excavation site (the late imperial roman wooden wreck of Torre Santa Sabina - Carovigno, Brindisi, Italy).

*"There are more ships lying at the bottom of the sea than there are sailing on it."
"Ci sono più navi che giacciono in fondo al mare di quante non vi navighino sopra"*