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Editorial

Editorial for Underwater 3D Recording & Modelling

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The Special Issue "Underwater 3D recording and modelling" is focused on challenges for 3D modeling and ways to overcome them in the underwater environment. Given that existing sensors and algorithms are not optimized, nor present the best possible solutions for the harsh conditions of the submerged environment, new techniques and methods need to be developed. During the last years, we have witnessed groundbreaking technological developments, which allow underwater documentation with unprecedented accuracy and detail. Photogrammetry-based approaches coupled with virtual and augmented reality (VR/AR) applications are becoming infused in interdisciplinary research in topics such as archeology, biology, industry.

The Special Issue received considerable attention in the combined community of photogrammetry and marine biology. A total of 10 papers are included in the Special Issue, covering a wide range of applications. Three main themes are identifiable in the issue: the accuracy potential problem; geomatics applications to marine ecology with emphasis especially on benthic communities; artificial intelligence (AI). State of the art AI algorithmic solutions have been proposed for improving bathymetric accuracy, supporting 3D modelling of benthic microhabitat and automating semantic segmentation of benthic species and communities [1–3]. Remotely Operated Vehicles (ROV) are also discussed in two articles; in [2] they are exploited for data acquisition, while in [4] a laser scaling approach is proposed for solving the scale ambiguity problem in markless 3D photogrammetric reconstructions obtained with ROVs equipped with a single camera.

Underwater photogrammetric accuracy is still an interesting topic, despite the revolution Structure from Motion (SfM) and Multi View Stereo (MVS) brought in the community of underwater research. Evaluation of accuracy and detailed 3D reconstruction for demanding multitemporal monitoring of benthic communities is described in [5], where the estimation of the coral reef growth rate is of the highest importance. In [6] authors are using photogrammetry to precisely quantify the three-benthic cover and structures, and extract several geometric metrics, using a multi resolution approach, to associate them with habitat complexity.

Extensive evaluation of underwater stereo camera calibration methods and error magnitude estimation, using synthetic and real data is discussed in [7]. A review of existing methods is also provided to classify all existing underwater camera calibration methods, and explicit and implicit modelling approaches of the refractive interfaces in multi-media photogrammetry are discussed and analyzed.

As authors report in [8], underwater chromatic aberration is more dominant in the underwater environment, and therefore significantly affects accuracy. Experiments using low-cost cameras, in water and in air show that accuracy varies considerably.

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An industrial application is present in [9], where photogrammetry is employed for multi camera offline monitoring of large steel pipe installation simulation in towing tank.

In [3] authors used labelled orthophotos for training a CNN for automatic segmentation and ecological analysis of coral habitats. Such approach will allow for a higher degree of automation by addressing the fundamental challenge of increasing the spatial and temporal scale of coral reef monitoring and management.

Markers in the underwater sites can support navigation to large areas, provide information on selected points and assist Augmented Reality (AR) applications in research projects. Authors in [10], present a new algorithm for the detection of fiducial markers that is tailored to harsh and low visibility condition of the underwater environment.

ROV are an excellent data acquisition platform for 3D reconstruction using SfM and MVS. Nevertheless, in some cases the lack of control points or scale bars, restricts the use of the final 3D model. Authors in [4] exploit the use of lasers projected over the object, to obtain scale for the model.

Optical bathymetry in shallow waters using Unmanned Aerial Vehicles (UAV), is only possible if two media photogrammetry is applied. Despite the ease of acquisition and processing coastal site aerial photos with SfM and MVS, the results are inaccurate in depth. Authors in [1], propose a Support Vector Machine for correcting the Digital Surface Model created by such methods, which along with the mono image depth water refraction correction can lead to correct coastal orthophotos.

As a conclusion, we can foresee that applications of photogrammetry and computer vision in the underwater environment will continue increasing. AI, VR and AR have a lot of unexploited potential in the peculiar underwater environment. Need for accurate and detailed 3D and color reconstruction, affordable small ROV as data acquisition platforms will lead future research, while a variety of cultural heritage and marine biology applications will benefit from such outcomes.

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