Optical sensors and photogrammetry for the detection of fine-scale biometric parameters and changes in marine bioconstructors

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Bioconstructor species are threatened by anthropogenic pressures and climate changes, making the early identification of impacts and damages a primary goal for the preservation of coral reefs. This research aims to implement optical methods, based on underwater fluorescence imagery and photogrammetry, to monitor marine communities in the Mediterranean. The study optimizes laboratory-based methodologies for the surveying, 3D reconstruction and monitoring of fragments of the endemic coral *Cladocora caespitosa*. A proper set up for photogrammetric reconstruction was defined, and the analysis of the resulting 3D models compared with traditional approaches based on 2D images. Tests with a fluorescence camera, blue and violet leds, and special excitation-emission filters were also performed to examine the fluorescence of corals (GFP proteins) and associated zooxanthellae. The implemented methodologies resulted in products with a sub-millimetre resolution, facilitating the identification of biometric parameters (polyps, colony areas, and volumes) and highlighting morphological changes over time (e.g., growth of corallites). The fluorescence imagery allowed an easier distinction between polyps, coral skeletons and substrate, providing an indicator of corallites' health. Both 2D and 3D methods experienced the polyp retraction and the presence of algae; 3D reconstruction accounts for surface variations due to the complex morphology of some species, allowing for standardized measurements and multi-temporal comparisons. The methodologies presented in this study will be further tested and implemented with the use of ROVs (Remotely Operating Vehicles) for open water applications, but they also open up new perspectives for the accurate monitoring of coral growth in aquaculture for coral reef restoration.