Università Politecnica delle Marche
Scuola di Dottorato di Ricerca in Scienze dell'Ingegneria
Corso di Dottorato in Ingegneria Industriale

Underwater Non-Contact Measurements for Corals Colour and Shape Assessment

Ph.D. Dissertation of:

Rachele Napolitano

Supervisor:

Prof. Enrico Primo Tomasini

Assistant Supervisor:

Dr. Paolo Chiariotti

Ph.D. Course coordinator:

Prof. F. Mandorli

XVII^0 edition - new series

Abstract

The proposal of this doctoral thesis is to understand the exploitability of scanning technologies for studying and observing the shape variability of marine sessile benthic organisms with particular focus on isolated corals in shallow water. This study aims to compare two different systems, laser-based and image-based techniques, for 3D shape reconstruction and colour information.

The first part of this thesis concerns a general description of the zonation, morphology and biological monitoring of the coral reef, in order to collocate this work in a larger project, in which the possibility to describe the modification of the bottom topography by means of underwater 3D sensors is an important contribution for the marine flora and fauna. A brief review of the underwater scanning methods is performed, highlighting the advantages and the drawbacks of the different solutions.

The approach to the study is schematized by describing the different case studies (terrestrial and underwater conditions) adopted for the survey of small-sized samples, supported by laboratory tests. A particular focus is on the reduction of the underwater images quality in the photogrammetric approach, limited by the light attenuation. This is a fundamental issue, mainly for the acquisition in shallow water where the artificial light may not be an exploitable solution. For this reason, the investigation involves the implementation of a colour correction algorithm to restore the degraded images. The main contribution of this image pre-processing step is the drastically improvement of the matching point recognition and the reconstruction of the whole object independently to environmental illumination changes.

The results show the difference between the 3D models obtained from a prototype 3D colour laser scanner (RGB-ITR) developed in ENEA ArtVisLab (Frascati) and a photogrammetric approach based on standard commercial cameras with different optical lenses.

The colour and shape reconstruction capabilities of the latter technique, which proved to be superior to the laser-based one in underwater applications, were metrologically assessed by dedicated tests.