Coupling underwater autonomous vehicles and automatic video analysis for efficient monitoring of coral reef ecosystems: promises and challenges

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Coral reefs are facing increasing effects of global changes. Yet, diver-based surveys do not allow assessing the subsequent changes of reef fish assemblages over large areas and at high frequency. Development of Semi-Autonomous Underwater Vehicle (SAUV) and Deep Learning technologies could help to tackle this challenging task. To this end, we developed a small-size underwater vehicle carrying stereo cameras and environmental sensors, capable of automatically perform standardized trajectories in a complex environment. Our robot can, for example, dynamically verify mission-dependent properties (remaining to a constant depth or altitude, moving below a maximal speed, following a virtual transect line, etc.) and automatically transition among missions. We are actually working toward full autonomous functionalities in order to remove the umbilical cable presently necessary for human operators to visually detect dangerous obstacles. The umbilical cable limits drastically the operational range of the system, increases the logistical burden and induces huge disturbances on the system (it can cling on coral, creates overwhelming drag, limits the action range of the robot, etc.). But, removing the umbilical cable implies to improve autonomous system reaction to specific troubling events (obstacle detection and avoidance, energy management, essential sensors failure, etc.). In parallel, we developed Deep Learning based computer vision algorithms capable of automatically, locating and identifying fishes in videos for post treatment of recordings.

Tests of these novel tools revealed that diver and SAUV -operated video recordings showed little differences in describing overall structure of fish assemblages (both set of video were treated manually by the same operator). SAUV even appeared to be more appropriate to survey commercial species, which are probably more scared by the potential “human predators”. Similarly, Deep Learning algorithms were as good as humans to identify fish species but at a higher rate.

Full autonomy is still a hard point to reach for mobile robotics in harsh environment such as oceans, but combined with automatic video analysis, such tools are now necessary to succeed in ecosystems monitoring. While necessary hardware are now becoming available, greater effort needs to be made in algorithmics.