VIEWING THE UNDERWATER WORLD AT UP TO 18,000 FRAMES/SECOND

Grace C. Young
DPhil Candidate, University of Oxford Department of Engineering Sciences

Submitted to OCEANS '15 MTS/IEEE Genova Conference December 2014

EXTENDED ABSTRACT In May 2014, the Edgertronic company released a compact high-speed video camera that cost orders of magnitude less than its competitors. With the Edgertronic costing $5,000 and its competitors starting at $50,000, finally there was a camera not only capable of filming at up to 18,000 frames/second, but also compact enough (even in an underwater housing) to be operable by SCUBA divers and affordable to the oceanographic research community

Collaborating with the Massachusetts Institute of Technology, Northeastern University, Edgertronic, and the Sexton Corporation, we adapted the Edgertronic for underwater use in time for Fabien Cousteau's Mission 31 in June 2014. To our knowledge, it was the first time a high speed camera was used underwater. During the Mission, saturation divers filmed with the camera for 15 days straight, up to 8 hours/day, at 60 ft deep outside the Aquarius underwater habitat off the Florida Keys.

The result was video footage of marine animal behavior faster than can be seen with the naked eye, such as feeding, den-building, and retreating, viewable in ultra-slow motion. Figure 1 contains example images captured with the Edgertronic underwater. After Mission 31 the camera was used in laboratory environments to study the color-changing skin of cuttlefish and vortex shedding around a model seal whisker. There is significant potential for this technology to be used in further marine research, such as of cavitation bubbles and other ultra-fast underwater phenomenon of interest to the marine biology, fluid dynamics, and even arts community.

Using cutting-edge technology not meant for the oceans is not easy. Lighting was a big concern; with very high shutter speeds there is little time for light to reach the camera sensor and therefore bright lights are necessary, on-land and especially underwater. Lights from Orcalight and Light & Motion provided enough illumination for the filming. Another challenge was operating the camera from inside the underwater housing. We fit a battery pack and Raspberry Pi control system into the housing, so the camera could be operated independently, as a modular unit. We also tethered the camera back to the underwater habitat, where someone could change settings and push the trigger from a laptop.

A full presentation of this work will include underwater footage captured with the system and a discussion of the abilities and limits of the system, as well as future work needed to further develop the technology.

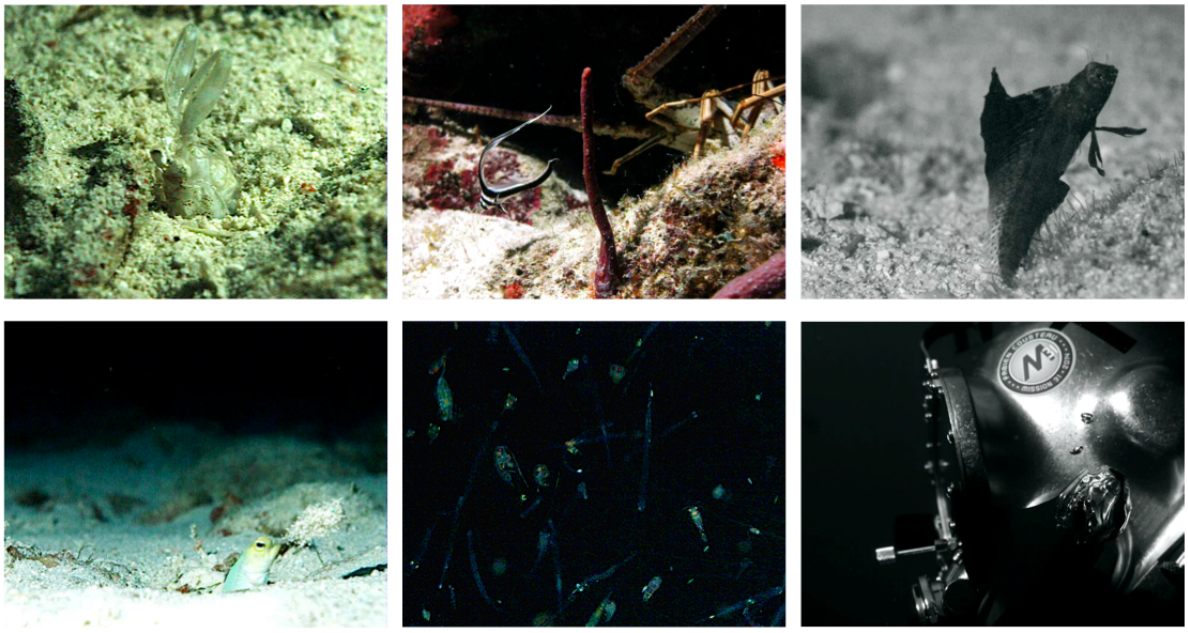

Figure 1: Stills captured with the Edgertronic underwater. From left to right: (top row) mantis shrimp lunges for its prey, spotted drum dances in front of lobster, sailfin blenny elongates its dorsal fin, (lower row) yellowhead jawfish ejects sand from its den, zooplankton and copepods cluster at night, and diver breaths air from diving helmet.

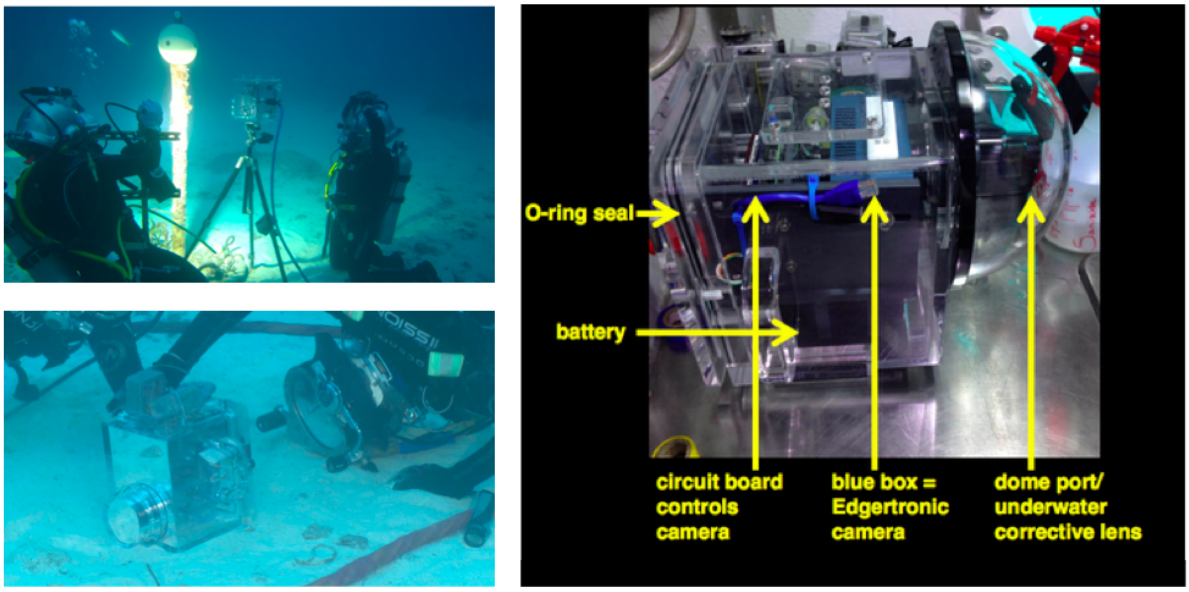

Figure 2: (left) Divers Grace C. Young and Liz Magee operate the Edgertronic camera 60 ft underwater outside the Aquarius habitat. (upper left) Magee shines bright light on Christmas tree worm while camera films worm closing at 2,000 frames/second. (lower left) Young adjusts camera low-to-seafloor to film camouflaged mantis shrimp. (right) Diagram of camera and housing.