A Smart Light Trap for Zooplankton Monitoring

Edmund Trinh, Elizabeth Zhang, Yu-Hao Cheng
Industry Mentor: Paul McElhany, NOAA
Faculty Mentor: Lih Lin

ELECTRICAL ENGINEERING
UNIVERSITY of WASHINGTON

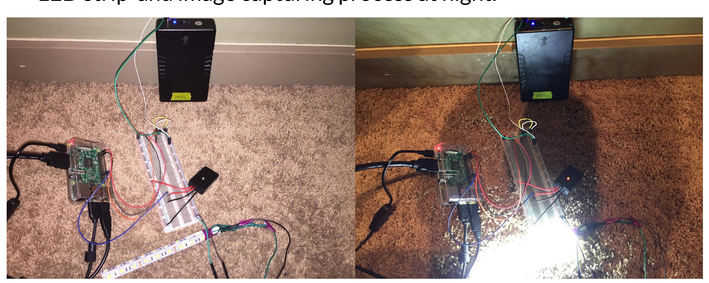
Introduction

- With the declining population trend of Puget Sound species, including Dungeness Crab, population analysis becomes important.
- We have developed an underwater camera system that can take photos of zooplankton using a floating light trap for capturing and imaging zooplankton species.
- The entire system must be economical (less than $1000 per unit) for mass deployment, waterproof to operate underwater, and camera and lens combination must be able to take photos of the zooplankton.

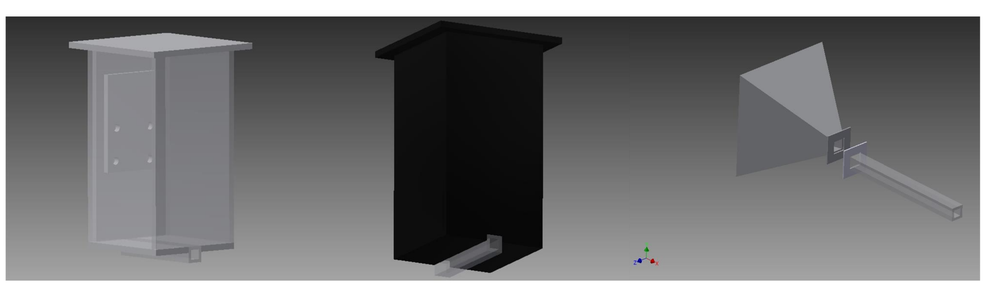
Dungeness Crab Megalopa (2mm), Adult Dungeness Crab (20-25cm)

Design & Methods

- Raspberry PI 3 Model B is interfaced with a programmable Baser Dart area-scan camera mounted on a 16mm focal length lens.
- C++ programming and bash scripting is used to control the camera.
- Pylon software package and OpenCV library are integrated into the program.
- Camera system is installed into a self-designed waterproof casing.
- Light sensing switch interfaced with Raspberry Pi GPIOs to trigger LED strip and image capturing process at night.



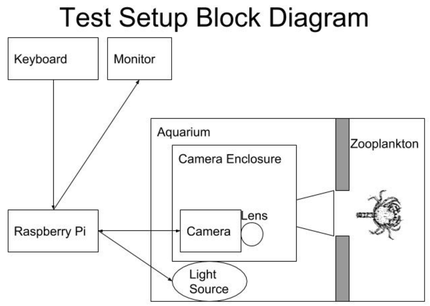
(a) LED strip off (sensor reading high light) (b) LED strip on (sensor reading low light)



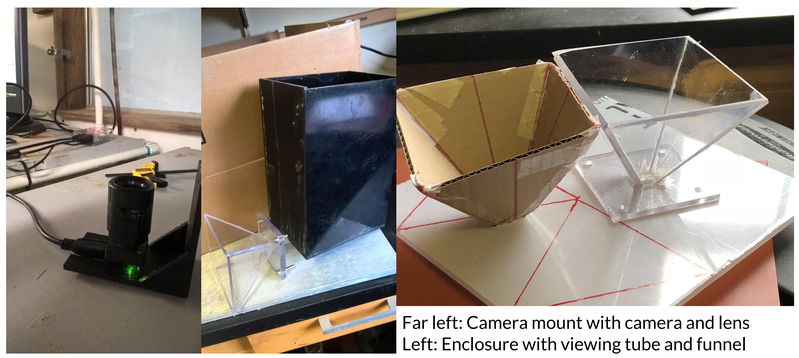
Autodesk Inventor models for camera enclosure, viewing tube, and collection funnel

Experimental Setup

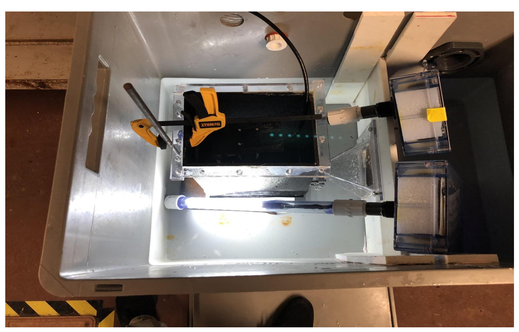
- Camera and lens mounted within enclosure
- Raspberry Pi, keyboard and monitor outside enclosure
- External light sources near enclosure
- Enclosure and funnel mounted inside plastic aquarium filled with seawater
- Aquarium is divided so entering plankton are forced to swim through the funnel towards the light



Laboratory setup with aquarium and monitor



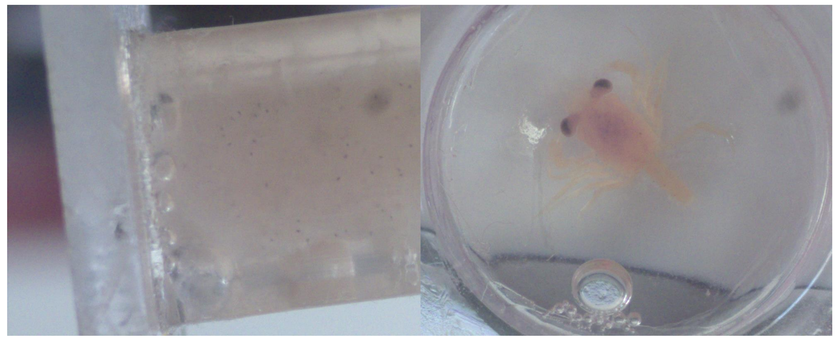
Far left: Camera mount with camera and lens
Left: Enclosure with viewing tube and funnel
Above: Funnel prototype and acrylic funnel



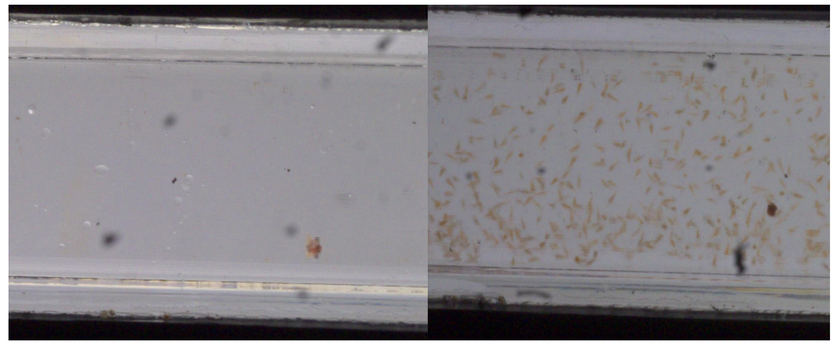
Aquarium setup consisting of the camera system, LED light strips and the sample zooplankton.

Results

- Camera can take an area of interest of 22 mm by 30 mm, with an adjustable aperture and a working distance of about 130 mm.
- Camera is capable of taking 15,000+ pictures with average saving time of 1.3 seconds per photo.
- Waterproof casing successfully encases system with minimal leakage.
- Light strip activates when surrounding light is dark, and turns off when surrounding light is bright.



Left: Camera image of preserved crab zoeae Right: Camera image of preserved crab megalopa



Left: Camera image of live Dungeness crab zoea (Artemia) Right: Camera image of live brine shrimp

Conclusion

- Camera and Raspberry Pi are sufficient for image acquisition onboard light trap.
- Off-board image processing could be added for easy recognition and counting of zooplankton species.
- Next steps include adding renewable energy sources (e.g. wind and solar) as well as creating a setup testable in the ocean.

References

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[2] S. Samson, T. Hopkins, A. Remsen, L. Langebrake, T. Sutton and J. Patten, "A system for high-resolution zooplankton imaging," in *IEEE Journal of Oceanic Engineering*, vol. 26, no. 4, pp. 671-676, Oct 2001.
[3] Basler AG. “C++ Programmer’s Guide and API Reference for Pylon.” Basler AG, 19 July 2017.
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