“See Urchin” Project Proposal

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Abstract

After spending time surfing, snorkeling, or swimming in the waters of Newfoundland, one can't help but to notice the beauty of the underwater ecosystems found along the coast. It is now possible to capture footage of these ecosystems with the use of Underwater Remotely Operated Vehicles. This project overview presents the steps taken toward designing and building a waterproof camera system with the resources available at the Marine Institute of Memorial University of Newfoundland. The report will also list and describe various types underwater footage, along with real-time video editing, and various types of still image editing anticipated with this project.

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1.0 Introduction

There are many steps to consider in underwater photography. This project presents the steps that have been achieved so far to challenge the complexity of underwater photography. Included in this report are the objectives for this camera. The report will cover the problems faced with underwater photography, the camera, and housing material selection. Also included is a description of the custom made components, their use, and how they were tested.

2.0 Project Objective

The purpose of this project is to capture underwater footage of ecosystems surrounding the coasts of Newfoundland. This will be done with the use of a remotely operated vehicle. The footage will be used to perform experimental work with real-time video editing and still image editing, such as underwater photomosaic and underwater time-lapse. The expected footage will be recorded near the shore in shallow waters around the Avalon peninsula during summer of 2018.

2.1 Underwater Photomosaic

Underwater photomosaics are created by overlaying photos of the seabed to capture an image of a large target. Originally, photographic mosaic mapping was used to record ancient shipwrecks in the Mediterranean Sea (Rebikoff, 1972). This technique is necessary since underwater photography tends to require a close range to the target to ensure good image quality. To experiment with photomosaic, images will be taken from a remotely operated vehicle with a camera facing down at the seabed. With the use of image editing software, the images will be assembled to provide an overall view.

2.2 Underwater Time-Lapse

A time-lapse is created by capturing repetitive images from a stable position at a constant time interval. Those images are then viewed at a rate faster than the interval, exposing longlasting movements that would not be noticed otherwise. The goal is to capture the movement of slow moving marine life in shallow waters.

3.0 Problem Description

3.1 Optics

When choosing a camera for underwater footage, it is important to consider the effects of light absorption. Since images captured underwater tend to have blue-green dominance, steps must be done to compensate that effect. Examples of this include the use a corrective lense to provide the camera with the correct amount of red pigment to balance the image, or the application of an external light source with the appropriate color to balance the image (Valentine & Rebikoff 1968). Another way to compensate is to modify the image after it is recorded. The IP camera chosen for the test can automatically balance the color with tone mapping.

3.2 Electronic Enclosure

There are many challenges when designing an electronic enclosure for underwater use. One method gaining popularity in the robotics industry is biomimicry, which is done by imitating elements of nature to achieve similar goals. The inspiration for the front camera housing comes from the complex internal structure of sea urchins. This design is made to distribute the water pressure evenly away from the camera module. This design was custom made with the help of 3D printing technology. Since 3D printers work in layers, shapes previously complicated to manufacture can be made with ease (Figure 1).

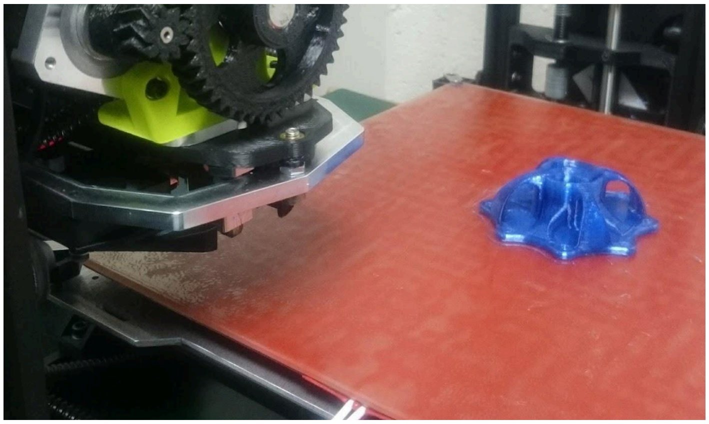


Figure 1 - Front face of enclosure on 3D printer be

3.3 Thermal Effects Housing

When selecting material for an underwater camera module enclosure, it is necessary to consider the effects of temperature change on the housing unit. During its use, the housing will be submerged in cold water, while the camera module produces heat. This can have a direct effect on the material chosen for the housing, and on the camera module itself.

4.0 Housing Design

The housing design is composed of four main components which work collectively to protect the IP camera module from water ingress. The enclosure is held together with the use of 8 sets of nuts, bolts, and washers, seen in Figure 3.

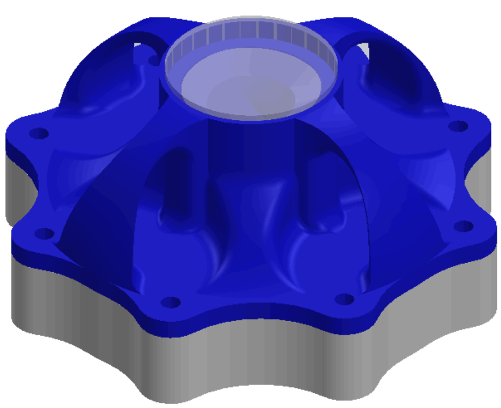
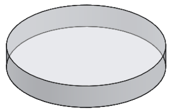
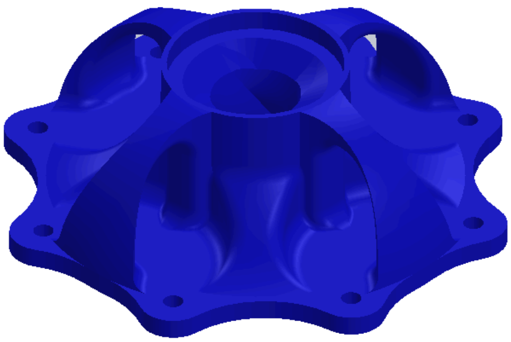


Figure 2: CAD drawing of Camera Housing

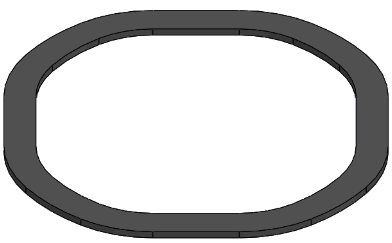
Figure 3: Front View of Camera Housing



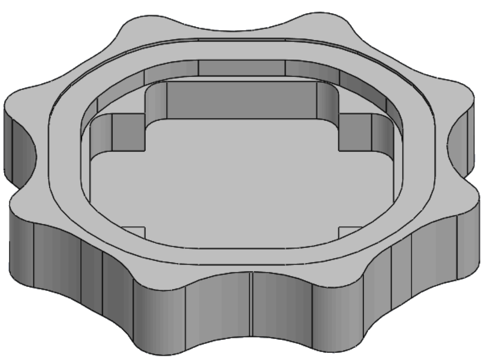
The clear polycarbonate lense allows the camera to view outside the enclosure. This component is made with the use of CNC milling technology. It is held to the front face of the enclosure with clear epoxy.



The front face of the enclosure is made with the use of Fused Deposition Modeling (FDM) 3D printing technology. It is made from Polyethylene Terephthalate (PETG) which is lightweight and rigid. Its rigidity makes the component less likely to deform due to water pressure, however PETG does not provide adequate layer adhesion. During the initial submersion test, water ingresse was noticed between the layers of the component. To prevent this, the component was covered in a layer of water resistant resin.



The gasket provides a sealed connection between the front face and the back side of the enclosure. It is made from synthetic rubber and is shaped to minimize the size of the enclosure.



The back side of the enclosure is made from High-Density Polyethylene (HDPE) with the use of a Computer Numerical Control (CNC) milling. This component holds the camera module board, and allows both power and communication cables to enter the enclosure. These cables are sealed with marine grade epoxy.

5.0 Heat Distribution on Housing

During the model tests, it was noticed that a significant amount of heat was produced by the camera module. Two experiments were performed to analyse the effect of heat on both the camera module and the housing. The first experiment was completed using a full scale replica of the front face of the enclosure, made from color-changing filament that reacts to change in temperature (Figure 4). The purpose of this experiment was to examine how the heat generated by camera module is distributed on the housing. The experiment indicated that the heat was contained within the gasket (Figure 5). The second experiment was done to verify if the camera module could be damaged when operating in an enclosed space for a large period of time. The camera was enclosed in the PETG housing and left running for 4 hours. No damage or deformation of the housing were noticed.

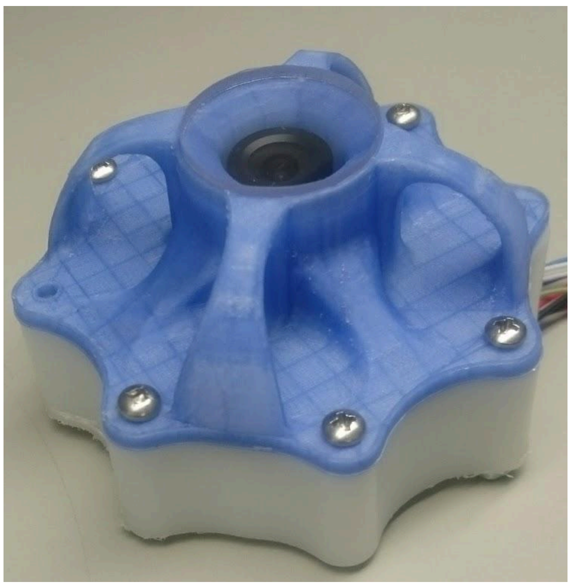


Figure 4: Outside view of color-changing material

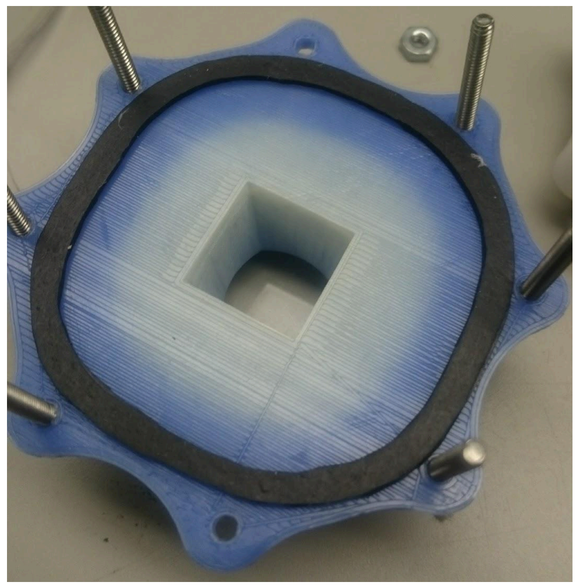


Figure 5: Inside of color-changing material view after test

6.0 Underwater Test

Once the housing was confirmed to be watertight, the tone-mapping function could be tested in the Marine Institute's acoustic tank. The tone-mapping function, included in the IP camera, will adjust the tone of the image by applying a color filter on the final stream to balance the blue-green dominance. Figure 6 and Figure 7 demonstrate a slight adjustment in color. The windows located in the acoustic tank are suspected of preventing the full effect of tone-mapping. Once the camera was directed outside the water, the red filter was noticeable (see Figure 8) until gradually balancing to original colors.

Figure 6: Camera initially submerged

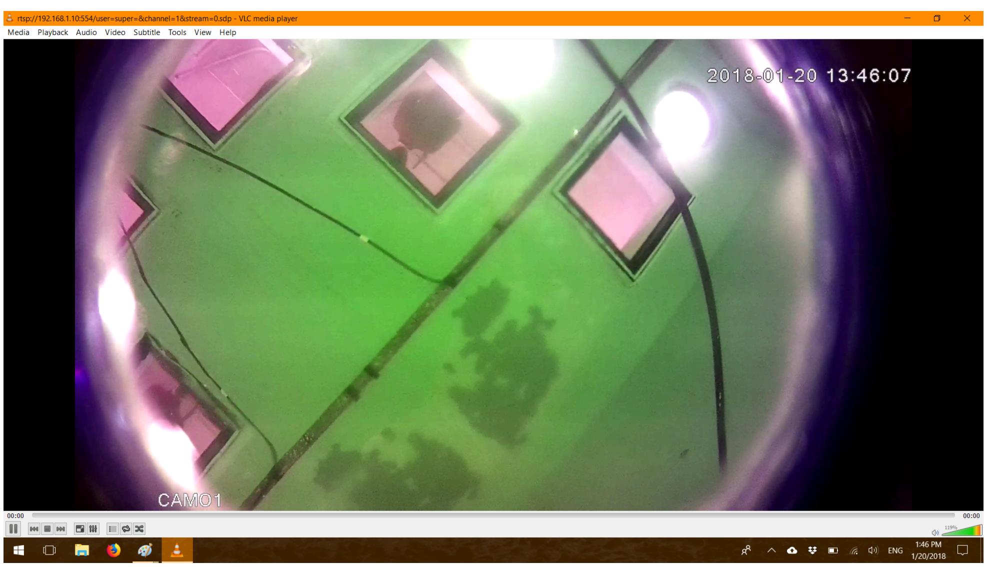


Figure 7: Camera after adjustment

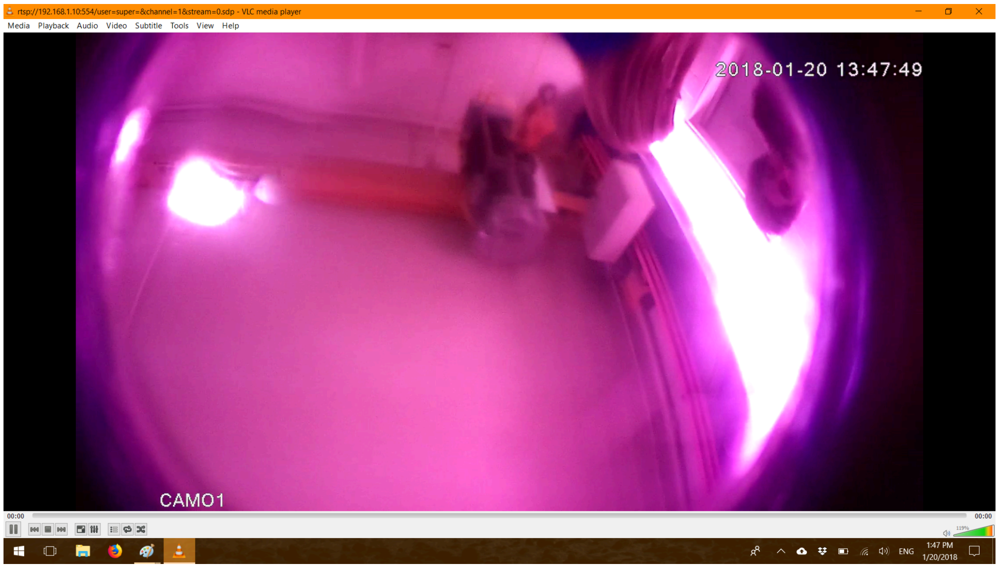


Figure 8: Camera directed outside water

7.0 Conclusion

After considering the factors which affect the performance of underwater cameras, there remains room for improving the quality of the image captured. As this project continues, adjustments will be made to allow this model to be used for photomosaic and time-lapse recording.

References

Rebikoff, D. (1972). Precision underwater photomosaic techniques for archaeological mapping Interim experiment on the Bimini “Cyclopean” complex . *International Journal of Nautical Archaeology,* 184-186.

Valentine, J M & Rebikoff, D. (oct., 1968). Photographic Underwater Exploration. *Oxford University Press on behalf of the American Institute of Biological Sciences, 18*(10), 967-968. Retrieved December 18, 2017.