University of Waterloo

UW2TT Lighting System

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1.0 Introduction

UW2TT is a University of Waterloo marine robotics team. The scope of the team is to build a Remotely Operated Vehicle (ROV) which will compete in the annual MATE (Marine Advanced Technology Education) competition. The focus of this report is to document the findings and options available to the team with regards to the on-board lighting system proposed for the vehicle. This report details several options and approaches to the open ended requirements the team has set.

2.0 Assumed Requirements

Due to the open-endedness of the project, several assumed requirements and constraints are posed.

Caveats:

1. **Buoyancy**: The lighting system as a whole shall be deemed neutrally buoyant as to not effect the tuning of the ROV.
2. **Intensity**: The system should provide adequate luminous intensity to the camera so that clear images may be captured.
3. **Cost**: The solution should be as cost effective as possible in order to allow for cost allocation to more critical subsystems.
4. **Environment**: RoHs compliancy would be beneficial.
5. **Depth Rating**: 2 meters required 10 meters desired.

3.0 Feasible Solutions

During the course of research several options and methodologies are being pursued. Detailed here are the most feasible solutions.

3.1 Integrated Lighting Control

Integration of the lighting system with the existing vehicle power supply provides for several features.

Positive

- Reduced maintenance checks since additional batteries are not required
- Availability to control items such as intensity and direction.

Negative

- Greater cost due to expensive *SEACON* or *IMPULSE* connectors
- Greater development duration due to custom design.

3.1.1 Traceable Lighting

A viable integrated lighting control option is to include a pan and/or tilt mechanism to external lights. Restricting the light distribution to the camera's instantaneous field of view allows for reduced power needs. Providing lights when and where needed increases the efficiency of the overall system. However, this type of system proves to be more complicated, increasing design and production costs.

3.1.2 Dispersed Fixed Lighting

Due to the Nature of the Pan and Tilt camera, a lighting area of 180 spherical degrees needs to be covered with even lighting. Given omni-directional vision is desired in low light conditions, lighting arrays need to be placed in each possible facing direction. Provided the lighting is integrated, LEDs pointed in different areas can be turned on as the camera enters their field of luminosity.

3.2 Independent Lighting

Two options exist for extrinsic lighting. It is possible to design a self contained, neutrally buoyant light. The second option is to purchase a pre fabricated diver's flashlight and ballast it in order to meet specifications. Both options will be investigated in this section of the report

Positive

- Modular, and portable
- Custom configurations are easily created

Negative

- External power supplies require frequent replacement.

3.2.1 Custom Designed Lighting

A custom designed lighting solution that is externally mounted is often desired because of its modularity. Since there are no wired connections to the ROV, leaks are minimized. Replacing and maintaining the system becomes simple because of the short assembly time. Explicit lighting control may still be available in this area via short range wireless communications. Individual lights may be dimmed in order to create the desired light distribution.

3.2.2 Depth Rated Flashlight

A more cost effective solution uses a prefabricated flashlight which is rated for underwater use. This solution would illuminate a fixed area over a course of time, and is the best solution for a low time budget project. The recommended dive flashlight was chosen based on performance, size and cost. The *Underwater Kinetics SL4 eLED* light has a runtime of approximately ten hours as seen in Figure 1.

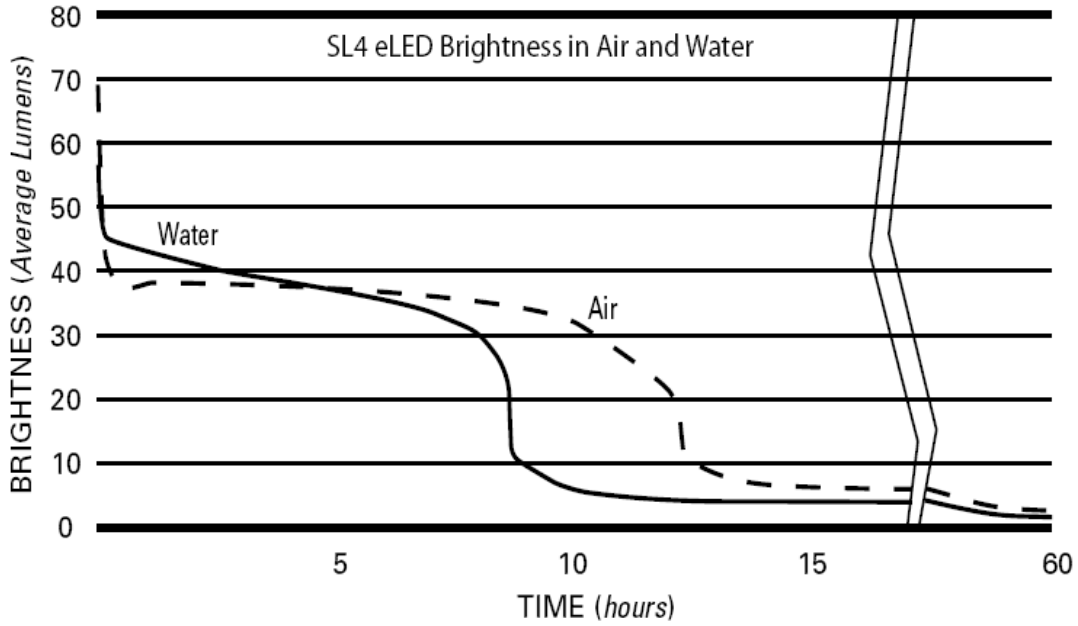

Figure 1- *UK SL4 eLED* Performance[1]

The above plot shows how the lamp fairs with regards to duration of brightness. When submerged in water the light tends to be brighter initially, and then decrease its brightness. When in air, there is a slightly reduced brightness for a greater duration of time.

The shape and functionality of the light has advantages over other dive flashlights such as the P*elican Nemo* models[2]. The light is significantly shorter, and promises more secure mounting due to its flat faces. Figure 2 details the switch, positioned in a way that is unlikely to interfere with mounting. The comparable P*elican* lights function in a twist-on fashion, proving less flexible when mounted against flat or cylindrical surfaces.

Figure 2 - Left View of the *UK SL4 eLED* Light[3]

An estimated three such units would be required to provide sufficient lighting for the camera. Each lamp normally emits 35 lumens on average; three units would emit approximately 105 lumens. Each flashlight produces a brightness 10-15 lumens greater than the floating flashlights used on the ROV previously* [4].

*based upon an average handheld lantern light bulb of similar size

4.0 Recommendations

Based on the above possible solutions, an integrated lighting solution would be best as it exemplifies greater effort in research and design. Specifically, the fixed integrated lighting control option. It promises the best lighting with the most efficient power operation.

However, from a cost standpoint, the pre-fabricated solution is best. It requires a minimal concept to final design timeline, allowing for implementation within weeks rather than months. Due to the low initial cost of this solution, it also serves as the best financial option.

5.0 References

[1] SL4 eLED Dive Light Manual, Underwater Kinetics, Tuesday, January 15, 2008 <http://www.uwkinetics.com/files/56/SL4eLEDinstr.pdf>

[2] Nemo Series Lights, Pelican Products Lights, Tuesday, January 15, 2008 <http://pelican.ca/lights_category.php?Category=Nemo&LampType=%&Submersible=%&New=%>

[3] Sunlight SL4 eLED®, Underwater Kinetics, Tuesday, January 15, 2008 <http://www.uwkinetics.com/products/detail.php?ProductID=9&cat=6#colors>

[4] Reflectalite Halogen Light Bulbs, Tuesday, January 15, 2008 <http://www.reflectalite.com/halogenpage.html>