Project Title: Underwater Stereo Cameras for 3D Reconstruction
Project Manager: Aaron Marburg
Requested By: Aaron Marburg, 29 July 2016
Approved By:

Change Request #002

Title: Replace Subconn 8-contact ethernet bulkhead with 13-contact bulkhead.

Technical Description:

The original MaSCOT design specified an 8-contact Subconn ethernet bulkhead connector (Figure 3a) as the only wet connection to the MaSCOT camera enclosure. This connector was selected in part because it allowed reuse of the three existing Subconn/Falmat gigabit ethernet cables originally purchased for Sexton subsea cameras owned by the Stewart lab. The MaSCOT design replicated the physical interface of those cameras, with the 8-pin connector on the web camera unit providing both gigabit ethernet and 802.3af/at Power over Ethernet (PoE) over a single 8-conductor twisted pair Cat-6 cable (Falmat XtremeNet P/N FM022208-08).

The Sexton subsea cameras consume approximately 7.7 W. The 802.3af standard allows for 15.4 W of DC power at the injector end (less at the device end due to I^2R losses in the cable), while the 802.3at extends this to 25.5 watts. The estimated power budget of MaSCOT is 46W: 14W for the Jetson TX mainboard, 2W for the SATA SSD and Zed camera, and 15W for each of the two BlueRobotics lights at full brightness. These approximate values were subsequently validated with bench testing, although the consumption of the Jetson TX1 is highly variable with computational load.

To accommodate this increased power requirement, MaSCOT was designed around a non-standard 60W PoE injector/splitter pair. High-power PoE systems, while not compliant with an existing IEEE standard, are increasingly available from wireless manufacturers as they accommodate the power requirements of extended range, multi-band and multi-radio/MIMO enterprise wireless WLAN systems. The splitter installed in MaSCOT includes power regulation to 19VDC which can be accepted natively by both the Jetson TX1 and the BlueRobotics lights. The PoE system has limited surge capacity and it was possible to reboot the Jetson TX1 by turning both lights on suddenly, but implementing a smoothly ramping turn-on/turn-off procedure in the companion board resolved this problem.

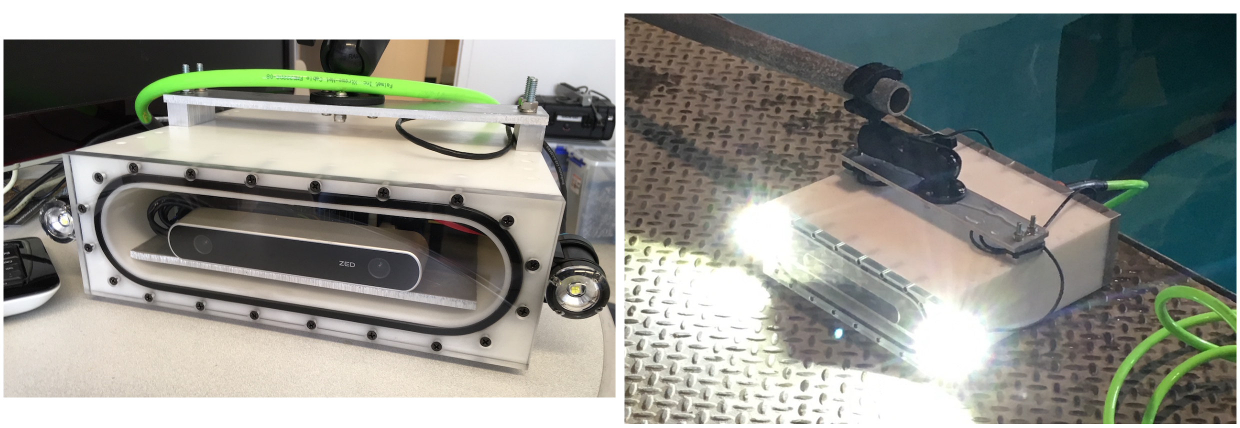
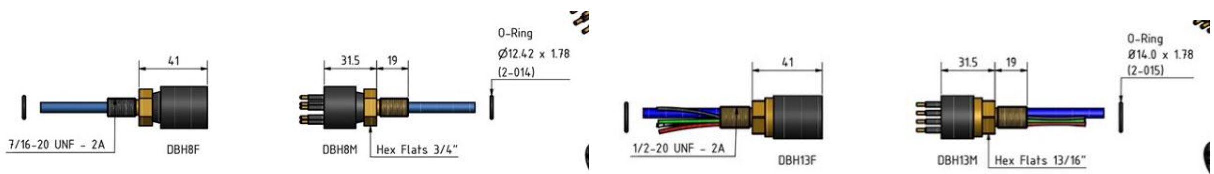


Figure 1: Two images of MaSCOT during testing.

Under testing, it was determined that two BlueRobotics lights at a nominal 1500 lumens apiece produced insufficient light for many in-water testing scenarios, resulting in low contrast and blurring in the video images (Figure 2). The simplest solution would be to add additional lights. As the BlueRobotics lights are inexpensive and compact, four more light units could be added trivially to the existing MaSCOT package. Doing so, however would exceed the power capacity of of the PoE-based power system.

(a) Image at 3-4m   (b) Image at 1-2m

Figure 2: Two images from testing in the OSB pool with part of an OOI shallow profiler. Some of the differences in apparent brightness can be attributed to auto-exposure controls in the camera.



(a) 8-contact   (b) 13-contact

Figure 3: Subconn Ethernet bulkhead connectors.

The proposal is to replace the 8-contact ethernet-only penetrator (Figure 3a) with a 13-pin penetrator (Figure 3b) which adds four additional conductors (and a shield connection) to the eight ethernet pins. The additional pins (at 4A nom each) can then used as an independent power bus. Notably, this connector is also used on the Adaptive Monitoring Package (AMP) and TUNA WEBS for similar purposes (ethernet plus power).

The final configuration will have six BlueRobotics LED lights, with a nominal power budget of $\sim 105W$. The power conductors will supply 2.1A at 48VDC nom. from the topside. The BlueRobotics lights will take up to 48V (less cable losses) directly, but the Jetson requires a DC/DC converter to generate 9-18VDC. The addition of the DC/DC converter also provides some amount of power bus isolation between the two units.

This would necessitate the following changes:

- Replace the Subconn 8-contact DBH8M bulkhead with a 13-contact DBH13M bulkhead. The DBH8M is threaded into the aluminum MaSCOT endcap with a 7/16-20 UNF thread, while the DBH13M has a 1/2-20 UNF thread. If the 7/16-UNF thread has been cut to spec, there should be sufficient material left to re-drill and re-tap to 1/2-20.

- Add four additional BlueRobotics LED lights, mounted adjacent to the existing lights. These additional lights will be daisy-chained to the current lights using the daisy-chain penetrator provided by BlueRobotics. This will maintain the existing MaSCOT design of having two independent left-right light banks, but will require no additional penetrations through the MaSCOT endcap.

  As the BlueRobotics penetrations are DIY, putting these penetrations in the light units rather than into the main MaSCOT housing reduces the risk if they should fail (water intrusion to light electronics rather than Jetson/Zed). This is contingent on being able to chain three lights together, which depends on the current-carrying capacity of the BlueRobotics cabling.

- Purchase of a new wet cable at ~ 50 ft incorporating the 13-pin Subconn connector.

- Replace the PoE injector at topside with a deckbox which terminates the wet cable into Gigabit ethernet (as a punchdown jack?) and power leads. This deck box would incorporate the main power supply for MaSCOT, a 48V 150W+ AC-DC converter.

- Replace the PoE splitter in MaSCOT with a 12V output, 30W DC/DC converter. The proposed unit has a similar, if slightly smaller physical envelope than the existing PoE splitter.

- Add fuses inside the enclosure for the two BlueRobotics light chains.

Table 1: Cost Estimate

Description	**Cost (ex. tax)**	**Source**
Subconn DBH13M bulkhead, locking ring, dummy plug.	\$256	Quote, Ocean Innovations
DB13IL connector on 50m Falmat FM022208-10 cabling	\$784	Quote, Ocean innovations
BlueRobotics Led Lights (Qty 4)	\$400	BlueRobotics online store.
CUI PYB30-Q48-S12-U 12VDC/30W DC/DC converter	\$52	Digikey
TDK-Lambda LS150-48 48VDC/150W AC/DC power supply (or equiv)	\$42	Digikey
Misc topside supplies, enclosure, fuseblocks.	\$150	Estimate
Labor: Machine shop	\$100	Estimate
Labor: Robert Karran, 4 hours	\$60	Estimate
Total	\$1884	

Change Request Impacts

Scope	As the first phase of MaSCOT development is complete, this change does not affect the original SEG IRD project scope or schedule.
Schedule	As above, this change is in response to the results of the original MaSCOT project, and does not affect the schedule of the original MaSCOT project, which is in its reporting phase. Mechanical and electrical re-work can be performed on an as-available basis by Robert Karran with support from the UW-APL machine shop.
Cost	The known expenses for a new bulkhead, wet cabling, etc. are well known and fit within the contingency remaining in the MaSCOT budget. If the existing aluminum endcap cannot easily be re-tapped for the larger penetrator, the costs for a new alu. endcap may exceed that contingency, making this change infeasible.
Quality	Enables MaSCOT to produce better video images. As the lights are dimmable, there is no risk of producing a light package that is "too bright."
Risk	Mechanical risk from re-working and using the reworked alu. endcap. Increasing the number of BlueRobotics light penetrations increases the opportunity for leaks, esp. with the DIY BlueRobotics penetrations.
Alternatives:	Power lights through independent, parallel power cable(s)? This would require either a second penetration into the MaSCOT housing or a wet splice of the power cabling to the lights.

Decision/Rationale