Monterey Bay Aquarium Research Institute

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ROV-VR Camera Statement of Work

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1 Introduction

This document intends to outline the expected body of work for VRTUL and the Sexton Company, designing a system under funding for the ROV Virtual Reality project at MBARI to help achieve the goal of bringing virtual reality to the deep oceans within and around the Monterey Bay aboard the ROV Doc Ricketts. This project intends to field a new multi camera system aimed at collected video data to facilitate 3D Virtual Reality products for outreach and scientific observation.

1.1 Background

MBARI has been deploying Remotely Operated Vehicles (ROVs) in the Monterey Bay for over 30 years. As an institute, we contribute part of our success to our rapid access to this amazing resource. Deep, biodiverse environments offer endless inspiration to both scientists and the general public. We have identified that virtual reality technologies are quickly becoming a familiar and acceptable part of the media landscape. At its best we believe that virtual reality can emplace people like few other tools. To that end, we aim to bring scientists and others to the deep parts of the Monterey Bay, where few can ever go on their own. This project has been an effort since 2017. We have investigated the VR landscape, understood the limitations, and identified partners that match our own goals.

1.2 Scope

To that end, MBARI is looking for partners to help bring virtual reality to the deep seas, through development of a custom video collection system that can integrate with our large working-class ROV, Doc Ricketts. Vendors interested in providing a system should expect a high level of design involvement and oversight by MBARI personnel.

We are excited that VRTUL and Sexton have expressed interest in moving forward with a custom design for MBARI. Scope of work is to build a camera system that meets the defined set of requirements set forth by MBARI, subject to you review. VRTUL/Sexton are expected to design,

build and calibrate the system, with integration and testing done with MBARI personnel. See Figure 1 for a proposed work breakdown structure.

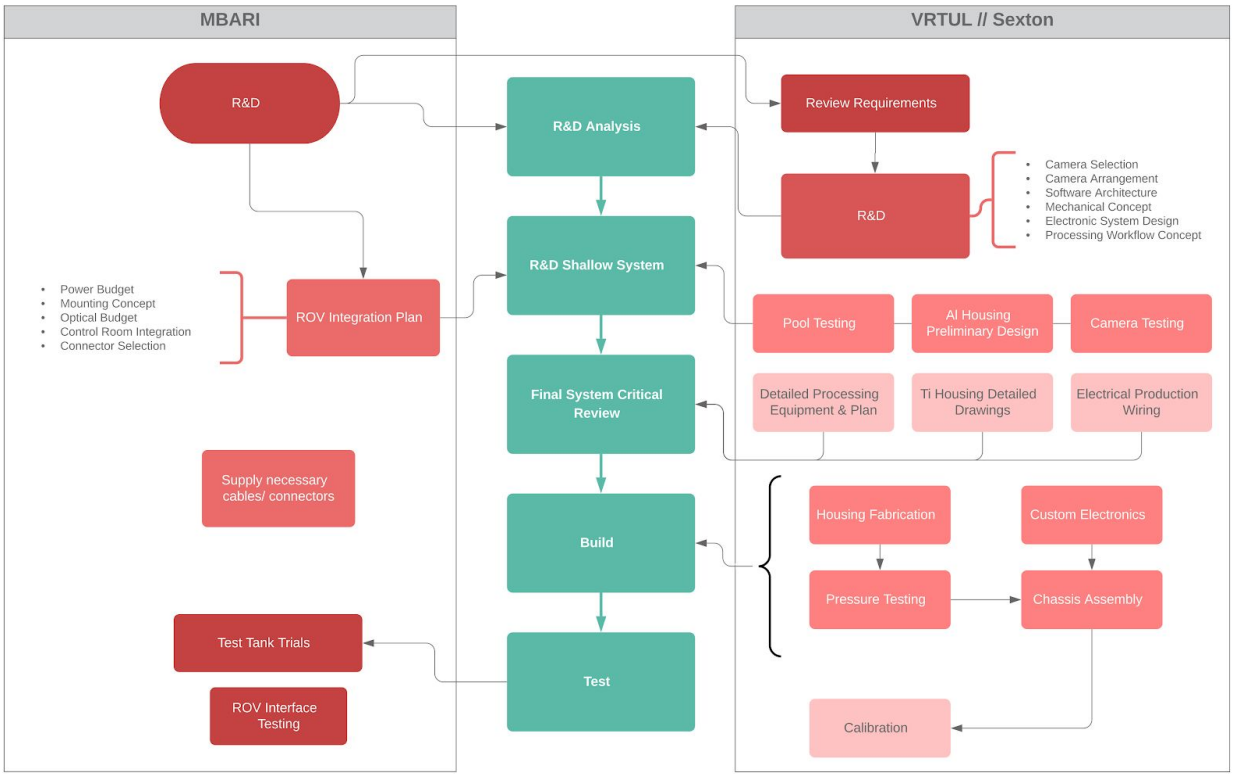

Figure 1: Work Breakdown Structure

2 References

The following links provide some introductory information regarding the ROV

- ROV Doc Ricketts Specifications[1]

The ROVVR team at MBARI:

- Project Manager: Ben Erwin berwin@mbari.org
- Principal investigators:
    - Heidi Cullen hcullen@mbari.org
    - Steven Haddock haddock@mbari.org
    - Kakani Katija kakani@mbari.org
- Project Engineer: Eric Martin emartin@mbari.org
- Research Technician: Susan Von Thun svonthun@mbari.org

[1] https://www.mbari.org/at-sea/vehicles/remotely-operated-vehicles/rov-docricketts-specifications-2/

3 Requirements

Please see the appended requirements document for design guidelines of the system.

3.1 Tasks

We would like to frame this development if possible as a custom product under development by VRTUL and Sexton for MBARI. MBARI has a great amount of experience in developing deep water housings, including domed camera housings, and can offer input if required.

The following items are tasks expected to be completed by VRTUL / Sexton:

- Design, production, and pressure testing of a multiport underwater camera housing.
- Topside equipment selection and packaging for equipment rack installation.
- Software development to produce live VR and stream recording.
- Training for use and service of the system.

MBARI tasks during development will include:

- Design review
- ROV integration plans
- Cabling and connectors as required for rov integration and tank testing.
- Specifying fiber optic components for the delivered system.
- Support for tank trials at MBARI's test tank.
- Support for at sea testing.

3.2 Deliverables

- Camera System that meets requirements.
- Topside processing and live display VR components.
- Topside with near-line storage for video.
- Field service kit.
- Adequate spares of custom designed components and parts lists for off-the-shelf parts.

The acceptance of the system will follow testing at the MBARI test tank, with field testing conducted by MBARI staff.

3.3 Schedule

As laid out in the work breakdown structure, MBARI expects VRTUL/Sexton to submit to three small reviews along the development path: a Concept Review, Preliminary Design Review, and a Critical Design Review.

- Concept complete by the end of January, 2019
- Preliminary design by mid-February, 2019
- Critical Design by mid-March, 2019.
- Demo unit late-May at the MBARI test tank, with extended testing and integration with the ROV in June.
- July and August both have research cruises on the R/V Western Flyer headed by Principal Investigators of this project, Steven Haddock and Kakani Katija.

We respect that this is an aggressive schedule, however, we feel that if production and calibration could be complete by May, we would be well positioned to demo the system sufficiently for use at the end of summer.

3.4 Design Guidelines

3.4.1 Requirements

System shall:

- Be capable of recording multiple simultaneous live video streams.
- Be capable of synchronizing multiple video streams.
- Be capable of recording in necessary quality for best experience.
- Recorded video allows for data analysis.
- Be capable of recording simultaneously with live-feed.
- Be capable of providing live panoramic 3D feeds to a Virtual Reality headset.
- Be capable of filming content in the region illuminated by the ROV.
- Have cameras optically spaced to allow for near human inter-ocular scaling.
- Withstand pressures consistent with all ROV Doc Ricketts operations.
- Integrate with standard ROV electro-optical interfaces.
- Be capable of time synchronization to ancillary data sources.

3.4.2 Design Derived Requirements

- Camera shall use multiple, best in-class (4k or better) cameras to provide image angles appropriate for gathering sizing data after calibration.
- Camera selection shall maintain the maximum allowable housing form factor. See Design Constraints.
- Depth of field of each camera must start at minimum distance of 0.5m from the camera and extend to 10m.
- Communications shall use a fiber optic solution for video signal transmission, and must be powered from an ROV DC power source.
- Stitched product field of view will encompass a panoramic field of view.
- Recording system shall allow for a “Per-dive” storage requirement of at least 2 hours (This does not need to be “on-board camera” storage).
- Video must remain in format that allows for processing using common editing and processing toolchains. Open source protocols are preferred.

3.4.3 Environmental Requirements

System shall:

- Operate in ocean depths of up to 4 km.
- Operate in external temperatures of 2° to 35°C.

3.4.4 Operational/ Maintenance Requirements

- Entire system must be maintainable by MBARI personnel, which includes the knowledge and ability to repair non-functioning items in the subsea housing. Alternatively, a service life of 3 years must be guaranteed by any 3rd party.
- A contracted company will recommend high quality stitching workflows, and assist in training MBARI personnel in creating final production stitched video for use in outreach.
- Calibration of cameras will be reproducible and appropriate for both real-time and post-production workflows.
- Data will be stored with the MBARI ITD department in compliance with current standards for opportunistic video collection.
- Routine operations do not require internal access to the subsea components.

3.4.5 Design Constraints

- Fit within space allotted on Doc Ricketts. System shall not exceed 9.125 inches in outer diameter, and not exceed 15 inches in length.
- Camera shall run electrically via a Seacon MinK-10 connector @ 24VDC/<2A with RS-232/485, a Seacon MinK-10L connector @ 110VAC/<10A with Ethernet, or both.
- Camera system must transmit each video stream optically via standard CWDM wavelengths in the following ranges: 1350-nm, 1370-nm, 1470-nm, 1490-nm, 1510-nm, 1530-nm, 1550-nm, 1570-nm.
- Optical fiber connectors must be Lancer ST fiber connectors (PN# 500-BST-S1-B02-000)
- Top side recording and distribution equipment (excluding real time stitching computer) must be 19” rack mountable format.

3.4.6 Other Constraints

- None at this time.

3.4.7 Interfaces

- System shall be capable of remotely interfacing to each camera, RS-232, RS-485, and Ethernet are supported communication protocols on the ROV. Alternatively, a custom interface can be provided through the fiber optic connections mentioned in Design Constraints. Software GUIs must allow for basic adjustments (white balance, exposure, ISO, etc.) and operation of each camera.
- Real-time viewing software must be quickly accessible and easily started.

4 Monitoring / Compliance

MBARI is hopeful that VRTUL/Sexton can provide a complete system. We ask that you view the three reviews as opportunities for us to provide comment and steer the project so that we can meet goals effectively. The concept review, in particular, should be a place to revise requirements as necessary. VRTUL/Sexton should not expect to have to be in person for any of these reviews, but we do expect final delivery to have some presence during initial tank testing and system verification.

The only compliance/safety measure that we expect to see as part of this design are copies of the subsea housing pressure testing reports.