901209 Imaging for Mid-water Autonomous Platforms Camera and Lighting Systems Design Requirements

DRAFT

13AUG14 – rev. E. Added sensor list. Mrc
18AUG14 – rev.F. Added light dimming, file naming requirement. Mrc.
19AUG14 – rev.G. Removed ECO Puck. Mrc.

1. Image Capture.

1.1. The camera system is to be mounted on an AUV and used for recording visual transects in an ocean seawater environment.

1.2. Capture format. The imaging system must capture in a progressive scan format with a minimum resolution of 1920 x 1080 4:2:2 format at 10 bits at 60 frames per second or greater (1080P 60). NOTE: The design plan is to initially capture in 2k format (2048 x 1080 progressively scanned at 60 frames per second), and it is desirable to migrate to 4k format (4096 x 2160) when 4096P 60 video recording is available.

1.3. Camera Shutter. The camera system must include the ability to set the exposure duration (shutter) at 1/120 and 1/240 second exposure time.

1.4. Camera System.

1.4.1. The camera must be a Sony F-5 or F-55 Cine Alta camera with a DIN “super 35” image format.

1.4.1.1. Imager size: Bayer array imager 24 x 12.7mm (27.1mm diagonal).

1.4.1.2. Imager aspect ratio: 1.89:1 (17:9).

1.4.1.3. Imager resolution: 4096 x 2160.

1.4.1.4. Lens mount: PL

1.5. Optical System.

1.5.1. Performance requirements. All requirements are for the camera system submerged in clear seawater.

1.5.1.1. The imaging system aspect ratio is 16:9.

1.5.1.2. The dome port and adapter optics must have the required spatial resolution (MTF), and minimized chromatic aberration across the full imaging area such that the overall camera and optical system limiting resolution is the 4k camera imager and lens resolution and NOT the dome port and adapter optics.

1.5.1.3. The Horizontal viewing angle must be greater than 80 degrees and less than 100 degrees.

1.5.1.4. Depth of Field (DOF). The depth of field must resolve millimeter size objects across the range of 10cm to 2.5 meters distance from the front surface of the optical dome port. See appendix 1.

1.5.1.5. The visual area of highest importance is approximately 0.5 meters from the front surface of the optical dome.

1.5.2. The camera lens must be a Sony SCL-P11X15 lens set to 11mm focal length. There is no dynamic lens control requirement. *Note: There is a possibility that the lens specification may change to the Arri/Zeiss 12mm T2.1 standard prime. Final lens determination will be made before the detailed optical design starts.*

1.5.2.1. Calculations show the lens can be set to F5.6 and the lens object focus distance can be set to 0.8 meters (31.5 inches) to meet the depth-of-field requirements.

2. Lighting System.

2.1. Functional Requirements

2.1.1. The light bars must hold 4 DSPL Sealight sphere near the nose of the AUV, facing forward. Note: approximate scene illumination is 3600 Lux.

2.1.2. It is desirable that the light interface support light dimming.

2.1.3. The lights must be mounted in a position that minimizes backscatter and glaring.

2.1.4. The bars light must survive or be easily replaceable in case of a collision with the ship or other object.

2.1.5. The light bars must have a shape that minimizes the risk or entanglement with kelp, jellies, or lines.

2.1.6. The drag from the light bars must not destabilize the AUV when operating a low speed (0.5m/s).

2.1.7. The light bars must be easily mounted on, or removed from, the AUV.

2.1.8. The lights must be connected to a power source inside the AUV (or in the imaging payload).

2.1.9. The light's cables must be protected, and securely attached in a way that minimizes drag.

2.1.10. Is it desirable that the lights be dimmable using software control.

2.2. Design Derived Requirements

2.2.1. The lights must be mounted in a rectangular pattern, approximately 21" x 42" and face forward.

2.2.2. The light must be mounted as far forward as possible (while still meeting requirement 2.2.4).

2.2.3. The bars must flex, or have a weak link that bends or break in case of a collision with the ship or other object, in order to avoid damage to the lights or to the AUV.

2.2.4. The light bars must be swept back at a 30 degree angle minimum and have no sharp corners where a line or other object could catch, when the AUV is moving in the forward direction.

2.2.5. The bars must be strong enough to resist minor hits that occur during handling on the ship.

2.2.6. In case the bars break, the lights must remain attached to the AUV.

2.2.7. The bars must be attachable both vertically and horizontally.

2.3. Operational/ Maintenance Requirements

2.3.1. Light bars must be mounted easily on the AUV, without special tools.

2.3.2. When mounted on the AUV, the light bars must leave the AUV's top fairing accessible.

2.3.3. In case of damage to the light bars during transit or launch, they must be repairable on the ship within 10 minutes.

2.3.4. Design Constraints

2.3.5. The weight in water of the light bar must not exceed xx lbs.

2.3.6. The weight in air of the light bar must not exceed xx lbs.

3. Image Recording, Annotation and Retrieval.

1.6. The AUV transecting system must maintain the current image data processing and video annotation chain OR create a new processing chain that can be executed with a similar degree of complexity and effort. The current system uses the standard video data load path into MBARI's video annotation and archival operation. Tapes are moved to the video lab and played back using the VARS annotation system. Instrument data and screen captures are automatically transferred back to the shoreside expedition database. Video tape annotation data is combined into the data base with the CTD and ACM (Acoustic Current Meter) distance traveled data. Deck control is from VARS using the tape players *remote* interface (RS-422 or RS-232).

1.6.1. The video records must include SMPTE UTC timecode data that is synchronous with the environmental instrumentation data.

1.6.2. The video transect video file records must be named with the UTC date in ISO 8601 format.

1.7. The image must be recorded in a progressive scan format with a resolution of 1920x1080 4:2:2 format at 10 bits at 60 frames per second or greater (1080 60P). Note: The current design plan is to initially capture in 2k format (2048 x 1080

Progressively scanned at 60 frames per second) and record using an Apple ProRes 422 (HQ) 10 bit CODEC).

1.8. CODEC. The image must be processed by the coder/decoder (CODEC) in the 1080 60P 4:2:2 10 bit format. It is preferable that the CODEC is based on the H.264/AVC or an equivalent standard.

1.9. The recording format and recording method must record for a minimum of 11 transects of 330 meters at one knot or about 120 minutes. Note that if the AUV speed and the frame rate increases then the minimum required recording time goes down (the amount of data remains the same).

1.10. Data download time must not exceed Dorado AUV battery charging time (~5 hours).

1.11. The image archival and retrieval method must support conformance with MBARI's data embargo policy.

2. Environmental Instrumentation.

2.1. The Dorado camera payload must include and provide for simultaneous operation with the following environmental sensors. The data must be available as part of the standard AUV data load path and be accessible to VARS. The data must be time-stamped synchronously with the ADVL and recorded video data.

- 2.1.1. SBE 25plus Sealogger CTD Board Set
- 2.1.2. SBE4C conductivity sensor
- 2.1.3. SBE 5 pump and TC duct
- 2.1.4. 2x SBE 43 polarographic oxygen sensors and ducts
- 2.1.5. Transmissometer (25 cm)

2.2. ADVL (acoustic Doppler velocity log) data is required for knowing the total distance traveled through the water column. This data must be part of the standard AUV data load path and be accessible to VARS.

3. Physical Requirements.

3.1. Operate at specific depths from 50 meters to **1500 meters** performing 11 individual transects of 330 meters length.

3.2. Operate in an ambient environment from 4 to 25 Degrees C.

4. Control and Operation.

4.1. Meet the weight, balance, interface and configuration requirements of a Dorado AUV payload such that extraordinary measures are not required for routine AUV operation.

4.2. Be installed and removed from the AUV Dorado with a minimum of effort, consistent with similar nose cone payloads. The payload will be exchanged at least once per month.
4.3. Dorado must maintain a constant speed of about one knot (50 cm per second) relative to the water column. It's possible this speed can be increased to two knots (100 cm per second) if the image capture rate is increased to 60 or 120 frames per second.
4.4. Dorado must maintain a constant depth during a commanded transect to within +/- 1 meter.
4.5. Dorado must maintain a constant pitch angle during a commanded transect of +/- 10 degrees.
4.6. Dorado must maintain a constant roll angle during a commanded transect of +/- 20 degrees.

5. Software Interface.

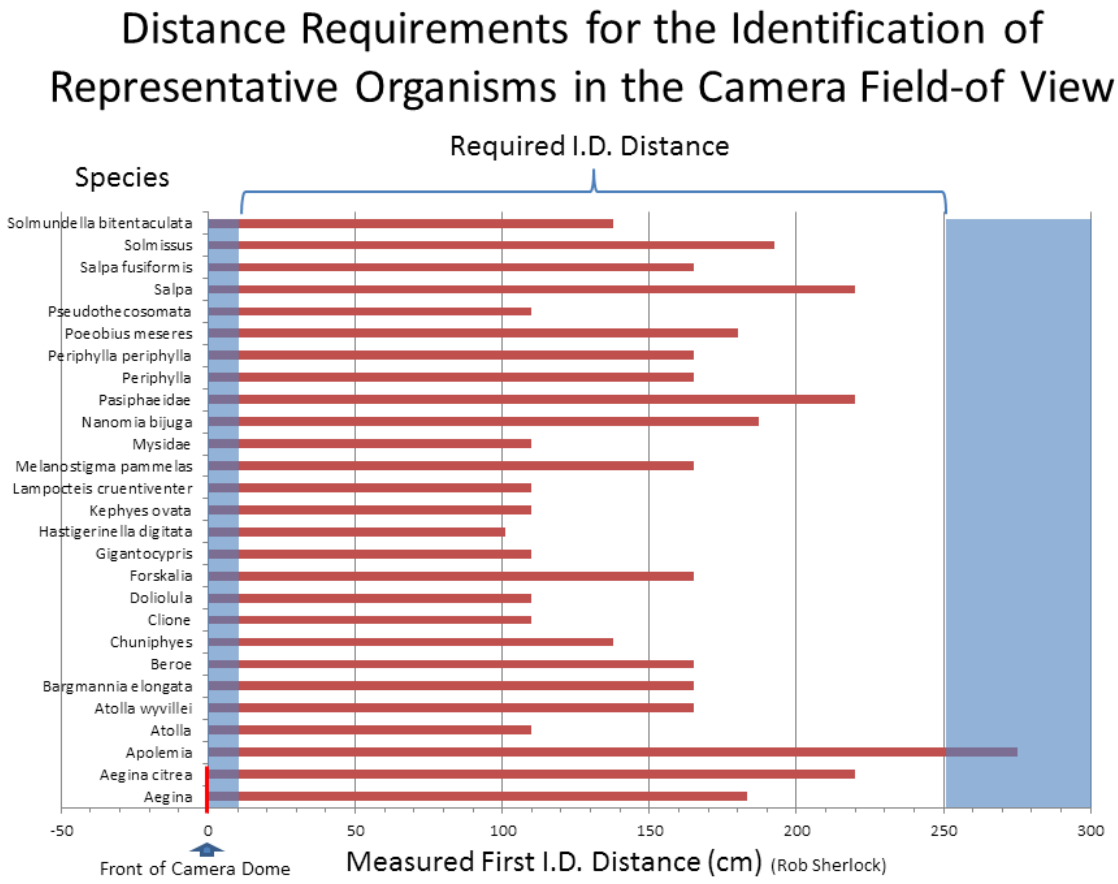
5.1. The software interface must allow the following commands to be sent from the AUV control computer:
- 5.1.1. Power on/off to lights. See limitations in section 6.1.1.
- 5.1.2. Power on/off to camera.
- 5.1.3. Power on/off to recorder.
- 5.1.4. Set timecode to UTC time.
- 5.1.5. Set filename to UTC date in ISO 8601 format.
- 5.1.6. Start/stop recording.
- 5.1.7. Start/stop playback
- 5.1.8. Put recorder in data mode.
- 5.1.9. Put recorder in record mode.
- 5.1.10. Return system status consisting of:
  - 5.1.10.1. Remaining recording time

6. Hardware Interface.

6.1. The electrical interface to the Dorado AUV must be compatible with:
- 6.1.1. 18 to 36 Volts DC. Note that the camera system control must not allow the lighting system to be energized when the AUV battery bus Voltage is below 25 Volts.
- 6.1.2. 15 Amperes maximum continuous current.

6.2. The data interface is 10/100BaseT Ethernet.

7. Appendix 1.


Distance Requirements for the Identification of Representative Organisms in the Camera Field-of View
Required I.D. Distance
Species
Solmundella bitentaculata
Solmissus
Salpa fusiformis
Salpa
Pseudothecosomata
Poeobius meseres
Periphylla periphylla
Periphylla
Pasiphaeidae
Nanomia bijuga
Mysidae
Melanostigma pammelas
Lampocteis cruentiventer
Kephyes ovata
Hastigerinella digitata
Gigantocypris
Forskalia
Doliolula
Clione
Chuniphyes
Beroe
Bargmannia elongata
Atolla wyvillei
Atolla
Apolemia
Aegina citrea
Aegina
-50
0
50
100
150
200
250
300
Front of Camera Dome
Measured First I.D. Distance (cm) (Rob Sherlock)