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

DRAFT

22JUL13 – rev. 0 mrc

29JAN14 – rev. A Added field width and depth of field.

19MAR14 – rev. B Added light bar info. from Francois.

1. Image Capture.

1.1. The AUV transecting imaging system must replicate the existing ROV based quantitative mid-water transects such that the results of transects can be compared in a scientifically valid way.

1.1.1. At a minimum, the system must maintain the current ROV based system imaging and recording quality. The current system uses an Ikegami HDL 40 high definition television camera and high quality Fujinon HA 10X5.2 lens coupled with two corrector elements and a six inch equal radius borosilicate glass dome. The video standard is 1920x1080 interlace recording at a frame rate of 29.97 (or 30) frames per second. The current recording media is HD D5 format on using Panasonic AJ-HD3700 tape recorders recording at 300 mbit per second with a 4:1 intra-frame compression.

1.2. Capture format. The imaging system must capture in a progressive scan format with a minimum resolution of 1920x1080 4:2:2 format at 10 bits at 60 frames per second or greater (1080 60P).

1.2.1. Volume sampled.

1.2.1.1. Depth of field. The imaging system shall allow the identification of small plankton such as (see appendix 1) at a range from 0.1 to 2.5 meters from the camera dome with the camera lens in a fixed focus position. Note: it is desirable but not required that the camera system be able to image objects further from the camera than 2 meters, ideally out to 10 meters distance.

1.2.1.2. Width of field. The lens system shall have at least an 80 degree horizontal viewing angle.

1.2.1.3. Aspect ratio. The horizontal to vertical aspect ratio shall be 16:9.

2. Lighting System.

2.1. User/High Level Requirements

2.1.1. The light bars shall hold 4 DSPL Sealight sphere near the nose of the AUV, facing forward.

2.1.2. The lights shall be mounted in a position that minimizes backscatter and glaring.

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

2.1.4. The light bars shall have a shape that minimizes the risk or entanglement with kelp, jellies, or lines.
2.1.5. The drag from the light bars shall not destabilize the AUV when operating a low speed (0.5m/s).
2.1.6. The bars shall be operable 12 times per year for 10 years.
2.1.7. The light bars shall be easily mounted on, or removed from, the AUV.
2.1.8. The weight in water of the light bars must be compensated by corresponding buoyancy inside the AUV.
2.1.9. The lights shall be connected to a power source inside the AUV (or in the imaging payload).
2.1.10. The light's cables must be protected, and securely attached in a way that minimizes drag.

2.2. Design Derived Requirements

2.2.1. The lights shall be mounted in a rectangular pattern, approximately 21" x 42" and face forward.
2.2.2. The light shall be mounted as far forward as possible (while still meeting requirement 2.2.4).
2.2.3. The bars shall 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 shall 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 shall be strong enough to resist minor hits that occur during handling on the ship.
2.2.6. In case the bars break, the lights shall remain attached to the AUV.
2.2.7. Damage from corrosion and wear should be negligible for 10 years of operation.
2.2.8. The bars shall be attachable both vertically and horizontally.

2.3. Operational/ Maintenance Requirements

2.3.1. Light bars shall be mounted easily on the AUV, without special tools.
2.3.2. When mounted on the AUV, the light bars shall leave the AUV's top fairing accessible.
2.3.3. In case of damage to the light bars during transit or launch, they shall be repairable on the ship within 10 minutes.
2.3.4. Cost of replacement light bar not exceed $xxx
2.3.5. Design Constraints
2.3.6. The weight in water of the light bar shall not exceed xx lbs.
2.3.7. The weight in air of the light bar shall not exceed xx lbs.
2.3.8. Cost not to exceed $xx

3. Image Recording, Annotation and Retrieval.

1.3. 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).

1.4. The video records must include SMPTE timecode data that is synchronous with the environmental instrumentation data.
1.5. 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).
1.6. CODEC. The image shall be processes 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.
1.7. 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).
1.8. Data download time shall not exceed Dorado AUV battery charging time (~5 hours).
1.9. The image archival and retrieval method shall support conformance with MBARI's data embargo policy.

2. Environmental Instrumentation.

2.1. The Dorado camera payload shall provide for simultaneous operation with the standard CTD, oxygen (x2?), and fluorometer instruments of the CTD AUV OR duplicate these instruments on the camera payload. 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.
2.2. 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 shall maintain a constant depth during a commanded transect to within +/- 1 meter.
4.5. Dorado shall maintain a constant pitch angle during a commanded transect of +/- 10 degrees.
4.6. Dorado shall 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.

5.1.2. Power on/off to camera.

5.1.3. Power on/off to recorder.

5.1.4. Start/stop recording.

5.1.5. Start/stop playback

5.1.6. Return system status consisting of:

5.1.6.1. Remaining recording time

6. Hardware Interface.

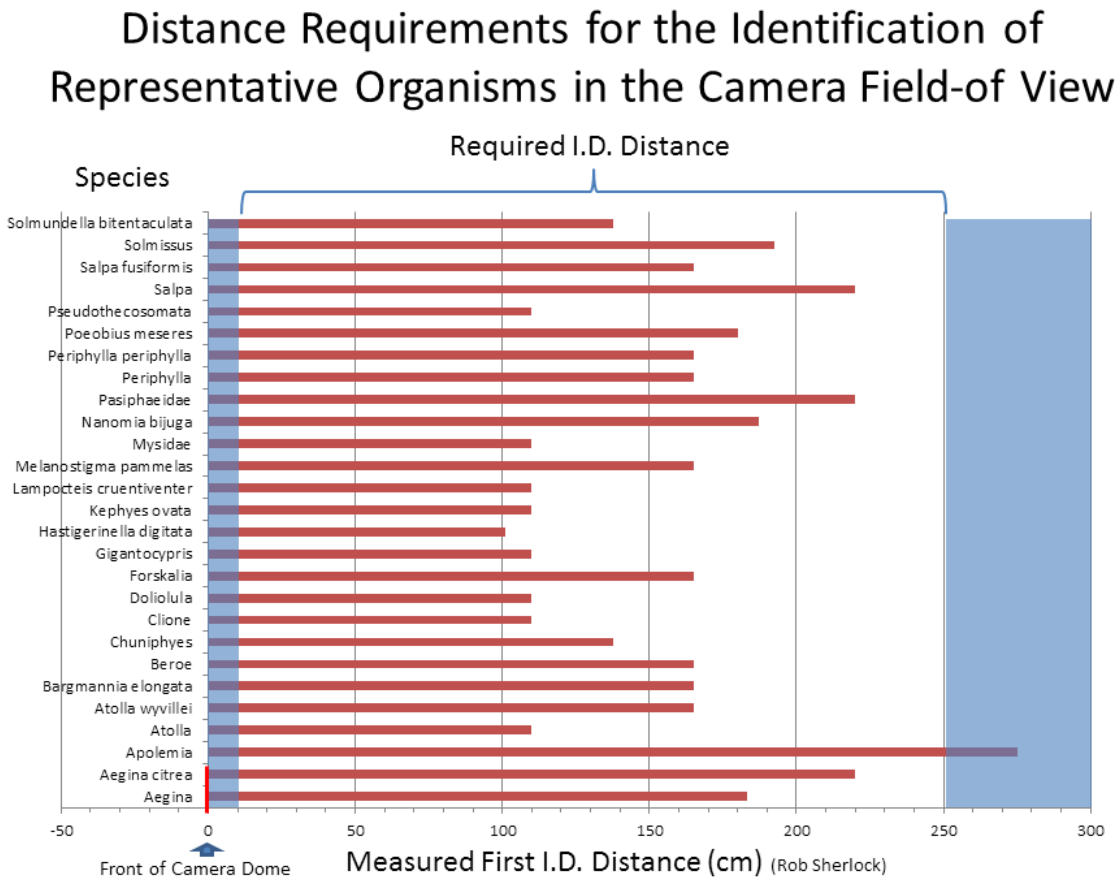
6.1. The electrical interface to the Dorado AUV must be compatible with:

6.1.1. 18 to 36 Volts DC.

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)