PAST, PRESENT AND FUTURE OF SEAFLOOR IMAGING SYSTEMS IN SAANICH INLET

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Benthic ecology and dynamics
Saanich Inlet Symposium
10 May 2016
PAST, PRESENT AND FUTURE OF SEAFLOOR IMAGING SYSTEMS IN SAANICH INLET

Outline:

(1) Camera systems deployed to date
(2) Scientific outcomes
(3) Future seafloor imaging projects
PAST AND CURRENT SEAFLOOR CAMERAS

DISCO (DIGITAL STILL) CAMERA – SAANICH INLET (96 M)
CMAP CYCLOPS CAMERA

Features

DISCO
- Olympus C8080 wide zoom camera (8 Mpxels, f2.4, 5Å optical zoom)
- ROS PT-25B pan and tilt (+/- 90° tilt, +/- 180° pan)
- Ikelite 200 Ws flash
- AGO subsea 44W lights (2)
- Scaling lasers (4)
- Web-enabled interface to control camera settings (image preview function)
- 70,800 images archived

CYCLOPS
- Olympus C8080 wide zoom camera (8 Mpxels, f2.4, 5Å optical zoom)
- Sidus SS109 pan & tilt unit (+/- 90° tilt, +/- 180° pan)
- Ikelite 200 Ws flash
- Deep Sea Power and Light Rite-Lite 100 W incandescent lights (3)
- Scaling lasers (red, 10 mW)
- 56,950 images archived
PAST AND CURRENT SEAFLOOR CAMERAS

FORENSIC CAMERA

Features
- HDTV video – AXIS PTZ 1346
- 18x optical zoom
- High-speed pan and tilt
- Mounted on a VENUS frame
- Connected to a SIIM module
- 4 LED lights

History
- 5 deployments
- 100,120 video files archived
PAST AND CURRENT SEAFLOOR CAMERAS

3D CAMERA (Developed by Herb Yang and Steve Sutphen, Computer Science Dept.)

Features
- Circular steel plate 8 feet in diameter, legs are 5-feet high and central post at 6’6” high
- Platform weight 1500 pounds, loaded up with cameras, projectors and PCs.
- Mounting brackets for (8 cameras, 3 projectors, and 2 PC controllers)
  - 45 degree tilt in the vertical plane
  - 1.5 m focal range
  - 18x optical zoom

Deployed
- Sept 2014
  - Bad focus calibration (recovered in May 2015)
- August 2015
  - Recalibrated and working

Schedule
- Photographs at 6 hr intervals

8 cameras
3 light projectors
2 PC control modules
PAST AND CURRENT SEAFLOOR CAMERAS

3D CAMERA

- Underwater 3D image reconstruction using accurate camera positioning and calibration
- Algorithm development for organism tracking/identification

8 cameras
2 PC control modules
PAST AND CURRENT SEAFLOOR CAMERAS
- SAANICH INLET

Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>CMAP</th>
<th>DISCO</th>
<th>FORENSIC</th>
<th>3D Cam</th>
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<tbody>
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Camera deployments
SCIENTIFIC OUTPUT USING SEAFLOOR IMAGING SYSTEMS

Peer-reviewed publications

Yahel et al 2008_MEPS (CMAP + ROPOS transects)
Kats et al 2009_Global Biogeochem. Cycles (CMAP+ROPOS)
Matabos et al 2011_JEMBE (CMAP)
Aguzzi et al 2011_Sensors (CMAP)
Katz et al 2012_Limnology & Oceanography (CMAP)
Matabos et al 2012_Plos One (CMAP)
Anderson and Bell 2014_Plos One (FORENSIC)
Chu et al 2015_Global Env. Change (DISCO-CMAP + ROPOS transects)

Thesis, Dissertations

Jackson Chu, Verena Tunnicliffe (advisor) – PhD, ongoing (CMAP-DISCO)
Carolia Doya, Jacopo Aguzzi (advisor) – PhD, ongoing (CMAP-DISCO)
Xida Chen, Herb Yang (advisor) – PhD, defended (now post-doc) (3D Cam)
Neda Al Sabbbadi, Herb Yang (advisor) – MSc, ongoing (3D Cam)
Saeed Hojjati, Herb Yang (advisor) – MSc, ongoing (3D Cam)

Conference papers (only recent, many more…)

Chu et al 2015, Deep-Sea Biol Meeting, Aveiro, Portugal (DISCO-CMAP + ROPOS transects)
Yau et al 2013 – IEEE, Portland, OR (3D Camera)
Chen and Yang 2014 – IEE, Columbus, OH (3D Camera)
SCIENTIFIC OUTPUT USING SEAFLOOR IMAGING SYSTEMS

ONC Peer-reviewed publications

<table>
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<tr>
<th>Year</th>
<th>Video data from Cameras</th>
<th>Other</th>
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<tr>
<td>2014</td>
<td>17%</td>
<td>83%</td>
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<td>2013</td>
<td>16%</td>
<td>84%</td>
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<td>2012</td>
<td>20%</td>
<td>80%</td>
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<td>2011</td>
<td>22%</td>
<td>78%</td>
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11 cameras
> 200 instruments

5% Other
95% Video data from Cameras
**Scientific Output**

**Aguzzi et al. 2011 Sensors**

- Automated counts based on filtering and background correction on RGB channels
- Higher percentages of images were correctly classified and lower misclassification errors (an animal is present but not detected)

**Article**

**Automated Image Analysis for the Detection of Benthic Crustaceans and Bacterial Mat Coverage Using the VENUS Undersea Cabled Network**

Jacopo Aguzzi 1*, Corrado Costa 2*, Kathleen Robert 3, Marjolaine Matabos 4, Francesca Antonucci 2, S. Kim Juniper 3,4 and Paolo Menesatti 2
Scientific Output

Aguzzi et al. 2011 Sensors

Automated Image Analysis for the Detection of Benthic Crustaceans and Bacterial Mat Coverage Using the VENUS Undersea Cabled Network

Jacopo Aguzzi 1,*; Corrado Costa 2,*; Katieen Robert 3; Marjolaine Matabos 4; Francesca Antonucci 2; S. Kim Juniper 3,4 and Paolo Menesatti 2

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Manual processing
Automated processing
New camera systems in development

**Sediment Profiling Imaging (SPI) Camera**

Researchers involved
- Martin Solan (NOC)
- Paul Snelgrove (Memorial Univ.)

Research questions
- Linkages between benthic diversity and ecosystem function at unprecedented temporal resolution:
  - Particle redistribution (bioturbation)
  - Organism-sediment interactions
  - Responses to long-term environmental change (temperature, oxygen, etc)
- Investigate the role of large (highly mobile) bioturbators. Deployments employing cage settings to control for those large mobile organisms.
New camera systems in development

Black Magic Cinema 4K Cameras

Improvements:

- Proper software driver for controlling the camera (instead of VPN connection to shore station PC)
- LED sets instead of flash (avoid synchronization issues)
- Higher image resolution
- Relay board to independently control lights and lasers
- Serial control of PAN and TILT system

Standard DSLRs – Nikon DS7200
NEW CAMERA SYSTEMS IN DEVELOPMENT

ACOUSTIC CAMERAS

ARIS dual frequency sonar

Researchers involved
- Francis Juanes, Aharon Fleury - UVIC
- Jeff Drazen, UH Manoa
- Jacopo Aguzzi/Carol Doya/Ulla Arcadya – ICM-CSIC

Research questions
- Study fish and invertebrate behavior without effects of light attraction and avoidance effects
- Generate a species ID list based on frequencies to correlate with sounds (hydrophone co-located) generated by fish and invertebrates