R2B: Optical and Acoustic Imaging Underwater
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Photomosaicing
Acoustic Bathymetric Mosaicing
Visually Based Navigation
Camouflage
Optical Imaging Underwater

Non-linear attenuation of EM spectrum,
Highly unstructured environments

Lighting  |  Backscatter  |  Wide Baseline
Large-Scale Photomosaicing

Individual Images

As assembled into a photomosaic strip with registration toolkit

2000-2005 Ruth and Paul Fye
Best Paper Award
Oscar Pizarro et al
3D Structure from Motion

Individual image

2D View

3D Reconstruction
Ground Truthing 3D Structure From Motion

Image Derived Structure

Difference: Laser vs Imagery

Ground Truth - Laser Scan

Ground truth - Error Plot
Visually Based Navigation (RMS Titanic)

Photomosaic

- 866 images
- 3494 camera constraints
- Path length 3.1km 2D / 3.4km 3D
- Convex hull > 3100m²

2005 ICRA
Best Student Paper Award
Ryan Eustice

VBN Reconstruction
Sanity Check: VAN Triangulated Structure

Clipped Point Cloud Triangulation Error

Scene Relief
- Pairwise
- VAN

Triangulation Error [cm]
High Resolution Multi-beam

- Scanning sonar or multibeam (ranges and angles)
- Navigation
  - Attitude sensor (heading, pitch, roll)
  - Depth (surface relative)
  - Velocity (bottom relative)
  - Maybe, position (Long Base Line (LBL))

![Images of underwater equipment and sensors]
Multibeam - A Submapping Approach

Submaps iteratively being added into final map

Gridded sub-map surfaces

Individual sub-maps
New Project - Understanding Camouflage

How can we:

* Characterize the efficiency of camouflage?
* Quantify the methodology of animal (cuttlefish) camouflage?
Quantifying Camouflage
R2B: Summary & Future Plans

**Summary**
- Continued progress on all fronts driven by diverse applications
- Mosaicing, FishRock toolkit released
- Public Awareness and Outreach was outstanding (e.g., National Geographic, Discover Magazine, Der Spiegel, Oinnos)

**Short-term Plans**
- Generalize mosaicing toolkit for full 3D reconstruction

**The longer term**
- Continue work on information extraction