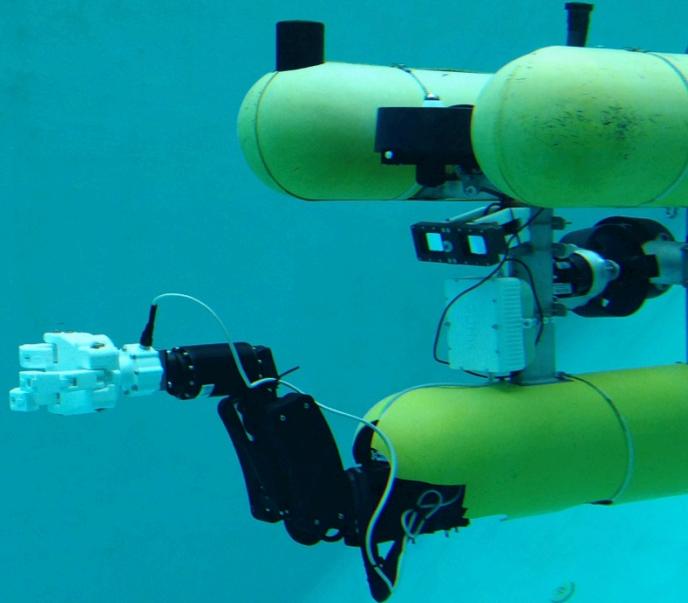


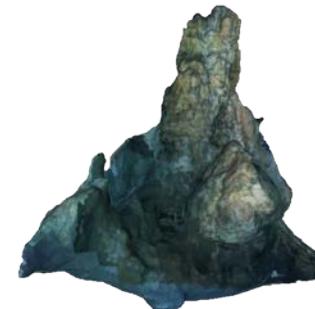
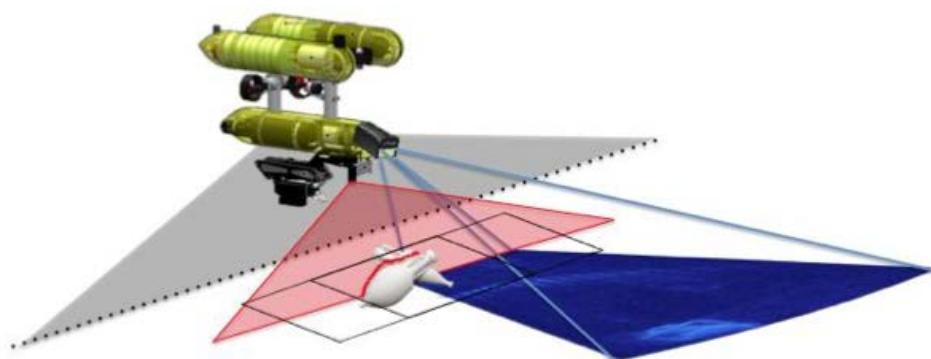
Advanced AUV capabilities for inspection and intervention

Marc Carreras
marc.carreras@udg.edu
<http://cirs.udg.edu>



2015 Research Planning
Workshop
August 25-26, 2015, Maui, HI,
USA

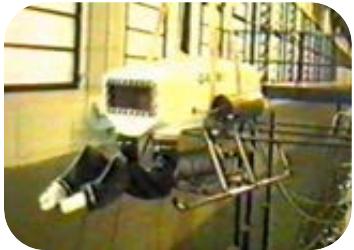
- Senior staff:
 - Pere Ridao
 - Rafael Garcia
 - **Marc Carreras**
- Postdoc staff:
 - David Ribas
 - Nuno Gracias
 - Narcís Palomeras
 - Angelos Mallios
 - Natàlia Hurtós
 - Ricard Campos
 - Ricard Prados
- Technical & administrative staff:
 - Lluís Magí
 - Carles Candela
 - Joseta Roca
 - Mireia Frigola
 - Anna Ferrarons
- 10-15 PhD & undergraduate students
- Research topics:
 - Hovering AUV design
 - Mapping (2D, 3D, Photo, Acoustic)
 - Image processing
 - Intelligent behaviour
 - Intervention AUVs



GIRONA UNDERWATER VISION AND ROBOTICS LAB



20 Years of experience developing AUVs



1995

2000

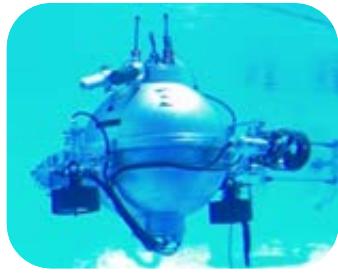
2004

2006

2010

2011

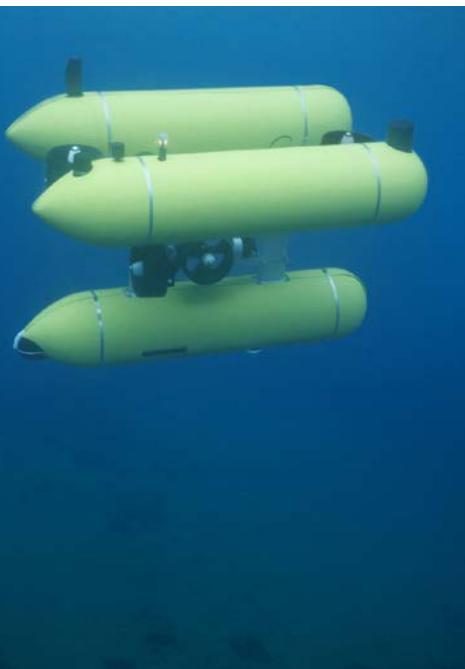
2014



GIRONA 500 AUV

SPARUS II AUV

The concept: Multipurpose hovering AUVs



From inspection ...

- Neutrally buoyant, stable in Roll and Pitch, low weight, small size, easy operation
- Hovering capabilities for tasks requiring movements in several DOFs
- Efficient Hydrodynamics
- Payload area for easy integration (open hardware).
- Software architecture based on ROS (open software)



ROS



... to intervention.

Applications

Inspection



Dam Inspection



Hull Inspection



Harbour Inspection



Chain Inspection



Pipe Inspection



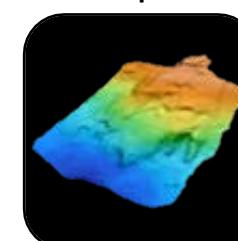
Habitat



UXO



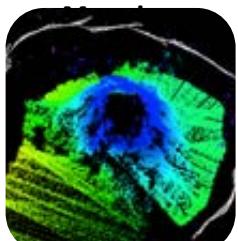
Dehazing



Bathymetry Mapping



Archaeology



3D Mapping



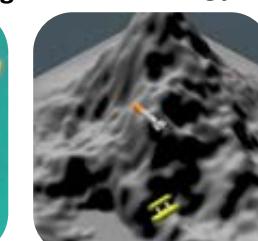
Cave Mapping



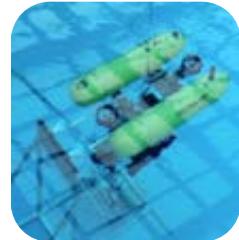
3D Reconstruction



Multiple Vehicle Mapping

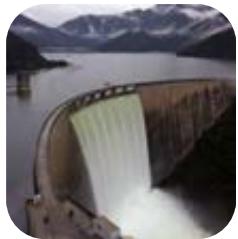
RT Path
Planning &
Mapping

BlackBox S&R

Docking Valve
Turning & Hot-stabFree Floating
Valve Turning

Applications

Inspection



Dam Inspection



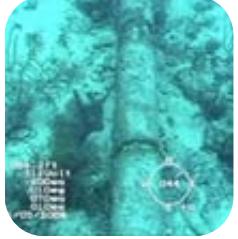
Hull Inspection



Harbour Inspection



Chain Inspection



Pipe Inspection



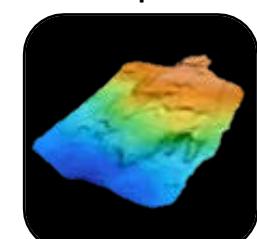
Habitat



UXO



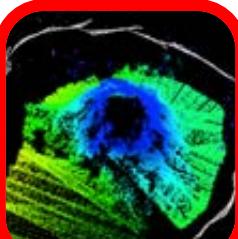
Dehazing



Bathymetry Mapping



Archaeology



3D Mapping



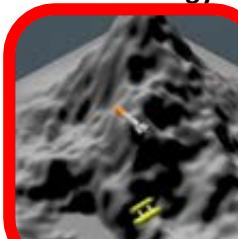
Cave Mapping



3D Reconstruction



Multiple Vehicle Mapping

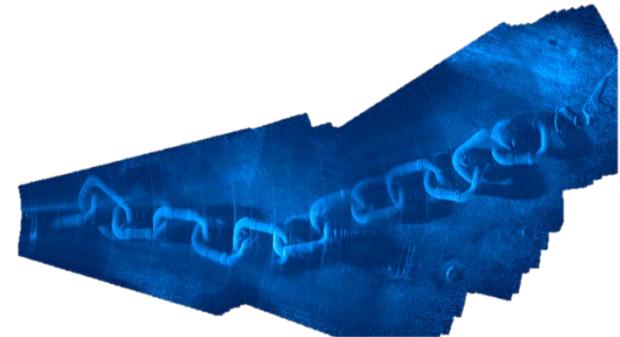
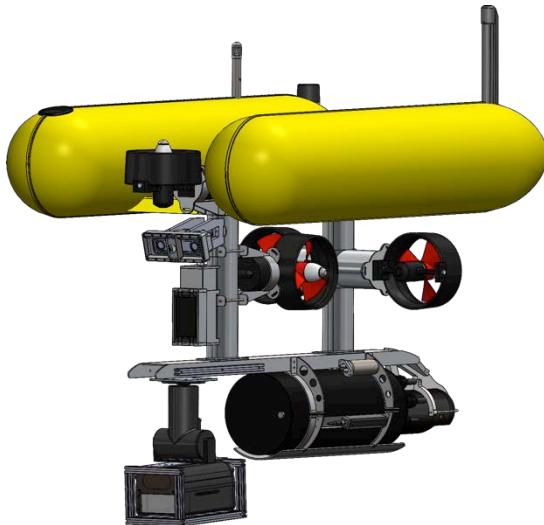
RT Path
Planning &
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BlackBoxS&R

Docking Valve
Turning & Hot-stabFree Floating
Valve Turning

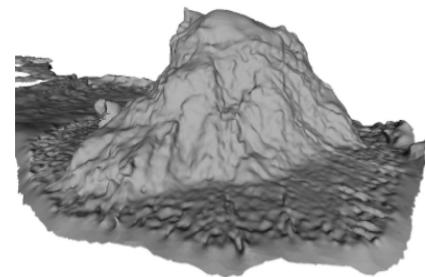
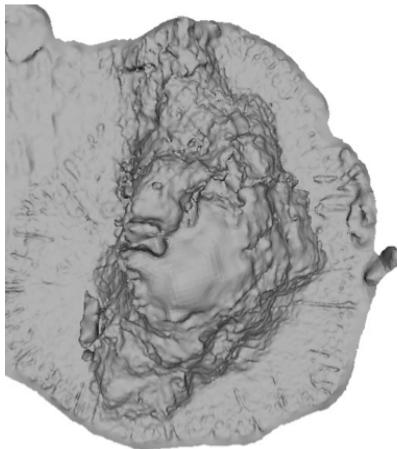
Chain inspection, horizontal chain search and inspection

- Real-time chain detection with FLS
- Pattern matching for link detection
- Search & following trajectory
- Acoustic mosaicking of the seabed and chain



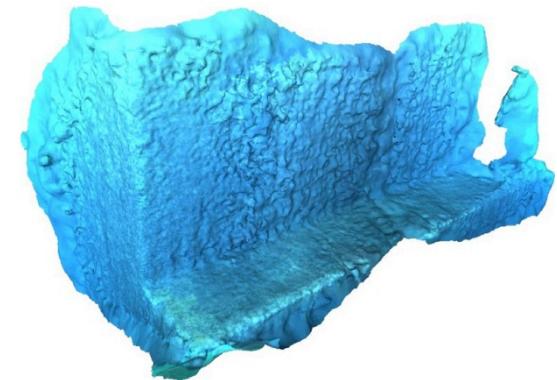
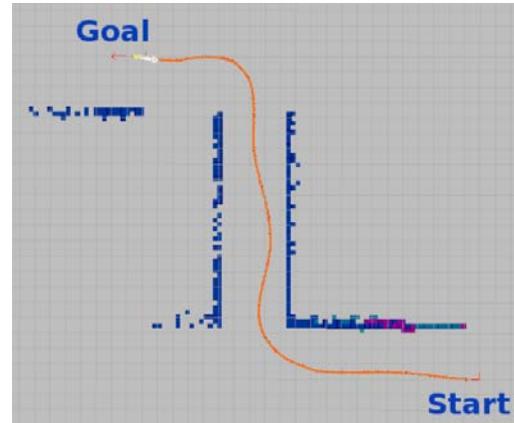
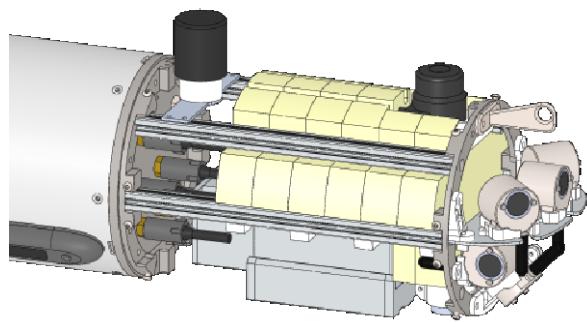
3D Mapping, underwater seamount inspection

- Offline path planning from bathymetry
- Real-time mapping with acoustic profiler
- Real-time trajectory adaptation
- Offline 3D reconstruction

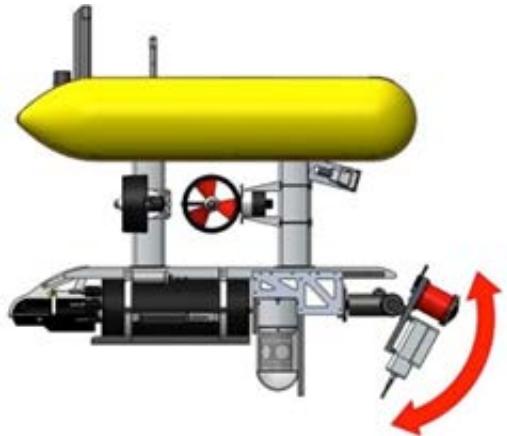


Motion planning for structure inspection

- Real-time acoustic mapping
- Real-time motion planning
- Kinematic & safety constraints
- Offline seabed reconstruction



Motion planning in 3D, future work ...



Relevant related I-AUVs demonstrations



2003 - ALIVE AUV

EU project
ALIVE consortium
(Cybernétix)

- Docking + valve turning
- 2 hydraulic arms for docking
- 1 electrical manipulator (7DOF)
- 3.5 tons AUV
- Sonar & video feedback



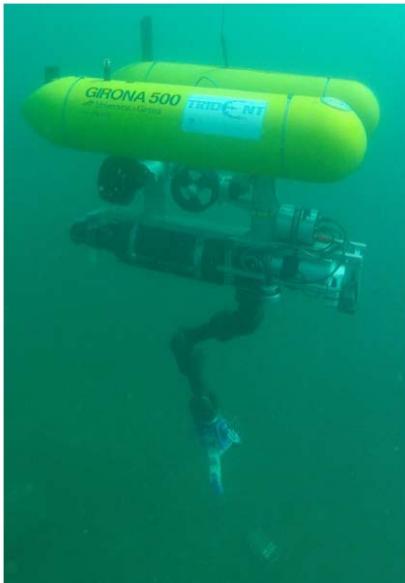
2009 - SAUVIM AUV

ONR project
ASL, Hawaii, USA

- Free floating object recovery
- 7 DOF electrical manipulator
- 6 tons AUV
- Video processing for known objects

I-AUV, object recovery

- Girona 500 AUV (4 DOF)
- Graaltech manipulator (7 DOF)
- UNIBO end-effector.
- 200 Kg AUV
- Free-floating intervention.
- Vision-based target detection.



TRIDENT

I-AUV, docked valve turning & connector plugging

- Girona 500 AUV (4 DOF)
- ECA manipulator (4 DOF)
- Docking + intervention.
- Vision-based panel detection.



TRITON

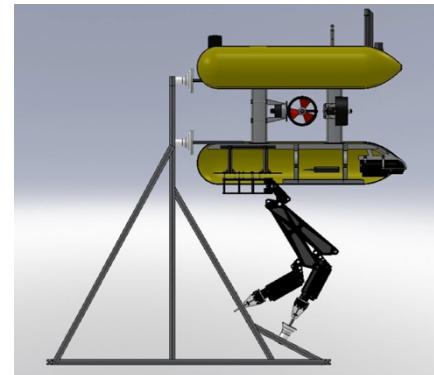
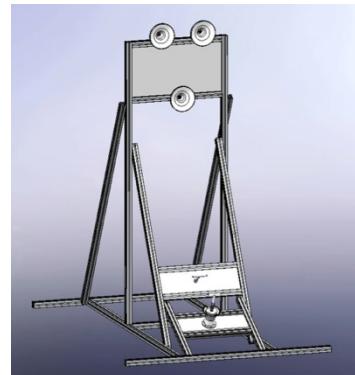
Intervención Submarina mediante Robots Marinos Cooperativos y Percepción Multisensorial

AUTONOMOUS UNDERWATER INTERVENTION

Docking & Intervention

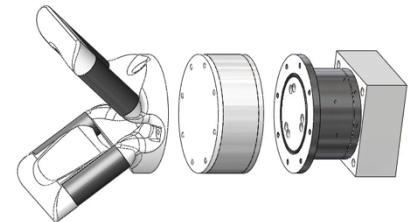
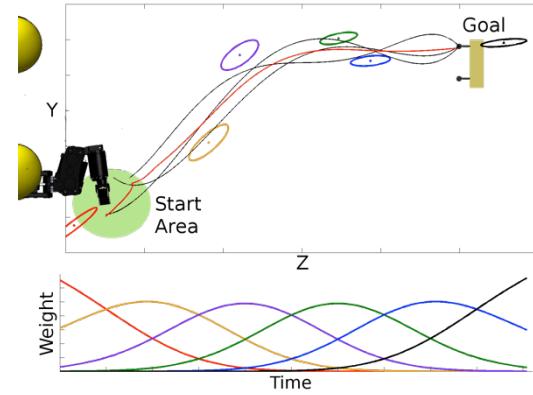
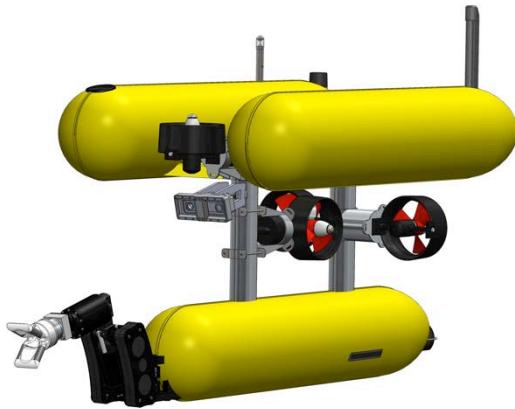


Universitat de les Illes Balears



I-AUV, free-floating valve turning with LBD

- Girona 500 AUV (4 DOF)
- ECA manipulator (4 DOF)
- Pandora end-effector.
- Free-floating intervention.
- Learning By Demonstration



I-AUV, free-floating valve turning with LBD

- Persistent experiment:

- Mission planning (>3h)
- 37 valve turning attempts
- Water current perturbations (up to 80% success)
- Blocked valves
- Unknown panel location
- Panel occlusions



Final remarks

- How can inspection and intervention AUVs benefit oceanographic campaigns?
- What scientific applications can make use of this new technology?
- What are the necessary steps to integrate this technology in oceanographic ships?

