Underwater Vehicle Systems at IFREMER

*From R&D to operational systems*

Jan Opderbecke

IFREMER

Unit for Underwater Systems
Underwater Systems Unit
38 permanent staff

Operational Engineering
- Mechanical and systems engineering
- Marine robotics, mapping, acoustics, positioning
- Electronics and embedded control software

Technological R&D
- Autonomous mission control
- Coordinated/cooperative MV control
- Image processing, mapping, classification, reconstruction
- Acoustics and positioning
- UW communication
- Innovative systems

Department for the national Oceanographic Fleet

National Programming Committee for ships, u-w systems and equipement

Operating Company GENAVIR affiliated to IFREMER
- Ship & Vehicle operations
- Maintenance

Science Departments
At Ifremer, but Universities etc.

HOV Nautilis
ROV Victor
HROV Ariane
AUVs asterX & idefX
Unit for Underwater Systems

Nautilie: future of HOV in Ifremer / France / Europe?

Victor 6000: evolution of ROV to new ways of deep-sea science

HROV Ariane: facilitate access to underwater investigation

AUV Coral: towards a mobile observatory

R&D: key technology topics
Underwater robots for ocean sciences

Global changes and modeling

Living resources

Mineral and Energy resources

Biodiversity
National deep sea intervention capability

BEA - black box search, “first aid” on Prestige wreck site

ANTARES & MEUST deep sea observatory (Neutrino telescope)

- 900 PMTs
- 12 lines
- 25 stairs / line
- 3 PMTs / stair
Nautilier – a reference
1900 dives in 30 years
Autonomous vehicles AUVs asterX & idefX
open platforms for versatile usage
The hybrid ROV Ariane

Motivations:

- Exploration & intervention in coastal areas down to 2500m
- Deployment from small non-specialized vessels
- Flexible programming related to coastal fleet, fast mobilization
- Optimized cost of operations (ship size/space, operating crew)

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<th>Development with industrial architect</th>
<th>Work stopped, batterie fire</th>
<th>Test cruises, commissioning</th>
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Main features

- Long range multi-scale survey
- Close to sea-bed optical inspection (ground truthing)
- Complete data sets from multiple scientific sensors including in-situ filtering & analysis
- Target detection and detailed investigation – reactive mission strategies
- Dual use with ROV or HOV

**Design studies**
- 2016

**Development with industrial architect**
- 2017

**Integration & sea trials**
- 2019

**Test cruises, commissioning**
- 2020
Technology topics

Mission language for enhanced autonomy

- Servicing of deep-sea observatories

High bandwidth optical communication

- Water sampling & in-situ analysis for AUV/ROV

Advanced imaging & processing

- Web-based mission management sw & tele-presence

Aided manipulation & augmented reality
DCNS & Ifremer: Docking of AUV under moving vessel

**DOCKING in compliant structure**

*under ship hull*

- Cooperation DCNS-IFREMER
- USBL and optical guidance
- 2 knts relative speed
- Security strategies adapted to manoeuvre under ship hull
- Demonstration at sea in 2014
Advanced Communications

*Opticomm*: wireless optical data transfer

- Bandwidth 10Mbit/s: Transmitting live video
- Range >50m: Wireless ROV control (battery powered)
- TX angle > 45°: vehicle-to-vehicle & vehicle-to-observatory scenarios
- TRL 7-8: Product introduced, demonstrated in Med Sea 2015
Optical imaging and processing

- Image sensor integration and optical optimization
- Image analysis and qualification
- Functional analysis and design from sensor to processing
Image processing

• Image correction: lighting, distortion
• Image processing: geo-referenced moaïcking, monocular 3D reconstruction
• *Matisse*: operational software for optical mapping

Images to 3D points

3D points to surface

Preserve and enhanced Details
10 years progress in Image processing
FP7 MORPH - Heterogeneous cooperating multi-robot fleets

*MORPH (finished 2016)*

- Vehicle fleet (6) adapting to task & environment
- Multi-agent cliff mapping
- High level mission planning for complex tasks
- Networking acoustic communication
- Distributed navigation by range-only data fusion
- Shared modular control software (ROS)
Remote mission management & cruise lab

Web based mission management
- Dive planning and following
- Charts & data managements
- Unified data base accessed from vessel / shore

Remote Scientific Cruise Lab & Telescience
- Web data portal
- Smart search, visualization, annotation, analyses
- Faster assessment of data during cruise
- Augmented reality displays
Thank you!