Networked systems for situational awareness and intervention in maritime incidents

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Outline

- Why networked vehicle systems?
- Project overview
- Cathach exercise
- Pobra de Caraminal exercise
- Porto exercise
- Conclusions
WHY NETWORKED VEHICLE SYSTEMS?
LST-S FEUP

LABORATÓRIO DE SISTEMAS E TECNOLOGIA SUBAQUÁTICAS
UNMANNED VEHICLE SYSTEMS FOR A SUSTAINED PRESENCE IN THE OCEAN

Mission: Design and deployment of innovative solutions for coastal oceanographic and environmental applications
Portable/scalable system of interacting autonomous vehicles, operators and satellites

Vehicles come and go

Control station

Operators come and go

Control station

AUV

Surface buoy

Navigation beacon

Mixed-initiative

Coms. links

Data mules/DTN

Sensing links

Localization links

Autonomous surface vehicle

Moored sensors
Connecting the Dots
Networking Maritime Fleets of Autonomous Systems for Science & Surveillance

By
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A network of national observatories is being coordinated to provide ocean data for the Global Ocean Observing System (GOOS, http://www.ioo.goes.org). Many observatories are surface or seafloor moorings with sensor arrays. Where moorings are cabled to shore for power, a few observatories include buoyancy gliders as observing system components. Discussions have been underway to further develop Integrated Ocean Observing Systems (IOOS) which also include propeller-driven autonomous underwater vehicles (AUVs), autonomous surface vessels (ASVs), and autonomous or unmanned aircraft systems (UAS).

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This is a logical approach for IOOS because these autonomous technologies together provide greater spatial and temporal sampling than fixed observatories and do so more cost-effectively than manned ships or aircraft. Propeller-driven AUVs and ASVs can also sample in shallow waters, at spatially limited features (like oceanographic fronts), and areas of high current velocity where buoyancy-propelled gliders have limitations. Additionally, by combining sub-surface, surface, and airborne sampling platforms, collection of data on air-sea gas, heat and moisture fluxes is possible for studies of climate dynamics and ocean acidification. Finally, autonomous systems networks can be cost-effective for maritime surveillance in search and rescue (SAR) cases, to monitor illegal fishing, or to respond to ship grounding or oil spills without risks to human health and safety.

DTN Communications Enable Near Real-Time Control of Autonomous Observing Systems
In making networks of autonomous systems effective ocean observing systems (OOS) components, several capabilities are required. The first requirement for using multiple autonomous vessels in an OOS is a reliable communications system across vehicles, underwater, at the surface, and in the air. Delay/Disruption Tolerant Networking (DTN) communication protocols have been adopted by ocean scientists. DTN communications protocols know when links are disrupted, and resume transmitting data when the communication link is re-established. This DTN functionality is important for large file transfers in communications-challenged maritime environments.

A series of ocean field exercises coordinated by the Portuguese Navy and the University of Porto, called REP ( Rapid Environmental Picture), have focused on demonstrating Delay/Disruption Tolerant Networking communications between ships, AUVs, ASVs and UAS. This has allowed near real-time control and data exchange among platforms to coordinate control and inter-vehicle interaction for an optimally-employed autonomous OOS network.
Ocean vehicles

- Low cost vehicles
- Common software/hardware platforms
- Inter-operability frameworks
Making L&R simple
**UAS**

**X8 based UAV (1.400 €)**
- RC model based platform
- Autopilot
- Onboard computer for autonomy
- WiFi coms (up to 10Km range)
- IP video camera
- HD digital camera or IR camera
- DUNE on-board software
- IMC command and control protocol
- Battery powered

**UAV system**
- Flight time: 1h
- Range: 10Km (video feed)
- Hand launched or catapult launch
- Fully autonomous (soon: no pilot required)

**Ground station**
- Laptop & antennas
- Neptus antennas
- IMC command and control protocol
- Multi-vehicle control
- Internet enabled

**Applications**
- Maritime surveillance
- Aerial photography/mapping
- Biological studies
- Search and rescue
- Fisheries
- Incident response (floods)
- Inspection of power lines
- Illegal hunting

**Data visualization/storage**
- Maximizing the audience
Recognized Environmental Picture – REP 14

Organized by
- PO Navy
- Porto University
- Centre for Maritime Research and Experimentation

Participants
- University of Rome
- Certh
- Royal Institute of Technology
- Evologigs
- OceanScan

Areas
- Mine Warfare
- Harbour Protection
- Expeditionary Hydrography
- Search and Rescue
- Maritime Law Enforcement
- Environmental Monitoring

Large scale experimentation
“Truly” autonomous UAV/AUV operations
Coordinated observations - coastal fronts
UAVs for “bent” LOS communications
Mixed initiative control ASVs, AUVs, UAVs
New: UAS controls (feedback) a submerged AUV with the help of a Wave Glider

- Wi-Fi
- AComs
- Manta gateway
Coordinated air/ocean observations Split Sept 2014

UReady4OS project demonstration
PROJECT OVERVIEW
Objectives

- Demonstrate, evaluate and disseminate new robotic systems, sensors and networking technologies in maritime incidents
  - Air and sea going robotic vehicles provide new capabilities.
  - Networking technologies enable orchestration of existing assets.
  - C4I provide new capabilities for coordination of existing assets, vehicles and operators
  - Environmental assessments with unprecedented resolution provide reality checks for social networks and motivate public participation.

- Project organized around demos led by operational partners
  - Harbor in the proximity of a metropolitan area,
  - Estuary
  - Open sea.

- Universities & RD institutions demonstrate new tools/technologies.
- RETEX workshops to transition tools and technologies to operational practice
Consortium

- **Partners**
  - FEUP – Faculty of Engineering, Porto University (PT)
  - APDL – Administração dos Portos do Douro e Leixões, SA (PT)
  - FUAC – Fundación Universidade da Coruña (SP)
  - PG - Portos de Galicia (SP)
  - TECNALIA – Fundacion Tecnalia Research & Innovation (SP)
  - ENSTA, Britain – Ecole Nationale Supérieure des Techniques Avancées (FR)
  - UL – University of Limerick (IRL)
  - NMCI - National Maritime College of Ireland (IRL)
  - UKSpill – UK Spill Association (UK)

- **Associate partners**
  - CINAV - Portuguese Navy (PT),
  - Portuguese Ports Association (PT),
  - Shanon-Foynes Port Company, Lda (IRL),
  - University of Southampton (UK)
  - UK Maritime Coastguard Agency (UK).

- **Approximate budget: 2.800.000 Euros (Duration: 30 months)**
Workplan

WP1 Management

WP2 Stakeholders & Users Networking

WP4 Harbor Demo

WP5 Estuarine Demo

WP6 At Sea Demo

WP3 Emergent Systems & Technologies

WP7 Returns of Experience

WP8 Communication
EXERCISE “CATHACH”
WP5 – ESTUARINE DEMO

Shannon’s estuary
Ireland
17th-18th April 2013
Key players

- NETMAR
- Irish Coast Guard
- Sea-Pt
- Irish Naval Service
- Shannon Foynes Port Company
- Commissioner of Irish Lights
- Clare, Limerick, Galway and Kerry Council Councils

Links to other projects
- MARICE
- DARIUS
Shannon estuary
Scenario

- **Ship in bad weather requests refuge in Shannon Estuary**
- IRCG enact MARICE procedures to establish cargo and associated dangers
- **Directed to anchoring position H**
- En-route steering fails and ship ends up on five fathoms rock
- On falling tide, ship lists and looses some deck cargo. Heavy fuel oil also begins to leak from bunker.
- IRCG helicopter airlifts personnel
- Shannon Estuary oil pollution response and NHS response enacted.
- Shannon Estuary oil spill tracking model used to predict where oil is most likely to come ashore
- IAA permit segregated airspace for UAV’s, 17th – UAV deployed to survey scene at first light and also identify oil dispersion (ground truthing re-input into tracking model)
- INS ship LE Orla arrives on scene and establishes a waterborne exclusion zone.
Air vehicles

FULMAR 3.2m – TECNALIA

AscTec Falcon 8 – NUIM (IAA Approved)
Underwater vehicles

ROV LATIS – 400m Tether - UL

ROV Cherokee – with manipulator - INS

SEACON AUV - FEUP
Ships

LÉ Orla - INS

ILV - Granuaile
Misc

SFPC - Shannon One

SFPC – Oscar

Celtic Rebel – Tug boat

Shannon Search & Rescue helicopter – Coast Guard
Shannon Estuary Incident Response
April 17-18 2019
www.shannonresponse.com

Unmanned vehicles for dirty, dull and dangerous operations

Simultaneous ocean/air observations with adaptive spatial resolution

Networking systems, people and institutions

www.shannonresponse.com
EXERCISE “A POBRA DO CARAMINAL”

WP6 Pobra do Caraminal
Spain
October 1st 2014
Pobra do Caraminal

Organized by Puertos de Galicia in cooperation with Spanish Authorities
- Multiple ships
- Oil-pollution teams
Advanced gas sensors for detection based on nanofibers

- Lower detection limits
- Faster response time
- Faster recovery time
- Low cost

DEVELOPED By TECNALIA

commercial sensor.
HARBOR EXERCISE

WP4 Porto de Leixões
Portugal
May 2015
The Largest Seaport in the North of Portugal
Port management

Automatic Authorizations
Operation Impacts / Risks

OIL SPILL

Jetty A - Crude Oil
Jetty B - Refined products
Jetty C - LPG, Chemicals

Offshore Terminal
TOGL Terminal Oceânico Gaip Leça

CALM - Catenary Anchor Leg Mooring
SPM - Self Point Mooring

Monobóia SPM
Offshore Terminal

Sea Line

Refinery

Terminal Petroleiro
Pipeline

REPSOL

CEPSA
Conclusions

Unmanned vehicle systems provide measurements with unprecedented spatial and temporal resolution in 3D environments and also support communications.

Ready for operations?