Presentation Outline

- Laboratory overview
- Hardware Technologies
- Software Technologies
- Operations and Results
- Ongoing and Future work
Lab Overview
Established in 1996
20+ researchers from various backgrounds
Emphasis on applications and field operations
Tight collaboration with end-users such as Navy, Biologists, Archaeologists, Oceanographers, etc.
Approach: Networked Vehicle Systems

- Heterogeneous
  - Vehicles
  - Capabilities
  - Communication links
  - Operator needs
  - Op. Scenarios
Approach: Networked Vehicle Systems

- Common
  - Software Infrastructure
  - Protocols
  - Centralized services
  - User Interfaces
Hardware Technologies
LSTS: Marine Robots

1997

2007

2011

2011

2014

2016
LAUV: Light Autonomous Underwater Vehicle

- Up to 24h endurance
- Easy launch / recovery
- Wi-fi + Iridium (surface)
- Acoustic modem (uw)
- Modular payloads
- FEUP + Oceanscan MST
LSTS: Aerial Robots
Skywalker X8 Fixed-wing UAV

- 40 minutes endurance
- Real-time video feed
- Visual + infrared cameras
- Easy launch / recovery
- Long-range (10Kms) Wi-Fi comms

- FEUP + NTNU
Waterproof Multi-copter UAVs

- Up to 20 minutes endurance
- Real-time video feed
- Visual, infrared + multi-spectral cameras
- Acoustic Modem
- Water landing / take-off
Flightwave Edge VTOL UAV

- 2h endurance
- real-time video feed
- visual + infrared cameras
- collaboration with Flightwave
Other Systems

- Same software stack
- Shared drivers / hardware
- All part of the same network
Manta Communications Gateway

- 10h endurance
- Wi-Fi
  - omnidirectional, sectorial, directional antenna
- GPS, Compass
- Iridium, HDSPA
- Acoustic Modem
  - Evologics, Micromodem
Software Technologies
Operations and Results
Multi-vehicle front detection (2013)
• Multi-hop networks tolerant to disruptions
• Heterogeneous network links
Sunfish tracking (2014)
Sunfish tracking (2014)

- Situational awareness provided in real-time to scientists
- High-level control of AUVs using Iridium
- Plans adapted onboard by AI planner (T-REX/EUROPA)
Sunfish tracking (2014)

Correlation between fish density, plankton and the Huelva front
Oil Spill Detection (2015)

- Surface plume detection using UAVs
- Underwater detection / confirmation using AUVs (oil/rhodamine sensor)
- Coordinated execution of multiple vehicles
- Demonstration using 4 AUVs, 2 UAVs, 1 ROV, 1 ASV
REP-Atlantic (2010-?)

- Annual exercise organized by LSTS and the Portuguese Navy
- Novel ConOps using fleets of autonomous vehicles
- Coordination of Navy / LSTS / partners assets

Ops with NRP Arpao
Whale tracking (REP15)

- Tracking whales for environmental characterization with UAVs
Whale tracking (REP15)

- Tracking whales for environmental characterization with AUVs (CTD/HOLO/Fluorometer)
Archaeology Surveys (2017)

- AUVs equipped with
  - Self-compensating Magnetometer
  - Sidescan Sonar
  - Video Camera

- Major breakthrough in Esposende
  - Ship from Portuguese discoveries (circa 1530) was found
Internal Wave Detection (REP17)
River Plume Tracking (2017)

- Use multiple vehicles to detect and sample plume in-situ
- UAVs used to detect front, AUVs used to sample and track the plume autonomously
River Plume Tracking (2017)
Ongoing and Future work
Ongoing and future work

- Autonomous UAV front tracking
  - Automatic detection (infrared) and autonomous tracking

- Autonomous ASV+AUV deployment / docking

- Integration of wind, currents, AIS in automated planning

- Automated Habitat Mapping
  - Bottom characterization using Sonars / ML

- 24/7 operations
  - Migrating agents software infrastructure
  - Web-based situation awareness and control of multiple assets
EUROPtus – Mixed-Initiative Controller for Multi-Vehicle Oceanographic Experiments

Thank you!

http://lsts.pt