

Cooperative Perception of the Surrounding Environment

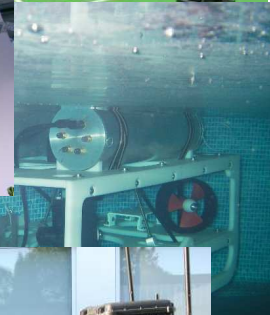
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INESC Porto - Who we are

- INESC Porto -
- R&D Institution
- ISEP – Porto Polytechnic School of Engineering

- INESC Porto – Robotics
 - Industrial robotics
 - Field robotics
 - Aerial robots
 - Ground vehicles
 - Marine and
 - underwater vehicles



Robot tools



- Air, land and sea autonomous vehicles
- Grifo UAS prototypes
- ROAZ Unmanned Surface Vehicle
- Outdoor UGVs



An aerial view of a simulated environment showing various robots. In the upper left, a large red and white helicopter flies. To its right, a small white and blue fixed-wing aircraft is visible. Below the helicopter, a red rescue boat is shown. In the center, a black quadcopter drone hovers. At the bottom right, a red catamaran-style boat is on the water, emitting a wide, semi-transparent red cone of light that illuminates a dark object floating in the water. The background consists of a blue sky and a dark, silhouetted mountain range.

Monitoring the SRA – robots for surveillance and exploration

Product Visions

- Border Surveillance
- Disaster Management

Disaster management application

- Example: Search and rescue at sea
- Autonomous surface and aerial robot cooperation scenario
- UAVs as search platforms
- Surface robots search as rescue support

- Challenges
 - Detection of people at surface
 - USV and UAV design
 - Platform control and cooperation
 - Integration in the manned search and rescue operational scenario
 - Communications
 - Regulations and legal issues

Border Surveillance

Example: extended decentralized perimeter surveillance

- Autonomous surface/terrestrial and aerial robot cooperation scenario
- UAVs as search platforms
- tracking/event detection, in hostile environments
- Challenges
 - Detection of people and objects
 - USV/UGV and UAV design
 - Platform control and cooperation
 - Integration in the manned search and surveillance operational scenario
 - Communications
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- All agree “Disaster Management and Border Surveillance can benefit from multi-robot cooperation”
- inter-related components of multi-robot cooperation
 - Motion Coordination
 - Cooperative perception of the surrounding environment

Multi-robot cooperation

- Robot motion coordination
 - Current state of the art address formation for sensing and tracking but assume full knowledge of the formation state, little relevance is given to cooperatively tracking moving targets by a formation, and to the requirements this imposes to the formation geometry,
- Cooperative perception
 - To improve the target detection and tracking quality:
 - The vehicle formation geometry will change dynamically so as to optimize the accuracy of cooperative perception
 - Distributed sensor fusion
 - Assume limited communications

Robotics as a tool to cooperative perception

- Real scenarios mean real wireless communications, plagued with link failures and limited bandwidth, perception noise and motion dynamic.
- Real robots and moving targets imply real-time requirements, and cope reduced-dimension data representations
- Embedded frameworks that take into account power, communications and computational requirements, communications middleware to provide efficient use of the available resources, interoperability, heterogeneity abstractions, automatic re-configuration, and real-time communication protocols.

Robotics as a tool to cooperative perception

- Cooperation with human infra-structure
 - Mixed-initiative missions – human in the loop
 - Operation integrated with current human centered organization
 - Legal issues
 - Risk perception
 - Autonomous decision integration
 - Information sharing and integration
 - Cost/performance and economic issues

Scientific and technological challenges

- Dynamic 3D environment perception
 - Example; effort in SAA, and clouds modelling
- Decentralized low-communication full state estimation (cooperative SLAM)
- Dynamic goal driven formation control
- Decentralized data fusion
- Communications
 - Link failures
 - Low bandwidth
 - Range
- Increasing robot autonomy

Legal constraints operations

Overcome legal constraints

Example:

Last ICAO Circular 328 is a major step

But not takes in account Robotics cooperation.

Still mandatory to fly with:

VLOS;

pilot in chief; and

conservative security envelope

Thank you for your kind attention

- Final note
- Cooperation with GMES programmes
Verification of satellite data with Insitu data gathering tasks

