



Robots to the Rescue

Application to civil security scenarios, new trends and a Catalan outlook

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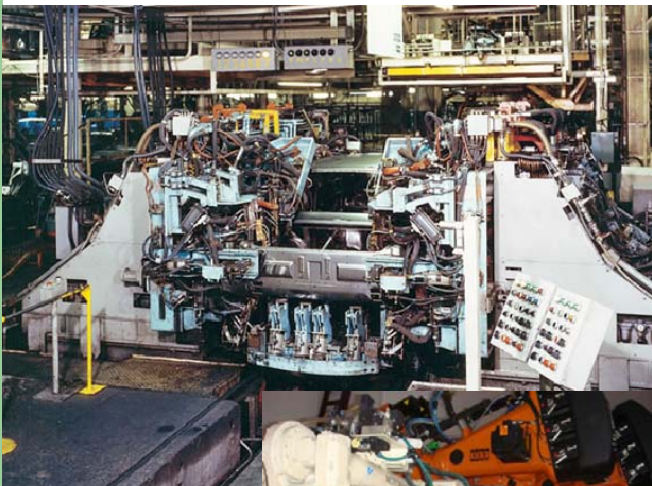
enric@ac.upc.edu



Which is your view about robots?



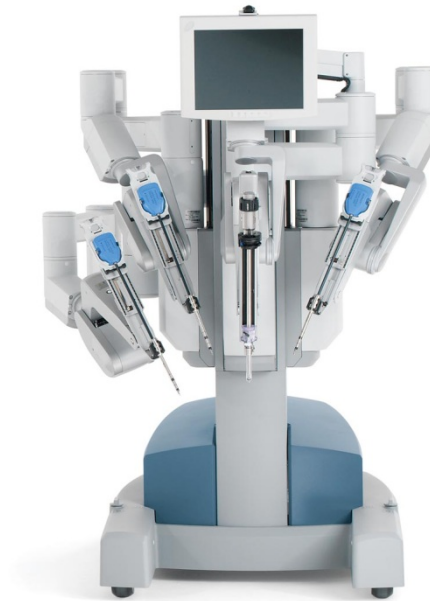
- We are slowly getting used to see robots around us:
 - Manufacturing
 - Humanoids
 - Space exploration



Which is your view about robots?



- And more recently at the hospitals and at home:



Which is your view about robots?



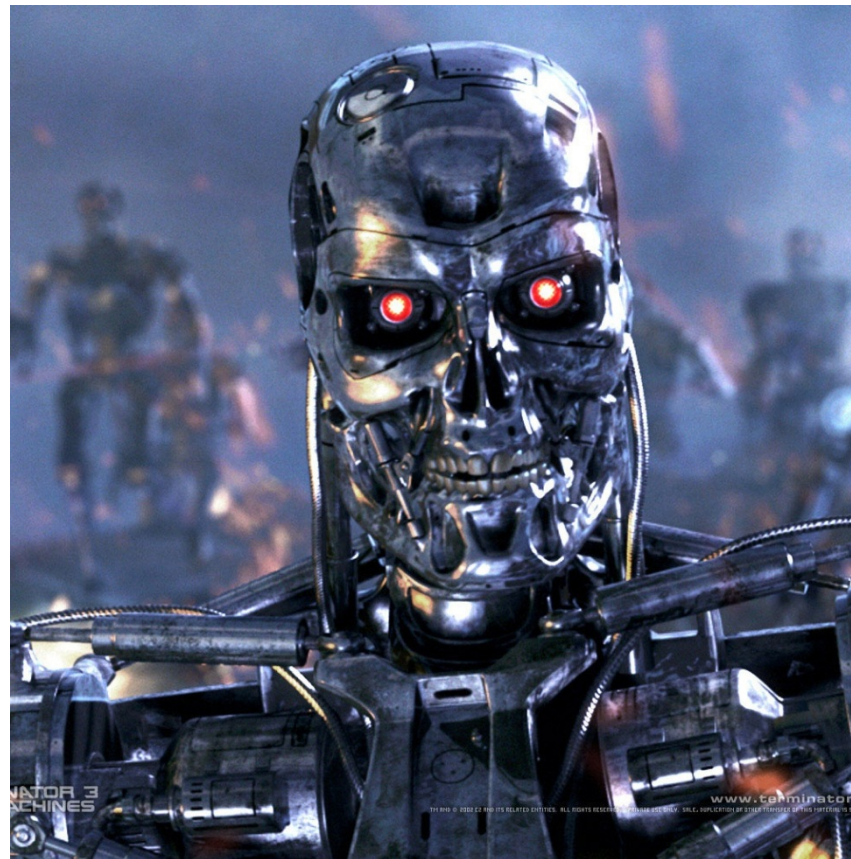
- Of course military is always there with new systems:



Which is your view about robots?



- So, do we have to be afraid??:



My positive view



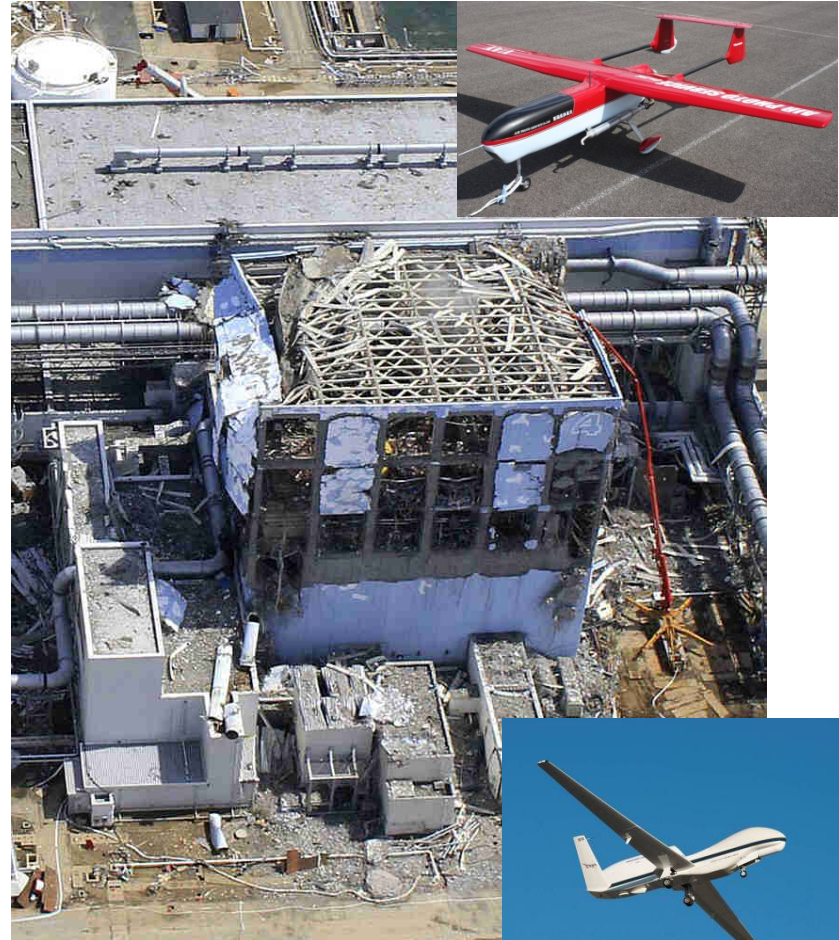
- NO, robots are here to help us:
 - In areas that we do not expect
 - To do dangerous tasks
 - To improve our security as citizens
 - To improve the security of public servants: police, fire fighters, rescue and medical personnel
- My goal today:
 - To give you a positive so that I can get your interest
 - To demonstrate that Catalonia is trying to lead in some specific areas



Fukushima is a good motivation

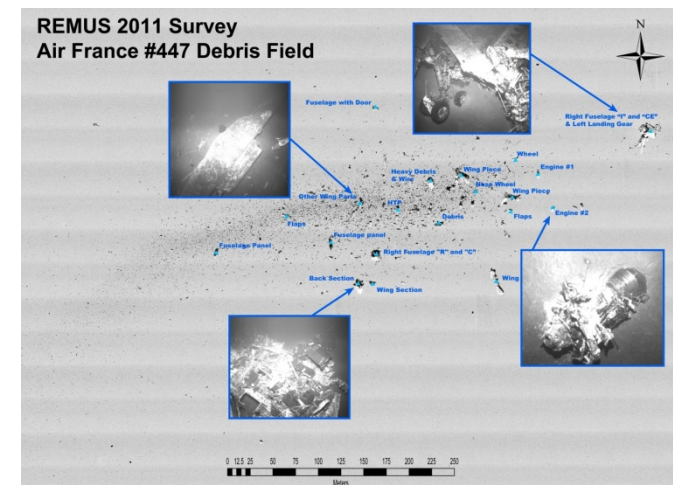
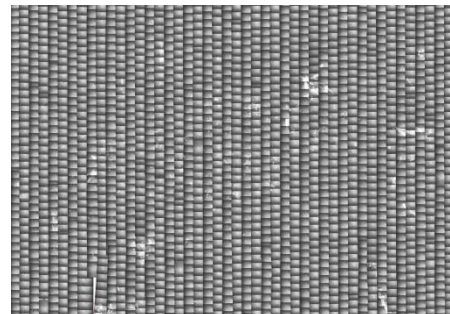
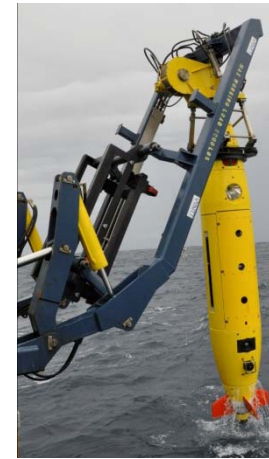


- Robots helped approaching the reactor and save lives.

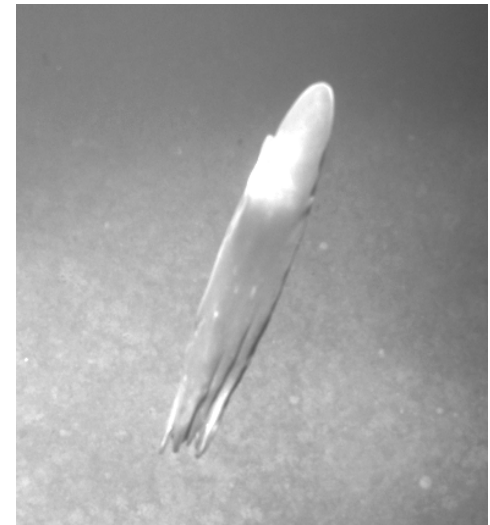
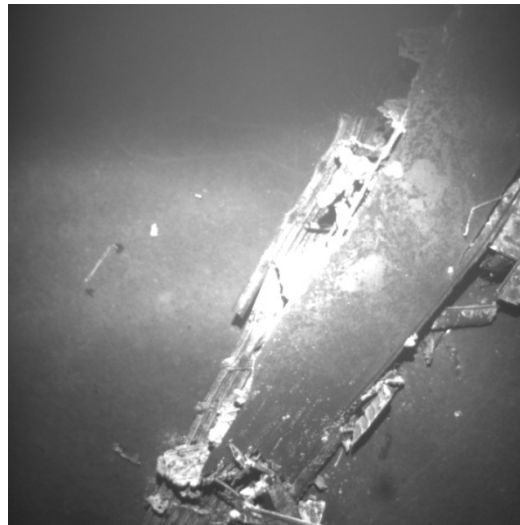
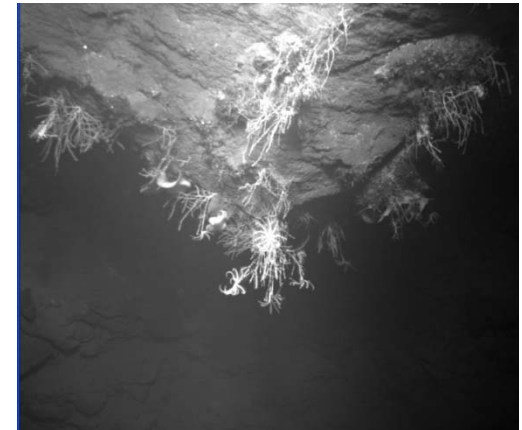
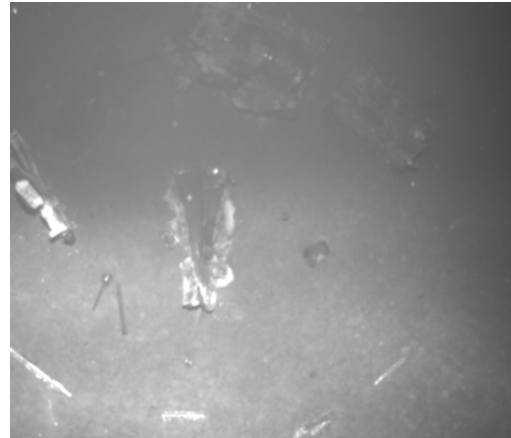
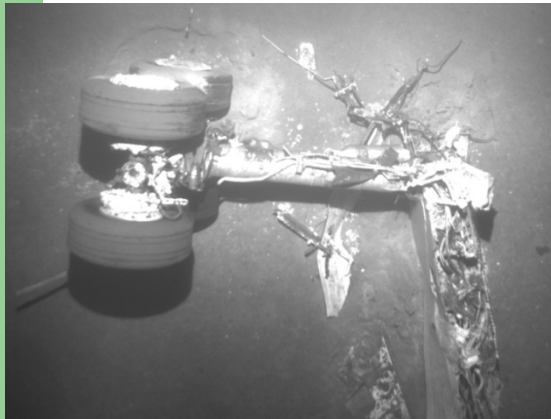


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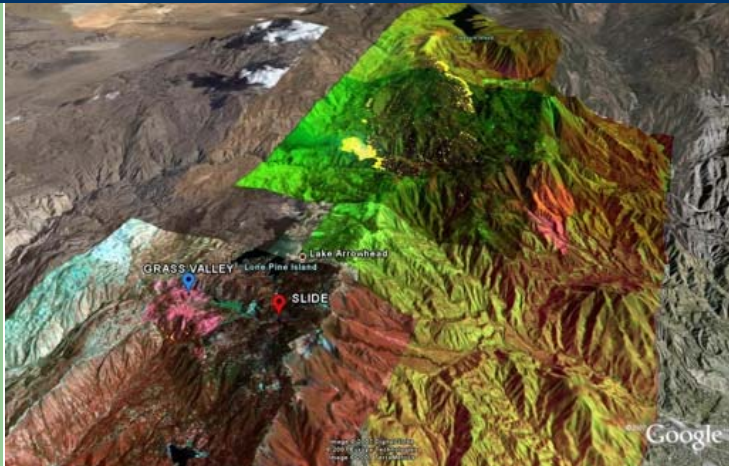


Air France 447 finally found

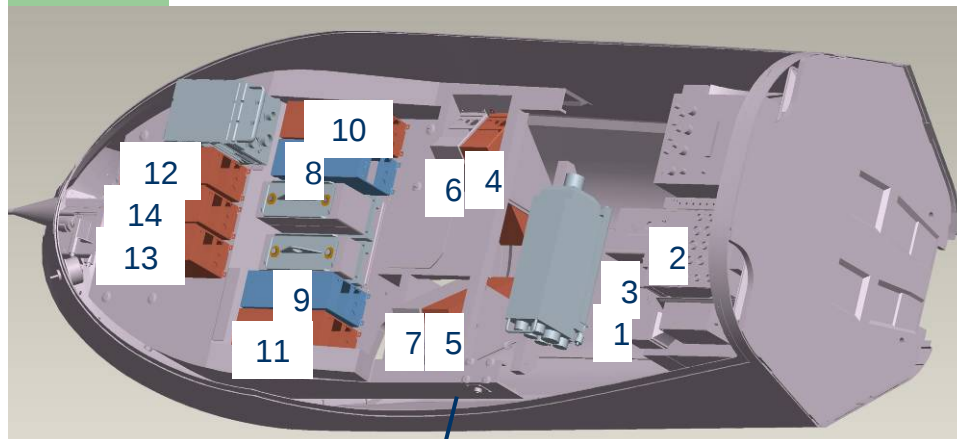


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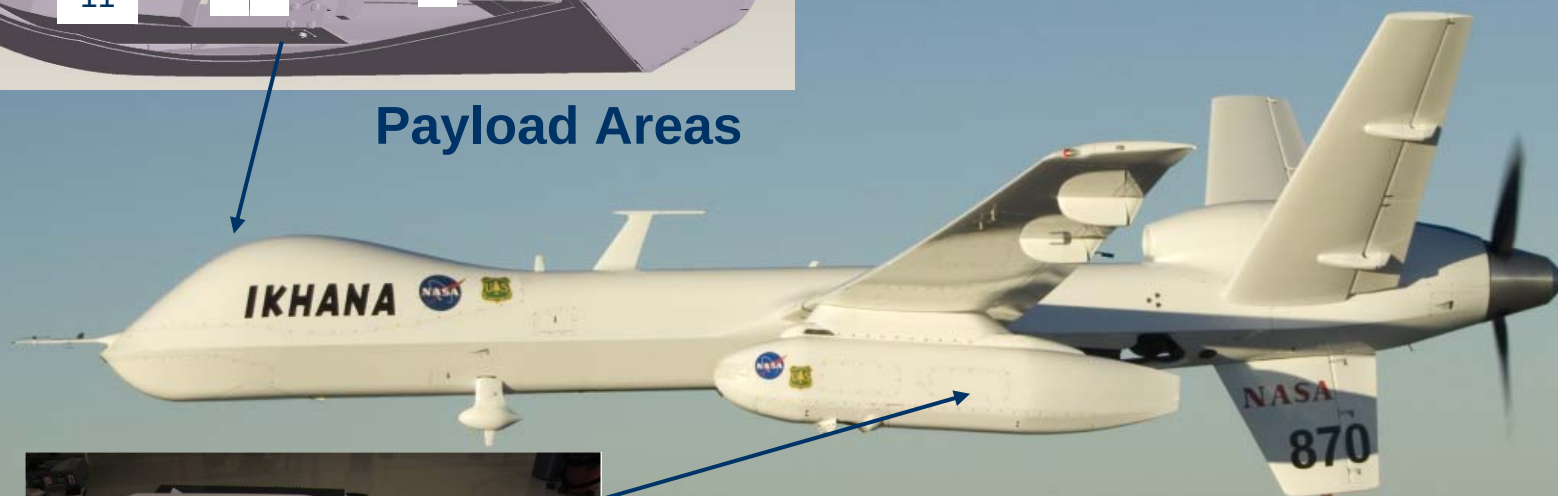
Western States Fire Mission



Western States Fire Mission



Payload Areas



Infrared Wildfire Scanner

Haiti Earthquake



- 7.0 Magnitude: 200,000 killed
- State Dept-> DoD MDSU2
- SeaBotix LBV
- Identify debris in shipping lanes, *integrity of port structures*, then manual divers could safely enter and clear.



Deepwater Horizon Oil Spill



- Explosion on drilling rig leads to massive underwater oil spill
- BP Oil Company
- Multiple ROVS
 - Schilling Ultra Heavy Duty
 - Oceaneering Maxximum, Millenium
- Perform inspection and manipulation
- Collided with and knocked out collection tube, Collided with collection cap, 1 ROV lost, May have been a collision between ROVS



Pike River Coal Mine NZ



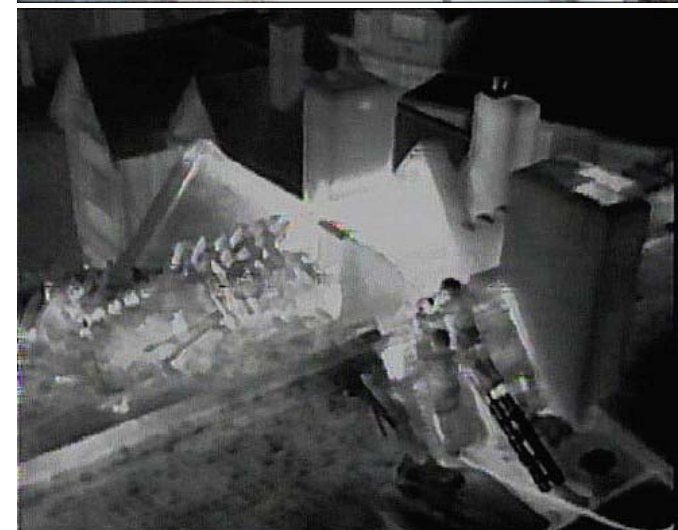
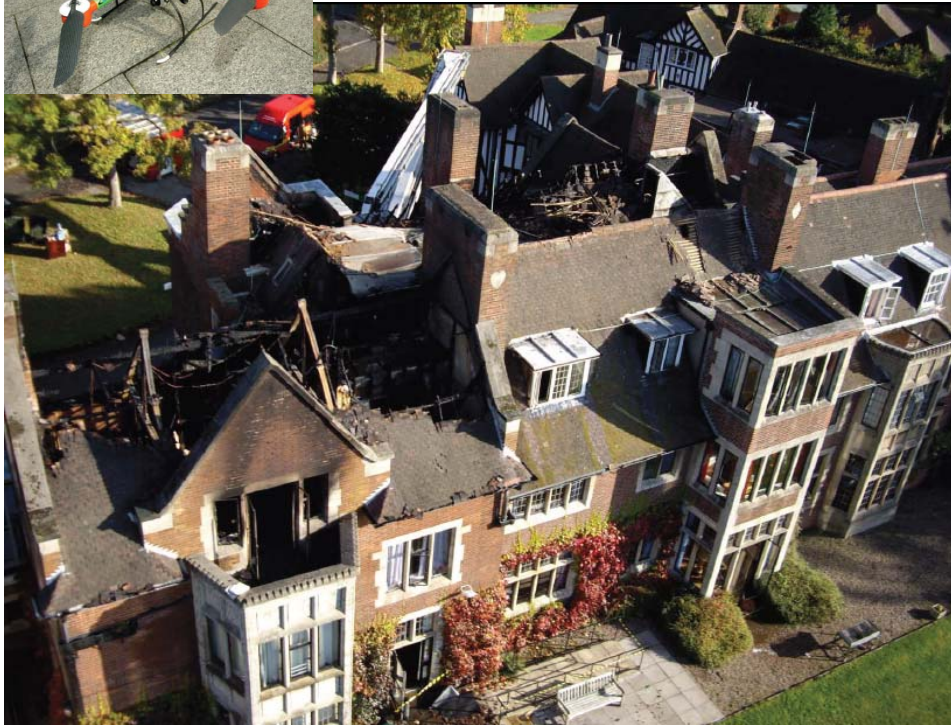
- Explosion, 29 miners killed
- Tasman Police District-New Zealand Defence Force, Australia Water Company, MSHA
- Multiple robots
 - 2 Unknown IED UGVs
 - *Australian pipe inspection robot*
 - *MSHA mine-permissible Wolverine*
- NZDF 1 failed due to water, was restarted then batteries died; NZDF 2 entered, but second explosion



Can help your local fire fighters



- Improve reactions and reduce unnecessary risks.

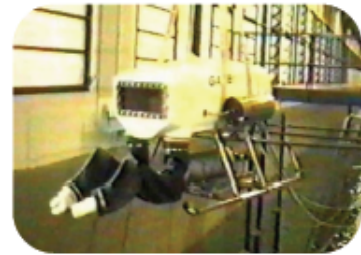


What are we doing in Catalonia?



- High level research and first class production vehicles in all main areas:
 - Underwater robotics (AUV)
 - Aerial robotics (UAS)
 - Ground robotics for security (ROV)
 - Participation in key European initiatives.
 - Although we miss having a common strategic agenda that improves our position in Spain and worldwide.





1995

1997

1999



2001

2003

2005



2007

2009

2011

2013



■ More than 15 years expertise

■ 6 vehicles designed & implemented

■ ROVs

GARBI^{ROV}

URIS

■ AUVs

GARBI^{AUV}

ICTINEU

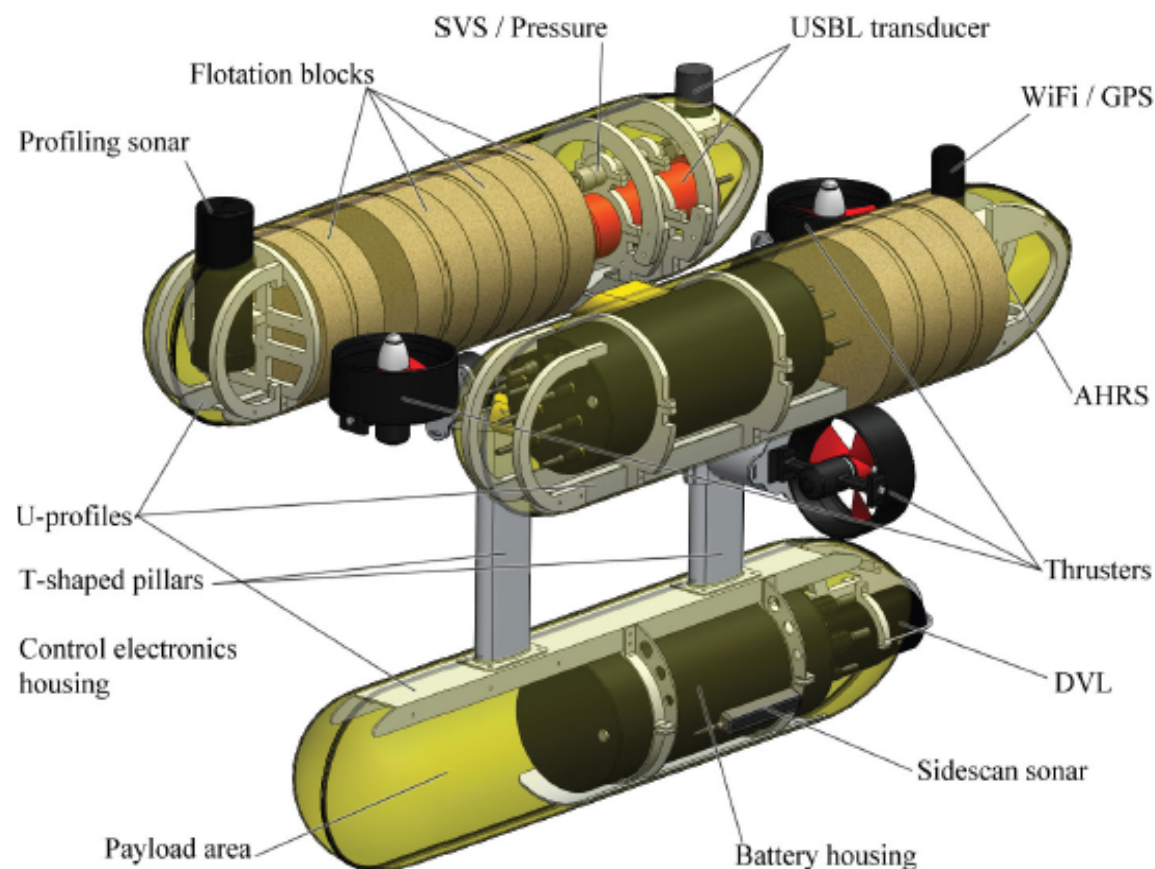
SPARUS

GIRONA500

} OPERATIVE

The Girona 500, a Multipurpose Autonomous Underwater Vehicle

Vehicle Description

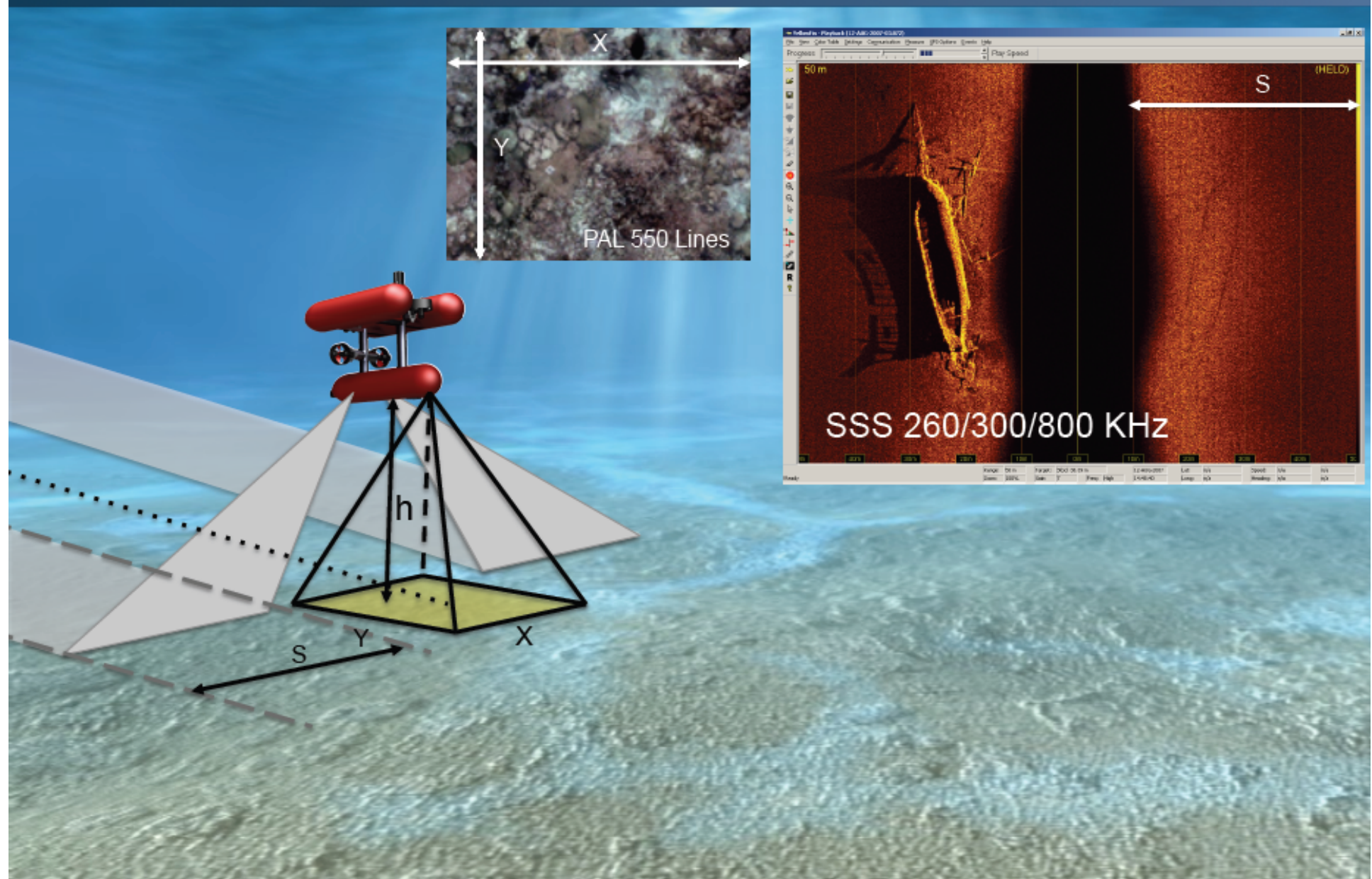


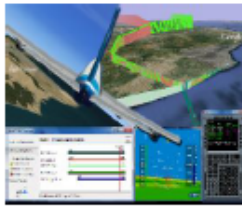
Vehicle specifications

Height:	1 m
Width:	1 m
Length:	1.50 m
Hull diameter:	0.3m
Weight in air:	from 140 kg
Maximum depth:	500 m
Energy:	2.2 kWh Li-Ion battery cluster
Endurance:	> 8hrs (Dependent on speed, payload and propulsion system configuration)
Propulsion system configurations:	from 3 thruster (3DoF) to 8 thruster (fully actuated).
Tracking:	emergency transponder.

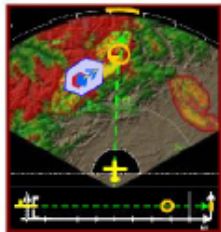
The Girona 500, a Multipurpose Autonomous Underwater Vehicle

Mapping Capabilities

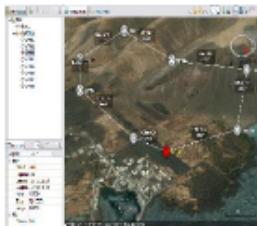




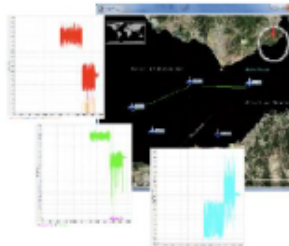
AVANT



WeaFusio



ITUMA



GEMA



AQUILES ROI



REHABILITA



LIFT

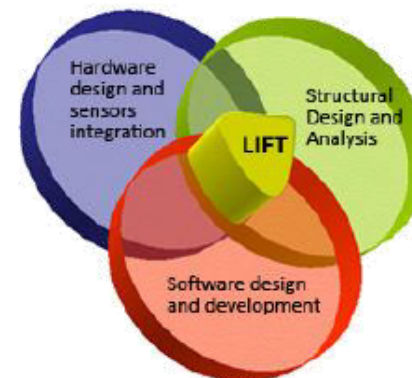


Rho³

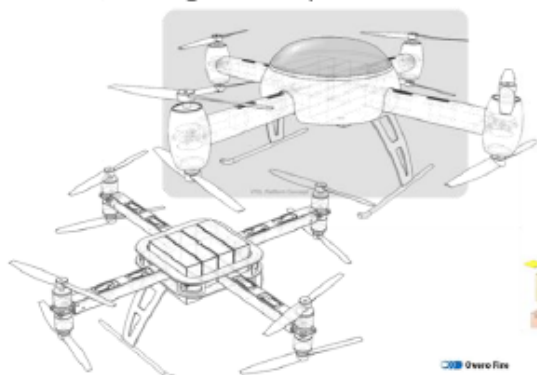


ICARUS: Integrated Components for Assisted Rescue
and Unmanned Search operations

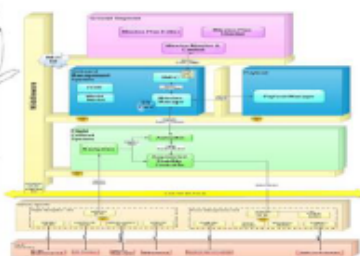
LIFT: End-to-end systems of an intelligent, small and low-cost unmanned aircraft system (UAS) platform.



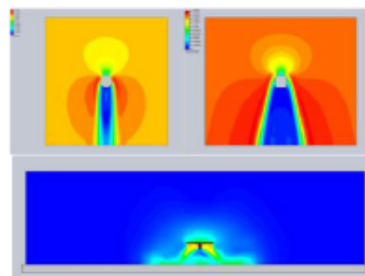
Design Concepts



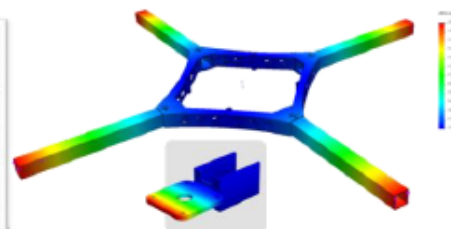
On-board Software



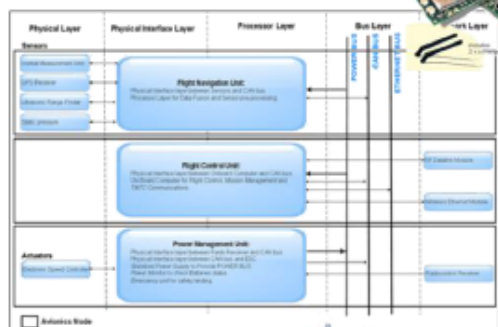
CFD Studies



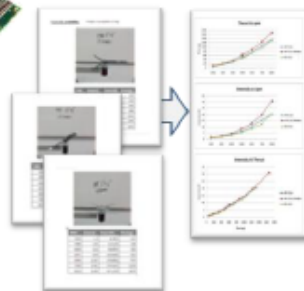
Finite Elements Analysis



Avionics and Electrical System



Propulsion test



Set of integrated components to **assist search and rescue teams in dealing with the difficult and dangerous, but life-saving task of finding human survivors**

- 4 UAVs, 1 light UGV, 1 large UGV with robotic arm manipulator, 1 maritime robotic raft capsule with 1 kit delivery capsule.
- Special thermal sensors tuned for victim detection.
- Command, control, communications, computers and intelligence (C⁴I);



An example of a International Satellite System for Search and Rescue (No ICARUS)

CLOSE-SEARCH

www.close-search-project.eu



The **CLOSE-SEARCH** project (European FP7/2007-2013) targets the *search* component in **Search-And-Rescue** missions

*...development of a **fully-autonomous UAV***

*...**thermal-vision** to search lost people*

*...**geo-reference a lost person***

and contact with SAR teams

*...**day-&-night** ... adverse weather...*



Coordination:



Partners:



CLOSE-SEARCH

www.close-search-project.eu

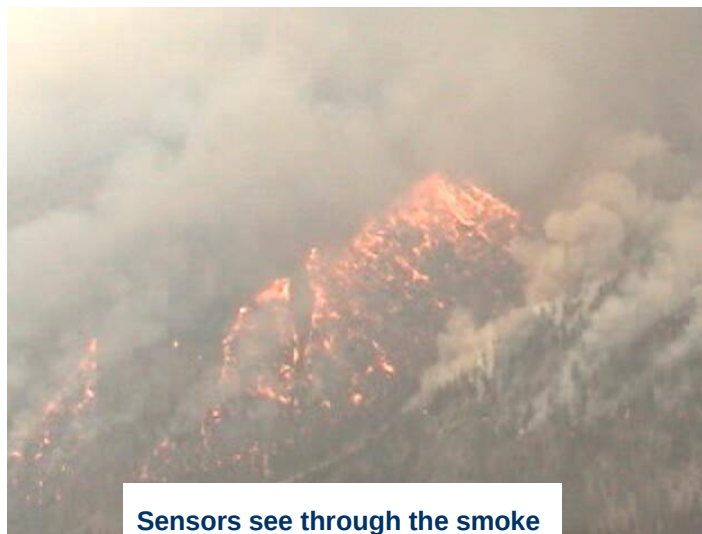
Safety in UAV missions must be ensured from high-level (mission, environment...) to low-level (electronics, navigation...).

CLOSE-SEARCH implements **ultra-safe navigation**, based on sensor **redundancy**, solution **robustness** against outliers and **confidence** bounds for position.



System	Error	Reliability
GPS (today)	$H < 5 \text{ m}$ $V < 10 \text{ m}$	
GPS-EGNOS (today)	$H \sim 1 \text{ m}$ $V \sim 3 \text{ m}$	
CLOSE- SEARCH (2012)	$H \sim 1 \text{ m}$ $V \sim 1 \text{ m}$	
Galileo (~2014)	$H < 1 \text{ m}$ $V < 1 \text{ m}$	

Technology must support fire fighting



Sensors see through the smoke



Real-time fire monitoring



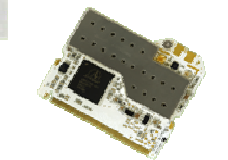
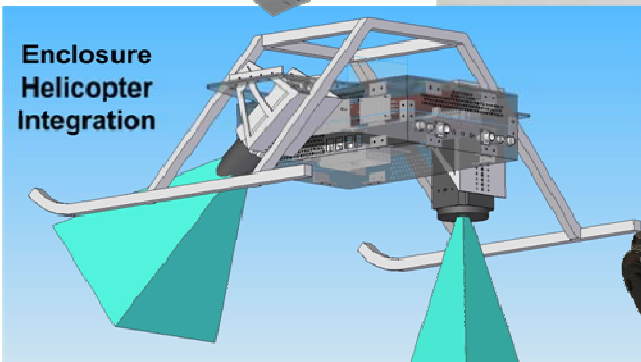
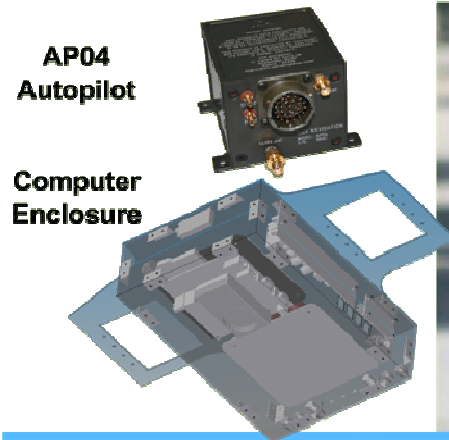
Reduce risk for humans



Monitoring during night

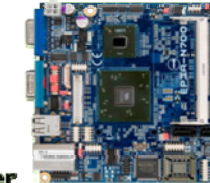


Sky-Eye development platform



WLAN Mission Communications

**Mission Computer
Flight Plan
Mission Management**



Thermal Camera

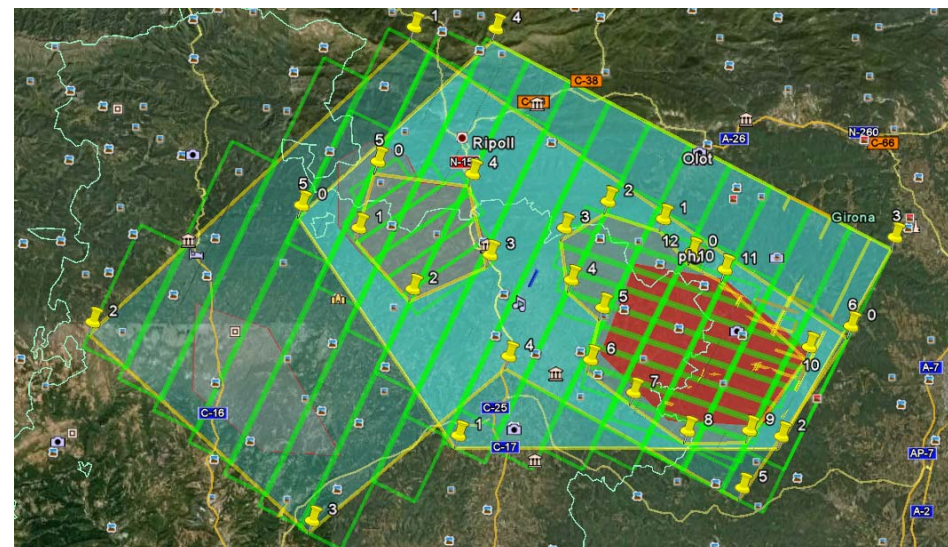
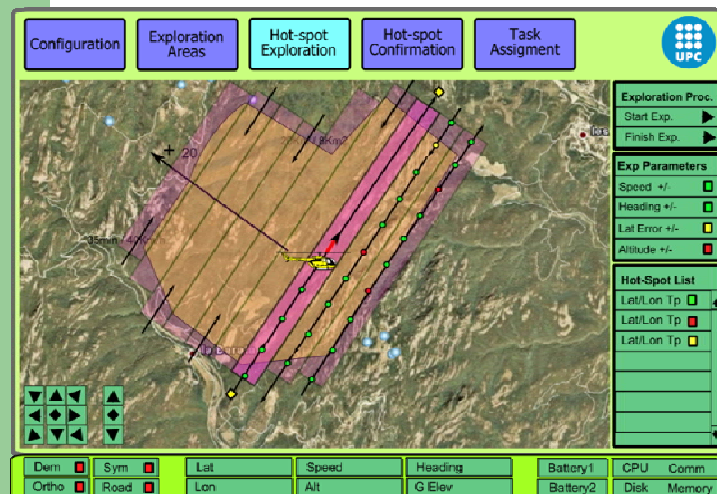
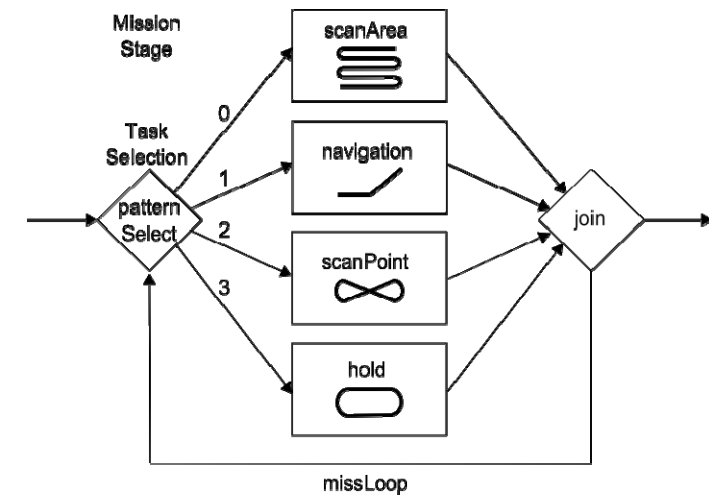
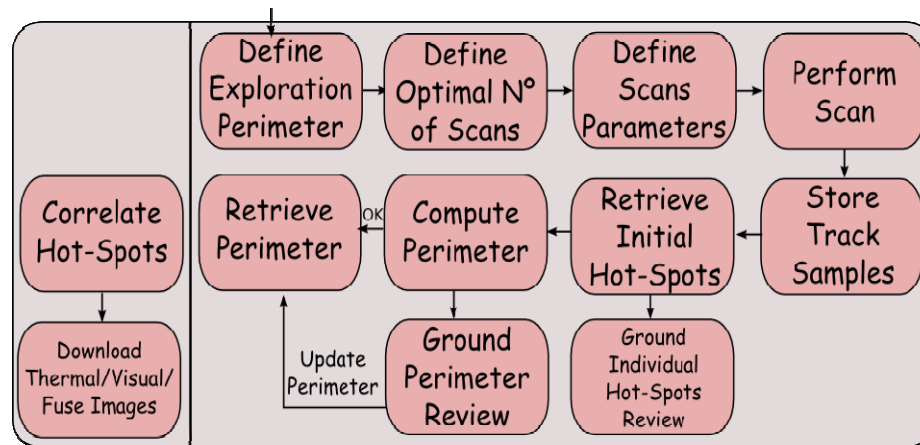
Pilot-view Camera

**3.5 Mpx
Visual Camera**

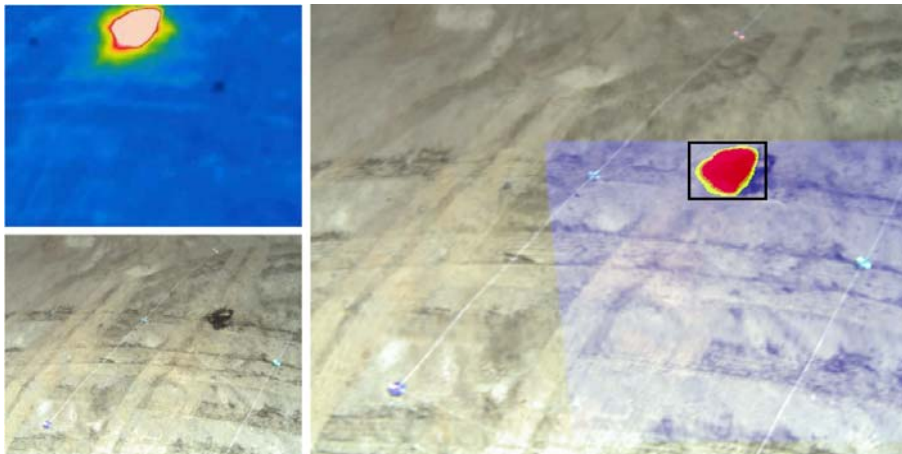


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Automation key for productivity



Automation key for productivity





SMOS Radiometers **Mobile Robotic Arm**



8 meters high and 4 degrees of freedom Mobile robotic Arm. It operates 2 radiometers (300 kg weigh each one) supporting 100Km/h winds with 1 degree inclination. Marine aluminium high precision machining.

aquiles I

- Wide..... 60 cm
- Large 110 cm
- Height 51 cm
- Platform weight 59 kg
- Arm d.o.f..... 4
- Arm weight 30 Kg
- Max. battery autonomy 2 hours
- Recharge time 4 hours
- Radio frequency range..... 1000m
- Night vision 15m
- Max. lift weight in arm..... 15Kg
- Made in aluminum-magnesium
- Suspension Air - Oil
- Connection of accessories..... "plug & play"



We appreciate the collaboration of





EOD, Risk Missions



Huge range of applications

aquiles protector

Nuclear & Chemical Facilities

- Wide..... 57 cm
- Large 103 cm
- Height 75 cm
- Platform weight 110 kg
- Arm d.o.f..... 6
- Arm weight 30 kg
- Max. battery autonomy 4 hours
- Recharge time 4 hours
- Radio frequency range..... 1000m
- Night vision 15m
- Max. lift weight in arm..... 15Kg
- Made in aluminum-magnesium
- Connection of accessories..... "plug & play"
- Transportable in standard vehicles



**Versatile
All terrain**





Telescopic Arm



aquiles protector

Equipment / Accessories

- Cameras (infrared, PTZ, thermal) according to customer requirements
- Telemeters (Large/Small distance)
- Spotlights
- Telescopic system with camera
- Accessories for NBQ systems and sensors
- Digital video system (4 video signals simultaneously)
- Bidirectional audio
- Frontal shelf
- Lasers



Improved mobility
6x6



Cameras
Control interface



Conclusions



- Lots of work to be done.
- Need to push national and international markets:
 - We are leading certain areas (e.g. ROVs, small UAS)
 - Have to generate products to avoid losing the opportunity
 - Keep doing R&D
- Complicity of end-users may provide the edge:
 - Critical evaluation by those how know the business
 - Help designing products that really fit the market
 - Increase confidence in the “*Catalan DO*”

