INESCTEC

|Centre for Robotics and Autonomous Systems|

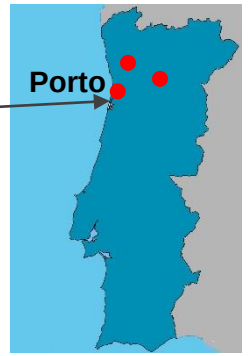
Discovering Technological Opportunities in Exploring the Deep-Sea, Earth, and Outer Space

Ana Pires

INESC TEC / ISEP Porto Polytechnic
Portugal

Research centers

isep Instituto Superior de Engenharia do Porto



- **R&D non-profit research center and technology interface institution**
- Researchers from multiple universities in northern Portugal
  - University of Porto
  - **Porto Polytechnic Institute - ISEP**
  - Univ. Minho
  - UTAD
- 725 researchers (350 PhDs) dedicated to R&D and advanced consulting

CRAS
Robotics and Autonomous Systems

CRIIS
Robotics in Industry and Intelligent Systems

CITE
Innovation, Technology and Entrepreneurship

CESE
Enterprise Systems Engineering

CEGI
Industrial Engineering and Management

CAP
Applied Photonics

CTM
Telecom. and Multimedia

C-BER
Biomedical Engineering

CPES
Power and Energy Systems

CSIG
Information Systems and Computer Graphics

LIAAD
Artificial Intelligence and Decision Support

CRACS
Advanced Computing Systems

HASLab
High-Assurance Software

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Center for Robotics and Autonomous Systems

Make robotic and other autonomous systems able to operate in **complex**, **unstructured** and **dynamic environments** with increasing levels of autonomy, by enhancing their perception, understanding, reasoning, decision, and interaction capabilities.

Motivation & Drivers

The Extension of the **Portuguese Continental Shelf**, and **the national Plan for Recovery and Resilience**.

Horizon Europe Missions

- Adaptation to Climate Change
- Restore our Ocean and Waters
- Climate-Neutral and Smart Cities

UN Sustainable Development Goals

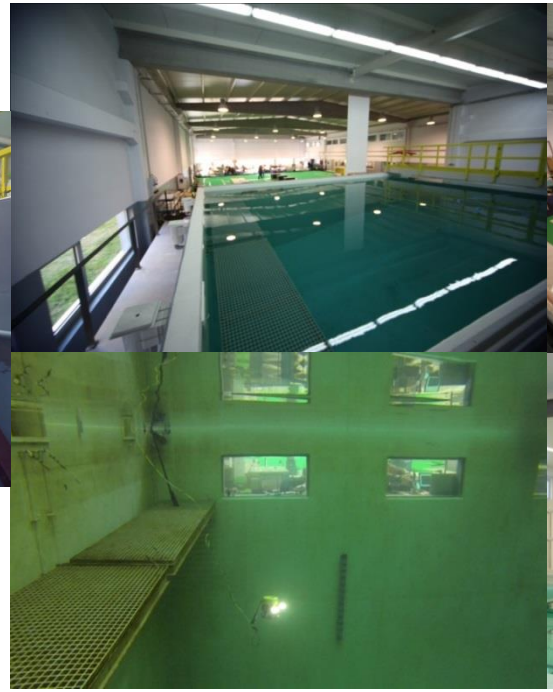
- Clean Water and Sanitation
- Climate Action
- Life Below Water

RL1 – Navigation & Control
RL2 – Interaction with Environment
RL3 – Mapping & Real Time Perception
RL4 – Platforms & Operations
RLNew – Space Geo-Robotics and Geo-Technologies

INOV1 – Robotics systems prototyping and upscaling
INOV2 – Navigation and mapping
INOV3 – Component development for robotics systems
INOV4 – Underwater acoustics for positioning, navigation and communications

Robotics & Autonomous Systems Laboratory

- More than 1000m2 of lab space
  - Large indoor space robot testing
- Two test tanks
  - 10 x 6 x 5 m
  - Underwater vision-based ground-truth system
- Hyperbaric chamber
  - 750 bar (7500m)
  - 400 bar (4000m)
- Production facilities
  - CNC, 3D printing etc.

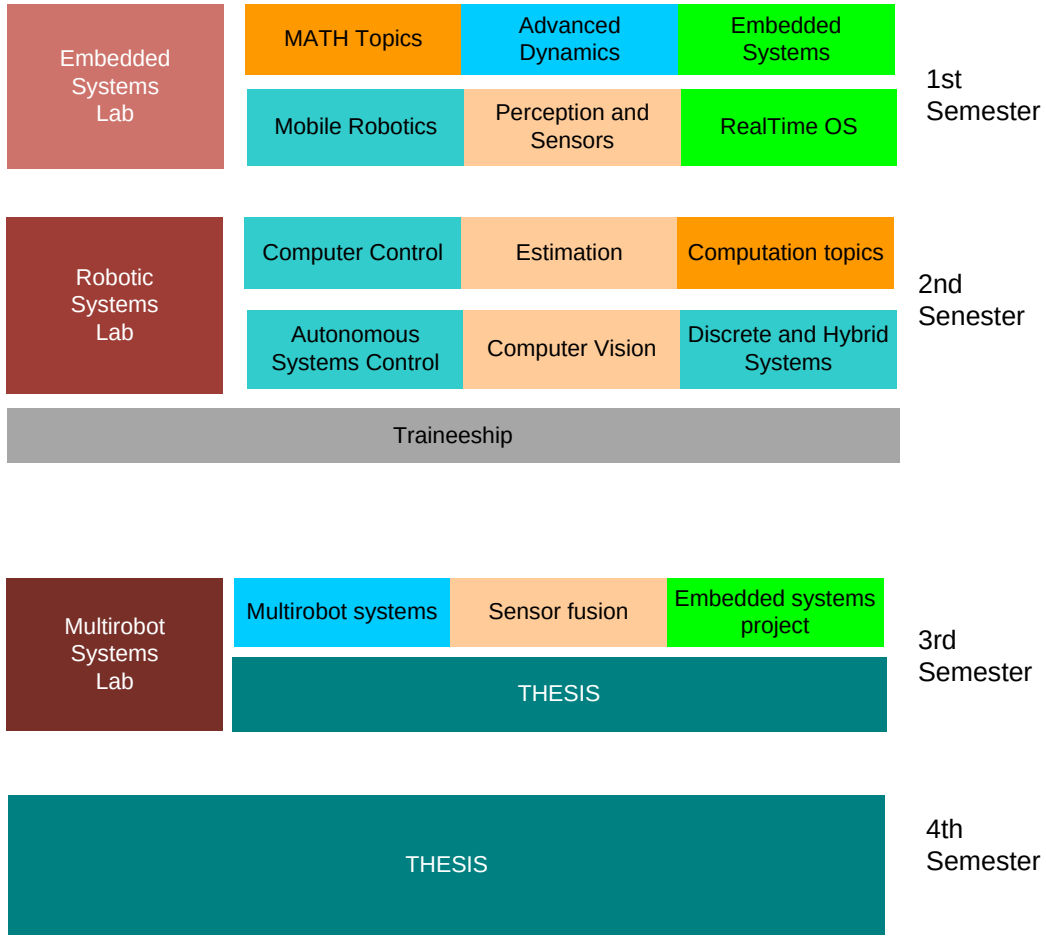


Research Vessel *- Mar Profundo -*

- Coastal research and technology development vessel
- Catamaran, 19m length
- A-frame 1.5 ton and 700 kg crane
- On board lab
- Capacity for 9 researchers
- Ocean operations, tailored for missions up to 60 nautical miles

Research support MSc. EEC - Autonomous systems

- **MSc. Electrical and Computer Engineering – Autonomous Systems**
- Trimester curricular units + semester laboratory
- Continuous work oriented and integrated with laboratory research work.
- **High degree of student participation in lab research activities**
- International networking
- Robotics competitions



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Scientific capability building & Research infrastructures

Scientific capacity building (H2020 CSA/Twinnings)

STRONG MAR

Strengthening Maritime Technology Research Center (finished)

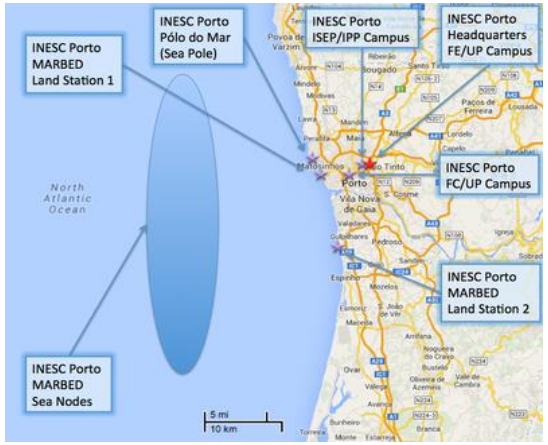
DEEPFIELD

Deep learning in field robotics: from conceptualization towards implementation (on going)

- Scientific training
- Joint research activities
- Summer/winter schools
- Research of excellence on the areas of marine technology and robotics and deep learning in field robotics

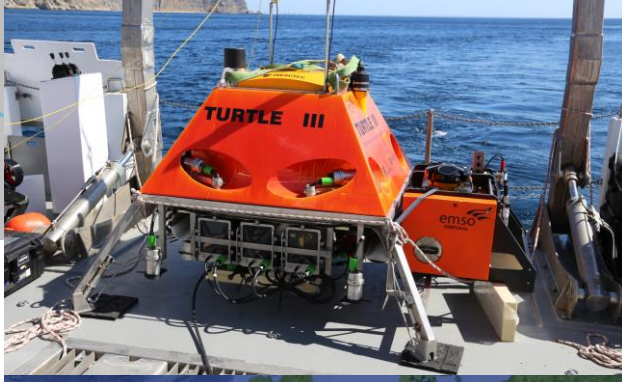
TEC4Sea National research Infrastructure

- National Research Infrastructure for development of technology for the sea
- Integrated in national research infrastructure strategic plan (5.3 M€)
- Instrumented open sea area on the north Portuguese coast
- 20m long sea operations research and support ship
- Mobile laboratories and operations support
- Specialized sea technology labs and equipment



Support research, development, and test of marine robotics, telecommunications, and sensing technologies for monitoring and operating in the ocean

EMSO-PT



- **Integrated in national research infrastructure strategic plan**
- **Part of European Multidisciplinary Seafloor Observatory (EMSO)** - *Real time monitoring for long time periods environmental processes related with interaction between geospatial/biosphere/ hydrosphere*

Atlantis

The Atlantic Testing Platform for Maritime Robotics

- **Establish a pioneer pilot infrastructure in the Atlantic Ocean**
- **Demonstrate key enabling robotic technologies for inspection and maintenance of offshore wind farms**

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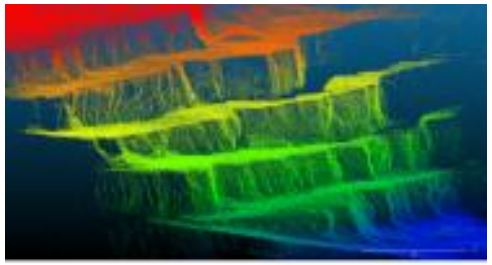
Aerial robotics

Underground 3D mapping and reconstruction

Aerial robotics

- Research
  - Perception and navigation
  - Hyperspectral imaging
  - 3D modeling
  - Semantic perception
- Applications
  - Security
  - Search and rescue
  - Disaster management
  - Mapping
  - Infrastructure inspection



MineHeritage

Historical Mining – tracing and learning from ancient materials and mining technology

Wider Society Learning project that intends to use Cultural Heritage, Mining and Raw Materials to create popular educational tools for the dissemination of the importance of Raw Materials to society through historic periods

Segment: Wider Society Learning

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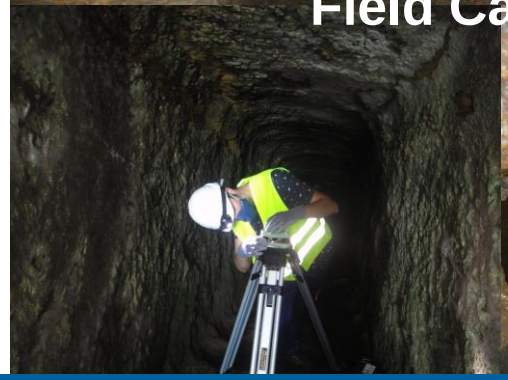
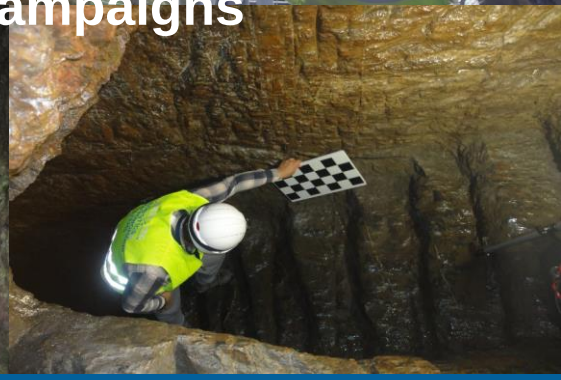
GeoTEC SYSTEM
STORK I | UAV

Made in INESCTEC, Portugal

Field Campaigns





FINAL OUTPUTS

GeoTec system | 3D mapping and imaging – Main Tunnel

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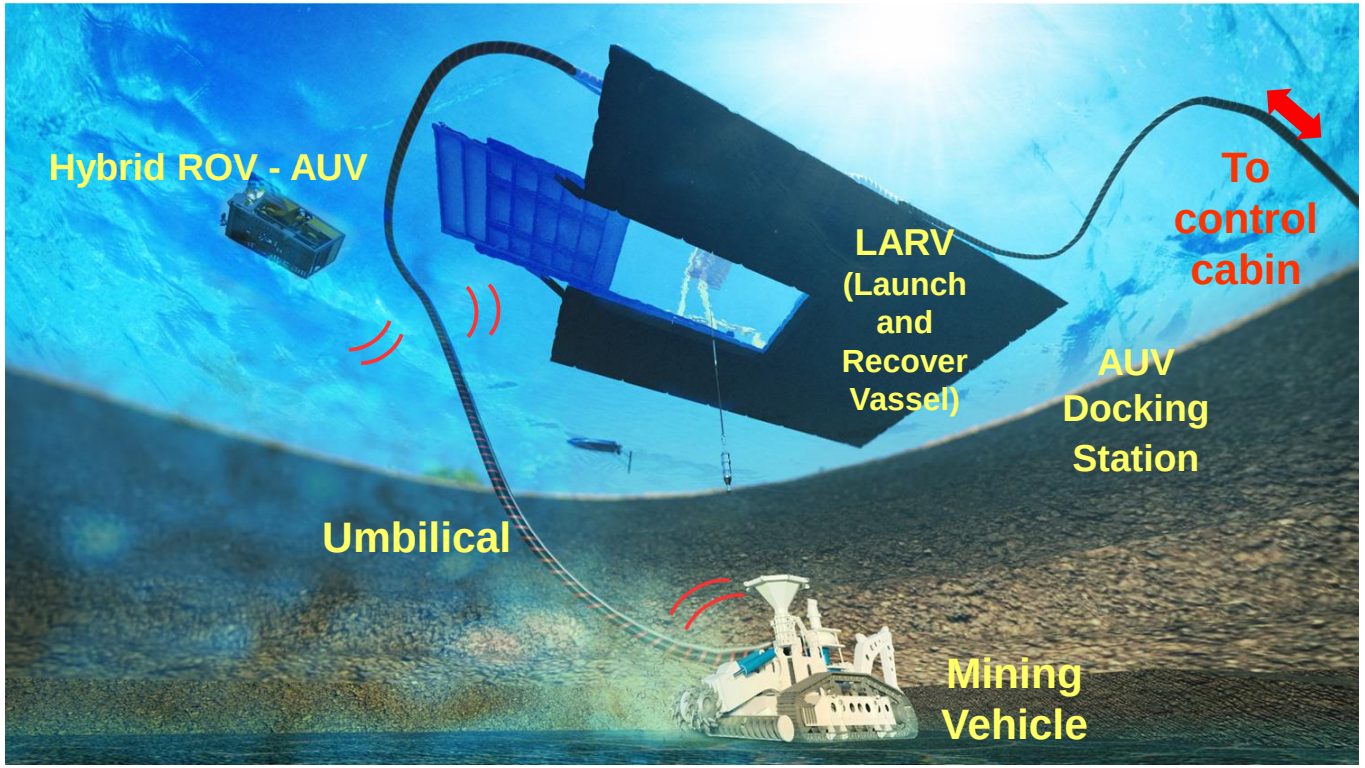
Marine and Underwater robotics

VAMOS – Viable Alernative Operating System

- EU H2020 Raw Materials project
- **New underwater, commercially viable robotic mining technology**
- 12.9 M€, 2015-2019, 17 partners, 9 countries
- Partners: BMT, SMD (UK), INESC TEC, Damen Dredging (NED), Trelleborg (NED), Sandvik (AU)...
- INESC TEC: Positioning, navigation and awareness system

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642477.

VAMOS System Overview



Command and Control
VR based interface

Hybrid ROV / AUV

Remoted operated Mining Machine

Support Vessel

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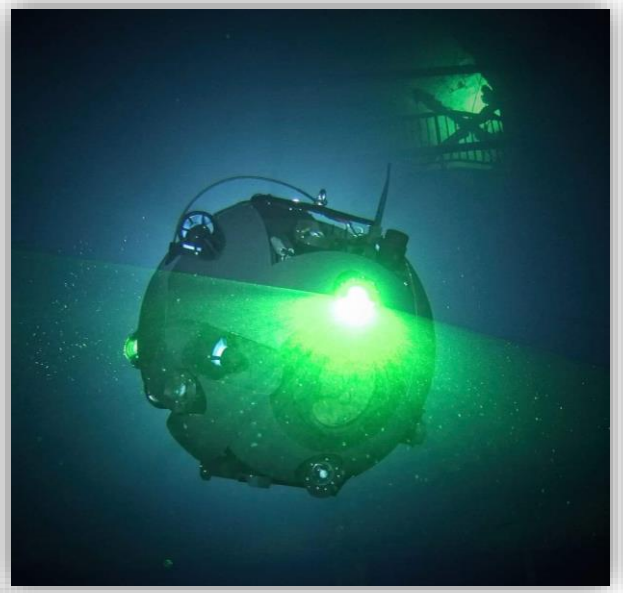
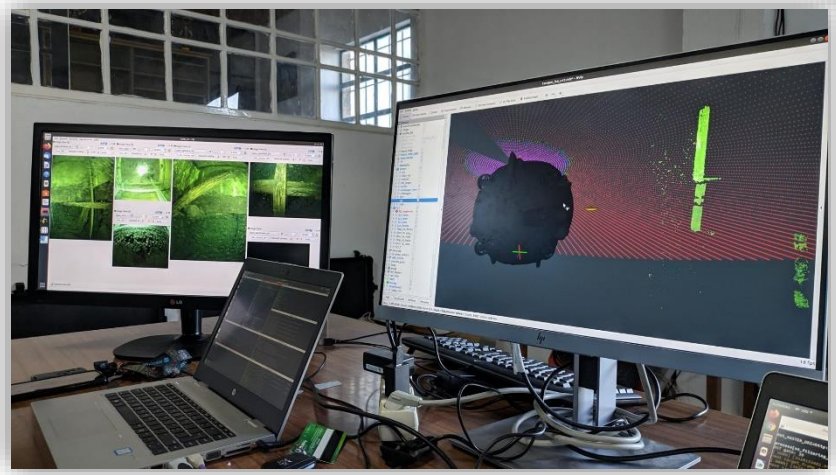
UNEXMIN Project

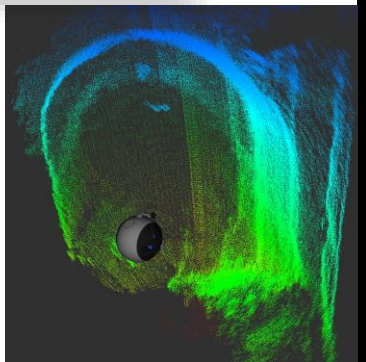
European Union's Horizon
H2020 research and innovation program
+ info: www.unexmin.eu



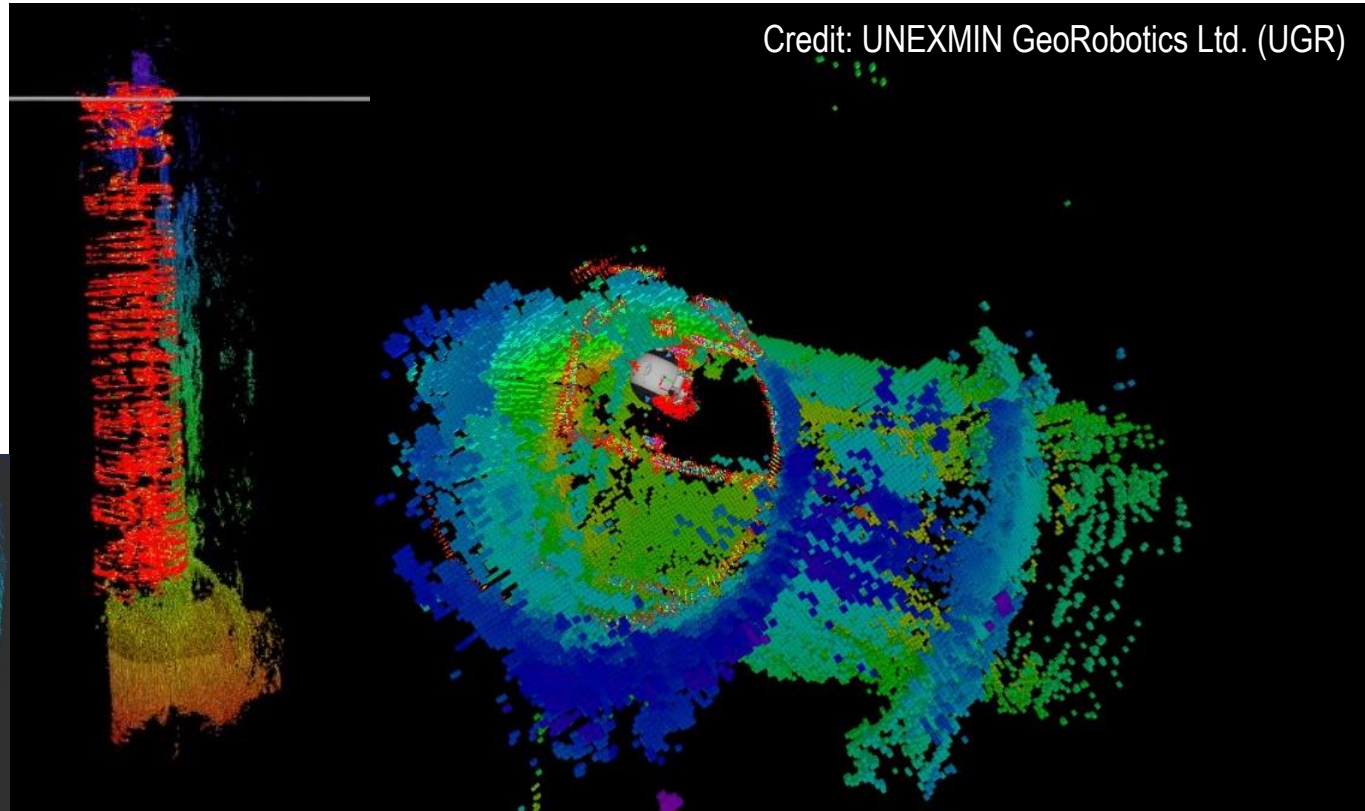
UNEXUP

Upscaling Project funded by EIT Raw Materials
+ info: www.unexup.eu





- Challenging scenarios
- Mapping
- Perception
- Navigation and Localization



Credit: UNEXMIN GeoRobotics Ltd. (UGR)

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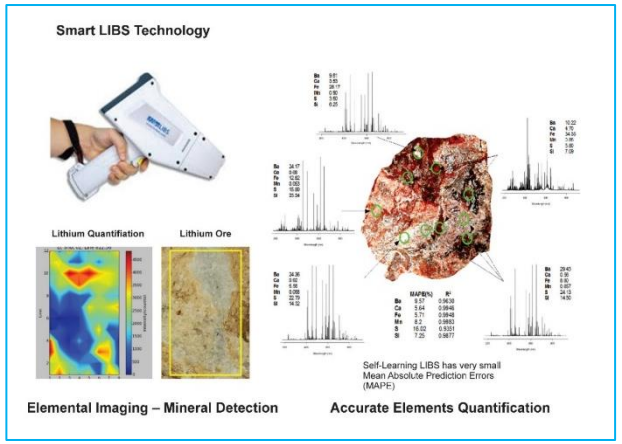
Future Perspectives & Future Geotechnologies

INSite Project

Insitu ore grading system using LIBS in harsh environments, funded by EIT Raw Materials a body of the European Commission, on going project

+ info1: https://twitter.com/INSiteProj
+ info2: https://www.linkedin.com/in/insite-project/



First Prototype tested by potential costumer, prepared for field tests

Field Tests in real environment - aggregate production facility in Žerjav, Slovenia

- ***(October 2022)***

EITRM115926
O4.2 Demonstrator of a Portable LIBS system

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Space Geo-Exploration Project: Development of Geo-Technologies

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INTERNATIONAL INSTITUTE FOR ASTRONAUTICAL SCIENCES

NASA'S FLIGHT OPPORTUNITIES PROGRAM

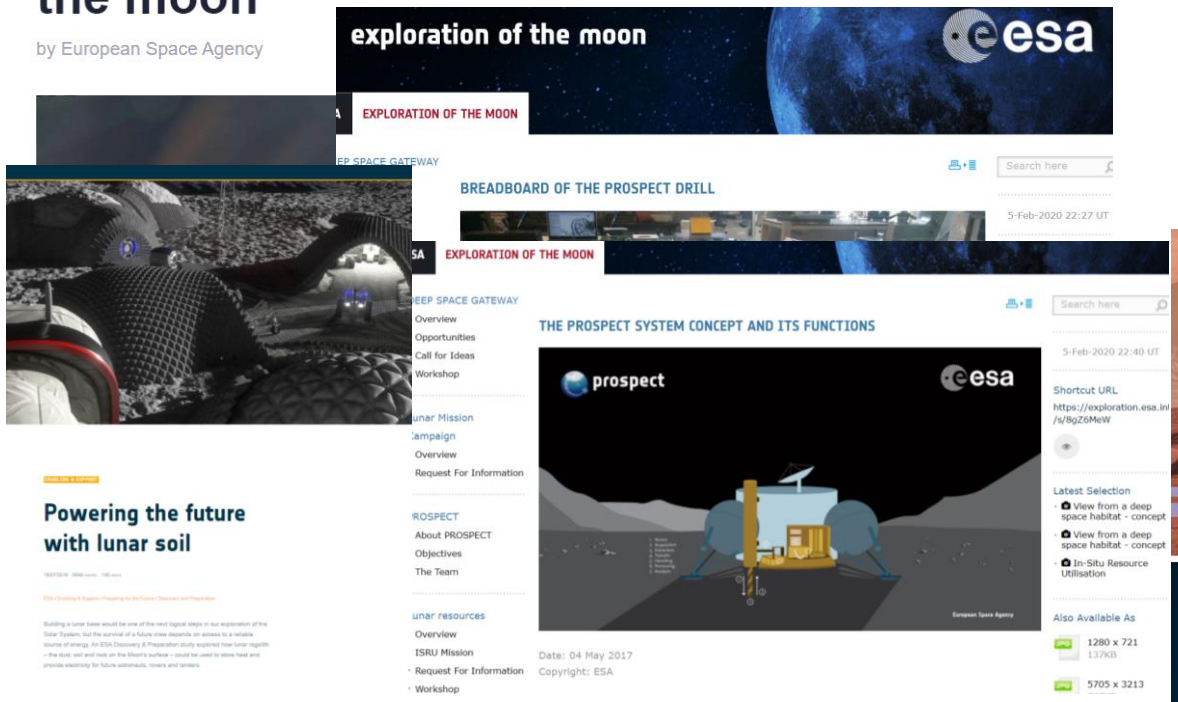
APPLIED ASTRONAUTICS PROGRAM

International Institute for Astronautical Sciences

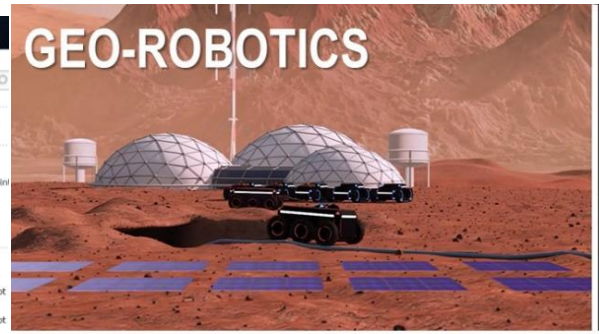
DEVELOP TECHNOLOGIES

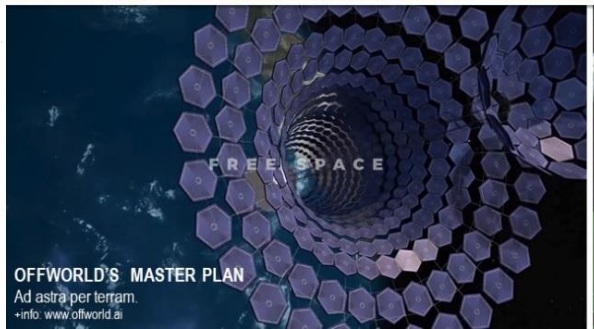
EXTREME ENVIRONMENTS
ENGINEERING SPACE AND SEA
SPACE-EARTH-SEA INTERACTION

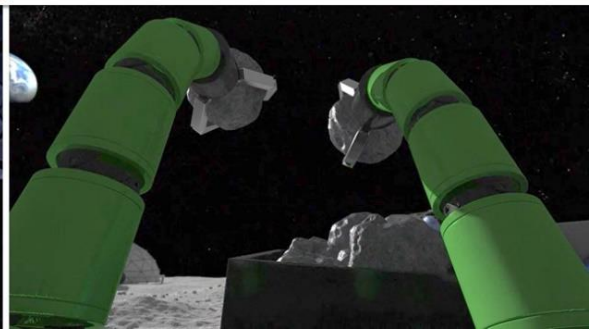
NASA and ESA tests system for recovering downed astronauts on the moon



SPACE RESOURCES (ISRU CONCEPT)







SPACE GEO-EXPLORATION
SPACE MINING

Looking ahead… Towards the Future!

- Underwater perception a major research
- New sensing capabilities
  - Hyperspectral
  - In situ – spectroscopy
  - Biological information sensing and in situ processing
  - …
- New approaches for information interpretation (AI, distributed multiple system based, etc)
- Pushing the boundaries of underwater robotic technology with innovative applications
  - Long term permanence
  - Underwater cargo transport
  - Seabed processing
  - …
- Other emergent **R**esearch **L**ines
  - Space Geo-Robotics and Geo-Technologies
  - Space Resources and Space Mining
  - …

Students Opportunities

- **To work aligned with the Research Lines previously presented**
  - ***Or other thematic that can merge with our main topics (after analysis and discussion with our Coordinator)***
- **Educational Internships**
- **Master Thesis Supervising**
- **Or (when possible) internship or research development under the scope of a project**
- The possibility to work very closely with our researchers and networking (several partners involved in many of our projects)
- Transfer Technology learning (Industry connection)

Thank You for Your Attention…

Ana Pires

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