



UNIVERSIDAD DE MÁLAGA

# Space Robotics Laboratory 2016 - 2023



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UNIVERSIDAD  
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# Space Robotics Laboratory



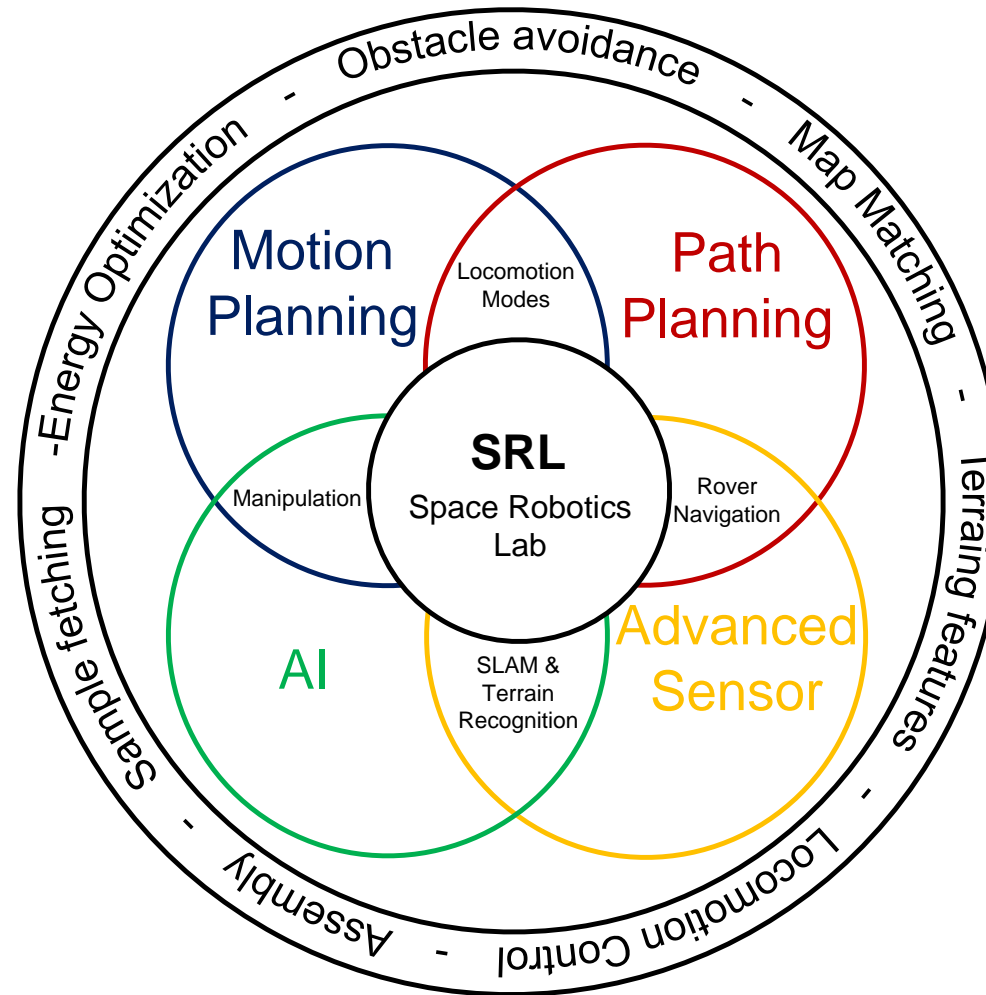
- **Started in 2016** with the signature of the first contract between the European Space Agency and the University of Malaga to research novel methods to improve autonomy on rovers.
- **It belongs to the group of Systems Engineering and Automation, which has more than 30 years of experience in robotics.**
- **Mission:**
  - Research novel methods to solve issues related to space robotics.
  - Earth to Space technology adaptation and vice-versa.
  - Training future engineers in the field of space robotics.
  - Collaboration with other research institutions on joint projects.
  - Technology transfer to industry.
- **Main Collaborations:**
  - European Space Agency: Research activities and training.
  - DFKI: Joint EU projects and PhD.
  - GMV Aerospace S.A.U.: Joint EU and ESA Projects
  - Andalusian Institute of Astrophysics (CSIC): Joint Research Unit



European Space Agency



- **Main objective:** Research how to increase autonomy in planetary exploration vehicles.





- **Long & short range path planning:**
  - Using global maps provided by orbital imagery.
  - Reacting to obstacles that are detected locally.

## Autonomous Navigation Field Test

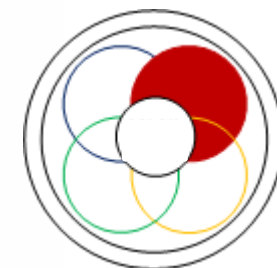
HDPR at Decos - 19th July 2018

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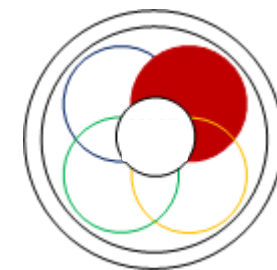


# Path Planning

- **Cooperative guidance for multiple robots (CoRob-X):**



Image source: own production.

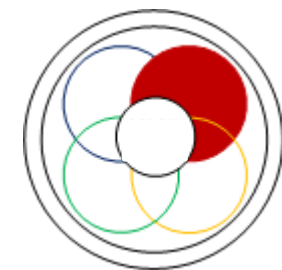


# Path Planning

- **Path Planning for fast traverses:**
  - Speed > 1m/s



Image source: own production.



- **Thermal sensors**
  - Thermal inertia analysis.
  - Martian chamber tests.
  - Experimental terrain tests.

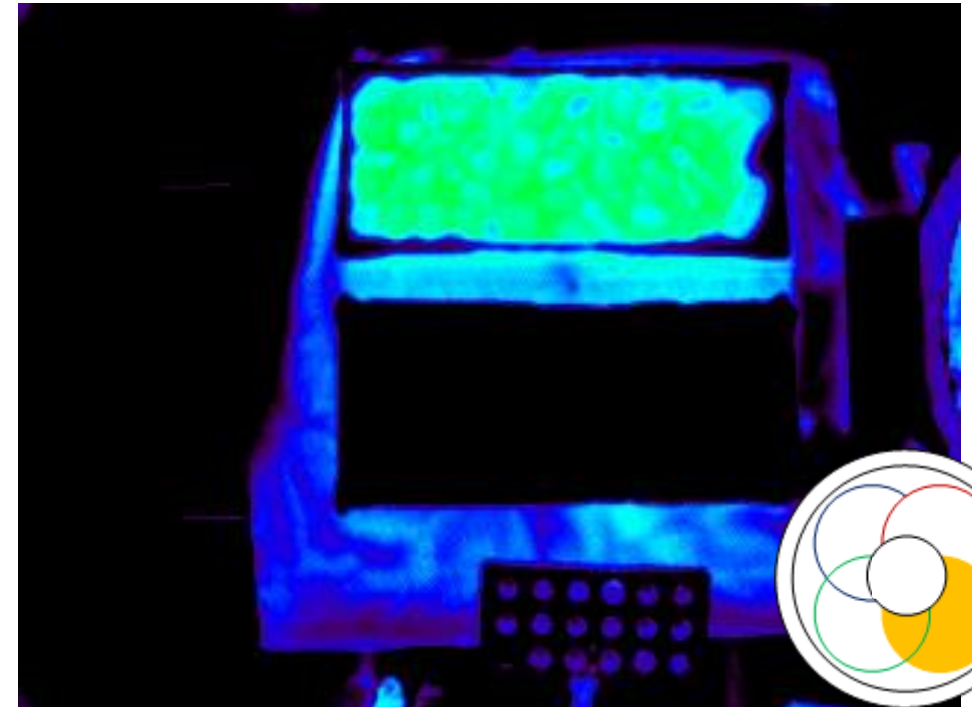
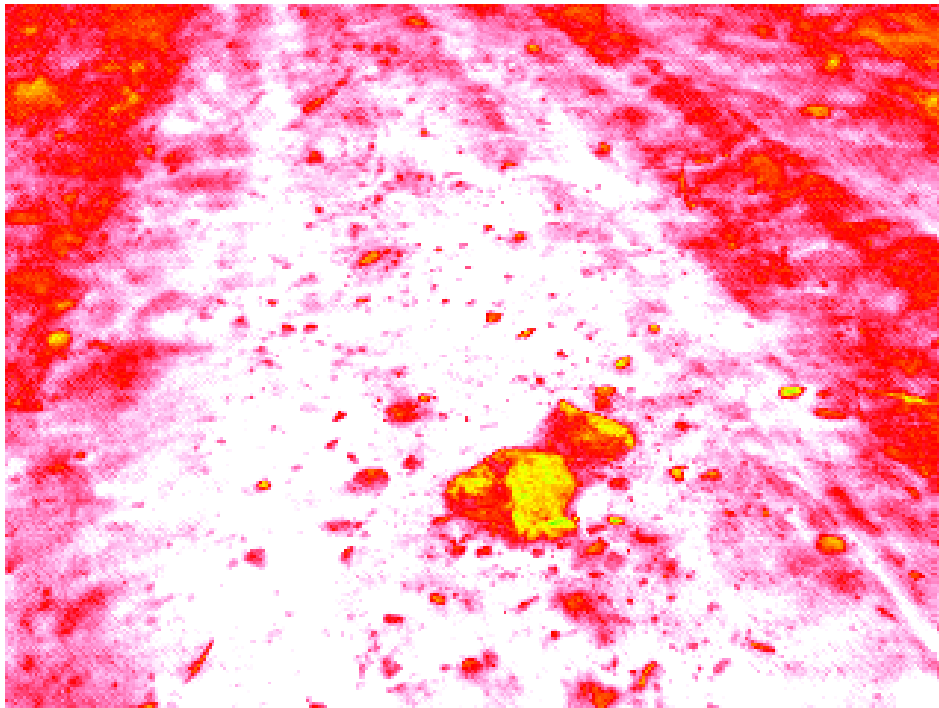
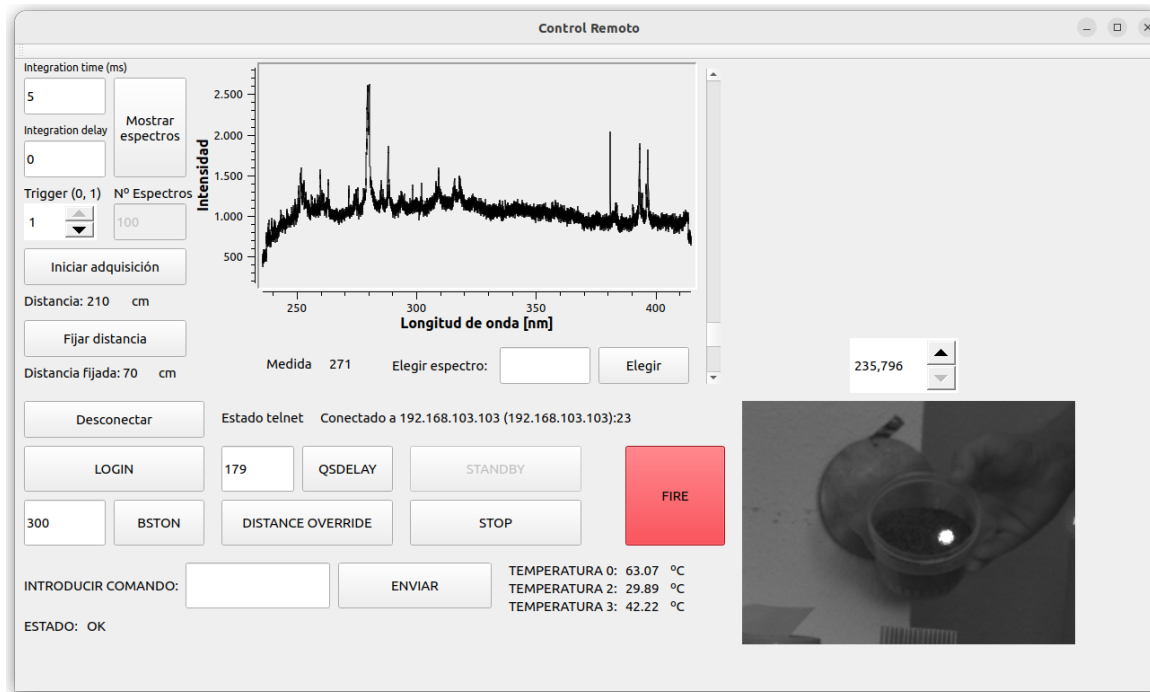


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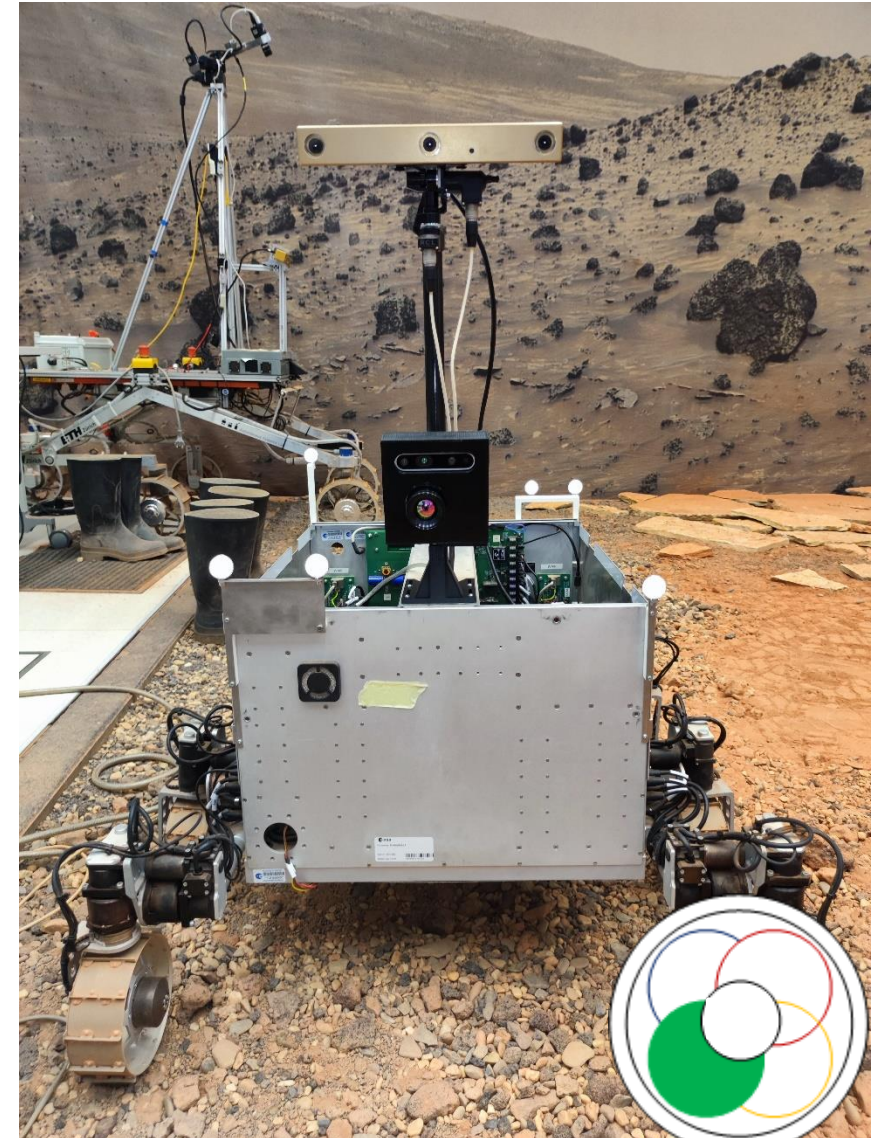
- **Chemocopter**
  - Transportable instrument for stand-off chemical análisis using LIBS.

Collaborating with:

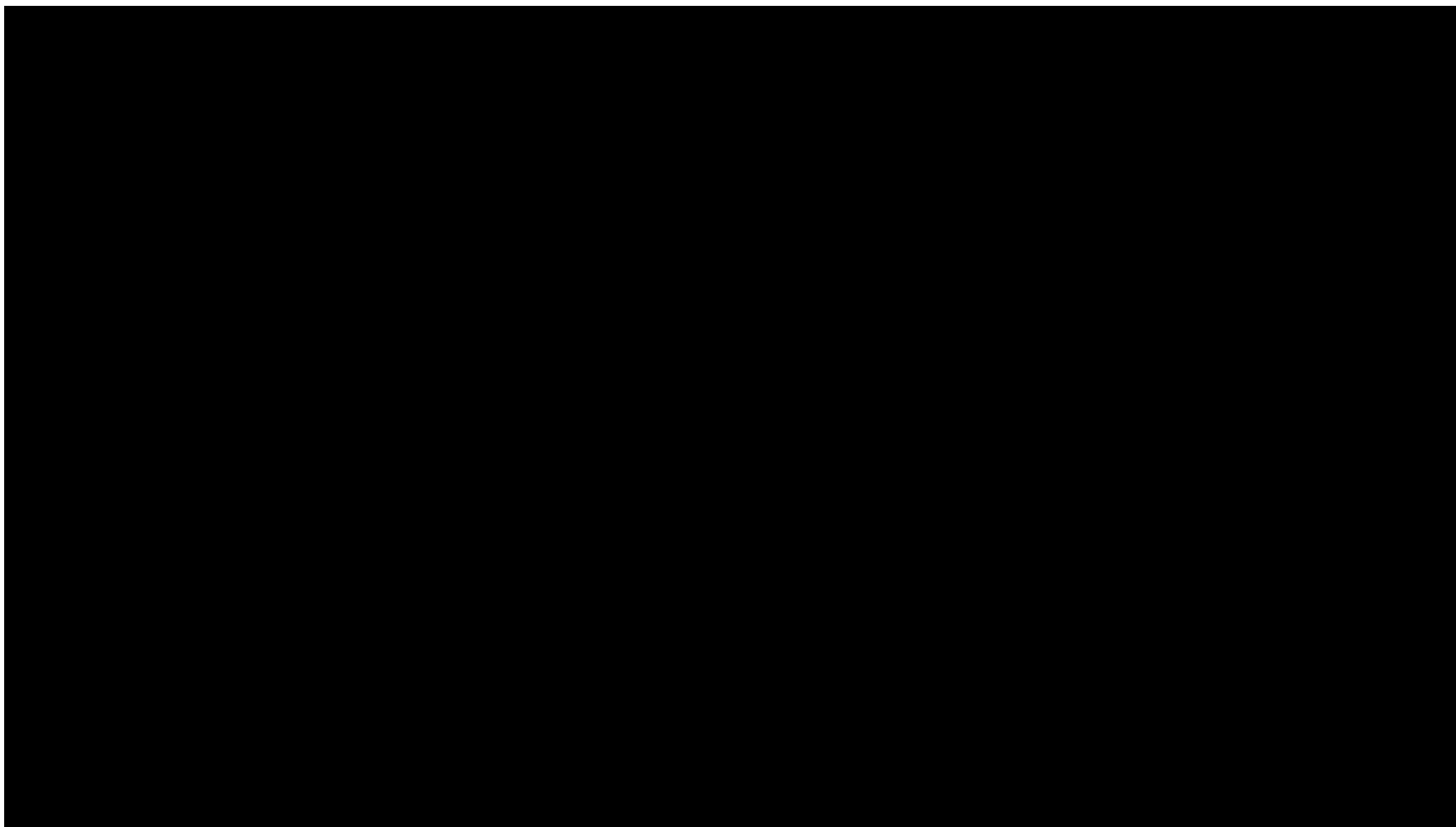


# Artificial Intelligence

- **Terrain segmentation using multimodal information through Deep Learning:**
  - RGB images.
  - Distance.
  - Thermal images.



- **AI, Path Planning and Manipulation:**
  - Sample Fetch Rover.

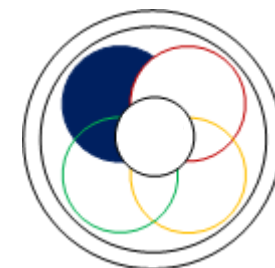
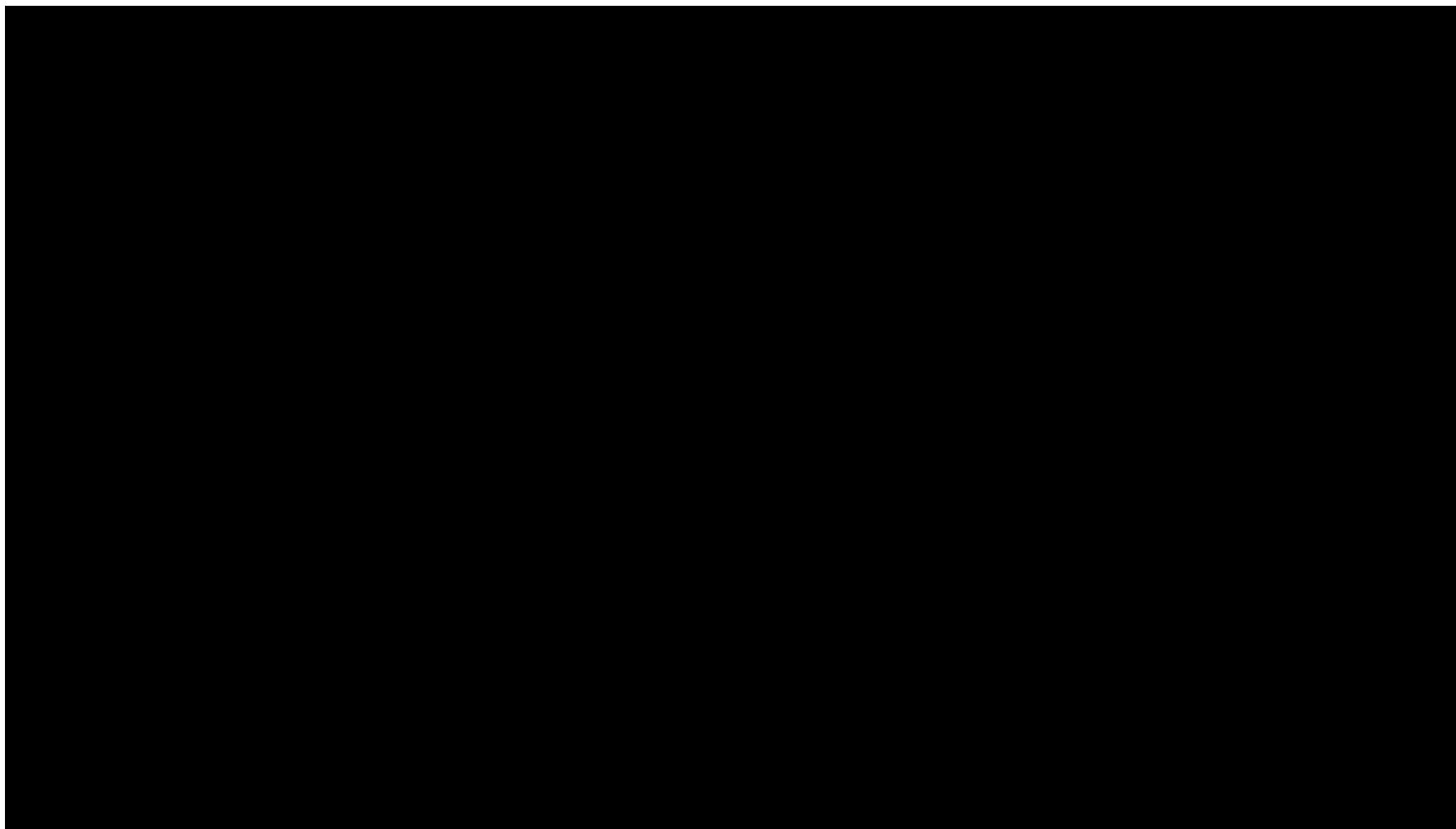


<https://youtu.be/6nDSPn1uV7E>

<https://riuma.uma.es/xmlui/handle/10630/24497>

# Motion Planning

- **Kinodynamic Motion Planning:**
  - Sample Fetch Rover with 5DoF Manipulator.



<https://youtu.be/xDFv4Ho4KZs>

<https://arxiv.org/pdf/2207.14659>

- **Kinodynamic Motion Control:**
  - Mobile manipulation for rappelling.



Image source: own production.



# Motion Planning

- **Novel locomotion systems:**
  - Lava cave exploration is challenging.
  - Romela IMPASS arise as an interesting robot.
  - Development of a Wheel prototype.

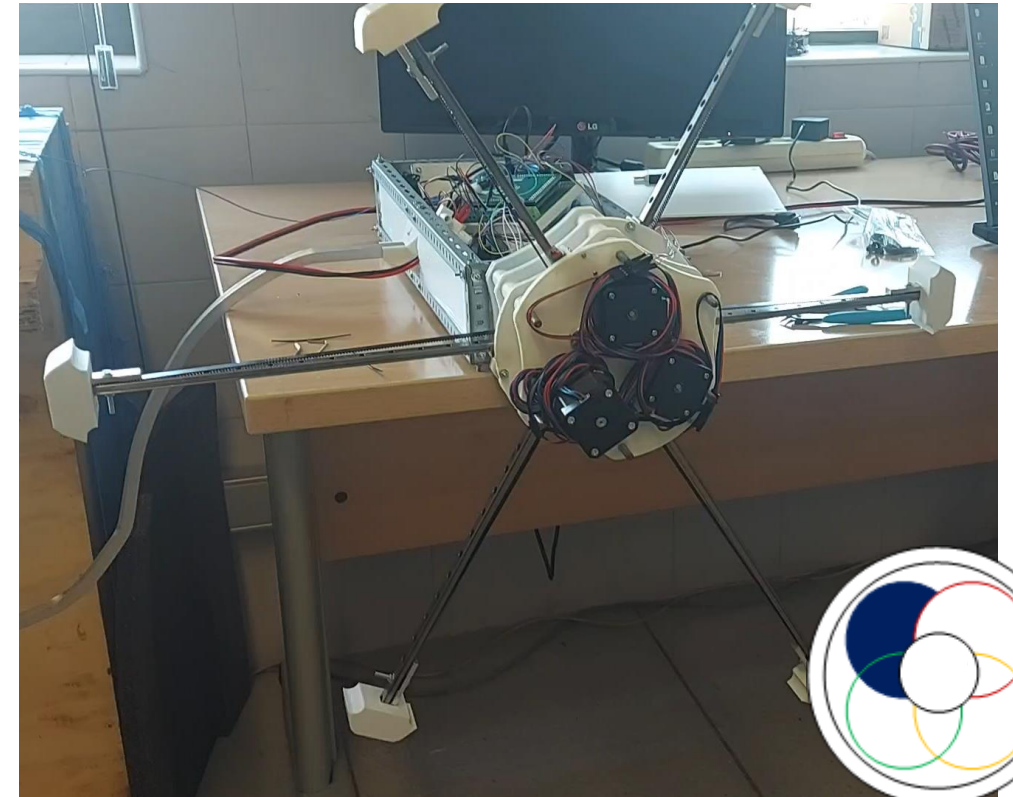
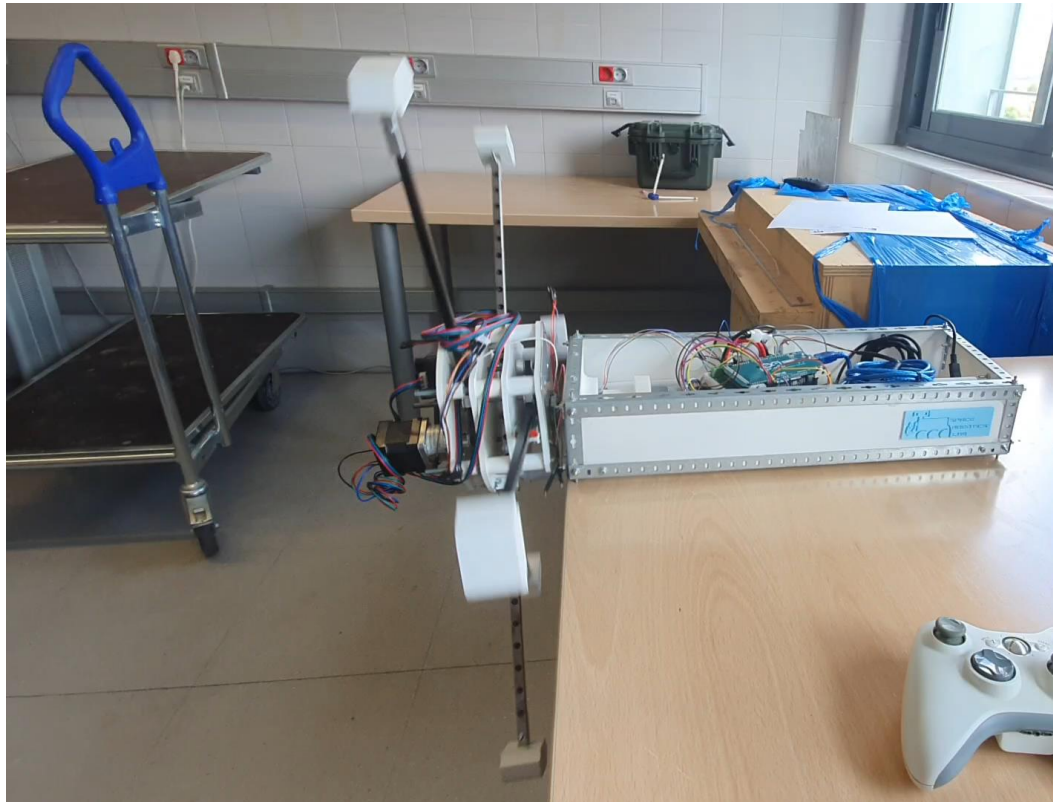


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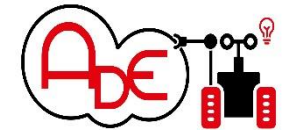
# Past and current projects



- **AI for Planetary Exploration (2023 - 2025)**
  - ESA activity reference: 4000140043/22/NL/GLC/ces
  - Main contractor: University of Malaga
- **Extended Reality (XR) Lab for Mars Experiments (2022 - 2023)**
  - ESA ideas activity reference: AO/2-1829/22/NL/GLC/ov
  - Main contractor: Sirin Orbital Systems AG
- **Robust and (Semi) Autonomous Platform for Increased Distances (RAPID) (2022 - 2023)**
  - ESA ITT Activity reference: 4000136833/21/NL/RA
  - Main Contractor: GMV Aerospace S.A.U.
- **Cooperative Robots for Extreme Environments (CoRob-X)**
  - H2020 project with grant agreement: 101004130
  - Coordinator: DFKI
- **Intelligent Multimodal Sensor for Identification of Terramechanic Characteristics in Off-Road Vehicles (IMSITER) (2020-2023)**
  - Granted by the Andalusian Regional Government
  - Coordinator: University of Malaga
- **Autonomous DEcision making in very long traverses (ADE) (2019-2021)**
  - H2020 project with grant agreement: 821988
  - Coordinator: GMV Aerospace S.A.U.
- **Autonomous Routing in Extreme Terrains (ARES) (2016-2020)**
  - ESA Activity reference: 4000118072/16/NL/LvH/gp
  - Main contractor: University of Malaga

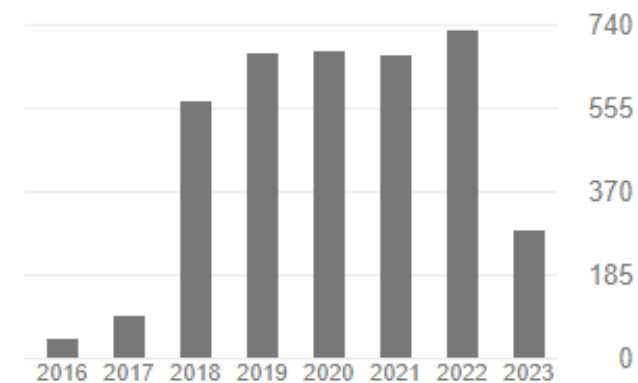
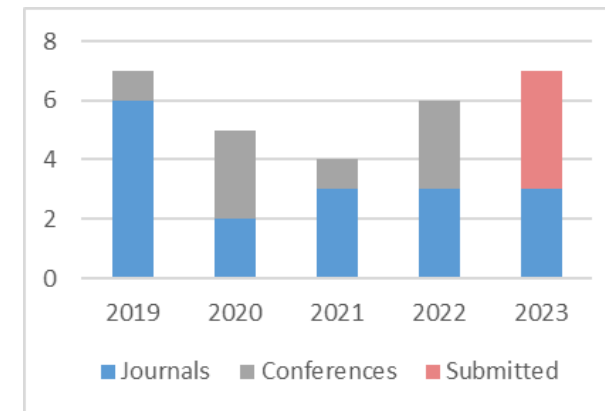


European Space Agency



# Academic results

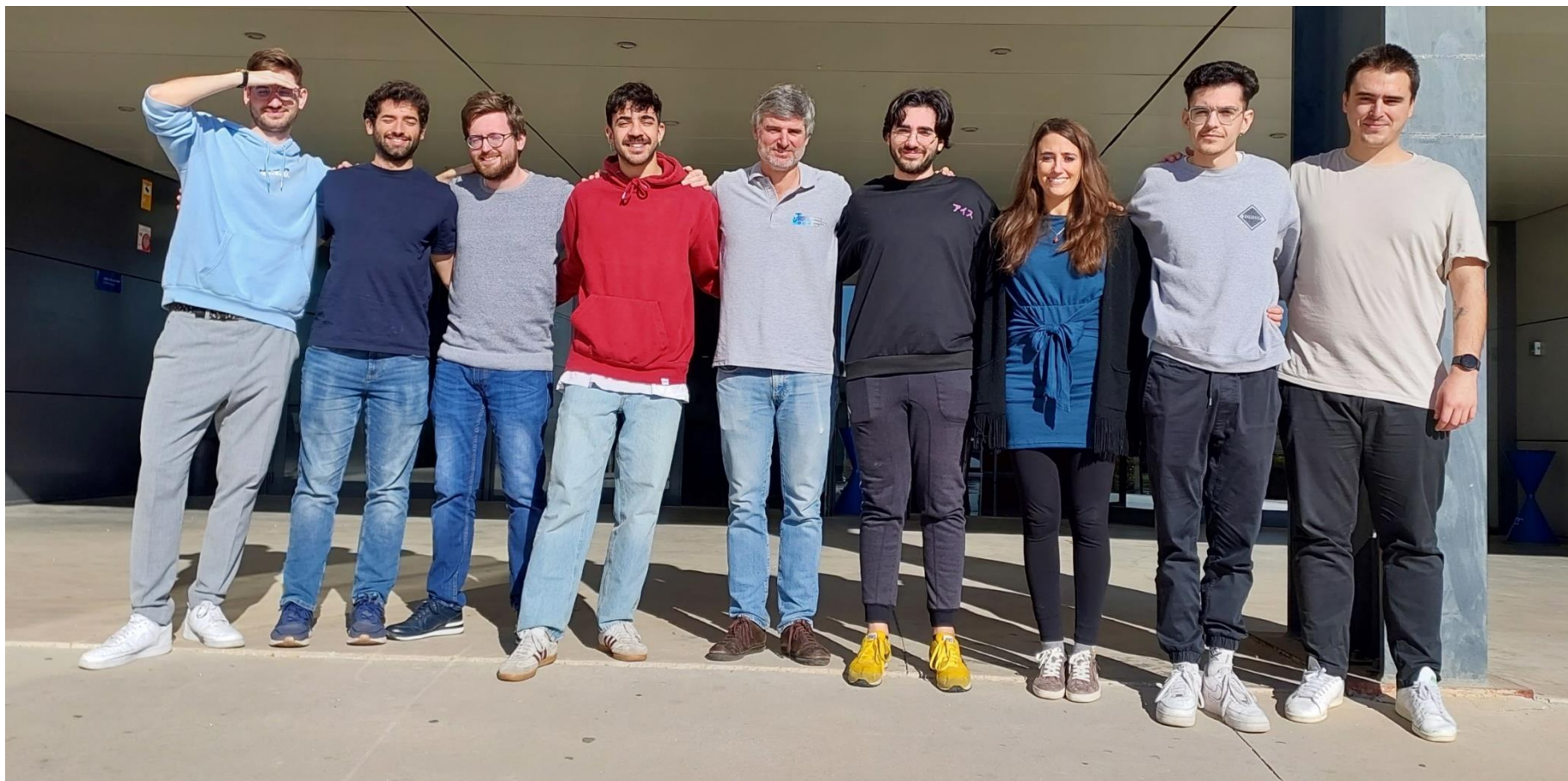
- **PhDs:** 8 (Ongoing: 5)
  - **2015 – 2021: M.C. López Casado (Assistant lecturer at UMA)**
  - **2017 – 2021: Martin Azkarate (GNC Engineer at ESA)**
  - **2016 – 2022: J. Ricardo Sánchez Ibáñez (GNC Engineer at AIRBUS UK)**
  - 2020: Gonzalo Paz Delgado (Co-Supervised PhD at DFKI and UMA)
  - 2020: Raúl Castilla Arquillo (Research assistant at UMA)
  - 2021: Levin Gerdes (GNC Engineer at ESA)
  - 2021: Petr Kubanek (System Engineer at LSST)
  - 2023: Ignacio Pérez García (Research assistant IAA-CSIC)
- **Dissertation Works:** Msc. > 3, Bsc. > 3 every year.
- **Msc. Student internships:** 2-4 every year.
- **Publications**
  - 21 papers published in high impact journals (Field Robotics, IEEE Robotics & Automation Magazine, etc.).
  - 16 papers in International Conference and Workshop proceedings (ICRA, IROS, ASTRA, i-SAIRAS, etc).





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# Thanks for your attention!!



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