AUTONOMOUS DECISION MAKING IN VERY LONG TRAVERSES (ADE)

A H2020 project funded by the European Commission within the Strategic Research Cluster (SRC) on Space Robotics Technologies Programme

http://www.h2020-ade.eu

ABSTRACT

ADE, Autonomous Decision Making in Very Long Traverses, refers to the 10th Operational Grant (OG10) of the Compendium of SRC activities (for call 2-topic SPACE-12-TEC-2018) within the H2020-SPACE-2018-2020 call. The challenge of OG10-ADE is to demonstrate in a planetary analogue environment the rover-based system needed to achieve very long traverses (kilometres per sol) with high reliability. Beside the traverse capabilities, the system should autonomously take the decisions required to progress in nominal conditions and/or in the presence of conflicting goals; guarantee consistent detection of scientific targets along the mission path; handle rover on-board resources in both nominal and non-nominal conditions; achieve a high level of performance whilst reducing mission risks and seizing opportunities for data scientific collection in a Mars Sample Return (MSR) mission scenario.

AUTONOMY & DECISION MAKING TO EXPLORE UNKNOWN ENVIRONMENTS IN PLANETARY MISSIONS

The ADE project is devoted **to maximize the scientific yield** of a rover mission, in spite of time constraints (solar eclipses, limited life duration). The project outcomes will help reduce in planetary missions **downtime, operator resource, power consumption**, **risk**, etc.

The rover will be required to travel independently from a starting point (e.g. a lander) towards an end point (say a sample cache), autonomously perform opportunistic science on the way and return to the lander with the acquired soil sample. The outcome sought in OG10-ADE is the demonstration of such capabilities in a terrestrial analogue of a planetary environment.

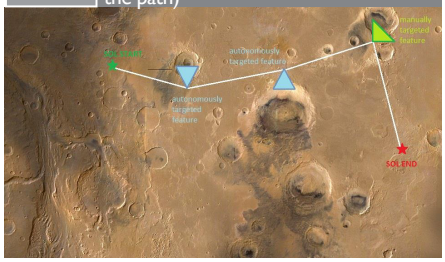
KEY CONCEPTS OF ADE

The ADE system encompasses the contemporaneous presence of the following **autonomous functionalities** for a planetary mission.

High-level goal commanding (E4) from ground station

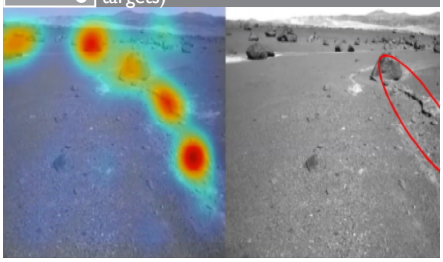
Decision making in presence of conflicting objectives

Long range autonomous rover navigation (and its disturbances along the path)



Long-term path planning and execution.
Adaptive execution of activities

AI-based Opportunistic Science (continuous detection of scientific targets)

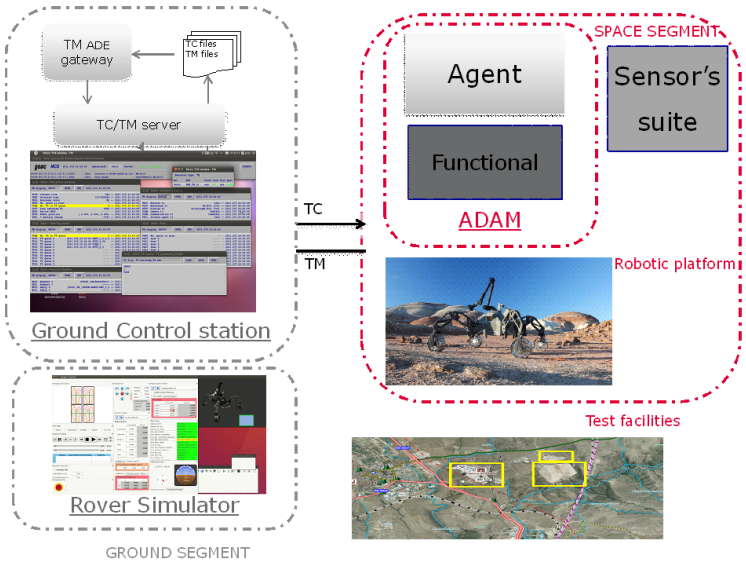


Continuous Identification of scientific targets and planning of navigation as well as scientific tasks

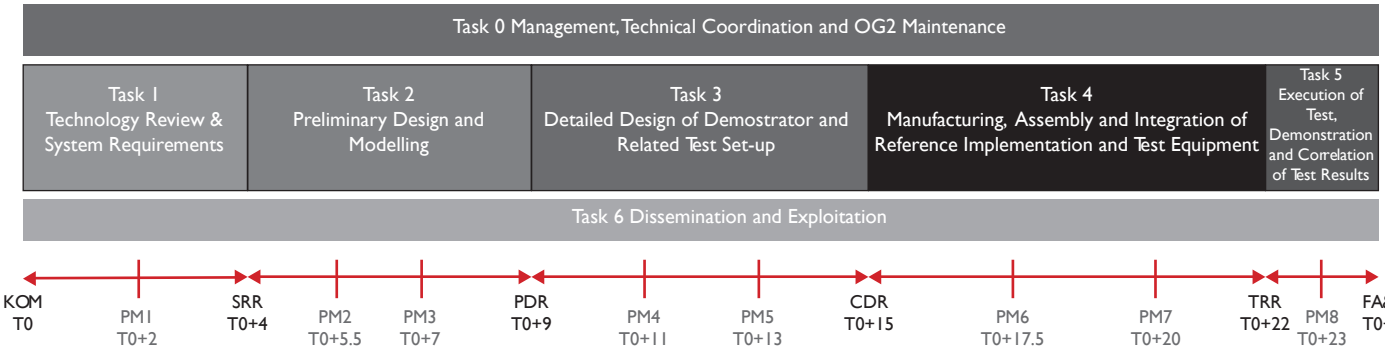
ADE COMPONENTS

The **on-ground demonstrator** has three high-level components:

1. Rover System including the on-board software (ADAM), sensors and robotic platform. The rover platform to be used in ADE is the SherpaTT rover (provided by DFKI).
2. Ground Segment, composed of the Ground Control Station (GCS) and the Rover Simulator.
3. Testing equipement for the Mars analogue test sites.



TIMELINE OF THE PROJECT



SCOPE OF WORK PER PARTNER

PARTNER	COUNTRY	ROLE IN ADE
GMV Aerospace & Defence SAU	ES	Overall coordination and interface with other operational grants Coordination of technology review and state-of-the-art Overall ADAM SW and HW architecture, design, validation and integration within the rover avionics OG2-ERGO and OG1-ESROCOS adaptation to OG10-ADE Maintenance of OG2-ERGO Responsibility for demonstrator testing facilities detailed design Simulation and field tests V&V Field test organisation
GMV Innovation solutions Ltd	GB	ADAM Planner-agent interfaces, prototyping, coding and final validation
DFKI "German Research Center for Artificial Intelligence"	DE	Rover integration Support to new avionics integration on rover Rover simulator and simulation toolsets Contribution to field tests
King's College London	GB	Mission Planner interfaces with the agent, prototyping, coding and final validation
Thales Alenia Space	IT	Mission and technology review and state-of-the-art System and demonstrator scenario requirements OG4-I3DS review and state-of-the-art
Université Grenoble Alpes	FR	ADAM formal validation and verification
Airbus Defence and Space	GB	Rover Guidance - Autonomous navigation solution adaptation, prototyping, coding and final validation
Oxford Robotics Institute University of Oxford	GB	Opportunistic Science: identification and assessment of scientific targets in high-resolution and thermal images using AI & ML Solving challenges faced by the nuclear industry by applying the developed AI & ML methods
Joanneum Research Digital	AT	Ground truth Scientific target characterization ADE test plan definition
Magellium	FR	Localization and mapping as from OG3-InFuse adaptation, prototyping, coding and final validation
Universidad de Málaga	ES	Coupled control motion rover-robotic arm
Università de Salento	IT	Soil navigation estimation
TRASYS International	BE	Rover Control Station

Strategic Research Cluster (SRC) - Horizon 2020

The 1st PERASPERA call was aimed to the development of the so-called "building blocks", i.e., different blocks aimed to fulfill a specific functionality. They are basic technologies that lay at the beginning of a European space robotics roadmap, designed to be compatible among each other. These OGs ranged from operating systems (OG1) to control and planning systems (OG2), data fusion (OG3), sensors (OG4) and actuators (OG5).

The second phase of the Space Robotics Technologies SRC, where OG10-ADE is included, will develop applied technologies, targeting specifically the orbital servicing and assembly, and the planetary exploration tracks, using the building blocks of the 1st call. The applications and activities selected for the second call contain enabling elements for enhancing and fostering commercialisation of space considering aspects of New Space and Industry 4.0.

In particular OG10-ADE has the specific purpose to integrate the common technology building blocks previously prepared in a planetary rover demonstrator, contributing to the development of space-robotics applications in the field of orbital and planetary use (phase 0/A studies).

QUESTIONS & ANSWERS

What is the project designed to achieve?

The ADE project will test an autonomous decision making system suitable for planetary rovers able to perform long traverses (kilometers per sol), take decisions, required to progress, reduce risks and seize opportunities for the scientific data collection and global exploration of unknown regions.
This will allow to improve the scientific return of planetary missions, increasing the quantity, diversity, and quality of the collected data and support the future human planetary missions.

Why is this project important for Europe?

The impact of space activities on innovation and competitiveness is a key driver for progress in Europe. One of the human challenges is the scientific planetary exploration which requires a higher level of robotic autonomy to maximise mission efficiency (getting the most for their money invested). Autonomous exploration systems make rovers more efficient and cover larger areas to collect more quantity and better quality data. It will enable the mission to reach areas far away from landing zones, access hard to reach and previously unexplored areas such as craters and caves, and enable automated processes such as sample collection and eventually mining and construction.

What is the impact of the project for European citizens?

The demonstration of these new autonomous capabilities in Mars/Moon terrain analogues strengthens the European essential technology for the exploration of the Solar System, increases the efficiency of exploration missions and enables safer and sustainable human exploration.
Furthermore, these robotics applications address potential spin-off and spill-over effects to other areas of robotic activity on Earth, such as mining, infrastructure monitoring, construction, agriculture, nuclear site inspection, etc.

ADE CONSORTIUM:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 821988

PROJECT INFORMATION

AUTONOMOUS DECISION MAKING IN VERY LONG TRAVERSES (ADE)

ADE answers to the Operational Grant 10 of the topic call 2-topic SPACE-12-TEC-2018 "SRC – Space Robotic Technologies"

PERASPERA support programme: www.h2020-peraspera.eu/

Grant agreement N° 821988

Project start: February 2019

Duration: 2 years

EU Contribution: € 3.000.000

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