MOONWALK Newsletter #3

July 2016

Newsletter

Project MOONWALK, a step further into the future of human space exploration, where humankind pairs with technology to transcend known boundaries

MOONWALK simulations at Rio Tinto, Bruno Stubenrauch 2016

Project MOONWALK – comes to a successful close

MOONWALK simulations have been completed after a whirl-wind of effort put forth by project partners at the trials in Rio Tinto and at Marseilles. MOONWALK conducted earth-analogue simulations testing new hardware and various spacewalk scenarios at the ***Subsea Marseilles Lunar Analogue site*** in France and ***Rio Tinto Mars Analogue site*** in Spain in preparation for a future human and robotic mission to the moon and/or to Mars.

Tests of the equipment for the communication and collaboration between human and robot have been rewarding and a learning experience for the team. New technologies and procedures have been developed and tested and they serve as the starting point for future developments along these lines.

Thomas Vögele, *DFKI (MOONWALK coordinator)**:***

"The new ways of controlling a robot by a person, through for example, 'gestures,' is something very interesting for space research"

Accomplishments

For the first time in the EU, MOONWALK has successfully accomplished and demonstrated throughout these simulations in Marseilles and Rio Tinto:

- *the collaboration between an astronaut and a helper rover (YEMO) controlled by gestures;*
- *the use of the new EVA (Extravehicular Activity) simulation spacesuit, Gandolfi-2, for exploration of Lunar and Martian terrain that is suitable for testing in two environments, both on ground and immersed in water;*
- *an advanced EVA information system suitable for underwater partial gravity simulations;*
- *the integration of a self-deployable simulation habitat into an analogue test (SHEE- Self-deployable Habitat for Extreme Environments, www.shee.eu)**

*For further EU exposure, the habitat, SHEE (Self-deployable Habitat for Extreme Environments) was incorporated into the simulation campaign of MOONWALK at Rio Tinto. The habitat, completed in 2015 through an EU-FP 7 grant, provided shelter and suitport ingress/egress for the simulation astronauts.

MOONWALK aligns with the goals outlined by ESA's director Jan Wörner, calling for a 'new vision' for future space travel beyond that of the ISS. Wörner envisions a 'Moon Village' – where astronauts and robots from different nations would collaborate for purposes ranging from pure scientific discovery to business opportunities such as mining and /or tourism both private and public.

MOONWALK project, a 3-year cooperative Research & Development project that will be completed in September 2016, compared the performance of different compositions of astronaut-robot teams over multiple tasks and operational scenarios, in two analogue environments.

Funded by the European Commission under the Space theme of the 7th Framework Programme, MOONWALK works towards the aims of ESA's vision for astronaut and robot collaboration on the Moon and developed technologies and systems to support this vision.

However, the developments achieved in MOONWALK are not only important for future space exploration, but also because of their potential implementation on Earth:

Potential directions for industry spin-offs

MOONWALK project developed a number of technologies that can be used both in space and terrestrial applications. Potential terrestrial utilisation of MOONWALK technologies when further developed includes:

Amphibious Scout Rover

Search & Rescue, emergency response

Light-weight scout rover with good all-terrain capabilities that can be used for exploration of inaccessible areas (slopes, caves, trenches, underwater environments, etc)

Gesture Control

ROV control by diver, emergency response, industrial robots, motion tracking of workers (e.g. for health & safety)

Novel method for human-robot interaction – human controls robot through gesture. Gestures are tracked with IMU sensors attached to the human

EVA Information System (EVAIS)

All terrestrial applications where efficiency and safety of human operators depends on close interaction with a central control centre (e.g. emergency response)

User-friendly system to enable efficient communication and exchange of data between astronaut and ground control centre (also in extreme environmental conditions (dust, water immersion)), control of robots

360 Degree Omnicam

Surveillance of assets, subsea scientific observations

Camera used to produce a constant 360-degree video stream

Generic follow-me function

Hybrid human-robot teams (Search & Rescue, emergency response, consumer market, industrial production)

Function that allows the robot to follow the astronaut autonomously, based on image analysis and machine learning

Gandolfi-2 Space-Suit Mock-Up

Future analogue tests of equipment and crew training

A space-suit mock-up that simulates all relevant constraints to astronaut movement. The suit can be used on land and underwater for astronaut training

Manual Soil Sampling tools

Sampling and object manipulation in contaminated areas (chemical, radioactive)

Sampling tools – foldable, extendable, adaptable for sample collection

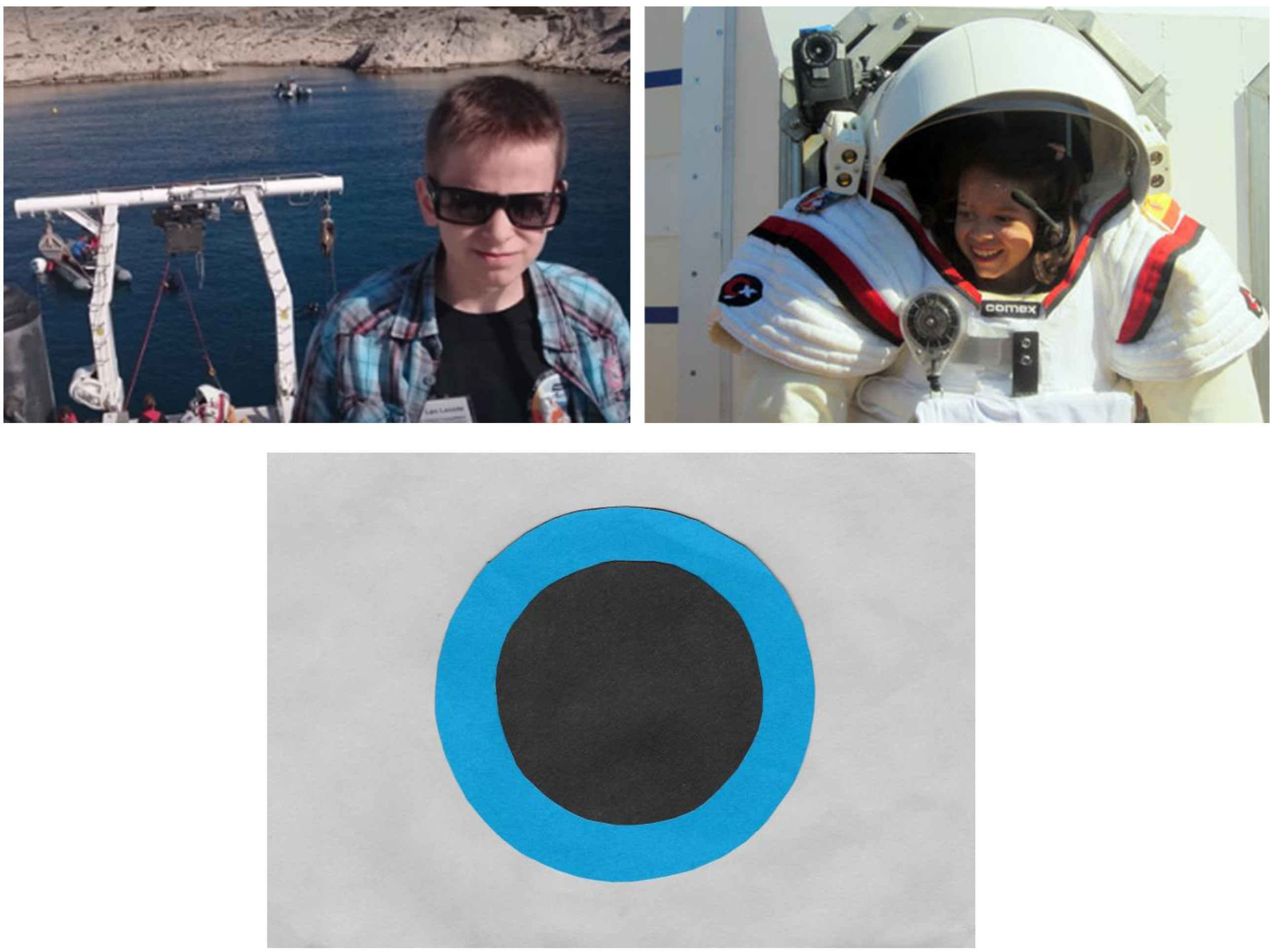
Bio-Monitoring System

Human operators of safety-critical systems, sports, health & elderly care

Easy-to-deploy biomonitoring tool to assess stress level of astronaut

Results of the Children Competition

The MOONWALK Consortium is very proud to have hosted the next generation of space explorers through the Children Competition. Guadalupe Maíz López from Spain won the “first phrase to be spoken on Mars” competition with ***‘Today Mars, tomorrow the stars,’*** and Leo Leoste from Estonia was the winner of the new flag for the moon contest. The flag represents the moon eclipsing the earth, seen from the far side of the moon.



Top left: Leo from Estonia, winner of the Moon flag aboard COMEX Minibex ship in Marseilles; Top right: Guadalupe from Spain, winner of the phrase to spoken on Mars in the Gandolfi II space suit in Rio Tinto; Bottom centre, new Moon flag by Leo

External Experiments

Several guest researchers participated with external experiments in the simulation campaigns in Rio Tinto and in Marseilles by conducting parallel research alongside the MOONWALK team.

ADAPA 360 - 360-Degree VR Video Camera System for Space Suit and Helmet

Team: Ali Zareiee, ADAPA, Norway

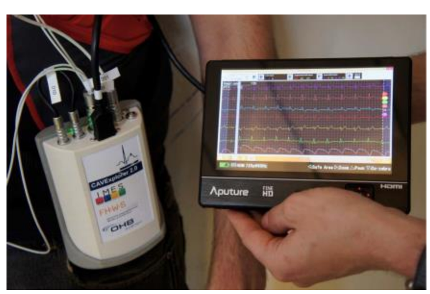
Documented Rio Tinto using ADAPA 360-Degree Camera. Provided excellent footage of site and MOONWALK project.

Video Still from Adapa 360 Rio Tinto Credit: Adapa Trino

Cave Explorer - Assessment of performance for the wearable electro-optical diagnostic health assistant system

Team: Human Spaceflight Department, OHB System AG; Medical Engineering Department, IMES University of Applied Sciences Würzburg-Schweinfurt

Tests were conducted for a new, mobile, digital diagnostic system for medical monitoring astronauts during manned space missions called the CAVExplorer 2.0. Comprised of electrodes worn on the body of an astronaut and sensor detectors on the earlobe, the CAVExplorer 2.0 measures electrical signals and monitors the health of the heart and circulatory system.



CAVExplorer 2.0; Photo: Walter Kullmann, 2016

Lunar Lander Pivot Beam Support System

Team: Aedel Aerospace Unipessoal, Portugal

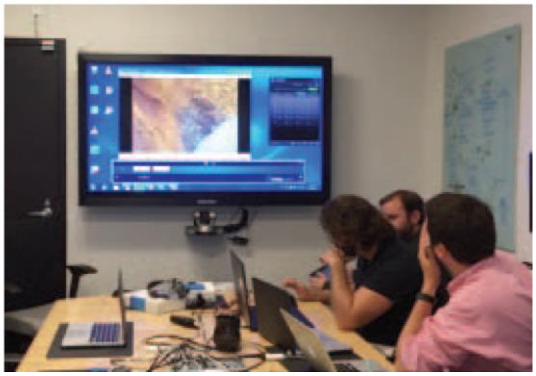
A mock-up of a structure with a pivoting arm showing one activity as part of construction operations was tested in subsea Marseilles.

SCALE: Shared Cognitive Architecture for Long-term Exploration

Team: Leslie DeChurch (Georgia Tech), Noshir Contractor (Northwestern), Jeff Johnson (U. of Florida); United States (NASA Behavioral Health & Performance)

Communications by EVA crew, habitat crew and MCC were logged for analysis by the SCALE team in order to develop new methodologies and technologies to improve shared cognition during space missions.

In addition, Mission control was handed over for the afternoon of the 28th of April 2016 to Georgia Tech during the Rio Tinto simulations, demonstrating the capability of involving international teams into the modular MOONWALK simulation architecture.



SCALE, Georgia Tech Mission Control Centre; Photo: Georgia Tech, 2016

Psychobot: Human Psychological Relationship with a Planetary Exploration Robot

Team: Yvett Mikola, PhD student, Complutense University of Madrid (UCM). Madrid, Spain

The experiment tried to prove the possibility that humans develop an emotional attachment to their robotic “working partners” when interacting with them on a daily basis. To measure the qualitative and quantitative changes in the human-robot teams, four questionnaires were developed to be used with a pre-post method for each simulation astronaut.

Artist Astronaut Performance

Dr. Sarah Jane Pell

Simulation Astronaut and Professional Diver researching human performance and interactions of the Artist-Astronaut

Simulations

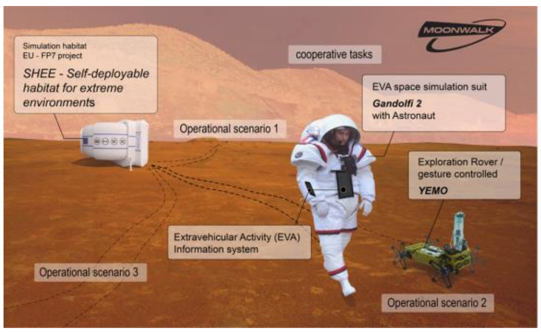
Rio Tinto analogue test site

***Michael Mcdowell,** Airbus:*

"We are here in Rio Tinto as it's an excellent location for astronaut simulations, especially for Mars. It's got interesting biological, geographical and geological features – a lot of it is to provide, really accurate and really realistic simulations for the astronauts. So they can truly experience what it would be like on Mars."

***Victor Parro Garcia,** INTA:*

"The objective of the simulation is to have the robot and the astronaut, do different tasks so that we can answer three main scientific questions. The first is exploring, or mapping the land. The second is searching for resources on the landing site. Let's say material for construction or some minerals. And the third one is the astrobiology. We wanted to search for any evidence of life in the context of the mission."

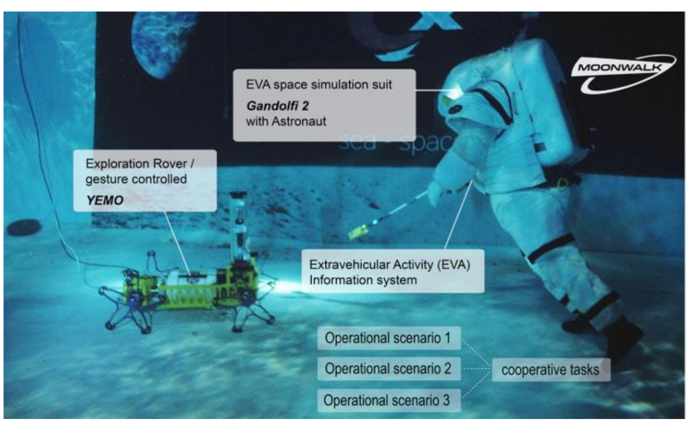


Left: Diagrammatic scheme of the simulation tests at Rio Tinto
Right: photo of actual simulation site Rio Tinto, Bruno Stubenrauch, 2016

Subsea Marseilles analogue test site

***Thomas Vögele,** DFKI:*

" … the main focus of our developments was on new methods for the control of a scout rover through an astronaut; an astronaut who is very limited in his movements due to the very heavy (simulation) spacesuit he wears, for one, and also an astronaut who moves differently than he would on earth because he's, for example, on the moon with much less gravity. So this is what we tested in Marseilles. We tested the astronaut, the rover and their collaboration underwater in low gravity, in lunar gravity."

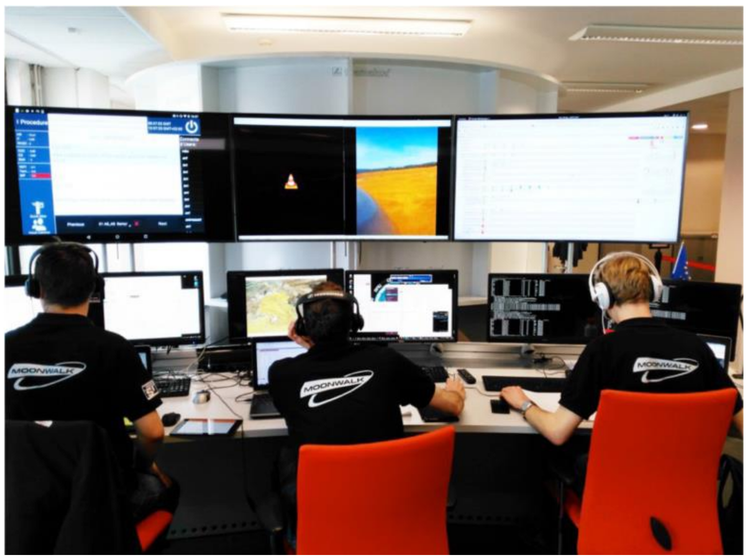


Left: Diagrammatic scheme of the simulation tests at Marseilles
Right: photo of the simulation site in Marseilles, Comex, 2016

The International Analogue Mission Control Centre - Belgium

Diego Urbina, *Space Applications Services:*

"We also have a mission control center in Brussels from which the whole mission, including video feeds and procedures, can be monitored by a group of flight controllers. They are coordinating operations with people from the science team who, based on their knowledge in this field, inform the astronauts about what to do in terms of science when exploring the planet."



Mission Control Centre, Brussels, Space Applications, 2016

Jean-Francois Clervoy, *former ESA astronaut, Novespace:*

"Moonwalk prepares humans to explore the surface of the Moon or Mars, together with robots that can assist humans in difficult tasks, dangerous tasks, or repetitive tasks … also as an assistant to carry tools, to carry samples. That is why it is interesting through the Moonwalk project to look how astronauts can be helped by rovers."

Contact

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