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International Executive Committee

CSA
Martin Picard

DLR
Bernd Sommer

ESA
Gianfranco Visentin

JAXA
Hiroshi Ueno

ISAS/JAXA
Takashi Kubota

NASA
Richard J. Doyle

JPL
Richard Volpe

Sponsored by

[GMV logo]
## Programme Overview

### Sunday 3 June 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>18:30</td>
<td>Pre-registration</td>
</tr>
<tr>
<td>18:30</td>
<td>Welcome Cocktail</td>
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<tr>
<td>19:30</td>
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### Monday 4 June 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>07:45</td>
<td>Registration</td>
</tr>
<tr>
<td>08:40</td>
<td>Welcome and Introduction</td>
</tr>
<tr>
<td>08:50</td>
<td>Session 1: Programmatic</td>
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<tr>
<td>10:45</td>
<td>Session 2a: Mobility Analysis</td>
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<tr>
<td>10:45</td>
<td>Session 2b: Orbital Missions</td>
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<tr>
<td>10:45</td>
<td>Session 2c: Spacecraft Autonomy 1</td>
</tr>
<tr>
<td>13:35</td>
<td>Session 3a: Mobility in Low Gravity</td>
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<tr>
<td>13:35</td>
<td>Session 3b: Orbital Robotics Technologies</td>
</tr>
<tr>
<td>13:35</td>
<td>Session 3c: Spacecraft Autonomy 2</td>
</tr>
<tr>
<td>15:30</td>
<td>Session 4a: Mobility Planning 1</td>
</tr>
<tr>
<td>15:30</td>
<td>Session 4b: Robotic Testing Facilities</td>
</tr>
<tr>
<td>15:30</td>
<td>Session 4c: Autonomous Science</td>
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<tr>
<td>17:45</td>
<td>Cocktail + Poster Session</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session 5a: Mobility Planning 2</th>
<th>Session 5b: HRI</th>
<th>Session 5c: Robot Swarms 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:25 – 10:55</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session 6b: Robotic Software Engineering</th>
<th>Session 6c: Robot Swarms 2</th>
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<tbody>
<tr>
<td>11:10 – 12:50</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session 6a: Robotic Software Engineering</th>
<th>Session 6c: Robot Swarms 2</th>
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<tbody>
<tr>
<td>14:00 – 14:30</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session 7a: Planetary Perception and Navigation 1</th>
<th>Session 7b: Orbital Missions 2</th>
<th>Session 7c: Robot Mechanism DDV</th>
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<tbody>
<tr>
<td>14:40 – 16:20</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session 8a: Planetary Perception and Navigation 2</th>
<th>Session 8b: Orbital Perception and Navigation</th>
<th>Session 8c: Hoppers</th>
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<tr>
<td>16:35 – 18:15</td>
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<thead>
<tr>
<th>Time</th>
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<td>20:00</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Dinner</th>
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<td>20:30</td>
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<tr>
<td>Time</td>
<td>Activity</td>
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<td>----------------------------------------------</td>
</tr>
<tr>
<td>08:45</td>
<td>Plenary Talk</td>
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<tr>
<td>09:25</td>
<td>Session 9a: Perception 1</td>
</tr>
<tr>
<td>09:25</td>
<td>Session 9b: Robot Control</td>
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<tr>
<td>09:25</td>
<td>Session 9c: Autonomy Frameworks</td>
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<tr>
<td>11:10</td>
<td>Session 10a: Perception 2</td>
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<tr>
<td>11:10</td>
<td>Session 10c: Robots and ISRU</td>
</tr>
<tr>
<td>14:00</td>
<td>Technical Tour</td>
</tr>
<tr>
<td>19:30</td>
<td>Arrival back at the Hotel</td>
</tr>
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</table>
Sunday 3 June 2018

18:30  Pre-registration
18:30  Welcome Cocktail
19:30  End of the Welcome Cocktail

Monday 4 June 2018

07:45  Registration

Welcome and Introduction
Room: Europa

08:40  Welcome and Introduction
J. Gavira

Session 1: Programmatics
Room: Europa
Chair: J. Gavira

08:50  Al and Space robotics at ESA 2018
G. Visentin, European Space Agency

09:15  Automation and Robotics within the German Space Programme
B. Sommer

09:40  2018 Robotics Activities at JPL
R. Volpe

10:05  AI and Space Robotics Activities in JAXA
T. Kubota

10:30  Coffee break

Session 2a: Mobility Analysis
Room: Europa

10:45  Including the effect of gravity in wheel/terrain interaction models
B. Ghotbi

Proceedings - i-SAIRAS 2018, 4-6 June, Madrid, Spain
11:10  **Gait Analysis of a Free-Climbing Robot on Sloped Terrain for Lunar and Planetary Exploration**  
Y. Shirai

11:35  **Lunar Pit Exploration with Probe Launching System**  
H. Arisumi

**Session 2b: Orbital Missions**  
*Room: America*  
*Chair: B. Sommer*

10:45  **Readiness of proximity operation on MINERVA-II rovers onboard Hayabusa2 asteroid explorer**  
T. Yoshimitsu

11:10  **Development of Mini Space Elevator Demonstration Satellite STARS-Me**  
M. Nohmi

11:35  Bartolomeo - A New Facility on the International Space Station Well-Suited for Artificial Intelligence, Automation and Robotics Payload Hosting  
K. Pegg

**Session 2c: Spacecraft Autonomy 1**  
*Room: London*  
*Chair: G. Visentin*

10:45  **Embedding a Scheduler in Execution for a Planetary Rover**  
S. Chien

11:10  **Development of Low-cost and High Performance Attitude Sensor applying Neural-network Image Recognizing Technology**  
Y. Kikuya

11:35  **Monte Carlo Squeaky Wheel Optimization Scheduler Priority Management for an Onboard Planetary Rover Scheduler**  
S. Chien

12:00  **Fault-Tolerant Plan Validation for Europa Clipper**  
S. Schaffer (S. Chien)
12:25  Lunch break

**Session 3a: Mobility in low gravity**
*Room: Europa*
*Chair: T. Kubota*

13:35  Hopping simulation for small rover using regolith model considering the result of vacuum and small gravity flight experiment  
*T. Maeda*

14:00  Locomotion in uncertain low-gravity environments: preparing for the Mascot mission  
*F. Wolff*

14:25  Simulation Study on Landing Behavior of Spacecraft in Microgravity Environment based on Multibody Dynamics Model  
*H. Katsumata*

14:50  Experimental Analysis on Landing Dynamics of Martian Moon Spacecraft based on Similarity Law  
*D. Yamaguchi*

**Session 3b: Orbital Robotics Technologies**
*Room: America*
*Chair: S. Aziz*

13:35  Robot Servicer Interaction with a Satellite During Capture  
*J. Brannan*

14:00  Reaction Force Observer for a Free-Floating Robot  
*D. Hirano*

14:25  Parametric Analysis on Repeated Impact-based Capture of a Free-Floating Cylindrical Object by a Dual-Arm Space Robot  
*N. Hase*

14:50  Parameter Identification of a Space Object in the Precapture Phase  
*O. Christidi-Loumpasefski*
Session 3c: Spacecraft Autonomy 2
Room: London  
Chair: S. Chien  
13:35  Experiments in Segmenting Mars Craters using Convolutional Neural Networks  
D. DeLatte  
14:00  Terrain classification with an omni-directional camera based on convolutional neural network  
Y. Suebe  
14:25  Predicting non-geometric hazards using machine learning for safer rover mobility operations  
M. Faragalli  
14:50  Deep Learning Based Pose Estimation in Space  
D. Hirano  
15:15  Coffee break

Session 4a: Mobility Planning 1
Room: Europa  
Chair: C. Pérez Del Pulgar  
15:30  A Lunar Micro Rover Path Planning based on Environmental Constraints  
T. Oikawa  
15:55  Multi-scale Path planning for a Planetary Exploration Vehicle with Multiple Locomotion Modes  
J. Ricardo Sánchez Ibáñez  
16:20  Efficient gait selection for quadrupedal robots on Moon and Mars  
H. Kolvenbach  
16:45  Path Planning with Risk Consideration by Hopping Mobility for Long Distance Traversability  
Y. Kunii
### Session 4b: Robotic testing facilities

*Room: America*

*Chair: J. Rodriguez Gonzalez*

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>15:30</td>
<td>The DLR Terramechanics Robotics Locomotion Lab</td>
<td>F. Buse</td>
</tr>
<tr>
<td>15:55</td>
<td>ORGL – ESA’s Test Facility for Approach and Contact Operations in Orbital and Planetary Environments</td>
<td>M. Zwick</td>
</tr>
<tr>
<td>16:20</td>
<td>Preliminary Investigations on Ground Experiments of Variable Shape Attitude Control for Micro Satellites</td>
<td>Y. Shintani</td>
</tr>
<tr>
<td>16:45</td>
<td>Full lifecycle support for modular satellite systems provided by comprehensive Virtual Testbeds</td>
<td>T. Osterloh</td>
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</tbody>
</table>

### Session 4c: Autonomous Science

*Room: London*

*Chair: L. Joudrier*

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>15:30</td>
<td>Cloud Filtering and Novelty Detection using Onboard Machine Learning for the EO-1 Spacecraft</td>
<td>S. Chien</td>
</tr>
<tr>
<td>15:55</td>
<td>Novelty or anomaly hunter – driving next-generation science autonomy with large high quality dataset collection</td>
<td>M. Woods</td>
</tr>
<tr>
<td>16:20</td>
<td>Self-Reliant Rovers for Increased Surface Mission Productivity</td>
<td>D. Gaines (S. Chien)</td>
</tr>
<tr>
<td>16:45</td>
<td>Heuristic Guided Orbit Selection for a Low Frequency Radio Interferometric Spacecraft Constellation: Summary Report</td>
<td>S. Chien</td>
</tr>
</tbody>
</table>

17:45 Cocktail + Poster Session

19:15 End of day 1

*Proceedings - i-SAIRAS 2018, 4-6 June, Madrid, Spain*
Tuesday 5 June 2018

Plenary Talk
Room: Europa
08:45  TG-2 Robotic Task: China's Robot On-Orbit Servicing Experiment In the Spacelab
Z. Li

Session 5a: Mobility Planning 2
Room: Europa
Chair: D. Wettergreen
09:25  The LUCID field test campaign – Results of operations with a rover in a similar lunar environment
F. Gandia
09:50  RaCER: Determination of the maximum speed of the fast teleoperated rover for lunar exploration
P. Wittels
10:15  Image based Behavior Planning Scheme for Autonomous Planetary Exploration Rover
M. Sakuta
10:40  Overcoming the Challenges of Solar Rover Autonomy for Long-Duration Planetary Navigation
O. Lamarre

Session 5b: HRI
Room: America
Chair: M. Picard
09:25  Intuitive “human-on-the-loop” interface for tele-operating remote mobile manipulator robots
K. Kruusamäe
09:50  Multisensory real-time space telerobotics. Development and analysis of real-time telerobotics systems for space exploration
M. Ferraz
10:15  Lean lunar rover mission control: human-machine interface design following User Centered Design principles  
       *O. Gásquez García*

10:40  **SOLEUS : Space Countermeasure with Ankle Foot Orthosis, Scientific Evaluation and Perspectives**  
       *P. Letier*

**Session 5c: Robot Swarms 1**  
*Room: London*  
*Chair: R. Volpe*

09:25  **Preliminary Studies on Computation Sharing in Mars Spacecraft Network**  
       *T. Vaquero (J. Wyatt)*

09:50  **Physically Distributed Control and Swarm Intelligence for Space Applications**  
       *A. Redah*

10:15  **Swarm Technologies for Future Space Exploration Missions**  
       *E. Staudinger*

10:40  **Termite algorithms to control collaborative swarms of satellites**  
       *H. Hildmann*

10:55  Coffee break

**Session 6b: Software Engineering**  
*Room: America*  
*Chair: M. Azkarate*

11:10  **Flight System Architecture of the Sorato Lunar Rover**  
       *J. Walker*

11:35  **Astrobee Robot Software: Enabling Mobile Autonomy on the ISS**  
       *L. Fluckiger*
12:00  cFE Extension for the Use of ROS Applications in the Space Missions  
T. Saito

12:25  Binary software packaging for the Robot Construction Kit  
T. Roehr

Session 6c: Robot Swarms 2  
Room: London  
Chair: D. Nölke

11:10  Strategic Deployment and Rerouting Methods for Wide-range Surface Exploration using Multiple Rovers  
R. Nakanishi

11:35  Multi-rover Coordination Algorithms for Autonomous Planetary Cave Exploration  
T. Vaguero (E. Jay Wyatt)

12:00  Monitoring and controlling of modular meshed networks  
D. Timmermann

12:25  Autonomous Networking for Robotic Deep Space Exploration  
E. Jay Wyatt

12:50  Lunch break

Plenary Talk  
Room: Europa

14:00  Automated Detection and Tracking of Plumes at 67P/Churyumov-Gerasimenko in OSIRIS/Rosetta image sequences: Summary Report  
S. Chien

Proceedings - i-SAIRAS 2018, 4-6 June, Madrid, Spain
Session 7a: Planetary Perception and Navigation 1  
Room: Europa  
Chair: J. Hidalgo Carrió  

14:40  **SPARTAN: Vision-Based Autonomous Navigation System for Fast Traversal Planetary Rovers**  
M. Avilés  

15:05  Adaptive SLAM for Autonomous Planetary Exploration using Global Map Matching  
M. Azkarate  

15:30  **Exploration in inaccessible terrain using visual and proprioceptive data**  
D. Kuehn  

15:55  **Exomars visloc – the industrialised, visual localisation system for the exomars rover**  
M. Woods  

Session 7b: Orbital Missions 2  
Room: America  
Chair: S. Aziz  

14:40  **A Study of an Astronaut Support Robot with a Morphable-beam-based Extendable Arm**  
H. Nakanishi  

15:05  **Crew-supportive Autonomous Mobile Camera Robot on ISS / JEM**  
S. Mitani  

15:30  **Underactuated gripper design for the assembly of infrastructure in space**  
N. Mulsow  

15:55  No presentation scheduled
Session 7c: Robot Mechanism DDV
Room: London
Chair: M. Zwick

14:40  Evolution of the ExoMars Sample Crushing Unit from Breadboard to Flight Model
D. Redlich

15:05  ExoMars Rover Sample Handling System QM/FM Design and Testing
R. Paul

15:30  Actuator Development Projects in FY2017 in the Space Exploration Innovation Hub Center
T. i Yano

15:55  No presentation scheduled

16:20  Coffee break

Session 8a: Planetary Perception and Navigation 2
Room: Europa
Chair: M. Woods

16:35  Robust Localization of Mars Exploration Rover Using Geo-registration by Ground-to-Air Image Matching
K. Ebadi

17:00  Theoretical Analysis of Triangle Matching Method Based on Craters for Spacecraft Localization
F. Uwano

17:25  Sampling-based Descent Trajectory Planning and Autonomous Landing Site Selection for Icy Moon Missions
A. Arora

17:50  How to Detect Essential Craters in Camera Shot Image to Increase the Number of Spacecraft Location Estimation while Improving its Accuracy?
H. Ishii (K. Takadama)
Session 8b: Orbital Perception and Navigation
Room: America
Chair: L. Joudrier

16:35 Robust Model-Based Tracking for Active Debris Removal and Autonomous Rendezvous
M. Avilés

17:00 Motion Estimation of Axial Symmetry Object for Active Debris Removal Mission
I. Takahashi

17:25 Satellite Inspection Applications of Reflectance Transform Imaging
W. Bezouska

17:50 RVS3000-3D: LIDAR meets Neural Network
C. Schmitt

Session 8c: Hoppers
Room: London
Chair: K. Yoshida

16:35 Motion analysis of jump robot with tether for lunar exploration
Y. Sugawara

17:00 Traversability Analysis of Hopping Rovers on Small Solar System Bodies
B. Hockman

17:25 Design for wheel grouser geometry to direct a hopping rover
M. Otsuki

17:50 A Novel Small Hopping Robot with SMA Driven Legs for Lunar Exploration
T. Sakamoto

20:00 Conference Dinner departure

20:30 Dinner
Wednesday 6 June 2018

Session 9a: Perception 1
Room: Europa
Chair: L. Joudrier

09:25 Development of I3DS: an integrated sensors suite for orbital rendezvous and planetary exploration
V. Dubanchet

09:40 An SSDP based ICU for pre-processing and Control
J. Manuel Rodriguez Bejarano

10:15 High-performance Image Acquisition and Processing System for Space Debris Mitigation
S. Kimura

10:40 No presentation scheduled

Session 9b: Robot Control
Room: America
Chair: Mini C. Saaj

09:25 Optimal Control of a 3-DOF Free Floating Platform on a Flat Floor
C. Velosa

09:40 H-infinity control for a controlled floating robotic spacecraft
A. Seddaoui

10:15 Automatic Levelling of a Platform to Achieve Artificial Gravity
C. Velosa

10:40 Effective and accurate method for ground and on-orbit verification of control systems for free-flying robot with low thrust force
N. Tanishima
Session 9c: Autonomy Frameworks
Room: London
Chair: G. Visentin

09:25  A Common Data Fusion Framework for Space Robotics - Architecture and Data Fusion Methods
R. Dominguez

09:40 CASE: A Cognitive Architecture for Space Exploration
R. Bonasso

10:15 Performance of high-complexity algorithms for feature detection, image processing, and embedded visual odometry in a hybrid logic-software computing environment
E. Edwards

10:40 Using the ERGO framework for space robotics in a planetary and an orbital scenario
J. Ocón Alonso

10:55 Coffee break

Session 10a: Perception 2
Room: Europa
Chair: L. Joudrier

11:10 Joint Visual and Time-Of-Flight Camera Calibration for an Automatic Procedure in Space
T. Conceicao

11:35 Quality of the 3D Point Cloud of a Time-of-Flight Camera under Lunar Surface Illumination Conditions: Impact and Improvement Techniques
K. Uno

12:00 Enabling active perception through data quality assessment: a visual odometry use case
A. De Maio

12:25 No presentation scheduled
Session 10c: Robots and ISRU
Room: London
Chair: H. Ueno

11:10  Towards In-Situ Supply Chain Manufacture of All-Purpose Magnetic Devices from Rare Earth Materials Mined from Asteroids
A. Ellery

11:35  Developing Techniques to 3-D Print Electric Motor
A. Elaskri

12:00  Requirements for a mobile lunar prototype for additive layer manufacturing
A. Voß

12:50  Lunch break

14:00  Technical Tour

19:30  Arrival back at the hotel
Posters

P.01 Parametric influences on the behavior of planetary s regolith using DEM simulation
R. Lichtenheildt

P.02 Real-Time Implementation of a feature detection algorithm for usage in space applications
S. Hardt

P.03 Preliminary Design and Study of Performance of a High Mobility Sample Fetching Rover
J. Estremera

P.04 Retractable Anchors for Soft Sand Anchoring
S. Lam

P.05 Destination Accessibility of a Hopping Robot on Small Bodies in Microgravity
K. Kobashi

P.06 Automatic Experimental Design Using Deep Generative Models of Orbital Data
A. Candela

P.07 Minimum Object Internal Force Trajectory Optimization For On-Orbit Dual-Arm Space Robots
N. Mavrakis

P.08 LUVMI: a rover platform for volatiles instruments operation at the Lunar poles
J. Gancet.

P.09 Comparison of Gabor Filters and Wavelet Transform Methods for Extraction of Lithological Features
A. Tettenborn

P.10 Study on DEM Co-registration Algorithm for Improving Rover Landing Positioning Accuracy
L. Feng

P.11 Utilization of the Field Robots of the Earth as to Realize the Moon life
D. Takuji Ito

Proceedings - i-SAIRAS 2018, 4-6 June, Madrid, Spain
P.12  VaMEx - LAOLa Valles Marineris Exploration - Local Ad-hoc Positioning- and Landing-System
   T. Walter

P.13  Modelling of manipulator-satellite interaction using MATLAB/SIMULINK
   H. Jahn

P.14  Design and Implementation of a Hardware-in-the-loop Robotic Testbed for the European Robotic Arm’s Wrist Cameras
   M. Krainski

P.15  Characterisation of Exomars rover wheel in Simulated partial Gravity
   P. Niskarat

P.16  Toward Automated Robotic Tasks in Microgravity using Assistive Free-Flying Spacecraft and Adhesive Grippers
   A. Cauligi