Proceedings of the

8th ESA Workshop on

Advanced Space Technologies for Robotics and Automation

ASTRA 2004

NOTE: THIS is a hypertextual document

Navigation instructions:
Titles of sessions and papers are hyperlinked, that means that:

• when you see the pointer changing from 🖱 to 🕹 you can click over to open the hyperlinked document.
• to go back (and forth) in your navigation you can use the navigation buttons in the Acrobat Reader toolbar
• To start the navigation click HERE
8th ESA Workshop on
Advanced Space Technologies for Robotics and Automation
‘ASTRA 2004’

ESTEC, Noordwijk, The Netherlands
November 2 - 4, 2004
8th ESA Workshop on Advanced Space Technologies for Robotics and Automation

ASTRA 2004 Workshop

November 2 - 4, 2004
ESA/ESTEC, Noordwijk, The Netherlands

Organised by the European Space Agency (ESA)
Directorate of Technical and Quality Management
Mechatronics & Optics Division,
Automation & Robotics Section (TEC-MMA)
INTRODUCTION

The Automation and Robotics Section of the European Space Agency (ESA) Directorate of Technical and Operational Support organized the eighth Workshop on “Advanced Space Technologies for Robotics and Automation (ASTRA)”. ASTRA 2004 was held from November 2nd – 4th, 2004, at the European Space Research and Technology Centre (ESTEC) in Noordwijk, The Netherlands.

ASTRA 2004 built on the tradition of the previous seven ASTRA Workshops. It was a forum for information exchange and discussion of the European space Automation and Robotics (A&R) community. Participants obtained an up-to-date picture of • currently envisaged space missions and application scenarios where A&R could play a major role, • the A&R technology needs, which can be derived from these application scenarios, • the current status of European research and development programmes in the field of space A&R, and • new technology trends for space A&R.

The Aurora long-term mission framework for robotic and human exploration of the bodies of the Solar System - particularly those holding promise for traces of life - which ESA is setting up at this moment, is expected to increase the need for space Automation and Robotics. Furthermore, recent trends indicating interest in manned missions to the moon, demand for robotic technologies in order to prepare future manned visits to our neighbouring celestial bodies.

ASTRA provides an overview of technologies, which are available or are being developed in Europe and in the ESA member states in particular, or which should be included in future ESA-managed R&D activities.

SCOPE

The scope of the ASTRA Workshop is A&R technology and its application in space. The following areas should be covered:

• automation and robot system technologies
  (design and development methodologies, operational concepts, simulation and calibration techniques, multi-robot cooperation architectures, “evolutionary” robotics, micro-system technologies, etc.)
• robotic support equipment technologies
  (testbeds, simulators, training equipment, etc.)
• robot ground segment technologies
  (for programming and verification, commanding and monitoring, teleoperation at various levels of abstraction)
• robotic mobility technologies
  (arm relocatability, rover locomotion on / above / under the surface, etc.)
• manipulation subsystem technologies
  (kinematics, structures, actuators, proprioceptive sensors, harnesses)
• end-effector and sensor instrumentation technologies
  (grippers, hands, tools, drilling and sampling devices, payload interfaces, exteroceptive sensors including robotic vision, etc.)
• robot control technologies
  (space compatible hardware platforms, rover navigation and piloting techniques, control algorithms, intelligent sensor based control, human-computer interfaces, etc.).
• robot-friendly payload technology and design methodologies
• (non-robotic) technologies for space laboratory automation
  (payload control systems, data communications and imaging technologies, user interface and “telepresence” technologies)
• test and operations.

Papers on the following topics were especially encouraged:

• Programmatic (e.g. cost reduction, novel project management approaches, risk analysis, increasing competitiveness, failure detection)
• Robotic autonomy (e.g. operations autonomy, science autonomy, robotic task planning, scheduling)
• Miniaturization in robotics and robotic payloads (e.g. Contributions from High-tech to robotics, MEMS, Nano-technologies)
• User aspects (e.g. novel ideas for applications of space A&R, identified shortcomings of robotics for space applications, “success stories” from user’s point of view).

In particular, technology developers were invited to use their contacts with interested users, to forward this announcement to them and to make joint contributions.
ORGANISATION AND PROGRAMME COMMITTEE

Workshop Chairman:
H.P. Lutz ESA D/TOS, Head of Mechatronics & Optics Division (TOS-MM)

Programme Committee
B. Gardini ESA D/TOS, Head of Projects & Concurrent Design Office (TOS-AC)
R. Steinmeyer ESA D/MSM, Head of Human Spaceflight Systems and Robotics Division (MSM-MR)
P. Falkner ESA D/SCI, Head of Planetary Exploration Studies Section (SCI-AP)
C. Philippe ESA D/TOS, Head of Attitude, Navigation & Control Analysis Section (TOS-ESN)
P.R. Kerhousse ESA D/TOS, Head of Mechanisms Section (TOS-MMM)
G. Visentin ESA D/TOS, Head of Automation & Robotics Section (TOS-MMA)
A. Schiele ESA D/TOS, Automation & Robotics Section (Workshop Organiser)

Workshop Secretariat
For all administrative and organisational matters please contact:

ESA Conference Bureau (ADM-GTG)
PO Box 299
NL-2200 AG Noordwijk
The Netherlands
Fax +31-71-565 5658, Telephone +31-71-565 5056
E-mail: esa.conference.bureau@esa.int

Workshop Organizer
A. Schiele, Automation & Robotics Section (TOS-MMA)
Good morning Ladies and Gentlemen,

It is a great pleasure and honour for me to welcome you to ESA’s Space Research and Technology Centre, ESTEC, and to the 2004 edition of the ESA Workshop on Advanced Space Technologies for Robotics and Automation.

The ASTRA Workshops are traditionally held every two years here at ESTEC. Since the last ASTRA Workshop in 2002, we have been experiencing quite difficult times with regard to the potential use of Automation and Robotics in space. For one, ESA and its member states are facing severe financial problems related to the major programmes, namely the ISS, the Ariane-Launcher and the Galileo-Navigation programme, and this has caused delays and setbacks for a number of other activities. But on the other hand, promising new perspectives are opening up, particularly within the Exploration programme that ESA is currently putting in place. Indeed, if I look around, I see a quite promising landscape for the use of Automation and Robotics in space.

On the International Space Station, after the first Canadian robotic elements have long proven their effectiveness, new robotic systems are about to join in. The European Robot Arm is finally ready for its tasks on the International Space Station, and a date for its launch has been set. The EUROBOT development has been initiated with a first Phase-A contract and many R&D activities are now running to support it.

While the first practical uses of space robotics will be on the Space Station, ESA is also intensifying its activities in the area of planetary exploration by robotic means. The first ESA Exploration mission to another planetary surface, EXOMARS, has a rover as main actor of the mission. Furthermore, the Exploration Programme promises to make space robotics the main means by which several planetary exploration missions will be accomplished.

Large international co-operation is likely to be initiated soon for human exploration beyond Earth orbit. Also in these scenarios, Automation and Robotics will play a key role in preparing, enabling, supporting, amplifying, and protecting human operations.

Even in near-Earth orbit, after many setbacks in promoting robotic servicing of spacecraft, we finally have an ESA funded programme, the ConeXpress-Orbital Recovery Service (ORS) programme, which aims at extending the life of GEO satellites by means of captive carrying.
We believe that these endeavours into new missions and frontiers will fascinate the science community and public alike, and we are convinced that Automation and Robotics technologies will be among the essential elements to make such missions possible.

Ladies and Gentlemen, it is you who can reach these ambitious goals with your contributions as planners, researchers, technology developers, managers and users. I am very grateful that you have followed our invitation to come to ESTEC to share your views with us on this important topic. I wish you all the best in your endeavours and I look forward to yet another stimulating and rewarding conference.

I hereby declare OPEN the ASTRA Workshop 2004.
# TABLE OF CONTENTS

## Session A: Programmatic

<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>An Overview of Mission Applications for Space A&amp;R</td>
<td>Visentin, Gianfranco*</td>
<td>A-01</td>
</tr>
<tr>
<td>*ESA/ESTEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESA’s Technology Reference Studies</td>
<td>Falkner, Peter*; Lyngvi, A.<em>; van den Berg, M.L.</em>; Renton, D.<em>; Atzei, A.</em></td>
<td>A-02</td>
</tr>
<tr>
<td>*ESA-ESTEC, SCI-A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian Activities in Intelligent Robotic Systems - An Overview</td>
<td>Piedboeuf, Jean-Claude*; Dupuis, Erick*</td>
<td>A-03</td>
</tr>
<tr>
<td>*Canadian Space Agency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmanned on-orbit servicing (OOS), ROKVISS and the TECSAS mission</td>
<td>Sommer, Bernd*; Turk, M*</td>
<td>A-04</td>
</tr>
<tr>
<td>*DLR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Session B: Orbital Robotics I – Applications

<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>*European Space Agency, **ESA, ***Alenia Spazio Torino, ****Dutch Space</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Orbit Servicing of Satellites Using Automation &amp; Robotics: Satellite Capture Tool</td>
<td>Naumann, W.<em>; Hofmann, P.</em>; Landzettel, K.*</td>
<td>B-02</td>
</tr>
<tr>
<td>*Kayser-Threde GmbH, **DLR GmbH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An Overview of Technology Development for On-Orbit Servicing Activities in Canada</td>
<td>Piedboeuf, Jean-Claude*; Martin, Eric*; Doyon, Michel*</td>
<td>B-03</td>
</tr>
<tr>
<td>*Canadian Space Agency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Orbit Servicing (OOS) &amp; Its Potential Impact on Design, Operations and Efficiency of Future Space Infrastructure</td>
<td>Kreisel, Joerg*</td>
<td>B-04</td>
</tr>
<tr>
<td>*JOERG KREISEL International Consultant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Session C: Manipulation Subsystems I - Robotic Arm-systems

DEXARM – a Dextrous Robot Arm for Space Applications
Rusconi, Andrea*; Magnani, P.*; Grasso, T.**; Rossi, G.**; Gonzales Lodoso, J.F.***; Magnani, G.****

Dextrous Robot Arm
Hirt, Martin*; Gruener, Gabriel**
*CONTRAIVES SPACE AG, **CSEM

Eurobot End-Effector
Michaud, Stephane*; Dominguez, M.*; Nguyen, Uy-Liem*
*CONTRAIVES SPACE AG

LMF: The lightweight manipulator vehicle of Kerntechnische Hilfsdienst GmbH
Süss, Uwe*; Abadie, Vincent**; Joudrier, Luc***
*KHG, **Cybernétix, ***ESA/ESTEC

ROGER - Robotic Geostationary Orbit Restorer
Bischof, Bernd***; Starke, Juergen**; Guenther, Hansjuergen***; Foth, Wolf-Peter*; Kerstein, Lothar***
*EADS Space Transportation, **EADS-ST, ***EADS ST

Session D: Planetary Robotics I - Missions to Mars (Exomars)

Overview of exomars mission preparation
J. Vago*
*ESA/ESTEC

FORMID: A Formal Specification and Verification Environment for DREAMS
Guy, Bormann*; Joudrier, Luc**; Kapellos, Konstantinos*;
*TRASYS, **ESA / ESTEC

Concept study for the subsurface sampling system for the Pasteur payload of the ExoMars Mission
Anttila, Matti*
*Helsinki University of Technology

Sample Acquisition and Management Systems for Missions to Mars.
Magnani, Piergiorgio*; Re, E.*; Gelmi, R.*; Olivieri, A.**
*Galileo Avionica S.p.A., **ASI

Chassis Concepts for the ExoMars Rover
Kucherenko, V.*; Bogatchev, A.*; van Winnendael, M.**
*RCL, **ESA/ESTEC
**Session E: Autonomy**

Demonstrating Robotic Autonomy in NASA’s Intelligent Systems Project

*Morris, R.* ; *Estlin, T.* ; *Pedersen, Liam* ; *Williams, Brian***

*NASA Ames Research Center, NASA Jet Propulsion Laboratory, QSS Group Inc., MIT Massachusetts Institute of Technology*

Autonomous Robotics Toolbox

*L’Archeveque, Regent* ; *Allard, Pierre* ; *Dupuis, Erick***

*Canadian Space Agency*

Towards Autonomous Long Range Navigation

*Dupuis, Erick* ; *Allard, Pierre* ; *Bakambu, Joseph* ; *Lamarche, Tom* ; *Wen-Hong Zhu***

*Canadian Space Agency*

Integration of On-board EOS Schedule Revision with Space Communication Emulation System.

*Khatib, Lina* ; *Morris, Robert***

*Kestrel Technology, NASA Ames*

**Session F: Planetary Robotics II – Exploration**

Venus Orbiter and Entry Probe: An ESA Technology Reference Study

*Phipps, Andy et al.* ; *Underwood, John et al.* ; *Van den Berg, Marcel*** ; *Falkner, Peter***

*Surrey Satellite Technology Ltd, Vorticity Ltd, ESA/ESTEC*

Atmospheric Microprobes for Venus: A preliminary probe design and localisation method

*Wells, Nigel* ; *Ballard, A.* ; *Cosby, M.* ; *Eldridge, A.* ; *Singh, R.* ; *Picardi, E.* ; *Taylor, F.* ; *Bowles, N.* ; *Wilson, C.* ; *Lacy, S.* ; *Doherty, J.*

*QinetiQ, University of Oxford*


*Noth, A.* ; *Bouabdallah, S.* ; *Michaud, S.* ; *Siegwart, R.* ; *Engel, W.*

*Swiss Federal Institute of Technology (EPFL)*

Wireless Power Transmission Experiment Using an Airship as Relay System and Moveable Rover as Ground Target for Later Planetary Exploration Missions.

*Steinsiek, F.* ; *Weber, K.H.* ; *Foth, W.P.* ; *Foth, H.J.* ; *Schaefer, C.*

*EADS Space Transportation, Technical University Kaiserslautern*
Session G: Control I - Groundstations and Controllers

A-DREAMS: An Advanced Ground Control Station for Teleoperation & Telemanipulation
Didot, Frederic*; Kapellos, Konstantinos**; Schiele, Andre*
*ESA / ESTEC, **TRASYS S.A.

A robotic task scheduler – Task Planner for Automation and robotics in Space (TAPAS)
Focant, G.*; Fontaine, B.*, Steinicke, Leif*; Joudrier, L.*
*Space Applications Services, **ESA/ESTEC

CONTEXT – Space A&R Controller Capability Extension
Bologna, Patrizia*; Mondellini, C.*; Crudo, E.*; Didot, F.**; Foresti, L.*
*Galileo Avionica S.p.A., **ESTEC

New Generation Robotic Controller Software For Space Manipulators
Cikic, N.*; De Marchi, E.*; Filippini, M.*; Fusco, F**; Grasso, Tiberio*; Olivieri, A.***; Rusconi, A.**
*Tecnomare S.p.A., **Galileo Avionica, ***Italian Space Agency (ASI)

Session H: Mobile Robotics I – Simulation

Advanced Modelling and Simulation Methods of Planetary Rover Mobility on Soft Terrain
Gibbesch, Andreas*; Schäfer, B.*
*DLR

Performance Evaluation of locomotion modes of an hybrid wheeled-legged robot for self-adaption to ground conditions
Ben Amar, Faiz*; Grand, Ch.*; Besserer, G.*; Plumet, F.*
*Université Pierre et Marie Curie, Paris 6,

Modelling and Comparision of Wheeled Rovers
Lamon, Pierre*; Thueer, Thomas*; Jordi, Rolf*; Siegwart, Roland*
*EPFL

Rover Mobility Performance Evaluation Tool (RMPET): A Systematic Tool For Rover Chassis Evaluation Via Application of Bekker Theory
Patel, Nildeep*; Ellery, Alex*; Allouis, Elie*; Richter, Lutz**
*University of Surrey,**DLR
<table>
<thead>
<tr>
<th>Session I: Exhibit Session</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>An Approach to Reliability-Adaptive Multi-Robot Coordination</strong></td>
<td>I-01</td>
</tr>
<tr>
<td><em>Rakowsky, Uwe K.</em>; Schneeweiss, Winfrid G.*</td>
<td></td>
</tr>
<tr>
<td><strong>Entrainment as a Paradigm for Modelling a Planetary Robot's Circadian Rhythm</strong></td>
<td>I-02</td>
</tr>
<tr>
<td><em>Rocks, Claire</em>; Barnes, Dave*</td>
<td></td>
</tr>
<tr>
<td><strong>Electroactive Polymer Actuator design for space applications</strong></td>
<td>I-03</td>
</tr>
<tr>
<td><em>Fernández Infante, Diego</em>; Moreno, L.E.<em>; Baselga, J.</em></td>
<td></td>
</tr>
<tr>
<td><strong>Exhibit: Planetary Rover Simulator</strong></td>
<td>I-04</td>
</tr>
<tr>
<td><em>Rastel, Laurent</em>; Maurette, M.M.*</td>
<td></td>
</tr>
<tr>
<td><strong>ASVIS, an Operational Vehicle Servicing the ISS</strong></td>
<td>I-05</td>
</tr>
<tr>
<td><em>del Cura, Juan Manuel</em>; López, A.<em>; Colmenarejo, P.</em>; Strippoli, L.<em>; Modrego, D.</em></td>
<td></td>
</tr>
<tr>
<td><strong>Imaging and localisation package for a Martian balloon based aerobot</strong></td>
<td>I-06</td>
</tr>
<tr>
<td><em>Barnes, Dave</em>; Shaw, A.<em>; Summers, P.</em>; Ward, R.<em>; Woods, M.</em>; Evans, M.<em>; Paar, G.</em>;</td>
<td></td>
</tr>
<tr>
<td><strong>Analysis of Flapping Wing Robots for Exploration. An evolutionary approach.</strong></td>
<td>I-07</td>
</tr>
<tr>
<td><em>Salles, Renato</em>; Schiele, Andre*</td>
<td></td>
</tr>
<tr>
<td><strong>MAGRITTE: a graphic supervisor for telerobotics interventions</strong></td>
<td>I-08</td>
</tr>
<tr>
<td><em>Leroux, Christophe</em>; Guerrand, Martine*; Leroy, Christophe*; Measson, Yvan*; Boukarri,</td>
<td></td>
</tr>
<tr>
<td>**The results of ESA/ESTEC and VNII Transmash &amp; RCL joint R&amp;D activities aimed at the</td>
<td>I-09</td>
</tr>
<tr>
<td><em>Matrossov, S.</em>; Gromov, V.<em>; Malenkov, M.</em>; Vladykin, S.*</td>
<td></td>
</tr>
<tr>
<td><strong>Development of a bioinspired insect leg</strong></td>
<td>I-10</td>
</tr>
<tr>
<td><em>Oszwald, F.</em>; Wedler, A.<em>; Schiele, A.</em></td>
<td></td>
</tr>
<tr>
<td>**The mole with sampling mechanism (MSM) – Technology Development and Payload of Beagle</td>
<td>I-11</td>
</tr>
<tr>
<td><em>Richter, L.</em>; Coste, P.<em>; Gromov, V.</em>; Grzesik, A.*</td>
<td></td>
</tr>
<tr>
<td><strong>Index-5</strong></td>
<td></td>
</tr>
</tbody>
</table>
Session L: Manipulation Subsystems II - Modelling and Simulation

Modular, Generic Inverse Kinematics Algorithm Applied to Kinematically Redundant Space Manipulators
Krenn, Rainer*; Hirzinger, G.*
*German Aerospace Center (DLR)

In-situ calibration methods for damaged planetary manipulator robots
Taylor, Edward*; Barnes, Dave*
*University of Wales, Aberystwyth

Object-oriented modeling of a space robotic manipulator
Ferretti, G.*; Magnani, G.A.*; Rocco, P.*; Viganò, Luca*; Gritti, M.*; Rusconi, A.**
*Politecnico di Milano,**Galileo Avionica

Session M: Vision

Imaging and Localization for a Planetary Aerobot
Vergauwen, Maarten*; Matthews, Glyn*; Van Gool, L.*; Fontaine, B.**
*K.U.Leuven,**Space Applications Services

High resolution 3D terrain mapping with low altitude imagery
Lacroix, Simon*
*LAAS/CNRS

Far-field terrain evaluation using geometric and toposemantic vision
Avedisyan, A.*; Wettergreen, D.**; Fong, Terrence*; Baur, C.*
*Swiss Federal Institute of Technology (EPFL),**Carnegie Mellon University

Imaging and localization package for a Martian balloon based aerobot
Barnes, Dave*; Shaw, A*; Summers, P*; Ward, R**; Woods, M**; Evans, M**; Paar, G***; Sims, M****
*University of Wales Aberystwyth, **SciSys (Space & Defence) Ltd., ***Joanneum Research, ****University of Leicester

Session N: Control II - Telemanipulation & Telepresence

ROKVISS: Orbital Testbed For Tele-presence Experiments, Novel Robotic Components and Dynamics Models Verification
Schäfer, Bernd*; Landzettel, K.*; Rebele, B.*; Albu-Schaeffer, A.*; Hirzinger, G.*
*German Aerospace Center (DLR)

Comparison of Control Methods in Time-delay Teleoperation
Fiorini, Paolo*; Botturi, Debora*; Castellani, Andrea*; Moschini, Davide*
*University of Verona

Analysis and Synthesis of an Impedance Matching Scheme for Emulation of Space Robots
Aghili, Farhad*; Dupuis, Erick*; Namvar, Mehrzad*
*Canadian Space Agency
Session O: Mobile Robots II – Mobility

RCET: Rover Chassis Evaluation Tools
Michaud, Stephane*; Richter, Lutz**; Patel, N.*; Thueer, T.***; Huelsing, T.******; Joudrier, Luc.*****; Siegwart, Roland***; Ellery, Alex****;
*CONTRAVES SPACE AG,**DLR,***EPFL,****SURREY,*****ESA******EADS Bremen
O-01

Ambulating Robots for Exploration in Rough Terrain on Future Extraterrestrial Missions
Spenneberg, Dirk*; Kirchner, F.*; De Gea, Jose*
*University of Bremen
O-02

Robustness Concepts for Hopping Robots
Fiorini, Paolo*; Marchesi, Massimiliano*
*University of Verona
O-03

New Robot Concept for Mars Soil Exploration: mechanics and functionality
Rovetta, A.*; Paul, E.*
*Politecnico di Milano
O-04

Session P: Demonstration Session

High Resolution High Frame Rate Video Management Unit.
Severi, M.*; De Nino, M.*; Quadarella, R.*; Capuano, G.*; Monti, F.*
*Techno System Dev. S.r.l.
P-01

Live Demonstration SCORPION: An Ambulating Robot for Exploration in Rough Terrain
Spenneberg, Dirk*; Kirchner, F.*
*University of Bremen
P-02

A simple embedded stereoscopic vision system for an autonomous rover
Genta, Giancarlo*; Chiaberge, Marcello*; Amati, Nicola*; Padovani, Mauro*; Sansòè, C*; Rolando, P*
*Politecnico di Torino
P-03

Session Q: Control III – Simulation

Simulation of Contact in Multibody Dynamics using Simulink
Gonthier, Yves*; Lange, Christian*; McPhee, John**; Piedboeuf, Jean-Claude*
*Canadian Space Agency,**University of Waterloo
Q-01

Recent results in visual servoing for robotics applications
Chaumette, Francois*; Marchand, Eric*
*IRISA / INRIA Rennes
Q-02
Session R: Mobile Robotics III - Alternative Mobility Concepts

Biologically inspired solutions for robotic surface mobility
Ylikorpi, Tomi*; Halme, A*; Jakubik, P*; Suomela, Jussi*; Vainio, Mika*;*Helsinki University of Technology

Ground Mole Demonstrator for Mars subsoil exploration – Design and Testing
Parzianello, G*; Angrilli, F*; Bettanini, C*; Campaci, R**; Debei, S*; Finotello, Roberto**; Rossi, G**; Visentin, G***; Zaccariotto, M*
*CISAS Università di Padova, **Tecnomare S.p.A., ***ESA/ESTEC

An Artificial Neuro-Endocrine Kinematics Model for Legged Robot Obstacle Negotiation
Henley, Julian*; Barnes, D.P.*
*University of Wales – Aberystwyth

Bionics & Space System Design Project - Progress Report for ESA Advanced Concepts Team
Scott, Gregory*; Ellery, A*
*University of Surrey

Session S: Orbital Robotics III - Systems and Payloads

ERA Operations Verification: Results and Lessons Learned
Heemskerk, Cornelis*; Petersen, H*; Aris, L*; Slott, R**; Didot, F**
*Dutch Space, **ESA/ESTEC

Scanning Time-of-flight Laser Sensor for Rendezvous Manoeuvres
Michel, K.*; Ullrich, A.**
*Jena-Optronik GmbH, **Rieg1 Research GmbH

Stereo Vision Measurement System - Satellite Maintenance Mission Application
Ferrario, R.*; Finotello, Roberto*; Losito, S.**; Marcon, A.*; Mondellini, C.***; Rossi, G.*; Scaggiante, A.*; Viareggio, A.*; Zampato, M.*
*Tecnomare S.p.A., **Italian Space Agency, ***Galileo Avionica

CRM, a novel approach for mini manipulators for space
Foth, Wolf-Peter*; Maediger, Bernd**; Maediger, Cornelia**; Guenther, Hansjuergen**
*EADS Space Transportation, **EADS ST