Proceedings of the

8th ESA Workshop on

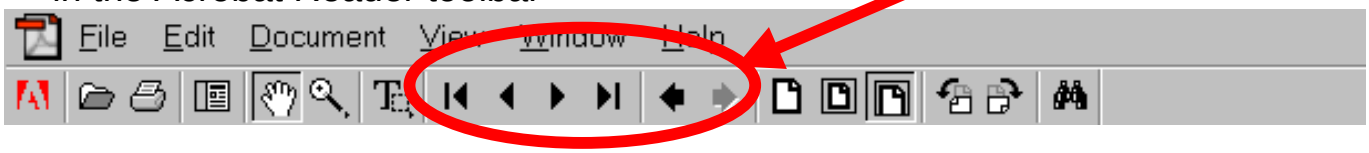
Advanced Space Technologies for Robotics and Automation

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



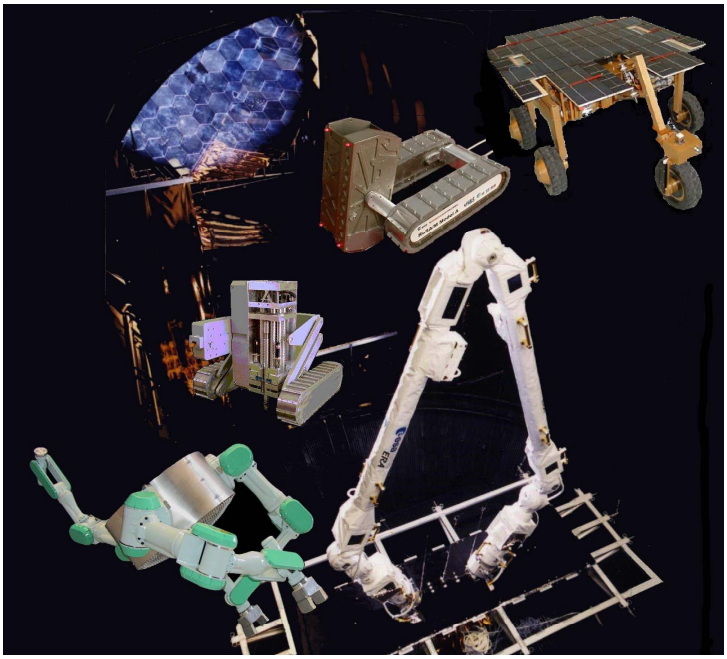
- To start the navigation click HERE

ESA-WPP 236

8th ESA Workshop on

Advanced Space Technologies for Robotics and Automation

‘ASTRA 2004’



ESTEC, Noordwijk, The Netherlands

November 2 - 4, 2004

Proceedings

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 were 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)

ASTRA 2004 Workshop

WELCOME ADDRESS

H. Lutz
Head of Mechatronics and Optics Division, ESA/ESTEC
ASTRA 2004 Chairman

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 C: Manipulation Subsystems I - Robotic Arm-systems

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

Session E: Autonomy

Session F: Planetary Robotics II – Exploration

Session G: Control I - Groundstations and Controllers

Session H: Mobile Robotics I – Simulation

Session I: Exhibit Session

Session L: Manipulation Subsystems II - Modelling and Simulation

Session M: Vision

Session N: Control II - Telemanipulation & Telepresence

Session O: Mobile Robots II – Mobility

Session P: Demonstration Session

Session Q: Control III – Simulation

Session R: Mobile Robotics III - Alternative Mobility Concepts

Session S: Orbital Robotics III - Systems and Payloads