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An Overview of Mission Applications for Space A & R

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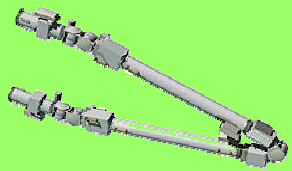
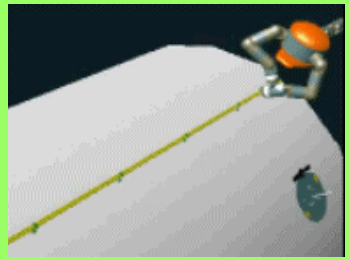
Overview of Application Scenarios

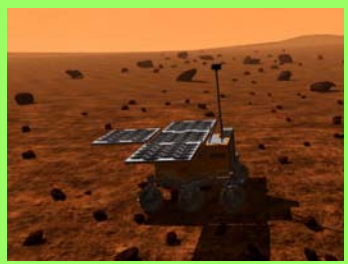
☺ ISS applications
- system servicing robots
- payload tending robots

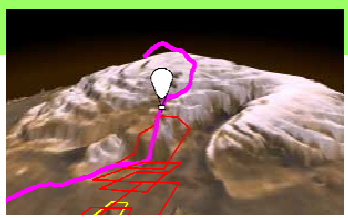




☺ Satellite servicing
- ❄ application mainly in GEO
- ❄ often LEO demonstrators

☺ Robotics for surface exploration in Solar System
- ★ Essentially rovers
- ★ Also robotic instruments





😐 Innovative robotics for subsurface and arial exploration

Robotic System Servicing on the ISS (1)

Large robot systems for ISS assembly and servicing

ERA (European Robot Arm) on Russian Segment

WILL FLY: A launch date in 2007 has been set

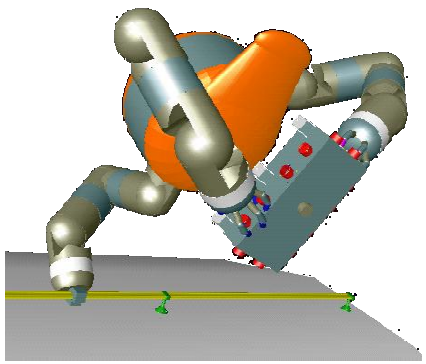
Operation Verification (Orbital Robotics III)

Mission preparation Support (Visit to ESTEC A&R Laboratory)

Engineering Model (Visit to Dutchspace)

Robotic System Servicing on the ISS (2)

EUROBOT



A quasi-anthropomorphic robot system capable of dextrous EVA.

Phase A study has been launched by the Human Spaceflight and Microgravity Directorate (paper in Orbital Robotics I session)

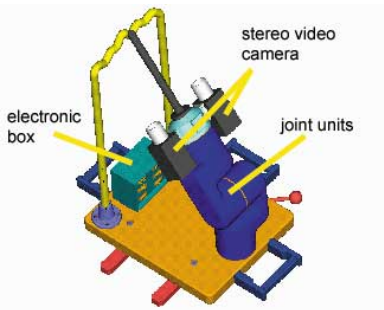
This very challenging project will have to rely on the many R&D activities running under the Technology Programmes.

Some of the contributing developments (arms, end-effectors) are illustrated in papers Manipulation Subsystems session

Robotic Tending of Payloads on ISS

Tending of externally-mounted payloads (EVA robotic tending)

☹ None of the many proposals of the past years (Robotic-EUTEF, EUROPA, MISSIS) have materialised



☺ DLR work on technology for teleoperated robot system on ISS (ROKVISS) see paper in Programmatics session and in the Teleoperations and Telepresence session

Robotic Satellite Servicing in GEO (1)

ESA: Results of General Studies aiming at maintaining the GEO orbit safe and performing (ROGER = RObotic GEostationary orbit Restorer) given in Manipulation Subsystems I. However due to limitations of the R&D programmes, no further work is planned.

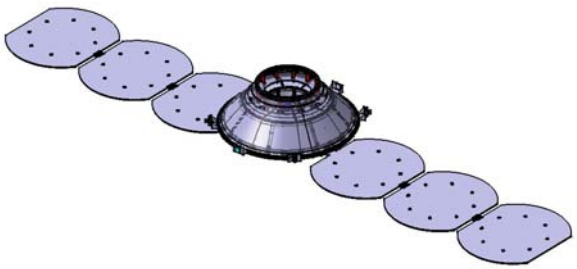
DLR: very active on the subject (Capture Tool, TECSAS, OOS survey) . An overview of their developments is given in the Orbital Robotics I session

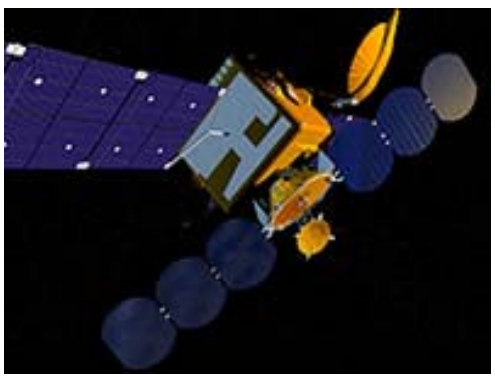
CSA: active on the subject. An overview of their developments is given in this same session

OTHERS: An analysis of potential for in-orbit servicing is given in the same session

Robotic Satellite Servicing in GEO (2)

ESA: ConeXpress - ORS mission is to provide low-cost lifetime extension of nearly fuel-depleted operational geostationary telecommunication satellites.





Based on existing A5 payload adapter

Many launch opportunities

Additional contraptions as 2624 structure avoided

Developed together with Arianespace, meets A5 launcher requirements

Large payload capacity

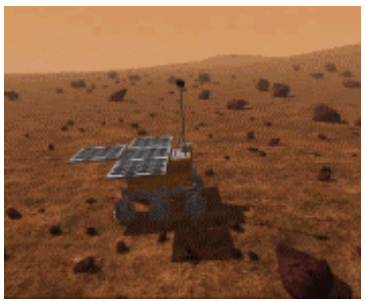
Electric propulsion for transfer orbit and station keeping of the captive spacecraft

DLR provides docking technology. A paper is in Orbital Robotics I session

Surface Exploration in Solar System (1)

Mars surface science / exploration

☺ ExoMars mission



An ESA mission to deliver a rover for Exobiology investigation to Mars
The mission has a huge scientific payload to accommodate with minimal resources. Tight integration, high optimization and efficient use of energy are capital to make the mission feasible.
Approaches to robotise the payload are shown in the Planetary Robotics I session, and the very relevant issue of terramechanics is addressed in various papers in Mobile Robotics - 1 session
Simulation and verification issues are also addressed in the same sessions

Surface Exploration in Solar System (2)

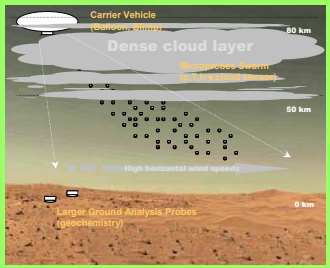
Robotic Moon surface science / exploration

- ☺ Intended to be a stage of the Exploration Programme
- ☺ A CDF study was performed to size a mission and identify elements that Europe could contribute as part of an international effort

Robotic support for a Human missions to Mars

- 😐 Remains a long (long, long) term goal for the Exploration Programme
- ☺ A&R has been identified as one strategic technology for European contribution !

Surface Exploration in Solar System (3)



Microprobes: to intelligently collect data with in-situ measurements over large areas (see paper in Planetary Robotics II). Very interesting for Venus

Robots with alternative locomotion: Walking / Hopping robots. Their efficiency is undisputed. They are very interesting for hazardous environments (cliffs/ heavy cluttered terrains). However can they be used in space? See Mobile Robotics II session

Flying robots (Aerobots):
For balloon smart localisation, see the results of first ESA technology development activity in Vision session
For fixed-wing, see results of ESA study in Planetary Robotics II

Robotic Surface Exploration in Solar System (4)

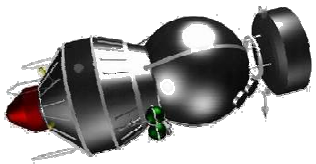
Underground Science:

Robotic Drills: will be used in ExoMars and Mars Sample Return

Smart moles/robotic earthworms: to collect samples or to bring instruments deep underground, see papers in Mobile Robotics III session and exhibits in Exhibit session. Very interesting for Mars exploration.

Non-Robotic Automation: Status

FOTON M2 and M3



In FOTON M2 there will be an upgraded version of Telescience Support Unit (TSU) which flew successfully on Foton 12 (9/99) being the first real flight use of telescience. This time many more payload of FOTON will be served by the TSU.
In FOTON M3 a new TSU (to be developed under the R&D programme) will be baselined for every payload

MFC (Microgravity Facilities for Columbus)

Material Science Laboratory (MSL), Fluid Science Laboratory (FSL), BioLab, European Physiology Module (EPM) successfully passed PDR / CDR stages of development
A&R contributions to embedded automation, more effective ground interaction (BioLab even has an internal manipulator)
MSL-Electromagnetic Levitator (MSL-EML) for Columbus (joint ESA / DLR development) ending Phase A/B initiated in 2000
features enhanced automation technology

Summary

Space robot systems for ISS servicing

- ☺ After long delays ERA will fly
- ☺ EUROBOT is getting real

Robotic payload tending on ISS

- 😐 So far only technology demonstrations

Satellite servicing robotics

- ☺ GEO servicing has finally a real project in ConeXpress

Planetary robotics

- ☺ ExoMars is getting real. Rover and payload are fantastic robotics developments

Innovative robotics

- ☺ finally R&D work was started in Aerobots and smart moles/robotic earthworms

There has never been a more positive outlook for space robotics at ESA. Our discipline has finally major programmes (though in phase-A) in most of the application scenarios. However the bad economics situation may again preclude final success.