Keynote Address I

Robotics Technology for Space Exploration Missions

Richard Volpe

Manager of the Mobility and Robotics Systems Section,
Autonomous Systems Division, Jet Propulsion Laboratory, USA

Abstract:

The Jet Propulsion Laboratory, California Institute of Technology, is NASA’s lead center for robotic exploration of the solar system. Scientific investigation of Mars has been of primary importance, with success of the Phoenix Lander, ongoing operation of the Mars Exploration Rovers, and construction of the 2011 Mars Science Laboratory rover. Additionally, technology development for steep terrain access and sample acquisition with return is also being prepared for the next decade. But Mars is not the only focus of our efforts—prototypes are under development for mobile habitats on the Moon, as well as aerial exploration of Titan and Venus. This talk will provide an overview of the technology development and mission infusion pathways for these challenging scenarios, and provide some recent results from our Mars exploration experience.

Biography

Richard Volpe is Manager of the Mobility and Robotic Systems Section of the Jet Propulsion Laboratory (JPL). A team of over 80 robotics engineers doing research and spaceflight implementation of robotic systems for Roving, Digging, Ballooning, Drilling, and other modes of in-situ planetary exploration. Richard is also a member of JPL’s Science and Technology Management Committee, and has been a member of the 2007 Phoenix Mission Robotic Arm Team. From 2001 through 2004, Richard served as the manager of Mars Regional Mobility and Subsurface Access in JPL’s Space Exploration Technology Program Office. In addition to guiding technology development for future robotic exploration of Mars and the Moon, he has been actively involved in 2003 & 2011 rover mission development. This has included managing internal JPL rover technology development, as well as external university research funded by the Mars Technology Program.
Keynote Address II

Adaptive Systems for Space: A Smooth or a Disruptive Evolution?

Philippe Armbruster

Head of the Data System Division, ESTEC, European Space Agency (ESA), The Netherlands

Abstract:

Space evokes distance and hence space missions are remote by nature. Remoteness can be expressed in terms of distance or in terms of time; its dual dimension while considering for instance radio communication propagation delays. Space missions are designed in order to cope with remoteness, by implementing for example telecommand and telemetry links either directly, via data relays or associated to on-board data storage when visibility from earth ground stations is not permanent. This classical scheme, successfully used in current space missions is complemented by sophisticated means allowing to mitigate failures via reconfigurations validated according to well defined FDIR scenarios. Switching over from one configuration to another one can be controlled from ground or managed autonomously by the spacecraft. Indeed such a commonly used scheme has some limitations. The first one is related to the high mass and complexity overhead induced by redundant units and cross-strapping, the second being that only pre-analyzed contingencies can be mitigated in flight.

We have also to introduce a third expression of remoteness; knowledge remoteness. This applies typically to exploration missions for which the environment cannot be fully characterized up-front (e.g. temperature, radiation conditions), for which the exact behavior of embarked sub-systems (e.g. shortened lifetime of electronics and materials) was unpredicted or for which unexpected contingencies at mission level (e.g. failure of a ground station or a data relay satellite) were not taken into account.

Adaptive systems could then be defined along the lines defined above as systems able to cope simultaneously with space, time and knowledge remoteness. Introducing the latter constraint in a space mission design can appear as somehow unorthodox to the point of jeopardizing the mission approval during initial reviews. Knowledge remoteness could translate directly into risk levels considered as unacceptable for expensive missions.

Based on recent progresses of technologies and concepts, the presentation will address as a starting point how risks associated to knowledge remoteness can be counterbalanced by using adaptive hardware and systems. The second aspect developed relates to how these new concepts should be introduced; as a smooth or as a disruptive evolution.

Biography

Philippe Armbruster is heading the Data Systems division of ESA’s Technical and Quality Management Directorate. The division is responsible for future developments related to satellites Avionics, On-board computers, Storage units, Payload electronics and microelectronics in general. Following a mid and long-term vision aiming at federating on-board communication via networks, Philippe initiated activities that led to the
SpaceWire links and networks standard. In addition, he is supervising the development of key building blocks such as microprocessors, ASICs and units for open interface Avionics architectures. Philippe Armbruster received an Engineering degree of Physics and Electronics in 1983 and then a PhD in Signal and Image Processing from the Louis Pasteur University of Strasburg, France. In 1989, he started working at the technical center of the European Space Agency, ESTEC, located in The Netherlands.
Keynote Address III

Adaptive Learning with new pattern recognition method CHLAC

Tetsuya Higuchi

National Institute of Advanced Industrial Science and Technology, Japan

Abstract:

This talk introduces a new pattern recognition method called CHLAC (Cubic High-order Local Auto Correlation) and its applications. CHLAC attained the best performance at the gait recognition competition held by NIST in 2005. Since then, CHLAC has been applied for a wide variety of applications including cancer cell screening, semiconductor chip inspection, and cow breeding system. The talk covers the latest results of CHLAC applications.

Biography

Tetsuya Higuchi graduated from Keio University, Japan, and received Ph.D degree in 1984. He entered Electrotechnical Laboratory (now AIST) and developed a massively parallel associative memory machine for AI applications. Since 1992, he has been involved in the research of Evolvable Hardware (EHW) and has published numerous papers about EHW applications. Recently he also conducts the research of power line communications and CHLAC. He is also a professor at the University of Tsukuba.