Paper ID: 14433
oral
student

SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies for Enable Future Building Blocks in Space Exploration and Development (3)

Author: Mr. Giuliano Punzo
University of Strathclyde, United Kingdom, giuliano.punzo@strath.ac.uk

Dr. Derek Bennet
University of Strathclyde, United Kingdom, derek.bennet@strath.ac.uk
Dr. Gordon Dobie
Centre for Ultrasonic Engineering, University of Strathclyde, United Kingdom, gordondobie@eee.strath.ac.uk
Dr. Malcolm Macdonald
University of Strathclyde, United Kingdom, malcolm.macdonald@strath.ac.uk
Mr. Jonathan Jamieson
University of Strathclyde, United Kingdom, jonathan.jamieson@strath.ac.uk

LOW-COST, MULTI-AGENT SYSTEMS FOR PLANETARY SURFACE EXPLORATION

Abstract

The use of off-the-shelf consumer electronics combined with top-down design methodologies have made small and inexpensive satellites, such as CubeSats, emerge as viable, low-cost and attractive space-based platforms that enable a range of new and exciting mission scenarios. In addition, to overcome some of the resource limitation issues encountered with these platforms, distributed architectures have emerged to enable complex tasks through the use of multiple low complexity units. The low-cost characteristics of such systems coupled with the distributed architecture allows for an increase in the size of the system beyond what would have been feasible with a monolithic system, hence widening the operational capabilities without significantly increasing the control complexity of the system. These ideas are not new for Earth orbiting devices, but excluding some distributed remote sensing architectures they are yet to be applied for the purpose of planetary exploration. Experience gained through large rovers demonstrates the value of in-situ exploration, which is however currently limited by the associated high-cost and risk. The loss of a rover can and has happened because of a number of possible failures: besides the hazards directly linked to the launch and journey to the target-body, hard landing and malfunctioning of parts are all a threat to the success of the mission. To overcome these issues this paper introduces the concept of using off-the-shelf consumer electronics to deploy a low-cost multi-rover system for future planetary surface exploration. It is shown that such a system would significantly reduce the programmatic-risk of the mission (to for example catastrophic failure of a single rover), while exploiting the inherent advantages of cooperative behaviour. These advantages are analysed with a particular emphasis put upon the guidance, navigation and control of such architectures and using the method of artificial potential field. Numerical simulations and laboratory tests on multi-agent robotic systems support the analysis. Principle features of the system are identified and the underlying advantages over a monolithic single-agent system highlighted.