HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Poster Session (P)

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GROUND PLANNING FOR REMOTE AUTONOMOUS SYSTEMS

Abstract

IRONCAP is an ESA study project to explore and define the concepts and interactions needed to control and plan the activities of autonomous agents such as an interplanetary rover.

The key objectives of the study include (a) the definition of advanced concepts for controlling and monitoring rover operations, considering the presence of autonomous planning and execution capabilities in the rover segment; (b) the development of a general-purpose proof-of-concept prototype providing a coherent and complete working implementation of an Automated Ground Activity Planning/Scheduling and Validation System for rover operations for ESA.

The approach and prototype allow supporting the top-three levels of autonomy defined in the ECSS-E-70-11 standard for space applications, i.e. E2 - Execution of pre-planned mission operations on-board; E3 - Execution of adaptive mission operations on-board; and E4 - Execution of goal-oriented mission operations on-board.

The essential functionality that are supported by the proposed concept and system architecture are operation planning, operations plan verification, domain model validation, long-term planning, telemetry processing, and command generation.

This functionality is supported for the several classes of plans required to support the various levels of rover autonomy to be supported by the ground planning system, from simple time-tagged sequences of activities to conditional plans and networks of goals.

The planning techniques implemented to support the core of the planning algorithms are based on model-checking techniques, which better allow addressing the problems inherent to the uncertainty in the rover environment and in the reactions of the autonomous system.

The paper will introduce the operations concept for the ground planning of autonomous rovers, and the architecture of the ground systems proposed to support this concept. It will elaborate on the issues raised by the need for situational assessment in the planning context, the synchronisation required between the various models used to support the planning and validation on the ground and on-board, and the characteristics of the reasoning algorithms used to support the planning with uncertainty.

Finally the lessons learned from the evaluation of the IRONCAP concept and prototype in the context of realistic case studies will be presented