Paper ID: 12452
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Robotic Precursors to Human Exploration (03)
Robotic Precursors to the Mars System (2)

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AUTONOMOUS CONTROLLER FOR SPACE ROBOTIC SYSTEMS BASED ON HIGH LEVEL GOALS

Abstract

The use of robotic systems for space exploration has opened new possibilities to face long standing problems in space missions. In the presence of long round-trip communication delays, a typical condition in space exploration missions, relying on ground for decision making may lead to low performances at mission level and mainly for what concerns science optimization and exploitation. Moreover, it can be surely unsafe for the spacecraft if environmental conditions have a high degree of uncertainty as it happens when exploring the surface or the atmosphere of a planet.

This situation can be improved if the space segment is based on a robotic system that can make decisions on its own. By closing the decision-making loop on board, the robotic system can undertake the mission targets in a safer and faster way (compared with relying on ground for decision making) and it can address opportunistic science objectives identified while operating. Furthermore, ground operators and scientists can remain focused on their domains, rather than getting into cumbersome details. This approach requires the robotic system to be highly autonomous, i.e. it must be capable of meeting its objectives without external intervention.

In particular, in this context, autonomy involves the ability of reasoning: operators tell the system what to do instead of how to do it; the latter will be decided by the robotic system.

In order to make decisions autonomously, a robotic system must have information about all its possible behaviors, including all kind of operational and safety constraints, and it must continuously perceive the environmental conditions.

Additionally and in order to reduce risks in certain conditions, it must be possible for the ground system to take control over the space system at any time if the mission requires so.

This paper will detail the Goal-Oriented Autonomous Controller (GOAC) system, which was developed under ESA contract by a team led by GMV with participants from research institutions LAAS-CNRS, VERIMAG, ISTC-CNR, and Dr. Kanna Rajan from MBARI as consultant. GOAC enables in a space mission to flexibly move the decision-making process from ground to space for the sake of improving the performance and the safety of the mission. A prototype of this system has been designed and developed in the frame of an ESA project by a team of experts in key areas: deliberation, planning and execution.