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DESIGN AND ANALYSIS OF MECHANICAL, ELECTRICAL, AND SOFTWARE SYSTEMS FOR AUTONOMOUS MARS ROVERS

Abstract

In recent years, increased attention has been focused on human-machine systems, their architecture and operation. The purpose of this paper is to describe the mechanical, electrical and software systems required for the autonomous navigation and operation of a rover on the surface of Mars. Emphasis in the autonomy of a Mars rover is analyzed, as well as some software platforms that play a decisive role in autonomy. Building upon the overarching focus on human-machine systems, the paper delves deeper into the specific mechanical, electrical, and software innovations that enable Mars rovers to navigate and operate autonomously in one of the most inhospitable environments known to humanity. Research focuses on aspects of the structural design, power systems, and stand-alone software platforms like OASIS, CASPER, and CLARAty. Based on this, the paper investigates and reviews the interaction of different kinds of navigation algorithms, power management solutions, and sensor technologies involved for the purpose of overcoming Mars' harsh conditions, from extreme temperatures to dust, ending with low solar radiation. Advanced materials, suspension systems are the things that have become vital in view of mobility and stability. On the other hand, sustainable power should be provided by hybrid power solutions, including solar panels, batteries, and radioisotope thermoelectric generators (RTGs). The research underlines that AI-based systems could create a revolution regarding real-time decisions on data priority. Taken all together, these improvements contribute to a substantial enhancement in the efficiency, lifetime, and scientific performance of the Mars rovers. The paper concludes by proposing an integration framework for these systems, which will help address the existing challenges and provide a basis for next-generation autonomous rovers that can support long-duration missions and extend the boundaries of human exploration on Mars.