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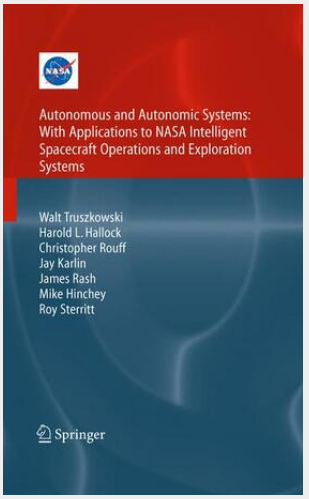
Autonomous and Autonomic Systems: With Applications to NASA Intelligent Spacecraft Operations and Exploration Systems



In the early 1990s, NASA Goddard Space Flight Center started researching and developing autonomous and autonomic ground and spacecraft control systems for future NASA missions. This research started by experimenting with and developing expert systems to automate ground station software and reduce the number of people needed to control a spacecraft. This was followed by research into agent-based technology to develop autonomous ground c- trol and spacecraft. Research into this area has now evolved into using the concepts of autonomic systems to make future space missions self-managing and giving them a high degree of survivability in the harsh environments in which they operate. This book describes much of the results of this research. In addition, it aimstodiscusstheneededsoftwaretomakefutureNASAspacemissionsmore completelyautonomousandautonomic.Thecoreofthesoftwareforthesenew missions has been written for other applications or is being applied gradually in current missions, or is in current development. It is intended that this book should document how NASA missions are becoming more autonomous and autonomic and should point to the way of making future missions highly - tonomous and autonomic. What is not covered is the supporting hardware of these missions or the intricate software that implements orbit and at- tude determination, on-board resource allocation, or planning and scheduling (though we refer to these technologies and give references for the interested reader).

Technologies enabling autonomous and autonomic behaviors of spacecraft have steadily progressed, but, as argued in this book, need to be extended much farther to enable success of the most advanced un-crewed space-mission concepts in the future. This book describes these technologies and their relevance not only for NASA space missions that have flown, but also for advanced future mission concepts. Early parts of the book present general background information on space missions that have flown, including mission design and operations, followed by descriptions of future mission concepts, all in relation to autonomy and autonomic capabilities. Readers will find chapters on flight and ground software and evolution of flight and ground autonomy, as well as chapters on technologies for developing autonomic systems, agent-based autonomy, cooperative autonomy, constellation missions, and swarm missions. One appendix covers spacecraft attitude and orbit determination and control, and a second appendix describes operational scenarios supported by agent interactions. No specialized background is needed to absorb the material in this book. The material is relevant to students in aerospace science or engineering, and is a useful source of supplementary material for more advanced engineering courses.

235,39 €
219,99 € (zzgl. MwSt.)

Lieferfrist: bis zu 10 Tage

Artikelnummer: 9781447125266
Medium: Buch
ISBN: 978-1-4471-2526-6
Verlag: Springer
Erscheinungstermin: 01.03.2012
Sprache(n): Englisch
Auflage: 2010
Serie: NASA Monographs in Systems and Software Engineering
Produktform: Kartoniert
Gewicht: 470 g
Seiten: 289
Format (B x H): 155 x 235 mm