SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (4)

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ANALYSIS OF ON-BOARD COMPUTER ARCHITECTURE CONCEPTS FOR FUTURE PLANETARY EXPLORATION ROVERS

Abstract

Robotic rovers have been used on several missions to explore other celestial bodies. These sophisticated machines have given planetary researchers a way to greatly increase the scientific return per mission to the Moon and Mars over previous stationary landers. The Mars rovers have been especially useful as their longevity and mobility have allowed them to explore multiple regions and maintain a continuous surface presence since 2004.

However, despite significant advances in the field, planetary rover technologies are still limited and thus unable to provide comprehensive exploration coverage. Current limitations include low speed, high reliance on communications with Earth for guidance, as well as relatively low computing power. Future rovers will need to be more autonomous and efficient which requires more computing throughput.

The architecture of on-board computers used in the Mars rovers has remained largely unchanged. These systems, although reliable, have low processing throughput compared to today's state of the art processors as they are constrained by high reliability requirements. Building a rover with higher computing power would create numerous benefits such as more efficient and capable autonomous operation, image processing, instrument data processing and many others.

This paper examines the technological advances in the fields of computer hardware and software and suggests how these could be implemented in future planetary rover missions. In particular, it focuses on the use of radiation-hardened processors in a multiprocessor and multicore arrangements as well as the multitasking functionality of Real Time Operating Systems. Other aspects of on-board architectures such as instrument interfaces, data storage, and system maintenance are also considered.

Several possible solutions for improving on-board computing power are identified and their advantages as well as disadvantages assessed using representative figures of merit. If successfully implemented, these architectures could enable better processing capabilities while retaining hardware and software reliability of current systems and thus enable future rovers to be more capable and effective explorers.