IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies that Enable Space Systems (2)

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ONBOARD PROCESSING WITH HYBRID COMPUTING ON SMALL SATELLITES

Abstract

Due to the increasing demands of onboard autonomy, data processing and decision making, one of the principal needs and challenges for future small spacecraft is onboard computing. Onboard computers must provide both high performance and reliability with limited resources such as power, size, weight, and cost in an extremely harsh environment due to radiation, temperature, vacuum, and vibration in space. As spacecraft becomes smaller in size, while playing a growing role for science and defense missions, the challenges for onboard computing become particularly acute. Onboard processing for advanced AI/ML algorithms, especially deep learning algorithms, requires an improvement of several magnitudes in computing power compared to what is available with legacy, radiation-tolerant, space-grade processors in space vehicles today. The next generation of onboard artificial intelligence (AI) and machine learning (ML) space processors will likely include a diverse landscape of heterogeneous systems such as high-performance DSP, FPGA, GPU and NPU. The availability of AI chipsets has enabled the practical use of AI for satellite applications in terrestrial and onboard scenarios. This article surveys the requirements and applications of powerful hybrid onboard processing platforms including typical application cases, system architecture, interconnections and software architecture. Available commercial AI chipsets are listed out and compared with each other, pros and cons of these chipsets are concluded. At last, for reliable application of onboard hybrid computing chipsets, fault tolerant methods of hybrid onboard computers for small satellites are recommended.