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Machine Learning Onboard Resource-Constrained Spaceflight Embedded Platforms

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Abstract

The rapid advance of modern processing technology, such as graphics processing units (GPUs), has allowed for machine learning (ML) and deep learning solutions to solve challenges in fields from autonomous cars to healthcare. However, ML solutions are not yet widely used to solve challenges onboard spacecraft. Current spaceflight hardware lags behind the state-of-the-art technology on the ground due to the need for radiation tolerance, low power consumption, and high reliability. These constraints make it challenging to implement ML models, which require high processing power, onboard a spacecraft. Southwest Research Institute (SwRI) has developed a set of tools and the capability necessary for integrating ML and deep learning algorithms onboard resource-constrained space hardware.

This presentation will discuss the implementation of a convolutional neural network (CNN) designed for space instrument data compression on spaceflight embedded hardware. The CNN was ported to the programmable logic of a Xilinx Zynq Multi-Processor System-on-a-Chip (MPSoC). The network's architecture, optimization techniques, hardware utilization, and performance, as well as possible implementations on other embedded platforms, such as the Xilinx Virtex 5 FPGA or the Nvidia Tegra K1 processor, will be discussed.