Paper ID: 68810
oral
student

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies to Enable Space Systems (3)

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MISSION CONTROL'S EDGEAI ACCELERATOR TOOLCHAIN – A HARDWARE AGNOSTIC TOOL FOR DEPLOYING DEEP LEARNING MODELS ON LOW-POWERED EDGE PROCESSORS

Abstract

As the space economy grows, there is an increased need for advanced autonomy and computation capabilities on-board the space systems. Whether for space exploration programs such as Artemis, or for next-gen satellites for earth observation and remote sensing, the need for high-performance computation on the edge is becoming increasingly important to process the high volumes of data being produced, infer key patterns, and make intelligent decisions without time-consuming ground support.

One increasingly popular method of achieving advanced autonomy is via Deep-Learning based Artificial Intelligence models. However, traditionally, such models require a high amount of compute power for both learning and inference, and are difficult to deploy on low-power edge devices, such as those found on space systems.

Mission Control's EdgeAI Accelerator Toolchain is a software stack that allows performing State of the Art Deep Learning inference on low-power embedded edge processors, including GPUs and FPGAs. The stack is designed to be agnostic of hardware and easy-to-use for developers, with a focus on efficiency and interoperability with multiple Machine Learning frameworks. The toolchain is being developed specifically for spaceflight applications, to enable Artificial Intelligence on low-powered, resource constrained, and radiation hardened semiconductor devices in the austere environments found in Space.

Mission Control's EdgeAI Toolchain allows researchers, scientists, and engineers to focus on AI model development and performance, without worrying about how to port it onto an edge device for a spaceflight application.

With this EdgeAI Toolchain, the typical development cycle can take the following steps:
1. Develop a Deep Machine Learning model using a high-level programming language (ex. Python) and common ML frameworks (ex. PyTorch, TensorFlow).
2. Train and test the model on the developmental computer - typically a high-power computer.
3. Use EdgeAI Accelerator Toolchain to port the model onto a low-powered edge processor, such as a flight computer for a spacecraft. This process takes a few minutes and requires no re-coding or knowledge

of Hardware Description Languages.

4. Run the model live on the edge hardware device.
5. Repeat Steps 1-4 as needed - the edge hardware may be re-programmed at any time.

In 2022, Mission Control will participate in the international science collaboration of the Emirates Lunar Mission (ELM), led by the Mohammed Bin Rashid Space Centre (MBRSC), which will send a micro-rover to the Moon on-board an iSpace Lander. Using a model deployed with the EdgeAI Accelerator Toolchain, Mission Control will perform Deep Convolutional Neural Network inference on images obtained by the Rashid rover for automated terrain classification on the lunar surface. The classifier will identify high-level geological features in images from the rover's navigation camera and downlink the outputs to science teams, to be used in rapid terrain assessment for science and navigation decision-making. This is anticipated to be the first-ever deployment of Deep Learning AI on the lunar surface.