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A NOVEL APPROACH TO DEPLOYING ARTIFICIAL INTELLIGENCE ON THE EDGE FOR EARTH OBSERVATION WITH MISSION CONTROL'S SPACEFARER AI

Abstract

As Earth Observation (EO) becomes more accessible and affordable with the proliferation of satellites and lower launch costs, there is a growing demand for enabling autonomy for EO data processing and analysis for complex missions in communications-denied environments. EO systems can increasingly leverage Artificial Intelligence (AI) to enable intelligent on-board data analysis and speed up decision-making processes such as intelligent prioritization of data to downlink to Earth. With novel technology to deploy and maintain the use of AI in spaceflight, Mission Control is pioneering how EO missions can leverage onboard AI to achieve greater autonomy, lower costs by maximizing downlink efficiency, and reduce downstream response times.

In this paper, we present a novel approach taken by Mission Control to deploy AI models that can benefit EO missions. The development and deployment of AI algorithms for space missions requires a holistic approach to user needs, data curation, model documentation, and production on flight hardware. Mission Control has developed a deep learning framework for space, supported by our Spacefarer AI line of products, that methodically executes these elements. A core tool of this framework is Mission Control's Spacefarer AI Deployment Toolkit which takes pre-trained machine learning models built in a high-level format and implements them on low power edge computers for space. We demonstrate the capabilities of this novel approach by presenting two examples of its use for spaceflight missions.

In Q1 of 2023, Mission Control will conduct an in-flight demonstration of Deep Learning on an FPGA onboard the European Space Agency OPS-SAT platform already in orbit, for an Earth image processing application. Our experiment will compare the deployment process and operational performance of a pre-existing high-level implementation of an AI model with a low-level implementation of the same model using our AI Deployment Toolkit. Furthermore, in Q2 of 2023, Mission Control will achieve the historic milestone of deploying the first Deep Learning based AI model on the surface of the Moon, called MoonNet, which will classify lunar surface features in images from the Emirates Lunar Mission rover.

Our Spacefarer AI Deployment Toolkit was designed in particular to optimize and deploy AI models for heavily resource-constrained architectures in these two in-flight demonstrations. Mission Control is now leveraging this technology to support EO mission developers that can improve their operational efficiency with AI-based autonomy onboard their satellites.