IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

Author: Mr. Maciej Ziaja
KP Labs, Poland, mziaja@kplabs.pl

Mr. Michal Gumiela
KP Labs, Poland, mgumiela@kplabs.pl
Mr. Piotr Bosowski
KP Labs, Poland, pbosowski@kplabs.pl
Mr. Michal Myller
KP Labs, Poland, mmyller@kplabs.pl
Mr. Marcin Cwiek
KP Labs, Poland, mcwiek@kplabs.pl
Mr. Tomasz Lakota
KP Labs, Poland, tlakota@kplabs.pl
Dr. Jakub Nalepa
KP Labs, Poland, jnalepa@kplabs.pl

ROBUSTIFYING THE DEPLOYMENT OF THE IN-ORBIT AI FOR EARTH OBSERVATION

Abstract

Edge AI is an umbrella term for a family of artificial intelligence solutions that run on embedded systems in constrained execution environments. With advancements in hardware and software technologies, edge computing can be applied to in-space tasks and deployed to satellite devices. Enabling in-orbit solutions to efficiently perform onboard AI operations is an important step toward automatized, independent, and more autonomous Earth observation missions. Edge AI can be utilized in remote sensing tasks that aid agriculture, natural disasters supervision, and automatic monitoring.

In this work, we present our approach to an efficient and robust procedure of deploying deep learning models to in-orbit edge devices. A well-crafted process of combining hardware and software resources to create operational deep learning-based systems is a crucial point in raising the TLR (technology readiness level) of AI in space. We discuss the model design principles and robust deployment pipeline using Xilinx's FPGA-based Vitis AI technologies. We demonstrate our benchmarking approach to exploring hardware capabilities. Our evaluation strategy takes into consideration different use cases, parallelization, and multithreading capabilities regarding the trade-off between the performance and energy consumption. The benchmarking process is designed to estimate hardware capabilities in real-life scenarios, aid design processes, help to fine-tune AI solutions, and expand the know-how about deploying AI in space. The evaluation is performed using different neural network models designed for various remote sensing applications (hyperspectral segmentation, terrain classification, crater outlining). Our approach examines varied networks in a range of operational use cases to draw a full picture of hardware and software capabilities under different circumstances. We report the results of benchmarking for our hardware platform, referred to as Leopard, designed for the CubeSat standard. However, the process can also be applied to other hardware platforms.

Finally, we also emphasize the necessity of the appropriate data preparation in the course of deploying AI to the edge. We show an example of how sensor simulation can vastly impact the viability of a deep learning model operating with a satellite equipment. Our work highlights the ongoing advancements in state-of-the-art solutions for preparing training data, modeling, deploying, and benchmarking AI solutions

on the edge for remote sensing applications. The software, hardware, and data-related processes that we present describe a set of necessary actions that can transform a lab-made deep learning model into a robust real-world solution.