IT UNIVERSITY OF COPENHAGEN

29 September, 2023

This letter is written to nominate the MSc thesis of Robert Bayer (roba@itu.dk), titled "Techniques for increasing efficiency of Intel Neural Compute Stick 2" for the 2023 IT MSc Thesis Prize. The thesis was graded 12, and the censor was Yongluan Zhou (zhou@di.ku.dk).

Robert's thesis focuses on characterizing the performance of a diverse set of resource-constrained hardware platforms like microcontrollers with general-purpose CPUs, system-on-chip platforms that combines CPUs and graphics processing units (GPUs), and very specialized hardware such as tensor-processing unit (TPUs) and vision processing units (VPUs). The motivation is based on the use case of the DISCO project[1], which is a collaboration across Danish universities and aims at launching three student CubeSats into Low Earth Orbit. The goal of the DISCO project is to offer the students the opportunity to design and operate a small satellite and gain space flight experience.

The main target application for DISCO is image analysis to detect, for example, land, ice, clouds, etc. for Earth observation. Since the link between the satellite and the ground station is of limited bandwidth, one should ideally perform some of the image analysis on the satellite and filter unnecessary images to minimize the data movement between the satellite and the ground. Since the satellite also poses physical and power constraints, there are a limited set of hardware devices that could be the candidates to be deployed on the satellite to do such image filtering efficiently.

Robert's thesis has two parts. The first part characterizes the performance of a variety of suitable devices to see if they could fit the latency and power constraints of the satellite's use case. The second part digs deeper into the Intel Neural Compute Stick (NCS), which employs a VPU, a specialized processor for AI-based image processing. The results demonstrated that while NCS shows superior performance compared to most of the devices we analyzed, it requires higher power to do so. Therefore, for the satellite, the TPU-based CoralAI device is deemed the most appropriate choice.

This thesis work, therefore, has led to both high-quality academic results and real-world impact. The results of this thesis influenced the building of the first satellite in DISCO project that is launched into space in April 2023[2], and is submitted to the research track of the ASPLOS conference. In addition, we publicly shared the key findings of Robert's thesis together with our lessons-learned while building the DISCO satellite on arXiv[3], which already has a citation[4].

Overall, it has been a privilege to supervise Robert's thesis. All the hardware platforms he had to benchmark require different system optimizations and depend on different software stacks. Robert could deal with all of them quite independently, which is rare for his academic age. It is therefore my pleasure to nominate him for the 2023 IT MSc Thesis Prize.

Supervisor: Pınar Tözün (pito@itu.dk)

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[1] https://discosat.dk/
[2] https://www.dr.dk/nyheder/indland/dansk-satellit-kom-endelig-afsted-det-er-et-helt-rumprogram-der-starter-os
[3] https://arxiv.org/abs/2301.04954
[4] https://scholar.google.com/citations?view_op=view_citation&hl=en&user=JTmMb3kAAAAJ&sortby=pubdate&citation_for_view=JTmMb3kAAAAJ:70eg2SAEIzsC