Dear editors and reviewers,

Here is the manuscript for the *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD)*, entitled "INCAME: INterruptible CNN Accelerator for Multi-robot Exploration". In this manuscript, we extend our previous work "INCA: INterruptible CNN Accelerator for Multi-tasking in Embedded Robots" which is accepted by the Design Automation Conference (DAC2020), and “CNN-based feature-point extraction for real-time visual SLAM on embedded FPGA”, which is accepted by International Symposium on Field-Programmable Custom Computing Machines (FCCM2020), with the following novel contributions. We have attached a copy of the conference papers with our submission.

1. We deploy and evaluate the INCAME framework in a practical robot task, Multi-robot Exploration, which is a basic problem in robotics. In this manuscript, we detail the system framework, algorithm components, and the data flow, as well as the related works. With the help of this case example, readers can better understand our motivation, methods, and evaluation. The application detail of Multi-robot Exploration is carefully explained in Section I.
2. We have surveyed different algorithms for the visual-based robot, such as feature-point extraction and place recognition. The robotics algorithms are given in Section II(A). We have also surveyed related studies for implementing robot applications on hardware and the scheduling methods for CNN accelerators. These previous hardware works are shown in Section II(B) and (C).
3. Besides the hardware conflicts when applying CNN accelerators to a real-world robot system, some other operations, such as SoftMax, Ranking and Normalization, are also time-costing, making it difficult for CNN-based algorithms in the real-time embedded system. We design hardware architectures for these operations in our FCCM2020 paper. Furthermore, in this paper, we propose a method to combine the CNN backbone and these operations to make robotics developers easier to deploy algorithms onto embedded hardware. The scheduling across the CNN backbone and post-processing are introduced in Section III(B).
4. Robot Operating System (ROS) is widely used in robotics. In this manuscript, we introduce the programming paradigm of ROS in detail, and design the corresponding interface for ROS. Thus, the robot developers can make a better use of the software and hardware systems in INCAME. The ROS framework is introduced in Section III(A).
5. Our virtual instruction interrupt method is based on an extended ISA. In this paper, we give the ISA implementation and analyze the dynamic characteristics of ISA under different scheduling conditions. The VI-ISA and a vivid example of the VI-ISA is detailed in Section IV(E) and (G).
6. We add more experimental results in this manuscript to further analyze the performance and cost of our method, including the extra cost of fetching modified instruction sequences [Section VI(B)-2,3], the evaluation of hardware resources [Section VI(A)], and the quantitative results of some experimental cases [Section VI(B)-1,2].

We believe this work is suitable for publication on TCAD, and readers will be interested in how to improve the performance of a real-world robot system with specialized hardware and hardware-software co-design and optimization. We appreciate your time and efforts spent in reviewing this submission.

Best

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