Dear editors and reviewers,

Here is the manuscript for the *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD)*, entitled "INCAME : INterruptable 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:

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 work. 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 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 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 using CNN accelerator to a real-world robot system, some other operations, such as SoftMax, Ranking and Normalization, are also time-costing and make it difficult for CNN-based algorithms in the real-time embedded system. Our FCCM2020 work designed hardware architectures for these operations. 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 is 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 better use the software and hardware system 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 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], hardware resources evaluation [Section VI(A)], and the quantitative results in 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 effort spent in reviewing this submission.

Best

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