Announcing the Final Examination of Li Yang for the degree of Master of Science

Time & Location: November 1, 2018 at 10:00 AM in HEC 450
Title: A Fully Onchip Binarized Convolutional Neural Network FPGA Implementation with Accurate Inference

Deep convolutional neural network has taken an important role in machine learning algorithm which has been widely used in computer vision tasks. However, its enormous model size and massive computation cost have became the main obstacle for deployment of such powerful algorithm in low power and resource limited embedded system, such as FPGA. Recent works have shown the binarized neural networks (BNN), utilizing binarized (i.e. +1 and â€“1) convolution kernel and binary activation function, can significantly reduce the model size and computation complexity, which paves a new road for energy-efficient FPGA implementation.

This thesis proposes to implement a new parallel binarized convolutional neural network (i.e. PCâ€“BNN) on FPGA with accurate inference. The embedded PCâ€“BNN is designed for image classification on CIFARâ€“10 dataset and explores the hardware architecture and optimization of customized CNN topology.

The PCâ€“BNN replaces the original binary convolution layer in conventional BNN with two parallel binary convolution layers. PCâ€“BNN achieves 86% on CIFARâ€“10 dataset with only 2.3Mb parameter size. We deploy our proposed PCâ€“BNN into the Xilinx PYNQ Z1 FPGA board with only 4.9Mb onâ€“chip RAM. Since the ultra-small network parameter, it is feasible to store the whole network parameter into onâ€“chip RAM, which could greatly reduce the energy and delay overhead to load network parameter from offâ€“chip memory. Meanwhile, a new data streaming pipeline architecture is proposed in PCâ€“BNN FPGA implementation to further improve throughput. The experiment results show that our PCâ€“BNN based FPGA implementation achieves 930 frames per second and 387.5 FPS/Watt, which are among the best throughput and energy efficiency compared to most recent works.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2014, Northeastern University at Qinhuangdao

Committee in Charge:
Deliang Fan, Chair, Electrical and Computer Engineering
Mingjie Lin, Department of Electrical and Computer Engineering
Wei Zhang, Department of Computer Science

Approved for distribution by Deliang Fan, Committee Chair, on October 15, 2018.

The public is welcome to attend.