ADAS and Video Surveillance Analytics System using Deep Learning Algorithms on FPGA

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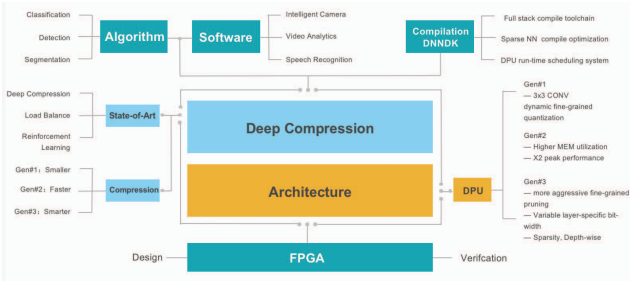
***Abstract*—Deep learning algorithms, such as CNN (Convolutional Neural Network), could provide high accuracy for great number of applications including ADAS (Advanced Driver Assistance System) and video surveillance analytics. Considering processing speed and energy efficiency, FPGA is a good hardware to construct customized CNN solution. In this demo session, we want to benefit from hardware technology, and show a fast speed and accurate video analytics system using state-of-the-art deep learning algorithms running on low power FPGA. This system could process 16 channels of continuous input video with the resolution of 1080p. Two functionalities could be easily switched by just clicking a button in this live demo: one ADAS system for vehicle, non-motorized vehicle, and pedestrian detection, tracking, and attributes analytics; and the other video surveillance system for face detection and recognition. The deep learning algorithms used are SSD and densebox for two kinds of objects' detection, which have state-of-the-art accuracy. The FPGA used is Xilinx MPSoC ZU9, and the whole board including this FPGA only cost about 50 Watts with Peak performance at 5.6 TOPS.**

There are 3 things that audience could enjoy with our demo. The first one is sending 16 channels of 1080p videos from laptop to our FPGA board by Ethernet. The FPGA board will run deep learning algorithms and display the results on monitor. It looks like surrounding view cameras among the vehicle to do Level-3 ADAS functionalities. The second one is using cameras to capture the real-time video in the conference hall, using FPGA analyze the video, and displaying the face recognition results on the screen. The third one is deploying any CNN network belonging to our architecture specification range on our FPGA system within several seconds. This is because we have design a customized deep learning processing unit on FPGA which could accelerate most of the CNN models. Generally speaking, the audience will find fast speed, low power, and high flexibility deep learning processing with our hardware design on FPGA, especially in ADAS and video surveillance analytics applications.

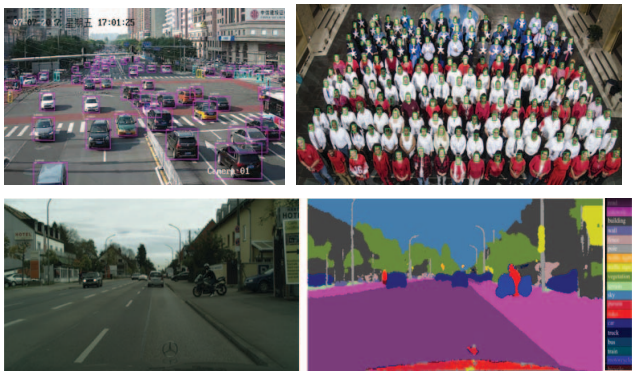
***Keywords*—FPGA, deep learning, ADAS, video surveillance**

I. Technology

In order to compute convolutional neural networks (CNN), we have designed an efficient hardware architecture. Nearly one hundred of instructions are defined by ourselves to form the operations commonly exist in CNN models. With the customized instruction set, a processor is designed with high parallelism. Also, some optimizations are utilized according to FPGA's special features, such as DSPs utilization and frequency improvement. Besides the hardware, a software stack is also built to compile from the model structure to instruction sequences automatically and deploy the application to the FPGA system easily. Model compression has also been used to reduce the computation amount of the original deep learning models without hurting the accuracy.



Our demo's novelty is just that our FPGA system has a deep learning processor inside and that could process much faster than previous hardware for Level-3 ADAS and video surveillance analytics with relatively low power consumption. Another novelty is that our system could deploy different models by seconds to change the functionality due to our own defined hardware architecture and instruction compiler. The audiences could try to deploy models themselves and try the face recognition system on FPGA with very high processing speed. Also, the system could capture the video input from camera to do 16 channels real-time processing of vehicle detection.



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