1-1-2019

Edge Heterogeneous Hardware Evaluation Based on Real Connected and Autonomous Vehicles (CAVs) Workloads

Mustafa Ahmad

Edge Heterogeneous Hardware Evaluation Based on Real Connected and Autonomous Vehicles (CAVs) Workloads

WAYNE STATE College of Engineering

Mustafa Ahmad
Faculty Advisor: Dr. Weisong Shi
PhD Mentor: Yifan Wang

Connected and Autonomous dRiving Laboratory(CAR LAB)

Computer Science

Opportunity and Significance

In recent years, there has been a wide expansion of hardware to assist in Autonomous driving tasks. With the hardware expansion, there now is a variety of deep learning models to assist in Connected Autonomous Vehicle detection of pedestrians, lanes, and open roads. We want to build create these deep learning models and use different performance metrics to understand resource demand from different hardware configurations. By understanding the resource demand we can better understand hardware requirements for running these models and further assist researchers in understanding the limitations of the hardware and the software.

Technical Objectives

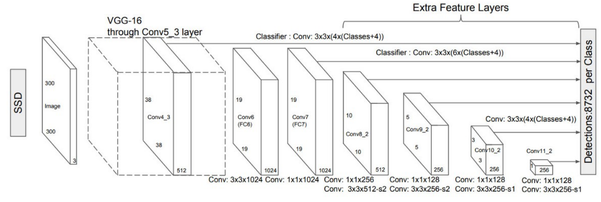
Several pioneer efforts have focused on the edge computing system and architecture design for the CAVs scenario and provided various heterogeneous platform prototypes for CAVs, such as NVIDIA DRIVE PX. The CAR Lab has already developed a first version benchmark suite for CAVs computing system and architecture, and we want to add more workloads to evaluate more heterogeneous hardware. On this project, we focus on using some state-of-the-art deep learning workloads in CAVs scenario, such as object detection and object tracking to evaluate the heterogeneous hardware.

Related Work and State of Practice

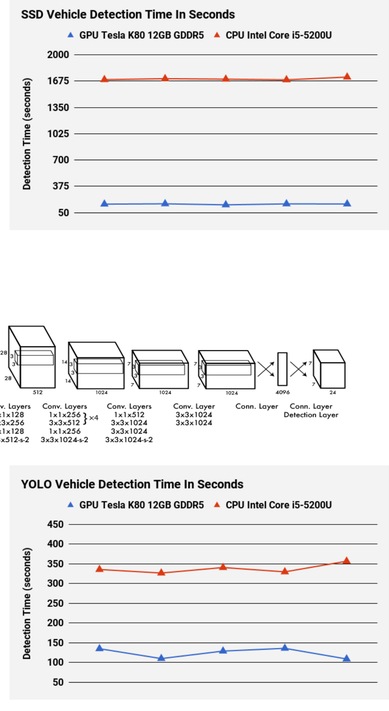
Wayne State University's CAR LAB has related projects.

- CAVBench is a benchmark suite to evaluate the connected and autonomous vehicles (CAVs) computing platforms performance.
- PCAMP is a comprehensive performance comparison and analysis of several state-of-the-art deep learning packages on the edges, including TensorFlow, Caffe2, MXNet, PyTorch, and TensorFlow Lite.

Testing Data, Model Architecture

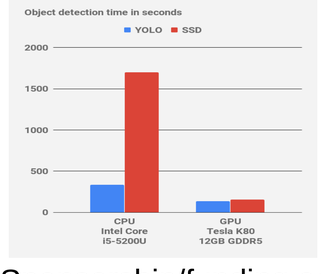


	GPU Tesla K80 12GB GDDR5	CPU Intel Core i5-5200U
1	156	1693
2	160	1705
3	147	1699
4	159	1691
5	158	1725



	GPU Tesla K80 12GB GDDR5	CPU Intel Core i5-5200U
1	135	336
2	110	327
3	129	341
4	136	330
5	109	357

Average Detection Time SSD vs YOLO, Results



Sponsorship/funding acknowledgement goes here

Technical Approach, Accomplishments

- First before building anything we reviewed the latest deep learning research papers and select the ones we believe will be useful for CAVs applications.
- We selected **YOLO** "You Only Look Once Unified Real-Time object Detection" and **SSD** "Single Shot MultiBox Detector".
- I had to begin learning and expanding my knowledge of deep learning models and using **Tensorflow** and **Keras**.
- Through this process I have gained a very strong understanding of deep learning models, research, and using **Tensorflow** and **Keras**.
- We were able to recreate both **YOLO** and **SSD** models and detect vehicles within images.
- Our models are currently being tested on a CPU only machine, a GPU machine, and an NVIDIA DRIVE PX2. We hope to measure resource use and speed of each deep learning model on each platform.

Commercialization Plan & Partners

I worked with members of the CAR Lab and Dr. Shi paired me with a PhD mentor, Yifan Wang. The goal is to publish a workshop paper to help with researchers who need benchmark data.

Next Steps for Development and Test

Some other deep learning networks can detect using Lidar. There are also other CAV applications such as SLAM, localization, lane detection, and open space detection. Benchmarking and evaluating these applications on a variety of hetergenous platforms can provide further clarity for overall CAV applications.

References

Redmon, Joseph, et al. "You only look once: Unified, real-time object detection." Proceedings of the IEEE conference on computer vision and pattern recognition. 2016.

Liu, Wei, et al. "Ssd: Single shot multibox detector." European conference on computer vision. Springer, Cham, 2016.