Video As a Sensor

Kyle Begovich

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1 Introduction

Video As a Sensor is a continuation of the Spring project Geometry of Autonomous Vehicles and work over the Summer on the project under the same name. These projects have all been efforts to repurpose a complicated convolutional neural network (CNN), YOLO – You Only Look Once, to build a comprehensive networked mobility system having a future of bettering the traffic ecosystem, making it safer and ultimately incorporating the improvements into autonomous vehicles. We started this semester with a lot of progress already made, including software additions, training a CNN, and Open Source Software (OSS) policy and development. Our goals for this semester, then, were as follows:

- Optimize our existing system to make real-time detections.
- Deploy our system on a hardware platform capable for our use case.
- Package our working software with additional open source technologies.

2 The System

2.1 Hardware

We used two systems for our time over this semester, a large desktop computer system that has a two way SLI Titan X GPU setup, and the other is an NVIDIA Jetson system. The Titan X machine provided a sandbox environment with more than sufficient capability for our software, but more interestingly, the Jetson is a more modest powered and priced system that is practical for real applications.

2.2 Parallelized YOLO

This semester, we spent a large portion of time working to parallelize multiple instances of YOLO (specifically, the helmet version from the Summer and the original set of classes) on the same GPU at the same time. This included allocating the correct amount of processing cores for each process and threading them as to not create any conflicts in the code. We were very successful in this, and have been able to get the system running at the improved speeds we were looking for without any issue.

2.3 FaceNet and FaceYOLO

We started the semester working with an out-of-the-box software called FaceNet, which uses Google'd Tensorflow to detect people's faces. While it is very successful in detection accuracy, it did not meet the speed needs of our project, and we were forced to scrap it in favor of a pre-trained YOLO system from another group online. This is the system we've used for our demo and for foreseeable future use cases.

2.4 ALPR

Using this automatic License Plate Recognition system provided by openALPR, we are able to hash away licence plates to protect the privacy concerns of other drivers. Privacy has been a big concern since day one, and we spent a lot of time working to keep it safe, in addition to burring faces.

3 Goal Progress

Looking through the goals in hindsight, we accomplished the first two goals as much as we had hoped to. Our system now runs on an easy to deploy and relatively inexpensive hardware system in real time. We can use this system in a variety of applications in the transportation space and tangential fields as well. The system costs $300 upfront, and can accomplish much of what we've been working to accomplish, remotely. Reducing this cost much more would generally resort to deals with the manufacturers or bulk purchases instead of software optimization.

As for packaging our software with other OSS systems, we have definitely made progress. We are able to use two new systems, FaceYOLO and ALPR, in tandem with our original system. We still have some polish for the integration components, but nothing that should expect significant gains in run time, power consumption, or data requirements. These additions will be mostly in code cleanliness, robustness, and reputability of our system, as it is now an OSS project as well.

4 Future Applications

With this semester's goals accomplished, we have turned the focus to future work and applications. Our system is now able to be deployed in transportation systems such as public transit, red light cameras, etc. We will be coordinating with companies and local governments that may be interested in becoming a part of this project to accomplish this in the future. We also plan to empirically validate our system on the basis of its accuracy, and benchmark its performance speed in the near future.

5 Team and Thanks

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