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Vehicle Speed Estimation Using Cameras

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Introduction

The most common transportation method for individuals are vehicles. So, its not surprise that road safety and efficiency is a key component of country's economy. A simple way of finding faulty roads is to utilize cameras footage, monitor road user's activity and estimate vehicle speed. In this work, an automated vision-based system is developed to collect vehicles trajectories and estimate their speeds. Data analysis methods are further applied on the collected trajectories to provide more insight about the vehicles speed and activities.

Methodology

The developed vehicle speed system has three main components;

- **Detection**

The detection system is utilizing YoloV3 to detect cars in each individual frame, using Coco dataset.
The objects that fall under the category “car” are anything labeled as car, truck, or bus.

- **Tracking**

Every frame the system will check the distance between all the cars that were detected in the current frame and the previous frame, utilizing the distance formula. When a match is found, they are stored in a list containing the location of the car in that specific frame.
Each vehicle is assigned a number label which is determined by how many vehicles have appeared prior to that vehicle. The label is unique to that car and appears in both the car location and car speed tuples.

- **Data/Storage**

Data is stored in an excel file when the vehicle has been dropped by the tracking system, a car is dropped if the tracking system does not find a proper match for that car in 3 frames.

Results

The program will return 3 items. An excel sheet with frame-by-frame vehicle location, an excel sheet with vehicle speed, and a video with the vehicle speed/tracking.

$$Speed = \frac{Distance}{Time}$$

$$Distance = \sqrt{(PreX - CurrX)^2 + (PreY - CurrY)^2}$$

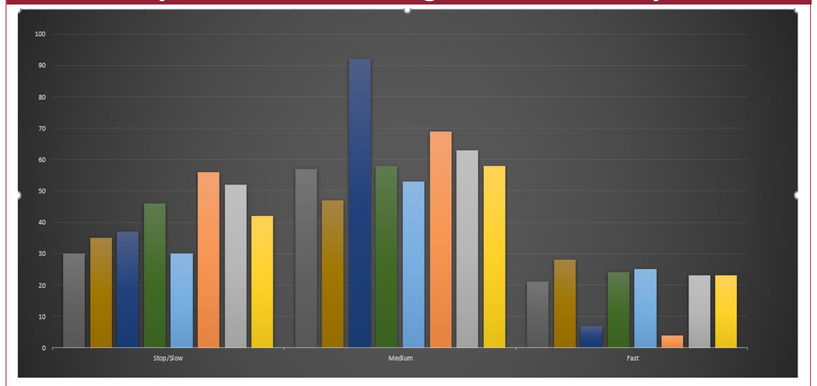
$$Time = \frac{\#Frames}{FrameRate}$$

Range

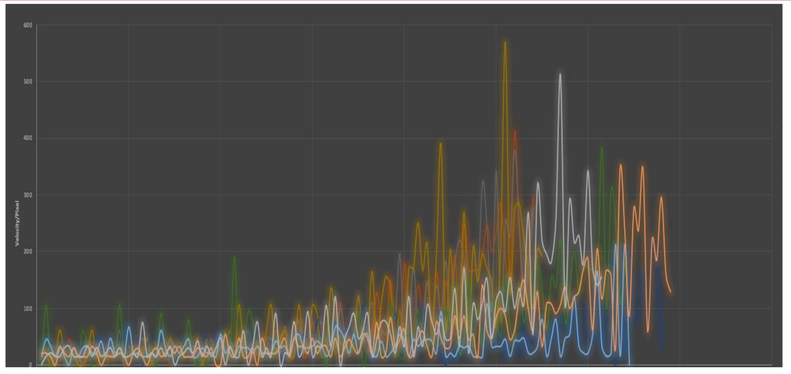
Slow/Stop : Speed < 25
Moderate : 25 < Speed < 115
Fast: Speed > 115

The two graphs represent data for the tracking of eight vehicles.

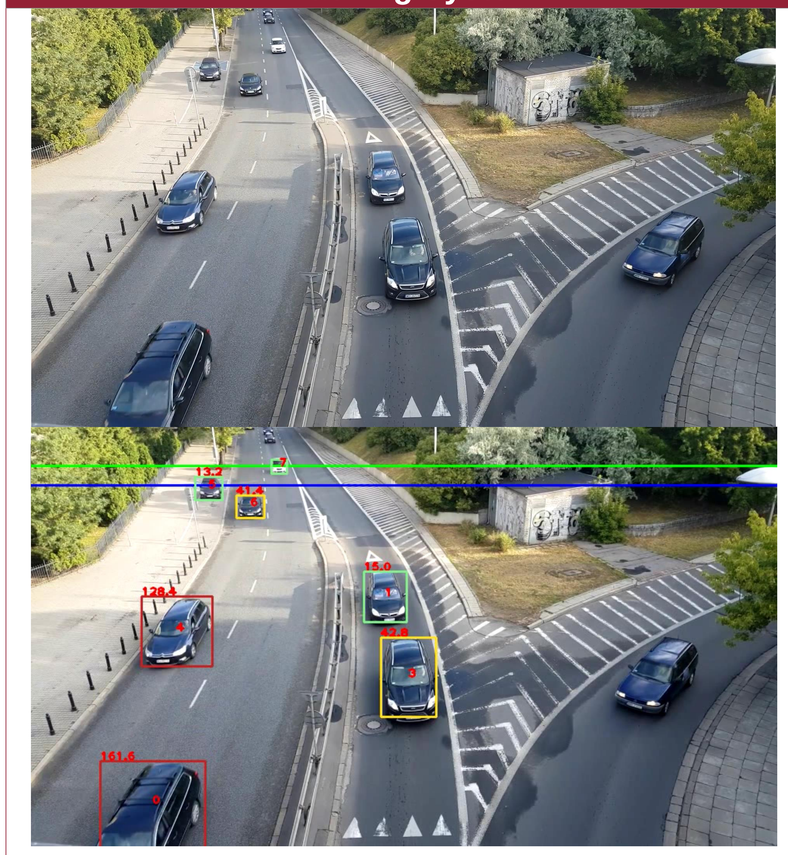
(Sum of each range for each car)



(Plot of all car speed data)



Tracking System



Conclusion

The collected data with the developed system provides a rough estimation of the vehicles speed, since each frame image is a 2D matrix. The next step would be to incorporate homography as this could produce more accurate results. With a fully functional vehicle speed estimation system every street with a camera could be analyzed and roads could be improved. Also, law enforcement could utilize this system to find what streets cars are speeding the most.

References

Redmon, J. % Farhadi. A.(2018). YOLOV3, https://pjreddie.com/darknet/yolo/
Coco Dataset , https://cocodataset.org/#home