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DynamicTrafficNet: A CNN-based framework for the reconstruction of traffic stream parameters from moving camera videos

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Background

Analysis of traffic stream parameters is essential for road traffic infrastructure management and transportation policies. Recently, lightweight and portable sensors such as smartphones and dash cams are quite popular and mounted on vehicles to record traffic incidents. These devices are a great source of the urban environment because of their continuous interaction with the surrounding. The utilization of such devices to study traffic flow, however, has been limited to using GPS sensor data. In this study, we use the videos from moving cameras mounted on a car to reconstruct traffic stream parameters using an embedded CNN based deep learning framework *DynamicTrafficNet*.

Framework

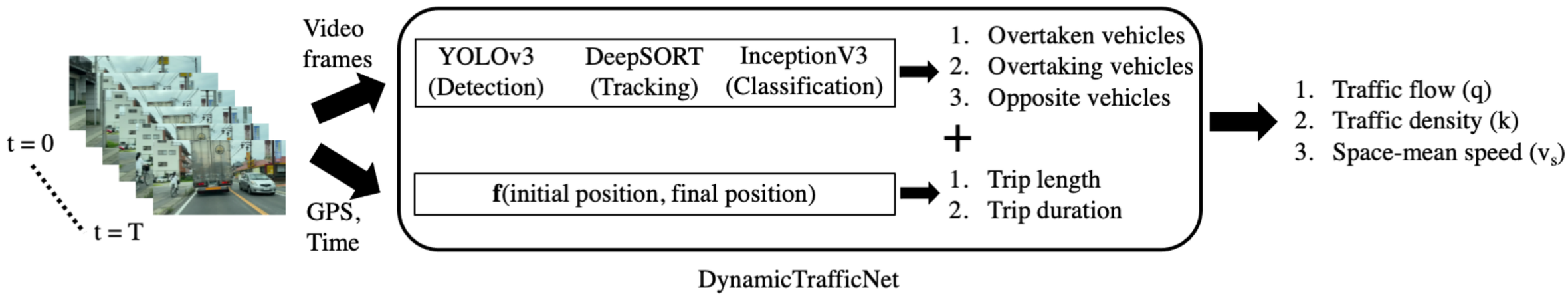

Figure 1. DynamicTrafficNet architecture consisting of embedded CNNs for detection, tracking and vehicle orientation classification for the reconstruction of traffic stream parameters from moving camera videos.

Methodology

Moving Observer Method is used to obtain traffic flow (q) and space-mean speed (v_s) using below equations. Traffic density is obtained from fundamental equation of traffic flow ($k = q / v_s$). We make a round trip of the road link to obtain traffic flow parameters for both lanes simultaneously.

$$q = \frac{n_{opposite,a} + (n_{overtaking,w} - n_{overtaken,w})}{t_w + t_a} \quad (1)$$

$$v_s = \frac{l}{t_w - \frac{n_{diff,w}}{q}} \quad (2)$$

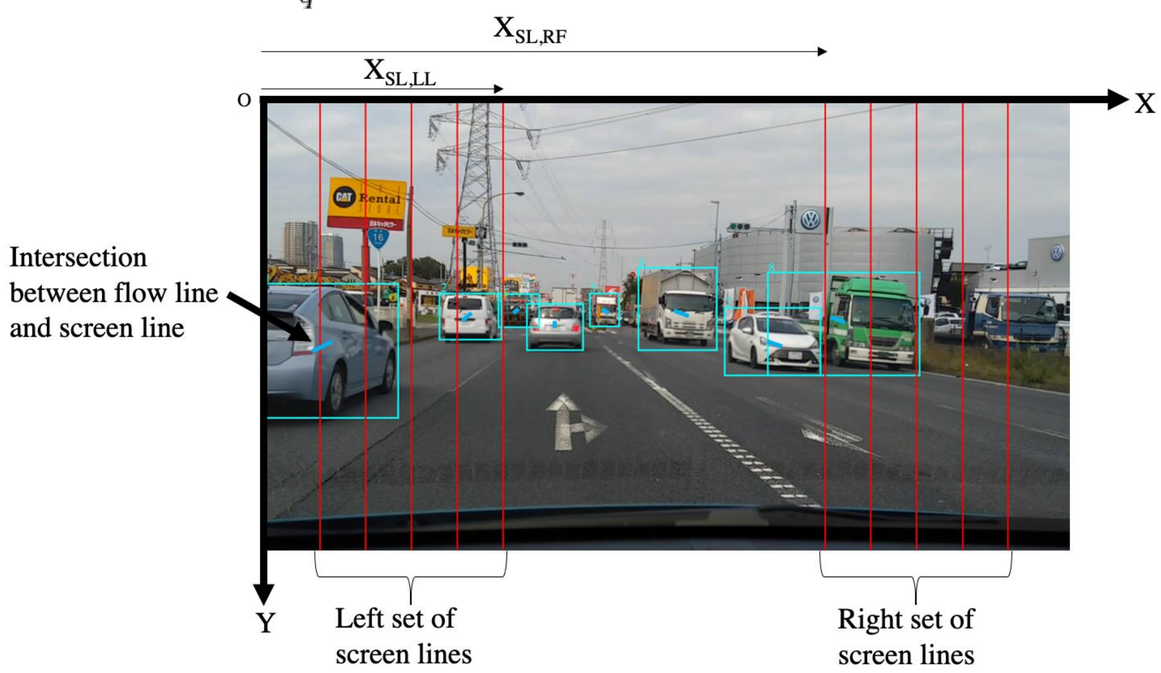

Figure 2. Figure showing the coordinate system, set of screen lines (red), flow lines of tracked vehicles (cyan).

Vehicle types	Conditions on intersection with the screen lines
Overtaken vehicles	$[Orientation == With]$ **AND** $[(Y_{centroid,final} > Y_{centroid,initial})$ **OR** $(X_{centroid,final} > X_{centroid,initial}$ **AND** $X_t >= X_{SL,RF})$ **OR** $(X_{centroid,final} < X_{centroid,initial}$ **AND** $X_t >= X_{SL,LL})]$
Overtaking vehicles	$[Orientation == With]$ **AND** $[(Y_{centroid,final} < Y_{centroid,initial})$ **OR** $(X_{centroid,final} > X_{centroid,initial}$ **AND** $X_t <= X_{SL,LL})$ **OR** $(X_{centroid,final} < X_{centroid,initial}$ **AND** $X_t >= X_{SL,RF})]$
Opposite vehicles	$[Orientation == Against]$ **AND** $[(Y_{centroid,final} > Y_{centroid,initial})$ **OR** $(X_{centroid,final} > X_{centroid,initial})]$

Traffic flow map

Figure 3. Traffic map showing different types of vehicles in Kashiwa city observed during the experiment run.

Results

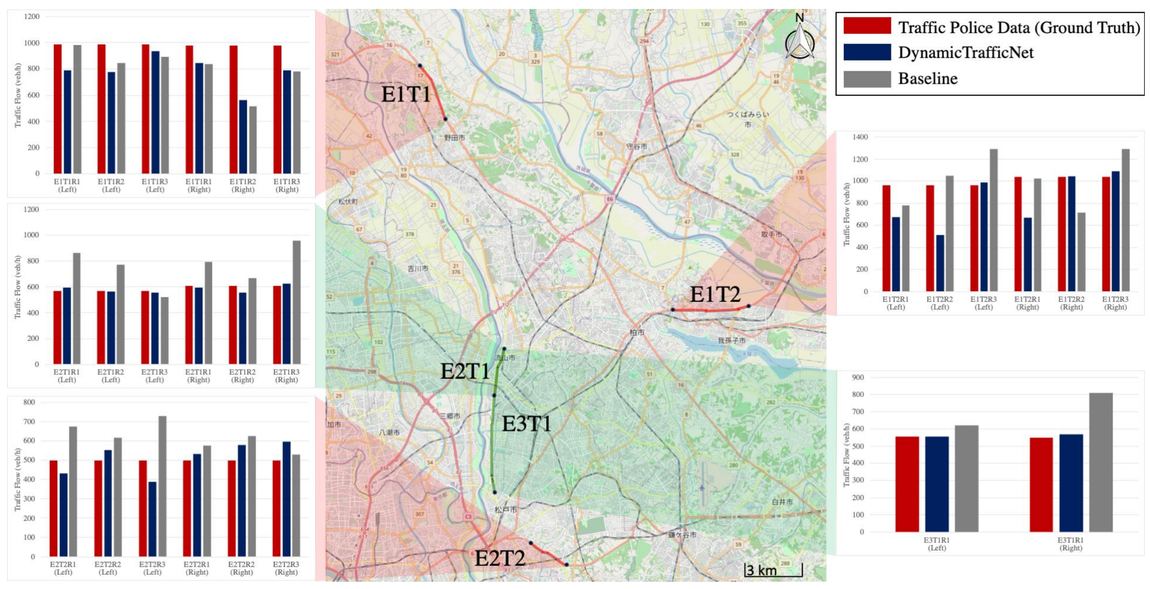

Figure 4. Comparison of the results of traffic flow from *DynamicTrafficNet* and Baseline with the traffic police data as the ground-truth. © OpenStreetMap contributors, cartography is licensed as CC BY-SA