東京大学　関本研究室 / Sekimoto Lab. IIS, the University of Tokyo.

Real-time citywide reconstruction of traffic flow from moving cameras on lightweight edge devices

Ashutosh Kumar, Takehiro Kashiyama, Hiroya Maeda, Hiroshi Omata, Yoshihide Sekimoto

Background

Traffic flow estimation is required for road infrastructure management tasks such as road development planning, routing, and navigation. Determining traffic flow on a citywide scale is challenging because of the expensive costs and portability of current devices. In this study, we optimize the vehicle detection neural network for inference on lightweight edge devices and develop a client-server framework to reduce and share the computational load to make accurate real-time traffic flow processing from moving camera videos. With the proliferation of moving cameras in vehicles (dash cams, stereo cams, etc.) and inexpensive edge devices, we expect our real-time traffic flow estimation algorithm to have a very promising future.

Overall framework

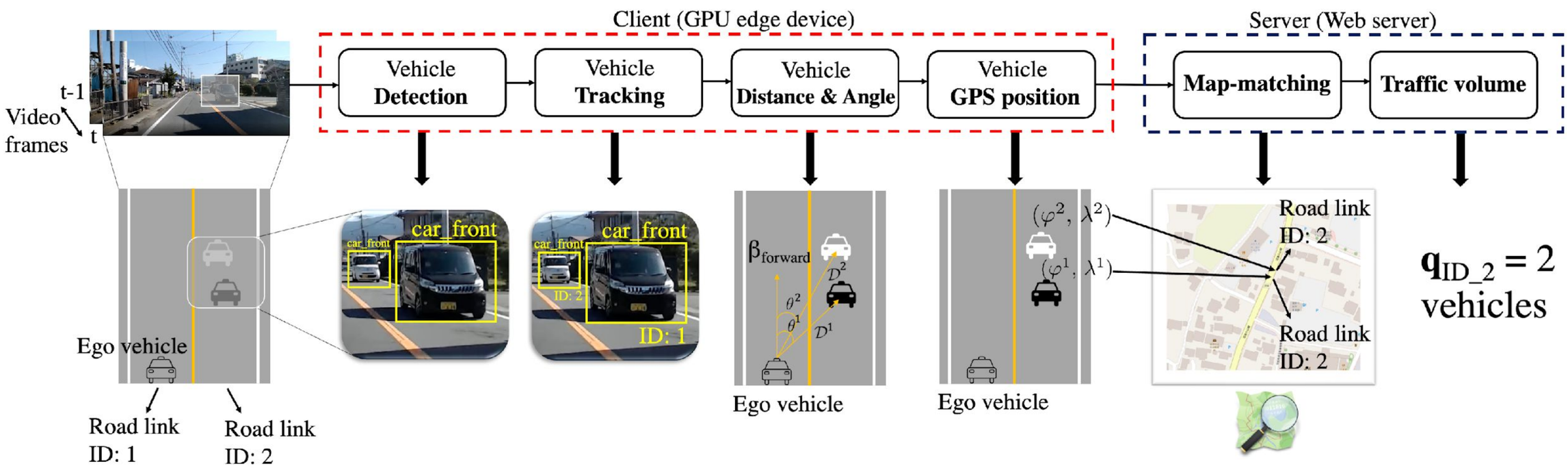

Figure 1: Client-server framework for estimating traffic flow from moving camera videos. Vehicles in the opposite lane with *front* orientation (e.g., *car_front*) are detected and sent to the tracker to identify their IDs. Based on the GPS position of the ego vehicle, we estimate the GPS position of detected/tracked vehicles (φ^i, λ^i) using their distance $(\mathcal{D}^i)$ and angle (θ^i) from the ego vehicle. The estimated GPS position (φ^i, λ^i) is sent to the server, which is map-matched on OSM road network to obtain the road link ID. The traffic volume is estimated by counting the number of vehicles on a given road link ID, which is shown for road link ID 2 as $\mathbf{q}_{ID\_2}$. © OpenStreetMap contributors, cartography is licensed as CC BY-SA

Results

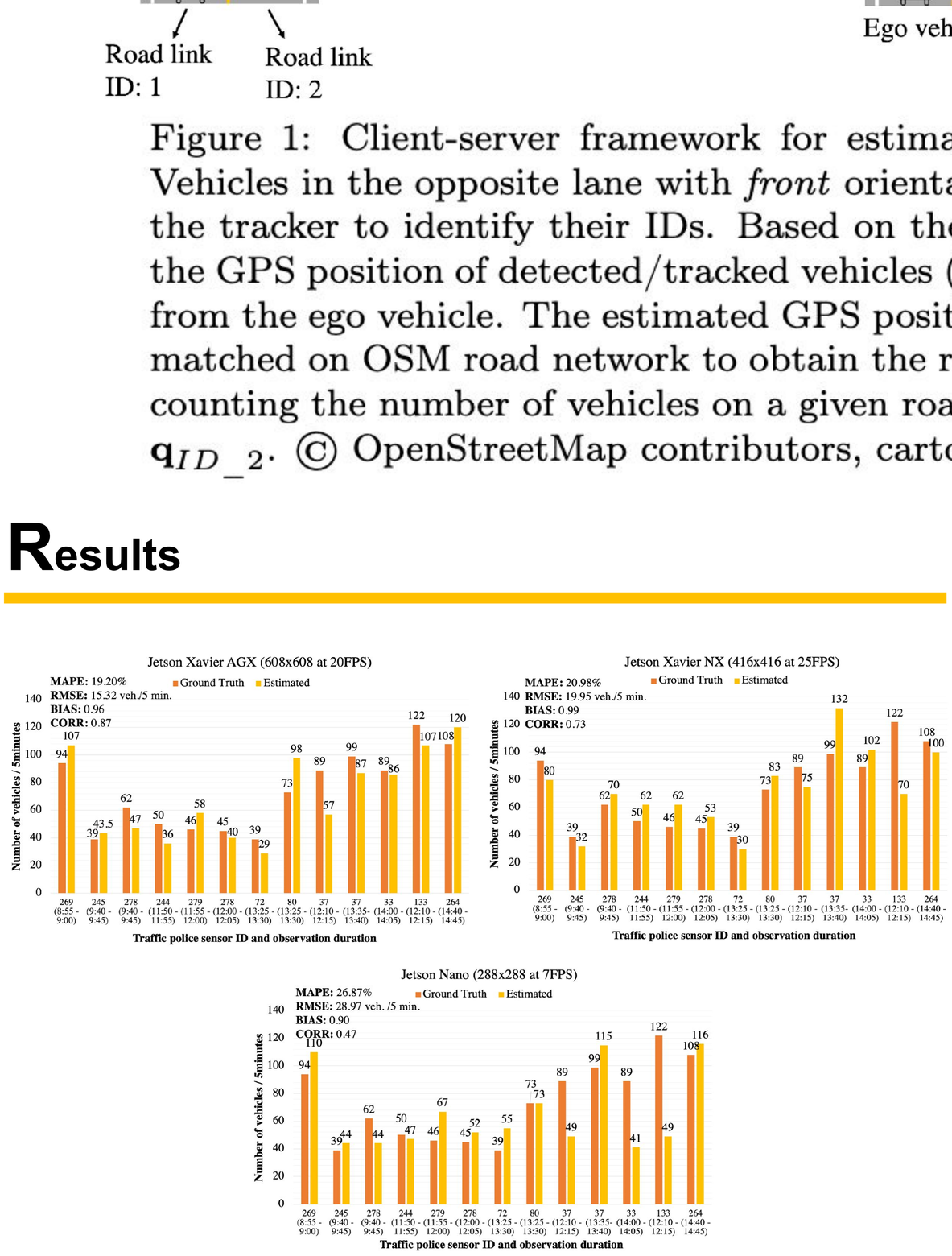

Figure 2: Comparison of the Jetson Xavier AGX, Jetson Xavier NX, and Jetson Nano traffic flow estimates with the highest accuracy using 13 observed samples.

Conclusions

This study presents novel algorithms for reconstructing traffic flow parameters from moving camera videos on lightweight edge devices. Our developed methodology can estimate traffic flow with an accuracy ranging from 73.1% to 80.8% for the three edge devices: Jetson Nano, Jetson Xavier NX, and Jetson Xavier AGX.

Static sources to estimate traffic flow has limitations in scaling due to lack of portability. As portable sensing devices on moving vehicles proliferate, we anticipate that our developed techniques for estimating citywide traffic flows will be highly scalable.