Vehicle re-identification and trajectory reconstruction using multiple moving cameras in the CARLA driving simulator

Ashutosh Kumar[1], Takehiro Kashiyama[2], Hiroya Maeda[3], Fan Zhang[4,5], Hiroshi Omata[1], Yoshihide Sekimoto[1]

[1]Institute of Industrial Science, The University of Tokyo, Japan, [2]Osaka University of Economics, Osaka, Japan, [3]UrbanX Technologies, Inc. Tokyo, Japan, [4]The Hong Kong University of Science and Technology, Hong Kong, [5]Senseable City Lab, MIT, Cambridge, USA

Background

Given the complexity of urban mobility and traffic flow patterns, estimating vehicle trajectory is a challenging task given the requirement to observe and re-identify vehicles repeatedly. In this paper, we present a novel method for estimating traffic flow using moving dashboard cameras. Observed vehicle trajectories are reconstructed using cameras on multiple moving observers by re-identifying the same vehicle at different locations and times. Our study introduces the CARLA ReID dataset, which includes over 50,000 images from 85 cameras spanning 700 vehicle models and trains a re-identification network. With the proposed framework, we estimate vehicle trajectories in the CARLA driving simulator and measure accuracy by SSPD and Hausdorff distance. A mean error of 5.13 meters (SSPD metric) was obtained in ten driving experiments.

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Overall framework

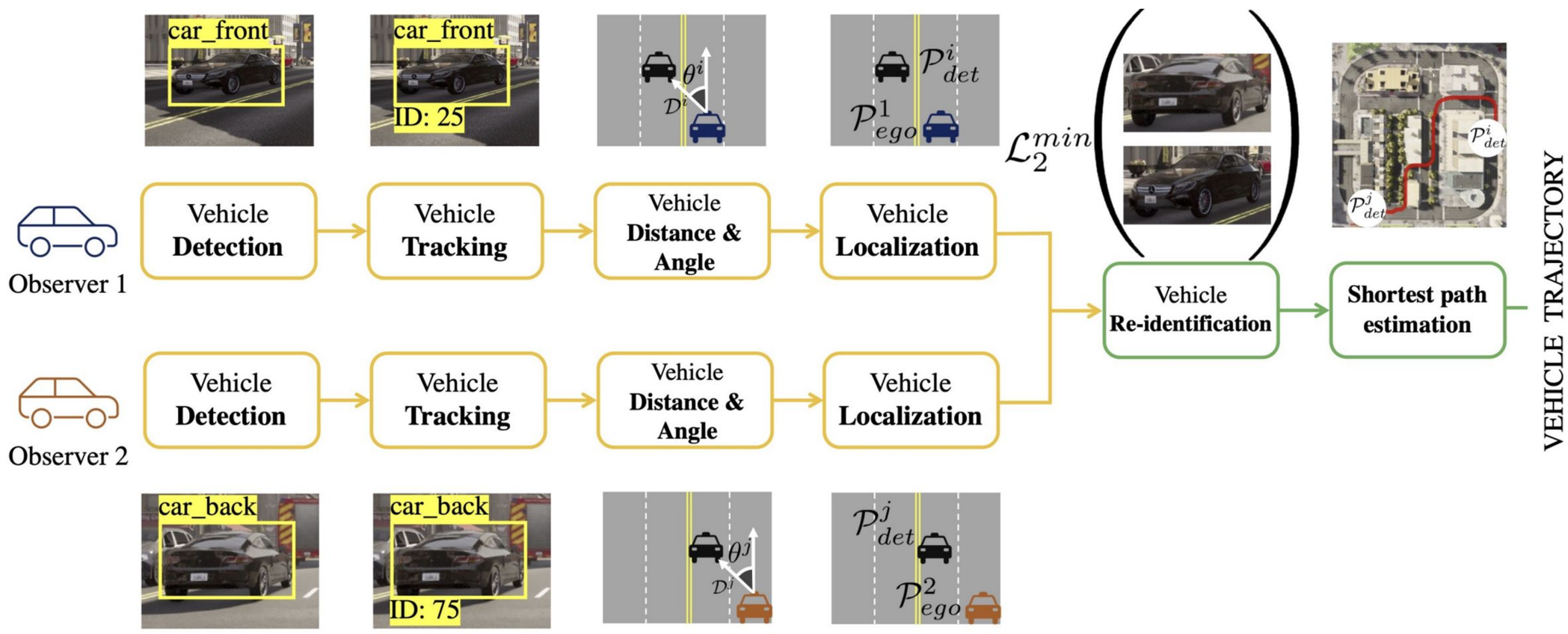

Fig. 1. The framework for the reconstruction of trajectory using two observers. The vehicles are detected/tracked and their distance and angle from the ego/observer vehicle is calculated to localize (e.g., $\mathcal{P}^i_{det}$) them on the map. A vehicle re-identification neural network finds the closest matching vehicles using $\mathcal{L}_2$ loss on the feature vectors. Re-identified detected vehicles' position is used to reconstruct the trajectory using shortest path algorithm.

Results

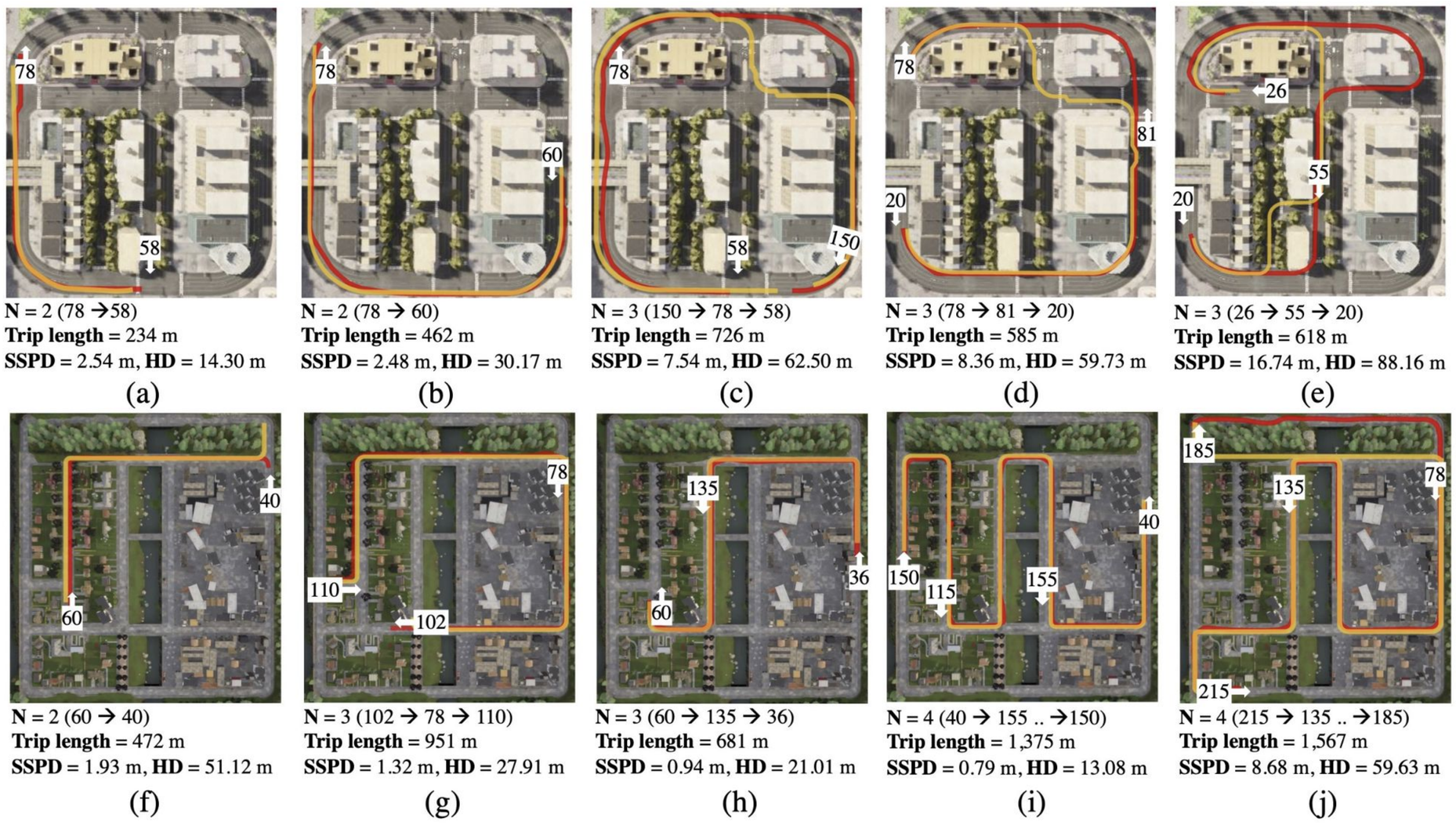

Fig. 2. Comparison of ground truth path and estimated trajectory of vehicles. The ground truth path is shown by the red line, while the yellow line shows the estimated path. The observer vehicle's location and ID are also shown with the arrow pointing towards the *front* direction of the vehicle.