# Capturing and Analyzing Human Driving Behavior to Improve Road Travel Experience

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**Abstract**

Due to the concentration of population and economic activities in metropolitan areas, urban transportation system suffers many challenges, e.g. traffic congestion and parking space storage, which affect each individuals travel experience. Previous studies looked into the transportation condition sensing using various static or mobile sensors and the travel support services based on the sensing results. However, human behaviors, as the direct indicator as well as the final modifier of traffic conditions, have not been fully explored to close the sensing-and-control loop in the urban transportation system. This dissertation aims to improve drivers road travel experiences by understanding and coordinating human drivers behavior in the vehicle routing and parking search process. In the first part of the dissertation, we focus on the traffic condition sensing and routing service design, altering the greedy routing strategy based on periodically updated traffic condition. We present a participatory system, Themis, that considers traffic condition sensing and route planning as a whole: (i) By analyzing time-stamped position reports and route decisions collected from driver's mobile navigation app, Themis estimates both the current traffic rhythm and the future traffic distribution. (ii) The routing requests are combined with the sensed traffic condition to coordinate drivers' routing decisions that minimize the travel cost of all drivers and proactively alleviate traffic congestions. Themis has been implemented and evaluated in both a simulation experiment using real data from over 26,000 taxis and a field study. Results from both experiments demonstrate that Themis reduces traffic congestion and average travel time at various traffic densities and system penetration rates. In the second part of the dissertation, we looked into fine-grained parking availability crowdsourcing, a key component of smart parking applications, and proposed a solution based on humans parking search behavior: taking/vacating a parking spot changes availability while ignoring a spot along the parking search trajectory probabilistically reflects the unavailability. To resolve the complications caused by drivers preferences, e.g. ignoring the spots far from the destination, we model human parking behaviors based on a dataset of over 55,000 real parking decisions and predict the probability that a driver would take a spot, assuming the spot is available. Then, we present a crowdsourcing system, called ParkScan, which leverages the learned parking decision model in collaboration with the hidden Markov process to estimate fine-grained parking availability. ParkScan has been evaluated with real-world data from both off-street scenarios (i.e., two public parking lots) and an on-street parking scenario (i.e., 35 urban blocks in Seattle). In both scenarios, ParkScan substantially reduces the error of spot-level parking availability estimation compared to the state-of-art solutions. Moreover, ParkScan tolerates extremely low penetration rate and in particular, cuts down over 15% of the availability estimation errors for the spots along parking search trajectory even if there is a single participant driver.

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