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主　論　文　の　要　旨

論文題目　**Dynamic Shared Autonomous Taxi System and Utilization of Collected Travel-time Information**
(旅行時間情報を収集・活用するライドシェア型自動運転タクシーシステムに関する研究)

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論　文　内　容　の　要　旨

Autonomous vehicles (AVs) have experienced rapid development in recent years. In some countries, AVs are allowed to enter select area. The research on impact of AV on traffic flow theory, traffic safety improvement, traffic organization at signalized intersections and so forth and the benefits of AVs has attracted many scholars. The AV has been regarded as a promising means of improving travel flexibility.

In traditional taxi systems, a taxi can only serve one customer or a group of customers with some seats vacant. Customers stand along a roadside to call for a vacant taxi, therefore customers often suffer from a long waiting time owing to the inefficient matching between customers and empty taxis. The AV are expected to solve the above problems, therefore this study replaces urban taxis with the AV, and considers ride-sharing among customers. Benefits of the new taxi system are examined.

Firstly, this study proposes two sharing strategies for the new autonomous taxi system, namely non-detour dynamic shared autonomous taxi (SAT) system and detour dynamic SAT system. their potential benefits are evaluated by comparing to a non-sharing autonomous taxi system. In the non-detour sharing strategy, taxis are prohibited to make detours to pick up sharing customers when riders are in the taxis; in the detour sharing strategy, both non-detour and detour situations are considered. An agent-based simulation is developed for evaluating the performance of the proposed sharing strategies. Simulation results show dynamic SAT systems outperform non-sharing autonomous taxi system with smaller fleet size, shorter travel times, larger sharing ratio and less emissions. Detour dynamic SAT system is also verified to be better than non-detour dynamic SAT system.

Next, owing to no human drivers in autonomous vehicles, each SAT requires very precise traffic information to independently and accurately select its route. The potential benefits of utilizing collected travel-time information for shortest travel time path finding in the new taxi system are examined. Specifically, four categories of available SATs for every taxi request were considered: currently empty, expected-empty, currently sharable, and expected-sharable SAT. Two simulation scenarios—one based on historical traffic information and the other based on real-time traffic information—were developed to examine the performance of information use in an SAT system. Interestingly, in the historical traffic information-based scenario, the mean travel time for taxi requests and private vehicle users decreased significantly in the first several simulation days and then remained stable as the number of simulation days increased. Conversely, in the real-time information-based scenario, the mean travel time was constant. As the SAT fleet size increased, the total travel time for taxi

requests significantly decreased, and convergence occurred earlier in the historical information-based scenario. The results demonstrate that historical traffic information is better than real-time traffic information for shortest travel time path finding in SAT systems.

Thirdly, customers' requirement on on-time arrival is taken into consideration in a dynamic SAT system. To improve the probability of on-time arrival, the reliable path concept and collected travel time information are used to facilitate path finding for SATs, and the potential benefits are examined. Two simulation scenarios—one based on historical traffic information and the other based on real-time traffic information—are also executed to evaluate the information's usefulness in reliable path finding. In simulation results, reliable path scenarios showed a higher on-time arrival ratio than shortest travel time path scenarios, in which the shortest travel time path algorithm is used in path finding for SATs, and the historical information-based scenarios showed a higher on-time arrival ratio than the real-time information-based scenarios. A system-beneficial path finding method is proposed and is verified to be effective for mitigating road network congestion, in which, both the on-time arrival of customers and the travel time saving of other traffic users are considered simultaneously.

Future study on this topic should focus on finding a reasonable and efficient method to charge customers based on on-time reliability in the SAT system. To improve the accuracy of reliable path finding and make the road traffic network more stable, cooperation strategies of all SATs and path finding methods under abnormal cases, especially traffic accidents and road infrastructure destroys, are urgent to be studied.