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主 論 文 の 要 旨

論文題目 PREDICTION AND ANALYSIS ON MICRO-CARS' INFLUENCE TO TRAFFIC FLOW, TRAFFIC SAFETY, AND ENVIRONMENT （超小型自動車が交通量と交通安全，環境に及ぼす影響の分析）

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論 文 内 容 の 要 旨

Transformational change is coming to the automobile. We are entering a new era when the automobile is unable to fulfill, in a sustainable manner, its function as the primary provider of personal powered mobility. There are many issues threatening the car's autonomy, such as peak oil concerns and rising fuel prices, legislation to reduce carbon emissions and other factors concerning climate change, congestion and parking limitations. Alternative vehicles have been developed and produced by niche manufacturers for decades, and these will enjoy mainstream popularity in years to come. Micro-cars are perhaps the most likely type of alternative vehicle to be seriously produced by the major Original Equipment Manufacturers (OEMs), given they are closest to the traditional car, no matter the shape, speed, or the weather protecting advantage when compared to motorcycle or the other types of alternative automobile.

Micro-car, usually two-seat, two-door, less than three meters in length, low weight, the smallest applied to standard small cars (being smaller than the city car), evolved out of necessity in a post-World War II Europe short of raw materials and money, have a rebirth and play an important role in the changing mobility landscape. Micro-cars are convenient for short and medium distance trips. They can provide convenient personal urban mobility at a cost below that of conventional cars; they will take up less of the city space currently needed for parking; they will significantly improve the throughput of streets and roads.

This research aims to analysis the effect of micro-cars after their introduction to the traffic flow in three aspects, their influence to traffic flow straightly, whether their join will cause safety hazard, as well as whether they have positive effects to the environmental if they are mixed to traffic flow. There are three levels for the analysis, road segment level, downtown small network level, and metropolitan network level. As to do realistic experiments is unavailable for many uncontrolled factors, TCA and VISSIM are chosen to complete simulations.

In road segment level analysis, VISSIM and TCA ' s performance is compared for research objective of investigating micro-cars ' influence in all traffic flow conditions, which is reflected by a density spectrum ranging from 0 veh/km to more than 100 veh/km in which it is a highest density on road for only-conventional-car traffic. Although VISSIM has the advantage that possesses more parameters than TCA to discribe detailed driving behaviors, the simulated results from VISSIM show some unstable points, and have deficiency of points in some density spectrums, especially on road segment with traffic signal. TCA has simpler rules and parameters, however, just so it can provide clear curves in different micro-car rate assumptions, not scattered points output from VISSIM, for the analysis in this research. So finally TCA was used to execute the segment level simulations after the comparison for the reasons mentioned above and its excellent ability in simulating realistic traffic in condition of the precise detailed driving behaviors are not necessary to catch, and its efficiency and fast performance when used in computer simulations.

In downtown small network level analysis, VISSIM is used to do simulations in the chosen network, as TCA models cannot easily handle dynamic traffic assignment for macroscopic simulation and driver behavior for microscopic simulation in network. And amount of required simulation results for the target analysis are computed.

For metropolitan network level analysis, TCA results are used to calculate the traffic flow and environmental effects on Nagoya metropolitan network in 2020, with the previous predicted traffic demand results. The predicted average traffic speed of every link is the original input for calculation. And all links have the same value for every micro-car rate assumption. This network and assumption are used because it will cost much time if use VISSIM to simulate large network and TCA model can simulate very fast.

In the congestion perspective analysis, micro-cars will relieve traffic congestion to some extent, and their introduction will bring about higher traffic volume in higher density traffic. It is confirmed that introduction of micro-car will relieve traffic congestion to some extent by the results from both TCA and VISSIM in segment level. The results also suggest that VISSIM provides more accurate results for expressway in some density region, while TCA seems more reasonable for arterial road with traffic signal. Many parameters for network performance evaluation are figured out during the network level simulations. The average speed, total travel time and total delay time are mainly used for the traffic point of view. The results suggest that more micro-cars gives positive effect on travel network when desired speed of micro-cars being the same with or a little lower than that of conventional cars, and more micro-cars cause negative effect when desired speed of micro-cars being close to the average speed of base model, even it is a little higher than the latter one. To balance between the effect from environmental analysis and effect from network performance analysis, micro-cars ' desired speed being 40-45km/h is recommended to be more applicable in downtown small network traffic. The results calculated on Nagoya metropolitan network suggest that travel speed in network have tiny change after micro-cars ' introduction, i.e. micro-cars ' effect on traffic flow is negligible.

For the safety influence analysis, mixed flows of conventional cars and micro-cars result in a negative effect on safety as measured by all the three assess indicators, number of lane changes, number of deceleration and coefficient of variation of speed on expressway in free flow, while in very congested flow, it will be safer after micro-cars' introduction both on expressways and arterial roads. However, micro-cars have a positive effect or no negative one on safety on arterial road for all the assess indicator except in free flow and very congested flow considering number of lane changing. Those are the results of road segment level. For network level, the results suggest that micro-cars will not produce negative effect for safety for number of lane changing point of view, and the same effect for number of deceleration point of view except they have much lower desired speed than conventional vehicles, and have positive effect for coefficient of speed variation consideration.

In the environmental effect analysis, introduction of micro-cars on road segment have evident positive influence on environment when consider HC, CO, NOx emissions as a measurement, on arterial roads, but have negative effect on expressway in free flow. So driving micro-cars on expressway is not recommended, while on arterial road is recommended. The needed power for the total travel demand is computed for the emission prediction in the VISSIM small network simulation. More micro-cars in traffic will reduce the emission, and so does the lower micro-cars' desired speed. More micro-cars driven on road give a positive influence to the atmosphere as they give less emission when driving in the 2020 Nagoya metropolitan network.