

論文 / 著書情報
Article / Book Information

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Title(English)	EVALUATING EFFICIENCY AND EQUITY CONCEPTS OF TRAFFIC CONTROL STRATEGIES: A NOVEL TRAFFIC CONTROL AND EQUITY MEASUREMENT APPROACH
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論文要旨

THESIS SUMMARY

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要旨 (英文 800 語程度)
Thesis Summary (approx.800 English Words)

Traffic congestion has been a problem since 1950's in the developed countries and parallel to the economic development in the world it is becoming a serious trouble for the cities of developing countries as well. Intelligent transportation systems offer different traffic control measures such as traffic signal, ramp metering, speed control, route guidance, etc. and they are used to minimize the impacts of traffic jams such as additional emissions and fuel consumption and to optimize the performance of the traffic network. One of the common features of these strategies is that they are designed to be implemented in the developed world countries. However, the traffic control techniques designed for the developed countries requires high amount of investments on infrastructure besides extreme management and maintenance costs to keep the system operational. Generally, efficiency is regarded as the only objective in the design and the management of traffic control systems, which is another important subject to be discussed. There are some studies showing that the long delays could be observed on the metered ramps (Levinson and Zhang, 2002) and the control strategies can create equity concerns while achieving a gain in congestion alleviation (Kotsialos and Papageorgiou, 2004). To gain public acceptance and support for the employment of the traffic control strategies, equity begins to emerge as an important issue.

There are numerous theoretical algorithms available to control the traffic dynamically. However due to the complex nature, in practice only few of these sophisticated algorithms are in use. Therefore, simple, applicable and efficient control strategies should be sought for the traffic congestion relief. The number of studies in analysis of equity issues in traffic control is limited, and their findings are mostly qualitative and sometimes even conflicting. For instance, efficiency and equity are usually considered as two competing requirements: the more efficient a control system is, the less equitable it becomes (Kotsialos & Papageorgiou 2004) (Meng & Yang 2002). Apparently, there is a need to resolve these contradictory findings, and develop proper equity measures to be used in the evaluation and further design of control systems that consider the efficiency and equity.

The main objective of the present research consists; investigation of an optimal cycle time for fixed-time ramp metering and optimal speed limit for speed harmonization control strategies besides development of an alternative equity index for evaluation of equity properties of traffic state. The proposed methodologies are examined within the traffic simulation environment. The traffic control strategies performances and equity index are compared with some common traffic control strategies and well-known indexes through simulations of real networks.

The research began with an extensive review of the fundamental relationships in traffic flow and traffic simulation. The models are classified according to level-of-detail and some key points are discussed. With respect to model applicability, microscopic simulation models are found more appropriate for this research that are more realistic and representative in terms of bottleneck formation. Hence, the traffic control and equity measurement analyses are performed with microscopic traffic simulation software.

For the traffic control theory, a fixed-time ramp metering control algorithm and harmonized speed control are proposed and the optimality of the cycle time and speed limits are analyzed through traffic simulation experiments. The fixed-time ramp metering considers bottleneck capacity, thus the underlying principle of control is the demand-capacity control. The offline demands are measured and the maximum admissible ramp volumes transformed into the green times for the control. The speed harmonization control applies the speed limits more particularly the speed ranges for the whole network. The optimum speed range is determined through a set of experiments in traffic micro-simulation program. The results implies that there is an optimal cycle length for fixed time ramp metering and optimum speed limit for harmonized speed controls that minimize the total travel time and maximize the average speed on the corridor which are found 15 seconds and 70km/h respectively.

In the equity measurement part of the study, the existing equity measurement methodologies developed for social sciences, economy and traffic researched are analyzed. It is found that the previous researches still did not have strong emphasis on the conceptualization of equity in traffic control where most of the indices are barrowed from econometric studies that are usually incorporating the differences of pairs among the mean values. There are also some other problems detected in terms of mathematical formulation of equity, for instance when the delay values are incorporated with Gini Index this would yield 0/0 indeterminate form if there is no delay in traffic. To overcome the drawbacks, a new equity index, namely K, is proposed to assess the equity of traffic considering the mathematical and theoretical subjects. The conceptualization of equity in K index is based on the notion that the ratio of the speed differences (vehicles or time frames) over a specific value which reflects the optimal flow. It is assumed that perfectly equitable state must be attained at the optimal flow not at the completely stopped traffic. The speed of a vehicle is found to be the most appropriate indicator for K index that gives the index flexibility to measure the equity of speed and delay distribution by taking the denominator as optimum speed or free-flow speed.

This research has presented the results of applying the fixed time ramp metering, speed harmonization and integrated control for the regulation of the inflow from on ramps to the mainstream of a highway corridor for the case study of Istanbul 0-1 corridor. Furthermore, extension of model predictive control strategies are derived and implemented as a series of freeway traffic control strategies as either a standalone strategy or the integrated ones, within the case study of Tokyo Route-3. The results also reveal that the speed increase (gain) in traffic comes up with an equity decrease (loss) for the ramp metering strategies. However, the trade-off is not the general pattern. The speed management control strategies can achieve increase in both efficiency and equity at the same time in expense of loss in efficiency compared to the ramp metering control. The integrated control strategies, which are the combination of ramp metering and speed management strategies, are more successful either in establishment of efficiency and equity at the same time.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 2 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 2 copies of 800 Words (English).