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## Modeling Passenger Travel Behavior and Guidance Optimization for Disruption Management in the Urban Rail Transit Network

*Haodong Yin*

Abstract

This thesis focuses on the problems of disruption management, including the passenger travel behavior modeling and optimization of guiding passengers under the alternative disruption scenarios. And this thesis aims at revealing the interactive mechanism among the disruption incidents, disruption management strategies and the passenger travel behavior. More detailed contents are listed below:

1) Macroscopic method of recognizing the impact of operational disruption incidents. Firstly, a simulated-attack method based on the complex network theory is proposed to explore the significant influence of different types of operational disruptions on the macro connectivity efficiency of urban rail network. Secondly, a data-driven Bayesian prediction method is adopted to estimate the extent, time-spatial scope of the disruption impact on passenger flow demand.
2) Modeling passenger travel behavior under alternative disruption scenarios. This paper aims at revealing the decision-making mechanism of passenger travel behavior under the condition of complex station closure and line/segment disruption. Firstly, the passenger behavior optimization model under the condition of alternative closure scenarios is constructed. Secondly, in the line/segment disruption scenario, a mathematical optimization model of rescheduling the train timetable is constructed. And then, an algorithm to find K-shortest paths in time-expended rail network is proposed. Finally, the decision-making mechanism of passenger travel behavior under segment disruption is proposed, which is also integrated with the above-mentioned models.
3) Bi-programming based optimization and modeling of passenger inducement. The bi-level programming model of optimizing passenger inducement is proposed, considering the scope and content of the inducement information dissemination. The lower level is to model the passenger travel behavior under the guidance information. The upper layer model depicts the decision variables of the scope of the induced information. Finally, a hybrid intelligent algorithm is designed to solve the proposed model with the integration of a multi-agent based passenger flow simulation and a genetic algorithm.

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### Energy-Saving Oriented Train Timetable Optimization Methods in Urban Rail Transit

*Xin Yang*

Abstract
The main purpose of this research is to optimize the timetable for reducing the energy consumption of urban rail trains. From two perspectives of improving the utilization of regenerative energy and directly reducing the tractive energy consumption, this paper studies the model formulation and solution algorithm of timetable optimization.

The paper firstly introduces the distribution of energy consumption in urban rail transit systems. Then the tractive energy consumption and regenerative braking energy which are closely relative to train operations are analyzed.

The paper proposes a timetable optimization method to improve the overlapping time between accelerating and braking processes of adjacent trains within the same electrical section, such that the regenerative energy from braking trains can be immediately utilized by accelerating trains to reduce their tractive energy consumption. We formulate an integer programming model and design a genetic algorithm to find the optimal solution.

Based on the above optimization method, this paper further develops an energy-efficient timetable optimization method using the mechanical energy consumption as the objective function instead of the overlapping time. The main contributions are considering the utilization of regenerative energy among all trains within the same electrical section instead of adjacent trains and keeping the cycle time and the number of trains unchanged in the metro operations.

According to the uncertainty of train mass at different inter-stations and at different operation periods, this paper develops an integrated timetable and speed profile optimization method to minimize the total tractive energy consumption. A two-stage stochastic programming model is formulated and a simulation-based genetic algorithm incorporated with the optimal train control algorithm is designed to obtain the optimal solution. Two numerical examples based on the operation data from the Beijing Metro Yizhuang Line are presented. The results show that the integrated optimization method can achieve a good energy performance in comparison with the current timetable and speed profile.

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### Road Scenarios Modeling and High-accuracy Localization for Intelligent Vehicles

*Yicheng Li*

Abstract
High-accuracy localization is one of the core problems for intelligent vehicles. This dissertation presents a "representation-to-localization" strategy for intelligent vehicle localization. In summary, the contributions of this dissertation are listed as follow:

First, a road scenarios representation model is built from the data captured by monocular/binocular cameras, DGPS, IMU, GPS receiver and laser scanner, etc., for intelligent vehicle localization. With this model, road scenarios consist of a sequence of nodes. For each node, there are visual features, 3D data, and trajectories. These three elements can represent the uniqueness of each node. In practice, all road scenarios models were built with prototype intelligent vehicles.

Second, a multi-scale localization method is proposed based on road scenarios model from monocular vision and ordinary GPS. The model follows a "coarse-to-fine" strategy. In coarse localization step, GPS data are matched within

the nodes in the road model to derive initial node candidates. In image-level localization step, both holistic and local features are extracted and matched with those from the initiate candidate nodes, respectively. The matching results are fused by KNN-MFS (K-nearest neighbors-multiple feature spaces) to obtain a unique candidate node. In metric localization step, the local features are matched with the 3D data of the candidate to further refine the localization results by solving a PnP (perspective-n-point) problem. The method allows us to derive a "closest" node in the road model such that the pose of intelligent vehicle is obtained for accurate localization.

Third, a vision-only localization method without GPS data is proposed. In this method, we utilize a topological model rather than GPS to derive coarse localization results. Specifically, "feature-zone" is first defined. Then, a topological localization approach based on feature-zone is developed, with which initial localization range is obtained. Furthermore, a vision-motion model is developed from the defined vision-speed and vision-acceleration. A Bayesian topological localization method based on vision-motion is then proposed to further narrow down the localization space. This method addresses the localization problem in GPS blind areas.

The researches in this dissertation suggest low-cost solutions to accurate localization of intelligent vehicles, which can be significant to promote the development of intelligent vehicles.

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