Enhancing the Function of the Train Operation Forecast Simulation System

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1. Introduction

In this study, we have implemented a program to enhance the existing train operation forecast simulation system that includes train operation and passenger behavior simulators. The goal of the study was to be able to evaluate train operation plans with higher precision by reproducing small scale delays that would occur on a daily basis in high density urban operation and to determine the impact of these small delays on the behavior of train groups.

2. Background of the Study

In a period of high frequency operation such as morning rush hours in an urban area, delay propagation is likely to occur. The propagation begins when an increase in train standing time occurs due to passenger concentration on a specific train. This results in the train being delayed and the operating interval increases between this train and the one ahead. The delayed train will then become the more crowded resulting in further delays. In turn, this delay gives rise to a higher likelihood of making the following train vulnerable to the signal-induced speed limit, and thus the delays can propagate readily. Accordingly, when evaluating a train operation schedule, these conditions need to be simulated in detail. Unfortunately, however, the currently available simulators have been unable to provide an accurate evaluation while taking these conditions into consideration.

3. Details of the Implementation

In the calculation of travel time between stations with the use of an available simulator, the signaling conditions are not taken into consideration. Thus the simulations tend to become simplified calculations to determine the running time based on a) the departure time at the last station, b) the predetermined shortest travel time between stations, c) the minimum required operation interval and d) the specified arrival time. Consequently, travel time between stations cannot be estimated precisely when a train is subjected to a speed limit by means of signaling.

Accordingly, we first developed the function to calculate travel time between stations when train operations conformed to signaling conditions by simulating the signaling status. Secondly, we analyzed the influence of the passengers' behavior, signaling conditions and operating method on actual train operations to compile Fig. 1, and installed a simulator that takes accounts of these interrelationships. To verify the effectiveness of the system, we prepared the data of a model line section. Fig. 2 shows an example display screen of the simulated results. Besides the train operation diagram, the system can display the number of occupants in each coach of a train, the degree of passenger congestion in each coach, the number of people waiting to board at each station, the operating method exercised between stations, the train locations, signaling conditions and other factors recognizable on the operation diagram.

The new train operation forecast simulation system can evaluate the railway operation from every conceivable aspect. We are considering deploying this simulation system in other applications such as evaluating energy consumption and train control systems.

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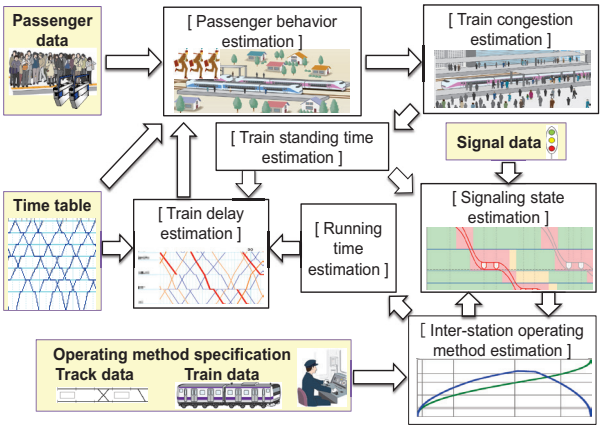
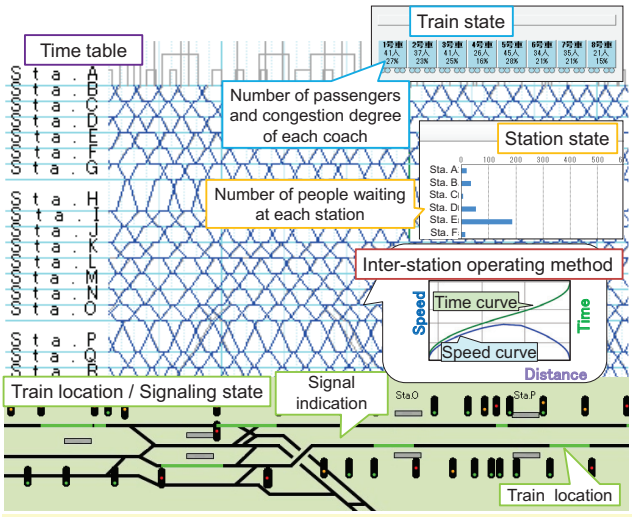


Fig. 1 The influence of passengers' behavior, signaling conditions and operating method on the train service status



No. of stations: 20, Total track length: approx. 22 km, Total No. of trains: 1,072
Total No. of passengers: approx. 193,000, Calculation time per day for train diagram formulation: 17 minutes and 30 seconds (a general purpose PC employed)

Fig. 2 Example display screen of simulation results of a model line section