RTRI Develops Driver Advisory System for Energy Saving Utilizing Speed Transition Estimation

The Railway Technical Research Institute (RTRI) developed driver advisory technologies utilizing speed transition estimation and a prototype system thereof (hereinafter, “driver advisory system”) for energy saving.

The driver advisory system estimates speed transition extending from the location of the train at the present time to the location of the next station to be passed. A tablet device installed on the driver’s cab of a train that passes through numerous stations estimates speed transition concerning multiple train operation status based on train set specification and running conditions. From the estimated speed transition, the system chooses and displays for the driver the recommended driving operation that are excellent in terms of punctuality and energy efficiency (Fig. 1).

Fig. 1 Example of Driver Advisory System Installed on Driver’s Cab

1. Background of Development

Saving energy consumption and driving efficiently are important in achieving cost reduction and decarbonization. The energy consumed during train operations varies with the choice of driving methods even in the same sections where trains run. Therefore, to achieve further efficient running, it is required to support train driving operation depending on the running conditions (location of the train and speed), while complying with the conditions (travel time,

speed limit, and the like) and taking into account train set specification (trainset weight, running resistance, characteristics of electrical equipment, and the like) and running route profile (gradient and the like). To this end, the RTRI developed driver advisory technologies and a prototype system for energy saving, which shows train drivers the most recommended driving operation estimated in real time by using a tablet device.

2. Overview of Energy-Saving Driver Advisory System

To achieve energy saving while maintaining punctuality, the system shows the driver the recommended driving operation from which energy consumption reduction can be expected, by utilizing the following two methods.

- Reducing energy loss during operation while considering running resistance and characteristics of electrical equipment used on the train
- Reducing the number of acceleration and deceleration intervals to adjust running time, by utilizing high-precision estimation of the running time that the train is expected to pass through the station

The system estimates several speed transitions as candidates depending on train set specification, the speed and the location of the train, by defining several operation patterns for driving to the next station to be passed (Fig. 2). Specifically, the system selects driving operation status such as “powering operation”[*1], “constant speed operation”[*2], and “coasting operation”[*3], then the system determines transition points and speed at which the operation status is switched, and then, the system estimates speed transition according to the several operation patterns. Among thus obtained candidates, the operation pattern which pass the next station at the time closest to the planned time and consume less energy is shown in real time to the driver as recommended driving operation. Thus, the system displays on the screen the most recommended driving operation at present and other information including the estimated time that the train is expected to pass through the station. The summary of the displayed information is also provided by audio notifications (Fig. 3). Such recommended operation enables drivers to perform punctual and energy-efficient operation.

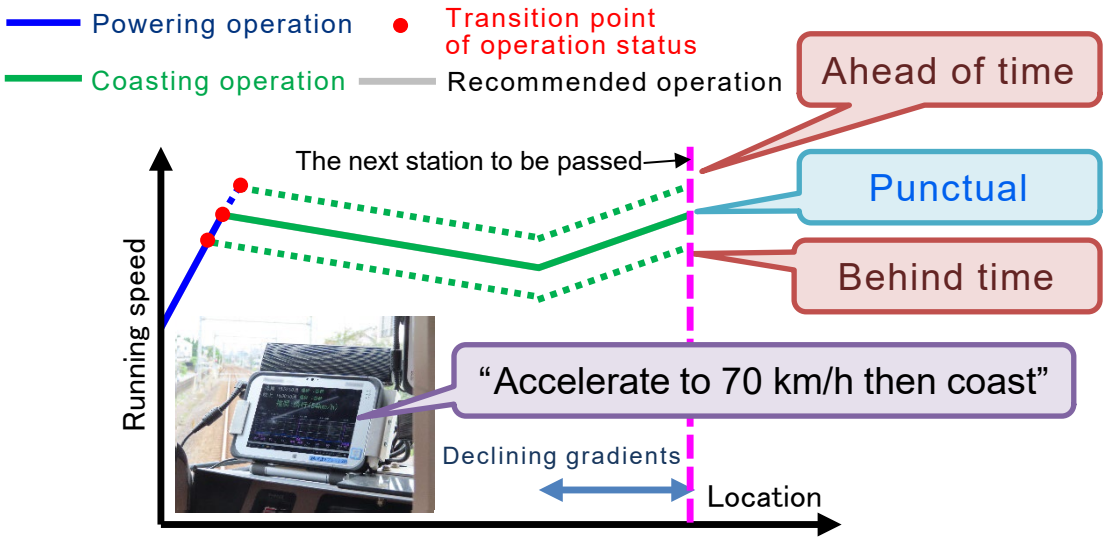

Fig. 2 Image of Estimated Speed Transition

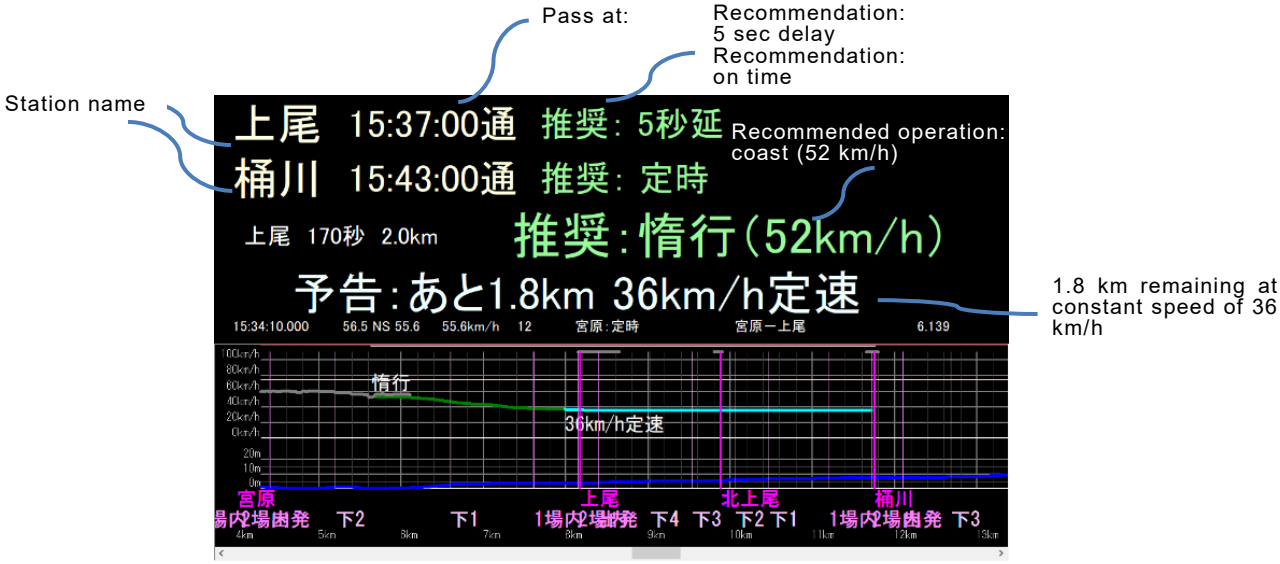

Fig. 3 Screenshot of Driver Advisory System

As a result of the verification using freight trains with electric locomotives hauling petroleum tank cars, approximately 4% to 14% energy saving was confirmed depending on running sections and train set specifications (Fig. 4).

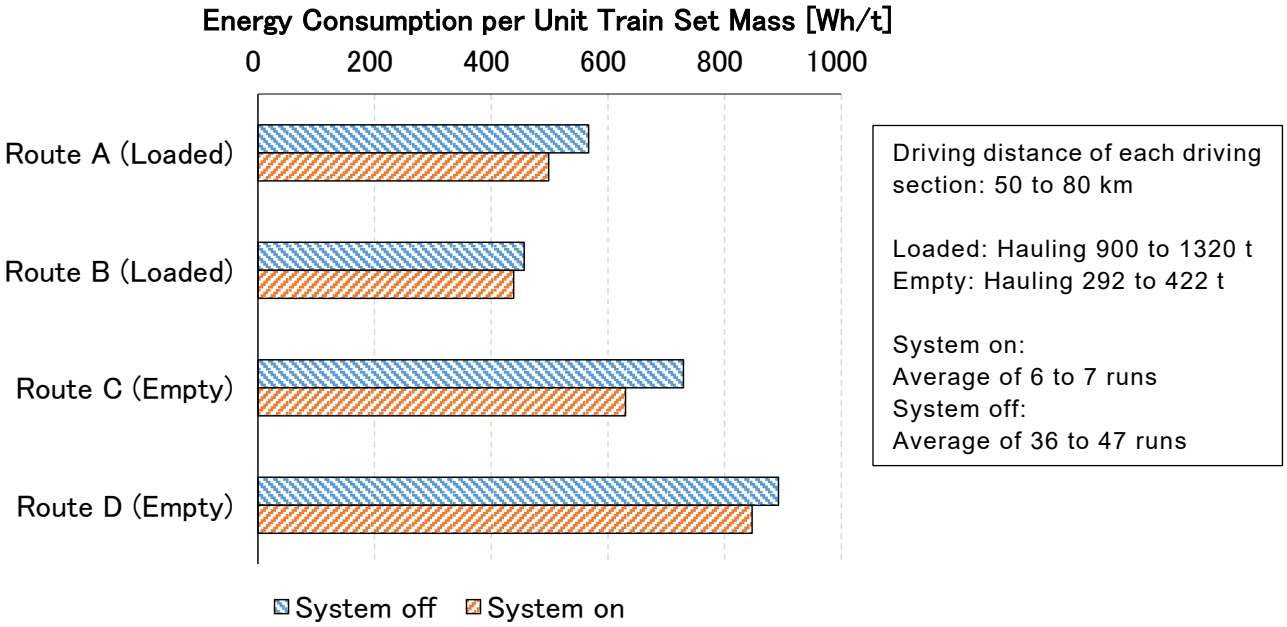

Fig. 4 Comparison of Energy Consumption
with or without the Use of Driver Advisory System

3. Schedule for the Future

While extending the scope of routes and cars for verification, trial operation of the driver advisory system will be carried out until March 2025, based on which, we will promote the practical use of the system.

*1 Powering operation is a status of driving operation in which power is provided by motors or engines to accelerate train speeds.

*2 Constant speed operation is a status of driving operation in which power provided by motors or engines is automatically adjusted during operation to maintain the train speed.

*3 Coasting operation is a status of driving operation in which trains run without power or brake applied.

Some of the technologies used for the aforementioned developed system have been patented (Japanese Patent No. 7365320).