A Study on Intelligent Trains to Improve Safety and Reliability of Operation

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To improve the safety and reliability of train operation further, it is possible to collect safety information of various categories on trains by utilizing sensing and telecommunication technologies. The Railway Technical Research Institute (RTRI) is now studying methods, therefore, to develop "intelligent trains" with heightened safety awareness to prevent accidents by detecting dangerous conditions based on the information obtained through sensors or other instruments incorporated in trains or installed on the ground (Fig. 1).

The subsystems to detect abnormalities currently under discussion are those to monitor bogie conditions for soundness, detect obstructions on tracks and detect mental/physical abnormalities of train drivers. The obstruction detecting system monitors tracks through the sensors on trains. It uses instruments installed on the ground to monitor the conditions of platforms and track where rock and stone falling is anticipated, with the monitored results transmitted to trains. To raise the detecting performance, the system combines the technologies of radars/distance sensors and camera image processing. So far, RTRI has developed basic algorithms such as those to extract track from the images photographed with cameras installed on trains and obtain true bird's-eye views converted from the forward photographic images (Fig. 2).

As a basic technology required for implementing intelligent trains, RTRI is also developing a method to detect position and speed at high precision without installing new facilities on the ground (Fig. 3). This is achieved by combining the technologies of existing tachometer-generators, inertia sensors, Global Positioning System(GPS) and millimeter wave to aim at position detecting errors of 5 m or less. For this purpose, RTRI is now evaluating the performance of component sensors and discussing applicable algorithms. Regarding inertia sensors, RTRI has already developed an algorithm to determine positions by making the detected angular speed corresponding to track curvatures and gradients. As the precision of tachometer-generators is not sufficiently high in low-speed ranges affected by wheel skids and slips, RTRI has also developed an algorithm to use inertia sensors to compensate for the errors in the position detected with tachometer-generators and confirmed its applicability in running tests at about 60 km/h on a test track (Fig. 4). RTRI has confirmed that the millimeter wave speed meters, used to calculate moving speeds based on the Doppler frequency of reflected waves, predict almost the same speeds as those obtained with tachometer-generators at a moving speed of about 60 km/h without being affected by soil or dirt staying thereon.

RTRI will promote development of component subsystems and a prototype unit including an intelligent device to integrate the outputs from the subsystems.

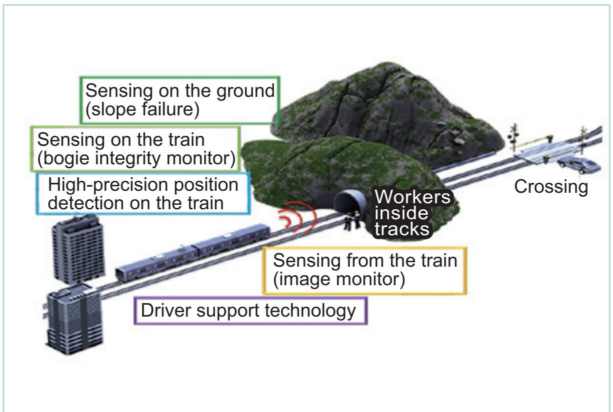

Fig. 1 An image of intelligent train

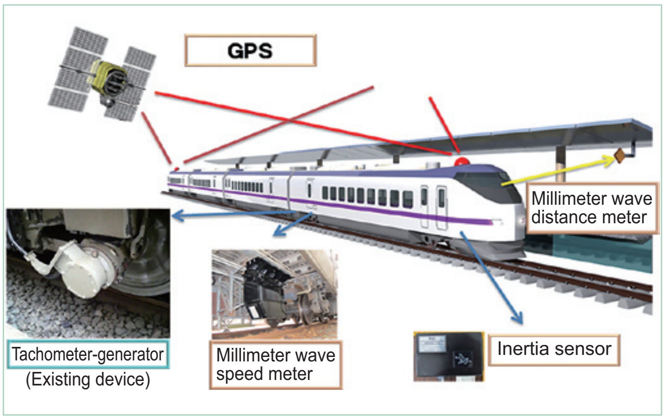

Fig. 3 Composite type high-precision position/speed detecting device

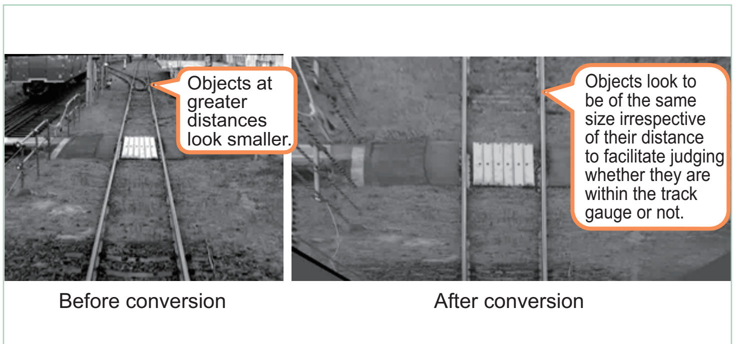

Fig. 2 Conversion by the "viewpoint converting algorithm"

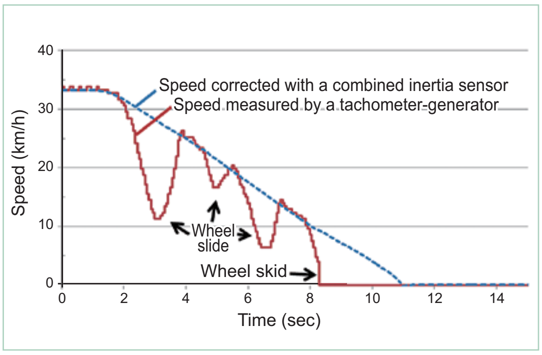

Fig. 4 Correction of speed with an inertia sensor