One-person Operation Support System for Urban Railways

Takenori Wajima
Takamichi Kadono
Fujihiko Yokose

*OVERVIEW: Recently, in the interests of improving operational efficiency for urban transportation systems, the transition to one-person operations is underway for existing as well as new lines. On the onboard side, the introduction of the one-person operation support system is progressing and now includes ATO*1 (automatic train operation) and car information control systems, which support crew operations. Additionally, platform monitoring and platform gate systems have now been actively introduced on the ground side to reduce labor costs and promote passenger safety. Further, a study of driverless operations has recently commenced to look at further improving operational efficiency. Hitachi, Ltd. provides a total solution, having unified the on-ground ATC*2 (automatic train control), ATO, the onboard car information control system, the platform monitoring system, the platform gate system, etc. We will support construction of a one-person operation support system designed to improve operational efficiency and passenger safety.*

*1 In some countries, 'ATO' is also called 'ATC (automatic train control).'
*2 In some countries, 'ATC' is also called 'ATP (automatic train protection).'

INTRODUCTION

CORRECTLY, Japan is experiencing a dwindling birthrate and an aging population, causing urban transportation systems to experience a reduced number of users together with an increase in use by elderly people. Railroad companies also face the problem of a loss of experienced employees, further underlining the need for efficient systematized operations. However, users also demand transportation that is safe and convenient.

One measure to resolve these problems is the introduction of one-person operations, or systematization through the one-person operation support system. Introducing a one-person operation requires a system that offers the utmost in safety while still being able to handle high-density operations. Furthermore, review of driverless operations is currently in progress in an attempt to further improve operational efficiency.

Here, we will describe Hitachi's one-person operation support system as well as a concept for changing one-person operations to driverless equivalents.

ONE-PERSON OPERATION SUPPORT SYSTEM

Implementing a one-person operation system involves analyzing operations that had, until now, been

TABLE 1. Functions Necessary for One-person Operations
Examples of the functions of the one-person operation support system corresponding to crew operations are shown.

Operation		System	Function
Startup check		ATI	Failure detection, etc.
Operation		ATO, TASC	Failure detection, etc. Automatic operation control
Safety monitoring	Platform approach	ITV → Platform doors	Passenger safety check → Securing it
	Status of disembarkation and embarkation	ITV	Passenger safety check
	Door check		
	Platform departure	ITV → Platform doors	Passenger safety check → Securing it
Announcement		Public address system	Passenger safety check
Onboard passenger service		Onboard public address system Onboard display Onboard temperature control	Provide onboard information
Emergency measures		Deadman switch (automatic operation stop) → Report to central control station via train radio	Emergency measures

ATI: autonomous decentralized train integrated system
ATO: automataic train operation
TASC: train automatic stop position control
ITV: industrial television

performed by a crew consisting of a train operator and conductor and refine and reallocate the tasks. Table 1 shows a summary of the functions required to implement this operation based on our analysis of crew operations.

To implement one-person operation support systems, the following measures are being introduced consecutively to support the operation, to monitor passengers getting on and off the train, and to prevent accidents, such as falling from the platform.

(1) Crew support systems such as ATO and car information control systems are used to support train operations, which, until now has been the main work of the train operator.

(2) Platform monitoring systems, ITV video viewing on control station monitors, and onboard monitor that ensure passenger platform safety.

(3) Platform gate systems, to prevent passengers from falling from the platform, gap fillers (horizontal mobile steps), to help prevent falling through the gaps present in curved portions of the platform, etc.

To realize the one-person operation support system, we must unify these subsystems and construct them as a total unit. (see Fig. 1)

New urban transportation lines were originally designed for one-person operations and now facilitate the implementation of safe and stable operations. However, Tokyo Monorail Co., Ltd. is an example of a one-person operation system introduced to an existing line that was not originally designed as a one-person operation system. The details are described in the following.

ONE-PERSON OPERATION SUPPORT SYSTEM PROTOTYPE

Tokyo Monorail Co., Ltd. introduced a one-person operation prototype in September 2002. It was designed so that capabilities necessary for one-person operations could be added to the existing monorail cars and ground facilities. These capabilities are intended to address the following concerns:

(1) To help passengers get on and off

In one-person operations, work previously performed by the conductor is performed by a single operator. Therefore, to avoid operational difficulties, various operation buttons and information displays must be located on the driver's control panel.

The following actions are monitored to ensure the safety of passengers disembarking and embarking.

(a) Checking the stop position upon arrival at the station,
(b) opening the doors,
(c) monitoring disembarkation and embarkation from the platform,
(d) closing the doors,
(e) checking door to ensure proper closure,
(f) checking the platform, and
(g) recommencing operations.

If the train stops at a predetermined position, the train operator then opens the doors. This control instruction is transmitted to a platform gate system by a transponder transmission system, and the gate doors open in conjunction with the car doors.

The train operator remains seated and observes the passengers getting on and off via a TV monitor placed

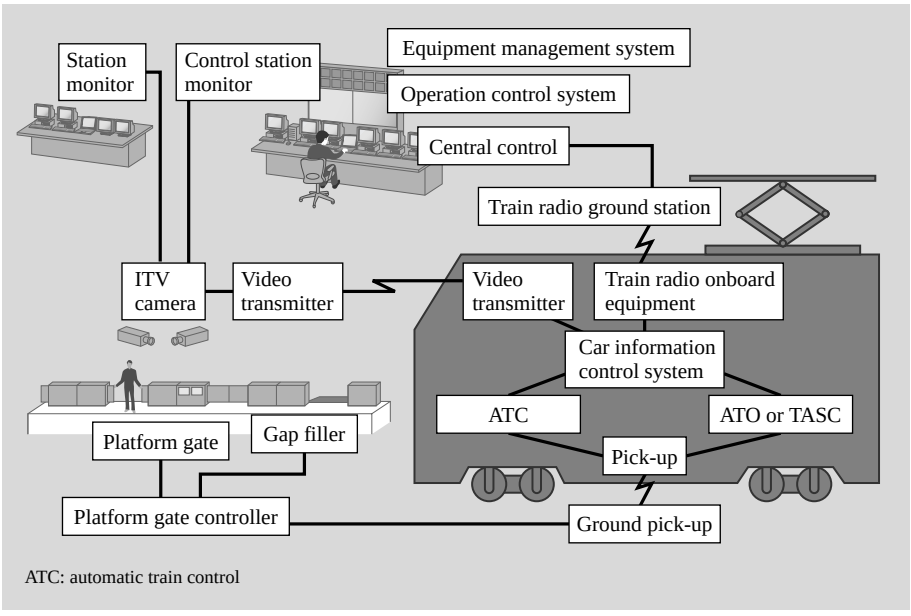

Fig. 1—Configuration of One-person Operation Support System. It shows the configuration of a system supporting one-person operation. The one-person operation support system includes a crew support system, such as the ATC, ATO and car information control system, an ITV platform monitoring system and a platform gate system to ensure safe embarking and disembarking on the platform.

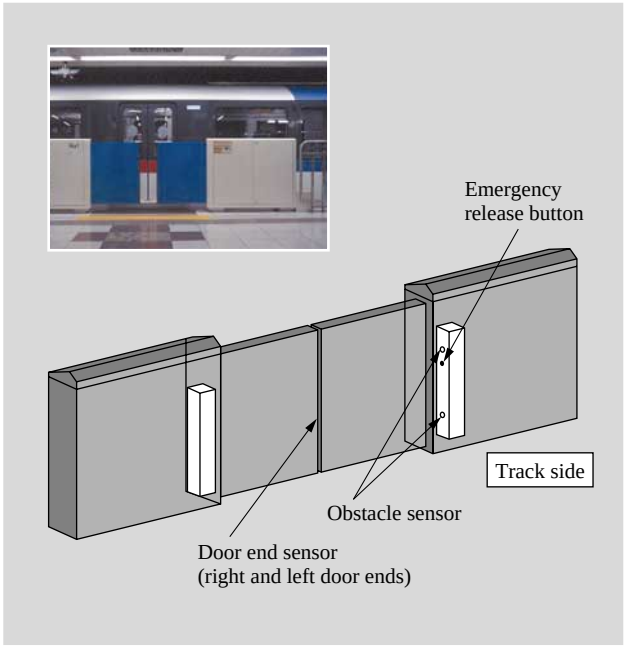

Fig. 2—Tokyo Monorail Co., Ltd.'s Platform Gate.
Passenger safety is secured with the platform gate system.

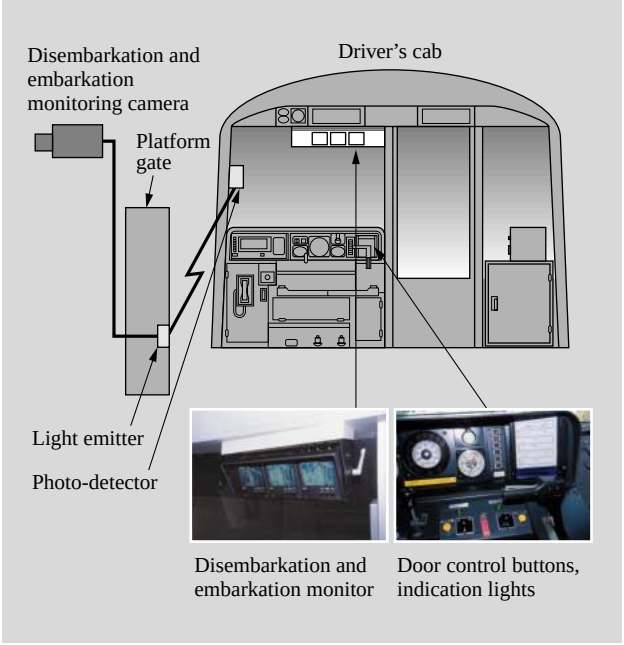

Fig. 3—Monorail Control Platform.
It supports one-person operations, and is more convenient for train operator.

in the driver's cab. The images are sent to the train from the platform through optical space transmission from a monitoring camera on the platform. A departure alarm is sounded by turning on a switch on the driver's control panel.

After checking passenger safety, the doors are closed. Once all the car doors and platform gate doors are closed, the display on the control panel indicates "complete closure" for the car doors and platform gates.

Fig. 2 shows an example of a platform gate. Tokyo Monorail Co., Ltd. set the opening width of the platform gate at 2,000 mm taking into account the car door width and allowing for car stopping error.

Door end and obstacle sensors are provided as safety devices so that the doors will automatically open if a person or an object is sandwiched between the doors. In addition, a manual operation panel for only opening and closing the platform gate is provided as an extra precaution.

(2) To provide passenger service

Onboard information for passengers is provided through an automated public address system that broadcasts events, news of emergency braking, transfer information, destination, and next stop. It can be adapted to an onboard broadcast system using a microphone on the control panel on orders received over the train radio.

For a shuttle service in fixed sections, in addition to being used to manually set the station, the onboard automated control panel can set the next stop from information relayed to it by a switching station sensor.

(3) To activate emergency procedures

In one-person operations, passenger safety must be ensured, even in cases where the train operator detects an abnormality.

If the deadman switch on the master control panel detects any abnormality in the operator, it triggers the emergency brake. The abnormality is automatically reported to central control via the train radio. Additionally, panic buttons are provided in the passenger compartments allowing passengers to converse directly with the train operator or central control.

Bi-directional flashing headlights are provided so that, in cases where the train operator confirms the presence of an abnormality and halts operations, he/she can protect the passengers from trains approaching from infront or behind. Fig. 3 shows an illustration of the driver's cab.

Even in cases where the car system is in a manual operating environment, one-person operations have been realized by adding devices that can convert the train to a one-person operation.

DRIVERLESS OPERATION

Forms of Driverless Operations

As with the ATO, the foundation for systems not requiring an onboard operator is being anticipated by introducing new technologies to ground and onboard railroad. Operations conducted without a train operator onboard are referred to as driverless operations. One of the biggest advantages is the improvement in operational efficiency.

Driverless operations often involve attendants, other than the train operator, staying aboard to fulfill the role of onboard monitoring, passenger service, and escape guidance in emergency situations where no train operator is onboard. An example of a driverless operation in Europe is Meteor Line in Paris. There also is an example in the automated guideway transportation in Japan.

Important Considerations for Driverless Operations

To implement a driverless operation system, the following points must be considered:

(1) Safe, smooth, and secure train operation control
(2) Ensuring passenger safety upon arrival and departure and on passenger embarkation and disembarkation
(3) Securing the safety of onboard passengers
(4) Securing the passengers' safety in emergency situations

ATC and ATO introduced in the one-person operation support system are required to implement the first point. An ITV platform monitoring system and platform doors are required to implement the second, while mechanisms for monitoring onboard status are required to implement (3) and (4), respectively. To promptly report and handle emergency situations, mechanisms are required that can promptly convey information to central control, via the train radio, while the train is being controlled by central control. Information from the operator and/or passengers is critical in this situation. Onboard the train, environment must allow essential information to be transmitted to and from central control quickly and efficiently using the broadband network system.

Therefore, in order to implement driverless operations, a communication system between the ground and the train must be added to one-person operation support systems. Fig. 4 shows the issues and measures involved in implementing driverless operations.

FUTURE PROSPECTS

There is an increasing demand for one-person operation support systems and driverless operations to improve the operational efficiency of urban transportation systems.

These systems can be implemented by combining time-tested systems like car control technologies, such

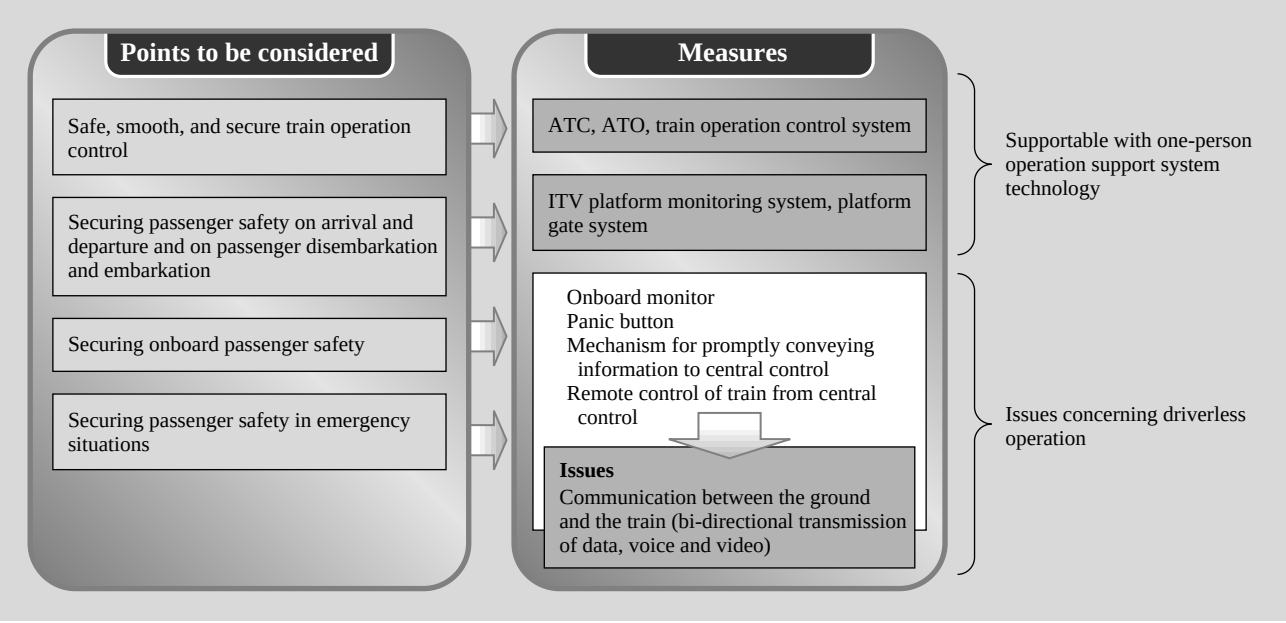

Fig. 4—Issues and Measures for Implementing Driverless Operations. Points to be considered and measures are shown.

as ATC, ATO, car information control systems, ITV platform/car video monitoring systems, train radio communication systems, and platform gate systems.

We must be particularly vigilant when using driverless operations during peak periods that operational emergency, onboard and ground systems are coordinated and functioning as integrated units.

CONCLUSIONS

This article described Hitachi's view of one-person operation support systems and driverless operations.

Hitachi will use its expertise as a total railroad system integrators, supporting functions from onboard to ground systems that include operation control and platform gate systems. With this expertise, Hitachi can construct one-person operation support systems and streamline driverless operations.

REFERENCES

(1) "Commentary on Technical Standards on Railroad (Operation)," Operational Technology Base Investigation Committee edited by Railway Bureau, National Land and Transportation Ministry (Jun. 2002) in Japanese.

(2) K. Ishida et al., "New Train Control and Information Services Utilizing Broadband Networks," *Hitachi Hyoron* **85**, pp. 553 –556 (Aug. 2003) in Japanese.

ABOUT THE AUTHORS

Takenori Wajima

Joined Hitachi, Ltd. in 1980, and now works at the Rolling Stock Electrical Systems Design Department, Mito Transportation Systems Product Division, the Transportation Systems Division, the Power & Industrial Systems. He is currently engaged in the design of onboard operation control apparatuses.

Takamichi Kadono

Joined Hitachi, Ltd. in 1973, and now works at the Signaling Systems Design Department, Mito Transportation Systems Product Division, the Transportation Systems Division, the Power & Industrial Systems. He is currently engaged in railroad system-related businesses.

Fujihiko Yokose

Joined Hitachi, Ltd. in 1988, and now works at the Operation & Management Systems Department, the Transport Management & Control Systems Division, the Transportation Systems Division, the Power & Industrial Systems. He is currently engaged in railroad system-related businesses.