Trial Installation of Guide Robots and Digital Signage at Takanawa Gateway Station

In order to cope with the significant changes occurring in the rail industry in Japan in recent years, in 2017 the East Japan Railway Company established the Mobility Innovation Consortium, and in July 2018 announced its groupwide management vision, "Move Up 2027." Since then it has implemented various verification tests to achieve this vision. Hitachi took part in verification tests in two phases held in 2018 and 2019 for one of these projects, for AI guidance systems. Hitachi's efforts in these verification tests were recognized and rewarded with the trial adoption of Hitachi solutions for AI-based guide robots and digital signage at Takanawa Gateway Station, which began operation in March 2020. This article describes these solutions and outlines Hitachi's future intentions for passenger information services.

Hirokazu Hattori
Ryo Shinoki
Fumihiko Inoda
Keisuke Hasegawa

1. Introduction

Recent years have seen significant changes happen in the rail industry, both due to social and technological factors. The demand for transport by rail is showing an increasingly marked decline owing to factors like the low birth rate, the shrinking population, and changing work styles. Lifestyles are also diversifying through the rise of online communities and technological innovations like artificial intelligence (AI) and the Internet of Things (IoT).

The East Japan Railway Company (JR-EAST) established the Mobility Innovation Consortium as a way to transform mobility through open innovation. As part of this, the robot utilization working group has been conducting verification testing with the aim of forming smart AI-based guidance systems[(1)].

At the same time, Hitachi has been actively promoting its Hitachi Rail Innovation initiative to realize a vision of future rail services driven by digital technologies[(2)]. For one of these categories, smart navigation, the aim is to provide guidance and support to individuals, to reduce congestion during extraordinary conditions, and to realize services meeting the needs of each traveler. In recent years, in addition to Hitachi's previous involvement in passenger information services such as emergency signage, train location information, and station congestion guidance, the company has also been developing a system to provide transport information to meet the needs of inbound tourists. One success so far is infotouch[*1], an interactive digital signage system for Narita International Airport Corporation. Hitachi is developing and putting into use more such solutions to enhance passenger information services.

*1 infotouch is a registered trademark of Narita International Airport Corporation.

2. Trends in Rail Passenger Information Services

2. 1
Challenges in Passenger Information Services for Public Transportation

According to a Public Opinion Survey on Public Transport[3] conducted by the Japanese Cabinet Office in 2016, overall 51.2% of people who use railways and buses feel that there is not enough information at train stations and bus stops.

Furthermore, in a Questionnaire on Creating a More Welcoming Environment for International Visitors to Japan[4] conducted in 2019 by the Japan Tourism Agency, commonly cited difficulties encountered when traveling in Japan include inability to communicate with staff of facilities and other places (17.0%), use of public transportation (12.2%), and the lack of signs in multiple languages or the difficulty of understanding signs (11.1%).

These responses indicate the urgent need to provide better information for inbound tourists with more detailed guidance regarding public transportation.

2. 2
Efforts by Railway Companies

Several railway companies are engaged in verification testing for passenger information services using AI to better serve the increasing numbers of tourists to Japan and reduce the burden of station staff.

JR-EAST conducted such testing at the JR EAST Travel Service Center in Tokyo Station in October 2016, using Hitachi's communication robot EMIEW to answer questions from tourists visiting Japan[5]. In May 2019, JR-EAST also conducted joint verification testing for a guide robot with Deutsche Bahn AG, a major German railway company[6]. Joint verification testing was also conducted in 2018 and 2019 for the project to develop guidance AI under JRE Robotics Station, LLP[7, 8]. In particular, the second phase focused on solutions to challenges identified in the first phase, such as multilingual capabilities and providing answers to specific questions on changing trains, areas around stations, and restaurants.

3. Hitachi's Solutions Trialed at Takanawa Gateway Station

3. 1
Background to the Trials

Takanawa Gateway Station, on the JR Yamanote Line, began operating on March 14, 2020. The station is designed to be a gateway connecting Tokyo to the world, at the heart of a new town under development for opening around 2024 under the concept of Global Gateway Shinagawa. JR-EAST has decided that this station will be the testing ground for the latest service facilities, and is conducting verification tests for AI-based guide robots, digital signage, and several autonomous mobile robots[9].

Hitachi has participated in this testing with EMIEW in first phase project to develop guidance AI[10], and with digital signage (hereinafter "signage") in Phase 2. Solutions combining both of these will be adopted for trials at Takanawa Gateway Station. Because of the results gained by EMIEW and signage respectively in the previously mentioned phases, it was judged that combining both would mutually complement their functions.

3. 2
General Overview of Hitachi's Solution

The solution provided by Hitachi is a guidance service combining EMIEW and signage (see **Figure 1** and **Figure 2**). The advantage of this solution is that it enables passenger information making use of the strengths of both EMIEW's many functions as a communication robot and the easy to understand displays and screen functions of the signage. EMIEW encourages conversation when it senses users nearby, chatting and answering common questions about the station. It suggests the use of signage for information on the area around the station or for changing trains. The signage recognizes speech at the push of a button, displaying maps and pictures on the screen to guide users. EMIEW

Figure 1 — Hitachi Solutions Provided at Takanawa Gateway Station

Overall view of EMIEW and the exterior of the signage.

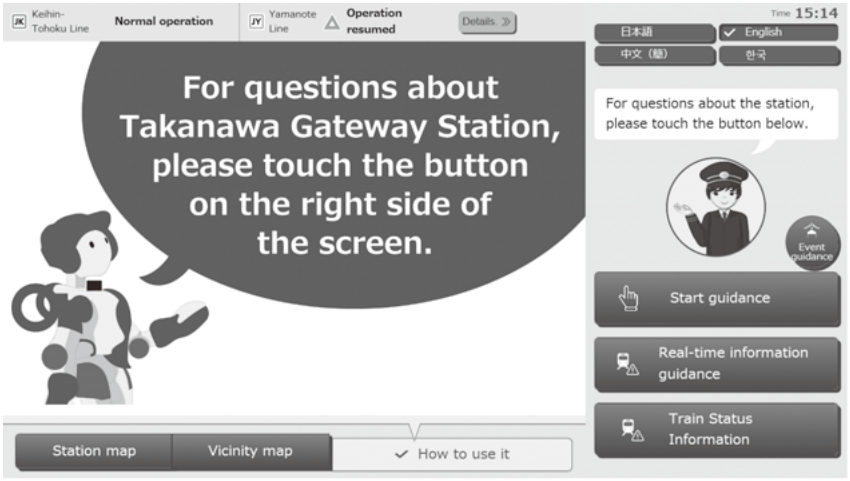


Figure 2 — Top Screen of the Signage Provided at Takanawa Gateway Station
The top screen of the signage also shows how to use EMIEW.

monitors the signage while it is in use, only answering to inquiries directed at itself (see **Figure 3**).

Refer to the references[10), 11)] for more information on EMIEW. The merits of the signage are as follows.

It is operated by a touchscreen display, and can recognize speech through audio devices. The external design allows operation by wheelchair users. It offers multilingual support with voice recognition and screen displays in four languages: Japanese, English, Chinese, and Korean.

Users start using the signage by pushing buttons to activate voice recognition, after which it analyzes the content and intent (semantics) of their question to display frequently asked questions (FAQ) onscreen or search results such as train transfers or maps with data taken from external services. After several suggestions are given, users can view more detailed information via screen actions with maps or by selecting from options, etc. The search results can be sent to smartphones with QR codes*2, allowing users to view the results while moving.

Station and facility names can not only be identified from dialog with users, but also suggestions can be made in response to phrases such as "How do I get to Tokyo Station from here?" or "Tell me what sightseeing places are near here," just like talking with station staff or operators. The following subsections describe the semantic search functions and coordination with external services.

*2 QR code is a registered trademark of Denso Wave Inc.

3. 3
Signage Semantic Search Function Mechanism

The mechanism allowing the signage to respond based on user questions is based on internal search functions. The search function processing compares the user's query to find the nearest preset potential question and outputs an answer based on that.

The semantic search function in action here identifies the intention of the user's query from a preset dictionary. Next it searches preset potential questions based on the identified intention and question wording (see **Figure 4**). This system dispenses with the need to register different types of potential questions with varying wording like "Tell me the price of admission" or "How much does it cost to get in?" It also reduces the work needed to fine-tune and maintain the system.

Figure 3 — Overview of the Services
EMIEW encourages conversation when it senses users nearby, chatting and answering common questions about the station. It suggests use of the signage to find out information on train transfers or facilities around the station area. It continues to monitor speech while the signage is in use, answering questions it detects as directed toward itself.

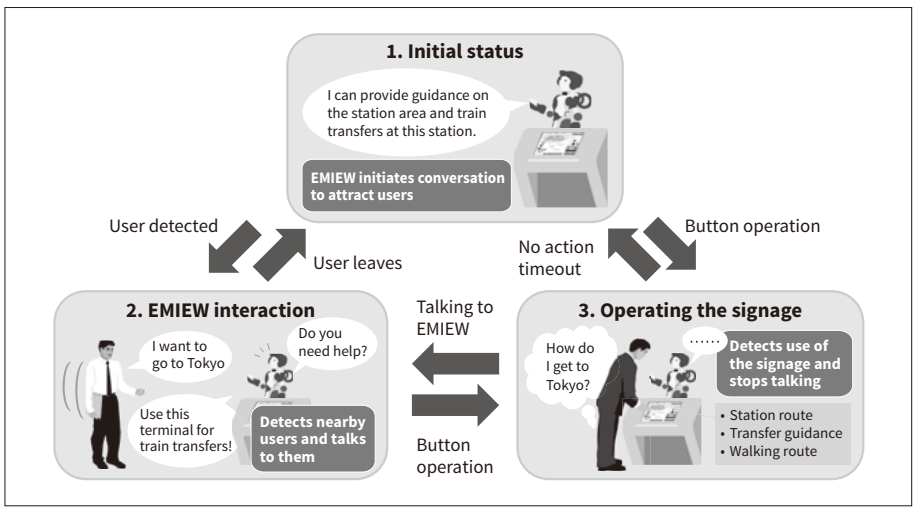
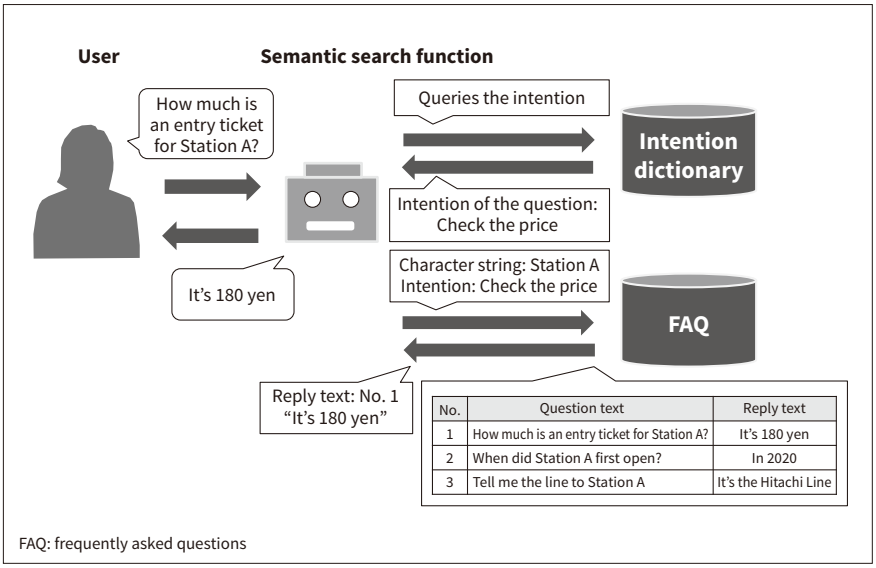


Figure 4 — Semantic Search Function Mechanism

User intention is identified from their questions using a preset dictionary. Preset potential questions (FAQ) are searched based on the intention and text of the query to find the reply text.



FAQ: frequently asked questions

3. 4
Coordination with External Services

The signage achieves coordination with three external services as follows (see **Figure 5**).

(1) Transportation route search service

(2) Outdoor map service

(3) Service availability information service

The signage links to external services to provide information on the area around Takanawa Gateway Station and its restaurants, or guidance for places users want to reach by train. Utilizing such external services is preferable to trying to solve everything by including all the station, facility, and category names that passengers might ask about in an FAQ, as that would require vast amounts of data to be registered and then kept up to date.

By coordinating with these three external services, the signage can guide users from the current location to where they want to go while also providing real-time information such as delays or suspensions of service.

Even more information will be provided in the future through additional external services, such as the actual location of trains, congestion in the station or trains, and seat reservations.

4. Potential for Rail Passenger Information Services

In future collaboration with JR-EAST, Hitachi hopes to see its solutions officially adopted at Takanawa Gateway Station and at other major stations in Tokyo, to realize a smart AI-based guidance system.

Hitachi intends to continue working on these smart navigation systems including the greater adoption of this solution. Providing information linked to various types of

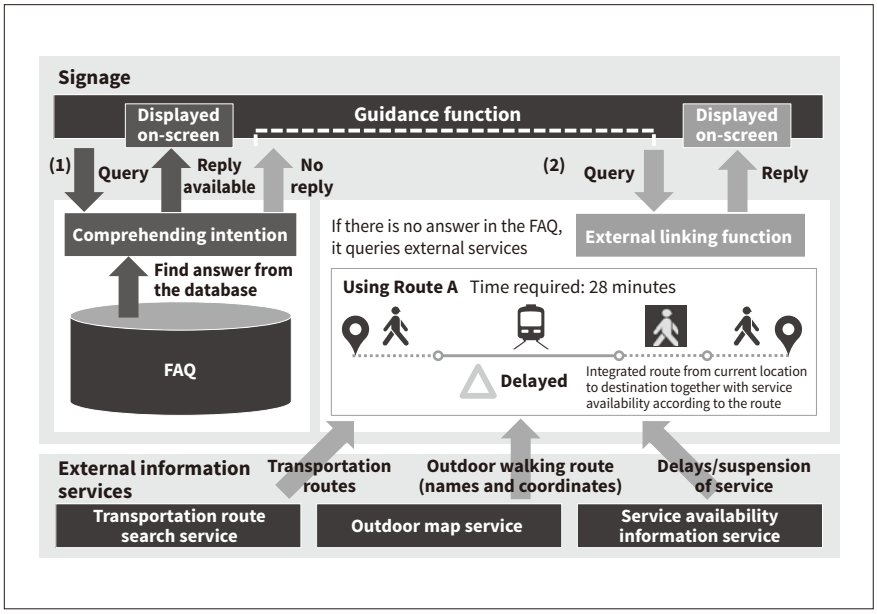


Figure 5 — Coordination with External Services

First the signage searches its FAQ. If no relevant answer is found, it connects to external services. This allows it to guide the user to their final destination, including routes from their current location to the platform, transfer guidance, and walking routes outdoors.

real-time data or dynamic guidance based on future forecasting of congestion or train locations will be necessary for Hitachi to achieve its future smart navigation systems: door-to-door navigation based on congestion and service availability, and personalized navigation based on individual status and preferences. Steps must also be taken to evaluate and measure the accuracy of and satisfaction with navigation results based on the information provided, and to gain user feedback for greater precision and sophistication of navigation.

Work must continue to resolve such challenges in collaboration with railway companies to eventually realize transportation guidance fully optimized for passengers and multiple companies.

5. Conclusions

This article described the trial adoption of AI-based guide robots and digital signage at Takanawa Gateway Station as an example of co-creation within the framework of JR-EAST's Mobility Innovation Consortium. Hitachi will continue to improve the quality of guidance services provided by railway companies while realizing seamless and stress-free travel for users.

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Authors

Hirokazu Hattori
Broadcast & Communication Solution Center, Transportation Information Systems Division, Social Infrastructure Information Systems Division, Hitachi, Ltd. *Current work and research:* Development of transportation information systems.

Ryo Shinoki
Transportation Systems Digital Solution Center, Transportation Information Systems Division, Social Infrastructure Information Systems Division, Hitachi, Ltd. *Current work and research:* Development of transportation information systems.

Fumihiko Inoda
Transportation Systems Digital Solution Center, Transportation Information Systems Division, Social Infrastructure Information Systems Division, Hitachi, Ltd. *Current work and research:* Development of transportation information systems.

Keisuke Hasegawa
Transportation Information Systems Division, Social Infrastructure Information Systems Division, Hitachi, Ltd. *Current work and research:* Development of transportation information systems.