Special edition paper

Research on Information Services at Stations






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Large-scale stations in the greater Tokyo area have complicated layouts. Users often get lost in such stations, so easy-to-understand information services are needed. Users of those stations are broad-ranging from commuters to travelers and foreign visitors as well, and diverse services are thus needed. In light of this situation, we have carried out research on improving information services in stations using information technology (IT). Specifically, we have developed a route information terminal with which users can search for route information and tourist spots in four languages and a touch panel information terminal that gives directions to locations inside and around the station. Effectiveness of these systems has been verified through field tests at stations. And with an aim of future improvement of information service, we have carried out research on in-station direction services using smartphones, on guidance using brochures and on an interface for the ATOS passenger information service terminal.

●Keywords: Information technology (IT), Service, Interface, Information design

1 Introduction

Information required by station users differs by individual. Such information includes that on locations inside and around the station and on railway routes. Currently, fixed guide signs provide every user with uniform information, but individualized information services are in demand as users' needs are increasingly becoming diversified.

In light of that, we have taken on improvement of information services utilizing information technology from the two perspectives of "information services to individual users" and "information service assistance for station personnel".

2 Research and Development of a Route Information Terminal

2.1 Background

The number of foreign visitors from China, Korea and other countries has been increasing each year since the start of the "Visit Japan Campaign" in 2003. As a railway operating company, JR East is facing a need to improve its information service for those travelers from abroad. At the same time, popularization of Suica IC tickets has created much unused space in the ticket vending machine area, which we should make more effective use of. We have thus developed a route information terminal with an aim of achieving appropriate guidance for foreign travelers and effectively using the unused space in the ticket vending machine area.

2.2 Development of the Route Information Terminal

We developed a route information terminal in 2007 for visitors from abroad and tested it at Tokyo and Akihabara stations. Four issues were discovered in the field tests: how to separated route information and tourist information, the need for browsable search results display, how to display a departure platform map and how to prevent paper jams. We solved those problems and developed a new route information terminal in 2008. Its features are as follows.

(1) Housing (Fig. 1)

- Can be installed in ticket vending machine area or made to stand alone
- Can be maintained from the front side (no need to enter the ticket vending machine room for maintenance)
- Does not need to be anchored (can be set with a plate to prevent falling over)
- Has a paper jam preventing function (in-terminal paper cutting function)

Fig. 1 Developed Route Information Terminal

(2) Route Information and Tourist Information (Fig. 2)

- Handles four languages (Japanese, English, Chinese, Korean)
- Can be set to provide information for use inside or outside the ticket gate (train information given priority in the ticketed area)
- Gives priority to display of Narita Express information
- Can display in-station maps (with departure platform information)
- Can display information on approx. 450 tourist spots across Japan (in four languages)
- Can print out search results and show ads

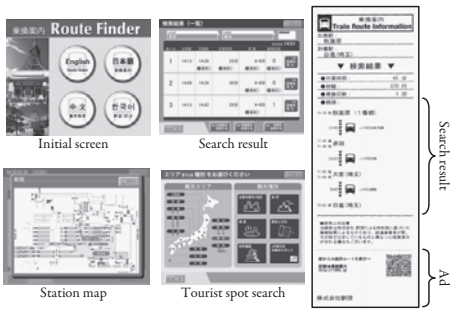

Fig. 2 Screen Interface and Output

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2.3 System Configuration

The system configuration is designed to prompt the route search server for results to searches from field terminals via the Internet (Fig. 3). If communications disruptions occur, the system reports that to the monitoring server. We also carried out tests using WiMAX as the communications method to verify feasibility of that method.

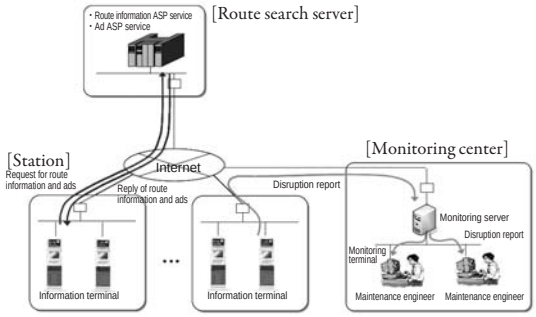

Fig. 3 System Configuration

2.4 Field Test Results

2.4.1 Results of Use at Akihabara Station

We installed the route information terminal at three locations (inside and outside the ticket gate, in the ticket vending machine area) in Akihabara Station of JR East in September 2008 to conduct the field tests. Table 1 shows usage of the terminals. Foreign languages were used approx. 40% of the time, and up to 570 route searches a day were made.

Table 1 Usage Results (for two months from Dec. 2008 to Jan. 2009)

	Route searches	Tourist spot searches
Average on holidays	456 times/day	142 times/day
Average on weekdays	302 times/day	95 times/day
Maximum usage	570 times/day, Dec. 6 (Sat.)	187 times/day, Dec. 31 (Wed.)
Language rate	Japanese 59% English 32% Chinese 6% Korean 3%	Japanese 55% English 26% Chinese 13% Korean 6%

(Numbers used are the total for the three terminals at Akihabara Station)

2.4.2 Interviews with Users

To quantitatively evaluate the developed route information terminal and verify its effectiveness, we interviewed users at the installed terminals in Akihabara Station for four days from December 11 (Thu.) to 14 (Sun.) 2008. A total of 223 people were interviewed, 106 of them being foreign visitors and 117 Japanese.

(1) Distinction from ticket vending machines

Table 2 shows responses to the question "when you saw this route information terminal, did you immediately understand it was not a ticket vending machine?" More than 80% of the respondents said they immediately understood it, with few people misidentifying it.

Table 2 Assessment on Distinction from Ticket Vending Machine

	Foreign visitor (n = 106)	Japanese (n = 117)
Distinguished at once	84.9%	89.7%
No opinion	11.3%	8.5%
Misidentified as a ticket vending machine	3.8%	1.7%

(2) Screen interface

Ease of use was given good scores overall, with 81% of the respondents replying they "could operate it smoothly". But individual analysis revealed that problems remained such as "speed to reach the required information" and "text readability" for Japanese users.

(3) Best places to install

Both Japanese and foreign users replied that "around the ticket vending machines" would be the best place for the terminal to be installed (Fig. 4). That was followed by "near the concourse just outside the ticket gate".

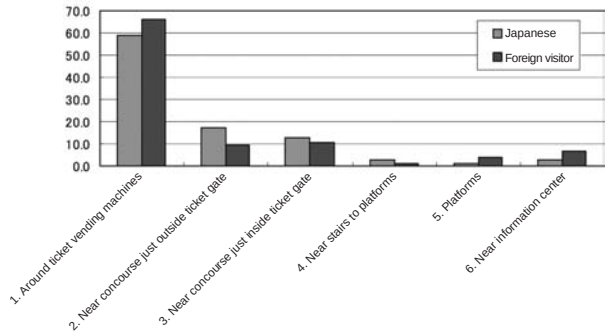

Fig. 4 Survey Results (requested place of installation)

2.4.3 Ad Access Result

The number of accesses using QR codes was 138 for the 17,792 printouts issued, meaning a 0.78% access rate to the websites. As the usual click rate of Internet ads is said to be 0.05 - 0.1%, we were able to confirm a certain level of advertising effectiveness.

2.5 Evaluation

The field test results verified that the route information terminal was effective as an information terminal for foreign users and as a measure to utilize vacant space in the ticket vending machine area. The appearance of the terminal has accepted well in terms of visibility, distinction from ticket vending machines and size. It was also well received in terms of ease of use for the touch panel. Analysis of the results showed different tendencies in information requested between Japanese and foreign users.

In actual deployment, it will be good to keep the present appearance and functions of the current terminal and to place the terminals around the ticket vending machine area. In actual use, we have to work out a method of reporting disruptions to station personnel.

3 Research and Development of a Touch Panel Information Terminal

3.1 Background

Easy-to-understand directions in and around the station are indispensable for station users. To meet the needs of the users, we have set up many guide signs, installed information counters and placed guidance personnel called "service managers".

Under the concept of integrating guide signs and information terminals, we have developed a touch panel information terminal that serves as a variable guide sign utilizing IT and a touch panel display. It is a direction information terminal that lets users find solutions themselves, offering in- and around-station guidance to meet individual needs of users in four languages. We tested the terminal at Shinagawa Station in 2007 and conducted field tests at Tokyo Station in 2008 on an improved version.

3.2 Development of a Touch Panel Information Terminal

3.2.1 Development of a Touch Panel Information Terminal for Shinagawa Station

We carried out field tests on the touch panel information terminal in Shinagawa Station from January to February 2008 (Fig. 5).

The developed product has the following four features.

- Initial screen displayed as a guide sign.
- Directions displayed by touching name of a facility on the screen
- Content displayed in order of frequency selected (learning function).
- Four-language support (in Japanese, English, Chinese and Korean).

Fig. 5 Touch Panel Information Terminal for Shinagawa Station

During field tests, the terminal was used approx. 500 times on weekdays and approx. 1,000 times on holidays. While information about the station was accessed most on weekdays, information on the facilities around the station, particularly on the amusement facilities, was often accessed on holidays.

Mechanical issues of the terminal found were...

- How to prepare installation standards for easy maintenance, and
- How to solve problems with the touch panel under direct sunlight.

The program-related issue found was...

- How to make updating content easier.

The problem with the touch panel was that it would freeze under direct sunlight because an infrared touch panel was used. After dealing with those issues, we developed an improved touch panel information terminal in 2008.

3.2.2 Development of Touch Panel Information Terminal for Tokyo Station

We developed an improved touch panel information terminal (Fig. 6) to deal with the issues found in the field test at Shinagawa Station and to finalize specs for actual deployment. In that development, we added the following features. The new terminal has undergone tests at Tokyo Station from August 2008 to January 2009.

(1) Improved mechanical structure
- Single unit terminal structure that keeps out dust
- Sunlight-resistant touch panel (adopted a dispersive signal touch (DST) panel)

(2) Improved interface
- Search function added (keyword search possible)
- Usability for those who cannot reach the upper part of the screen (operation by arrow keys)

(3) Added functions for actual deployment
- Constant status monitoring by remote monitoring function
- Ad display function (added ad area to initial screen)
- Authoring tool for easier content change

Fig. 6 Touch Panel Information Terminal for Tokyo Station

3.2.3 Authoring Tool

In the field test at Shinagawa Station, difficulty of updating content was found to be an issue. A system to easily maintain display content was also needed at Tokyo station because the layout of Tokyo Station changes day-by-day due to construction and opening of new shops.

The authoring tool we developed is the solution to that issue. As shown in Fig. 7, it can revise the display in the map by individual item. In that way, we built a system to allow content to be maintained without special training. In the field tests at Tokyo Station, we set up the authoring tool in the service manager's room and the service managers updated the content.

Fig. 7 Authoring Tool

3.3 System Configuration

Taking the network configuration in actual deployment into consideration, we introduced a system configuration consisting of a central server, a station server and local terminals (Fig. 8). That enables centralized administration of content.

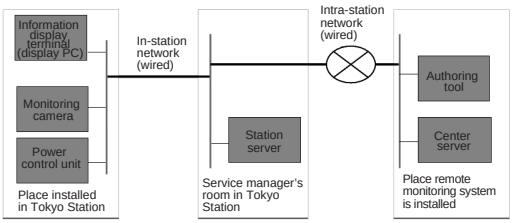

Fig. 8 System Configuration (2008)

The WiMAX high-capacity communications service was launched in 2009, so we changed the system configuration to use WiMAX. Tests were performed on feasibility of use as the communications service method (Fig. 9).

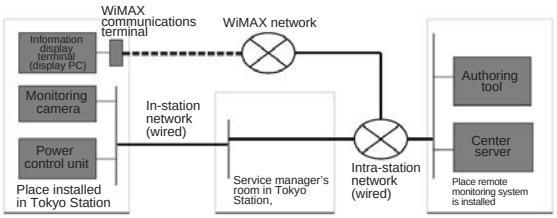

Fig. 9 System Configuration (2009, via WiMAX)

3.4 Field Test Results

In August 2008, we installed improved touch panel information terminals at the central corridor (inside the ticket gate) and at the Yaesu North entrance (outside of the ticket gate) of Tokyo Station and carried out field tests on them (Fig. 10).

Fig. 10 Touch Panel Information Terminal
(at central corridor of Tokyo Station)

Table 3 shows a summary of results of use from August 2008 to January 2009. Looking at the numbers of users on weekdays and holidays, we see that more people used the terminals on holidays. The results mirror the trend seen at Shinagawa Station. That means that many people unfamiliar with the layout of Tokyo Station visit on holidays and require guidance services. Maximum usage in one day was 870 times a day at the central corridor on December 29 during year-end holidays.

Table 3 Usage Results (Aug. 2008 to Jan. 2009)

	Central corridor	Yaesu North entrance
Average on holidays	633 times/day	472 times/day
Average on weekdays	372 times/day	258 times/day
Maximum usage	870 times/day	680 times/day
	Dec. 29 (Mon.)	Dec. 29 (Mon.)

The use ratio of languages used was 90% in Japanese, 6% in English, 2% in Chinese and 2% in Korean. Use in Japanese accounted for an overwhelming majority, even though the terminal was designed to display in four languages. One of the reasons for the large ratio of Japanese users could be that not many people knew it operated in foreign languages because the initial screen was used as a guide sign in Japanese. Another could be that even a large number of Japanese users need in- and around-station information.

The content selected most in the filed test was, at the Yaesu North entrance, restrooms, Kurobei-Yokocho (nearby restaurant area) and Shinkansen entrances. Route maps, Shinkansen entrances and automatic lockers were selected most at the central corridor. A tendency was found where facilities not shown in fixed guide signs was often searched for both in Japanese and foreign languages.

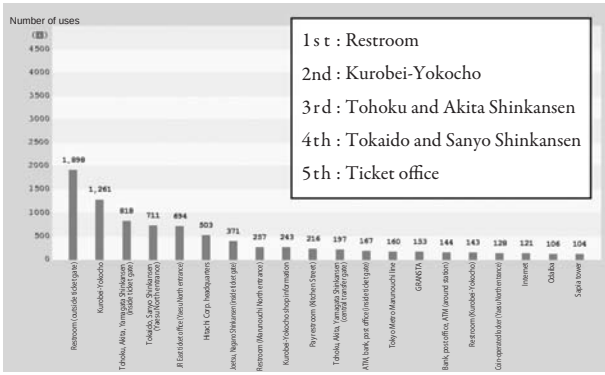

Fig. 11 Content Frequently Used (at Yaesu North entrance)

3.5 Evaluation

(1) Interface

The interface of the touch panel information terminals developed with a focus on ease of operation and understanding was viewed favorably by users. We thus believe that this interface should be adhered to in actual deployment.

(2) Mechanical Structure

The DST panel display is resistant against dust and direct sunlight in the station, with field tests proving its effectiveness against those elements. And using WiMAX as the network will reduce communications-related installation costs compared with the initially proposed network configuration that involved laying optical communication cables.

(3) Actual Deployment

Total cost reduction and establishing a content maintenance system are issues that need to be overcome for actual deployment.

4 Research on Station Guidance Using Smartphones

4.1 Background

Large-scale stations such as Tokyo and Shinjuku Stations have complicated layouts. Many passengers get lost in them, so personalized guidance to destinations is needed. But it is difficult to identify one's actual location in stations because GPS devices and compasses often lose functionality there.

Use of high-performance smartphones, however, has become widespread. Utilizing their state-of-the-art technologies such as image recognition technology and augmented reality (AR) technology, direction information can be sent to personal mobile terminals.

In light of the situation, we have developed and verified in this research a station guidance system using smartphones and image recognition technology. Image recognition was tested for existing guide signs and newly developed floor markers.

4.2 Research on Station Guidance Using Image Recognition of Guide Signs

We carried out research on finding one's location by image recognition of existing guide signs in the station. In the research, we developed a system to find locations whereby the user sends to the server a photo taken with a mobile phone with a camera function (smartphone) for image analysis to find the location. Model guide signs were set up in the laboratory building of the Research and Development Center, and we tested the rate of recognizing those (Fig. 12). Using OpenCV as the algorithm, positions were calculated based on contrast, color and height information unique to the individual guide signs.

Fig. 12 Image Recognition Test with Guide Signs

The screen interface used was simple. With this interface, the user could send images taken with the camera by touching the image (Fig. 13 left) and have his or her current location displayed on a map (Fig. 13 right).

Fig. 13 Interface of Guide Sign Image Recognition System

The results of the recognition rate test were 67% correct recognition, 7% incorrect recognition and 25% no recognition. We thus could not obtain a recognition rate that was sufficient to practical use.

In light of the test results, we carried out further tests to improve the recognition rate by improving the algorithm and the interface in the Smart Station laboratory building as a research project in FY 2010.

This system might make incorrect recognition when there are more than one of the same guide signs, so we need to combine it with other positioning technologies such as Wi-Fi positioning. However, we studied the following for positioning with recognition markers.

4.3 Research on Station Guidance Using Image Recognition of Floor Markers

Many guide signs in stations are located on the walls or overhead; however, floor signs may be more suitable for the elderly. Furthermore, there are few signs showing compass directions in stations. We thus developed floor markers with a recognition ID and a compass direction mark and tested those in the Smart Station laboratory building. For the recognition rate test, two markers with a recognition ID and a compass direction mark and a picture marker (for markerless AR) were drawn on the floor as shown in Fig. 14.

Fig. 14 Floor Markers (three patterns)

AR technology was used for the display application. As shown in Fig. 15, the tags of the facilities in the station are displayed by recording the marker with the camera, and detailed information is shown by touching a tag.

[System in use] [Display using AR] [Detailed information on tag]

Fig. 15 Station Space Directions Using AR Technology

All three types of markers recorded almost 100% recognition rates in any direction within 1.5 - 2.0m from the center of the marker. Future issues to be covered are deciding the method installing markers and how to achieve an easy-to-follow interface.

4.4 Evaluation

The greatest advantage of the image recognition system is that it uses existing guide signs, needing no additional equipment in

stations. Still it has problems in the recognition rate and incorrect recognition when the same signs exist.

The system using floor markers needs new floor signs installed in stations. But at the same time, it could allow new services using ID to be deployed once the markers are set. We are thus going to study the service most appropriate from the viewpoint of users in tests in actual stations.

5 Research on Guidance Using Brochures

5.1 Background

Public spaces and commercial facilities have traditionally used paper brochures and floor maps as the information media users can carry around. Navigation via mobile phones and other personal information terminals also has become common in recent years. Paper media is limited in capacity of information it can provide and is ill-suited for timely provision of information. On the other hand, the number of persons employing personal information terminals is limited due to factors such as level of information literacy and adoption of applications for navigation. We thus developed the "Kamishirube" (name coined from "paper" and "guidepost" in Japanese) information service system. It achieves interaction with digital information displayed on the floor using a paper brochure and can be used by anyone.

5.2 System Overview

Fig. 16 illustrates the configuration of the Kamishirube system. When a user holds a brochure up in a specified area, the system recognizes the brochure with an infrared camera installed overhead. Information related to an item the user points to on the brochure is displayed on the floor via projector A above.

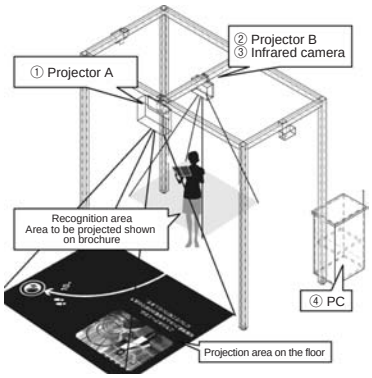

Fig. 16 Kamishirube System Configuration

To allow the system to recognize items on the brochure with a camera, a marker with a thick square frame and a pictogram inside is allocated to each item (Fig. 17). The system recognizes the markers according to image information obtained (AR Tool Kit is used as the marker recognition engine). It identifies the marker hidden with user's finger as an item on which additional information is requested and displays the information on the floor. We have paid attention to intuitive understandability too. Projector B of the system focuses spotlights on markers the user can select at the current location so the user can intuitively know that information can be obtained by pointing to them with a finger.

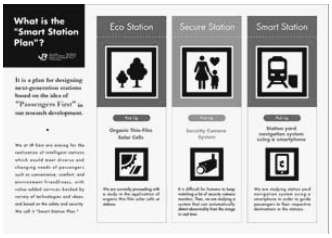

Fig. 17 Brochure Design Image

Information is displayed on the floor because that would be the best way to give easy-to-follow guidance on destinations such as those inside the station. We designed two types of content this time assuming navigation in a station (Fig. 18). One guides to a destination with an arrow if the user's destination is clear, and the other directs to possible destinations in a map if the user's destination cannot be vague.

Fig. 18 Design of Content Displayed on Floor (Arrow and map display)

We also prepared brochures in Japanese and English and gave the system the ability to distinguish the language with a camera. By holding the English brochure, the system displays information on the floor in English.

5.3 Proving Tests

We had 134 persons test Kamishirube in the Smart Station laboratory building and then answer a questionnaire. The questionnaire had questions on ease of use, and the test subjects rated them on a five-point scale. The numbers of the test subjects who responded in the two most positive levels on each question are as shown in Table 4, proving good results.

Table 4 Number of Subjects who Replied that Ease of Use is "Good"

Content of question	Number of persons	Ratio
Understandability of operation	122	91%
Usability of paper brochure	102	76%
Understandability of display on the floor	111	82%

(Number of subjects: 134)

5.4 Evaluation

While the response of the test subjects was largely positive, the tests clarified some problems to be solved. Those include need of improvement of operation response, limited space in which to

install the system and difficulty of use at peak times because information is shown on the floor. We will continue testing the system in the Smart Station laboratory building to find improvement measures.

6 Research on Interface for Passenger Information Service Terminal

6.1 Background

More than ten years has passed since the introduction of ATOS (Autonomous decentralized Transport Operation control System) that plays an important role in transport management in the greater Tokyo area. We are now studying new functions to add to ATOS when currently used equipment is upgraded. In order to meet the information needs of increasingly diverse passengers, the new ATOS should have improved functions in for providing information. At the same time, a limited number of station personnel can operate the terminals to provide information from ATOS due to poor usability. Since operation is difficult, ATOS information is not being used appropriately in information services for customers. This issue must be overcome.

Under those circumstances, we have drawn up a concept of an interface for easier-to-understand screen design and improved operation flow of station terminals. We hope improved usability of the terminals operated by the station personnel will to lead to customer-friendly information services. The final objective of this research is to make proposals on future ATOS functions.

6.2 Overview of Passenger Information Service Terminal

In the area covered by ATOS, information services for passengers (including transport disruption information, flash news information and information related to specific trains) are performed by passenger information service control units. Those units control automatic announcements and train departure displays based on train schedule and train operation information from ATOS. Using passenger information service terminals connected to the control unit, station personnel can edit information provided to passengers, change where information is sent and otherwise set information according to the actual needs of each station. Fig. 19 shows the scope of the research this time.

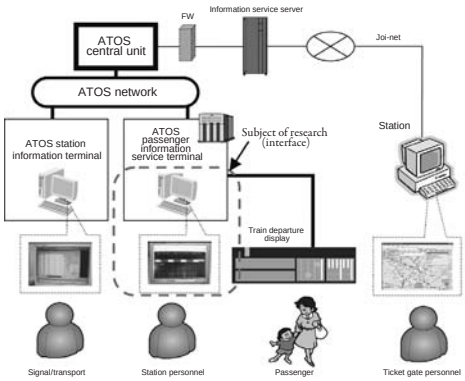

Fig. 19 Scope of Research

6.3 Design of Concepts for Interface of Passenger Information Service Terminals

Based on a survey on how the station personnel currently use passenger information service terminals, we have extracted problems and drawn up concepts of what is needed in the interface for new passenger information service terminals.

6.3.1 Extracting Current Problems

We interviewed six staff members of large stations in the greater Tokyo area to find problems in usability of the customer information service terminals. The following are typical comments of the station personnel regarding the system in individual situations.

1. When viewing train operation status
   - Operation status screen is small and hard to read.
   - Finding required information on the screen is difficult.
   - Update of displayed information is sometimes delayed.
2. When preparing information to display to passengers
   - How information will look cannot be checked before displaying it.
   - Displays need to be prepared in advance for use in urgent situations.
   - Descriptions of functions are not easy to understand.
3. When displaying information
   - Difficulty of operation limits who can operate the terminals.
   - Operation is not efficient.

Fig. 20 Current Interface of Passenger Information Service Terminal

6.3.2 Concepts for Interface of Passenger Information Service Terminals

Based on the analysis result of the hearing from the station personnel, we have summarized as follows concepts for the interface required for passenger information service terminals.

Concept 1: Improvement as an operation management terminal

The passenger information service terminal was originally intended to be a terminal to set information for departing train displays and automatic announcements. But, the survey result revealed that it is often used in offices of small- and medium-sized stations as a terminal to check real-time train operation status information from ATOS. In this research, we thus emphasized use as a train operation information display terminal and investigated requirements on an interface design for showing train operation information.

Concept 2: Any staff member can set as needed

The survey clarified that settings for information display are not being made appropriately at some stations. Reasons those settings are not being made include the station personnel not knowing exactly what can be done with the passenger information service terminal or how to operate it.

Thus, in this research, put together requirements for the interface that allow even ordinary station personnel to set the minimum required display information in cases such as abnormal train operation. As display settings are not often changed, we made a prototype design that allows effective operation when needed.

6.4 Development of Interface for Passenger Information Service Terminal

The following five items are the improvement requests found by interviewing station personnel and the functions added to the interface to achieve them.

① Easy check of train operation status
→ Information displayed in colors according to level of importance, and operation status displayed enlarged when the terminal is not being operated

② Ability to check how information will look before displaying to passengers
→ Added check function using a preview mode

③ Easy-to-follow description of functions
→ Added extra function descriptions

④ Ease of use even by ordinary station personnel
→ Designed according to common rules used in PC applications

⑤ Efficient operation
→ Use of templates and history of past settings

Fig. 21 Sample Operation Screen of Passenger Information Service Terminal

6.5 Assessment

6.5.1 Assessment Method

Six employees of JR East and two designers assessed the developed interface for passenger information service terminals by a cognitive walkthrough method*. Specifically, they assessed from the viewpoint of users through the following four steps for every process of tasks to be done.

(i) Target setting: Set what is to be done at the current step.
(ii) Searching: Search what operation to do with the interface at hand.
(iii) Selection: In order to carry out the task at hand, select and execute the most appropriate operation with the interface at hand.
(iv) Assessment: Interpret feedback from the system and evaluate if the task at hand is progressing correctly.

*Cognitive walkthrough method
A method to extract problems whereby assessors suppose the behavior of the user in the flow of operation steps to carry out tasks assumed in the use of the product.

6.5.2 Assessment Results

We assessed the structure of each screen and the screen transition and summarized requirements of the interface to improve the current problems pointed out in 6.3.1. Based on those, we made a prototype design of the passenger information service terminal that was well received as being very usable. However, we did find the following points that could be improved on for better usability.

① More intuitive operation
More intuitive operation should be allowed by adding functions to make information currently being provided visible on the terminal and by allowing a preview of the whole train departure display.

② Avoiding human errors
We aimed to avoid human errors by making operation intuitive, but a need for further error check by the system was suggested.

6.6 Evaluation

We were able to confirm that the prototype design can overcome the usability problems of current passenger information service terminals. The prototype interface can also be operated more intuitively.

On the other hand, the assessment revealed points to be improved on in terms of convenience and prevention of human errors. We determined the target user employees in this development based on their IT literacy and frequency of using the passenger information service terminal, so we have to repeat the usability assessment by station personnel who will use the terminals to actually improve on those points.

7 Conclusion

We have taken two approaches in this research and development to allow easy and reliable use of railway infrastructure by passengers. Those approaches are information services for passengers and assistance to station personnel using IT.

Needs of passengers are becoming increasingly diverse particularly in the area of information services for passengers. We have thus focused on individualized information services in R&D for ways of distributing information and for the content distributed. We will continue to work on R&D with an aim of achieving easy-to-use and reliable stations while keeping up with customer needs and technical trends.