The Frontier Service Research Laboratory was established in 2001 at the launch of the Research and Development Center of JR East Group in order to enhance the R&D structure of JR East. Our mission up to now has been to perform R&D to create new services and to provide service infrastructure. And our members with diverse backgrounds have been working on R&D in a wide range of fields under the concept of “creating value, amenity, and spaces”.

Priority has been placed especially on R&D related to providing information to customers using ICT and related to civil engineering technologies. Case examples of past R&D include initial-stage R&D on the “JR East App” that allows train operation status to be viewed by smartphone and platform gates introduced in places such as the Yamanote Line. This article introduces the current and future direction of R&D at the laboratory.

2. The Digital Revolution and Increased Customer Expectations

Technologies are advancing rapidly, especially in the areas of the Internet and smartphones as well as AI, big data, and IoT, with those bringing added convenience, so I myself as an ordinary consumer frequently feel the convenience of those. For example, social network services (SNS) that let one connect with family, friends, and coworkers regardless of place or time, an Internet web environment that allows one look up information on unfamiliar topics, online shopping that lets goods to be delivered a day or two after ordering, digital books that can be read whenever one feels the urge to read them regardless of place or time, car sharing where cars can be used without needing to own one, and other services that were unimaginable 10 or 20 years ago are appearing one after another and rapidly caching on.

There seem to be common elements from a user standpoint when examining the background to such services and the reasons for their success. Those elements are that even better services can be obtained at lower cost, that effort required for communication, shopping, and the like is greatly reduced, and that savings in time—what is most important to users—can be achieved.

Users can no longer be satisfied with services they previously used once they become accustomed to services with greater convenience. So, businesses and products that fail to improve service levels probably lose customers and decline.

Looking at JR East’s railway business from the same perspective, we see that we have not yet met users’ heightening expectations in saving effort and time. We must not forget that there are often short or even long delays in train operation during commute hours, taking away the resource of “time” that is most precious to customers. And we must not overlook the risk that customers may rapidly move away from using railways when an option with better convenience and lower cost than railways comes about. Particularly in the area of automation for cars, global competition in development means that it may be only a matter of time before full automation is achieved. Before door-to-door fully automated driving is achieved for automobiles, we have to make further efforts to advance railways.
Of course, it is difficult to eliminate disruptions to train operation caused by external factors such as natural disasters, incidents at level crossing, and the like. Even so, at the current level of ICT technology, it is quite feasible to provide customers with the information that they demand in a timely manner, such as estimated recovery time when delays occur in train operation. Past surveys have shown that customers have a high level of expectation regarding this matter.

At our laboratory, we work to achieve deep understanding of the information that customers want in order to provide information that matches their needs in a timely manner. Specific efforts include development of a server that accumulates and integrates JR East App data and external data. That consolidates map data and internal data such as that from ATOS, COSMOS, and onboard weight sensors, which is used in various guidance content such as operation information, departure board information, train location information, and station guidance. By incorporating those into the smartphone JR East App and an SNS app (currently being tested), it will be possible to provide higher quality information than ever before. In fiscal 2017, we set up guidance signage in Tokyo and Kunitachi stations and are conducting field tests to verify impressions and usability. And by incorporating external traffic data and route search functions, we will study how to provide information for future door-to-door services.

Fig. 1 Left: JR East Chatbot, Right: Guidance Signage (Tokyo Station)

3. Improving Quality of Services in an Aging Society with Lower Birthrates

Japan will see further decreases in birthrates and aging of the population in the years to come, bringing about a decrease in the working age population. That is expected to affect the areas of both demand and supply.

In the area of demand, Japan is making concerted efforts to attract customers from abroad to make up for the decrease in domestic demand, with record numbers of inbound tourists seen in 2017. With the 2020 Tokyo Olympic and Paralympic Games coming up, customers from abroad are expected in increase even more, and efforts such as multilingual services using ICT will be needed.

The Frontier Service Research Laboratory is currently working on a system to deliver in-car announcements in text format. We face an issue in that passengers with hearing disabilities and passengers visiting from abroad cannot hear or understand in-car announcements made audibly in Japanese. We are thus developing a mechanism to deliver to passengers’ smartphones in-car announcement information converted to Japanese and foreign language text. Specifically, we are building a mechanism whereby, when crew members speak announcements into an onboard microphone, an audio input connection device performs voice recognition and displays multiple choices for the text to deliver that are assumed to be close to the in-car announcement, and the crew makes a selection to send text data in Japanese, English, Spanish, etc. to the smartphones of passengers onboard the train. We completed field tests for that in fiscal 2017.

Also, we have received feedback that it is difficult for customers in wheelchairs to touch the reader part of Suica IC ticket gates, so we are studying whether that issue can be solved by ticket gate design. We proposed a housing where the reader and display parts can be touched/seen from both above and the side by placing them at an angle instead of the upward as they are currently oriented. Modifications are being made for the housing where just the top part of the existing ticket gate is replaced, enabling both functionality and cost to be achieved and making so replacement of old equipment can be handled flexibly.

Fig. 2 Automatic Ticket Gate Easy to Use from Wheelchairs (Center)
As a measure for future ticketless operations, we are conducting R&D on non-contact gates that utilize millimeter waves. Millimeter waves are highly directional electromagnetic waves, and by performing fare examination within the width of automatic ticket gates, it is possible to perform communications with just the customers passing through those gates. Millimeter waves also have characteristics in that they enable exchange of much information in a short period of time. Communications with a millimeter wave transceiver built in to a smartphone will enable non-contact operation. We are also studying informing users via smartphone of the track number for the train and the location of the seat they reserved and displaying related sightseeing information and the like.

We plan to continue to work on R&D on both physical and applicational aspects with a goal of being a railway that can be used easily by anyone.

4. Dealing with Lack of Human Resources

The business resource of human resources is becoming even more scarce and high priced with decreasing birthrates and aging of the population. There have thus been strong demands for duties performed by humans up to now to be gradually replaced where possible with those by AI, robots, and the like and for humans to be shifted to tasks with high added value.

Our laboratory thus worked to improve quality of call center response by using AI. The JR East call center takes calls for a wide range of inquires about the railway, and we face an issue in improving response rate and securing operators. Operators require a broad range of knowledge and their training takes much time, so we worked on utilizing AI to reduce that burden. We developed a mechanism in which questions in customers’ calls are converted to text in real time by voice recognition technology and AI displays answers with high relation to that content on operator terminal screens. We put that into practical use in fiscal 2017. And in an effort to reduce the number of inquiries, we are proceeding with development for automated response to customer inquires without the need of human intervention by utilizing a chatbot program.

Meanwhile, we are also developing robots capable of moving autonomously in station spaces in order to deal with the labor shortage in such locations. A prominent characteristic of station spaces not seen in other spaces is the spontaneous occurrence of large passenger flows. R&D is underway with an objective of robots being able to avoid impeding that flow or moving with the flow. Functions and performance of the robots alone are insufficient for that, so we are aiming to achieve a high level of autonomous movement by setting up sensors to identify the situation in the station, integrating information in a “Cloud Station” and delivering that information to the robots.
5. R&D Supporting Shinkansen and Other Wayside Infrastructure

Since the inception of the Frontier Service Research Laboratory, we have been constantly working on civil engineering structure R&D such as that for concrete. We have been utilizing our own testing facilities to actively develop new construction methods, and we have obtained multiple patents for those. We are working in close cooperation with the Railway Technical Research Institute and others on R&D for noise countermeasures and micro-pressure wave countermeasures for wayside infrastructure in order to enable Shinkansen commercial operation at 360 km/h.

We also need to put priority on R&D in efficient maintenance methods for tunnels, viaducts, and the like ahead of large-scale renovation with future aging and deterioration of Shinkansen infrastructure. So, we are actively proceeding with that R&D, including public solicitation of outstanding construction methods.

6. Conclusion

The Frontier Service Research Laboratory has worked on a variety of R&D themes with the cooperation of outside partners in order to contribute to improved service at JR East. Into the future, we intend to further collaborate with external entities to create new value, actively gathering information from and disseminating information to entities outside the company.

And as it is extremely important for us as a company laboratory to put the results of R&D into practical use, we intend to achieve closer communication with other departments in JR East in order to implement in a timely manner R&D that meets the company’s needs and thereby contribute to overcoming issues faced by the company.

Moreover, we have been cooperating with German national railway Deutsche Bahn AG for the past 25 years in a number of areas, making efforts to learn areas the other party excels in with each other’s technical levels and service levels as benchmarks. We would like to further advance our cooperative relation into the future.

In our Mid-to-Long term Vision for Technological Innovation (JR-EAST Innovation Vision) announced in 2016, we aim to achieve a “revolution in mobility” through IoT, big data, AI and the like, touting promotion of further open innovation in the four fields of “Safety and Security”, “Service and Marketing”, “Operation and Maintenance”, and “Energy and Environment”. By actively collaborating with internal and external partners even more than before, we aim to provide customers with the values of “Now, Here, Me” personalized service.