A New Passenger Support System for Public Transport Using Mobile Database Access

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Abstract

We have been developing a mobile passenger support system for public transport. Passengers can make their travel plans and purchase necessary tickets by accessing databases via the system. After starting the travel, a mobile terminal checks the travel schedule of its user by accessing several databases and gathering various kinds of information. In this application field, many kinds of data must be handled. Examples of such data are route information, fare information, area map, station map, planned operation schedule, real-time operation schedule, vehicle facilities and so on. Depending on the user's situation, different information should be supplied and personalized. In this paper, we propose a new mechanism to support passengers using the multi-channel data communication environments. On the other hand, transport systems can gather information about situations and demands of users and modify their services offered for the users. We also describe a prototype system developed for visually handicapped passengers and the results of tests in an actual railway station.

1 Introduction

The mobile computing technologies are rapidly growing and spreading their application field [1, 2, 3]. Especially supporting human activities in the outdoor environment is one of the principal applications of mobile computing. As the public transport systems have very important roles for the outdoor human activities especially in the cities, it is indispensable for the mobile computer systems to have functions supporting the utilization of the public transport systems for the users. We have been developing a new mobile passenger support system for utilizing the public transports such as railways or bus transports[8, 9]. To realize this type of system, various kinds of data must be handled and integrated. Examples of such data are route information, fare information, area map, station map, planned operation schedule, real-time operation schedule, vehicle facilities, congestion information etc. Some of them are dynamically changing according to the actual activities of the transport systems. Moreover depending on the user situation such as destination, current location, current time etc., different information should be supplied. So personalized user interface for handicapped and old people is especially required.

The support process of the system is as follows. At first, the user of the system makes a travel plan by accessing central database using mobile terminal. The center system offers several plans that satisfy the requirements of the user. The user selects a plan and reserves tickets if necessary. After starting the travel, the mobile terminal accesses the central database or local databases and gathers various kinds of information and checks the schedule of the travel plan. The user can go on the travel according to the appropriate guide messages offered by the mobile terminal. In the outdoor field, there are two kinds of data sources, fixed and moving. The data of the local databases are offered by two kinds of data sources, which are fixed data sources and moving data sources such as trains and buses. The data from the moving sources are temporarily supplied. Although most of user requests are processed by means of integrating broadcast type data, on-demand process should be also required.

The system must be used in the case of emergency

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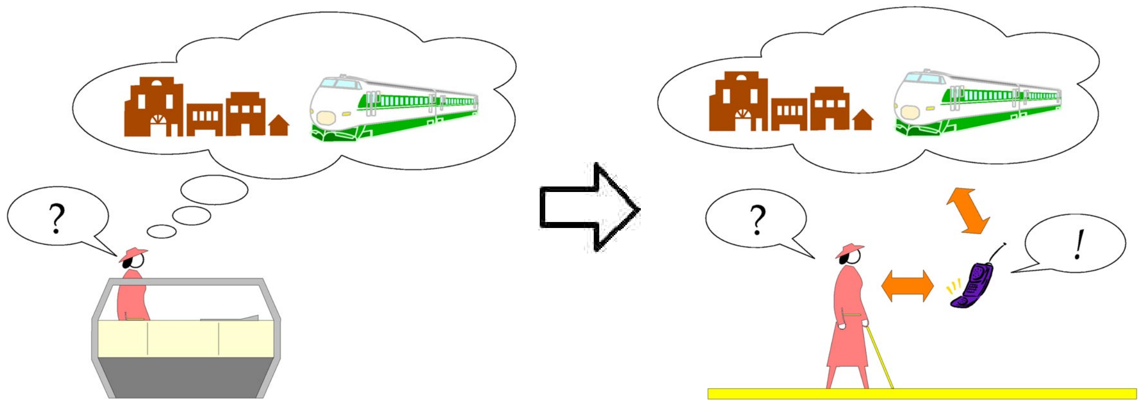

Figure 1: Current user situation and new user situation

when the system load is expected to be very high. Because of this condition we will not use a centralized system. Various kinds of data are transmitted to mobile terminals. Integration, personalization and filtering are performed at each mobile terminal. In this paper we will discuss efficient methods to handle dynamic integration, personalization and filtering using multiple data dissemination channels and on-demand data channels. Current prototype system to be used by visually handicapped passengers is also shown.

2 Requirements

One of the important applications of the very large databases is to support the activities of people moving outdoor environments[4]. In outdoor fields, people can access many data sources such as web sites and get useful information from the digital world. And the users can begin the next activities using that information. In case that the user goes around the cities , he/she may utilize some public transport facilities. Actually in the central areas of large cities, public transport systems execute very important roles. For supporting the users of mobile information systems and related databases, handling the information concerning with the public transport systems is indispensable. When a user enters a control area of a public transport service, such as a railway station, the user should be able to get guide information about the railway utilization. The information is filtered, personalized and integrated according to the personal situations of the user, such as the location, favorite things and physical conditions.

On the other hand, the public transport systems should get useful information about passengers using mobile communications, such as numbers of the passengers, their destinations, future plans etc. The services of the transport can be changed according to the real-time demands. This scheme is not possible by the current operation systems of public transports. Acquiring the real-time demands of the passengers is difficult. The bi-directional relation between passengers and systems is a very important research theme. If the transport systems have abilities to change their services according to the demands, the system can offer more convenient environments for the passengers. Using the proposed passenger support system, the information from the passengers can be gathered and offered to the public transport systems. Although services may be adaptively changed according to the demands, the public transport systems are not able to offer an individual service for each user because they are 'public'. It is impossible to satisfy all the passengers perfectly, because the services have tendency to answer to the average requests. So it is very important to inform passengers of current conditions of services and offer personal guide messages, such as "what to do next", "how to do that" and "where to go next" to satisfy his/her own demand. One of the objectives of our research is to realize such services.

3 Solutions

To utilize the public transport, a passenger needs various kinds of information. They must know transport service networks and what kinds of services are offered. Additionally there are many kinds of information to be known as mentioned in the previous section. The passenger must gather necessary information and decide their next actions. The left side of Fig. 1 shows this situation.

Suppose you are the passenger and you have an attendant. When you would like to go somewhere, you will tell the attendant the destination of the travel. The attendant will consult timetables and ask railway operators about the information of the congestions and reservations, and finally propose you several travel plans. You will choose one of the plans, considering your preference, budget, etc. The attendant will make necessary arrangements for the travel. In the morning of the travel, the attendant will come to your house to pick you up. Transport modes that will be used on the day would be public transport fundamentally. As the attendant knows the current condition of the transport, you will be required to follow what the

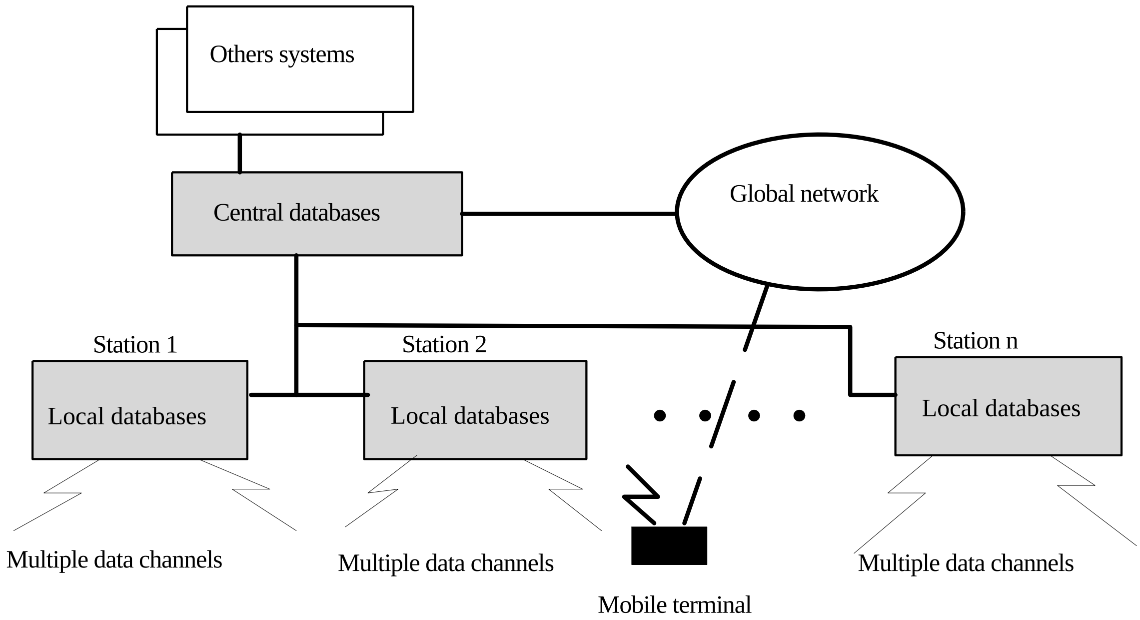

Figure 2: System configuration

attendant says, even if there are some changes from the original plan. The attendant could explain sights to see when you are lonely or remain silent when you are sleepy. Even if you miss the targeted train, you don't have to run in the station to get the next train reservation. The attendant already arranged or is arranging a new plan. You can change your travel plan anytime, just by telling the attendant what you would like. If you would like to drop in at a shop or a restaurant, the attendant will give you enough information. You don't have to think about the fare calculation even if you changed your travel plan. The fare would be minimum as if you know what you had done beforehand. If some of your relatives would like to know where you are, the attendant could inform him/her of your position if you allow the attendant to do so, this would be very convenient service to guardians. If you really could have this attendant free of charge or reasonable cost, you would not be bothered by travels using public transport? We think that we could realize this business model using information technologies and this model will give passengers and public transport operators much benefits. If we could realize this mechanism, the attendants would do the current jobs being done at a station. Therefore, conventional station functions are no more necessary. The new functions of a station will be a contact point between a cyber space and a real space, such as in electronic commerce. This indicates the changes of business model of public transport.

Our solution is to develop a personalized support system using a mobile terminal working as the attendant mentioned above. The mobile terminal should have functions to collect information, make travel plans according to the user's requests, purchase necessary tickets and guide the passenger on the all the way of the travel. Although on-demand communications are suitable for making plans, broadcast communications are necessary for real-time guiding in service fields. The reason is that there are a vast number of passengers in the same area and the system must be used even in the case of emergency when the system load is expected to be very high. So we have adopted the decentralized system in which the mobile terminals act a main role for supporting passengers. In this environment a user can ask a question to the mobile terminal at any time and any place, and he/she can get an appropriate answer from the mobile terminal. The right side of Fig. 1 shows this new situation.

Integration, personalization and filtering are performed at each mobile terminal. Depending on the user situation such as destination, current location, time etc., different data should be supplied and personalized user interface for handicapped and old people is especially required. Although most of user requests are processed by means of integrating disseminated data, on-demand process should be required for purchasing tickets on site or other transaction based requests. It is necessary to provide multiple communication channels, some for data dissemination and others for on-demand processing.

4 System configuration

The basic system configuration of the proposed passenger support system is shown in Fig. 2. There are basically three components in the system, namely central databases, local databases and mobile terminals of users. The mobile terminals can communicate by both on-demand mode (mainly with the central server) and broadcast mode (mainly with local servers and moving data sources).

4.1 Databases

4.1.1 Central databases

A passenger can communicate with the central server directly using on-demand channel including Internet. The central server has its own databases containing information about the transport services such as transport network, fares, station map, operation schedules etc. The central server is connected to other systems such as seat reservation system for supporting passengers in several aspects. Generally the information given by the central server is not so detailed, but of enough level to make travel plans. The detailed information can be given in service fields such as railway stations. The central server also gives the following information concerning local data channels: Types (broadcast or on-demand), frequencies, contents, data organization structures, service locations, timing and conditions, etc., which the mobile terminal must know to get necessary information in the actual travel phase.

4.1.2 Local databases

The servers of the local databases are placed at service fields such as stations. The central server can deliver common information of the transport system to the users in the fields via local servers. A local server sends these common data to passengers with the following location dependent data using several communication channels.

- Detailed station map
- Operation schedules of trains departing from and arriving at the station
- Platforms related to trains
- Real-time operation information
- Information about shops and restaurants etc.
- Other facilities in the station

4.2 Data sources in the traveling fields

4.2.1 Fixed data sources

A fixed data source disseminates data from a fixed place. If the contents of a channel are geographical data of a station, the transmission area is within the station. If the contents are data about a shop, the transmission area is the neighborhood of the shop and the data are provided during the time when the shop is open. If the contents are the total operation schedule of trains, the transmission area may cover all the regions of the railway. Same radio frequencies are shared by different data sources geographically and timely.

Some channels are used for on-demand information retrieval. By connecting with the central server or local servers, mobile terminals can retrieve information and execute some transaction type processes. The number of channels, however, is smaller than the number of the passengers of the site, so some connection requests may be rejected. Fig. 3 shows the image of fixed data sources.

4.2.2 Moving data source

Trains and buses also broadcast data about their operations (time table, stopping station list etc., accommodation and facilities etc.) as moving data sources. Passengers can get accurate information about the train operations. Even if trains of different destinations will come at the same platform, the mobile terminal can receive the data from the current train and tell the user to ride it or not according to the destination of the user. Moreover, if necessary, the mobile terminal can make or remake the schedule of the passenger on site. This function is very useful for visually or aurally handicapped passengers because the guide information is given by visual or voice messages in the public transport and these passengers cannot use some of them. Fig. 4 shows the image of a moving data source.

4.2.3 Data access method

There is a directory channel in every local area. The mobile terminal can check the channel and know how to get necessary data using data channels. As for the access method to each channel, we can use the results of the researches for channel efficiency and saving of the battery of mobile terminal [5, 6, 7]. The user may get data of the same attribute from the different sources in different granularity. Generally a user wants to see which station are the starting station and the ending station in the planning phase and need not know the detailed structure of the stations. If the user wants to get details in the planning phase, the central server can search the location of the information and retrieve it. The granularity of the same item may change according to the following channels;

- Global information network (Internet level)
- Local area channels (Station level)
- Small area channels (Facilities or utilities level)
- Moving channels (Vehicle level)

4.3 Mobile terminals

Each passenger has a mobile terminal. There is a software agent having abilities to support the user's travel. The abilities are such as;

- to retrieve data according to the requests of the user

Figure 3: Image of fixed data sources

Figure 4: Image of moving data sources

- to make a travel plan that satisfies the requests of the user by communicating with the central server
- to offer appropriate guide messages by integrating and personalizing information for the user
- to check the conditions of the public transport services
- to modify the travel plan according to the actual service conditions

The agent can use personal data of the user and the past travel records. The agent supports the user activities using the central server and local servers according to the user's requests and personal data. For handicapped passengers, mobile terminal should have suitable user interface for them. Namely for visually handicapped passengers, mobile terminals should communicate by means of voice.

The functions of mobile terminals are divided into four categories. These are user interface, information management, communication control and machine control.

1. User interface

   Functions of this category are for the communication with the user. Though normally the mobile terminal has buttons for input of data or commands and some display for information output. Voice communication method is important because of the restriction of the size of the mobile terminal. As we will show in the discussion of the prototype system, oral communication is especially useful for visually handicapped users. Functions for conversation control and user requests management are necessary for the high level communication with the user.

2. Information management

   Functions of this category are for management of the data and travel schedule. Several kinds of data are stored in the mobile terminal. Personal data are used for personalization of data acquisition and presentation. Some data such as transport service status, station maps are temporarily stored. The travel plan of the user is updated according to the changes of the locations of the user.

3. Communication control

   Functions of this category are for channel communications. The mobile terminal monitors the data channels and stores the status of channels. According to the situations or the requests of the user, the mobile terminal gets data from the adequate data channel. The mobile terminal must have the functions for on-demand communication too. The function for acquisition of location data is included in this category.

4. Machine control

   Functions of this category are for hardware monitoring and control. The monitored components are such as battery, memory space, input/output devices. The alarm message shall be offered to the user if there are irregular situations.

5 Database access

5.1 Database access in travel planning phase

A user who wants to travel to some place can make a travel plan by accessing the central server using his/her mobile terminal as follows;

1. The mobile terminal has personal data about the passenger, such as age, sex, physical conditions and favorite places etc. beforehand.

2. The user indicates the destination, a rough schedule of the travel and other requests on the travel to the mobile terminal.

3. The mobile terminal communicates with the central server and makes several travel plans using related databases and computing abilities of the central server.

4. The mobile terminal shows the candidate plans of the travel.

5. The user chooses one of the plans shown by the mobile terminal.

6. The mobile terminal purchases or reserves necessary tickets for the plan. In future the digital data recorded in the mobile terminal shall work as tickets themselves.

7. The mobile terminal set the determined travel plan in it. The plan is used in actual traveling phase to guide the user.

The user can start the process at any time, even if the user is already in some station not at home. The planning of a travel is the start of a contract of the travel. Once users get the guidance, they do not have to buy tickets or consult timetables by themselves. The users don't have to input the similar information several times, where the current systems may insist them.

5.2 Database access in traveling phase

5.2.1 Travel plan

As mentioned above, after starting the travel the mobile terminal has the concrete travel plan of the passenger. The mobile terminal gets the several information such that locations of the passenger, operation schedule of vehicles, information about the facilities of stations and so on. During the travel, the mobile terminal checks the travel plan and offer the passenger appropriate guidance as the attendant of the section 3 does. The executed parts of the travel plan are memorized as the records of the actual travel of the passenger as shown in the Fig. 5.

If the passenger set the mobile terminal in the "beginner mode", it can start from "guidance on the warning just before the departure time, followed by the route guide to a station, and provision of detailed information inside the station". When a change of vehicles is required, it will tell the passenger where he/she should change trains, considering the current train operations. In case of disruption of train schedule, it will show alternative routes depending upon the situation and personal preference, as if a faithful and professional travel agent paged him. If a passenger knows the route very well and is annoyed by such functions, he/she could switch off the service, telling the system that no announcement is necessary except a big change happens.

The integration method of information is a very important issue of the support system. The mobile terminal should present personalized information in a consistent manner in spite of the change of channels and their contents according to the movement of the user and the situation of the transport services dynamically. As passengers don't want to know the details of the system structure, information must be seen as if it is given from a one large database reflecting the environments. The support procedures in the normal situation and the emergency situation are shown below.

5.2.2 Normal procedure

The outline of the normal procedure in the case of utilizing railways is as follows. The user has already made a plan before arriving at A station. The plan is to go to B station from A station via the route C until time D.

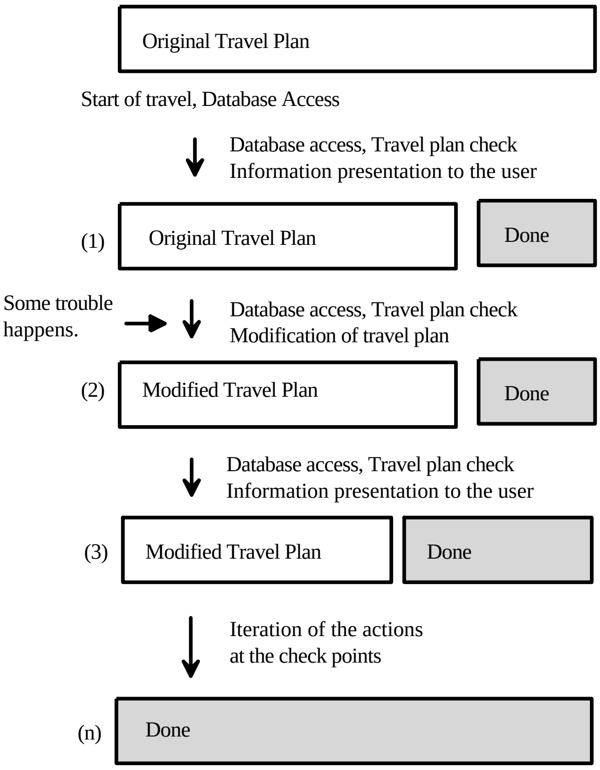

Figure 5: Database access using travel plan

1. At the entrance of the A station, the mobile terminal checks the directory channel of A station.

2. The mobile terminal gets station map and train operation data from the corresponding channels.

3. The mobile terminal selects the train to ride for going to B station via the route C until time D.

4. If necessary, the mobile terminal reserves a seat using on-demand channel. The mobile terminal may works as a ticket itself.

5. Using the station map the mobile terminal tells the direction to go to the platform. If the user wants to see the message using a display, the guide message is shown on the display.

6. If the user wants to go to other places such as toilets or restaurants. The mobile terminal checks the map and guides the user. During the walk, the mobile terminal can get more detailed information about the route and destination.

7. After arriving of a train at the platform, the mobile terminal gets the data from the train and checks whether the user should get on it or not.

8. In the train, the mobile terminal gets the schedule of the train and tells the user if there is an irregular situation or not.

9. Just before arriving at B station, the mobile terminal tells the user to get off.

10. After getting off the train, the mobile terminal gets the map of B station and guides the user to the exit.

5.2.3 Emergency procedure

In the real environments, services may change according to some accidents or other irregular events. In such an emergency situation, it is necessary to inform all the passengers of the current service status and modify the travel plan. As there are a huge number of passenger in the same public transport service area and their objectives are different one another, it is considered that communicating them through on-demand communication network is very difficult.

Our solution is that the directory channel gives an irregular signal and how to get the details of the current situation (mobile terminals check the channel periodically). Each mobile terminal checks data channels and examines whether it is necessary to change the plan of their users. If it is necessary, such mobile terminals start to make modified plans. The flow shown in Fig. 5. Of course the on-demand data channel may be used to the limited number of mobile terminals (the number depend on the communication environment of the area). It is possible that a data channel sends software to improve the functions of mobile terminals.

6 Data acquisition from passengers and demand-oriented services

The data flow is not restricted only the direction from the system to users. When the users enter an area supported by the system, the mobile terminal can communicate with the system and register the existence and demands (destination, desired arrival time etc.) of the user. If the user need execute some specific process, he/she also executes it using the mobile terminal. An example of such a specific process is reservation of train seats. By communicating with the users, the transport system can get the following information:

- The number of the users existing in the service area
- The distribution of destinations of the users
- The user flows of the transport network
- The possible users of other facilities in the service area, such as shops in the station
- The existence of users who need specific services, such as physically handicapped people

As for the railway, to change the operation schedules of trains is not easy because resources of cars and

Figure 6: Prototype mobile system

crews for trains are restricted and the frequent changes of work schedules may bring confusions. However the small changes are possible. For example the departing period between one train and the next train can be changed. In case that many passengers miss a train if the train keeps on the original departing time, the time should be delayed according to the information about the passenger flow. This kind of on-demand service can be adopted more easily for the operation of buses. Even for the railway, if the automatic operation system is adopted, the train operation re-scheduling can be executed is more easily. In case that the frequency of train operations is high, the train services may be offered as if they were elevators moving horizontally according to user demands.

Even if it is impossible to change the operation of trains, the support system can advise users to avoid the unbalance concentration. Namely the system can tell some of users which car they should choose.

The one of the procedures to acquire the user data and is as follows;

- When a user enters into the some supporting area, the user communicates with the system to register his/her existence in it and tell his/her demands. The mobile terminal executes this process automatically.
- The system gives some number (or identifier) to the user to be classified for getting information afterwards. Namely the user belongs to the some groups of which users have the same objectives.
- The user can get information by filtering the broadcast data according to the given group number.

This mechanism can make reduction of communication loads. In the public transport system, generally destinations of users can be classified into a small number of groups. For example, at a station users can be classified into two groups, one for riding trains bound for Tokyo, and the other for riding trains out of Tokyo. Trains may be divided into more classes, such as express train and ordinary train and the each group may be divided into more sub-groups. But the number of groups is considered to be not big. The group number has time restriction. If a number becomes timeout and the user of the number remains in the same area, the user must re-register for getting new group number.

The system can utilize this scheme to control users for improving environmental conditions of the area. For example, to distribute the flow of users in the station, the system can advise some groups to go through one way and for other groups to go through the other way. Of course users have liberty to choose any route. One-to-one communication is not suitable in case that a huge number of users exist in the same area. The system we proposed here is a solution for such an environment.

7 Prototype system for visually handicapped passengers

There are many handicapped passengers in transport environments such as disabled people (visually disabled, auditory or physically disabled persons, etc.), aged persons, pregnant women, small children, foreign persons who can not speak Japanese and ordinary people who are not familiar with using transport facilities. The system proposed in this paper is very suitable to support these handicapped passengers and it can make public transport systems friendly to use. We are now developing a prototype system for visually handicapped passengers as the first target [8]. Fig. 7 shows the basic configuration of the system. To support visually handicapped passengers, we need location data of the accuracy of at least 30cm because there are many dangerous places in the station, such as platforms. We have adopted the technique to embed RF/ID data tags recording location data under guide blocks for blind persons on the station floor (Fig. 8). The mobile terminal can read location data through a cane in which a small reader is installed. The communication distance between the cane and data carriers is about 20 cm. The size of the mobile terminal is 145mm x 80mm x 20mm and the weight is about 240g including battery. Fig. 6 shows a cane and a mobile terminal. The system may use other location system such as GPS additionally.

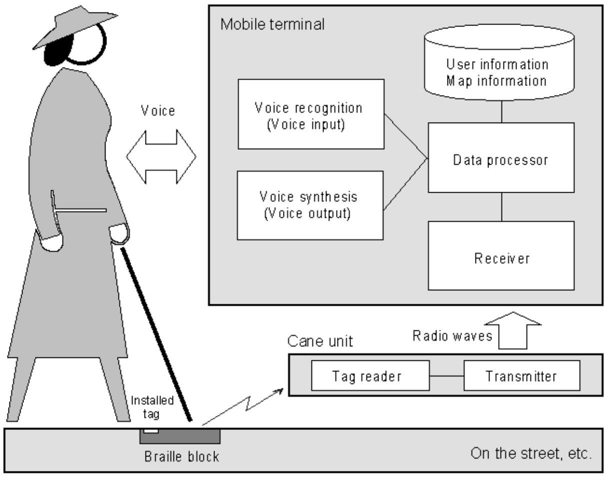

Figure 7: Configuration of prototype system

Figure 8: RF-ID tags embedded under the guide tiles on the station floor

The prototype system can get location information from the embedded RF-ID tags and other information from a radio communication channel as shown in Fig. 9. The mobile terminal is able to communicate with the center server via telephone network too. All operations of the mobile terminal can be done by voice and messages are given by voice too. Every time the mobile terminal gets a location datum from a data carrier, it generates a message about the current situation by mapping the location datum with the station map. If the user misses a message, it is possible to repeat the message by saying 'repeat'. So visually handicapped passengers can know where they are now and which direction they should go by using the mobile terminal.

The examples of these messages are as follows.
- At the stairs: Here are downward stairs of 20 steps.
- At the concourse: Here is a ticket vending machine in front of you. You are in front of a rest room.
- At the platform: This is the platform No.3 or the platform for XXX-line. This is the Hikari super express No.51.
- In the coach: This is the coach No.5.

It is also possible to make a more adaptive message by setting a destination. The mobile terminal guides the user to the destination by voice. If the user is on the wrong way, the mobile terminal makes an alarm such as "Return to the last informed position and turn to the right". If a passenger is in a dangerous situation (for example, the user is walking on the edge of a platform), the mobile terminal gives a beep sound alarm or vibration alarm of the cane. The scheme of our system can be adapted to other kinds of disabled persons. If the user is a person disabled to move, for example, he/she can get information about equipment to support him/her to move in the station, such as elevators, escalators and slopes through his/her mobile terminal attached to his/her wheelchairs.

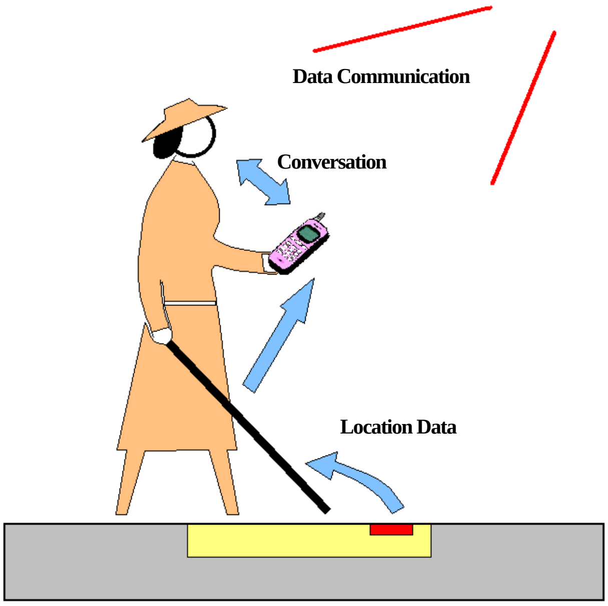

Figure 9: Database access in traveling phase

8 Field test in an actual station

We have conducted a field test in an actual station in Tokyo metropolitan area. About one thousand RF-ID tags were embedded in the floors of a concourse and a platform of the station. The radio communication equipment, however, has not been set in this test. The participants in the field test for estimating the basic functions of the system were 10 real visually disabled people. We did not change or control the conditions of the environment of the station, such as train schedules, broadcasting voice messages and passenger flows. However, in the case where there was a dangerous situation such that another passenger may hit the disabled person, we intervened in to guard the disabled person. Before starting an examination, the participants were given the information about the improved points of the new system and used it in the concourse of the station for getting accustomed with the usage of the system.

Then, we gave them three subjects to:
(a) Walk from a place outside the station to another place which is positioned in front of a train door on a platform (there are steps in the route),
(b) Walk using two kinds of guidance levels that differ in their details of guide messages and compare them, and
(c) Use the function by which the system gives the users the information where they are now.

During their test walks using the system, we took videos with two video cameras, and recorded the guide messages and the reactions of users on notebooks by walking with them. A scene of the test is shown in Figure 8. By examining the results of the field test, we have confirmed that the functions of the system work effectively in actual stations too.

The considerations about the results of the test are as follows.

1. Move by voice guidance and navigation

   The subject (a) is to walk from a point before ticket vending machines to the point in front of a specific train door on a platform. This route is about 100m long and there are ticket checking gates and descending steps on the way. We have confirmed that the user can arrive at the destination by following the guide messages of the system. The mean time required to the destination is 3 minutes and 58 seconds. The mean speed is 0.57 m/sec when walking in the concourse. We asked the participants who have the mental map of the test area beforehand to walk along the same route in the concourse without using the system. The mean speed in this case is 0.60 m/sec. In the hearing session after the test, they said that the move by the guide of the system is satisfactory. However, examining the video recorded in the test, five of ten participants sometimes went past the turning point one or two steps. We expect that this phenomenon will disappear if they become more familiarized with the usage of the system.

2. Installation of the guide blocks

   There is an expansion joint — joint position of buildings — in the concourse and it often confused the participants because they misunderstood that it was a line of Braille blocks. The complicated installation of blocks such as those near a toilet entrance perplexed their walks. In order to use this system more effectively, it is required to consider the optimum installation method of the Braille block.

3. Arrangement of RF-ID tags

   The radio tags are embedded in intervals of less than 5 m along the straight line of Braille blocks. On the turning point, in order to guide them quickly, tags are embedded in the blocks adjacent to the turning point. Consequently, it was sometimes observed that detecting the tag at the center of turning point is difficult for the user who has stopped at the turning point. So it is considered that tags should be embedded in the Braille block positioned at the center of the turning point.

4. Size and weight of mobile terminal

   Nine of ten participants desired that the mobile terminal would be smaller and lighter. Five participants commented that the cane is heavy. As the current system is a trial product, it is designed with a margin in the size and weight. So many of the participants were not satisfied with the current system contrary to our expectations.

5. Guidance level

   The system has two guidance levels, the detailed level and the simple level. At the detailed level, the system tells the user the distance to the destination and the distance to the next right- or left-turning point. At the simple level, the system omits the distance information, etc. We asked the participants to compare the two guidance levels considering the user-friendliness. Although the opinion on which level they prefer differs from person to person, most comments can be summarized as "I want to select either of them depending on the situation whether I am familiar with the station or not." Moreover, all participants estimated the function as "it is very good for users to be able to select the guidance level according to their will, like with this system."

6. Human interface

   In order to evaluate the human interface of the system, we asked participants to operate the system by themselves. The operations they performed are setting destinations, selection of a guidance level and setup of a voice pitch of messages offered by the system. As a consequence, we have confirmed that even aged participants can use the system without special training. In the hearing session after the test, they answered that the operation by using collar unit is satisfactory. As for the operation by voice, eight persons answered "it is easy," but two persons commented that the performance of voice recognition is poor. In addition, a few persons commented that it is

Figure 10: Field test in an actual station

necessary to be able to sense more clearly how it works when he/she operates the small volume dial attached to the mobile terminal.

7. Mental stress and resource for attention

   In the test at the actual station, noise from the environment, such as announcement, voice of other passengers and noise generated by trains, differs from that of the test field at the institute. In addition, visually disabled persons get more stresses caused by the interference of other passengers and the fear of the fall from a platform, etc. Since visually disabled persons cannot depend on visual information like other passengers, they need to pay attention to the aural information and the contact information from their feet or canes to detect the difference in level or obstacles. We asked the participants about their mental stresses and resource for attention. All of them answered that it is possible to pay attention to the surroundings and sense dangerous points. They also said that they could get information from this system easily even when a train was approaching.

8. Others

   The points that many participants estimated as good about the functions are as follows;

   (a) Although there is a restriction that they must use it only on Braille blocks, they can get the current location whenever they want.

   (b) The system offers proper information to guide to the train door or stairs even on platforms. Moreover, if he/she misses the route, the system offers a message to correct the route.

   (c) The system gives the opportunity for them to use various equipment and utilities at large stations effectively as they can receive appropriate information.

A past research in Japan, which investigated the difficult tasks when a visually disabled person uses a railway without a care worker, reported the difficult tasks at a railway station are "purchase of tickets," "move to a platform" and "move on a platform." Orientation — knowing the relative position between him/herself and surroundings — is indispensable to the task about moving. The reason why the task about "moving" is considered so difficult is that it is very difficult to get information about "orientation" if they cannot utilize visual information. We think that the participants evaluated the system as (a) and (b) above, because the information about orientation is given by the system easily. As a common opinion, they told that "I want to carry this system and use large stations alone even if I am not familiar with the stations."

9 Concluding remarks

In this paper we have introduced a new concept of passenger support system for the public transport system based on information integration and dynamic personalization in multi-channel data dissemination environments. The prototype system for visually handicapped passengers has been presented. There are many research issues to be resolved in future. These are radio communication method for multi-channel data dissemination, data organization of each channel, efficiency and reliability analysis, effective personalization technique, improvement and evaluation of the prototype system, implementation of intelligent software agents, good human interface and cost analysis etc. We will continue to research on these issues for implementing the system in the real world.

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