

# Development of Optimized User Interface of Public Transit Navigator for a Smartphone

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**Abstract**—We develop a new interface for Bus-Net which is optimized for a smartphone. We are continuing to develop the shortest path planning system of public transportation called “Bus-Net” in Tottori prefecture as web application to improve the usability of public transportation. Recent trend of computing platform, however has shifted to an advanced mobile device called a smartphone such as iPhone and Android in Japan. A smartphone has different characters with existing feature phone in terms of OS, large touche panel, and several other features. We derive a guideline to design the new interface for a smartphone to full use of the functionality. The guideline is about simplicity of user’s operation, location awareness and usability. We developed the new interface for “Bus-Net” on iPhone referring to the guideline. Due to the evaluation, the application interface we developed is better than the existing web-based interface in terms of the usability.

**Keywords**—Path Planning, Public Transportation, Smartphone, User Interface

## I. INTRODUCTION

WE develop the new “Bus-Net” application to use on a smartphone. We have already developed the shortest path planning system called “Bus-Net” [1]–[3], and operating the system as a web-based service in Tottori prefecture. We designed the system in order to improve the usability of transportation whose user has been declined. When the “Bus-Net” system has designed, the system is assumed to be used on a PC and a mobile phone. Therefore, the user interface of the system is not suitable for the use on a smartphone.

There are several researches and products of navigation and public transit navigator for mobile devices [4]–[8]. Some are designed for obsolete PDA, some are for the future phone, and the recent products and researches utilizes a smartphone as their platform. Although the mainstream platform is changing, there is a few discussion how such kind of navigation should be designed for the smartphone. A smartphone has many new features which open the door to the application unlike anything seen before. Developer needs This paper analyzes the feature of smartphone, and derive a guideline to design an application for a smartphone. Then develop the “Bus-Net” application for a smartphone based on the guideline. A user need friendly interface used the system from smartphone. Therefore, we develop system interface with the guideline. Then we compared the developed application with the existing system with an interface designed for the feature phone.

The key function of “Bus-Net” is a shortest path planning engine. The engine considers not only transferring at the

station or bus stop, but also walking from one bus stop to the other bus stop. Since the bus stops are dense in the urban area, considering walking is needed to calculate practical path of public transportation.

Users can be classified into three groups based on their situation they are using bus-net. First is a user who is using from their home and office. Second is a user who uses at the public place. Third is a user who uses anywhere on his/her mobile device. We can expect the third group as the user of an application on a smartphone.

We conducted a questionnaire from people in Tottori Prefecture. In the result, more the a half prefer using “Bus-Net” on a mobile phone of a smartphone. Fig.1 shows the result of a questionnaire.

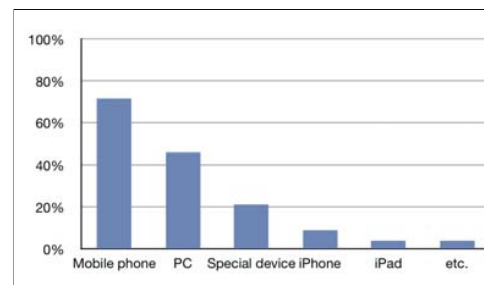


Fig. 1. Gleaned from a questionnaire from public

Section 2 writes the system we developed and used situations of system for user. In section 3, we make three guidelines from characters of device used the shortest path planning system. In the 4th section, the system makes a list needed functions. Theses function of system makes new interface form concepts. The interface makes a list of contraptions of start point, destination point and transition of screens. The application new interface we developed compare with the system current interface. The results discuss three points of interface design concept for better point and refinements. In the final section, we discuss the future work and conclude this paper.

## II. THE ADVANCEMENT OF A USER INTERFACE ON A MOBILE DEVICE

Following discusses the detail of advancement of a user interface of a mobile device.

### A. A User Interface for a Feature Phone

After the appearance of a cell phone which was originally designed for voice communication, a variety of functionality

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has been added to the cell phone. A cell phone with rich functionality is often called feature phone. A web and a text message made our mobile communication multimodal. Also they made it possible to access to many web-based services from anywhere even while moving. The advance of the feature phone made it possible to enjoy online service in anywhere.

When designing a service for a feature phone, optimizing its user interface for the UI of the feature phone is important for the usability. Since the origin of a feature phone is a device for calling, its main input device is ten-key numeric keyboard, its screen is small and often monochrome, and the bandwidth of the network is so narrow. Due to these restrictions, a designer of a service for feature phones gave up rich function and appearance, instead, he/she is eager to reduce the size of the data, cut down the information to optimize to the small screen, make the UI operatable with a numeric keypad.

### B. Characteristics of a Smartphone

A smartphone is designed to make a mobile internet device from scratch, where application for calling is treated the same as other applications. The Apple iPhone, Android are the examples. Followings are characteristics of a smartphone.

1) *High Resolution Touchscreen Display*: Most smartphone is equipped with a high resolution touchscreen display. A user can operate the smartphone intuitively where he/she can manipulate the content on the screen directory with his/her finger.

2) *Large Amounts of Storage*: Many smartphone are equipped with large amounts of storage. A user can store many applications and personal data on the storage.

3) *Modern OS, Application Frameworks and Networking*: The operating system for the smartphone is based on the modern OS such as UNIX, Linux, and have several application frameworks which support development of applications and unify the look and feel of each applications.

4) *Sensors to Recognize User's Behavior*: Smartphones are equipped with various sensors such as GPS to acquire his/her location, gyro and accelerometer to detect posture of the phone, and proximity sensor to detect if user is holding the phone close to his/her head. With these sensors, application on the smartphone recognizes behavior of the user.

## III. A GUIDELINE FOR MOBILE APPLICATION ON A SMARTPHONE

Considering characteristics of smartphone as mentioned above, we derive the guideline for the design of application on a smartphone as follows.

### A. Simplify User's Operation

It is needed to simplify the way of operation of the application using touchscreens, sensors and advanced graphics and computations. For example, making an object operatable on the touch screen with his/her finger can simplify user's operation such as selection, picking, navigation of the information on the screen. Inference of user's intention and activity from the output of the sensor can also help to develop simple user interface.

In "Bus-Net", user selected departure or destination landmark. The system offer the candidate of landmark for him/her. He/she cannot understand if all landmarks is shown in random order. The system searches the landmark incrementally, the possible landmarks on the window are updated each time a user types the keyboard.

### B. Location Awareness

The application needs to behave considering user's location. With the GPS technology, a smartphone can acquire user's present location, with which the system assume where the user is in, what the user is doing, and what the user want to do. With these assumption, an application can reduce user's explicit operation such as input the name of the nearest place. An application can also provide information corresponding to the user's location. For example, it can provide a map of the position to navigate without asking where it is.

In "Bus-Net", the system automatically suggest the nearest landmarks when the user is setting the departure/destination point. Also the user can use the coordinates of the point as the departure/destination point instead of using a landmark. The system navigate the user to the bus stop using a location aware maps.

### C. Personalize

The application needs to be personalized; it remembers preferences, routines that the user often try, and it estimate from the personal preference. Even privacy-related preferences such as user's address and phone number can use for personalization by storing the data on its storage.

In "Bus-Net", the system stores history of his selection of landmarks, and suggest the history when he/she is selecting the landmark. It is sorted by the number of the selection. The more the user uses the system, the easier the system become.

The application in device has the database of landmarks. The application search landmarks fast, no communicate.

## IV. DEVELOPED THE INTERFACE

This section write down developed function of interface from the guideline. The interface for mobile device with touche screen we developed is used the guideline. The device developed user interface of the system is the Apple iPhone with Xcode [9].

### A. Path Planning System

In this system, user selects departure-landmark and destination-landmark for searching paths. Landmarks are registered into the "Bus-Net" database, and they are not only bus stops and railroad stations, but also sightseeing spots, shops, and so on. Now, about 10,000 landmarks are registered. Moreover, the place of departure and destination can be specified by using the "Google Maps" [10]. Thus, even if people can use this system who doesn't know bus stop names or bus stop positions, they can use a bus on a path. The system has many unique aspects such as an original path searching

algorithm, however, they are not referred in this paper. Fig.2 shows the select of path planning.

This is previous user interface used from both PC and mobile phone. We thought that in many cases, this system was may be used from PC or mobile phone. The site of Bus-Net has not utilize full ability of PC's web browsers. Because it also has to support mobile phone. For example, Browser on mobile phone lacks Javascript and output information is reduced for small resolution display. Thus, we develop optimized user interfaces for each device.

Fig. 2. Inputed user interface of the usual system

## B. Need Function Of The System

The shortest path planning system need some functions. The necessary functions are to select depart-landmark and destination-landmark, to set date and time, and to set used bus connections in the system. The result of shortest planning path is requested by using these functions. Therefore, this section write down these function.

*a) Selection of landmarks:* This function is the most important function. User select depart and destination of route. Selection of landmark is about 10000 landmarks. The system need to make the choices.

There are two selection how to select landmark from the current interface. The system use selection of landmark from registration landmarks. The system use latitude and longitude from point. Always, selection of landmark is user searched into data from landmark-name. The system get latitude and longitude from user selected maps.

Therefore, the interface make selection landmarks from need of user. For example, user select present location to use to get user place from GPS in system. The system make selection for selected history of user.

*b) Set departure or destination time:* The system used date and time for departure time or destination time from to search path. Selection how to set to time are six, the first destination for day, the final destination for day, used after minute from now and selected date and time for departure or destination.

*c) Used bus connection:* This function of system is to search path from used bus connection. The selection from used bus connection are Yes(use) or No(not use). The interface need to make the bus connection name and choice Yes or No.

*d) Result of the shortest planning path:* This function is to get the shortest planning path from the system. The device accesses web page of system transmitted to set parameters. Parameter to set of CGI consists of key and value is used for condition which is an input to a path planning program. The route search result used XML which is an output from a path planning program. The system we developed analyze data of XML and show the path.

## C. Switched to interface

The screen switched to others is stress for user. The new interface need few numbers of times for switched the screen. The interface use to scroll pages, because it is a little stress from switched screen. Therefore, the interface design need another type of method of selection. Type of selections of landmark show one page as much as possible. The design is effective design for to feel little stress of user.

## D. Landmark Selection

The interface selected landmark is key function of concept. Selection of depart-landmark and destination-landmark are many points. User cannot search list of all landmarks for himself. The system need to make simple list of landmarks for user.

The way is to search data from name of way. User select landmark from the list searched name. The system searched landmark name and reading the name. User input word used to search landmark name spell. This way is very simple.

However, the way is stress for user to input many type for buttons. We make list of history of user selected. This way is a few number of count of user input buttons.

One of other way is user present location. User present location from GPS is to get user latitude and longitude. This way is not not worry near the landmark for user. This way used to search around place from user present location. User selected around place for landmark selection. Registration point of location, user house, work place, etc.

History of user selection is used to user selected for easy. History saves landmarks for device. The newest selected landmark show first, and sorted into landmark new selected. This way is faster than searched landmark name from input button.

## V. EVALUATE THE INTERFACE

### A. Method of the Evaluation

We evaluate the interface we developed. Used device is the identical device to evaluate the interface. The method of evaluation is respectively count of actions, switched screen, scroll screen and touched screen key-board to selected departure landmark. Therefore, the evaluation is respectively count of actions to search planning path.

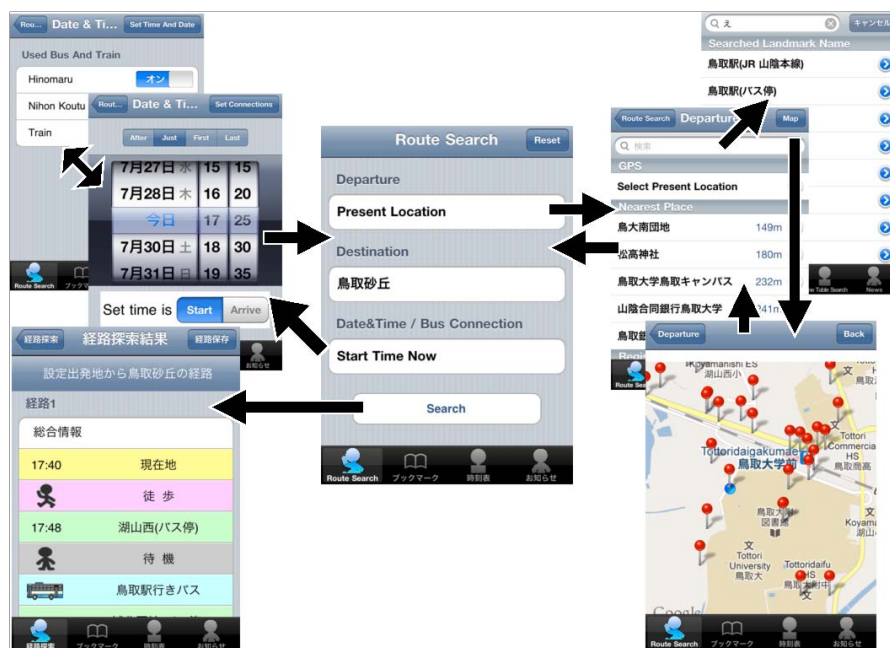


Fig. 3. The application interface switch with screen



Fig. 4. Top page of the interface



Fig. 5. Set to landmark

Evaluated number of user action is the total sums of respectively coefficient of evaluation multiply count of actions. Coefficients of evaluation are value of table I. A coefficient of switched screen is heavy cost. However, a coefficient of scrolled screen is light cost.

Evaluation of The method is few number of the total sums actions, that is little stress for him/her. Almost, number of results are fewer number than few process

We evaluate actions of selected departure landmark used the developed interface or usual interface. The evaluated departure is our lab, Keisanki-AB Lab. The nearest landmark of Keisanki-AB Lab is the Tottori University for searched landmark name. The method searched string of "tottori" from key-board.

By the method, the evaluation searched path used the developed interface or usual interface. Departure is present place as the Tottori University. Destination is the Tottori Sand Dunes, searched string of "sakyuu". The evaluation uses departure and destination only. Searched date and used bus connection of the evaluation are default settings. Therefore, there do not contain the evaluation heading.

TABLE I  
COEFFICIENT OF EVALUATION ITEMS FOR ACTIONS SETTED LANDMARK

Evaluate Items	Coefficient
Switched to Screen	25
Scroll to Screen	5
Touche to Key-board on Screen	10

### B. Evaluation of Respectively Heading

The result of number of the interface we developed is fewer than the usual interface. Results of selection of interface we developed compare with result of the usual interface. Procedures for selection of the interface diminish process from the usual interface. This origin of results is fewer count switched screen than the usual interface. Headings of selection of high score, present location and history of user selected landmark do not touch key-board on screen.

TABLE II  
RESULT OF EVALUATION OF THE WAY SELECTED LANDMARK

Selection	switching (times)	scroll (times)	touching (times)	evaluation
Usual UI Name	3	0	8	155
New UI Name	2	1	9	145
New UI GPS	2	0	0	50
New UI History	2	2	0	60

TABLE III  
RESULT OF EVALUATION OF THE WAY SEARCHED THE PATH

Selection	switching (times)	scroll (times)	touching (times)	evaluation
Usual UI				
Name to Name	7	0	15	325
New UI				
Name to Name	5	1	17	300
New UI				
GPS to Name	5	1	8	210
New UI				
GPS to History	5	2	0	135

The results of selected of departure landmark are tableII. The method of process of searched path are tableIII. The results of the process of searched path from the developed interface are fewer counted actions than the usual interface. Therefore, the developed interface is easy to search the shortest planning path.

## VI. CONCLUSION

In this paper, we developed a user interface of “Bus-Net” for a smartphone. This paper write down the guideline that a case of generally interface and the case of the system for smartphone. The guideline is effective developed user interface of a navigation system for smartphone. The target is open to public for the application of system. Now, the application is under the beta test in our laboratory. We are planing to release on App Store.

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