Take Me to the Bus Stop: AR Based Assistance System for Public Transit Users

Naoki Kanatani, Masaki Ito, Takao Kawamura and Kazunori Sugahara

Abstract—Route bus system is the fundamental public transportation system and has an important role in every province. To improve the usability of it greatly, we develop an AR application for "Bus-Net". The Bus-Net system is the shortest path planning system. Bus-Net supports bus users to make a plan to change buses by providing them with information about the direction. However, with Bus-Net, these information are provided in text-base. It is difficult to understand them for the person who does not know the place. We developed the AR application for Bus-Net. It supports the action of a bus user in an innovative way by putting information on a camera picture and leading the way to a bus stop. The application also inform the user the correct bus to get, the direction the bus takes and the fare, which ease many anxieties and worries people tend to feel when they take buses.

Keywords—AR, navigation, Bus-Net, transport

I. Introduction

AS Navigation using smartphone is one of the hot research topics of information technology [1], [2]. We focus on public transit navigator where the system supports riding bus and trains. We have already developed "Bus-Net", a shortest path planing system of public transportation.

The Bus-Net system is the Path Planning System, which supports passengers of a bus to make a plan to transfer by providing path information. The passengers can use the Bus-Net on Internet. The Bus-Net system we developed is a system that plans the shortest path and it improves the usability of public transportation [3]–[5]. A public transportation is important especially for elderly people and students in the region. However, the number of passengers is decreasing every year, because it is difficult to understand information of bus routes for bus passengers. The Bus-Net system supports bus passenger by providing the information. The average number of access to Bus-Net is more than 100,000 per month. Bus-Net is obviously contributing to improve the usability of public transportation. The Bus-Net system has a bus positioning system. We describe the bus positioning system as the bus location system. However, the bus location system is in the experimental stage. If users of the Bus-Net system input departure, destination, starting/arrival time and methods of transportation such as whether he/she use only bus, he/she can get a path information. The Bus-Net system supports user of public transportation to move by using information technology.

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However, navigation systems have two problems: 1. Information provided by navigation systems is not enough. 2. Information provided by navigation is difficult to understand. For example, many navigation systems only provide certain information about destination such as position, name and a map. The path information provided by the Bus-Net system is text-base, and that makes a person difficult to understand the information when he/she does not know the place. It can cause the person to fail to find the destination.

We use a smart phone, a mobile device with touch screen, and technology of augmented reality(AR). The technology of AR is studied in a variety of areas for over 10 years [6]–[9], and those studies produced many applications for navigation. We decided to use a smart phone and AR. We develop an AR application which provides information such as objects of bus stops that are overlaid on a camera picture for smart phones. We discuss what the application can do for passengers of buses. We focus on a smart phone and AR, and we develop the AR application to provide intuitive information.

In this paper, we discuss the need of AR for Bus-Net in Section II. In Section III, we explain AR. In Section IV, we discuss experiment on ahead for development of AR application. Discussion and Future work are discussed in Section V. Lastly, conclusion is reported in Section VI.

II. The necessity of AR

It is difficult to understand the path information such as shown in Fig1 for a person who does not know about the place. He is not good at reading a map. The path information are text-base. The Fig1 shows the output of Bus-Net. When he/she read this information, he/she may not understand it.

Let ' s imagine Mr.Yamada comes to Tottori City. He finds the Bus-Net system and he uses it. What he gets from the Bus-Net system is text-based information of the path. This information has a map, name of bus stops, route of buses, departure time and total times. However, he cannot understand the information because he is not good at reading a map. In addition, it is his first trip to Tottori City and he does not know the place. Because of these, he loses his way to the bus stop. After a while, he manages to reach the bus stop and gets on a bus. As the bus starts, however, he realizes he caught a wrong bus. There are many buses running in the center of Tottori City, therefore, he does not know the bus he has to get. He uses the Bus-Net again and gets new path information and gets on the correct bus. However, this time, as he does not know where the bus goes through on its way to the destination, he worries if the bus he rides on goes to the right direction.

Fig. 1. Path searching system

In addition, he does not understand the map and also worries about his destination.

There are many concerns in this story. We can divide these concerns into some parts like Fig2 In this section, we discuss these concerns and we offer a way to solve them.

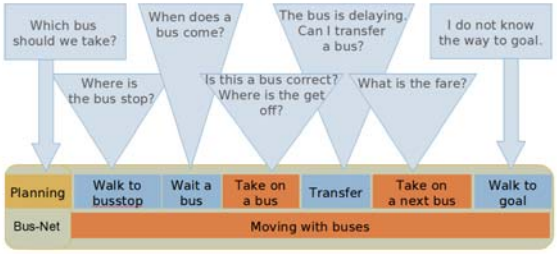

Fig. 2. Concerns with using buses

A. Needed Information for a Passenger

1) To the Bus Stop: A passenger who is walking to the bus stop requires detailed information about how to get to the bus stop which is suitable even for a passenger who is not good at reading a map. For example, he/she needs the detailed direction to the bus stop, the exact number of the platform at the bus stop, and if he/she needs to rush to the bus stop or not. These information should be intuitive and easy to understand. With these information, the passenger can reach the bus stop without getting lost.

2) At the Bus Stop: A passenger who is waiting a bus at the bus stop wants ease to his/her anxiety whether he/she can take the correct bus. He/she needs to find the exact bus that Bus-Net asked him/her to ride from many buses for different destinations which pass the bus stop. The bus may not come on time due to traffic congestion or bad weather. It is needed to provide information about the coming buses at the bus stop reflecting actual traffic situation.

3) On a Bus: Even after taking a bus, a passenger may not sure if he/she is on the right way to his/her destination. The bus does not provide either the current location or how long it will take to the destination. If his/her destination is not the terminal of the bus, he/she needs to be careful for approaching the destination that he/she does not know well in order to ring the bell. Therefore, it is needed to provide information about the route of the bus corresponding to the current location to ease the anxiety if the bus is correct, and to find when she/he should ring the bell.

B. A way to solve

Nowadays, a mobile device with touch screen such as smart phone spread rapidly. Therefore, we can imagine the number of accesses from the smart phone will increase. We think that smart phone and AR will support to understand the path information. Especially, we focus on a technology of augmented reality(AR). There are many technologies such as objects are overlaid on camera picture. We think the AR technology can inform various informations intuitively, if we use the AR technology for the Bus-Net system. The AR technology can overlay objects like bus stops on camera picture, and that will be a great help for passengers of a bus who are not good at reading maps understand a position of the destination.

A technology of AR spread surely. The Fig3 shows display of ”SekaiCamera”. The ”Sekai Camera” is iOS application. This application uses technology of AR. In Tottori prefecture, the application using a technology of AR called ”Tottori Air Map”is released. Tottori Air Map provides information of leisure venues. Tourists can search leisure venues by holding up the smart phone. Fig4 shows Tottori Air Map. In the future, a technology of AR is going to be used for many applications.

Fig. 3. SekaiCamera

Fig. 4. Tottori Air Map

III. Design of AR Application

A. Searching bus stop

A person who is not good at reading map, can understand the position of the bus stop intuitively. When the application user holds up a smart phone, objects of bus stops are overlaid on camera picture. These bus stops are within 200 meter of location of the application user. Touching one of these objects, the user can see the name of the bus stop. In addition, this function can access to Bus-Net server. The user can use path searching system. The Fig.5 shows the Searching bus stop function. The user can use this function instead of using a map. The user can see a countdown of minutes until departure of a bus. When the user gets an path information, this function supports the user to understand the information. Users of this function can solve anxiety as shown in Section II-A1.

Fig. 5. Searching bus stop function

B. Informing a taking bus

A passenger of buses can solve concerns such as transferring to a wrong bus. An user can get information about where the running buses are as shown in Fig.6. Objects of buses are overlaid on camera picture when holding up a smart phone. When the user touches one of the objects of buses, this function provides information of the bus such as delay time, position, route and destination. Users of this function can solve anxiety as shown in Section II-A2.

Fig. 6. Inform a taking bus

C. Inform a route information

This function solves anxiety about a bus. Fig.7 shows the inform a route information function. The user can grasp whether he/she is on a right bus. If a user holds up a smart phone forward when he/she is on a bus, he/she can see the next bus stop and a route of the bus on a map. In addition, the user can see which bus stop to get off at. When tapping an object of a bus stop, route information of the bus is provided The user can see destination of a bus and fare, and he/she solves anxiety as shown in Section II-A1.

Fig. 7. Inform a route information function

IV. Implementation

When develop AR, we use technologies given below.

- Getting a preview of camera picture
- Overlay objects on the preview
- GPS
- An acceleration sensor for detecting tilt of smart phone
- Compass(gyro sensor) for detecting direction
- The 3D animation

Of these technologies, we implement the 3D animation through the use of the OpenGL. Because the OpenGL is the best technology for 3D animation. We develop AR with Xcode [10].

We have to experiment before complete the development of AR application. There are several matters. First, we must design the interface of AR. We propose some design of the interface. We decide the interface of AR after hear the opinion of people using a system. Second, we have to check the accuracy of the GPS. There are some the smart phones such as iPod that it does not have compass and GPS. They get a GPS data by Wi-Fi network. Therefore, we have need to confirm an error. These experiments are important on development of application.

Here, we explain about implementation of functions we develop.

A. Searching bus stop

The smart phone gets data of bus stops from Bus-Net server. This data has location and name. This AR application calculate a direction and a distance between location of smart phone and bus stops. The system of this application is shown in Fig.8 The

AR application search bus stop. In addition, This application informs a route information by using the direction and the distance.

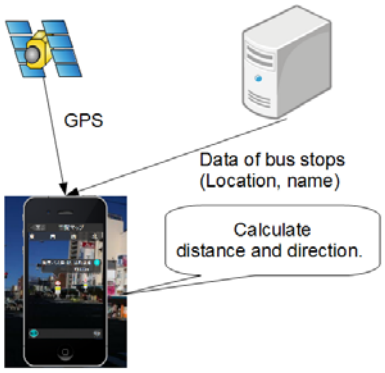

Fig. 8. System of AR application

B. Informing a taking bus

This function uses the bus location system. The bus location system is our original bus positioning system [11], [12]. If we use the bus location system, we can get information of buses such as a delay time, position, route, destination.

Therefore, this function can inform a delay time and position of buses. As shown in Fig.9 this function get information such as a delay time, position of buses, route, destination from the Bus-Net system server. We develop this function by using these information.

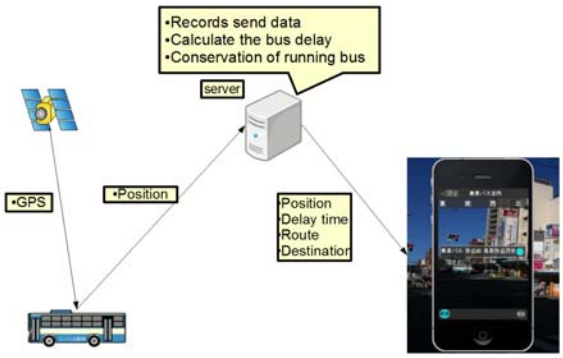

Fig. 9. System of the informing a taking bus system

However, the bus location system is in the experimental stage. Because of it, we can not develop impractical function. We have to be put to practical use the bus location system.

C. Inform a route information

This function can get nearest bus stop and next bus stop. This function uses GPS. The smart phone get GPS data every 10 seconds. When get GPS data, this function calculate distance between location of smart phone and all bus stops. Fig.10 shows how get a next bus stop.

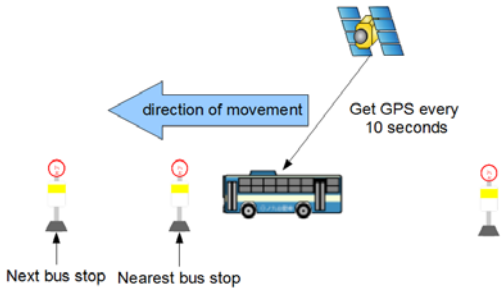

Fig. 10. Get a next bus stop

V. Discussion and Future work

We develop the AR application for the Bus-Net system. we use the technology of AR. The technology of AR is very useful. However, if many objects are overlaid on a camera picture, it is difficult to use AR. Therefore, AR is not so useful by our development approach. We have to improve the AR application as needed.

In addition, we have to be put to practical use the bus location system. The bus location system is in the experimental stage. Because of it, we can not develop impractical function.

We think, AR can give a catalyst for taking a bus. It is difficult to take on a bus for persons who are not take on a bus. Because they are not know information about a bus such as where is a bus stop and they has an image that they have to wait a long time as shown in Fig.11. AR can resolve these images by providing information such as position of bus stops and buses. Therefore, AR give a motive to take a bus to persons who are not take on a bus.

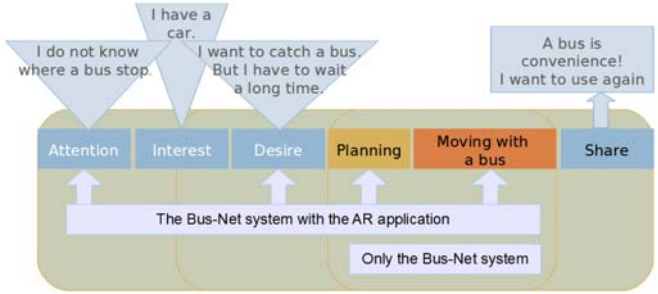

Fig. 11. In the process of taking a bus

VI. Conclusion

We develop the AR application for the Bus-Net system. This application supports passengers of buses. A passenger of bus can understand the position of the bus stop intuitively with this application. In addition, the user can see a route information of the bus such as destination and fare when getting on a bus. Before we develop the AR application, it is difficult to understand all of them for the person who does not know the place because the Bus-Net system informs text-based information. Therefore, we focus on a technology of AR. As a result, we improve the usability of Bus-Net and therefore improve the usability of transportation.

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