SICE Annual Conference 2010
August 18-21, 2010, The Grand Hotel, Taipei, Taiwan

Determining Location of Bus and Path Planning Considering Bus Delay

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***Abstract*—Route bus system is one of fundamental transportation device for aged people and students, and has an important role in every province. However, passengers decrease year by year. The reasons include the spread of private cars and depopulation. Therefore we have developed the shortest path searching system called "BUS-NET" as a web application to sustain the public transport. The path planning system that is one of the functions of a previous Bus-Net does not consider bus delay. Therefore, passengers may be unable to get on a target bus at the transfer when a bus is delayed. So the path planning system considering bus delay is necessary. To provide this function, we must estimate a bus delay. And to estimate the bus delay, we develop a system to determine the location of a bus. In this paper, we describe methods for the path planning considering bus delay and determining the location of the bus.**

***Keywords*—Path Planning System, GPS, Smart Phone.**

I. Introduction

In this paper, we develop a shortest path searching system to support a bus delay. Such a system already exists. However the enormous capital is needed to achieve this system. For example, it is necessary to set special device of each bus stop. In this study, this system was achieved low-cost with smart phones. In the following, the outline of the Bus-Net is described.

A local public transportation system is used as fundamental transportation device by a lot of people. A route bus especially has an important role in the region where other public transportation systems do not exist. However, passengers decrease by the spread of private cars and depopulation year by year. And the inconvenience of the bus that people do not know the position of the bus stop and the transfer method also influences a decrease of passengers. Then, to offer these information and to promote the use of a route bus, We have developed the shortest path searching system called Bus-Net in cooperation with bus companies and other enterprises and release it to the public as a web-service[1], [2], [3]. The average of accesses to the system is more than 50,000 per month. Taking into account of the current target area of the system is restricted, the number is very large and the importance of the system is confirmed. The system has many unique aspects such as an original path searching algorithm. However, they are not referred in this paper. Here, the path planning system is picked up.

The path planning system that is one of the functions of a previous Bus-Net does not consider bus delay. Therefore, passengers may be unable to get on a target bus at the transfer when a bus is delayed. To solve this problem, we propose methods for determining the location of the bus and the path planning considering bus delay.

This paper is organized in five sections. Section 2 describes the method for determining the location of the bus. Section 3 describes an algorithm for the path planning considering bus delay. Section 4 demonstrates the effectiveness of the proposed methods through experiments. Finally, Section 5 gives a conclusion of this paper.

II. Determining Location of a Bus

The delay can be estimated from the location of a bus. Information about passing bus stops and bus-service, a bus delay are assumed to be running-bus information. The longitude, the latitude of the bus and a transmission time of data are assumed to be location information. We are able to know bus stops that the bus is scheduled to arrive by running-bus information. Moreover, the bus delay is estimated by location information. A function that these information are managed on a server is implemented.

In this study, we use smart phones with GPS (global positioning system) to obtain running-bus information and location information of a running-bus. The smart phone sends running-bus information and present location obtained by GPS to the server. The server records these information on a database. As a base for these information, the server updates information about passing bus stops and estimates the bus delay.

Moreover, we develop an application for the smart phone. The setting of operation information and acquisition of the location information are done by this application. The application can be used with various smart phones as long as it installs. In this study, X04HT and X05HT, Windows phone of SoftBank Co. are used.

III. Path Planning Considering Bus Delay

First, the path planning system is explained. To do the path planning, this system constructs a network. The network is constructed with nodes which denote bus stops, arcs which denote bus routes and weights of the arcs which denote the needed time between bus stops. The path planning system uses

the Serializable Network. The Serializable Network including static part of network is made to shorten the search time when people do a search for bus routes by using this system. Static part of network is drawn up and saved in files previously.

Second, a file that bus delay information is written is explained. The value of bus delay and bus-service information are assumed to be bus delay information. The server draws up bus delay information in files per minute. In searching time, the path planning system reads this file.

Finally, the path planning considers bus delay is explained. In searching time, arrival times of each bus stop are reflected delay that is estimated by determining the location of a bus. The path planning system obtains arrival time of each bus stop by reading the network. A procedure of the path planning considering bus delay is displayed as follows.

1) The bus delay is estimated by determining the location of the bus.
2) The server draws up bus delay information in files.
3) In searching time, the path planning system reads the Serializable Network and those files.
4) The value of the bus delay is added in arrival times of each bus stop in Serializable Network.
5) It searches for a path based on changed arrival times.

The path planning considering bus delay is implemented on Bus-Net. Therefore, the path planning system corresponds to the following situations.

(A) A certain bus runs on schedule, and a target bus at the transfer runs on schedule. In this case, this system runs the path planned by previous Bus-Net.
(B) A certain bus is delayed, and a target bus at the transfer runs on schedule. When the certain bus is greatly delayed, passengers that get on a certain bus may be unable to get on a target bus at the transfer. In this case, this system runs the path planning considering bus delay. Its result is different from a path that the path planning of the previous Bus-Net displays.
(C) A certain bus runs on schedule, and a target bus at the transfer is delayed. When the target bus is greatly delayed, passengers that get on a certain bus may be able to get on the other bus at the transfer. And like the case (B), a path is different from the path of the case (A).
(D) A certain bus is delayed, and a target bus at the transfer is delayed. In this case, there is a possibility that case (B) and case (C) happen. Moreover, a certain bus and a target bus are greatly delayed. Then, a path that the path planning considering bus delay displays may be quite different from the path of case (A).

IV. Experiments

Experiments have done to check that changing a path when a bus is delayed. We have gotten on the bus with a smart phone. In additional, a bus delay is estimated by getting running-bus information and location information actually. The bus delay has become 5 minutes as a result of getting on the bus in a certain point. We have used to the path planning system at this time. In the case of starting point; "Jouhoku elementary school", destination; "civic gymnasium" and departure time; 14:50, the path not considering bus delay and the path considering bus delay it are indicated as shown in the Fig. 1 & 2. In Fig. 1, the path is displayed to get on "Hinomaru Saigo and Sanki line" at 15:10. On the other hand, it cannot get on "Hinomaru Saigo and Sanki line" because "Hinomaru Karo line" is delayed as shown in Fig. 2. However, the path planning considers bus delay has run, and the path is displayed to get on "Hinomaru Saji and Chizu line" at 15:20 as shown in Fig. 2. Moreover, the required time became the shortest when considering bus delay. At this time, the time required becomes longer when not considering bus delay.

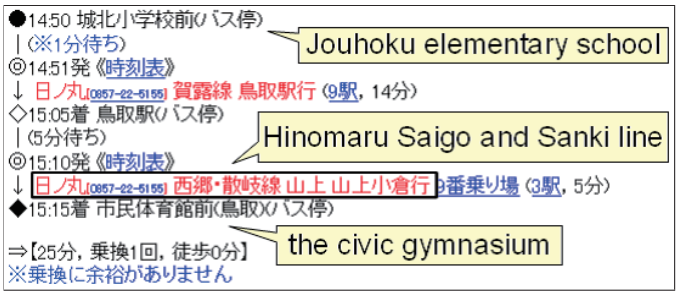

Fig. 1. Path planning result not considering bus delay.

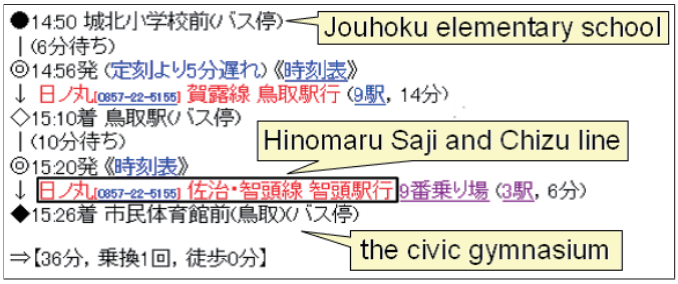

Fig. 2. Path planning result considering bus delay.

V. Conclusion

In this study, determining the location of a bus and the path planning considering bus delay are implemented to improve the practicality of Bus-Net. Location information and running-bus information are obtained by smart phones with GPS. Then, the estimation of a bus delay becomes possible because it used these information. Moreover, the application for the smart phone makes operation to obtain information easily. And, the path planning considering bus delay becomes possible by estimating the delay. The path planning considering bus delay is scheduled to be put to practical use in the future.

References

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