

# Development of Bus Location System Using Smart Phones

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**Abstract**—Route bus system is the fundamental transportation device for aged people and students, and has an important role in every province. However, passengers decreases year by year, therefore the authors have developed the shortest path searching system called "Bus-Net" as a web application to sustain the public transport.

But traditional Bus-Net can't inform passage information on a location of a running bus, and does not correspond to the case when the bus is delayed by the road situation. Then, we develop a bus location system that informs a location of a running bus and bus stop passage information. In addition, we develop an algorithm that estimates delay of the bus.

**Keywords**—Route Bus, GPS, Bus Location System, Estimate Delay.

## I. INTRODUCTION

As is well known, Japan faces the problems of aging population, and these problems cover a wide range. The sustaining of local public transportation systems becomes a problem along with them and the problem increases in importance for local governments.

Route bus system is the fundamental transportation device for aged people and students in the region where airlines and railways do not exist. However the number of passengers decreases year by year under present circumstances. As the reason, it is difficult to obtain route information on the bus compared with other public transportation facilities.

Increase of private cars is thought to be main aftereffects of these phenomena. Then, we proposed to enhance convenience by facilitating obtaining route information on the bus, and to promote the use of the bus.

Adoption of information technology (IT) is one of the effective methods. We have developed the shortest path searching system called "Bus-Net" 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, but they are not referred in this paper.

Bus-Net does not inform a location of a running bus and a delay time of a bus. The purpose of this study is to develop a bus location system using smart phones that have the GPS

function and an algorithm to estimate the delay of the bus based on location information.

Bus location systems are constructed in some municipalities. But the operation cost is risen because it was achieved by installing a sensor and telecommunications equipment on bus stops. However, it is possible to operate a bus location system low-cost by achieving it using smart phones without setting up telecommunications equipment in the bus stop.

In this paper, we report about development of the bus location system. And we report about development of an algorithm that estimates delay of bus. This paper is organized in five sections. Section 2 and 3 describe the bus location system and estimation of bus's delay. Section 4 reports the effectiveness of the bus location system and the estimation through experiments. Finally, Section 5 gives a brief conclusion of this paper.

## II. BUS LOCATION SYSTEM USING SMART PHONES

Smart phone equipped with the GPS function and communication handling is installed in each bus. Smart phone sends location information such as latitude, longitude and transmission time. Bus-Net has the data base with many tables to manage huge information. Smart phone sends running bus information such as an id on the first bus stop departure table and an id on the corporate information table. These information are sent every 1 minute.

Location of running bus is determined based on the location information. Fig. 1. shows a bus location display using Google Maps API.

When a bus icon is clicked, movement information such as passage scheduled time of ride bus stop, destination, route, and delay of bus is displayed. The movement information is obtained from running bus table where a running bus is managed and the route table where route information is managed. The delay is estimated by an algorithm which is explained later.

There are 2 kinds of bus location displays. The one is a detailed display of map where ride bus stop is made center. The other one is large area display of map which shows all buses running at the prefecture.

Next, the bus stop passage information display is shown in Fig. 2. This is displayed passage information on bus stops.

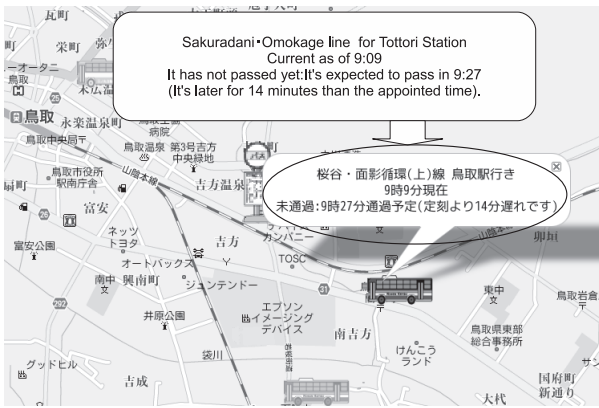


Fig. 1. Bus location display using Google Maps.

(日ノ川中河原下)線 雨滝行きバス接近情報図

※停留所で表記されたバス停留所は走行中です  
※青い文字で強調されている停留所名が乗車バス停です

番号	停留所名
0	鳥取駅(始発バス停)
1	太平橋
11	生田院(雨)
12	文化センター前
13	内吉方
14	立川二丁目
15	立川大橋
16	立川五丁目
17	緑町
18	三洋本社前
19	若倉(県道)
20	奥谷口(国府町)
21	客ノ下
22	客ノ下
23	国府町総合支所前
24	因幡力業歴史館入口(乗車バス停)
25	南津口
26	麻生(国府町)
27	上麻生

The bus stop it's passing (Utiyoshikata, Tachikawa2tyoume, Tachikawaoohashi)

The bus stop where I get (Inabamanyourekishikan)

Fig. 2. Bus stop passage information display.

The information is obtained from bus stop passage information table where passage information on a bus stop is managed. A bus stop that is the nearest a running bus and bus stop before and behind that are emphasized as shown in the part enclosed by oval A, and a ride bus stop is emphasized as shown in the part enclosed by oval B. The reason to emphasize 3 bus stops is described in section. III.

### III. CALCULATION OF DELAY OF BUS

We are confronted by a problem that existent system manages road information such as crook by installing a sensor and telecommunications equipment on bus stops, but a database of Bus-Net does not manage such the road information. Because of the problem, it is not possible to calculate delay of a bus with accuracy by comparing the location of a bus stop with the location of a running bus.

So, we have developed algorithm to estimate delay by obtaining a straight line distance from latitude and longitude at location of the bus and the bus stop, and using it. Detailed account of the algorithm is given below.

- 1) Distances of bus position and all bus stops are calculated based on the location information.

- 2) The shortest distance is defined the nearest bus stop among the distances calculated in the preceding clause.
- 3) Scheduled time that a bus passes over present location is calculated based on the scheduled time of passage of the nearest bus stop and bus stop before that.
- 4) Difference between the passage schedule time of the present location of the bus and current time is estimated as a delay.
- 5) The estimated delay is reflected in the running bus table.
- 6) It is assumed that it has passed over bus stops from the first bus stop to nearest bus stop, and reflected in the bus stop passage information table.

This algorithm is executed every time the location information is sent from smart phones. The algorithm can not judge whether to have passed accurately. Because of it, the bus stop passage information display becomes the one described in section. II.

## IV. EXPERIMENTAL RESULTS

We expected to verify operation of a bus location system and precision of estimation of delay.

We took 3 buses on Thursday, January 28, 2010. Those are the departure of Karo loop line from Tottori Station at 13:55, the departure for Amedaki from Tottori Station at 14:00 and the departure for Tottori Station from Amedaki at 15:10. We sent the location information every 1 minute from a bus, and performed path planning system of Bus-Net between bus stops in the route actually from a PC. And we checked the display which indicates the bus location and the bus stop passage information display were confirmed. The result of the experiment was that an accurate information of location of running bus and bus stop passage information were almost obtained, and it could confirm that the delay and passage information were correctly reflected in the bus table and the bus stop passage information table while operating it.

## V. CONCLUSION

We have developed a bus location system using smart phones and an algorithm that estimates delay of buses. As a result, passenger of a bus can obtain the location information and delay information on buses from PC and mobile phone. In addition, we can design the path planning system considering delay of bus.

This system is low cost compared with existent bus location system and can be managed, because equipment like sensors are not installed in bus stops.

The developed bus location system is scheduled to be put to practical use in the future.

## REFERENCES

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