Studies on collection method of Access Point in metropolitan-scale 802.11 Location Systems

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ABSTRACT
In this paper, we describe comparison of access point's collection method in 802.11 location systems. There have been some studies on metropolitan-scale location systems using 802.11 beacons [1][2][3][4]. In PlaceLab project, they proposed the Self-Mapping method of 802.11 access points [4]. Some startup access point's data are required for Self-Mapping, so it needs to consider the effective collection method of access points. We conducted experiments in commercial area, and compare the collection method of access point from a point of view about accuracy and coverage.

Keywords
Wireless LAN, Location System, Positioning, Location Based Services.

INTRODUCTION
Over the last few years, wireless LAN based location systems have been a hot subject of controversy. In this paper, we show some studies on a collection method of access points in 802.11 location systems. There are some differences the number of access points according to collection method. For example, if a user collects access points using by bicycle, small motor vehicle or car, the number of access points is different. Additional to this, if the user change route, the number also change. We conducted experiment using three types of collection method and five types of route in commercial area. Our results show these relationship and trade-off of collection method.

Experiments
We collected access point's information in Figure1. The size of this commercial area is 1km square. The access point's information is a set of MAC address, longitude, and latitude of access point. The collectors carried laptop, wireless LAN adapter, and GPS in a backpack. By using this backpack they aquired the access point's information. In this experiment, we examined following tow impacts of collection.

- Impact of Collection Method

For the purpose of evaluate relationship between accuracy, coverage, and collection method, these four collectors aquired access point's information in three methods. Collectors A and B used a bicycle. The collector C used a small motor vehicle and the collector D used a car in Figure 1 and collect the access point's information.

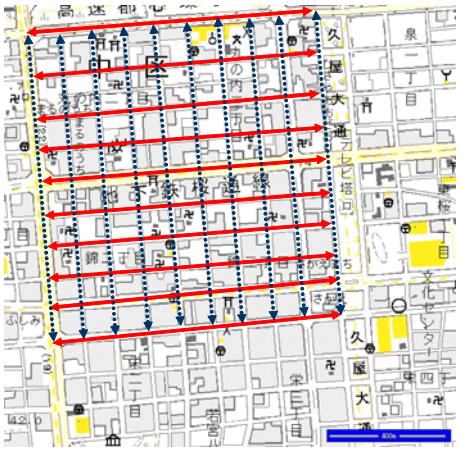

Figure 1. Overview of Experimental Environment

- Impact of Collection Route

To evaluate relationship between accuracy, coverage and route, these collectors conducted following five types of route.

(a) All route in Figure 1.
(b) Horizontal doted line in Figure 1.
(c) Vertical full line in Figure 1.
(d) All route of left figure in Figure 2.
(e) All rout of right figure in Figure 2.

If we define total distance of the route (a) as 1, the distance of the route (b), (c) and (d) are about 0.5. The distance of the route (e) is about 0.25.

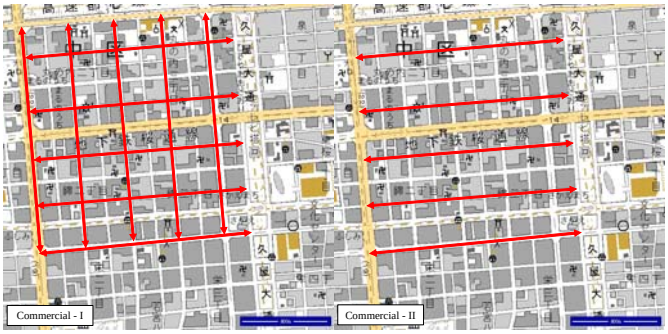

Figure 2. Difference of collection route

- Positioning Method

As positioning method, we used weighted centroid method. When a user observed signal strength $(ss_1 \ldots ss_n)$ from known access points $[AP_1(x_1,y_1) \ldots AP_n(x_n,y_n)]$, the system calculates the user's position (x_t,y_t) as follows (n is the number of access points which the user observed).

$$(x_t, y_t) = \left(\frac{\sum_{i=1}^{n} \frac{x_i}{10^{-32-\alpha_i/25}}}{\sum_{i=1}^{n} \frac{1}{10^{-32-\alpha_i/25}}}, \frac{\sum_{i=1}^{n} \frac{y_i}{10^{-32-\alpha_i/25}}}{\sum_{i=1}^{n} \frac{1}{10^{-32-\alpha_i/25}}}\right)$$

Result

In whole experiments, the four collectors found 878 access points. The collector A, B, C and D found 738, 644, 600, and 542 access points. Collection time of each collector was 8978sec, 7176sec, 4779sec, and 3064sec. A Small Motor vehicle and a car can collect access point information rapidly, but the numbers of access points were less than bicycle.

- Impact of Collection Method

We used data of collector A as estimation data and data of collectors B, C, D as study data. Table 1 shows the result of average, standard deviation (SD) and coverage. The Coverage means how many points can estimate user's position. The access point's data collected by Car (D) is worse accuracy and coverage than other 2 methods. Because this access point's data is less than others, average and coverage become worse. A car run route rapidly, but it is trade-off to accuracy and coverage. A small motor vehicle is a little worse than bicycle. Compare to bicycle, small motor vehicle and car had another disadvantage. They can't run on a one-way street, so its need to consider one-way street or not.

Table 1. Result of Collection Method

Collector	Average	SD	Coverage	Time
B (Bicycle)	48.7m	33.5m	98.8%	7176sec
C (Small motor vehicle)	51.7m	33.3m	94.8%	4779sec
D (Car)	52.6m	34.9m	92.4%	3064sec

- Impact of Collection Route

Table 2 shows the result of average, standard deviation, and coverage to each route collection. Although total distance of the route (b), (c), and (d) was down by half than the route (a), accuracy and coverage didn't decrease by half. The total distance of route (d) was down by quarter, but average and coverage didn't decrease by quarter also. It is a trade-off to select some meters accuracy or severalfold of distance cost in dozens of average location system.

Table 2. Result of Collection Route

Route	Average	SD	Coverage	Distance
(a)	49.1m	33.3m	96.0%	1
(b)	47.8m	32.4m	94.7%	0.5
(c)	58.6m	32.7m	85.8%	0.5
(d)	55.5m	36.9m	86.7%	0.5
(e)	68.3m	39.8m	58.2%	0.25

Conclusion

In this paper, we examined the relationship between accuracy, coverage, collection method, and collection route. Our results show:

- A vehicle can collect access point's information rapidly, but can't many access points compared with bicycle.

- If collectors decrease route by half, accuracy and coverage don't decrease by half. Therefore, it is better to use both case as the situation demands.

We increase efforts to collect many access points.

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