LockyUnderground : Subway Information System using WiFi Location Technology

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Abstract. In this paper, we propose a subway information system named "LockyUnderground" which utilizes WiFi location technology for supporting a user in the underground. The system is composed of a mobile device with a WiFi device and a communication server. We have developed seven location aware applications for the mobile device. Each of the application helps the user with current location information. We have performed a demonstration experiment in the subway of Nagoya City with 35 subjects and got a positive acceptance of the system.

Keywords: WiFi Location, Underground, Indoor Location, Location Information System

1 Introduction

WiFi location technologies become popular by the research papers[1,2] and several working services. Skyhook Wireless provides a service named "Loki"[3] and also serves for iPhone/iPod Touch WiFi location services. Koozyt also provides a WiFi Location Web services in Japan named "PlaceEngine"[4]. We have been also managing a portal page named "Locky.jp"[5,6] and gathered more than half million of AP location information for outdoor WiFi positioning. However, current working technologies are mostly for outdoors, because it is easy to gather the location of WiFi APs for outdoors using GPS and it is not easy to gather the indoor location of APs.

In this paper, we introduce a large-area indoor information system named "LockyUnderground" which utilizes WiFi location technology. We have developed seven mobile applications to support users of the Nagoya City subway system. We have performed a demonstration experiment in the subway of Nagoya City with 35 subjects and got a positive acceptance of the system. The demonstration system has a logging function to record 'What kind of application or operations are performed at which location'. Statistical information of the usage log are also presented in Section 4. The logs can be used for further analysis.

2 II. WIFI LOCATION DATABASE FOR UNDERGROUND

To implement a WiFi location system, we require a database for location of WiFi APs. Currently, there is no easy way to gather WiFi AP information for indoors. So we have developed software to locate ourselves and to record WiFi environment. We utilize a digital photo of a floor map. In the most of the public places, we have a floor map sign board. But it is not easy to obtain the digital version of the map. So we decided to use just a photo of the board. By this decision, one can easily gather the location information using a PDA or PC which has a digital camera and a touch screen. Fig.1 shows a screen shot of Subway Stumbler. User can import a photo and zoom/unzoom for locating himself. Additionally, we are planning to use the software to upload the gathered AP location data to the portal server like Locky.jp.

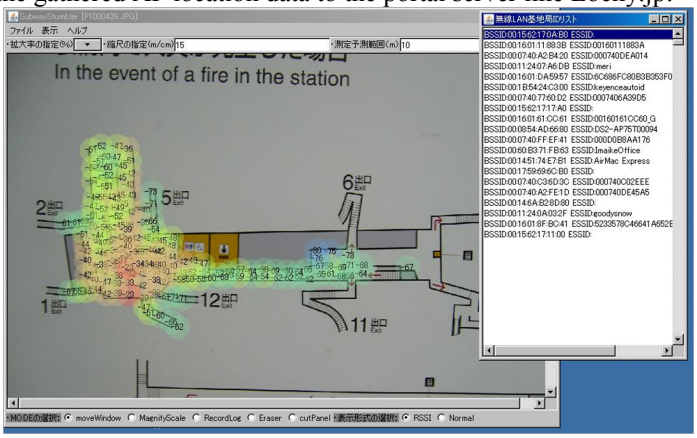

Fig. 1. Screen shot of the Subway Stumbler. Operator can point the map to record the current WiFi environment.

Table 1. Gathered WiFi AP Locations for Nagoya Underground

Number of Stations	83 stations
Number of Floors	356 floors
Number of APs	1,777 APs
Collected Points	28,620 points
Cost for gathering	30 man month

After the implementation of the Subway Stumbler, we started the AP information acquisition. We decide to gather the information of the WiFi in the stations of Nagoya Subway System because the subway just placed WiFi APs in 2007. Nagoya city is a large size city with two million citizens and have 6 subway lines with 83 stations. We map and gather the all floors of the all stations in Nagoya. Finally, we found APs shown in Table 1. We also transform the location of each APs from the relative position in the photo image into the absolute position in the WGS83 lon-lat. We put the all WiFi AP locations on the Google Earth.(Fig. 2.).

Fig. 2. Gathered WiFi AP location database for all 83 Nagoya Subway Stations

3. Mobile Location Aware Applications

We selected Apple's iPod Touch as a platform of the system because it has a WiFi, touch screen, large memory and good development environment. We have developed seven applications for Subway Information System on the iPod Touch such that, Launcher, TrainMap (Nagoya Subway Rail Map), NextTrain (Real time timeable), Friend Map, iNavi (Location aware database system), Underground Map and Station Map. Each application can start from the "Launcher" by using URL scheme with location information. TrainMap shows a real time status of trains from timetables (Fig.3). NextTrain count down a time for next train and FriendMap shows a location of your friend using location server (Fig.4). FriendMap has a function to chat with other friends.

Fig. 3. Screen Shots of Mobile Applications for LockyUnderground

4. Demonstration Experiment

By using these applications and iPod Touch, we have performed a demonstration experiment with 35 subjects. We made a group of a few subjects and gave a different

"task" for each. The task includes to find a shop, restaurant, etc. and to meet each other in the subway by using Friend Map. After the experiment, we collected questionaries from each subject about what they think in the experiment. We got positive responses from most of subjects while there are future improving points. Logs from the experiment are collected and analysed thorough the location and type of the application (Fig.4).

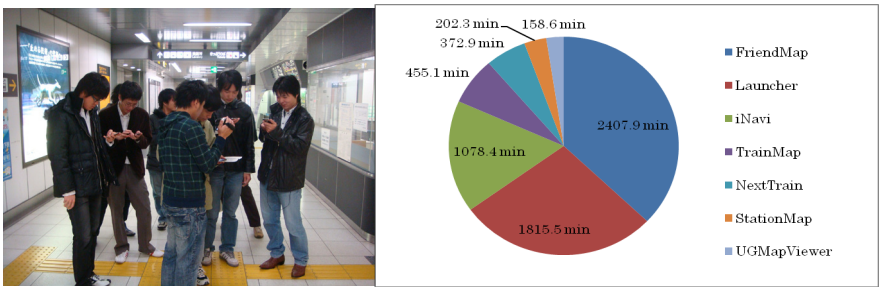

Fig. 4. Application Usage Statistics of the Subjects in the Demo. Experiment (Total over 100h)

5. Conclusion

In this paper, we introduce "LockyUnderground" which is our implementation of Subway Information System. We have recorded all user logs of each subject. We can extract the intent of each subject with the location. So we will analyse the log to make a better recommendation of the service.

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