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A System for detecting the Stray of Objects within User-defined Region using Location-Based Services

Byungkook Jeon¹ and R. Young Chul Kim²

¹Dept. of IT, Gangneung-Wonju Nat'l University,
Namwon-Ro, 150, Wonju City, Gangwon-Do, Korea

²Dept. of CIC(Computer and Information Communication), Hongik University
Sejong Campus, 339-701, Korea
¹jeonbk@gwnu.ac.kr, ²bob@hongik.ac.kr

Abstract

There are many applications using LBS such as navigations, location tracking, the whereabouts of a friend or employee. Most of these applications have the feature of active service mechanism. In this paper, we propose a system for sensing the stray of any objects within user-specified region as passive service mechanism. The proposed system has been initially authenticated the target objects and then matched between smartphone and a target object using LBS in smartphones. After a period of time, if the object has been break away from the specified boundary region, it is that the smartphone detects the straying status of the object. This system presents a virtual barrier such as a geofence. Therefore, the proposed mechanism will can be used of many applications such as anti-theft/anti-lost of any objects, preventing of stray children. Especially, it will be more opportunities combining with active service mechanism.

Keywords: Geofence, Sensing System, LBS, Active service, Passive service, Smartphone

1. Introduction

LBS(Location-Based Services) are an information service and have a number of uses in social networking today as an entertainment service, which are accessible with mobile devices through the mobile network and which use information on the geographical position of the mobile device such as smartphone, Tablet PC, etc.

LBS are used in a variety of contexts, such as health, indoor object search, entertainment, work, personal life, etc [1-8]. LBS include services to identify a location of a person or object, such as discovering the nearest banking cash machine or the whereabouts of a friend or employee [1, 4-8]. Most of these existing applications have the feature of active service mechanism [9].

On the other hand, geofencing service can be one of passive service mechanism [9]. Geofencing is a feature in a software program that uses the GPS(global positioning system) or RFID(radio frequency identification) to define geographical boundaries[10, 14]. Geofence programs allow an administrator to set up triggers so when a device crosses a geofence and enters (or exits) the boundaries defined by the administrator, an SMS or email alert is sent [9, 12].

Therefore, this paper proposes a system which looks like geofencing service. The proposed system is detecting the stray of any objects within user-specified region as a passive service mechanism. To do this, the target objects are initially authenticated and then the system has been matched between smartphone and an authenticated object

using LBS in smartphones. After a period of time, if the object has been break away from the user-specified boundary region, it is that the smartphone detects the straying status of the object. As a result, the proposed system presents a virtual barrier such as a geofence.

This paper is organized as follows. In Chapter 2, we will investigate the research background. The framework design of the proposed system is presented in Chapter 3 which consists of a server-side and client-side frameworks. The experimental results are described in Chapter 4. Finally, Chapter 5 provides concluding comments and suggestions for further research.

2. Related Work

LBS have become more and more important with the expansion of smartphone and Tablet PC markets as well[1-8]. LBS are used in a variety of contexts, such as health, indoor object search, entertainment, work, personal life, *etc* [1, 4-8, 14].

Especially, the term “geofence” or “geofencing” using LBS is popping up all over discussions of location-based services, with a special focus on its use in retailing [11].

A geofence is a virtual perimeter for a real-world geographic area [9, 10, 12]. A geofence could be dynamically generated - as in a radius around a store or point location. Or a geofence can be a predefined set of boundaries, like school attendance zones or neighborhood boundaries. Custom-digitized geofences are also in use.

When the location-aware device of LBS user enters or exits a geofence, the device receives a generated notification. This notification might contain information about the location of the device. The geofence notice might be sent to a mobile telephone or an email account. For example, geofencing or targeting shoppers near the point of sale is also catching on. Express offers coupons to those in and near its stores with its mobile app. The North Face offers deals not only to those near its stores, but also to those in recreational areas, via its VIPeak program. Its app offers lots of product info and great videos that the company's shoppers can engage with even when they are not shopping. Examples of their usage are shown in Table 1[7-9, 12].

Many geofencing applications incorporate Google Earth, allowing administrators to define boundaries on top of a satellite view of a specific geographical area. Other applications define boundaries by longitude and latitude or through user-created and Web-based maps

Recently, according to Google Co., Android location services now support geofencing from Google I/O 2013. With the new geofencing API an app can define geographic boundaries around specific locations and then receive notifications when a user enters or leaves those areas.

Even in the hardware field as well as software, there are emerging new devices such as Broadcom Corporation's GNSS(Global Navigation Satellite System) location chip with geofence capabilities, Philips' Hue light bulbs[14, 15].

Table 1. Usage Examples of Geofencing Service

Use	Example
Mobile device management	When a hospital Tablet PC leaves the hospital grounds, an administrator receives notification so the device can be disabled.
Fleet management	When a truck driver breaks from his route, the dispatcher receives an alert.
Human resource	An employee smart card will send an alert to security if an

management	employee attempts to enter an unauthorized area.
Compliance management	Network logs record geofence crossings to document the proper use of devices and their compliance with established rules.
Marketing	A retail business can trigger a text message to an opt-in customer when the customer enters a defined geographical area.
Asset management	An RFID tag on a pallet can send an alert if the pallet is removed from the warehouse without authorization.
Law enforcement	An ankle bracelet can alert authorities if an individual under house arrest leaves the premises.

3. The Proposed System Design

In this paper, the proposed system is sensing any breakaway objects within user-specified region as a passive service mechanism. This system is divided into a server side for recognition modules and service of smartphone, and a client side for an Id(identification) management module for recognizing the target object.

3.1. The Server-side Framework

The server consists of a framework structure as shown in Figure 1. This server framework is responsible for authentication, naming and network mediation services between any objects and smartphone.

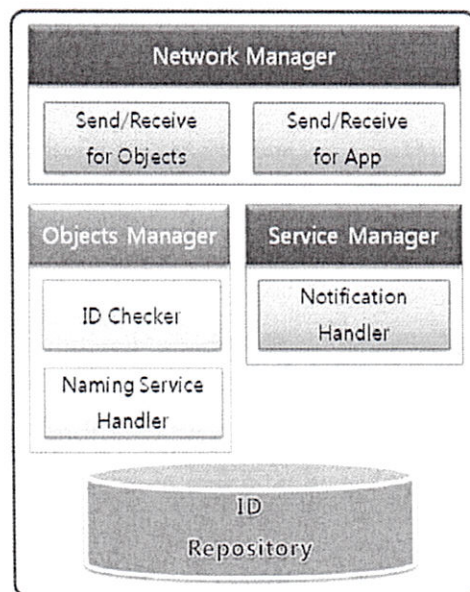


Figure. 1. The Server-side Framework

(1) Network Manager

- Sender & Receiver for Objects' Ids - Sending and receiving for objects' IDs
- Sender & Receiver in App - Sending and receiving Ids for App service of the smartphone

(2) Objects Manager

- Id Checker - Processing to match between the registered objects' Id and the requested objects' Id from App for security
- Naming Service Handler - Processing to create and register, authenticate the unique Id for new objects

(3) Service Manager

- Notification Handler – Processing to push service of messages or events

(4) ID Repository - Constructing database for Ids that are requested by the Data Manager

3.2. The Client-side Framework

The client-side framework consists of a target object framework and an app framework of smartphone. As shown in Figure 2, the object framework has holding authenticated Id via networks such as Wi-Fi, Bluetooth, RFID, TCP/IP. The app framework as shown in Figure 3 detects the registered objects breaking away from user-specified location using LBS in smartphone.

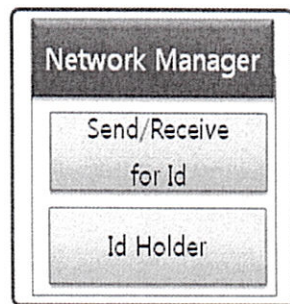


Figure. 2. The Target Object Framework

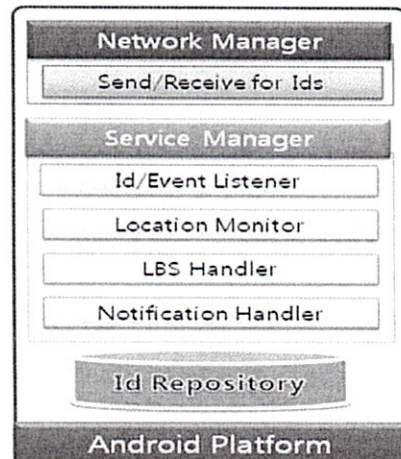


Figure. 3. The App Framework

(1) The Target Object Framework

- Network Manager - Processing to recognize simply a unique Id per object.

(2) The App Framework

1) Network Manager

- Sender & Receiver for Ids - Sending and receiving for the objects' Ids to recognize

2) Service Manager

- Id & Event Listener - Handling the target objects' Ids or the received events from the server

- Location Monitor - Deviation detection module that periodically checks the specified boundary of a target object
- LBS Handler - Monitoring range setting of the target object using the Google Map
- Notification Handler - Processing the message alert

3) Id Repository - Constructing local database for the targeted objects' Ids

4. Experimental Results

For the implementation of the proposed system as a passive service mechanism, an experimental model is assumed that the target object is set to a USB memory and how to detect the object through Android platform-based smartphone.

First of all, the server is started and ready to any events. Figure 4 shows current location of the smartphone to detect an object using Google map. Figure 5 shows that the server generates and registers a unique Id 'USB_Client@ad8659' for the USB memory by the naming service handler, and the smartphone is connected to the server. Next, the server sends target object's Id to the smartphone. The matching between the USB memory and smartphone is done by the registered and same Id value. The following Figure 6 shows sensing status of the registered object within pre-defined boundary such as 5 meters, 10 meters, 100 meters radius such as a geofence.

Also as shown in Figure 7, we can limit sensing range by changing the radius of 100 to 10 meters. After a certain period of time if the object or the smartphone has been break away from the user-specified boundary region, it is that the smartphone detects the straying status of the object. As shown in Figure 8, the user-specified boundary region was set up to notify the push alarm if the smartphone or the USB will be break away from the radius. When a user with smartphone get out of the user-defined region, the push alarm will continuously notified to the user.

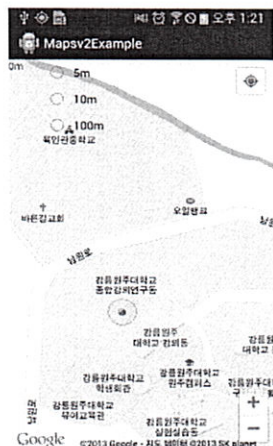


Figure. 4. A Google Map View of Current Location of the Smartphone

```
Server Open
Connected an Object
Connected ANDROID
rhkddb=ANDROID_Client
rhkddb=ANDROID_Client
{rhkddb=USB_Client@ad8659}
rhkddb=ANDROID_Client
```

Figure. 5. A View of Server-Side Event Log and Naming Service

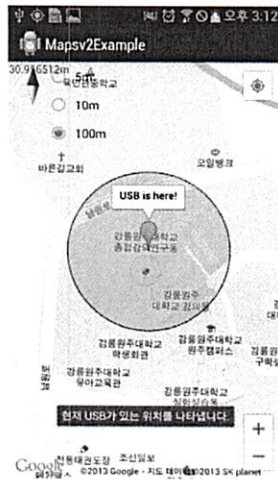


Figure 6. A Google map view after the USB was attached



Figure 7. Changing the sensing region within 10 meters

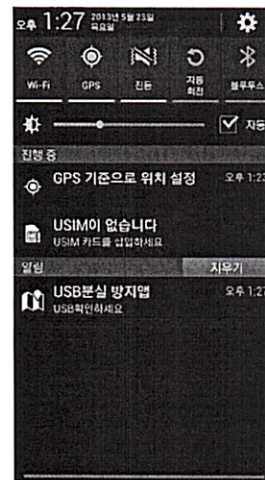


Figure 8. A view of push alarm service

5. Conclusion

LBS are used in a variety of contexts, such as health, indoor object search, entertainment, work, personal life, etc. LBS include services to identify a location of a person or object, such as discovering the nearest banking cash machine or the whereabouts of a friend or employee. Most of these existing applications have the features of active service mechanisms. On the other hand, geofencing service is one of passive service mechanism. Geofencing is a feature in a software program that uses the GPS to define geographical boundaries. Geofence programs allow an administrator to set up triggers so when a device crosses a geofence and enters (or exits) the boundaries defined by the administrator, an SMS or email alert is sent.

Therefore, in this paper, we proposed a system which looks like geofencing service. The proposed system is detecting the stray of any objects within user-specified boundary region as passive service mechanism. As a result, the proposed system presents a virtual barrier such as a geofence. The proposed system can be applied to more applications in conjunction with indoor LBS such as WPS (Wi-Fi Positioning System), HPS (Hybrid Positioning System). Especially, it will be more opportunities combining with active service mechanism.

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Authors



Byungkook Jeon received his B.S., M.S. and Ph.D. degrees in Computer Science from Kwangwoon University in 1985, 1991, and 2000, respectively. He is a professor in Gangneung-Wonju Nat'l University in Korea. His research interests include Geofence, LBS, BigData, Cloud computing, Smart agents, Sensor networks.



Robert Young Chul Kim received the B.S. degree in Computer Science from Hongik University, Korea in 1985, and the Ph.D. degree in Software Engineering from the department of Computer Science, Illinois Institute of Technology (IIT), USA in 2000. He is currently a professor in Hongik University. His research interests are in the areas of Test Maturity Model, Embedded Software Development Methodology, Model Based Testing, Metamodel, Business Process Model and User Behavior Analysis Methodology.

