Paradigm Shift and the State of the Art of LBS in the Advent of Smartphone

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Abstract. This paper presents the paradigm shift and the state of the art of LBS(Location Based Service) in the recent mobile environment. The advent of smartphone, especially, HW(Hardware) for localization, the middleware for LBS and map DB(Database), leads a big step towards LBS as a killer application. The LBS grows very fast with various smartphone applications. In feature phone, the service area of LBS was limited and the main usage was finding buddy. However, in smartphone, LBS merges other killer applications such as SNS(Social Network Service), AR(Augmented Reality), game, mobile commerce and so on. The abrupt evolution of technology and service requires appropriate laws and systems for the future development.

Keywords: LBS, Smartphone, Platform, Applications.

1 Introduction

With the advance of smartphone technologies, various LBS applications are being provided to the user. The main characteristics of cell phone, portability and mobility, make the device optimized for LBS[1,3].

In feature phone environment, however, the platform and technologies are not open to the developers. It was a severe drawback for the services and applications. Hence, LBS was just a possible candidate for the killer applications during the feature phone era.

The open platform in smartphone causes a big change in LBS. The smartphone platform in iPhone and Android supports HW, SW(Software) and DB related to LBS. It becomes foundation for the open development of LBS applications.

For the platform aspect, smartphone platform provides location functions using GPS(Global Positioning System), WLAN(Wireless Local Area Network)and Cell-ID(Cell Identification), the function of orientation recognition using digital

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compass, and the database for the map and the location. For the aspect of service, killer LBS applications such as Foursquare[4] appear merging other services such as SNS[4,5], AR[6,7], commerce[8], advertizement[8,9] and so on. However, the abrupt evolution of services causes problems of privacy preservation because anyone can be tracked easily.

In this paper, we analyze the paradigm shift of LBS in the advent of smartphone and describe the present and the future of LBS in smartphone, extending the previous work [10].

First, we analyze the main differences between conventional LBS based on feature phone and smartphone based LBS. Next, we summarize the LBS related technologies of smartphone and the state of the art of LBS applications. Finally, we present the future characteristics of smartphone LBS.

2 Paradigm Shift of LBS with Smartphone

The advent of smartphone causes a paradigm shift in LBS like other smartphone services. Table 1(a) and 1(b) show the characteristics of LBS in feature phone and smartphone, respectively.

Table 1. Characteristics of LBS according to the phone environment

(a) Characteristics of feature phone based LBS

Aspects	Characteristics
Technology and Industry	Telco. and manufacturer centric Not Open Platform Limited services
Law and System	Enable to control technology Only approved services Stable establishment
Monitoring	Monitoring of Telco. services

(b) Characteristics of smartphone based LBS

Aspects	Characteristics
Technology and Industry	User and developer centric Open LBS Platform Open services
Law and System	Impossible to control technology Difficult to approve services Difficult to establish laws Privacy protection is required
Monitoring	Difficult to monitor services

In feature phone environment, only telecommunication companies, cell phone manufacturers and approved companies can develop LBS applications. Thus, the

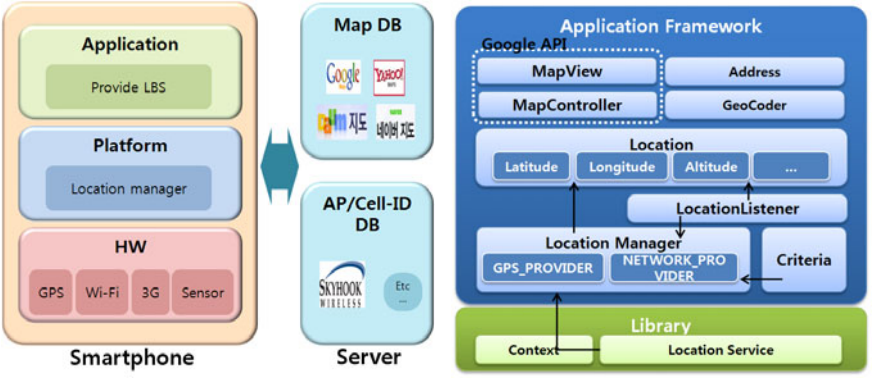
LBS platform is under control and service environment is restricted. In the aspect of law and system, government can control LBS related technologies according to the related regulations because only approved services can be provided to the user. Therefore, the whole services can be monitored with the help of telecommunication company.

Different from these, smartphone based LBS has different characteristics. The user and application developers are the main actors. Platform and service environment are open. Based on these facts, it is almost impossible to control technology. Also, the privacy protection becomes one of the main issues as anyone can be easily tracked.

As can be seen in Table 1(a) and 1(b), there is a difficulty in legislating laws and regulations appropriate to the smartphone environment. However, the establishment of law and systems will be very helpful to the evolution of smartphone based LBS.

3 LBS Related Technology in Smartphone

LBS related technologies in smartphone include the HW/SW technologies for the location, DBs for map and AP(Access Point) /Cell-ID and so on. Fig. 1(a) shows the components of LBS related technologies in smartphone. Several service DB's are important components as well as the platform in smartphone.



(a) Components of LBS for smartphone (b) LBS related components in Android

Fig. 1. Smartphone related LBS technology

The location is determined using GPS, WLAN and Cell-ID with the support of AP/Cell-ID DB. The digital compass measures 3-dimensional magnetic field and helps the determination of orientation. Map DB provides the geographic map to the smartphone. The application developer can make smartphone LBS

application using LBS related API(Application Programming Interface)s and DBs. Fig. 1(b) shows LBS related components in Android platform.

There are other components, which are not related to LBS directly but utilized for LBS. For example, AR services are widely provided based on LBS. In a certain case, it may be very difficult to make a touch input when using LBS. In such a case, voice search is very useful to LBS.

4 The State of the Art of Smartphone Based LBS

4.1 Service Types of LBS

In feature phone, the service types of LBS are limited such as tracking, finding buddy, navigation, traffic information etc. However, in smartphone, LBS applications merge with other application types. As in Table 2, various services such as AR, SNS, game etc. are combined with LBS and evolved to various applications. In fact, LBS smartphone applications have characteristics of many service types. In Table 2, we describe just one specific service type for one application.

Table 2. Examples of LBS applications in smartphone

Service types	LBS examples
Finding buddy	Google Latitude (http://www.google.com/latitude)
Navigation	GINI (http://www.gini.co.kr) T-map (http://www.tmap.co.kr)
SNS	Foursquare(https://foursquare.com/) Playmap (http://www.playmap.co.kr/)
Restaurant and spot	Yelp(http://www.yelp.com/) Gowalla (http://gowalla.com/) WhereIs (http://www.whereis.co.kr/) WHERE (http://www.where.com)
AR	Bionic Eye(http://www.bionic-eye.com) WorkSnug (http://www.worksnug.com) Sekai camera (http://www.sekaicamera.com/) Scan search (http://www.scan-search.com/) OVJET (http://www.ovjet.com/)
Game	Foursquare(https://foursquare.com/) iButterfly (http://www.mobileart.jp/ibutterfly.html) T-map geocaching (http://www.tmap.co.kr)
Commerce & advertizement	SKT AdZone(http://www.sktelecom.com/) AliGo (http://www.aligo.co.kr/)
Car sharing	ZipCar(http://www.zipcar.com/)

Table 3 shows nominated LBS applications. As in Table 3, LBS applications combining with other services become killer applications.

Table 3. Nominated LBS applications in smartphone

Application	Nomination
Yelp	App Store Essentials Hall of Fame
Golfscape GPS Rnagefinder	App Store Essentials Hall of Fame
Nike+GPS	App Store Essentials Hall of Fame
Yelp	Time 2009 Best Apps (Must Have Apps)
Trapster	Time 2009 Best Apps (10 Best iPhone Apps for Dad)
Fanfinder	Time 2009 Best Apps (10 Best iPhone Apps for Dad)
Kayak	Time 50 Best iPhone Apps 2011
Yelp	Time 50 Best iPhone Apps 2011
Weather Channel	Time 50 Best iPhone Apps 2011
Open Table	Time 50 Best iPhone Apps 2011
Hopstop	Time 50 Best iPhone Apps 2011
AroundMe	Time 50 Best iPhone Apps 2011
Google Earth	Time 50 Best iPhone Apps 2011
Zipcar	Time 50 Best iPhone Apps 2011
Foursqaure	Time 50 Best iPhone Apps 2011
Google Sky Map	Must Have Android App. Top 10 (NY Times)
CardioTrainer	Must Have Android App. Top 10 (NY Times)
UrbanSpoon	Must Have Android App. Top 10 (NY Times)
Playmap	Mobile Technology Awards 2009 (Korea)
OVJET	Korea Mobile App Awards 2010 (Korea)
Scan search	Korea Mobile App Awards 2010 (Korea)
I'm in	App Award Korea 2011 (Korea)
Seoul Bus	App Award Korea 2011 (Korea)

5 Toward Future LBS

Although many applications for LBS are provided in smartphone, there still remains lots of homework for the next generation LBS.

Most of all, in order to implement seamless LBS between outdoor and indoor LBS, the precision of location should be enhanced and indoor LBS should be fully developed. Hybrid location method can be applied to the smartphone with RFID(Radio Frequency Identification), ZigBee, VLC(Visible Light Communication), vision based LBS and so on. For map DB, 3D map should be provided for usability. With the user data for LBS, analysis of user experience can be very helpful to the LBS user. For the service aspects, the combination with mobile commerce and mobile advertizement can be profitable to LBS. Also, there are much problems for the privacy issues. Laws and systems should be established for the future LBS.

5.1 Technologies for the Evolution of LBS

Recently, indoor applications are commercialized based on WLAN or other technologies. Most of LBS applications are based on GPS and focus on outdoor LBS.

There should be the seamless LBS between outdoor and indoor LBS. Adequate technologies should be developed.

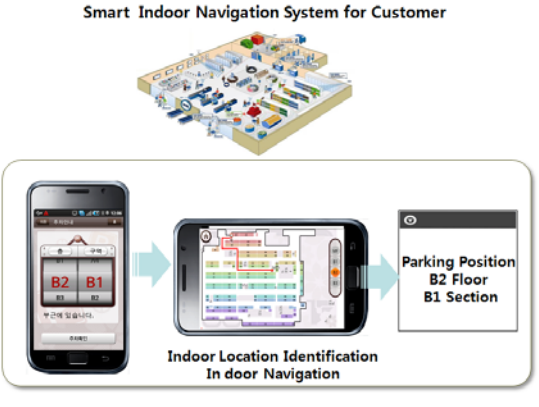
Also, the precision of location should be improved with various hybrid positioning scheme and for user's convenience, 3D map should be supported.

In ISO TC 211, the dynamic position identification scheme between indoor and outdoor environment has been discussed at ISO 19151. Also, in TC 204, the map format for indoor navigation and position DB have been under standardization.

For the aspects of technology, the following objectives are under consideration or being commercialized :

- Seamless LBS with indoor LBS [11]
- 3D map and 3D navigation [12][13]
- Precision enhancement of location determination
- Hybrid location identification
- Navigation for pedestrians
- Vision based LBS
- Convergence with navigation kit for automobile
- Unification of user interface between automobile and smartphone [14][15]

Fig. 2 shows examples of indoor LBS(SK Telecom) and 3D map(HYUNDAI MNSOFT).



(a) Indoor LBS

(b) 3D map

Fig. 2. Examples of indoor LBS (SK Telecom) and 3D map (HYUNDAI MNSOFT)

5.2 Services and User Experience

Based on the accumulated user data, user experience can be analyzed and the result can be provided to the user. Also, the combination with mobile commerce and mobile advertizement can be profitable to LBS.

For the aspects of services, the following objectives are under consideration or being commercialized :

– Analysis of user's LBS data [16]
– Mobile commerce using LBS [8]
– Mobile advertizement based on the location [8,9]
– Event data recorder for automobile
– Convergence with SNS, AR, Game and so on
– Convergence with off-line services [17]

Fig. 3 shows an example of mobile commerce and advertisement using LBS.

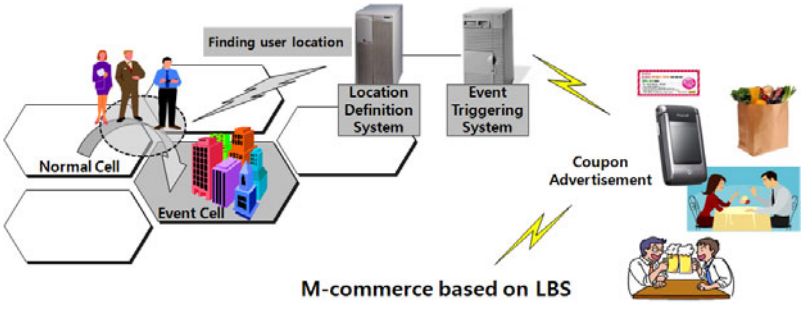


Fig. 3. Mobile commerce and advertisement using LBS of SK Telecom

5.3 Law and System for Smartphone LBS

Recently, the privacy problem for LBS service is being a critical problem. Location tracking issues for Google and Apple make critical issues for the location privacy and cause serious discussions for the safety of LBS.

In fact, the problem of LBS is more crucial than the general SNS. As in Table 4, in conventional SNS, only the data which the user has uploaded are reproduced. The data can be misused irrespective of user's intention, which can cause a problem.

In the LBS+SNS service like Foursquare, only the data which the user has uploaded are reproduced. Still, the location information can be misused irrespective of user's intention and it can cause a problem.

However, in LBS applications, there exist services which collect users location without any notice of user. Although there is a user's admission for the gathering location information at the fist stage of the service, it can cause a serious problem.

Table 4. Characteristics and problems of LBS and SNS

Application	Service type	Characteristics and problems
Google Latitude	LBS+SNS	Location information can be used without notice to user Cause serious problems for location privacy Essential information for LBS
Foursquare	LBS+SNS	Upload the location information by the user
General SNS	SNS	Upload information by the user

As in Table 4, there is a conflict that the location information is essential for the LBS applications but is dangerous for the user's privacy. Considering these facts, appropriate laws and systems should be established for stable LBS. Also, the user should protect user's own information by him/herself. For the popularity of LBS, we need more location information of users and we should establish concrete laws and systems, which will be the foundation of future LBS.

6 Conclusion

In this paper, we have presented the paradigm shift and the state of the art of LBS. With the open platform and the development of various applications, LBS becomes a killer application for the smartphone era.

Especially, LBS applications are now combined with other services like AR, SNS, game, commerce, advertizement, and even off-line services. The number of users grows fast in LBS applications such as Foursquare, Yelp, Playmap and so on over the world. Also, mobile commerce and mobile advertizement based on LBS will devote to the profit of LBS applications.

Although there are privacy problems for the location information, the establishment of laws and systems will be very helpful for the evolution of future LBS.

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