

Location Based Services (LBS) for the Elderly using Augmented Reality

Myeon-Gyun Cho

Associate Professor,

School of Information and Communication, Semyung University, Jecheon-si, 27136 Korea

mg_cho@semyung.ac.kr

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Abstract

Due to the transition to a rapidly aging society and nuclear family, the number of the elderly living alone in need of social attention and public welfare has also increased. In particular, the older people have a great difficulty in finding belongings in the house and evacuating in emergency situation, because they have no one to look after. By introducing location based services(LBS) through IT convergence with augmented reality(AR), it is possible to provide integrated services such as finding belongings in the home and saving the elderly from danger outside. In this paper, we propose an AR based LBS that locates belongings in the home, and evacuates the elderly from dangerous place or situations. Through the Bluetooth communication between smartphone and beacons, we have developed AR based LBS application in smartphone, with which the old can find their everyday belongings in home, and can escape dangerous areas during disasters such as fires and earthquakes. By introducing AR into LBS, the elderly could easily find belongings in home and quickly find way to outside from building in flames. To improve location accuracy of LBS, we used Bluetooth communication between beacons and smartphone.

This paper has developed an AR based application that finds location of personal belongings through Bluetooth communication and shows direction to the exit from dangerous place. By implementing LBS with two functions in smartphone, we can find that the old can easily find your belongings in the house and search for an escape route in case of fire wherever he goes. If the proposed system is adopted by elderly people living alone, the old will be able to lead independent lives conveniently and safely, both inside and outside the home. In the future, we will apply augmented reality technology to help the elderly to independently adapt to social life, which means fulfillment of public welfare.

Keywords: AR(Augmented Reality), Age Friendly Technology, LBS(Location Based Service), Public Welfare, Beacon Communication

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1. Introduction

Since rapid industrialization, urbanization, and nuclear families are being accelerated by socioeconomic developments, it makes increasingly difficult for families to support the elderly. Accordingly, various social problems arise due to the elderly living alone without being supported from their family [1]. Therefore, the state should ensure that the elderly is materially secured

to live a human life [2]. Concept of public welfare is changing and expanding from medical treatment through technology to solutions to various social problems such as aging, solutions to support the universal well-being of the people, to helping or supporting the elderly from daily life [3].

Based on the development of IT technology, the Fourth Industrial Revolution introduced an attempt to harness the human senses, which are augmented

reality(AR) and virtual reality(VR) technologies [4,5]. Augmented Reality consists of an interactive experience of a real-world environment whereby the objects that reside in the real world are augmented by computer-generated perceptual information sometimes across multiple sensory modalities. Virtual Reality completely replaces the user's real-world environment with a simulated one. In the 4th Industrial Revolution, AR and VR are representative technologies that can be applied to public welfare services for elderly, so called elderly friendly services [6-8]. The reason is that the visual, auditory, tactile technology and realistic contents that enable realistic experiences are showing great potential for the realization of public welfare.

Aging often leads to decreased social engagement. Since technology has the potential to improve the quality of life among older adults, some researches were done about effects of new technologies including VR and AR applications, on their well-being such as health care, rehabilitation and continuing education [9,10]. A comparison of the effects of AR and VR in the treatment of pulmonary phobia has shown that AR is more suitable for treating claustrophobia than VR in terms of cost and effectiveness [10]. Since 3D real time VR in web-based continuing education platform provides the more effective virtual learning environment, it improves the correctness, flexibility and efficiency of developing web-based continuing education platform, and improves the immersion of the learners finally [11]. However, such AR/VR technology has the following disadvantages. First of all, high-end H/W is required for continuous high-quality image processing, and expensive display equipment such as HMD (Head Mounted Display) is also essential. Secondly, long-term use may cause the elderly of dizziness or vomiting. Lastly, AR applications are not receiving much attention due to the lack of contents for the elderly.

With the proliferation of wireless infrastructure and the widespread use of high-performance mobile devices, the importance of Location-based Services

(LBS) is being highlighted [12]. LBS refers collectively to providing useful information to humans using location information of objects [13]. One of the notable applications of LBS is precision marketing and entertainments, which has displayed its attractiveness all over the world [13,14]. Another research presents IPS (Indoor Positioning System) and motion tracking system for elderly people staying alone [15]. The system can track the location of the elderly relative to the room in which it is currently located and recognizes whether the elderly is moving or sitting. Recently, there has been a simulation study modeling the stable evacuation index of older people when buildings are affected by earthquakes [16]. The simulation took into account LBS information such as human location within the building and the current evacuation route, as well as earthquake magnitude and body mass index (BMI).

However, few studies have been done in AR technology as a means of improving the lives of older people or evacuating from emergencies. Therefore, we have developed an AR based application that finds location of personal belongings through Bluetooth communication and shows direction to the exit from dangerous place. And beacon was added to improve the accuracy of location which is a disadvantage of the existing LSB technologies. Therefore, this paper suggests the convenience services in the home and the danger evacuation services that are essential for the elderly living alone. By implementing this LSB system on smartphones using augmented reality, we have shown that the proposed system is promising as an economical and efficient means of welfare for older people.

This paper is organized as follows. Chapter 2 introduces existing LBS technologies applied to silver industry and their current status. Chapter 3 proposes an elderly friendly LBS based on AR to solve the problems of the existing welfare supporting technologies for the elderly. Chapter 4 describes the implementation results of the

proposed system and Chapter 5 consists of the conclusion including future studies.

2. Related Works

VR/AR are one of the core ICT technologies that will change the pattern of life in the future. These technologies have provided entertainment in the traditional game, entertainment, and media fields. However, new attempts are being made to move beyond the traditional scope and to apply in the general fields of life and industry such as shopping, education, medical care, public welfare and manufacturing.

2.1 Public Welfare Service using AR and VR

It is the state's responsibility to ensure that all citizens live a human life with a happy life, which has been provided by a service called 'public welfare' [3]. Welfare technology goes beyond the concept of well-being technology, from medical treatment to human dignity. It has developed into a solution to solve the social problems caused by aging. Among the 4th industrial revolution technology, AR/VR technology is emerging as a welfare technology. The reason is that it is possible to provide the contents necessary for the realization of public welfare by utilizing the sense of sight,

hearing, and tactile sense that enable a realistic experience [4,5].

Thus, Table 1 shows the applications of VR/AR as a welfare technology. As shown in Table 1, VR/AR has achieved great results, especially in the medical field, such as medical diagnosis, rehabilitation, and psychotherapy, thereby enhancing the quality of medical services and maximizing added value [6-8]. One research shows that the emotional quality of life is improved by increasing the emotional happiness of the elderly, when contents related to travel and rest are provided to the elderly using the VR system [9].

As we enter an aging society, the social problems for the elderly is expanding, in order to solve them, MIT's startup renderer is producing and servicing VR content that can bring back memories of family events such as marriage [10]. Figure 1 shows the elderly relive their memories through the VR program provided by Rendeever. As for public welfare support, they proposed VR in web-based continuing education platform. By providing the more effective, virtual learning environment, it improved the correctness, flexibility and efficiency of developing web-based continuing education platform, and finally increased the immersion of the learners [11].

Table 1: Application Status of Public Welfare using AR/VR

Type of Welfare	Cases of Technology Application	Reference
Medical treatment (Medical care, Treatment, Rehabilitation)	Image training and education of surgery	[6-8]
	Psychiatric treatment (fear of heights, obstructive fear)	
	Early Diagnosis of Alzheimer Using VR	
Simple Daily Life Help	Emotion care service for the elderly	[9]
Solving Social Problems	Elderly and disabled care in social trouble	[10]
Universal Public Welfare Support	Vocational and continuing education using AR/VR	[11]



Figure 1. Elderly people relive their memories through VR programs [10]

However, such VR technology has the following disadvantages. First of all, high-end H/W is required for continuous high-quality image processing, and expensive display equipment such as HMD is also essential. Secondly, long-term use may cause the elderly of dizziness or vomiting. Lastly, AR is not receiving much attention due to the lack of contents for the elderly. Therefore, it is necessary to introduce an economical and simple age-friendly system by integrating AR technology into smartphones that everyone has.

2.2 Location Based Services using Smartphone

LBS (Location Based Service) refers collectively to providing useful information to humans using location information of objects. Recently, as high-performance personal handheld terminals are equipped with GPS (Global Positioning System) and ICT operators expand user support policies, research and development of LBS is being actively conducted.

Table 2: Types and Features of LBS using Smartphone

Type of LBS	Features	Reference
Commercial Advertisements/ Game	Notification of places of interest (restaurants, experiences) around user	[12-14]
	Commercial advertising around users	
	Location-based entertainment or game	
Indoor Positioning	Motion Tracking for the elderly living alone in case of a fall or emergency call	[15]
Outdoor Positioning	Check the final location of elderly people during natural disasters such as earthquakes	[16]

Table 2 shows the typical functions of LBS and its features. The first LBS field is commercial advertising and entertainments. As a service for the purpose of providing various information mainly based on location information, Includes information services (restaurants, gas stations, etc.), road conditions and traffic information services

[12]. Another application is that uses LBS commercially, and if you enter a specific location, you can see location-based advertisement, or get a discount coupon at nearby stores or shopping malls [13]. As a service area that has recently been in the spotlight, games that perform missions by location or face off against each other are already being

provided, and there are fortune-based services and meeting services based on location [14].

The second field of application for LBS is indoor and outdoor location tracking, security and accident prevention. An indoor positioning system (IPS) and motion tracking system were developed for the elderly, who are staying alone. By grasping the movements of the elderly living alone, they find out the emergency situation such as falls and notify the guardian automatically [15]. The outdoor positioning grasps the position of the elderly when moving outside, identifies the final location in case of natural disasters such as earthquakes, utilizes it in rescue, and warns them when approaching dangerous areas [16].

However, few studies have been done in AR technology as a means of improving the lives of older people or evacuating from emergencies. Therefore, we have developed an AR based application that finds location of personal

belongings through Bluetooth communication and shows direction to the exit from dangerous place. And beacon was added to improve the accuracy of location which is a disadvantage of the existing LSB technologies.

3. Proposed Methods

This chapter proposes a smart LBS that can provide welfare services suitable for the elderly by using positioning information from GPS and Beacon, and AR technique to easy use of the old people. The summary of functions and key features of the proposed LBS for the elderly is shown in Table 3.

In this paper, the beacon was used to identify the belongings or their exact position, and AR was introduced to maximize the realism to the user. We used BLE (Bluetooth Low Energy) communication between smartphone and Beacon to save the construction cost of the proposed system, and as a result, we can increase the accuracy of location information.

Table 3: Function and Key Features of the Proposed LBS for the Elderly

Type of LBS	Key Features	Techniques
Indoor LBS - Find out everyday belongings of the elderly	Put a small beacon on your main belongings	AR Bluetooth Beacons at Belongings
	Display direction and distance according to the strength and receiving direction of beacon signal mounted on belongings	
	Display direction on AR based screen in smartphone and beep sound according to distance	
Indoor LBS - Guide to escape from dangerous place for the elderly	Beacon is installed throughout the building to send ID and RSSI to nearby smartphones	AR Bluetooth Beacons at Building
	The cloud server sends evacuation information to your smartphone based on your location	
	The smartphone receiving the evacuation information displays the AR-based direction indication superimposed on the passage image.	

3.1 Indoor LBS for the Elderly: Find out every day belongings

Figure 2 shows the process diagram of the proposed Indoor LBS for the Elderly, with which

older man can find daily belongings using Bluetooth communication between a smartphone and Beacon. First, we must install the app for smartphones and attach the beacon to the key

items such as wallet, car key, notebook and handbag. Then launch the app and connect to Bluetooth to register major items to your smartphone.

One day, an elderly person living alone finds that one of the belongings he usually uses in his house is lost.

However, he can't think of that position due to forgetfulness. If so, he can start the searching process:

1) Touch item to find in the smartphone

2) Go around the house

3) Find direction using AR and Beacon from the smartphone (150cm~500cm)

4) Find item finally from beep sound (50cm~150cm)

The approximate direction of the object what we are looking for is found using the direction key provided by AR based video image in the smartphone, and the exact place is found by the beep sound.

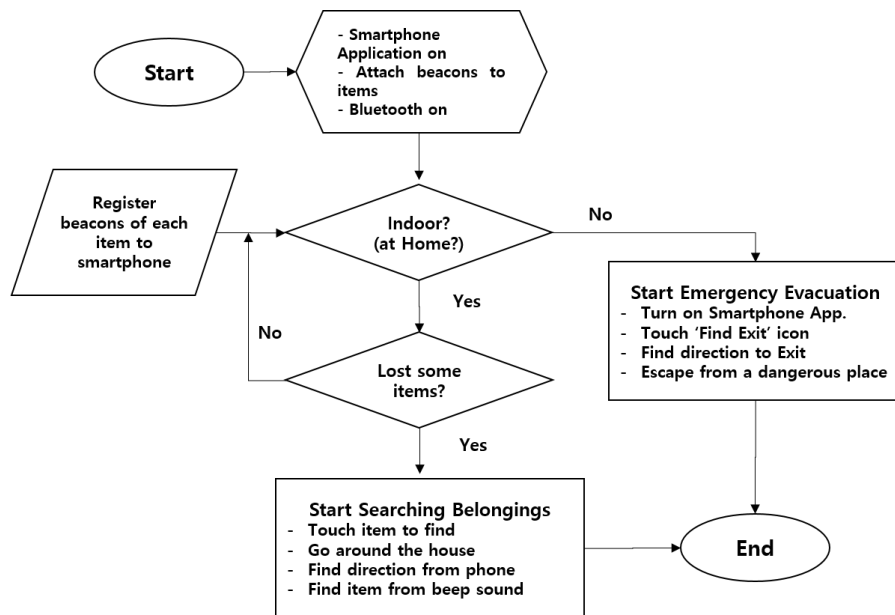


Figure 2. Process Diagram of the Indoor LBS for the Elderly

3.2 Beacon Service using BLE

In this paper, the beacon was used to identify the belongings or their exact position, and AR was introduced to maximize the realism to the user. We used BLE (Bluetooth Low Energy) communication between smartphone and Beacon to save the construction cost of the proposed system, Bluetooth-based technology released under the name of iBeacon has received a lot of attention because it can be applied to various applications [17]. iBeacon is a short-range data communication technology utilizing BLE (Bluetooth Low Energy), and based on proximity location information, and can provide various application services such as

object & context awareness, content push, indoor location positioning, and automatic check-in etc.

The operation principle and operation method of the beacon are shown in Figure 3. First, the beacon transmitter periodically signals its ID + RSSI (Rx signal strength indication) value. Second, when a person with a smartphone comes within range of the signal, the smartphone app recognizes it and sends it to the cloud server. Finally, the cloud server sends the appropriate action service information to the app of the smartphone again, the information is displayed on the user's smartphone screen in the end.

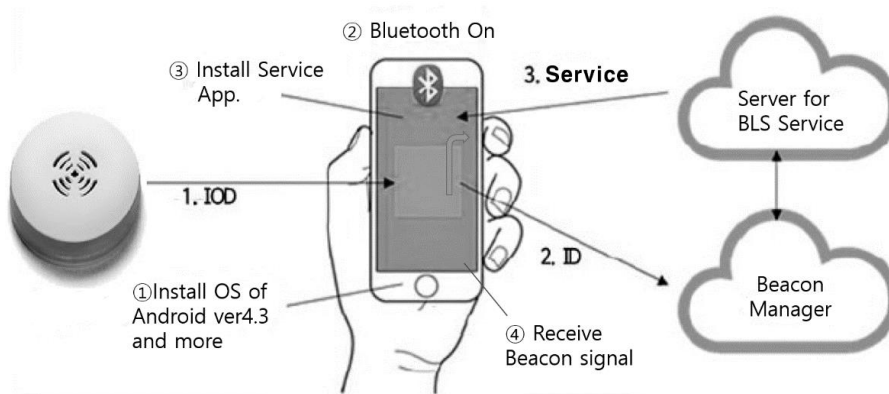


Figure 3. Operation Process for Beacon Service using BLE [17]

In this paper, we implemented the following procedure to receive such beacon service. Android 4.3 or higher operating system (OS) should be introduced, then turn on Bluetooth of smartphone, and install suggested LBS app to receive beacon signal. Only after that, we can achieve the welfare service for the elderly

3.3 Outdoor BLS for the Elderly: Guide to Escape from Dangerous Places

In this section, we describe the LBS that prompts the evacuation route when an elderly person experiences an emergency such as a fire or an earthquake in the building while out of house. Figure 4 depicts the process of outdoor LBS for the elderly.

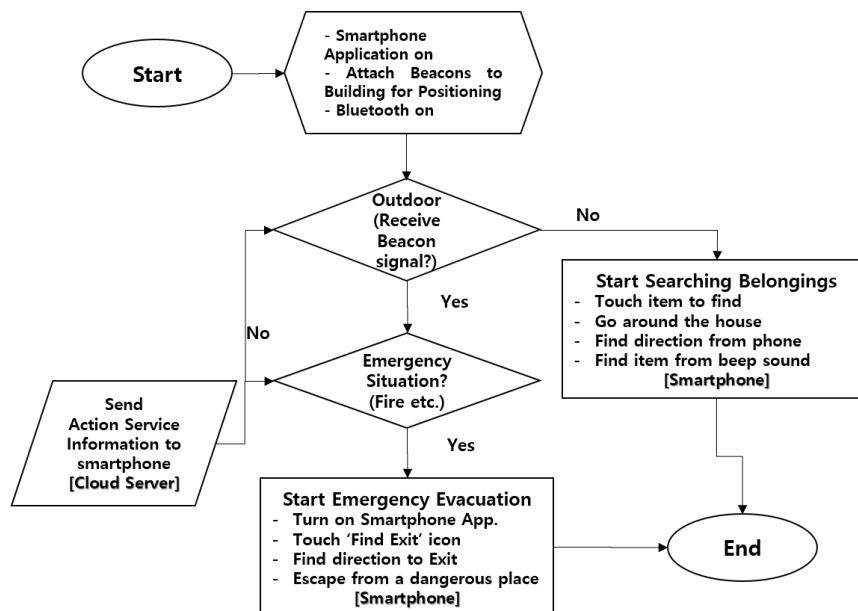


Figure 4. Process Diagram of the Outdoor LBS for the elderly

First, the user installs the suggested LBS app on the smartphone and activates Bluetooth. For public safety, buildings are assumed to have beacons installed inside them to give accurate location information to internal smartphone users.

Second, when the elderly go out and enter into the building where a beacon signal arrives, the location information received from nearest beacon send back to cloud server, as we explained in Figure 3.

Third, if there is a dangerous situation such as a fire or an earthquake in the building, the cloud server

will give the action service signal which has the direction to the nearest emergency exit from the user's location. Based on this direction information, the emergency evacuation app displays a virtual arrow in the AR-based passageway. The proposed AR-based direction evacuation app has the advantage of clearly leading to exits even in power outages and smoky environments. In other words, AR is introduced for ease of use and beacon is applied for accuracy of positioning.

4. Feasibility Test of the Proposed System

In this chapter, as a feasibility test of the proposed system, we implemented smartphone app of finding personal belongings of the elderly and guiding exit from dangerous place using AR technique and Bluetooth communication with Beacon.

4.1. Implementation of Indoor LBS for the Elderly: Finding Daily Belongings

We have implemented an application that finds key items of the elderly that are easily lost indoors using Bluetooth communication between the beacon and the smartphone.

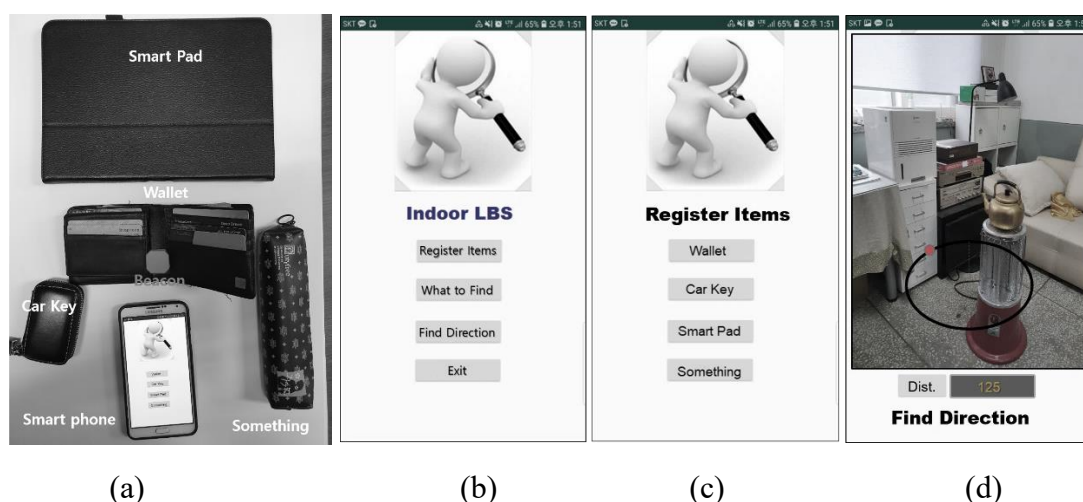


Figure 5. (a) Daily belongings with beacon to register in smartphone (b) Initial Screen of the Proposed App. including 3 categories, (c) Screenshot of registering item to find, (d) Screenshot of direction and distance to wanted item from smartphone with AR based video image (where, distance scale is 1cm)

In figure 5, we can find a smartphone application that tracks daily belongings of the elderly. As shown in figure 5 (a) and (c), we register beacons which are in our daily belongings in smartphone. Figure 5 (b) shows main screen shot of indoor LBS in which there are 4 icons; registering items to find, specify target to find, finding direction and exit. In figure 5 (d), it shows the direction to the selected item on the AR based video image and the distance between the wanted item and the smartphone.

4.2. Implementation of Outdoor LBS for the Elderly: Guidance to Exit from Dangerous Place

In this section, we have implemented an outdoor LBS app, with which the elderly can escape dangerous place easily and safely. First, four beacons were installed 4 Beacons on the 4th floor of the Computer Center building to guide the escape route in their location. Figure 6 (b) shows screenshot of 'Find Exit'; it shows direction to exit in the AR based video image in smartphone. By doing so, the app can help older people find direction to the exit and escape safely in dark environments. In figure 6 (c), we can find that the implemented outdoor LBS app expresses clearly the direction to the emergency exit (down stair) on

the video screen of the smartphone even in a dark circumstance. In summary, older people can escape easily and safely from disasters such as

earthquakes and fires, using the proposed outdoor LBS app in anytime and anywhere.



Figure 6. (a) Initial screen of the proposed app including 3 categories, (b) Screenshot of Find Exit; it shows direction to exit in the AR based video image in smartphone (c) Outdoor LBS app work well by indicating direction to the exit on the AR based video screen in smartphone in dark environment

5. Conclusion

VR/AR technology is a cutting-edge technology that emerged at the request of the times to contribute to the improvement of human life quality and social stabilization. VR/AR technology uses human senses and human emotion, so it can be naturally applied to treatment and rehabilitation of the elderly at the public welfare level. In particular, the elderly living alone most needs public welfare services that he can live comfortably at home without the help of their family and escape safely even in an emergency like earthquake or fire.

Therefore, in order to provide the services that the elderly need the most, we proposed LBS-based services of finding belonging at indoors and supporting emergency evacuation at outdoor in this paper. And to verify the feasibility of the proposed LBS algorithm, a simple S/W prototype of welfare system for the elderly was produced. By introducing AR into LBS, the elderly could easily find belongings in home and quickly find way to outside from building in flames. To improve location accuracy of LBS outdoor, we used

Bluetooth communication between beacons and smartphone.

If the proposed LBS system is adopted by elderly people living alone, the old will be able to lead independent lives conveniently and safely, both inside and outside the home. In the future, we will apply augmented reality technology to help the elderly to independently adapt to social life, which means fulfilment of public welfare. In addition, further research on how to increase the accuracy of the position will be done.

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