A Study on the Mobile Communication Network with Smart Phone for Building of Location Based Real Time Reservation System

Sin Kwan Kang[1], Hee Kuk Kang[2], Jung Eun Kim[2], Hyun Lee[3] and Jeong Bae Lee[3]

[1] *Dept. of Visual Media, Korea Polytechnic IV College, Asan, 336-781, South Korea*
[2] *Division of Robotics System, DGIST, Daegu, 711-873, South Korea*
[3] *Dept. of Computer Engineering, Sunmoon University, Asan, 336-708, South Korea*
kangsk@kopo.ac.kr, {comhero, jekim}@dgist.ac.kr, {hlee, jblee}@sunmoon.ac.kr

Abstract

Due to "Smart Big Bang" in recent, the applications of convergence industry between IT technology depending on smart-phone based mobile communication networks and others are expanding. Various technologies in other fields are adapted to smart-phone efficiently so as to support more convenient daily life service to smart-phone users. However, the developing speed of products is too fast to following most of issues of current smart-phone applications. The designing and developing techniques of smart-phone system become more complicate for adapting new technologies of smart-phone into wireless communication network. There is no perfect solution to solve these problems. Thus, we propose an Augmented Reality (AR) based embedded integration prototyping for the networked system management as one of method. In particular, we describe a network based ticket reservation system and its organization based on smart-phone applications with augmented reality (AR). Prior to developing and designing real smart-phone application, this embedded integration prototyping is helpful to control and predict operational process in big events such as Film Festival, Biennale, EXPO, and so on. Finally, we apply our proposed method into a certain specific zone such as YEOSU EXPO in order to build a location based real time reservation system.

Keywords: *Smart Phone Application, AR, GPS, LBS, Localization, Embedded Integrated Prototyping*

1. Introduction

In recent, various applications of convergence between IT technologies with a smart-phone based mobile communication network and other industry is expanding because of the Digital Big Bang [1] of smart-phones [2, 3]. For instance, a WiFi-based smart-phone with GPS and Gyro sensors provides services to users to support the specific application based program that works in a certain specific zone [4, 5]. This intelligent device composed of internet, cellular communication, and web searching function gives convenient daily life to users and causes the expansion of the mobile communication network usability [5]. However, the convergence industries with smart-phone based mobile communication network needs more academic and industrial efforts to following techniques of current smart-phone device. For example, most of new products that have additional functions are rapidly developed and produced periodically. Designing and developing techniques of a smart-phone system become more complicate for applying new emerging technologies. There is no perfected or appropriated solution for the problem that is frequently happened in a big event such as Biennale, Film Festival, and EXPO. When huge people gather in the same place, it is very hard to control products or users.

Figure 1. Examples of Smart-Phone Applications with AR

R\&D technologies in other fields are adapted to smart-phone applications effectively to develop smart-phone system and to support daily life more convenient based on the mobile communication network with smart-phone. Among approaches, one of the useful approaches is Augmented Reality (AR) [6, 7, 8]. AR is the combination of a virtual environment and a real world. AR allows users to see the real world with virtual objects in the same space. Thus, AR can supplement the reality rather than Tele-presence [9] that can completely replace the reality. In this paper, we apply AR into smart-phone based ticket reservation service system as a location-based service system in a certain specific zone. In particular, we propose an AR based embedded integration prototyping system. The system can be adapted to the established mobile communication network such as Social Network Service (SNS) [10, 11] to support more convenient daily life of users. The proposed prototyping reduces the possibility of errors and the fault factors of a system before we develop a real smart-phone application. In addition, a study on the mobile communication network and practical use of smart phone application for building of location based real time reservation system is useful to control the congestion of users in a certain specific zone. Various applications of a smart-phone are combined with AR to provide virtual information into users as shown in Figure 1. Figure 1 shows a location-based service system with AR based on the developed smart-phone prototyping system. Prior to adapting developing techniques to real smart-phone application, we can use this technique. The proposed operational smart-phone application method with AR is performed based on the integration of internet service and mobile communication network such as WiFi so as to support the location-based real time service.

The rest of the paper is organized as follows. In Section 2, we introduce some related works. In section 3, we proposed a method to optimize the specified zone as a space in the event. For a network based ticket reservation service system, we introduce a GPS and wireless based reservation system in Section 4. In Section 5, we discuss various kinds of a service based on the proposed smart-phone application designing and developing with AR that will be adapted to the real-time reservation in the big event such as YEOSU EXPO. Finally, we conclude the paper in Section 6.

2. Related Work

Recently, smart-phone provides the accelerometer and the position meter for the purpose of UI or entertainment. Smart-phone provides an entertainment application such as game using

the information of accelerometer or position meter. It also provides location based service using the location information such as coordinates [14]. However, the increased number of spatial queries in location aware service system can add the load to the server system. A location aware server system in [14] generates the information of speed and direction based on the accelerometer and position meter provided by this proposed hardware. This technique improves the performance of computational speed and accuracy of predicting utilizing the proposed location prediction.

Existing location aware system supports wide ranges of services using a Global Positioning System (GPS) [15] sensor of smart-phone. This service with GPS sensor is only possible in outdoor environments. In indoor environments such as Biennale, EXPO, or Film Festival where the congestion of the users are expanding, the location aware service has a problem and limitations. To solve these problems, some location aware systems support a service based on the mobile terminal location of mobile communication base stations. However, the error rate of localization is too big to support a service since the distance of base stations is too far. The location aware service in a big event such as EXPO is difficult by applying existing location aware method. Therefore, [16] utilizes advanced sensors such as GPS and GYRO sensor that are installed in smart-phone to design and develop a location based smart-phone application. In particular, [16] implements a public transport system based on the web application service obtained from the location based GPS information and mobile communication network. Then, [16] supports a real time traffic information to the users of smart-phone application based on location in a certain specific region.

Generally, GPS is a useful navigation system that can finds location and time information in anywhere if there is no obstructed line of sight when the GPS satellites used. In indoor environments, [17] researched on location tracking techniques by connecting both mobile terminals installed in indoor and outdoor, respectively. There is no extra system to support a location tracking service. It is the main advantage of this technique. In addition, Geographic Information System (GIS) [18] is moving rapidly from desktop GIS to mobile GIS. To satisfy the demand of users, Location Based Service (LBS) [19] is applied to GIS. The GPS module is combined with the GIS module so as to make a real time location tracking of the users and to construct a map application program in [20]. To support a service based on mobile device and to communicate with server system, the approach acquires current location information of the users and utilizes TCP/IP protocol. For instance, the proposed approach implements a lab system that can support wide ranges of information to users by using Google map [20].

The location aware system based on stereo camera has a limitation to satisfy the needs of the users. In [21], the developed new system obtains location information of the mobile based users by using distributed processing. In this case, the server program utilizes multi-threads composed of middleware such as a TCP based server/client structure. This approach has three advantages. First, it overcomes a hardware limitation to obtain location information of users with mobile environments. Second, it improves the execution processing speed of a system using distributed processing. Finally, it helps to recognize the location of the users using 3D coordinates. The mobile based location aware system makes a proactive service by supporting location information of users without regarding for time and place. In addition, the location of the node in MANET that has a location aware problem can be solved by Diamond Quorum System (DQS) based adaptive location service. In this approach, DB that stores information of the mobile location is efficiently selected from DQS [22].

Because of Smart Big Bang, the combination of context aware and LBS is proposed in [23] to provide optimized service to users when the users have impromptu meetings. This service supports context aware information of the related users that needs appointment time, location, and so on by considering the adequacy of the rendezvous point. Among LBSs, Moblog (i.e.,

Mobile + Blog) is a service that users upload and search contents with a real time in current location [10]. With this system, a service zone is temporarily divided by the system then the specific divided zone is fixed. In order to set a service zone dynamically, [23] utilizes Social Network Service (SNS). This service allows a user recommendation based on K-mean based clustering method. For example, the location based mobile service with multi-agent system is applied to an emergency rescue system in [24]. A location based recommendation system is proposed in [25].

In Ubiquitous Environments, a mobile based information retrieval service (M-IRS) [26] is important to share huge information and multimedia contents. However, M-IRS has three kinds of limitations and characteristics compared to PC based IRS. First, the accuracy is more important than recall rate because of narrow screen space. Second, users have interests more real world resource than simple text because of the portability of mobile devices. Finally, M-IRS has a slow response time (i.e., delay) compared to PC based IRS. In order to solve this problem, [26] supports a location based semantic information searching system. This system gives a location based multimedia content service based on mobile mash-up that obtained by GPS. The meaningful result is selected by users then the accuracy of searching is improved. For instance, ubiquitous Location Based Service (u-LBS) is combined with eCRM in [27] so as to support mobile-based customer marketing.

The convergence of the cellular network and Internet is proposed as the IP based cellular network. A Hierarchical Mobile IPv6 (HMIPv6) is proposed by Internet Engineering Task Force (IETF) to efficient mobile management. This method reduces the amount of signaling and improves the performance of MIPv6 for handover latency. However, the performance of mobile network is dependent on various system variables such as mobility model and packet arrival pattern even though HMIPv6 is an efficient method. Thus, the network performance should be analyzed when HMIPv6 moves to IP based cellular network. For instance, in [28], a location update method based on virtual mobility anchor point (V-MAP) is proposed to reduce the signaling traffic for location update in HMIPv6. The proposed approach improves the performance of a location update rate per users compared to HMIPv6. The proposed method reduces the packet loss and delay by eliminating no necessary location update.

A mobile search and reservation system that provides a personalized service by combining a web content mining and a location based context is proposed in [29]. A web content mining distinguishes the formal/non-formal information sector from web contents and converts web contents into XML contents. Location based context service uses the contextual information such as location, interests, log of the user. Diverse and high value-added mobile emergency service, mobile commerce, navigation has been developed from the existing services such as friends searching, map searching, etc. In this case, LBS is closely related to our lives because of institutional safeguards as the spread of mobile phones, the development of middleware, wireless communication and localization, and the legislation of location privacy and usability. In addition, the LBSs are needed to support diverse and high value-added mobile services. For example, the integrated information system is becoming a necessity from the service that is dependent on existing carriers. The personal location privacy is becoming a necessity as the legislation of the location information usability and protection. In order to minimize network load and to integrate wired/wireless LBS, the middleware technique is becoming a necessity [30, 31].

3. A Design Process for Optimal Zone of the Event

3.1. Space Optimization

Partitioning of the space is needed to support LBS when some peoples in a certain specific zone. Partitioning of the space based on the visitor's location information is dependent on the size of division area. It means that the number of classification of space in the limited area influences the error. Therefore, we simulate the optimal number of classification of space based on the maximum number of visitors that have a location-based information can be collected by smart-phone to make a reasonable size of the area. As shown in Figure 2, the number of target area is changed based on the size of division in the same size of space. If the size of division is larger, the error rate of distance in a certain specific zone is bigger even though we can reduce the error rate of the probability of distribution because the probability of the presence of visitors in a certain specific zone is larger. If the size of division is smaller, the error rate of the probability of distribution is larger even though we can reduce the error rate of distance in a certain specific zone. The error rate of distance and the error rate of distribution in a certain specific zone has an inversely correlation proportion. In addition, the size of division space is defined by absolute number. Thus, we make an optimal size of the division in a certain specific zone by applying the error size of the probability of the presence is the sample size based on the number of division.

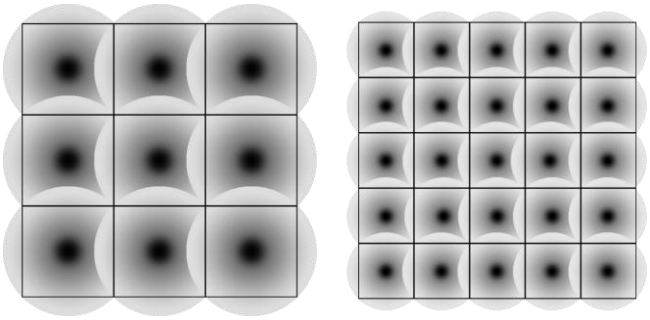

Figure 2. Partitioning of a Space for LBS (3X3, 5X5)

3.2. A Procedure of Space Optimization

The goal of space optimization is investigating the numbers of people in a certain space by examining samples of people. The LBS based on smart-phone is a service that provides required spatial information and additional information by recognizing the user's position and orientation. Depending on the accuracy of information of position and orientation, the quality of service can be different. In previous studies, researchers analyzed the accuracy of position and orientation of smart-phone with indoor/outdoor environments so as to suggest the problem of positioning and direction of recognition of smart-phone and to make a solution of the problem. According to the experiment results, the average distance error is 4.132m in outdoor (i.e., GPS reception is good), is 7.993m in outdoor (i.e., GPS reception is bad), and is 52.897m in indoor. In addition, the average orientation error is 7.563° in GPS reception is good outdoor, is 5° in GPS reception is bad outdoor, and is 17.668° in indoor [31]. It is difficult to make the LBS system based on GPS in indoor environment. Therefore, we calculate a location value based on wireless internet to support LBS. Depending on the accuracy of the location of a particular person, we can obtain the accuracy of LBS based on probability distribution of the total population and its tolerance. It means that we calculate the

optimized number of space division. The number of space division affects the size of space and the distance of mobile network that can analyze the location information in a specified space. Finally, the number of space division is a basic resource to design the infrastructure of devices for LBS.

We optimize the number of people in a certain zone by applying probabilistic calculations. We also know there is some tolerance in obtained data since we make the data by using the samples. In order to reduce this tolerance, we should calculate the optimized number of the investigation region. The applied population size and sample size is shown as Table 1.

Table 1. Population Size and Sample Size for Space Optimization

Total Population Size	Sample Size	Confidence Level	Tolerance
100,000 (100%)	10,000 (10%)	95%, 99%	1~20%
	30,000 (30%)	95%, 99%	1~20%
	50,000 (50%)	95%, 99%	1~20%

We assume that people are uniformly distributed for ease of calculation because we don't know the exact value of samples and the real distribution of the people. The probability that someone is in x zones is $p=1/x$. When the number of sample size is n and the confidence level is 95%, the tolerance of probability is $\pm 1.96SQRT((p(1-p))/n)$. When we multiplied by x (i.e., the numbers of space region), we calculate the tolerance of the number of people in a certain specified zone. The formula of tolerance in a certain specified zone is $\pm 1.96*x*SQRT((p(1-p))/n)$. We transform the above formula to obtain the number of space region for meeting the tolerance. If the tolerance is a, the above formula is transformed as $x=n((a/1.96)(a/1.96))+1$. If we change the confidence level form 95% to 99%, 1.96 in the formula is replaced by 2.58. The total population size is 100,000. It means that 100,000 visitors can stay in a certain zone of the exhibition concurrently. According to the above results, we can get 27 spaces when the numbers of smart-phone user are 10,000 with 95% confidence level, 10% tolerance, and the total size of population is 100,000. We can get 79 spaces when the numbers of smart-phone user are 30,000 with same conditions. We get 131 spaces when the numbers of smart-phone users are 50,000 with same conditions as shown in Table 2. Based on the results, we know that the numbers of a space are smaller in order to make a small tolerance. However, in real situations, if the number of space is too small, it is difficult to distinguish the location of the users in closed spaces. The calculations are performed by the assumption the people are uniformly distributed. However, the people are randomly distributed in different spaces.

Table 2. The number of Space Optimization based on Tolerance

(a) Total Population Size: 100,000 / Sample Size: 10%

Tolerance	95% Confidence Level	99% Confidence Level	Tolerance	95% Confidence Level	99% Confidence Level
	The number of Space Optimization			The number of Space Optimization	
1%	1	1	11%	32	19
2%	2	2	12%	38	23
3%	3	2	13%	45	26
4%	5	3	14%	52	30
5%	8	5	15%	60	35
6%	10	6	16%	68	39
7%	14	8	17%	76	44
8%	18	11	18%	85	50
9%	22	13	19%	95	55
10%	27	16	20%	105	61

(b) Total Population Size: 100,000 / Sample Size: 30%

Tolerance	95% Confidence Level	99% Confidence Level	Tolerance	95% Confidence Level	99% Confidence Level
	The number of Space Optimization			The number of Space Optimization	
1%	2	2	11%	158	92
2%	6	4	12%	188	109
3%	13	8	13%	221	128
4%	22	13	14%	256	148
5%	34	20	15%	294	170
6%	48	28	16%	334	193
7%	65	38	17%	377	218
8%	84	49	18%	423	244
9%	106	62	19%	471	272
10%	131	76	20%	522	301

(C) Total Population Size: 100,000 / Sample Size: 50%

Tolerance	95% Confidence Level	99% Confidence Level	Tolerance	95% Confidence Level	99% Confidence Level
	The number of Space Optimization			The number of Space Optimization	
1%	2	1	11%	95	56
2%	4	3	12%	113	66
3%	8	5	13%	133	77
4%	13	8	14%	154	89
5%	21	12	15%	177	102
6%	29	17	16%	201	116
7%	39	23	17%	227	131
8%	51	30	18%	254	147
9%	64	38	19%	283	164
10%	79	46	20%	313	181

As shown in Table 3, we can obtain the space optimization using smart-phone where if the number of visitors that can be recognized is more than 10% of the total population with the distance of signaling is within the distance of WiFi communication.

Table 3. Optimal Size with 100,000 Populations and 500 X 500m spaces

Sample Size	Optimal Space	Width*Height	Distance of Signaling (m)
10%	27	6 * 6	83
30%	79	9 * 9	56
50%	131	12 * 12	42

4. A Real Time Location based Reservation System

4.1. A Designing of Location based Smart-Phone Application

In order to make a ticket reservation system and its practical use based on smart-phone by applying space optimization, the real time location system (RTLS) which looks for object or people in real time utilizes not a GPS based LBS but a wireless network based LBS in indoor. As a wireless network based LBS method, there are two methods such as Client Based Design (CBD) and Beacon Based (BB).

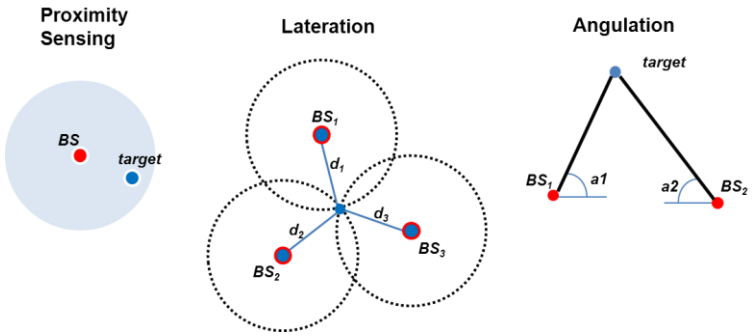

Figure 3. An Example of Localization Methods

The CBD is a method that calculates the position of smart-phone client by receiving the signal from reference nodes connected to smart-phone. This method is similar to the method of GPS that receives information from satellite. Inversely, the BB is a method that calculates positions of smart-phone by receiving the signal from reference nodes connected to wireless access point (AP). This method analyzes the position of a customer by using the strength of the signal received from customers, the direction of a signal, and the time difference of signal propagations. Depending on the relative displacement of the reference nodes, there are three types: 1) localization with fixed bacon, 2) localization with moving bacon, and 3) localization without bacon.

In addition, there are 1) Proximity Sensing that measures the presence or absence ranges of a signal of the bacon, 2) Lateration that measures the location by calculating the difference in arrival time and signal strength of a signal of the bacon from multiple points to the target point, 3) Angulation that measures the location by calculating the angle from multiple points to target point, 4) Dead Reckoning that measures the location by calculating the orientation and distance from the existing position, and 5) Computer Vision that measure the location based on the image processing method. Figure 3 shows an example of localization methods.

Moreover, Time Difference of Arrival (TDOA) localization is a method that measures the distance from the difference of a signal of the transmitter. However, it is difficult to apply TDOA to mobile network connected to smart-phone. Therefore, in this paper, we utilize a localization method based on the Received Signal Strength (RSS) to divide the several spaces as a structured space because the transmission device of a wireless network is not located in regular space. The RSS measures the location using multiple points (i.e., the minimum 3 base stations by calculating the distance from transmitter to receiver with considering the intensity of wave attenuation caused by distance as shown in Figure 4.

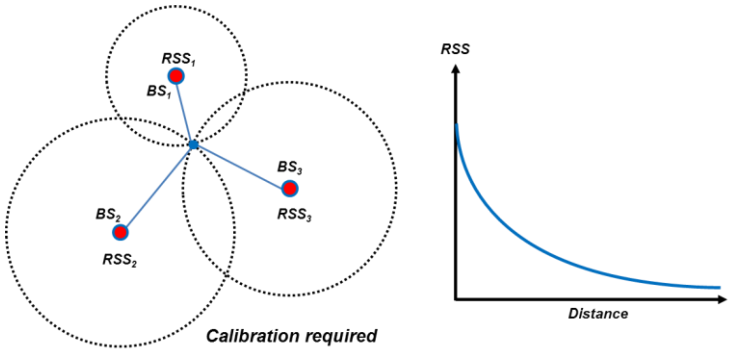

Figure 4. A Localization based on RSS

The RSS has a disadvantage that multi-path and noise affect the measurement accuracy. However, in this case, positioning accuracy tolerance that can be ignored because it is a LBS service based on general point. So to speak, we think that the space specification based on the RSS based localization is the optimal method for making a mobile communication network of smart-phone based LBS. GPS data are also used with RSS together in outdoor environments. For example, GPS based reservation system making a database of the ticketing management system operated by a smart-phone application based on the location and time of the exhibition is shown in Figure 5. In this case, a networked system h is installed more than one exhibition is designed into specific reserved region to give users the convenient access to the reservation service in any places depending on the boundary of the wireless communication antenna and wireless internet antenna.

4.2. A Location-based Smart-Phone Application

We can provide various location-based exhibition services to visitors based on the defined space optimization. Figure 6 shows an integrated system configuration for a location-based exhibition service. For instance, a smart-phone application transmits information of a current location of users that will be caught by GPS (i.e., location information server) to database (i.e., reservation management server). A reservation management server then makes a decision for the approval of this ticket reservation whether the location of a user is belongs to the specified reservation region or not. Finally, this decision for the ticket reservation is transmitted to the user's smart-phone application according to the possible number of users in that area. This procedure of a ticket reservation induces making the flow of users of smart-phone or visitor traffic in exhibition area more efficiently. We then expect that the traffic jam of the visitors in exhibition can be minimized.

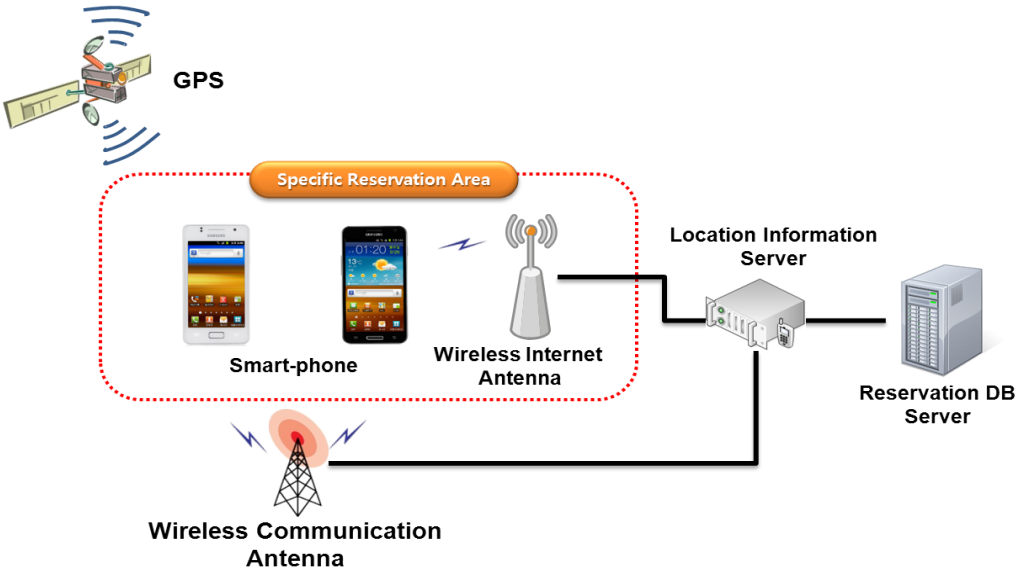

Figure 5. GPS-based Ticket Reservation System Structure

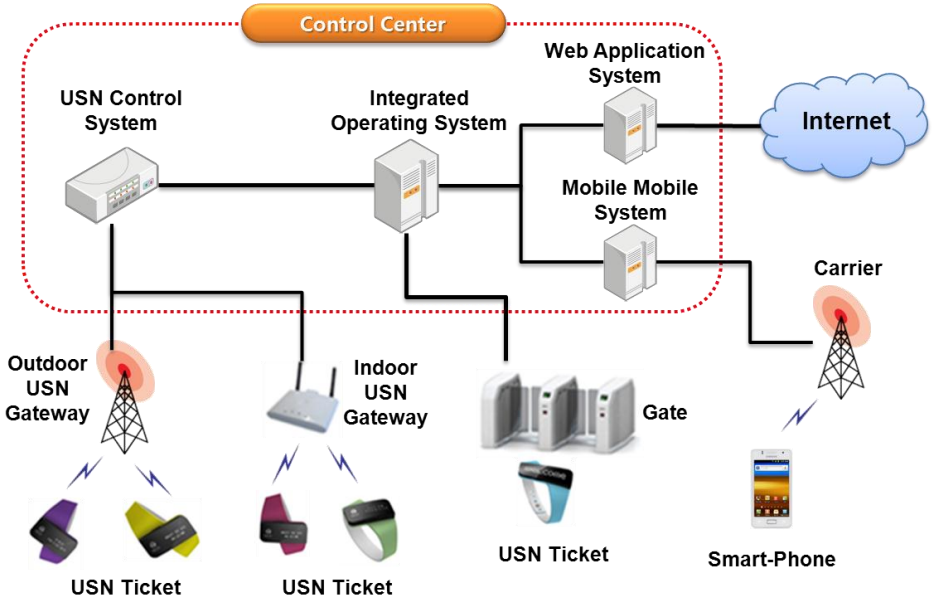

Figure 6. An Integrated System Configuration

4.3. The defined Structure of Ubiquitous Sensor Network (USN)

As shown in Figure 7, we connect a smart-phone with the defined U-ticket system based on Ubiquitous Sensor Network (USN). We define concepts of Ubiquitous to Mobile (U2M) [32] functions then categorize related technologies of U2M to support the visitors' convenience in exhibition area. For example, the installed RFID reader and the sink node in sensor network collect useful information from RFID tags and distributed sensor nodes in information source layer of Figure 7, respectively. The BCN backbone & access layer (i.e., distributed network infrastructure) transmits collected information to appropriate applications or stores it to USN server. The defined USN middleware should make the API connection to the USN application service layer to transmit information to the appropriate applications. Finally, depending on the selected API connections, different types of applications in USN application service layer can support useful services to the user or audience in USN structure. Furthermore, we induce idea modification about the usability of related technologies from two layers such as the highest layer (i.e., USN Application Service Layer) and the lowest layer (i.e., USN Information Source Layer) in USN structure [33, 34]. In particular, we treat problems caused by the integration of a smart-phone application and the developed U-ticket system. This is helpful to support the unconstrained smart-phone application service to the user of U-ticket system or the audience in EXPO exhibition area regardless of the source of information which collected in the defined zone.

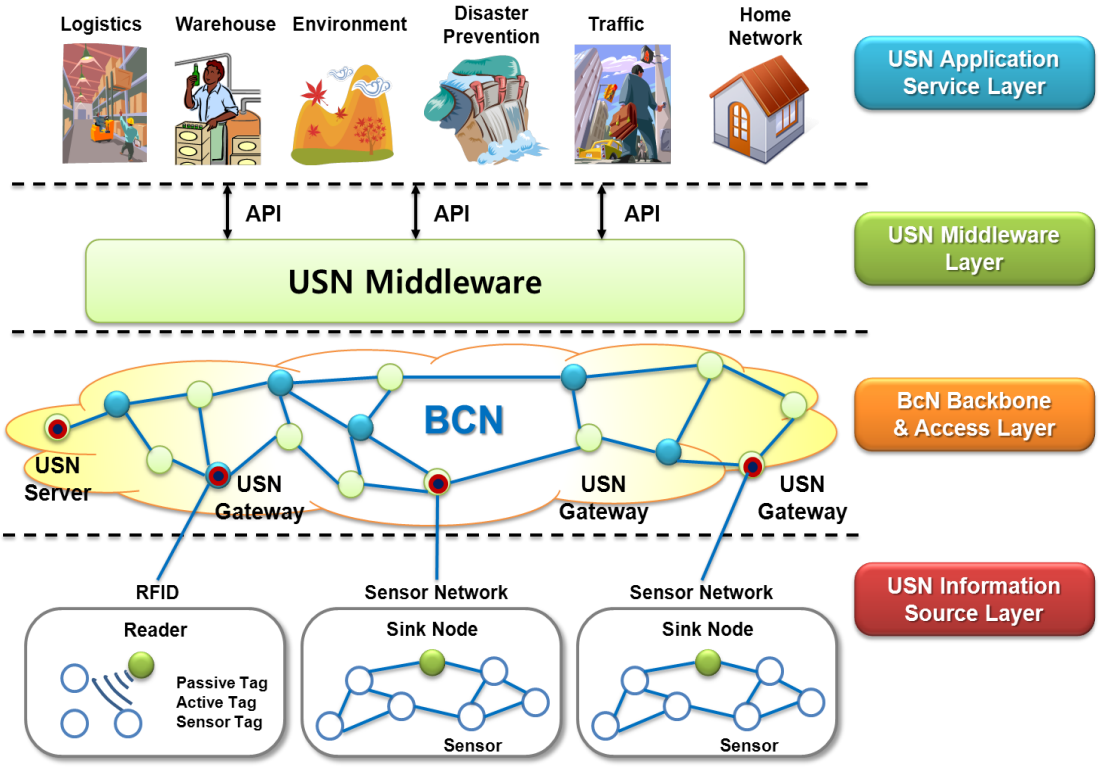

Figure 7. The Defined Structure of USN [12]

As an example of the convergence of U2M, we suggest a direction of system designing about travel related smart-phone application. We then apply the related techniques into the developing system in order to optimize and adapt them on Android-based phone and I-phone concurrently [35]. Moreover, we convert various kinds of on/off travel information into travel related smart-phone applications. For instance, we insert very useful information such as GPS based traffic information, weather information, Currency, shopping mall, Emergency call, SNS, and etc. into the developed smart-phone application system. This information increases the convenience of users or audiences. Finally, we can simulate the designing and developing procedure of the smart-phone application system by adapting the method into the developed system.

5. Location based Real Time Reservation Services

5.1. A Location-based Real Time Reservation Service

One of uncomfortable things in exhibition is a waiting blindly in front of the exhibition. To solve this, we build an exhibition reservation system. In this case, we must ensure the fairness of reservation to the visitors and we should not blindly to wait after booking. Generally, the working process is fairly maintained by using a number ticket in the banking area. However, the working process of a system has a limitation. After the visitor pulls up a number ticket, he must continuously wait for his order until the number is called. As shown in Figure 8, the

location-based real time reservation service is performed. First, if the visitor having a smart-phone arrives at a reservation zone, the smart-phone automatically recognizes the reservation zone, provides a waiting time based on the waiting number of reservation in the reservation server, and asks a booking decision. Second, if the visitor makes a reservation, the reservation information is stored into the reservation server. This reservation service induces the visitor with alarm by watching the exhibition at the appropriate time. Finally, this service gives an equal opportunity to the visitors who arrive at a specific location where a reservation can be built. This service can increase the comfort of visitors and can allow other activities during the waiting time. Thus, we can say that real-time visitor tracking service with a smart-phone makes a real-time location-based reservation service.

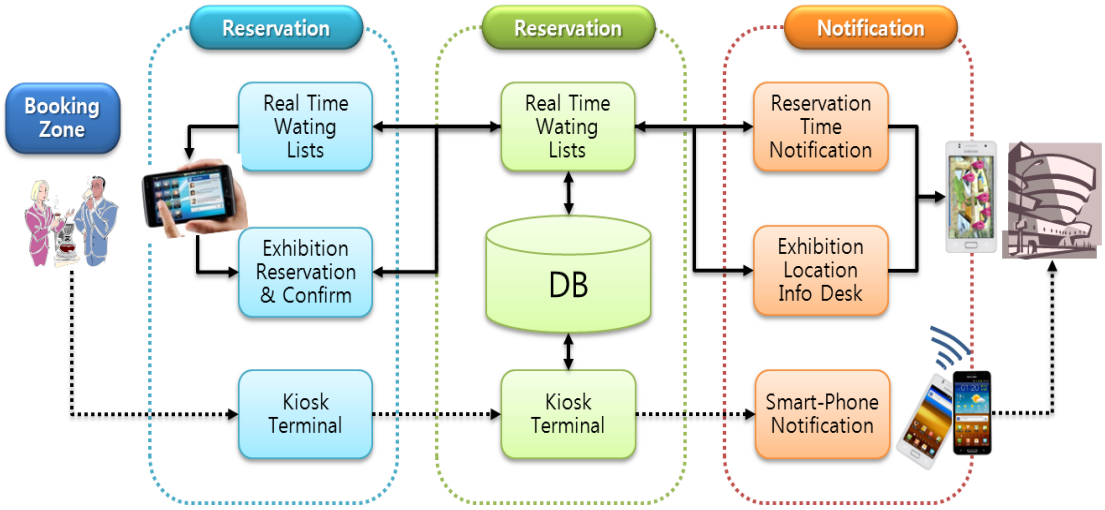

Figure 8. A Location-based Real Time Reservation Service

5.2. A Location-based Visitor's Tracking and Congestion Control Service

In exhibition, one of problems is identifying the movement of visitors and the degree of congestion caused by real-time location information of the entire audience. If we can identify visitor's movement and the degree of congestion in real time, we can provide various services to the entire audience. For instance, we can make congestion controls. We then induce visitors into the specific place where the waiting time is shorter than others. This allows the more efficient usability of the exhibition. As shown in Figure 9, we estimate the location of the entire audience based on the location-based information of the visitor who has a smart-phone in exhibition. In this case, we can calculate the optimal number of a space based on the optimal number of a visitor by applying the space optimization method in the previous section. Using the collected real time visitor's location-based information with smart-phone, we can control congestions of the audience in exhibition. We can propagate full flows of visitors using various methods such as an announcement board that can inform the information to the audience.

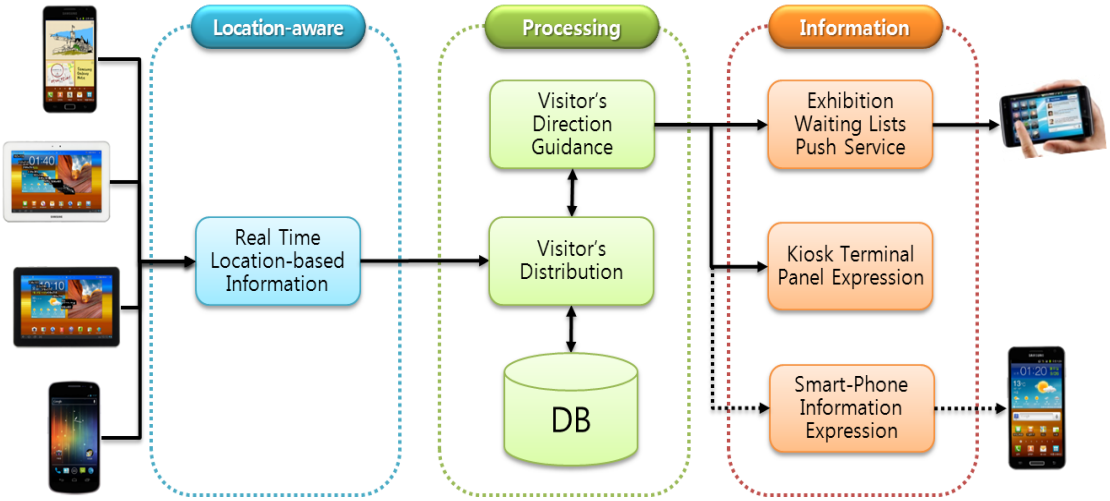

Figure 9. A Location-based Real Time Visitor Tracking and Congestion Control Service

5.3. A Location-based Real Time Partner Checking Service

In exhibition, it is also difficult to recognize the location of a partner because many people move concurrently. In addition, this situation is more difficult if a partner with children. Thus, we can implement a service that can find the location of a partner using smart-phone. In this case, we can support a service in conjunction with other devices such as Zigbee [36], [37]. Particularly, the indoor localization is more difficult than the outdoor localization. In this paper, we do that our proposed method is possible in indoor environment in real time. As shown in Figure 10, the system can inform the partner's personal location information to the audience group members by storing the partner's location information into Database server system in real time. This service can help to find the location of a partner and it can prevent stray child in real time in exhibition.

5.4. A Location-based Emergency Call Service

In terms of total operating of exhibition, the emergency situation is recognized in real time. To make this, the audience needs a device to inform his emergent situation information to manager of the control center in exhibition. In addition, we need the location information of a user who is in emergent situation. It is useful to many related people as an emergent person himself, a person simply need guidance, and a person who helps the injured person. As shown in Figure 11, the proposed location-based real time emergency call service is transmitted to the manger of control center of exhibition. Based on this, the helper who is stayed in closed location to the injured person performs an emergent service in real time. To support this service, the manager and the helper of the exhibition also have a smart-phone with installing a LBS function.

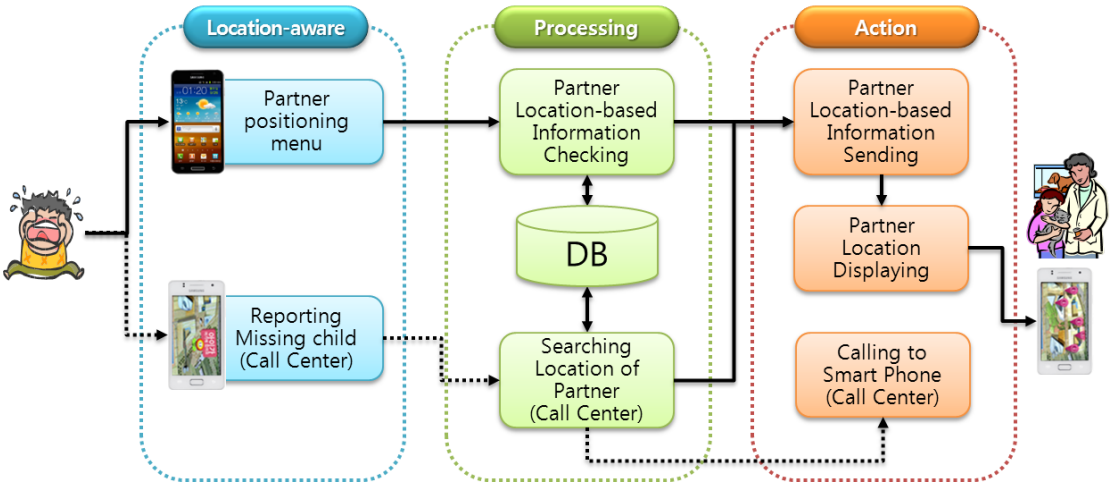

Figure 10. A Location-based Real Time Partner Checking Service

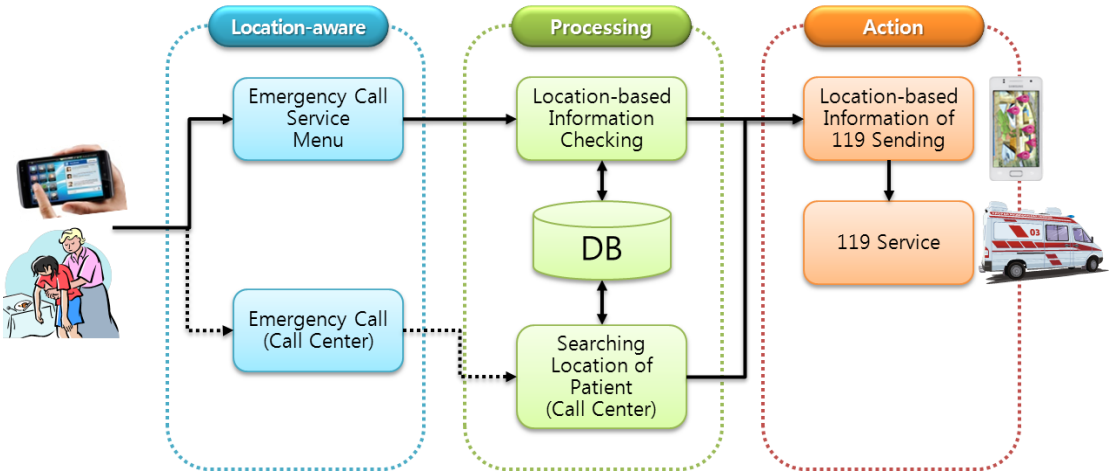

Figure 11. A Location-based Real Time Emergency Call Service

5.5. A Location-based Real Time Event Notice Service

One of the useful information in exhibition, various kinds of event information that are closed to the visitor's location can be supported to visitors. This service is similar to the LBS of a smart-phone. This service should be constructed based on several space areas since the exhibition area is a limited and compact space. In particular, the location information of the indoor environments is important than other case because visitors or audiences more frequently stay in indoor environments. However, the shaded area can occur due to limitations of the installing location of wireless network devices in indoor environments. In this situation, the service will be supported based on the last presented location of a visitor. If the event information is occurred, we first identify the target visitor from the entire audience based on the location and the reservation information as shown in Figure 12. We then transmit the information of a certain specific region to the target visitor. A location-based real time event notice service can reduce an unnecessary notice to visitors and can provide the personalized information to each visitor.

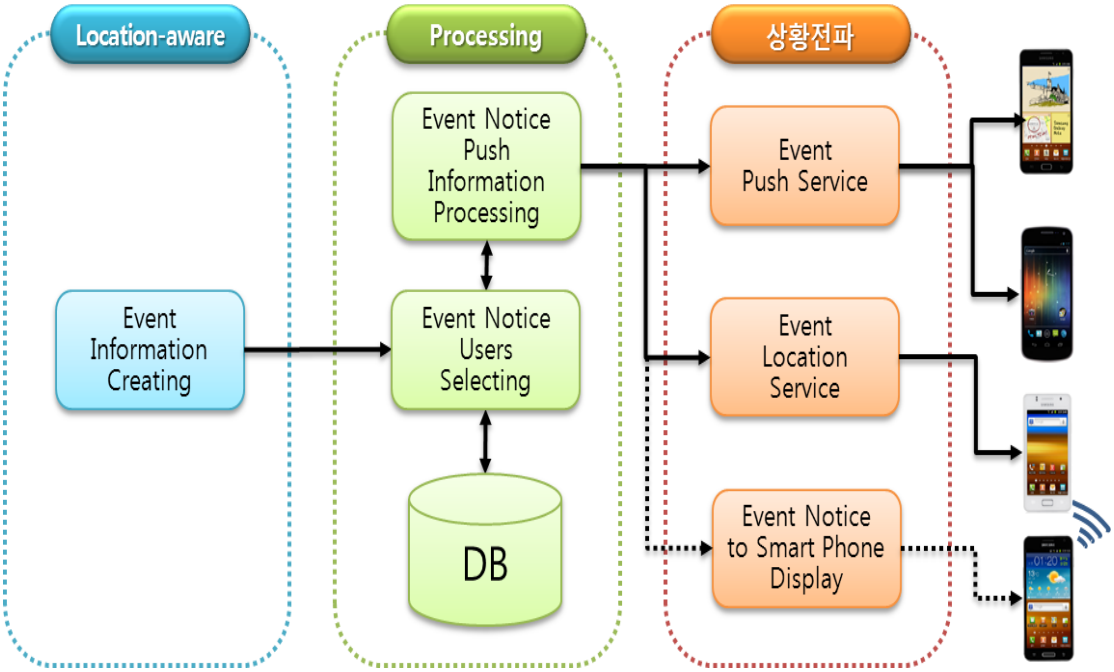

Figure 12. A Location-based Real Time Event Notice Service

5.6. A Location-based Real Time Information Flow

Based on the proposed services, we implement the system that can make a location-based information flow as shown in Figure 13. Particularly, the space optimization and the localization method that proposed in previous section are integrated with location information and various kinds of service information in order to make the augmented reality based embedded integration system. In addition, the control server of the system knows the distribution of the entire visitors and the location of each audience so as to provide the appropriate service even if the service shows in smart-phone application screen. This is helpful to make a flow of information and to support a convenience to the visitor. For instance, the satisfaction and safety is maximized and the waiting time can be reduced by the proposed system. The operation of the system efficiency can be increased since the best operating back up service. Some limited problems caused by a paper ticket or a simple RFID ticket can be solved through established various kinds of services. According to the result, we can expect increasing fast processing tasks and the reliability of visitors for the system. Finally, we propose an optimized operation method by controlling the flow of information of the customer such as visitors, smart-phone service provider, the manager of exhibition, and the supporter of organization in this paper.

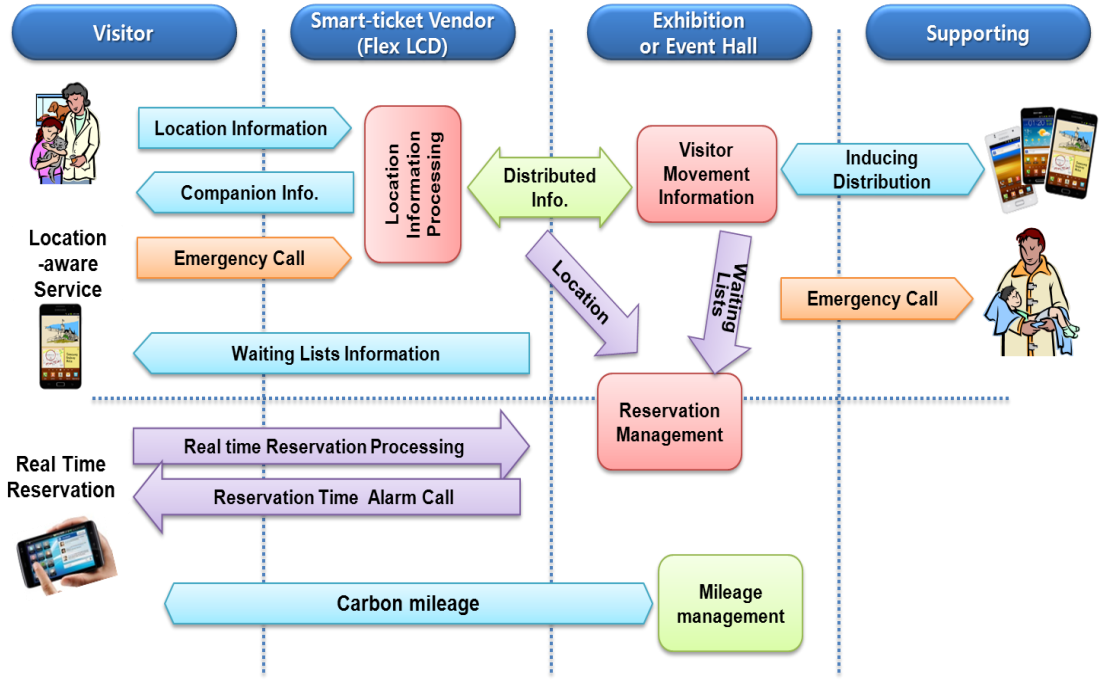

Figure 13. A Location-based Real Time Information Flow

6. Conclusion

Increasing the usage of smart phone application, the application field of convergence industry between IT technology based on the smart phone-based mobile communication networks and other industry branches is expanding. However, it is very hard to control these products and there is no efficient solution for this problem when many people are sent to specific area for big events, such as Biennale, Film Festival, EXPO, and so on. In this paper, we studied on the mobile communication network based on smart-phone for building of real-time location-based reservation system. In addition, we proposed our method by prototyping the system and service of the application. First, we proposed a space optimization method for installing a location-based real time reservation system into the exhibition. Second, we developed an optimized localization method depending on the integration of GPS and RSS techniques. Third, we proposed various kinds of the service model that can be useful in exhibition by applying the designed and developed space optimization and localization. Finally, we implemented the new service modeling based on the proposed AR based prototyping system. Our study will help to construct a LBS based infrastructure to support a convenience of the users in exhibition.

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Authors

Sin Kwan Kang

Prof. Sin Kwan Kang received the M. S. degree from the Department of Computer Engineering at Hoseo University, Korea in 2001. He has been working at Department of Visual Media, Korea Polytechnic IV College, Asan, Korea from 2001. Currently, his research interests include issues related to broadcasting, smart phone application, ubiquitous computing, and embedded system.

Hee Kuk Kang

Dr. Hee Kuk Kang received the M. S. degree and Ph. D. degree from the Department of Computer Engineering at Sunmoon University, Korea in 1999, 2011, respectively. He had been worked at Sunmoon University as a teaching faculty member for 7 years. In current, he is a senior research engineer at Division of Robotics system of DGIST, Daegu, Korea. His research interests include issues related to bio-inspired robotics, cyber physical systems, and real-time robot operating system for modeling and simulation robotics system.

Jung Eun Kim

M.S. Jung Eun Kim received the M. S. degree from the Department of Information and communication engineering at Daegu University, Daegu, Korea in 2009. She is working at Division of Robotics System at DGIST, Daegu, Korea from 2010 as a research engineer. Currently, she interests issues related to information and communication, computer networks, and wireless sensor networks.

Hyun Lee

Dr. Hyun Lee received the M.S. degree from Sunmoon University, Korea in 2002. He received his Ph.D. from the department of computer science and engineering, University of Texas at Arlington, Texas, U.S.A. in 2010. His research interests include issues related to sensor fusion techniques and the integration of heterogeneous sensors and RFID for autonomous computing in cyber physical systems. He was a senior research engineer at DGIST and currently he is an assistant professor at Sunmoon University.

Jeong Bae Lee

Dr. Jeong Bae Lee received the Ph.D. degree from Han Yang University, Korea. Currently, he is a professor at Computer Engineering of Sunmoon University from 2002 and works as a Chief Information Officer (CIO) at YEOSU EXPO. His research interest includes issues related to network-based information systems in ubiquitous computing environments. He also researches on rapid prototyping with embedded system.