A Network based Real Time System and its Organization based on Smart-phone Applications with Augmented Reality

Jeong Bae Lee¹, Hee KuK Kang², Hyun Lee¹,
Dong Ha Lee², Im Yeong Lee³, and Seung Jung Shin⁴

¹ Dept. of Computer Engineering, Sunmoon University, 336-804, Asan, Korea
² Division of Robotics System, DGIST, Daegu, 711-873, Korea
³ Dept. of Computer Software Engineering, Soonchunhyang Univ., Asan, 336-745, Korea
⁴ Division of Information Technology, Hansei University, Gunpo, 435-742, Korea
jblee@sunmoon.ac.kr, comhero@dgist.ac.kr, mahyun91@sunmoon.ac.kr,
dhlee@dgist.ac.kr, imylee@sch.ac.kr, expersin@hansei.ac.kr

Abstract. Various kinds of technologies in other fields are adapted to smart-phone efficiently to support convenient daily life service to smart-phone users. However, designing and developing techniques of smart-phone system become complicate for adapting new technologies with mobile communication network. Thus, we suggest a real time location-based system with augmented reality as one of a smart phone application to show the adaptation. Prior to developing a real smart-phone application, this prototyping with augmented reality is helpful to control and predict operational processes in various applications.

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

1 Introduction

In recent, 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 [1], [2]. The intelligent device gives convenient daily life to users and causes the expansion of mobile communication network usability [3], [12]. However, designing and developing techniques of a smart-phone service system become more complicate for applying new emerging technologies. There is no appropriate solution for problem that is frequently happened in big events (i.e., Biennale, Film Festival, and EXPO). Particularly, it is very hard to control products or users if huge people gather in place.

In order to designing and developing a smart-phone service system with a mobile communication network, one of useful approaches is Augmented Reality (AR) [4], [5], [6]. AR allows users to see the real world with virtual objects in the same space then can supplement the reality. We apply AR into a smart-phone service system such as a location-based real time reservation service system. The proposed system can adapt to the established mobile communication network (i.e., Social Network Service (SNS) [7], [8]). The proposed prototyping reduces the possibility of errors and fault factors of a location-based service system before we develop a real smart-phone application.
In addition, the service system can be useful to control the congestion of the users in a certain specific zone by predicting operational processes of users.

The rest of the paper is organized as follows. We introduce a space optimization method in section 2. We propose a real time location-based system with smart-phone applications as a prototyping system in section 3. We suggest and implement a GPS and wireless based real time services in section 4. Finally, we conclude the paper in section 5.

2 Space Optimization

Partitioning of the space based on the peoples’ location information is dependent on the size of a space partitioning to supporting location based service (LBS) [9]. The optimal number of a space partitioning based on the maximum number of peoples should be collected to make a reasonable size of a space optimization. The number of a target space is changed based on the size of a space partitioning. If the size of a space partitioning is larger, we reduce the error rate of peoples’ presence probability even though the error rate of a distance is bigger. If the size of a space partitioning is smaller, we reduce the error rate of a distance in a certain specific region even though the error rate of peoples’ presence probability. Thus, we show a space optimization by calculating the error size of peoples’ presence probability in a certain specific region. In particular, we should consider the position and orientation of peoples. Depending on the accuracy of information for the position and orientation, the quality of a service can be different.

In addition, there is a tolerance in obtained sampling data. To reduce this tolerance, we calculate the optimized number of the investigation region based on probabilistic approaches. For example, we assume that peoples are uniformly distributed for ease of calculation. The probability that someone is in \( x \) zones is \( p=1/x \) and the tolerance of probability is \( \pm 1.96 \sqrt{p(1-p)/n} \) when the number of sample size is \( n \) and the confidence level is 95%. Thus, the tolerance of the numbers of peoples in a certain specific region is \( \pm 1.96 \times a \times \sqrt{p(1-p)/n} \). If the tolerance is \( a \), the above formula is transformed as \( x=n((a/1.96)(a/1.96))+1 \). Finally, we obtain the space optimization using smart-phone as shown in Table 1.

<table>
<thead>
<tr>
<th>Sample Size</th>
<th>Optimal Space</th>
<th>Width*Height</th>
<th>Signaling Distance</th>
</tr>
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<tbody>
<tr>
<td>10%</td>
<td>27</td>
<td>6*6</td>
<td>83</td>
</tr>
<tr>
<td>30%</td>
<td>79</td>
<td>9*9</td>
<td>56</td>
</tr>
<tr>
<td>50%</td>
<td>131</td>
<td>12*12</td>
<td>42</td>
</tr>
</tbody>
</table>

3 A Real Time Location-based System

The real time location system which looks for object or people in real time utilizes not a GPS based LBS but a wireless network based LBS in indoor. A localization method based on Received Signal Strength (RSS) [14] is used to divide spaces as a structured space. RSS has a disadvantage that noise affects the measurement accuracy. However,
the tolerance of a positioning accuracy can be ignored since we use the GPS data with RSS together in outdoor environments. We make an integrated system configuration for a real time location-based system as shown in Figure 1.

![Fig. 1. An integrated system configuration for a real time location-based system](image)

### 4 A Real Time Location-based Service

Based on the integrated system configuration, we developed some real time location-based services. First, we build an exhibition reservation service as shown in Figure 2. One of uncomfortable things in a big event is a blind waiting in front of the exhibition. We must ensure the fairness of a reservation to peoples and should not blindly to wait after booking. After a visitor pulls up a number ticket, he must not continuously wait for his order until the number is called. The service gives equal opportunity to visitors who arrive at a specific zone where a reservation can be built with a real time people tracking service.

![Fig. 2. A real time location-based reservation service](image)

Second, we developed a real time location-based 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 entire visitors. This service is helpful to propagating full flows of visitors by calculating the optimal number of a space based on the optimal number of the visitors.
Third, a partner checking service is implemented to finding the location of a partner with smart-phone. It is difficult to recognize the location of a partner because peoples move concurrently. We support the service in conjunction with other devices such as Zigbee [10], [11], [13] in indoor environments. This service can help to preventing stray child in real time in exhibition.

Fourth, in terms of total operation of the exhibition, the emergency is recognized in real time. A real time location-based emergency call service is transmitted to manager of control center. The helper stayed in closed location to the injured person performs an emergent service in real time.

Fifth, one of useful information service in exhibition is event notice service that is closed to the location of visitors. We construct this service by partitioning space zones since most of the exhibition zones are constructed by limited and compacted spaces. If the event is occurred, we identify target visitors from entire visitors 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.

Finally, we implemented information flow with smart-phone application as shown in Figure 3. In particular, the proposed space optimization and the localization method are integrated with location and service information in order to making the AR based embedded integration system. The control server of the system knows the distribution of entire visitors and the location of each visitor to providing the appropriate service. It can make information flow and supports a convenience to the visitors. Some limited problems that are caused by a paper ticket or a RFID ticket can be solved through the established services. We can expect increasing fast processing tasks and the reliability of visitors for the system.

5 Conclusion

Until now, we studied real time location-based services based on the proposed real time location-based system with an augmented reality before we implemented a real location-based system. To make this, first, we proposed a space optimization method.
Second, we developed an optimized localization method depending on the integration of GPS and RSS techniques. Finally, we implemented service models based on the proposed AR based prototyping system. Our study helps to constructing LBS based infrastructure to support a convenience of the peoples in exhibition.

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References

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