Conference Paper

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Publication Date:
2018-01-15

Permanent Link:
https://doi.org/10.3929/ethz-b-000225609

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Navigation System Using Web-GIS and AR for Urban Tourists

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Abstract. The present study aimed to design, develop, operate and evaluate the navigation system using Web-GIS and AR (Augmented Reality) to support tourists’ excursion behavior, by accumulating, sharing and providing information about urban sightseeing spots. This system was developed by integrating Web-GIS as a base system, SNS, recommendation systems and AR terminals (smart eyeglasses) into a single system, and operated in the central part of Yokohama City in Kanagawa Prefecture, Japan in 2015.

Keywords. Navigation System, Web-GIS, SNS, Recommendation System, Augmented Reality (AR), Smart Eyeglasses

1. Introduction

The present study aims to design, develop, operate and evaluate the navigation system using Web-GIS and AR to support tourists’ excursion behavior, by accumulating, sharing and providing information about urban sightseeing spots. Web-GIS as a base system, SNS and recommendation system will be integrated to develop a system appropriate for three information terminals including PC, mobile information terminal and smart eyeglass, in order for this system to be available in various situations. The central part of Yokohama City in Kanagawa Prefecture, Japan was selected as the region of operation.

More specifically, the present study will develop a system to support tourists’ excursion behavior that values real-time information provisions by means of the integration of Web-GIS as a base system, SNS and recommendation system. Furthermore, it is possible for the users to smoothly
access to this system from smart eyeglasses in addition to PCs and mobile information terminals. Therefore, it is also possible for the users to conveniently obtain real-time sightseeing spot information, when they make sightseeing plans beforehand or search for information during tourists’ excursion behavior in sightseeing areas. The above-mentioned points show the usefulness of the system.

2. System Design and Development

2.1. System Design
The system of the present study is developed by integrating plural applications including Web-GIS, SNS, recommendation system and smart glasses. Specifically, it was possible to manage and visualize submitted information on the digital maps of Web-GIS, and share and exchange information between limited users by means of originally developed SNS. These enable users to submit, view and update information, while grasping geographical information related to sightseeing spots on the digital maps. Additionally, by combining recommendation systems with the above two applications, the information that matches the user’s preference can be offered from the accumulated, shared and provided sightseeing spot information on the digital maps. Thus, even when the system is operated for a long term and the amount of accumulated information becomes massive, it is possible to direct users to the appropriate information, and support them to efficiently obtain sightseeing spot information.

2.2. System Frontend
The system will implement unique functions for users, which will be described below, in response to the aim of the present study, as mentioned in section 1. In order to implement these several unique functions, the system was developed by integrating plural systems into a single system, and is also connected with external SNS.

(1) Information submission function
(2) Information viewing function
(3) Information updating function
(4) Sightseeing spot recommendation function
(5) Information display function of smart eyeglass
(6) Information management function
2.3. System Backend

(1) Processing related to recommendations on the internet

Using the knowledge-based recommendation method, the similarity level of each item is calculated in the backend and sightseeing spots are recommended. By registering preference information on the user information page, users can receive recommendations. More specifically, a feature vector is created with the registered user’s preference information and the characteristics of sightseeing spot information. The similarity level of user’s preference information and the evaluation information about each sightseeing spot is calculated by means of cosine similarity. In this way, the top five sightseeing spots in order of the highest similarity levels are displayed as recommendation results.

(2) Processing related to information display on smart eyeglasses

Regarding smart eyeglass, in order for users to use it for sightseeing on foot, sightseeing spots that are within a walkable distance are displayed. The backend will extract nearby sightseeing spots with user’s location information, and display the top five spots in order of the highest similarity levels. According to the study of the daily sphere by Ishihara et al. (2006), 400m is generally referred to as walking distance for normal people, acknowledged as a nearby distance in everyday life, and is defined as a distance that would not be difficult to walk to. Therefore, this system has set 400m as the distance which sightseeing spots can be extracted. If there are less than five sightseeing spots within that distance for recommendations, the distance will be expanded to double and sightseeing spots will be extracted from within that distance. Additionally, in order to lessen the load on the server which is frequently accessed and display real-time information in front of users, when they travel half of the distance (200m) from the central point from where the sightseeing spots were extracted, the similarity level will be recalculated and the sightseeing spot list will be updated.

2.4. System Interface

The interface is optimized according to the user’s PC screens (Figure. 1), mobile information terminal screens, and smart eyeglasses screens, and administrator’s screens. Users can properly choose the three types of information terminals such as PCs, mobile information terminals and smart eyeglasses. Though the mobile information terminal screens is basically the same as PCs, by changing the layout of items according to the size of the screen, the operability of this system is made easy. Regarding the interface for smart eyeglasses screens (Figure. 2), the distance and direction of the destination from user’s present location will be displayed. Additionally, in order to maintain safety while users are walking, information will be displayed only on the bottom half of the screen.
3. Operation

3.1. Operation directly via the Web using PCs and mobile information terminals

Firstly, the operation directly via the Web using PCs and mobile information terminals was conducted from October to November, 2015. Whether inside or outside the region of operation, the operation of this system was advertised using the Website of the authors’ lab, and the tourism department of Kanagawa Prefecture and Yokohama City in addition to the Yokohama Convention and Visitors Bureau (Yokohama City Tourism Association) supported the present study by distributing pamphlets and operating manuals.

![Figure 1. Interface for PCs.](image)

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User greeting</td>
</tr>
<tr>
<td>2</td>
<td>Display of user information</td>
</tr>
<tr>
<td>3</td>
<td>Display of ten latest pieces of submitted sightseeing spot information</td>
</tr>
<tr>
<td>4</td>
<td>Go to submitted information list and ranking page</td>
</tr>
<tr>
<td>5</td>
<td>Go to initial page (Sample information is displayed on digital map)</td>
</tr>
<tr>
<td>6</td>
<td>Go to user information change and registration page</td>
</tr>
<tr>
<td>7</td>
<td>Go to page for submitting sightseeing spot information</td>
</tr>
<tr>
<td>8</td>
<td>Go to page for viewing submitted sightseeing spot information</td>
</tr>
<tr>
<td>9</td>
<td>Go to page where sightseeing spots are recommended</td>
</tr>
<tr>
<td>10</td>
<td>Logout</td>
</tr>
<tr>
<td>11</td>
<td>Go to page for mobile information terminals</td>
</tr>
<tr>
<td>12</td>
<td>Marker legend</td>
</tr>
</tbody>
</table>
Table 1. Outline of users.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Display of the distance and direction of the destination from user’s present location</td>
</tr>
<tr>
<td>2</td>
<td>Display of sightseeing spots</td>
</tr>
<tr>
<td>3</td>
<td>User’s ID number</td>
</tr>
<tr>
<td>4</td>
<td>Display of the distance of the destinations from user’s present location</td>
</tr>
</tbody>
</table>

Table 1 shows the details of users during the eight-week operation, and the total number of users was 91. After having each user use this system for a month, the evaluation based on the online questionnaire survey was conducted. In order to solve the cold-start problem, the 181 items of sightseeing spot information gathered by Ikeda et al. (2014) was prepared as initial data. As the total number of submissions during the operation was 162, a total of 343 sightseeing spot information items were accumulated in the system.

Though there was a lot of submitted information during the operation period in categories such as restaurants/cafes (65 items, 40%), shopping (29 items, 18%), and famous spots/historical sites (23 items, 14%), information
was submitted in every category. Moreover, almost all the submitted information had related images. Therefore, sightseeing spots information, which had related images and was recommended to users according to their preference, was accumulated in this system in line with the purpose of the present study.

3.2. Operation via smart eyeglasses
Secondly, the operation directly via the Web using smart eyeglasses was conducted. In the Minato Mirai area located in the central part of Yokohama City, the operation via smart eyeglasses was conducted with tourists as subjects. Users put the smart eyeglasses on and received navigation in the Minato Mirai area. The reason why such a place was chosen is because there are no cars which enables users to safely receive navigation. Additionally, in consideration for the safety of users, an escort was assigned to all users. Table 1 also shows the details of users during the operation period, and the total number of users was 34, with 20 male users and 14 female users. When divided according to age, though those in their 20’s were the most numerous occupying 41% of the total number of users, the age of users were scattered, and no one had experience using the smart eyeglasses. Just after the operation, all users were required to answer the online questionnaire survey.

4. Conclusion
Thus, in order to support tourists’ excursion behaviors by accumulating, sharing and providing information about urban sightseeing spots, the navigation system was designed and developed, by integrating Web-GIS as a base system, SNS, recommendation system and smart eyeglass. Additionally, the central part of Yokohama City in Japan was selected as the region of operation. Concerning the operation of this system, all subjects, whether inside or outside the region of operation, were over the age of 18, and 91% were between the age of 20-40 among the 91 users. The ultimate number of submitted information was 162. Furthermore, regarding the operation using smart eyeglass, which was conducted with tourists in the Minato Mirai area, the total number of users were 34, age of users were spread out, and all users had no experience in using smart eyeglasses.

References