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DEVELOPMENT OF A DISTRIBUTED SIGHTSEEING SUPPORT SYSTEM USING GIS AND RECOMMENDATION SYSTEM

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Abstract: It is expected that concerns or crisis for the overtourism will increase in Japan, in the post pandemic. As countermeasures for the overtourism, such as to provide tourists with visible congestion statuses at sightseeing destinations and guiding tourists to disperse are raised. Then, the present study aims to develop a sightseeing support system that encourages users to go distributed sightseeing through two original functions. One is the function that provide users with visible congestion statuses by utilizing Web-geographic information systems (GIS). The other is that guides users to disperse by utilizing a recommendation system. These functions are implemented by utilizing reviews collected from web tourism medias. The system was developed by integrating social networking service (SNS), Web-GIS, and a recommendation system. Additionally, the system was operated for 12 people for one week in Kamakura City, Kanagawa Prefecture, Japan. And the system evaluated with web questionnaire survey. For operation, 30,357 reviews and 256 sightseeing spots and restaurants information were collected. From the results of questionnaire survey, the system can encourage users to consider desirable seasons or places when they plan to go sightseeing, and to make their interest for sightseeing spots which they did not know until then. Therefore, the system can encourage users to go distributed sightseeing.

Keywords: overtourism, distributed sightseeing, sightseeing support system, Web-GIS, recommendation system, text mining

Introduction

In Japan, it is expected that concerns or crisis for the overtourism that drew many people's attention before COVID-19 pandemic will be conspicuous again in Japan. According to the leaflet published by the World Tourism Organization of the United Nations (UNWTO), the word ‘overtourism’ was created by Skift that is a media in 2016. The universities collaborating on creating this leaflet defined overtourism as “the excessive impact of tourism on sightseeing destinations, its residents, their quality of life and quality of visitors’ experiences in a negative way” (UNWTO, 2018). In fact, the Japan Tourism Agency reported that the problems related to the overtourism such as a sightseeing congestion or sightseeing garbages had occurred in specific sightseeing destinations in Japan in June 2019 when COVID-19 pandemic had no impact (Japan Tourism Agency, 2019). At that time, due to the increase of crisis for the overtourism, the countermeasures against the overtourism were actively discussed. For examples, as the countermeasures, it was raised to provide tourists with visible information on congestion statuses in sightseeing destinations (Japan Tourism Agency, 2019), and to guide tourists to go distributed sightseeing (Choi, 2020). Additionally, Kwon (2018) suggested that

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the main reason for the occurrence of the overtourism is the large number of tourist visits. Thus, it is necessary to avoid the concentration of tourists to reduce the occurrence of the overtourism.

Based on above background, the present study aims to develop a sightseeing support system that have two original functions to encourage users to go distributed sightseeing. One is the function to provide users with visible congestion statuses utilizing GIS, and the other is the function to guide users to go distributed sightseeing utilizing a recommendation system. In the present study, distributed sightseeing is defined as sightseeing avoiding crowded seasons or places.

Related Work

The present study is related to three research fields including (1) studies related to distributions of tourists, (2) studies related to sightseeing support systems utilizing GIS, and (3) studies related to sightseeing support systems utilizing recommendation systems. Taking up the representative studies in the above three research fields, in (1), Ma (2018) described the analysis methods and utilization technologies of user generated contents (UGC) for the individualization and decentralization tourism. In (2), Kurata *et al.* (2015) estimated sightseeing potentials that quantify the attractions of sightseeing destinations based on the user-posted data of a photo-sharing site and sightseeing potential maps that provide visible sightseeing potentials on the digital map, and described application methods. In (3), Uehara *et al.* (2012) estimated the degree of similarity between sightseeing spots based on the sightseeing information on the Internet, and developed a sightseeing spots recommendation system using the degree of similarity. Sumitomo *et al.* (2020) scored sightseeing spots based on emotional words contained in word-of-mouth information, and developed a sightseeing spot recommendation system using these scores. In a research related to (1) and (2), Kawai *et al.* (2018) developed a system that provides users with congestion statuses of several hours later in an area that users specified by utilizing check-in-tweets submitted on Twitter using Swarm that is application to share users' current location. In a research related to (2) and (3), Ikeda *et al.* (2014) developed a social recommendation GIS that can recommend sightseeing spots using the similarity between users' preferences and sightseeing spot evaluation.

Regarding (1), Ma (2018) only describes the analysis methods and utilization technologies of UGC for the individualization and decentralization of tourism, but it does not actually support tourism using them. Regarding (2), it describes application methods of sightseeing potential maps that were created under various conditions such as year, season, rainfall, etc. Kawai *et al.* (2018) can encourage users that avoid crowded time or places in a few hours. However, it is limited to local use in sightseeing, and cannot contribute to long-term sightseeing distribution such as across seasons, because it only predicts congestion statuses in an area specified by users in a few hours. Regarding (3), because Ikeda *et al.* (2014) recommend sightseeing spots with their own unique perspective, it can recommend novel and appropriate sightseeing spots which suit the aims or preferences of users. However, it cannot encourage users to go distributed sightseeing, because it do not provide information of crowded seasons or places.

In comparison with the preceding studies mentioned above, the present study will show the originality to develop a sightseeing support system which have two original functions. One is a function to display monthly sightseeing congestion statuses on a digital map a utilizing GIS, and the other is a function to recommend sightseeing spots to users utilizing a recommendation system. Therefore, the system can encourage users to go distributed sightseeing by providing users with information of

crowded seasons or places, and recommending sightseeing spots that are not known well to users but suit to the aims or preferences of them.

System Design

System Characteristics

As shown in Figure 1, the system is developed by integrating SNS, Web-GIS and a recommendation system. The aim of the system is to encourage users to go distributed sightseeing using two functions, displaying function of sightseeing congestion statuses and recommendation function of sightseeing spots. Displaying function of sightseeing congestion statuses is implemented utilizing GIS, and encourages users to consider desirable seasons or areas by displaying sightseeing congestion statuses and providing users with visible information of crowded seasons or areas on the digital maps. Recommendation function of sightseeing spots is implemented utilizing a recommendation system, and guides users to disperse by recommending sightseeing spots that are not known well to users but suit aims or preferences of them, and discouraging users going sightseeing as only visiting popular sightseeing.

Additionally, the above two functions are implemented utilizing reviews collected from web tourism medias. Sightseeing congestion statuses are estimated based on data concerning the dates of visits attached to reviews. Feature quantities of sightseeing spots are calculated based on the words extracted from reviews' texts. Additionally, combining SNS and Web-GIS, as the system enables users to submit new sightseeing spots on the digital map, and it can easily gather and accumulate sightseeing spot information.

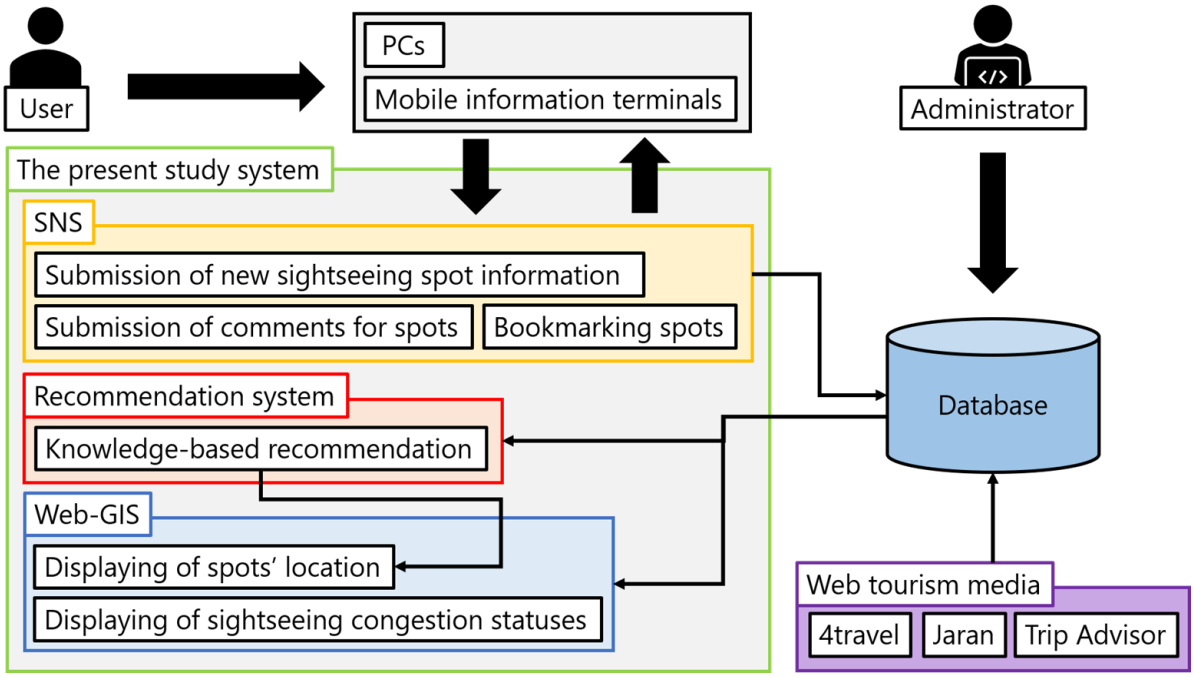


Figure 1: System design

Design of Each Systems

SNS

The main functions of SNS originally designed in the system are the submitting, viewing and bookmarking of sightseeing spot information. The function of bookmarking can be used in the page for sightseeing spot list or the detailed information of sightseeing spots.

Web-GIS

Outline of the Web-GIS in the Present Study

Though there are many types of Web-GIS, this system uses ArcGIS API for JavaScript provided by the ESRI to display the sightseeing congestion statuses and the location of recommended sightseeing spots, as it is convenient to access the websites without the installation of any software. Additionally, Leaflet, which is the JavaScript open-source map library using JavaScript, is used to display the range of recommendation as well as the location of sightseeing spots in the page for the detailed information of sightseeing spots.

The Displaying Function of Sightseeing Congestion Statuses

This function displays sightseeing congestion statuses estimated from collected reviews on digital maps utilizing GIS. The procedure for estimation of sightseeing congestion statuses is as follows.

1. Compiling collected reviews for each sightseeing spot.

2. Extracting the data concerning dates of contributors' visits attached to reviews.

3. Compiling the data concerning the date of visits for each month and calculating the numbers of visits for each month.

4. Creating the layer that combined location information of sightseeing spots with the numbers of visits.

5. Creating the layer by overlaying the layer created in step 4 on the layer of district boundary of the operation target area.

6. Calculating rates of numbers of monthly visits to total number of visits for each district by using equation (1) and are defined as sightseeing congestion statuses.

$$S_{i,j} = \frac{n_j}{N_i} \quad (1)$$

$S_{i,j}$: Sightseeing congestion statuses
n_j: Number of visits in j
N_i: Total number of visits at district boundary i
i: District boundary number
j: Month (January, February, …, December)

Sightseeing congestion statuses for each district are classified into 6 stages using natural breaks and color-coded according to stage. Additonally, the sightseeing congestion statuses are displayed on digital maps.

Recommendation System

Outlines of the Recommendation System in the Present Study

According to Jannach *et al*. (2011), there are 3 types of recommendation methods including collaborative recommendation, content-based recommendation and knowledge-based recommendation that can make recommendations from vast information groups to match the preferences of users. The system adopts knowledge-based recommendation method. The reason for this is that it was characterized by explicitly asking users for preference when making recommendation and it can be expected to recommend sightseeing spots that users really want to visit.

Additionally, the cold-start problem can be solved by adopting knowledge-based recommendation method. Cold start is a problem where appropriate recommendations cannot be made due to insufficient past information. Since knowledge-based recommendation methods are conducted by creating preference data of users, appropriate recommendations can be made without any past information by explicitly asking for their preferences beforehand.

The Recommendation Function of Sightseeing Spots

Because this function needs feature quantity of sightseeing spots calculated based on collected reviews, the procedure for calculation of feature quantities of sightseeing spots is as follows.

1. Extracting words from all collected reviews by using morphological analysis with MeCab.

2. Creating indicators that indicates sightseeing spots' features (feature categories).

3. Creating the table that shows the correspondence between words and feature categories confirmed by several people in order not to be strongly affected by individual subjectivity.

4. Putting together collected reviews by sightseeing spot.

5. Extracting words from reviews of each sightseeing spot by using morphological analysis with MeCab and calculating number of times words appear.

6. Calculating the term frequencies of words categorized to a feature category to total number of reviews by using the table created in step 3 and equation (2).

$$T_{i,j} = \frac{n_i}{N_j} \quad (2)$$

$T_{i,j}$: Term frequency in feature category i in sightseeing spot j's reviews
n_j: Number of words categorized to feature category i
N_j: Total number reviews of sightseeing spot j
i: Feature category number
j: Sightseeing spot number

7. The term frequencies are normalized in the range of 1 to 5 so that the system can use them, and defined as feature quantities of sightseeing spots.

Regarding knowledge-based recommendation method, user profiles are created by having users evaluate the items entered beforehand on a scale of 1 to 10. In the system, the half values entered are used. The created user profile is set as the user's characteristic vector. Additionally, sightseeing spots' characteristic vectors are created based on feature quantities of sightseeing spots extracted from the database. Based on created characteristic vectors for users and sightseeing spots, sightseeing spots in descending order of similarity will be recommended by calculating the degree of similarity using equation (3).

$$Sim_i = \frac{\sum_{j=1}^{n} U_j \times S_{ij}}{\sqrt{\sum_{j=1}^{n} (U_j)^2} \times \sqrt{\sum_{j=1}^{n} (S_{ij})^2}} \quad (3)$$

Sim_i: Degree of similarity
U_j: Evaluation information of user concerning condition j
S_{ij}: Evaluation data of sightseeing spots
i: sightseeing spots number
j: Item number of user's conditions and sightseeing spot's features

System Development

System Front End

Viewing Function of Sightseeing Spots

Users can transfer to the page for the viewing function of sightseeing spot information from the “viewing information” in the menu bar. Users can choice two viewing methods, “search from map” or “search from list”. When using “search from map”, a popup including the “name of sightseeing spot”, “category”, “address”, “business hours”, “business holiday”, “fee”, “phone number”, “parking information”, “link to the page for the detailed information of sightseeing spot” and “link to the external site of sightseeing spot” will be displayed by selecting the markers on the digital map. Additionally, the markers are color-coded according to category, and users can view location information of restaurants, bus spots and stations. On the other hand, when using “search from list”, users can view information of sightseeing spots or restaurants by list, and choice categories displayed on the list. Additionally, users can bookmark sightseeing spots or restaurants by putting the button “register bookmark” in the list, and view bookmarked spots in the page for information of a user.

User can transfer to the page for the detailed information of sightseeing spots or restaurants by selecting items of spots in the list. In the page for the detailed information of sightseeing spots, the “name of sightseeing spot”, “category”, “address”, “business hours”, “business holiday”, “fee”, “phone number”, “parking information”, “other details”, “External site URL”, “images”, “map”, “submitted comments” and “graph of visits by month” are displayed. Additionally, users can bookmark, modify sightseeing spot’s information and submit comments and images.

Submission Function of Sightseeing Spots

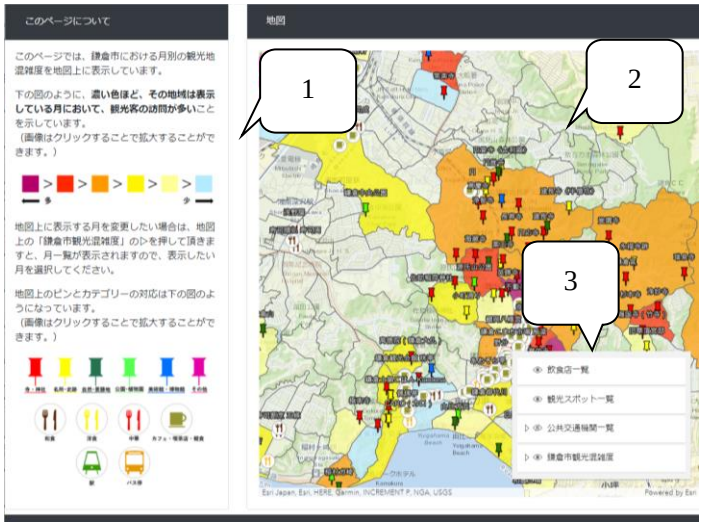
Users can transfer to the page for the submission function of sightseeing spots from the “submit new sightseeing spot” in the menu bar. In this page, a popup including the two forms, “sightseeing spots register form” and “restaurants register form”, will be displayed by clicking a spots’ location user want to register on the digital map or by acquiring the present location information.

In the page for registration form of spots, users can submit spots by entering the “name of spots”, “category”, and pushing the button “registration”. Entering information such as holidays and fees is optional, but entering the name of spot and category of the spot is mandatory. Additionally, It is not possible to register a spot with the same name as a spot that is already registered in the database. Users can submit comments for spots in the page for the detail information of sightseeing spots or restaurants.

Display Function of Sightseeing Congestion Statuses

Users can transfer to the page for the display function of sightseeing congestion statuses from the “sightseeing congestion map” in the menu bar. The page for the display function of sightseeing congestion statuses is shown in Figure 2. Users can select the sightseeing congestion status for the month they want to display on the map from the "Kamakura City sightseeing congestion statuses" tab on the digital map. Additionally, sightseeing congestion statuses are color-coded according to

strength. In this page, the location information of registered sightseeing spots and restaurants, bus stops and stations can be displayed on the digital map.



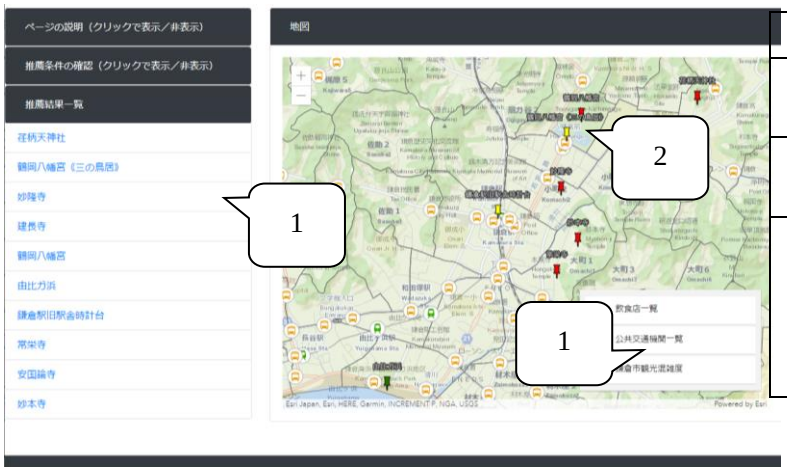
No	Description
1	Instruction of this page
2	Sightseeing congestion status map
3	Function box (Display map in other month, restaurants information, and bus stops and stations)

Figure 2: Page for the display function of sightseeing congestion statuses

Recommendation Function of Sightseeing Spots

Users can transfer to the page for the recommendation function of sightseeing spots from the "sightseeing spots recommendation" in the menu bar. By clicking onto the button of "send" after evaluating each item for sightseeing spots on a scale of 1 to 10, and selecting the "category", the range of recommendation results from "center station" and "distance (250m, 500m, 1km, 1.5km, or not specified) from the center station" and "number of results of displayed recommendation results (10 or 20)", users can move to the page for the recommendation results. The center of recommendations can be set as users' present locations by using their present location information.

The page for the recommendation results is shown in Figure 3. In this page, the recommendation results are displayed on the list or the digital map. Users can transfer to the page for the page of the detailed information sightseeing spots from a link in list or in a popup that will be displayed by selecting a marker on the digital map. Additionally, the sightseeing congestion statuses, restaurants, bus stops and stations can be displayed on the digital map.



No	Description
1	List of recommendation results
2	Recommendation results map
3	Function box (Display sightseeing congestion statuses, restaurants information, and bus stops and stations)

Figure 3: Page for the recommendation results

System Back End

In the system back end, processing recommendation of sightseeing spots was implemented. The processing steps are as follows.

1. Creating a user profile based on conditions by entering users.
2. Extracting sightseeing spots that match conditions from the database.
3. Calculating the degree of similarity between the user profile created in step 1 and the feature quantities of extracted sightseeing spots.
4. Sorting in descending order of similarity.
5. Displaying a specified number of recommendation results in order of similarity on a list and a digital map.

Interface

The interface of the system has 2 types: PC and mobile devise screen of users, and the PC screen of the administrator. For the users' screen, a responsive design was selected and 2 types of interfaces were prepared according to the screen size of the used devices. In the administrator's page, users, submitted information of sightseeing spots and restaurants can be usually managed and checked by them. By utilizing Graphic User Interface (GUI), malicious users and inappropriate information of sightseeing spots, restaurants or submission can be deleted by the administrators without being affected by their the information technology (IT) literacy.

Operation and Evaluation

Selection of Operation Target Area

Kamakura City, Kanagawa Prefecture, Japan was selected as the operation target area. The first reason for this selection is that the problems related to the overtourism such as a sightseeing congestion and tourists' manner are occurring (Kamakura City, 2016). The second reason is that many

tourists tend to visit in specific seasons. Then, providing users with visible information of crowded seasons or places by utilizing the displaying function of sightseeing congestion statuses, it is expected that the system can encourage users to consider their desirable seasons or places when they plan to go sightseeing. The Third reason is that tourists tend to visit to specific popular sightseeing spots. Therefore, by providing users with sightseeing spots information that match users' aims or preferences and users did not know until then by utilizing the recommendation function of sightseeing spots, it is expected that the system can guide users to disperse.

Operation and Evaluation Overview

The operation of the system was conducted over the course of 1 weeks (1 October 2021 – 8 October 2021) with 12 people inside or outside the operation target area as subjects. Users will register when using the system for the first time. Registration is completed by entering their account names, email address, genders, their ages and passwords. The email address and password are required when logging in to the system. For the operation, 30,357 reviews and 256 sightseeing spots and restaurants information were collected.

After the end of the operation, a web questionnaire survey for users was conducted to evaluate the system developed in the present study. In the questionnaire, items that ask whether the respondents considered desirable seasons and places when they plan go sightseeing as using the displaying function of sightseeing congestion statuses, and whether the respondents were interested in new sightseeing spots that they did not know until then and satisfied with the recommendation results are prepared.

Operation and Evaluation Results

The results of questionnaire survey is shown in Tables 1 and 2. Regarding the display function of sightseeing congestion statuses, both of items that ask whether the respondents considered desirable seasons or places when planning to go sightseeing, most of respondents answered "I think so." or "I somewhat think so.". Therefore, the display function of sightseeing congestion statuses by utilizing GIS in the system could encourage users to consider their desirable seasons or places when planning to go sightseeing.

Regarding the recommendation function of sightseeing spots, both of items that ask whether the respondents were interested in new sightseeing spots that they did not know until then and satisfied with the recommendation results, most of respondents answered "I think so." or "I somewhat think so.". Therefore, the recommendation function of sightseeing spots by utilizing a recommendation system in the system could recommend sightseeing spots that match users' aims or preferences and users did not know until then.

Table 1: Results of survey about the displaying function of sightseeing congestion statuses

Evaluation item	I think so.	I somewhat think so.	I don't somewhat think so.	I don't think so.
Becoming considering desirable seasons	3	6	2	1
Becoming considering desirable places	9	1	1	1

Table 2: Results of survey about the recommendation function of sightseeing spots

Evaluation item	I think so.	I somewhat think so.	I don't somewhat think so.	I don't think so.
Interest in new spots recommended	6	5	0	1
Satisfaction the recommendation results	3	7	1	1

Conclusions

In the present study, a system was designed and developed (Section 3 and 4), the operation and the evaluation were implemented (Section 5). The present study can be summarized in the following 3 points.

1. In the present study, a system was designed and developed by integrating SNS, Web-GIS and recommendation system in order to encourage users to go distributed sightseeing. In the system, by estimating the sightseeing congestion statuses and calculating the feature quantities of sightseeing spots based on collected reviews from web tourism medias, the display function of sightseeing congestion statuses and the recommendation function of sightseeing spots were implemented.

2. Kamakura City, Kanagawa Prefecture, Japan was selected as the operation target area, and the operation and the evaluation were conducted. Because Kamayurá City has various issues cause by overtourism. The operation of the system was conducted over the course of 1 week with 12 people inside and outside the operation target area as subjects.

3. From the results of the questionnaire survey, the 2 original functions in the system, which are the display function of sightseeing congestion statuses and the recommendation function of sightseeing spots, can encourage users consider their desirable seasons or places when planning to go sightseeing, and get them interested in not so popular sightseeing spots that users did not even know about. Therefore, the system can encourage users to go distributed sightseeing.

In regards to future research, the improvement of its utilization significance by increasing operation records of the system by conducting the operations in larger area and longer period. Additionally, the

authors will in increase users inside and outside the operation target area to operate and evaluate improved system.

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