International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 03 - Issue 02 || February 2017 || PP. 26-36

Recommendation of Tour Route from Tourist Motivation Improving Serendipity Occurrence

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Abstract: People want to go on a trip because of reasons specific to them. We regard it as trip motivation. They are satisfied for their trip matching their trip motivations. In addition, they raise their satisfaction for their trip when they experience serendipity on sight-seeing spots. In this paper, we propose a method to recommend the tourist route which not only matches user's trip motivation but also brings serendipity. In this method, we estimate user's trip motivation with photographs of sight-seeing spots. The method figures out sight-seeing spots from the estimation as expected points, so that they can satisfy what they expect. In addition, we determine the sight-seeing spots to intentionally generate serendipity based on user's fundamental desires, which the user wants to fulfil in her life. We refer them as unexpected points, because they have potential to make the user experience something valuable unexpectedly. We present a tourist route involving both of the expected and the unexpected points to recommend to the user. Experiments in Kyoto to verify the usefulness of this method proved that we can recommend tourist routes which can provide the same level of satisfaction as general Kyoto sight-seeing trips do. In addition, subjects experienced serendipity twice more in the sight-seeing spots in unexpected points than in expected points. This method can create the tourist route to strongly satisfy users with the combination of sight-seeing spots for serendipity and ones suitable for trip motivation.
Keywords: Trip, Recommendation, Tourist route, Trip motivation, Fundamental desires

1 INTRODUCTION

People go on a trip to heal their dairy fatigue and to change their feeling. The factor that makes them want to go on a trip is trip motivation. The trip motivation depends on their condition. They are satisfied for the trip by fulfilling their trip motivation.

Everyone has fundamental desires apart from their trip motivation. The fundamental desires are the desires that people want to fulfil in their dairy life. They try to cause unusual behavior to fulfil it if the fundamental desires are not fulfilled. What they try to go on a trip is one of them. Therefore, the trip motivation is the fundamental desires that do not especially fulfil then.

People who decide to go on a trip make a trip plan to be able to achieve expectations coming from their trip motivations. They are easy to enjoy serendipity in sight-seeing spots by making a trip plan. They raise the satisfaction degree for their trip if they enjoy serendipity. Therefore, in order to be satisfied with the trip, it is necessary to achieve expectations coming from their trip motivation and enjoy serendipity.

However, people sometimes decide to go on a trip, leaving their trip motivation unclear. If they select some visiting spots in the trip unsuitable for their trip motivation, they are less satisfied with the spots. They cannot raise the satisfaction degree for the trip. Some people do not have the time to make a trip plan because they work hard. They may not be able to enjoy serendipity during their trip. Therefore, they cannot be satisfied enough for their trip. It is necessary to have a mechanism to clarify the user's trip motivation and to experience serendipity in the trip.

In the related works, they recommend the tourist route by the collaborative filtering over trip histories of users. However, they cannot estimate the present trip motivations because they use trip histories. In addition, they cannot consider about occurrence of serendipity.

In this paper, we estimate user's trip motivation. We propose the method to recommend the tourist route that not only achieves expectations coming from user's trip motivation but also encourages the occurrence of serendipity. In this method, we present the photograph of sight-seeing spots for users. They create an image about their trip by looking them. We estimate their trip motivation by selecting the photograph suitable for their trip image. We determine the sight-seeing spot to achieve expectations coming from their trip motivation by estimated their trip motivation. On the other hands, we determine the sight-seeing spots to provide serendipity for users based on the fundamental desires of users. We create the tourist route with these sight-seeing spots and recommend it to users. Users can go on an optimum trip to achieve expectation coming from their trip motivations by recommending the tourist route. Therefore, they can gain the max satisfaction for their trip.

The remaining of the paper is organized as follows. Section 2 describes the method to be satisfied on a trip and the problems of present state. The detail of the proposed meth-od is presented in section 3. Section 4 illustrates experiments to verify the usefulness of the method. The paper discusses the experiment result in section 5. Section 6 gives the conclusions and future works.

2 METHOD TO BE SATISFIED ON TRIP

2.1 FUNDAMENTAL DESIRES AND TRIP MOTIVATION

In general, tourists have many desires they want to fulfil in their trips. These desires vary with individuals. For ex-ample, some tourists want to refresh their minds with beautiful scenery, while others want to taste local foods specific to the area they visit.

Out of various desires, people want to go on a trip when specific desires temps them to the trip. We regard a psychological factor which tempts them to go on a trip as a trip motivation. Trip motivations of people are classified into the five categories: getting rid of strains, pursuing amusements, strengthening relationships with somebodies, in-creasing knowledge, and expanding themselves [1]. People would gain satisfaction through the trip, achieving what they expect because of their trip motivations.

In our study, we regard the desire people want to fulfil in their dairy life as fundamental desires. Fundamental desires are classified into five categories: joyfulness, relaxation, relationships with the opposite sex, popularity from others, and a sense of seasons [2]. Each kind of trip motivation corresponds to one of fundamental desires. For example, people who have a strong desire for the relaxation as an element of the fundamental desires are more likely to go on a trip to get rid of strains, which is one of trip motivations. Trip motivation is the psychological factor to be more satisfied than others in the trip being planned. It implies trip motivations are fundamental desires which have not been satisfied for the time being. Therefore, it is assumed that a trip motivation is included in fundamental desires.

When tourists plan a trip, they imagine what they want to experience in the trip based on the trip motivations. They make a trip plan so that it meets the expectation coming from the trip motivation. For example, they decide sight-seeing spots to visit, restaurants for dinners, lodging accommodations, and so on, according to the expectation. After the decision, they make a tourist route to visit them.

2.2 SOMETHING TO SATISFY FOR TOURISTS

In a specific trip, tourists have expectations coming from trip motivations. The trip satisfies the tourists if the expec-tations come true in the trip. Needless to say, tourists are disappointed if the trip is different from what they expected in advance.

In the meantime, some fundamental desires tourists have not intended to fulfil unexpectedly come true in a specific trip. In this paper, we regard the fulfilment of unexpected fundamental desires in a specific trip as serendipity. Since trip motivations correspond to desires the tourists want to fulfil in their trip, the satisfaction increment the fulfilment brings falls within the estimation of the tourists. However, the fulfilment of unexpected fundamental desires gives tourists a big pleasure. The satisfaction increment by serendipity is much more than what the tourists feel for the fulfilment of their trip motivations.

2.3 PROBLEM FOR PRESENT TRIP

People need to understand their trip motivation so that they might satisfy their trip. People who decide to go on a trip with trip motivations can properly select sight-seeing spots to make their expectation come true. However, people sometimes decide to go a trip, leaving their trip motivation unclear. If they select some visiting spots in the trip unsuitable for their trip motivation, they are less satisfied with the spots. Eventually, they cannot raise the total satisfaction degree for the trip.

Some tourists cannot afford the time to build their trip plans. For example, those who work hard cannot spare their time for the planning. Those cannot gain benefits a trip plan brings. It is necessary that even busy persons can clarify their trip motivations, supporting to build their trip plans.

Furthermore, it takes considerable cost to make a trip. We should have users achieve satisfaction over the cost. From the discussion in section 2.2, users can attain great satisfaction, if we cause them to experience serendipity. We should supply a mechanism to provide serendipity for users.

2.4 RELATED WORKS

There are some related works to recommend a tourist route for users [3] [4] [5]. In these studies, they use the collaborative filtering over trip histories of users. They get the preference, to recommend the ideal tourist route for the users. However, there are two problems which cannot be solved by these studies. First, they cannot estimate the pre-sent trip motivations because they use trip histories. Trip motivations of a person usually

change into others after he makes a trip. The present trip motivation is seldom identical with the past one. Tourist routes recommended with his trip history are not acceptable, because the past trip motivations are different from the present ones. A tourist route planned with spots recommended based on the trip history of the user does not match his present trip motivation.

As another drawback of them, they do not consider serendipity. Users get a deep satisfaction for a trip from experiences of serendipity. After the planned trip is confirmed to meet expectations coming from their trip motivation, we should lead users to experience serendipity to improve their satisfaction for the trip.

We need to clarify present trip motivations of users to solve these problems. It figures out tourist spots matching user's trip motivation. In a target tourist route, we should include sight-seeing spots which intentionally generate serendipity. A user can gain a big satisfaction through the traveling a tourist route, if we can recommend a tourist route which meets expectations coming from their trip motivations as well as supplies serendipity,.

3 TOURIST ROUTE CAUSING SERENDIPITY

3.1 SERENDIPITY AS WELL AS TRIP MOTIVATION

Our study estimates user's trip motivation, making the user select some photos of sight-seeing spots which attract the user to go on a trip. At the same time, the proposed method estimates user's fundamental desires with the paired comparison test. Based on that, the proposed method recommends a tourist route which fulfils expectation coming from her trip motivation. In addition to that, the method chooses the route so that it can promote occurrence of serendipity. Figure 1 shows the proposed method.

Trip motivation is represented with a set of desires a user wants to satisfy on her trip. This method shows the user who wants to go on a trip some photos of sight-seeing spots to estimate her trip motivation. The photos bring the user concrete images for the trip being planned. The user selects photos of sight-seeing spots suitable for the trip motivation from the given ones. The selected photos enable us to estimate user's trip motivation.

The method calculates the similarity between user's trip motivation and sight-seeing spots. Sight-seeing spots with high similarity reflect the trip motivation. Meanwhile, it is assumed that the user can enjoy serendipity if she finds something to satisfy desires included in the difference set excluding the desire set corresponding to user's trip motivation from the set of her fundamental desires. The method aims occurrence of serendipity, getting the sight-seeing spots to satisfy desires included in the difference set. It recommends the tourist route covering these sight-seeing spots to the user.

3.2 ESTIMATING USER'S TRIP MOTIVATION

This study utilizes photos of sight-seeing spots.

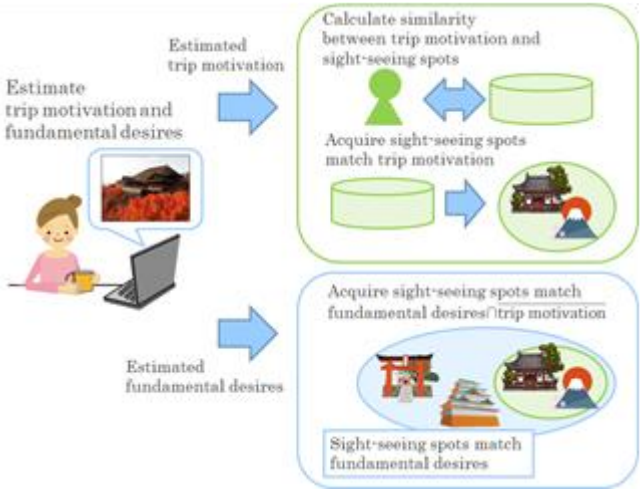

Fig. 1Proposed method

User makes concrete images for the trip being planned through photos of sight-seeing spot. The concrete image makes it easy for the user to judge whether each sight-seeing spot is suitable for her current trip motivation. It is assumed that photos of sight-seeing spots she chooses expresses her trip motivation.

Each photo of sight-seeing spots the user chooses has one subject. User's expectation coming from the trip motivation is fulfilled when the user visits the place corresponding to the subject. Each subject is associated

with numerical information on the proportion of the degree of the fulfilment. Figure 2 shows the method to associate the photo of a sight-seeing spot with the numerical information on a specific kind of trip motivation.

We represent trip motivation as a vector, assuming its 5 elements: getting rid of strains, pursuing amusement, strengthen relationship, increasing one's knowledge, and expanding oneself. In this study, we regard the vector as a set of real numbers to express the proportion of trip motivation matching in the trip. The vector of trip motivation is represented by the following equation (1).

$$\vec{M} = (m_1, m_2, m_3, m_4, m_5), \quad (1)$$

Where mi (i = 1,2,. . . , 5) denotes the five elements.

Each elements of the vector of trip motivation for a user is calculated using a co-occurrence network created with word-of-mouth for the subject. The co-occurrence network is generated as follows. A travel site in operation presents a lot of reviews as the word-of-mouth for the subject in the photo of sight-seeing spot used in this study. The proposed method creates a co-occurrence network using words that appeared in the word-of-mouth reviews for the subject. It is considered that the co-occurrence network shows characteristic words about impressions and emotions which have been received by an unspecified number of tourists visiting the sight-seeing spot.

It is assumed that user has the trip motivation associated with the co-occurrence network corresponding to the sight-seeing spot when user selects specific photos of sight-seeing spot. Whether a specific trip motivation is associated with a given co-occurrence network is determined in the following way. Each element of the trip motivation is associated with clearly stated actions [6].

Table 1 shows example actions associated with trip motivation.

Declinable words are extracted from phrases representing the actions, followed by further search for their synonyms. It examined whether the declinable words and their synonyms appear in the co-occurrence network created from the word–of- mouth reviews. If they appear, it is considered the place where the subject is located can matches the trip motivation corresponding to the word.

Considering the degree of co-occurrence of each word with respect to the subject, the weight of the word is calculated using equation (2).

Fig. 2 Method to associate photo of a sight-seeing spot with numerical information on a specific kind of trip motivation $\vec{M} = (m_1, m_2, m_3, m_4, m_5),$

Table 1.Example of action in a trip

Trip motivation	Example of actionin a trip
To get rid of strain	To take it easy
To pursue amusement	To eat delicious foods
To strengthen relationship	To become friends with other people
To increase one's knowledge	To learn about visits
To expand oneself	To act actively

$$\text{weight of word} = \frac{\text{the number of appearance times of co} - \text{occurring words}}{\text{the number of appearance times of all declinable words in the word} - \text{of} - \text{mouth reviews}} \quad (2)$$

The sum of the weights of the words belonging to each kind of trip motivation becomes the value of the element corresponding to the kind of trip motivation. The calculation is applied for all of the subjects.

Finally, it normalizes the elements of each kind of trip motivation. The equation for the normalization is shown in equation (3).

$$\text{The element value of element of trip motivation associating with the subject} = \frac{\text{the sum of element values for a subject}}{\text{the sum of element values for all subject}} \quad (3)$$

We can figure out the trip motivation vector with the above procedure.

When a user selects photos of sight-seeing spots suitable for the image of the planned trip from the photos associated with trip motivation vectors, the proposed method calculates the sum of the trip motivation vectors associated with chosen photos when user completes choosing the photos.

3.3 KIND OF SIGHT-SEEING SPOT GETTING BY OUR METHOD

In trips, users would try to satisfy their own desires with charms of sight-seeing spots they visit. Any user does not try to satisfy all the desires on the trip being planned, but tries to satisfy a specific set of desires. Trip motivation is represented with the set of desires that user tries to satisfy on the planned trip. In this study, we define an expected charm as one to match the trip motivation for the planned trip. On the contrary, we define an unexpected charm as one that satisfies fundamental desires but does not match trip motivation of a user.

In this study, as shown in Figure 3, we acquire two kinds of sight-seeing spots. One contains the sight-seeing spots matching the trip motivation of the user. The other contains the sight-seeing spots to promote occurrence of serendipity. Here, we refer to an expected point as a sight-seeing spot matching trip motivation of the user. In the meantime, an unexpected point means a sight-seeing spot which satisfies her fundamental desires but does not match user's trip motivation.

An expected point is the sight-seeing spot providing expected charms for the user. For example, suppose a user who wishes to go on a trip strongly aiming at getting rid of strain. She should visit sight-seeing spots that can achieve to get rid of strain. In this case, the charm matching the trip motivation involves many elements to get rid of strain in sight-seeing spots. It means expected points are sight-seeing spots having high value to get rid of strain. The sight-seeing spot with much expected charm is selected as the expected point.

Fundamental desires are the desire that people want to satisfy in dairy life. Fundamental desires are composed of five elements: joyfulness, relaxation, relationship with the opposite sex, popularity from others, and a sense of seasons. For example, it supposes that the user wants sense of season in her dairy life. She feels satisfied when she enjoys tasting seasonal cuisines and joining events specific to the season. An unexpected point is a sight-seeing spot having the charm to satisfy her fundamental desires other than the ones matching the trip motivation of the user.

Assume an unexpected point which has strong values in more unexpected charms than others. The unexpected point included in a tourist route would satisfy users more because of attainments out of expectation.

3.4 SIGHT-SEEING SPOTS MATCHING TRIP MOTIVATION

The proposed method retrieves some expected points with estimated trip motivation of the user. Candidate sight-seeing spots are registered in the sight-seeing spot database. Each of the candidate sight-seeing spots has a vector of trip motivation. The vector of trip motivation for the sight-seeing spot is calculated using word-of-mouth reviews of the sight-seeing spots. The method calculates the cosine similarity between the trip motivation of the user and trip motivation of each sight-seeing spot. Based on the calculated result, it can retrieve sight-seeing spots highly expected for the feasibility to match the user's trip motivation.

Further, the method calculates the rate each subject appears in the photos selected by the user. The subject selected by the user represents a concrete place that the user wants to go on in the trip being planned. Therefore, it needs to acquire the sight-seeing spot considering the incidence of each subject. It can acquire sight-seeing spots corresponding to user's trip motivation.

3.5 SIGHT-SEEING SPOTS PROMOTING OCCURRENCE OF SERENDIPITY

Our method figures outs the sight-seeing spots to promote occurrence of serendipity for a user with her fundamental desires. In this study, it calculates items of fundamental desires which user emphasizes by the paired comparison test.

Using the calculated the fundamental desires of the users, the method retrieves persons who are similar in the fundamental desires. It retrieves persons from a database in which the trip history and fundamental desires of other users are registered. People who have similar in their fundamental desires resemble with each other in their behaviour on a trip. The similarity means that a trip with the same trip motivation is likely to travel around

the same sight-seeing spots. For example, suppose that a user with strong motivation to get rid of strain as their trip motivation visits a hot spring to fulfil it. Person who are similar in fundamental desires would also visit hot springs when one has a strong "to get rid of strain" as a trip motivation. It is assumed that the satisfied sight-seeing spot is similar if the sight-seeing spot matching the trip motivation is similar. Therefore, the sight-seeing spots which satisfy persons who are similar to the user in fundamental desires are likely to satisfy the user. Let us search persons similar in fundamental desires, succeeded by the search of sight-seeing spots which satisfy those persons. The result brings the sight-seeing spots which are likely to satisfy.

The sight-seeing spots having similar trip motivation are excluded from the result. Through the procedure we can attain unexpected points in a specific trip of the user. Sight-seeing spots unknown for the user are unexpected spots. In section 3.4, we have already determined expected points, which match the trip motivation of the user. After the user visits the expected points, she can enjoy serendipity, visiting unexpected points. The tourist route involving both of those sight-seeing points is recommended to the user.

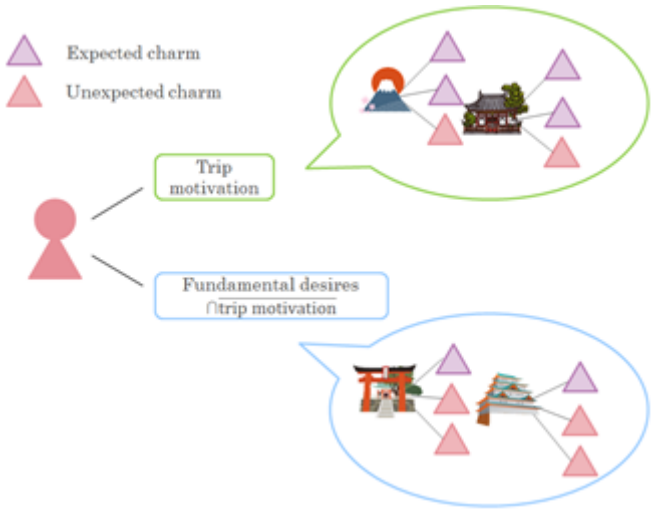

Fig.3Kinds of sight-seeing spots

4 EXPERIMENT

4.1 ENVIRONMENT OF EXPERIMENT

We had an experiment to verify the effectiveness of the proposed method. We chose subjects to appear in photos used to know trip motivation of experimentees from famous sight-seeing spots in Kyoto. The subjects are listed in Table 2.

The choice should not be biased with the experimenter's arbitrariness. The subjects were chosen, referring to the web site of JR Tokai [7]. The photos of sight-seeing spots used in the experiment were taken from the search results of Google image search [8] with the subject name specified as the keyword. The experimenter visually picked up photos which provided whole clear image of the subjects from the search results to get appropriate ones for the experiment. Three photos were prepared for each subject.

In order to calculate the vector of trip motivation to be given to the subjects, we collected some word-of-mouth reviews from the web site, Jalan sight-seeing spot search [9]. The number of word-of-mouth reviews was 2,000 for each subject. Morphological analysis was applied using MeCab [10] for them.

The co-occurrence network related to each subject was generated from the analysis result. In the same way, morphological analysis was also applied on the clearly stated actions related to trip motivation [6]. We acquired nouns and declinable words from the analysis results to generate a synonym database based on the Weblio thesaurus [11]. Element values of vectors of trip motivation were calculated, comparing the words in the co-occurrence net-work with the words in the synonym database.

4.2 FLOW IN EXPERIMENT

Three points to be verified in the experiment are the followings.

(1) How is the experimentee's satisfaction degree for a recommended tourist route?
(2) Are sight-seeing spots suitable for the trip motivation to satisfy the experimentees as they expected?
(3) Does serendipityoccurwithfundamental desires?

The experimentees in this experiment are 7 Japanese men from 22 to 26 years old. In addition to that, 15 Japanese men including the experimentees and 7 Japanese women, whose ages range from 21 to 26 years old,

joined the pair comparison test to find fundamental desires. They also answered preliminary questionnaires in advance. In the preliminary questionnaire, we asked the following three points.

(1) Trip destinations of their past trips along withtheir satisfaction degree and trip motivation for the trips.
(2) Sight-seeing spots of their past trips in Kyoto

From questionnaire results, we constructed a user database in the recommendation system. The following items for each user were stored in the database.

(1) Name,
(2) Fundamental desires,
(3) Trip destinations, the satisfaction degree, and trip motivation for their past trips
(4) Sight-seeing spots in Kyoto

The database is used to retrieve sight-seeing spots having unexpected charms.

This experiment is carried out under the situation "I decided to go on a trip to Kyoto in November, but I have not decided where I will go". In the situation, experimentees actually went on a trip to Kyoto, according to tourist routes suggested by the method. The procedure of this experiment is explained as follows. First, the experimentee makes the image of the Kyoto trip, looking at the ten photos of sight-seeing spots randomly arranged. The experimentees chose photos of sight-seeing spots suitable for their image of trips they want to experience in the experiment. Based on the chosen image, the system implementing the proposed method estimates the trip motivation of each experimentee. The system figured out sight-seeing spots based on the estimated trip motivation and the fundamental desires calculated beforehand.

The system composed a tourist route of the sight-seeing spots to recommend it to each experimentee. The exprimentees evaluate the recommended tourist route in the following viewpoints.

(1) Expectation for the tourist route
(2) Expectation for the subject corresponding to each sight-seeing spot in the tourist route

They evaluated the above in 7 grades, where 7 indicates the highest evaluation, while 1 indicates the lowest evaluation. After the evaluation, experimentees went out for the recommended tourist route. After they finished the tourist route, we conducted a questionnaire and interview.

The items to be acquired in the questionnaire are the following five points.

(1) the absolute satisfaction degree for the tourist route
(2) the relative satisfaction degree for the tourist route
(3) the absolute satisfaction degree for each sight-seeing spot in the tourist route
(4) the relative satisfaction degree for each sight-seeing spot in the tourist route
(5) scenes where they experienced serendipity and the contribution rate of each of the scenes for the satisfaction degree

The absolute satisfaction degree for the tourist routes and the sight-seeing spots was answered in 7 grades, where 7 corresponds to the highest, while 1 to the lowest. The relative satisfaction degree for the tourist route and the sight-seeing spots shows the increase / decrease of the satisfaction degree compared with the prior expectation regarded as 0. It is evaluated with a value ranging from -3 to +3. For example, suppose there are sight-seeing spots which relative satisfaction degree is 0. The sight-seeing spot brought no change in the satisfaction degree compared with the prior expectation. In other words, it satisfied the experimentee as he had expected.

In order to acquire all the scenes which brought serendipity, experimentees were interviewed while they are shown the video during their trip. There might be multiple occurrences of serendipity in one sight-seeing spot. Therefore, we asked the experimentees the percentage by which serendipity contributed to the satisfaction degree. We refer to the percentage as the satisfaction contribution ration. The satisfaction contribution ratio is answered so that the total value is 100% for one sight-seeing spot. For example, suppose there are three scenes which brought serendipity to an experimentee in a sight-seeing spot. Let the satisfaction contribution ratio for scene A, B, and C, were 30%", 20%", and 50%, respectively.

Every recommended tourist route involved three sight-seeing spots. Two of the three spots are sight-seeing spots matching the trip motivation. The other one is a sight-seeing spot the system presumed to have unexpected charm for the target experimentee. All of the tourist routes were recommended with the shortest route.

Table 2. Kinds of subjects

Subject
Art gallery
Museum
Shrine
Park
Japanese crafted product
Japanese garden
Temple
Green tea
Pickle
Traditional townhouse
Japanese confectionery
Japanese general goods

4.3 VERIFICATION OF SATISFACTION DEGREE FOR TOURIST ROUTE

We evaluated the tourist routes the method recommended.Table 3 shows the absolute satisfaction degree for the tourist routes of 7 experimentees. The absolute satisfaction degree was evaluated by the questionnaire conducted after the experiment.The average of the result is 5.71.

Table 4 shows the satisfaction degree of Kyoto sightseeing of anonymous Japanese tourists, which is announced as the Kyoto Tourism General Study in 2015 [12]. The same scale is adapted as the one used in our experiment.

The average of the result is 5.8. Therefore, it was found that the tourist routes recommended by the proposed method can gain the same level of the satisfaction degree as those are decided by the conventional method.

Table 3.Absolute satisfaction degree of recommended tourist route

Experimentee	A	B	C	D	E	F	G
Satisfaction	6	6	5	6	6	5	6

Table 4.Satisfaction degree of tourist route by conventional method

Satisfaction	7	6	5	4	3	2	1
Percentage	21.3	48.2	19.4	8.2	1.9	0.7	0.3

4.4 SATISFACTION FOR SIGHT-SEEING SPOTS MATCHING TRIP MOTIVATION

We examine the satisfaction degree for sight-seeing spots determined with the estimated trip motivation. There were 14 sight-seeing spots suitable for the trip motivation used in the experiment. Table 5 shows the distribution of the absolute satisfaction degree for 14 sight-seeing spots matching trip motivation.

Table 5 suggests that 71% of the sight-seeing spots in the experiment satisfied the experimentees, if we regard sight-seeing spots whose satisfaction degree is greater than 4 brings satisfaction. As we mentioned in section 2, fulfilling the expectation coming from the trip motivation leads to satisfaction with the trip.

Therefore, this experiment has proved users are satisfied with sight-seeing spots matching their trip motivation.Table 6 shows the relative satisfaction degree of experimentees with respect to prior expectations. Let us regard the experimentees expect their desires to be fulfilled with the sight-seeing spot, if the prior expectation is 5 or more. Table 6 shows there are 8 sight-seeing spots whose a prior expectation is 5 or more. In 6 out of them, the relative satisfaction degree is 0 or more. It means 75% of sight-seeing spots with high prior expectations gain the satisfaction degree same as or over the expectations of the experimentees. Eventually, we can say that 53(= 71 * 75)% of sight-seeing spots recommended with trip motivation satisfy the experimentees.

Table 5.Satisfaction degree of sight-seeing spots suitable for trip motivation

Satisfaction degree	7	6	5	4	3	2	1
spots	1	3	6	3	1	0	0

Table 6.Prior expectations and relative satisfaction degree

Experimentee	Place1		Place2	
	Expectation	Satisfaction	Expectation	Satisfaction
A	4	0	6	0
B	5	0	5	2
C	4	-2	5	0
D	6	-1	5	0
E	4	2	2	1
F	6	-1	4	1
G	5	0	4	3

4.5 VERIFICATION ABOUT OCCURRENCE OF SERENDIPITY

We verified the occurrence of serendipity in unexpected point.Experimentees were asked to list the scenes that they enjoy serendipity in the questionnaire. Table 7 shows the number of occurrences of serendipity in expected points and unexpected points. In all recommended tourist routes, there are 14 expected points, whereas 7 unexpected points. As shown in Table 7, the average number of occurrences of serendipity per point is 1.4 and 3.3 in expected points and unexpected points, respectively. The results of Table 7 suggest serendipity occurs twice more in unexpected points than in expected points. Therefore, tourist routes involving unexpected points can contribute to intentional occurrence of serendipity.

Table 7.Number of occurrence pf serendipity

	Expected Point	Unexpected point
occurrence	20	23
points	14	7
occurrence/points	1.4	3.3

5 DISCUSSION

5.1 EFFECTIVENESS OF FUNDAMENTAL DESIRES

In our study, we used fundamental desires to intentionally cause serendipity. According to the results of the experiment, the unexpected points caused twice more serendipity than the expected points did. However, we cannot attribute the occurrence of serendipity to fundamental desires. Here, we discuss what caused the serendipity. Table 8 shows the cosine similarity of the fundamental desires among the experimentees.

According to Table 8, the cosine similarity is high for the two experimentee pairs; one is the pair of A and B, and the other is E and G. We asked scenes the experimentees experience serendipity in the questionnaire and the interview for them after the experiment. Table 9 shows the number of scene where experimentees A, B, E, and G experience serendipity. We examined whether similar experimentees feel serendipity in similar scenes. Each experimentee went to different sight-seeing spots in the experiment. However, there were some common scenes which brought serendipity to the experimentee pairs, A and B, E and G. Table 10 shows the number of the common scenes. Each of A, B, E, and G experienced serendipity in the same scenes as the other experimentees, though their similarity is pretty low. Table 11 shows the average of the number of the scenes where both of them experienced serendipity. According to the results of Table 10 and Table 11, it is obvious the ex-perimentees of high similarity experienced much more serendipity than the experimentees of low similarity in same scenes. The similarity of the fundamental desires seems to effect on scenes bringing serendipity to the experimentees. It is implied fundamental desires work well to intentionally cause serendipity.

Table 8. Cosine similarity of fundamental desires among experimentees

	A	B	C	D	E	F	G
A		0.8474	0.3563	-0.305	0.4829	0.5936	-0.088
B	0.8474		0.1074	0.1296	-0.018	0.5419	-0.501
C	0.3563	0.1074		-0.390	0.4153	-0.433	0.2003
D	-0.305	0.1296	-0.390		-0.614	-0.065	-0.391
E	0.4829	-0.018	0.4153	-0.614		0.1956	0.8043
F	0.5936	0.5419	-0.433	-0.065	0.1956		-0.211
G	-0.088	-0.501	0.2003	-0.391	0.8043	-0.211	

Table 9.Number of scene

experimentee	A	B	E	G
the number of scenes	8	7	6	6

Table 10.Number of common scenes

pair of experimentees	A and B	E and G
the number of common scenes	3	3

Table 11.Average of number of scenes

Experimentee	A	B	E	G
Average	0.8	1.2	1.6	1.4

5.2 ACCURANCY IN ACTUAL RECOMMENDATION

In this experiment, the experimentees visited recommended sight-seeing spots regardless of the level of prior expectation. However, in actual situations, people rarely visit the sight-seeing spots where prior expectation is low, even though the system recommends those spots. Among 14 expected points recommended in this experiment, the prior expectations of the experimentees were high in 8 sight-seeing spots. Using estimated trip motivation of users, the method recommended the sight-seeing spots of high prior expectation, with the probability of 57%. From the result explained in section 4.4, the conditional probability that the sight-seeing spots satisfy the experimentees with the probability of 75%, if the experimentees had high prior expectation for the sight-seeing spots. As mentioned in the section, we regard the system succeeds in the recommendation of sight-seeing spots matching trip motivation of users, if the recommended spots of high prior expectation give the users the satisfaction degree same as the one they expected or higher than it. As a result, our method can recommend the sight-seeing spots matching the trip motivation of users with the probability of 43%.

The validity of the probability cannot be confirmed from the experiment results, because the number of experimentees is not enough. In the interview after the experiment, there was more than one opinion as follows. "After our selection from presented beautiful photographs of sight-seeing spots, the system recommended to visit 3 sight-seeing spots. Based on the beautiful photographs, we imaged a trip we were going out. The quality of the image was high. The prior expectation for the recommended trip did not rise in our mind, because the images were superior to the photographs of the recommended sight-seeing spots. "It is assumed that the prior expectation is influenced by the photograph presented to users. In the case that the experimentees has an excessively low or high expectation for recommended sight-seeing spots, the tourist route recommended by the method cannot give users valid satisfaction.

In order to provide valid satisfaction, the photograph de-scribing the recommended sight-seeing spot should give the same level of image as the photograph initially presented to estimate trip motivation of users. However, images photo-graphs provide vary with persons. For a specific photograph, some persons have good images, while others have poor ones. The probability to recommend a sight-seeing spot that matches user's trip motivation should be independent from the photograph initially presented to estimate the trip motivation. The probability to provide sight-seeing spots matching the trip motivation would be independent, if we apply the method to more experimentees. Experiments for more persons would make the probability accurate.

6 CONCLUSION

In this paper, we proposed a method to recommend tourist routes which not only meet expectations coming from user's trip motivations but also promote the occurrence of serendipity. The method estimates user's trip motivation from photographs of sight-seeing spots the user wants to visit in the trip being planned. It figure outs the sight-seeing spots matching user's estimated trip motivations as expected points. In the meantime, it also calculates the fundamental desires of the user. It determines the sight-seeing spots which are likely to provide serendipity for the user as unexpected points. It recommends a tourist route involving two expected points and one unexpected point. As a result of method experiment in Kyoto, the satisfaction degree of recommended tourist routes using the method was 5.71 on average, which is almost same as that of general Kyoto trip by Japanese tourists. Experimentees were satisfied with 71% of the sightseeing spots the method recommended according to user's trip motivation. The experimentees who visited unexpected points experienced serendipity 3.3 times in average. It is twice larger than those who visited expected points. It implies the method recommend a tourist route which not only matches user's trip motivation but also promotes serendipity. In the future, we will increase the number of subjects to attain more accurate probability of sight-seeing spots to satisfy users with their trip motivation and fundamental desires.

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