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A Framework of Time, Place, Purpose and Personal Profile Based Recommendation Service for Mobile Environment

Sineenard PINYAPONG[†], *Nonmember and* Toshikazu KATO[†], *Regular member*

Summary Nowadays more people have started using their mobile phone to access information they need from anywhere at anytime. In advanced mobile technology, Location Service allows users to quickly pinpoint their location as well as makes a recommendation to fascinating events. However, users desire more appropriate recommendation services. In other words, the message service should push a message at a proper place in time. In consequence, customers obtain a higher level of satisfaction. In this paper, we propose a framework of time, place, purpose and personal profile based recommendation service. We illustrate scenarios in "push", "pull" and "don't disturb" services, where our DB queries can recommend the relevant message to users. The three factors: time, place and purpose are mutually dependent and the basic rules to analyze the essential data are summarized. We also create algorithms for DB query. We are filtering messages by one important factor: personal profile such as user's preference and degree of preference. Furthermore, we discuss an implementation of the prototype system, including results of experimental evaluation.

Key words: *Time, Place, Purpose, Personal Profile, DB Query, Mobile Environment*

1. Introduction

Recent advances in wireless communication and hardware technologies have made the mobile phone an integral part of our private life. More and more people have started using mobile phone not only to communicate with each others but also to access the information they need from every place and every time. As such, when people visit particular places, they often want to use some appropriate service, as shown below:

- Exhibition: PDA or mobile terminal service which provides the guidance of each exhibition zone.
- Amusement park: mobile phone service that provides customers with the information about the entertainment locations, the waiting time for attractions, or the schedule of special events such as parades or shows.
- Shopping complex: people want to use mobile terminal as a walk navigator tool for obtaining maps and directions to the events that they are interested in.

Occasionally, customers visit any area with their specific target places. After visiting, they may consider to visit other places. Anyhow, they need to know "Where should we go?" or "Where are the interesting events taking place now?" or "Does it charge a fee?" or "How long does it take to get there?" They want useful access to such information and update it from their mobile phone.

Currently, a variety of services and tremendous information are recommended to customers. They are not only far from customer's satisfaction level but also nearly become spam messages. They are lacking in consideration of algorithms and personal profile, including control time of recommendation, for selecting useful information to be recommended to customers. Otherwise, inadequate filtering technique results in excessive message services.

In this paper, we will propose the solution based on the following:

Time, place, purpose factors: The three factors of each person with each activity are different. So, our service is based on these factors, each data of which we collect to summarize rules and algorithms. We can recommend near matches to user preference.

Push, pull and don't disturb services: Our system has three services: push, pull and don't disturb. Push and don't disturb services are automatically performed by the system in the service area to mobile phone users who have registered with the system, while pull service is performed by mobile phone users.

Personal profile and filtering: We are collecting each personal profile such as user preference and degree of preference and a budget user can expend on filtering messages into recommendations.

Experimental result: The proposed mechanism has been implemented as a prototype system and is discussed through the results of experiments.

The rest of this paper is organized as follows: Section 2 briefly discusses time, place, purpose and profile based requirements, and illustrates motivation scenarios, related study and mechanism requirement. Section 3 analyzes scenarios and summarizes basic rules to interpret data. We describe our algorithms to process queries in an efficient way. In addition, we exemplify "push", "pull" and "don't disturb" services. Section 4 we present an implementation of the prototype system and then discuss results of experimental evaluation. We come up with a concluding remarks and future work in Section 5.

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[†] The author are with Department of Industrial and Systems Engineering, Chuo University, Bunkyo-ku, Tokyo 112-8551 Japan.

2. Time, Place, Purpose and Personal Profile Based Requirements

2.1 Motivation

In our everyday life, we rely on various information on working, studying, researching, shopping and traveling. Such information has become an integral part of our life. One day in the morning we obtain news from online newspaper services, contact customers via e-mail at workplace in late morning, collect data to present in the afternoon meeting, choose a gift for special event and watch a television at home in evening. We are concerned with information altogether. However, the difference in time, place, purpose and profile to bring about also necessitate different information. Therefore, not only information has become a part of life, but also time, place purpose and profile are important factors. The following scenarios illustrate our vision of recommendation for future mobile services that involves with time, place, purpose and profile factors.

Motivating Scenarios

- Push service: Mr. A visits National Museum of Emerging Science and Innovation (MeSci) at Odaiba. Two hours later, he doesn't know where he will go next. Accidentally today is the last day of "Free riding a car Fair" at MEGA WEB. At the same time "Lady Fashion Sale" at Aqua City is also taking place. From Mr. A's profile, it turns out that he likes a car more than shopping then the recommendation service starts. While he is walking in MeSci, he gets a message saying that MEGA WEB is on the last day of its special event "Free riding a car Fair".

- Pull service: After Mr. A has studied at MeSci for about two hours, seen and ridden a car at MEGA WEB for one hour, he gets tired and wants to be relaxed and thus he searches via the mobile phone's system for a relaxing place. The system recommends a night fee at Oedo Onsen Monogatari before 6:00 pm. He wants to be relaxed and thus he goes to Oedo Onsen.

- Don't disturb service: Ms. B's mobile phone automatically change to don't disturb mode for three hours since she visits Fuji TV Studios at 12:30pm. At 3:30pm she gets a message informing about "Lady Fashion Sale" at Aqua City starting from 4:00pm. Aqua City is opposite to Fuji TV Studios and thus she decides to go to Aqua City.

From above scenarios, if the recommendation system is complete with detection of time spent for Mr. A at MeSci. and using Mr. A's profile for pull service, with being able to detect don't disturb service for Ms. B switched off as well, the system can provide *push, pull* and *don't disturb service* information fulfilling customer's satisfaction.

2. 2 Related Studies

In this section we briefly present some of business and research approaches related to database query, location service and personalization.

Amazon.com™ [15] is an online store, which records personal profile such as favorite areas, customer history and rated items for personalized recommendations service. Besides these, customers can edit their profile as well. Moreover, customers can create a wish list and let their friends as well as family know about their wish list.

NTT DoCoMo, Inc. provides DLP service (DoCoMo Location Platform) [18] which uses GPS (Global Positioning System) that lets users quickly pinpoint their location, within a radius of 50 meters, and download area maps and information. The provisions of GPS include public transportation, restaurant data as well as routing to help navigate to specific locations.

Madria et al. [8] proposes location-dependent data model that builds concept hierarchies and executes queries processing. For efficient query processing by horizontal, vertical partitions and replication of relations based on location. However, in the mobile environment, "moving object" means that query results needs to be updated. Therefore Ilarri et al. [4] proposes query processing approach that comprises analysis of the user query and initialization of DB query, which is managed by moving objects.

As another interesting approach, Georgia Koutrika [7] proposes a personalization framework based on user profiles. Preference model assigns personal degree of interest. Query proceeds in two steps: preference selection and preference integration.

A complementary work to our research is COMPASS Approach [1], which proposed Personalized and Situation Dependent Services. They are services based on three factors - time, place and person. However, these factors are not adequate to consider database query for useful information service to customer. Therefore, our work has considered mechanisms that require more factors such as: purpose, a charge of fee, and control time. We will describe this in next section.

2.3 General Mechanisms

From requirements and scenarios, how the system works and what factors that system requires to estimate the time spent of Mr. A. How the system manages and retrieves the user's profile as well. To achieve mobile service like above scenarios, we propose:

1) Time, place, purpose factors: The basic idea is that each person has different activities. Thus, they go to some place in sometime with different purpose and different interval time spent. We consider these factors and summarize basic rules to control time.
2) Purpose and payment: Visiting any place with a clear purpose has relation with amount of time spent as well as paid money. Therefore, we create basic rules to analyze this data. Moreover, the system also calculates interval time to automatically perform don't disturb service to users.
3) Personal profile and filtering: Each person has a different preference; therefore we create a personal profile database to store preference data of each person. An approach used to structure the database is a combination of preference data such as: preference, category of preference, degree of preference, budget etc. Moreover, the system takes personal profile into consideration and makes messages that have been filtered and will not be a spam.
4) DB query: Mobile phone has hardware and memory limitations: small size and narrow monitor. Therefore, more processes must works on server side. GPS, time and profile data on a mobile phone have been transferred for processing on a service provider. We compose a process to query data from database with smart engine in providing services or information. The results are recommendation messages that match customer's time, place and purpose factors and profile.

On the basis of time, place and purpose factors, personal profile and database query, we aim to achieve such a high degree of recommendation based on our approach on mobile environment.

3. System Framework

Mobile phones are small-sized, which means limited memory and a narrow monitor. As a result, the system framework must use only essential data in process and query. In this section, we propose a general framework and three services as follows:
1. Push service: performs when the mobile phone user arrives at Odaiba area.
2. Pull service: performs when the mobile phone user tries to access a mobile service.
3. Don't disturb service: not recommend any message to mobile phone user when he/she visits some place with a clear purpose and spends some time.

3.1 General Framework

3.1.1 Rules

In this section, we analyze scenarios according to a mechanism to summarize basic rules. In addition, we create algorithms to process recommendation service.

From scenarios, Mr. A goes to MeSci museum where he could learn something new. As he has to pay a fee, we assume that Mr. A has a specific purpose to visit there and spends about two hours over there. The system doesn't recommend anything during two hours because doing so can disturb him. Nevertheless, it will recommend something two hours later. In addition, it retrieves Mr. A's profile indicating that he likes a car. Consequently, it recommends "Free riding a car Fair" at MEGA WEB to him.

As Mr. A gets tired, he will next search via the mobile phone system for a relaxing place. From his profile and arrival time calculation, the system recommends Oedo Onsen Monogatari to him.

As another event, Ms. B goes to Fuji TV Studios since 12:30pm. The system checks with basic rules and detects an interval time of three hours. Then recommendation time will be three hours later. At 3:30pm no preference data from her profile matches the event, thus the system considers to recommend "Lady Fashion Sale" at Aqua City because she can go there in time.
From each scenario, we can analyze factors as shown below:
(1) *Time*: Time depends on the purpose and place. For example, it takes two hours or more to go to a museum, and going to Oedo Onsen Monogatari spends longer time as it takes about four hours or more or going to shopping can spend unlimited time.
(2) *Place*: Place depends on the type of place, position as well as a charge of fee. Otherwise, distance and traffic time will be considered.
(3) *Purpose*: "Clear purpose" such as seeing an exhibition and watching a movies will consume a different amount of time from "unclear purpose" such as strolling and shopping. For instance, when a customer is enjoying himself in an amusement park for a long time, if the system pushes a message, it possibly becomes a spam. On the other hand, when customer doesn't have any clear purpose, if the system pushes a message, it may be interesting to him.
(4) *Personal profile*: Besides time, place and purpose, personal profile is also an important data. It consists of useful data such as user's preference, degree of preference, budget and log data. The advantage of personal profile will be that it can provide more efficient service.

Table 1: Basic rules

Amount of time	Charge	Purpose	Estimate interval time	Action
Long time stay	Yes	Yes	$< long_1$	Not to recommend
			$\geq long_1$	To process
	No	Yes	$< long_2$	To process
		No	$\geq long_2$	Recommend
Middle time stay	Yes	Yes	$< mid_1$	Not to recommend
			$\geq mid_1$	To process
	No	Yes	$< mid_2$	To process
		No	$\geq mid_2$	Recommend
Short time stay	Yes	Yes	$< short_1$	Not to recommend
			$\geq short_1$	To process
	No	Yes	$< short_2$	To process
		No	$\geq short_2$	Recommend

From analysis above factors, three factors are mutually dependent. Then, we can summarize relationship between time, place and purpose in basic rules as shown in Table 1. Table 2 shows the examples of different place.

Table 2: Example of basic rules in some place

Place	Charge	Purpose	Estimate interval time	Action
Museum	Yes	learning, new knowledge	< 2 hours	Not to recommend
			≥ 2 hours	Recommend
Hot springs	Yes	relaxation	< 4 hours	Not to recommend
			≥ 4 hours	Recommend
Amusement Park	Yes	enjoyment, entertainment	< half day	Not to recommend
			≥ half day	Recommend
Shopping Complex	No	purchase or observation	0	Recommend anytime

We can apply the basic rules to push, pull and don't disturb services.

3.1.2 Algorithms

We use these algorithms of the framework to derive essential factors from basic rules. Then, we connect to DB and execute queries. Finally, filtering and pushing a message to customers conclude the process. Our algorithms comprise five steps as described below:
(1) Checking the basic rules from Table 1
After a customer's mobile phone in mobile GPS networks pinpoint its position. Customer's current position, current time, recent history and preliminary profile data have been transferred to the service provider. These data have been checked against basic rules.
(2) Interpreting data to build a DB query
Purpose and interval time have been derived from basic rule in Step 1. Afterward, the system interprets these data into attributes of the DB schema. Next step is to complete DB queries.
(3) Executing DB query
Connects to the DB and retrieves events that match factors' condition through making queries.
(4) Filtering a message
Connects to the personal profile database and retrieves customer's preference by a keyword. After this, it compares data from TPO Database and Personal Database then selects an appropriate message to be pushed to customer.
(5) Pushing a message
The system pushes a message obtained to customer.

3.1.3 Filtering

Our approach to recommendation is based on four factors, which are used in filtering. In this section, we will describe filtering algorithms.(Fig.1) The factors that we consider to filter recommendation messages are as follows:
User preference: The preferences of each user, degree of preference and budget have been stored in the database. (Table 3) In the first day of experiment, we used one major preference of each user (from three preferences). In the second day, we improved the user preference database and used three major preferences of each user (from five preferences).
Preference: The preferences are divided into category and hierarchy of category, which have been stored in the database.
Degree of preference: we use a degree to rank recommendation results that closely match user preference.
Budget: we also use a budget that user can expend on recommending proper information.

Table 3: Preference data

Prefid	ID	PREFER	Degree	Budget (Yen)
1	35	Amusement, Attraction	7	1-1000
2	35	Fashion, Lady	6	3000-10000
3	35	Restaurant, Chinese	5	1000-2000
……	…	…..	…..	……

Traffic time: For a user who can go to an event in time, the system also calculates traffic time and walking time. The time table of "Yurikamome line" has been stored in the database. The time taken to go to each place in Odaiba area is the time to a near station plus walking time of about seven minutes. The system adds traffic time and walking time and recommends events that user can go to in time within the total time.

Table 4: Traffic time of each station

ID	Start	Stop	Time (minutes)
1	Odaiba-kaihin koen	Odaiba	2
2	Odaiba	Aomi	5
3	Telecom Center	Odaiba-kaihin koen	5

Time: We use appropriate events time to make recommendation messages. Therefore, we consider restaurant and refreshment time to limit recommended restaurant time to between 11:30am-1:30pm and 6:00pm-8:00pm including refreshment time to between 2:00pm-5:00pm.

Visited place: the system doesn't recommend users visited places in that day. It considers to recommend a new place that users haven't visited yet.

Input: User preference U_i
Place P_i

R_k = {}

While (P_i not empty)
If (P_i has charge of fee) **Then**
time = current_time + interval_time
Else
time = current_time
End if

If (event_detail like U_i and
time < time_start and
budget>= budget_min and
place <> visited_place) **Then**
select (set of events)
Else
event not found
End if

If (current_time +
traffic_time +
walking time < time_start) **Then**
recommend message (R_k)
Else
consider recommend current festival
End if
End while

Output: Set of recommendation R_k

Fig. 1 Filtering algorithm

3.2 Push Service

When the mobile customers who have registered with the system arrive at Odaiba area, Global Positioning System (GPS) technology available in the mobile networks has already checked customer's position. The system uses this information to connect to the server and accesses the database to retrieve events that match the condition. Finally, the system pushes a message to a mobile phone customer. The example database is described by the schema below, where primary keys are underlined.

CUSTOMER (id, mobile_mail, name, mobile)
EVENT (event_id, event_name, place_name, detail, budget_min, budget_max,date_start,date_stop,time_start, time_stop)
PLACE (place_id, place_name, type_place, station)
PREF (prefid, id, prefer, degree, budget_min, budget_max)
PURPOSE (purpose_id, place_id, charge, aim, interval_time)
TRAFFIC (id, start, stop, time)

The algorithms used can be explained as follows:

Example 1:

Mr. A arrives at MeSci museum at 1:00pm.

1. Checks a purpose and estimate interval time with the basic rules. MeSci museum charges a fee. Therefore, the system presumes that Mr. A has a clear purpose of visiting there and the interval time is not less than two hours.
2. Interprets data to build a DB query as follows:

```
SELECT  event_name, place_name, date_start,
        date_stop, event_time, time_start, time_stop
FROM    event, place
WHERE   place_name = 'MeSci' and
        (date_start >= 'today' or date_stop >= 'today') and
        time_start > 'now' + (SELECT interval_ time
                              FROM  purpose
                              WHERE place_id = 1);
```

3. Executes the DB query.

Output:

(1) "Free riding a car Fair" 4:00pm at Mega Web
(2) "Lady Fashion Sale" 4:00pm at Aqua City
(3) "Sea World" 3:00pm at Museum of Maritime Science

4. Filters into a recommendation message.

Retrieving user preference data from the Personal DB:

```
SELECT  pref.id, prefer, degree, budget_min,
        budget_max, mobile_mail
FROM    pref, customer
WHERE   pref.id = '"+ 'A' +"' and customer.id=pref.id
ORDER BY degree desc;
```

Filtering with preference, degree, budget and visited place:

```
SELECT  event_id,event_name,place_name, detail,date_start,
        date_stop, time_start, time_stop, budget_min, budget_max
FROM    event
WHERE   place_name <> '"+'MEGA WEB' + "' and
        detail LIKE '%" + 'Onsen' + "%' and budget <= 2000
        (date_start >='today' or date_stop >='today');
```

Filtering with traffic time and walking time:

```
SELECT  time, event_id
FROM    event, traffic
WHERE (start ='"+place_id+"' and
       stop in (SELECT station FROM event, place
                WHERE event.place_id = place.place.id and
                      event_id = 2);

SELECT  event_id,event_name,place_name, detail, date_start,
        date_stop, time_start,time_stop,traffic.time, interval_time
FROM    event, traffic, purpose
```

```
WHERE ('now'+ interval_time+traffic.time+
        walking_time)  <  time_start;
```

Mr. A prefers "car" and thus the system will push a message " Free riding a car Fair" to him.
5. Pushes a message.
The system pushes a recommendation message obtained to Mr. A.

3.3 Pull Service

A mobile phone customer who has registered with the system accesses via their mobile phone to search for services or events by keywords. The system is responsible for creating complete DB queries from the keywords. The smart engine interprets data to build DB queries, which retrieve events that match the keywords from the database. Finally, the system sends recommendation messages to that mobile customer.
Example 2:
Mr. A searches for a relaxing place via the system running on his mobile phone. The system recommends a night fee at Oedo Onsen Monogatari before 6:00 pm.
1. Searches by keyword:
Position: MEGA WEB, time: 5:00 pm, keyword: "relax"
2. Interprets data to build a DB query as follows:

```
SELECT map, place_name, event_name
FROM   place, event
WHERE position_now = "MEGA WEB"
       date_start  <= "today",
       time_start >= "now" ;
```

3. Executes the DB query.
Output:
(1) "Special night price" before 6:00pm at Oedo Onsen Monogatari
(2) "Aromatherapy oil massage" before 10:00pm at Thai Massage, Aqua City
4. Filters into a recommendation message.
Connects to the Personal DB to retrieve user preference, and then filters with preference, degree, budget, visited place, traffic time and walking time in the same way as the push service.
Filtering with preference, degree, budget and visited place:

```
SELECT event_id,event_name,place_name, detail,date_start,
       date_stop, time_start, time_stop, budget_min, budget_max
FROM   event
WHERE  place_name <> '"+'MeSci' + '" and
       detail LIKE '%" + 'CAR' + "%' and budget = 'free'
       (date_start >='today' or date_stop >='today');
```

Filtering with traffic time and walking time:

```
SELECT  event_id,event_name,place_name, detail, date_start,
        date_stop, time_start,time_stop,traffic.time, interval_time
FROM    event, traffic, purpose
WHERE ('now'+ interval_time+traffic.time+
        walking_time)  <  time_start;
```

Mr. A prefers "Onsen" and thus the system selects a message "Special night price" at Oedo Onsen for him.
5. Pushes the recommendation message.
The system sends a message to Mr. A.

3.4 Don't disturb service

When customers go to a certain place with a particular purpose or that place charges a fee, the system can check with basic rules in Table 1 to estimate an interval time. The interval time is a control time that the system uses to consider not to disturb the customers with any unnecessary message. Later, the system will push a message after "don't disturb time" has been elapsed. In this case, the push service is the same as the one described in Section 3.2
Example 3:
Ms. B arrives at Fuji TV Studios at 12:30pm.
1. Checks a purpose and estimate interval time with the basic rules. Fuji TV charges a fee. Therefore, the system presumes that Ms. B has a clear purpose of visiting there and the interval time is not less than three hours. Therefore, the recommendation time will be 3:30pm.
As a result, the system does not recommend anything during these three hours, which is called "don't disturb time", and the user can receive pushed messages again after this "don't disturb time" has been elapsed. The system estimates the interval time and waits for the right pushing time.

4. Implementation and Evaluation

4.1 Implementation

In order to evaluate the proposed framework, we have implemented a prototype system. On mobile phone, user interface was developed for i-mode and EZweb phone in Japan.(Fig.2)

Fig.2: User interface for interacting with system

The web application server that recommends message to users is Tomcat 4.1.24 Servlet/JSP container. The system

communicates with all users via Java mail. The RDBMS used to store data and profile is PostgreSQL7.3.2 on RedHat 8.0 (Linux Kernel 2.4.18) operating system environment. J2EE programming has built a smart engine to calculate and derive essential data for the DB query. Furthermore, the J2EE application communicates with the database via JDBC.

The implementation system is shown in Fig.3. The minimum requirements in mobile phone are current place, recent history, partial of personal profile data such as: id, mobile mail, preference.

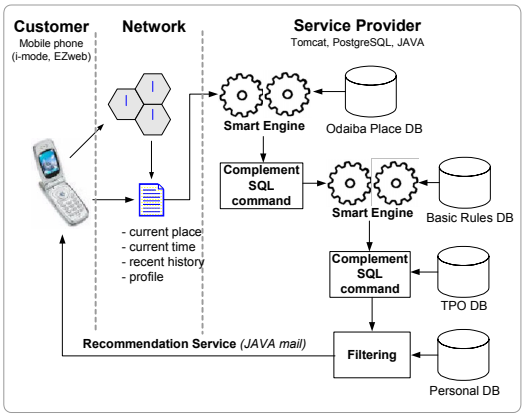

Fig. 3 Implementation system.

In this prototype, we assume that GPS data come from a user in the current place interacting with the system on Web pages. Mobile phone data has been transferred to service provider via network. Service provider at server side is composed of smart engine, complementing SQL command, filtering as well as database server. We describe the details of each component below.

Smart Engine: checks position with Odaiba Place DB and place and purpose with Basic Rules DB as well as calculates the interval time to spend at such places.

Complement SQL command: Derived data from smart engine is interpreted to fulfill Database queries. The queries retrieve events in addition to executing with TPO Database.

Filtering: The user preference, degree of preference, time, budget, traffic time and visited place are factors that are used in this module to filter appropriate messages to recommend.

Database Server: The actual database that was created for the experiments and contains information about Odaiba Place DB, Basic Rules DB, TPO DB and Personal DB.

4.2 Evaluation

For the experiment, we assume that users directly get a message from service provider. We have used 500 real events and shop information which are stored in the database. The information comes from shopping center, museum, studio, amusement park, etc. on the Odaiba home page[16][17]. The service areas are 12 main places in Odaiba area ranging from Odaiba-kaihin-koen station to Ariake station, such as: Decks Tokyo Beach, Aqua City, Fuji TV, MeSci, Venus Fort, etc.

In November 2004, the evaluation experiment of the system was conducted by 43 mobile users and over five hours at Odaiba in Japan. The subjects of the experiment are separated into two groups over two days, each with 11 users and 32 users respectively.

The users had already registered with the system, and profile data and degree of preference that we acquired from the questionnaire before the experiment had been stored as well. The users were sent recommendation messages to join three interesting events via their mobile phone. These three messages are ranked by degree of preference. All recommended events take place at Odaiba area and match time, place, purpose and profile of mobile users.

In the first day, we used a main preference (among three preferences) of each user and degree of preference in the personal profile database. We also prepared two questionnaires to obtain satisfaction level data from each user. One questionnaire was answered by mobile users when they received a recommendation message and the other was answered when they visited recommended place (Fig.4). After mobile users moved to another place, another recommendation messages were sent to them again.

Fig.4 Recommendation and questionnaire

In second day, we examined in the same way as the first day but used main three preferences (among five preferences) of each user. As a result, there were various recommendation messages and users had more choices. In the first day, there were redundant messages unused for recommendation such as: one that recommends a coffee shop to user A because he/she likes coffee or frequent refreshment messages. However, in second day we improved the user's preference database and filtering

mechanism and thus users could obtain proper messages and more satisfaction.

In addition, in second day the percentage of users who accepted recommendations and marked their satisfaction of "much more satisfied" and "more satisfied" levels increased by 13.16%, while the percentage of "less satisfied" and "much less satisfied" levels decreased by 33.96% (Table 5 and Fig.5).

Table 5: Satisfaction level of visited invitation message users

Satisfaction level	First day *1 (%)	Second day*2 (%)
Much more satisfied (5)	15.91	22.99
More satisfied (4)	29.55	35.63
Satisfied (3)	9.09	29.89
Less satisfied (2)	15.91	5.75
Much less satisfied (1)	29.55	5.75

*1) mainly use one preference from 3 preferences
*2) mainly use three preferences from 5 preferences

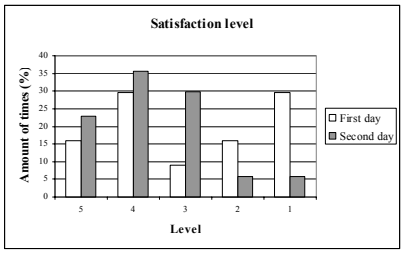

Fig.5 Satisfaction level of visited invitation message users

Moreover, mobile phone users who followed recommendation message 2 and 3 also increased by 11.01% and 9.23%, respectively, while those who did not follow recommendation messages decreased by 5.36% (Table 6 and Fig.6). This means the system can make recommendations that closely match user preference.

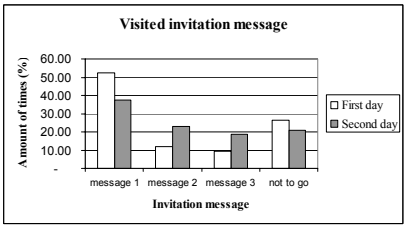

Fig.6 Amount of visited invitation message users

Table 6 Amount of visited invitation message users

Invitation message	First day (%)	Second day (%)
Message1	52.38	37.50
Message2	11.91	22.92
Message3	9.52	18.75
Not to go	26.19	20.83

Furthermore, the percentages of "much more satisfied" and "more satisfied" levels for three recommendation messages are close to and more than 50% in the second day (Fig.7).

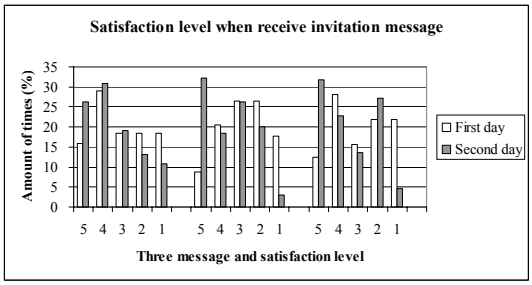

Fig.7 Satisfaction level when receive messages

In case of users who were accompanied by one or more friends, the system makes recommendations to each mobile phone based on each user's preference. This experiment had eight groups of two persons. There were cases where two persons have difference preference (the system recommends different events) but went to the same place. This means one person followed a recommendation message while another one didn't. In this case, after they visited a recommended place, their satisfaction level is "much more satisfied" or "more satisfied". This result is shown in Fig.7. Moreover, we have found that if one user is happy, another one is also happy.

The drawbacks of this system found in the experiment:

1. When user's preference is museum or hot spring for which there is only one place in Odaiba, the system cannot make any appropriate recommendation messages. For this problem, we plan to recommend a special event such as Christmas festival and New Year festival.
2. In case of user's preference is food, restaurant or refreshment, the system makes frequent recommendations to restaurant or refreshment in the first day. However, in second day we improved user's preference database and filtering mechanism, and consequently users could obtain proper messages and more satisfaction. For more efficiency, we plan to make recommendation messages in appropriate time such as: restaurant at noon and in the evening and refreshment in the afternoon.
3. The limited space on mobile monitor causes the limitation in displaying details. Because we cannot show detail or picture of recommended place, in some cases, users get a recommendation message but don't know what events or shops are.
4. Some people have a clear purpose. In spite of recommendation messages, those people do not follow them.

5. Concluding Remarks

In this paper, in order to build a more efficient recommendation service, we have proposed:
1) Time, place, purpose: We can summarize the mutual dependencies of these factors as basic rules to control external factors. Otherwise, these factors can be an answer to the question of when, where and how to recommend information or services to customers.
2) Push, pull and don't disturb services: we illustrated motivating scenarios which are specific example and can show our idea as well as more details of relationship between time, place, purpose and profile.
3) Filtering technique: the factors that we consider to filter recommendation messages are user's preference, degree of preference, budget, traffic time and visited place. We also have completed filtering algorithms.
4) DB query algorithms in mobile environment use four factors: time, place, purpose and personal profile.

We have implemented and evaluated our prototype system. This step could help us understand both the strength and weakness of the system. We will continuously improve and develop the system for higher level recommendation.

There are a lot of challenging issues to be tackled. Our future plans include user's preference model that can lead to a good selection of appropriate recommendations for customers. Furthermore, we will also establish the general rules that are applicable to any place for usefulness in our daily life.

References

[1] M. Amberg, S. Figge and J. Wehrmann, "A Cooperation Model for Personalised and Situation Dependent Services in Mobile Networks," Advanced Conceptual Modeling Techniques. LNCS 2784, pp. 136-146, 2003.
[2] W.T. Balke, W. Kießling and C. Unbehend, "Personalized Services for Mobile Route Planning: A Demonstration," Proc. ICDE 2003, Bangalore, India, IEEE Computer Society Press, 2003.
[3] C. Bobineau, L. Bouganim, P. Pucheral and P. Valduriez, "PicoDBMS: Scaling down Database Techniques for the Smartcard," Proc. VLDB'00, pp.11-20, Sept. 2000.
[4] S. Ilarri, E. Mena and A. Illaramendi, "Monitoring Continuous Location Queries Using Mobile Agents," ADBIS 2002, LNCS2435, pp.92-105, 2002.
[5] T. KATO, "Conputational Modeling of Perception Processes for Human-centered Information Environment -Artificial KANSEI-," Proc. Human and Computer, pp.164-169, Aug.2003.
[6] S. Konomi, "QueryLens: Beyon ID-Based Information Access," Ubicomp 2002, LNCS2498, pp.210-218, 2002.
[7] G. Koutrika and Y. Ioannidis, "Personalization of Queries in Database Systems," Proc. ICDE'04, Boston, USA, 2004.
[8] S.K. Madria, B. Bhargava, E. Pitoura, and V. Kumar, "Data Organization Issues for Location-Dependent Queries in Mobile Computing," ADBIS-DASFAA 2000, LNCS1884, pp. 142-156, 2000.
[9] T. Murase, M. Tsukamoto, H. Shibata, B. Liu and S. Nishio, "MobiView: A Database Integration Mechanism Based on Database View for Mobile Computing," IEICE Trans. Information and Systems, vol.E84-D, no.3, pp.340-347, March 2001.
[10] S.Pinyapong, T.Kato, "Query Processing Algorithm for Time, Place, Purpose and Personal Profile Sensitive Mobile Recommendation," Proc.CW 2004, pp.423-430, 2004.
[11] G. Samaras and C. Panayiotou, "A Flexible Personalization Architecture for Wireless Internet Based on Mobile Agents," ADBIS 2002, LNCS2435, pp.120-134, 2002.
[12] M. Wagner, W.T. Balke, R. Hirschfeld and W. Kellerer, "A Roadmap to Advanced Personalization of Mobile Services," Industrial Program of the 10th International Conference on CoopIS 2002, CA, USA, 2002.
[13] J. Weissman and Z.L. Zhang, "Smart Environments: Middleware Building Blocks for Pervasive Network Computing," IMWS2001, LNCS 2538, pp.90-105, 2002.
[14] E. Yano, E. Sueyoshi, I. Shinohara and T. Kato, "Development of Recommendation System with multiple subjective evaluation process model," Proc. CW 2003, pp. 344-351, 2003.
[15] http://www.amazon.com
[16] http://encyclopedia.thefreedictionary.com/Odaiba
[17] http://homepage2.nifty.com/odaiba-web/
[18] http://www.nttdocomo.com

Sineenard Pinyapong received the M.E. degree from Chuo University, Tokyo, Japan in 2002. She is currently a doctoral student under the supervision of professor Toshikazu Kato, Department of Industrial and Systems Engineering, Chuo University. Her research interest includes database systems, query processing and mobile information service.

Toshikazu Kato received the B.E., M.E, and Ph.D. degrees from Department of Information Science, Kyoto University, in 1980, 1982 and 1987, respectively. He joined Electrotechnical Laboratories (ETL), MITI, 1986. Since 1996, he is a professor of Department of Industrial and Systems Engineering, Chuo University. His research interest covers Kansei engineering, human computer interaction, image understanding, multimedia database systems. He is a member of IPSJ, IEICE, JSKE and IEEE CS.