2006 IEEE Conference on
Systems, Man, and Cybernetics
October 8-11, 2006, Taipei, Taiwan

A User Centric Mobile Information Service: MISAR

S. Pinyapong, K. Watanabe, S. Kimura, H. Shoji, and T. Kato

Abstract— *This study proposes a mobile information service adapted to user's requirements that allows the users who have not yet defined their desired information or whose desired information varies according to the situation to get appropriate information. When the user can specify their desired information to the system explicitly, we develop a "Pull" service. Conversely, when the user cannot verbally specify their desired information to the system, we provide "Push" service and "Don't disturb" option for the user who does not welcome this service. We consider the characteristics of the environment of mobile terminal to focus on "Time", "Place" and user's "Preference": long term and short term preference. We also create rules, algorithms and filtering to this service. Furthermore, the results of experiments verify the idea that different of user desired requires different information services.*

I. Introduction

It has been a long time since many people began to advocate the need for information services that allow anyone to get necessary information in a timely manner anytime and anywhere. The evolution and pervasion of technologies such as cellular phone and PDA and the progress of research on the ubiquitous information environment have caused the environment as a hardware/software system that can provide such services to be being in place. In the area of information retrieval technology, on the other hand, many R&D projects for efficiently finding desired information from large amounts of information have been conducted and consequently some useful tools have appeared.

However, it often remains a challenge that any user can get desired information in a timely manner anytime and anywhere. The possible reasons for that are as follows:

(1) The fuzziness of what information the user wants may prevent them from specifying it to the system.
(2) What information the user wants is prone to change depending on the situation.

Manuscript received March 15, 2006.

S. Pinyapong is with the Department of Industrial and Systems Engineering, Chuo University, Tokyo 112-8551 Japan (phone: +81-3-3817-1944; fax: +81-3-3817-1943; e-mail: sineenpy@indsys.chuo-u.ac.jp).

K. Watanabe and S. Kimura are with Graduate School of Science and Engineering, Chuo University, Tokyo 112-8551 Japan (e-mail: watakent@indsys.chuo-u.ac.jp, kimuraso@indsys.chuo-u.ac.jp).

H. Shoji and T. Kato are with the Department of Industrial and Systems Engineering, Chuo University, Tokyo 112-8551 Japan (e-mail: hiroko@indsys.chuo-u.ac.jp, kato@indsys.chuo-u.ac.jp).

The most of conventional information services are based on the implicit premise that the user has already defined their desired information. This study tries to resolve two problems mentioned above and to propose a mobile information service that allows the users who have not yet defined their desired information or whose desired information varies according to the situation to get appropriate information on a case-by-case basis.

This paper consists of Section II describes an approach to appropriate information service which are addresses the vagueness of information requirements and a change in requirement according to the situation, we focus on "Time", "Place" and the user's "Preference" which are long-term and short-term preference. Section III describes mobile information service adapted to user's requirements: rules, algorithm and filtering. Section IV presents interaction scenarios including scenarios analysis. In addition, Section V discusses results of experimental evaluation. Finally, a concluding remark and future work in Section VI.

II. Approach to Appropriate Information Service

As described previously, disincentives to timely and ubiquitous information service available to the user are as follows:

(1) The fuzziness of what information the user wants may prevent them from specifying it to the system.
(2) What information the user wants is prone to change depending on the situation.

A. To Address the Vagueness of Information Requirements

The retrieval of desired information from among a flood of information requires a user to describe their information requirement accurately and pass it along to a system. However, the user's information requirements are not necessarily definite, and the user often only has a vague notion. Taylor has grouped the definiteness (or vagueness) of information requirements from the user into the following four levels [19]:

1. Visceral need
2. Conscious need
3. Formalized need
4. Compromised need

At level 1, the user is conscious of lack of satisfaction with their current situation, but cannot elicit it in a specific expression such as language and other forms. At level 2, the user is clearly conscious of their problem, but can only elicit it in a vague or disorganized expression. At level 3, the user can elicit their problem in a concrete language expression. At level 4, the user can have their problem crystallized and defined as much as they can identify necessary information source.

At levels 3 and 4, the user can specify their desired information to the system explicitly (clearly and verbally). Therefore, if the user specifies their requirements first, the system can retrieve their desired information and present them with it. In order to bring such a feature into reality, we develop a "Pull" service. The "Pull" service is one that presents appropriate information for the requirements presented by the user, and can be said to be a kind of so-called information retrieval [2] function. The most of conventional computer systems including information retrieval systems assumed the concreteness and definiteness of information requirements (levels 3 and 4).

If the user is at level 1 or 2, they cannot verbally (by keywords) specify their desired information to the system, and cannot get necessary information efficiently. There have been several studies on the search method that allows the user with vague requirements to give a definite form to them through their interaction with the system to make an interactive and sequential search for necessary information. (For example, SMART system [15], Scatter/Gather [5], RABBIT system [20].)

However, this method for making a sequential search for desired information does not suit mobile information services. The user of mobile information services often wants to get necessary information without trouble between an interval of various works at various locations. Therefore, this study employs an approach of providing "Push" services to the user who cannot specify their requirements, i.e. the user at level 1 or 2. Push services are those such that the system presumes "information that the user is likely to need at present" and delivers it to them. In this case, the user does not need to specify anything to the system. Information that a Push service provides is one the system presumes that the user will want, and they do not necessarily truly welcome it. Conversely, there is a risk that information delivered without permission might annoy the user. Therefore, this study provides a "Don't disturb" option to turn off the Push service for the users who do not welcome it.

B. To Address a Change in Requirement According to the Situation

Human thinking may vary according to the situation. For example, we might often experience that a fruit that usually tastes very sweet does not taste sweet immediately after having very sweet stuff, and that souvenirs bought during a trip look nice at shops, while they do not after returning home. These cases show that human thinking varies depending on the situation.

It goes without saying that different thought requires different information. Therefore, we need a service that can provide desired information for the user depending on the prevailing situation on each occasion. For example, Matsushita et al. have conducted research focusing on the case where the information requirements of the user vary in the course of information searching [10]. Because a mobile information service as a target of this study is premised on that the user moves around using the service, better response to a situation change is strongly expected than for a system that is supposed to be used at a fixed location.

"Situation" includes many kinds, and this study considers the characteristics of the use environment of mobile terminals to focus on "Time" and "Place" in particular.

"Time":

Time is an important situational factor that is already used in currently available services. 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. It is the rule to select information to the current day or part of the day. Other services become more valuable when information can be offered at a precise moment in time; such as time-sale, special event, traffic alerts, etc.

"Place":

With the current GPS technologies, it is possible to detect where the end-user is physically located. For example, services that help user locate a physical object (ATM, restaurant, shopping-center, etc.) based on user's current location. For example, providing end-users with shop offers, discounts, announcements, menus, or timetables. Moreover, the system will estimate distance and the length time to the next destination.

The system considers the user's "Preference" (both long-term and short-term) as well as the situation ("Time" and "Place" in this case) to presume the user's desired information and provides a "Push"-type information service to the user.

"Preference" (both long-term and short-term):

In real life a user's preferences are typically not changed but varied due to different situations. This paper can classify into two types of user preference which are:

(1) *Long Term Preference (LTP)*: this preference generally holds user preference and does not depend on situations. Long term has a general structure that composes of basic user preference, preference category and degree of interest.

(2) *Short Term Preference (STP)*: this preference holds in exactly one situation or one day. Short term has a temporal structure that can be performed implicitly by observing the user's behavior and situation. Additionally, implicit observation does not require any extra time or effort from the user and can adapt to changes in the user's interests over time.

Accordingly, a use of preference is in general a Long Term Preference. Situation-dependent preference is Short Term Preference.

III. Mobile Information Service Adapted to user's Requirements: MISAR

Mobile phones are small-sized, which means limited memory and a small monitor. As a result, the system framework must use only essential data in processing and querying. In this section, we propose a general framework and services as follows:

(1) Push service: performs when the mobile phone user arrives at service area. This service provides a "Don't disturb" option for not recommending any messages to mobile phone user who does not welcome it.

(2) Pull service: performs when the mobile phone user tries to access a mobile service.

A. *Rules*

In this section, time, place, purpose and payment factors are analyzed to summarize basic rules as shown in Table 1.

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
Medium 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

The basic rules can be applied to push, pull and don't disturb services.

B. *Algorithms*

The system uses these algorithms to derive essential factors from basic rules. Then, the system connects to DB and executes queries. Finally, filtering and pushing/pulling a message to a mobile phone user. The algorithms comprise five steps as described below:

(1) Checking the basic rules from Table 1

After a user's mobile phone in mobile GPS networks pinpoint its position. User'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 and retrieval a message

Connects to the personal profile database and retrieves user's preference by a keyword. After that, it compares data from Database then selects an appropriate message to be pushed/pulled to user.

(5) Pushing or pulling a message

The system pushes or pulls a message obtained to user.

C. *Filtering*

Our approach to recommendation is based on situational information, which is used in filtering. The factors that considers to filtering messages are as follows:

(1) User's Preference:

In real life a user's preferences are typically not changed but varied due to different situations. This paper can classify into two categories which are Long Term Preference and Short Term Preference.

(1.1) Long Term Preference (LTP):

This preference generally holds user preference. Long term has a general structure that compose of

- Basic user preference: User preference can be performed explicitly by asking the users when users register with the system. Users can update their preference as well. Furthermore, it can be uploaded from existing STP.
- Preference category: The preferences have been divided into category and hierarchy of category, which have been stored in the database.
- Degree of preference: The degree of preference is used to rank recommendation results that closely match user preference.

(1.2) Short Term Preference (STP):

As a fact of life the user preferences may depend on underlying situations. For instance, users may have different shopping preferences depending on the location they are or on the time of day. In order to integrate such situations into preference, a short term preference algorithm has to be developed.

Short term preference holds exactly in a current session, one situation or one day. Short term has a temporary structure that can be performed implicitly by observing the user's behavior and situational information. Moreover, implicit observation does not require any extra time or effort from the user and can adapt to changes in the user's interests over time.

STP data automatically creates log file on the server. If same STP data store more than one time, it will be uploaded to user preference database as LTP. The different of LTP and STP are shown in Table 2.

(2) Event time:

The appropriate events time is retrieved to make recommendation messages. Therefore, the restaurant and refreshment time service has been limited to recommended restaurant time to between 11:30am-1:30pm and 6:00pm-8:00pm including refreshment time to between 2:00pm-5:00pm.

(3) Traffic time:

For a user who can go to an event in time, the system also calculates traffic time and walking time. The system adds traffic time and walking time and recommends events that user can go to in time within the total time.

(4) Visited place:

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

IV. Scenarios

A. Interaction Scenarios

The difference of time, place as well as preference (LTP and STP) causes situational differences which result into recommendation of service, information and product. The following interaction scenarios illustrate our vision about future mobile services: "Push", "Pull" services and "Don't disturb" option. In Tokyo with users who visit any place in anytime and any purpose.

(1) Push service

Monday at 12:00pm:

Today is Mr. A's holiday. He spends his free time at Venus Fort. He walks to see men's fashion, shoes and bags, but he doesn't want to buy anything. For a while, he gets a message which invites him to join "Dream Drive, Dream Live" at 1:00 pm. Shopping doesn't interest him therefore he decides to go to join a car show at MEGA WEB.

(2) Pull service

Monday

Ms. B has 2 hours before meeting up with her friend at Tokyo station. She wants to wait at book café store then she begins to search via mobile system. The system retrieves "BOOK&CAFÉ" at Daimaru 6F Tokyo Station to her. Later, GPS can locate Ms. B's position at BOOK&CAFE store then begins to recommend a new book while she's drinking coffee.

B. Scenarios Analysis

(1) Push Service

On Monday, Mr. A who has registered with the system arrive at Odaiba area, Global Positioning System (GPS) technology available in the mobile networks has already checked Mr. A'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 Mr. A.

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:

1. Checks position, a purpose and estimate interval time with the basic rules.

Venus Fort no charges a fee. Therefore, the system presumes that Mr. A has an unclear purpose of visiting there and not has the interval time.

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 = 'Venus Fort' and
       (date_start >= 'today' or date_stop >= 'today') and
         time_start > 'now';
```

3. Executes the DB query.
4. Filters into a recommendation message.

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 <> '"+'Venus Fort' + "' and
         detail LIKE '%" + 'CAR' + "%' and budget = 'free'
       (date_start >='today' or date_stop >='today');
```

Mr. A prefers "car" and thus the system will push a message "Dream Drive, Dream Live" to him.

5. Pushes a message.

The system pushes a recommendation message obtained to Mr. A.

Don't disturb option:

When mobile phone users go to a service area place and do not welcome any recommendation message, the users can choose don't disturb option. Don't disturb time is control time that the system uses to consider not to disturb the users with any unnecessary message. Later, the users 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.

(2) Pull Service

Ms. B who has registered with the system accesses via mobile phone to search for "book café". 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 recommends "BOOK & CAFÉ" at Daimaru 6F Tokyo Station to her.

The algorithms used can be explained as follows:

1. Searches by keyword:

Position: Tokyo station, time: 3:00 pm, keyword: "book café"

2. Interprets data to build a DB query as follows:

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

3. Executes the DB query.
4. Retrieves a message.

Connects to the Personal DB to retrieve user's preference, and then filters by preference, degree, budget, visited place, traffic time and walking time in the same way as the push service.

5. Pull message.

The system retrieves a message to Ms. B.

After GPS has already checked Ms. B' position at Book café shop and the system stores Ms. B' keyword as Short Term Preference to log file, the system initials push algorithms again. The system recommends a new message to her based on Short Term Preference ("book café"). For a while, Ms. B gets a recommendation message for a new book in this shop.

V. Evaluation Experiment

To evaluate the effectiveness of the proposed approach, an experiment has been conducted using the developed system. This section describes the content and results of the experiment. There are a broad range of considerations for discussing the effectiveness of the system, among which this paper discusses the effectiveness of the Push and Pull services and Don't disturb option in particular. The hypotheses to verify are as follows:

(1) The user who has more definite information requirements tends to more often use information retrieval functionality provided by the Pull service.

(2) The user who has less definite information requirements tends to more often use recommendation functionality provided by the Push service. At the same time, as their information requirements get more definite, they more often use the Don't disturb option.

To verify these hypotheses, we have carried out an experiment with four groups of subjects divided by definiteness of their information requirements at the beginning of the experiment. Specifically, twenty-seven subjects in total (male/female university students in their twenties) were allowed to move freely in the specified area and each group of them was given an assignment as follows:

Fig.1 User interface of the system (compatible with i-mode, Vodafone and EZweb services for mobile phone communications)

An assignment to each group was set to match the definiteness of information requirements of the group members at the beginning of the experiment with one of Taylor's four levels of classification. The subjects in group A have the least definite information requirements at the beginning of the experiment, while those in group D have the most definite requirements. The time allowed for the subjects to complete their assignments is four hours. They were supposed to walk about freely in the shopping center, amusement park, museum, and others in the specified area (Odaiba in Tokyo) carrying a mobile phone compatible with the system (see Figure 1) and determine three pieces of information to report. They were able to use services provided by the system any time if needed, and their uses if any were logged in the system. Once they have determined three pieces of information to report, their assignment is complete. Note that this study does not make an evaluation by the time required to finish the assignment because it does not intend to shorten the time.

- Group A: Get three pieces of information you like regarding Odaiba area.
- Group B: Get three pieces of information suitable for this season regarding Odaiba area.
- Group C: Get three pieces of information characteristic of Christmas day regarding Odaiba area.
- Group D: Get three pieces of information about Christmas trees in Odaiba area.

There were twenty-seven subjects in total: six in Group A, eight in Group B, seven in Group C, and six in Group D. Both Table 2 and Figure 2 show the average counts of uses of the Push and Pull services and Don't Disturb option by the subjects in each group.

This graph (Figure 2) shows that the most frequent user of the Pull service is group D, the second is Group C, the third is Group B, and the least frequent user is group A. The log of each subject reveals that the subjects in Group C and D tend to use the Pull service from the beginning of the experiment, whereas those in group A and B scarcely used it at the beginning. This means that the subjects in group A and B mostly have indefinite information requirements especially at the beginning of the experiment and have only a little information they want to retrieve via the Pull service. These results accord with one of our hypotheses that the user who has more definite information requirements tends to more often use information retrieval functionality provided by the Pull service.

TABLE 2
THE AVERAGE COUNTS OF USES OF EACH SERVICE PER GROUP

Group	Push (1 person)	Pull (1 person)	Don't disturb (1 person)
A	5.83	2.83	0.33
B	6.13	3.38	0
C	3.14	5.14	0.71
D	2.50	7.33	1.34

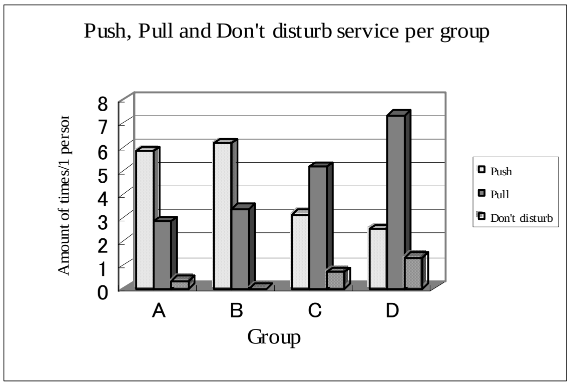

Fig.2 The average counts of uses of each service (Push, Pull, and Don't Disturb) per group

In addition, the most frequent user of the Push service is group B, the second is Group A, the third is Group C, and the least frequent user is group D. There is not much difference between the average counts of uses of each service for Group A and B. This is also true for Group C and D. Therefore, it can be said that the groups are polarized. As for Don't Disturb option, the most frequent user is group D, the second is Group C, the third is Group A, and the least frequent user is group B, although the counts of uses for group A and B are near zero. Groups with fewer uses of the Push service have more uses of the Don't Disturb option.

These results nearly accord with another one of our hypotheses that the user who has less definite information requirements tends to more often use recommendation functionality provided by the Push service, and at the same time they more often use the Don't disturb option as their information requirements get more definite. It is a contradictory trend to the hypothesis that group B has just a little more uses of the Push service than group A (as to the Don't Disturb option, the reverse is the case).

Reviewing satisfaction levels logged of subjects to information presented reveals that those in group B more often rated it highly. Therefore, the cause of the contradictory trend mentioned above is likely to be that much of the information presented by the system suits the assignment for group B that "Get information suitable for this season" and thus many of the subjects in group B tended to make a decision with such information acting as a prompt. Changing assignment settings and/or the variation of the information presented or repeating the experiment many times will presumably result in such a consequence that group A has more uses of the Push service than group B has, however, this issue should be further addressed in the future because it may be due to another cause.

VI. Concluding Remark

This study proposes the solution of information service. This paper addresses the vagueness of information requirements. We develop “Pull” service to present appropriate information for the requirements presented by the user and “Push” service to the user who cannot specify their requirements as well as “Don’t disturb” option for the users who do not welcome it. Moreover, this paper considers about the characteristics of the environment of mobile terminals to focus on “Time”, “Place” and user’s “Preference”. Preference can be divided into Short Term Preference (STP) and Long Term Preference (LTP). Long term generally hold user preference, while short term is depending on situation.

The experiment has been conducted using the developed system. This step could help us verify the level of information requirements and provide an appropriate information service for each level. However, we will continuously improve and develop the system for changing assignment settings and/or the variation of the information presented or repeating the experiment many times with a large number of subjects.

There are a lot of challenging issues to be tackled. Our future plans include the study of other ways for the efficient integration of Time, Place, Long Term Preference and Short Term Preference to filter information. In addition, the study of Short Term Preference model that can lead to a good selection of appropriate information service according to situation for the users.

References

[1] Amazon.com Online Shopping http://www.amazon.com

[2] 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.

[3] H. Bruce, “Personal anticipated information need,” Information Research, 10(3) paper 232. [Available at http://InformationR.net/ir/10-3/paper232.html] April 2005

[4] B.D. Groot, M.V. Welie, “Leveraging the Context of Use in Mobile Service Design,” Proc. of Mobile Human-Computer Interaction, pp.334 – 338, 2002.

[5] M.A. Hearst and J.O.Pedersen, “Revealing Collection Structure through Information Access Interfaces,” Proc. of IJCAI’95, pp.2047-2048, 1995.

[6] S. Holland, W. KieBling, “Situated Preference and Preference Repositories for Personalized Database Applications,” Proc. of ER’04, pp.511-523, Shanghai, China, Nov. 2004

[7] Gourmet Navigator http://www.gnavi.co.jp

[8] H.R. Kim, P.K. Chan, “Learning implicit user interest hierarchy for context in personalization,” Proc. of IUI’03, pp.101-108, Florida, USA, 2003.

[9] G. Koutrika and Y. Ioannidis, “Personalization of Queries in Database Systems,” Proc. of ICDE’04, Boston, USA, 2004.

[10] M.Matsushita, K.Nakakoji, Y.Yamamoto and T. Kato, ”Toward "Natural Discourse" for Exploratory Data Analysis - An Interactive Visualization System InTREND -,” Proc. of Interaction 2003 Tokyo, Japan, pp. 461-471, 2003. (in Japanese)

[11] NTT DoCoMo http://www.nttdocomo.com

[12] Odaiba http://encyclopedia.thefreedictionary.com/Odaiba

[13] Odaiba web http://homepage2.nifty.com/odaiba-web/

[14] S. Pinyapong, T. Kato, “A Framework of Time, Place, Purpose and Personal Profile Based Recommendation Service for Mobile Environment,” IEICE Trans. Inf. & Syst., vol.E88-D, no.5, pp.937-346, May 2005.

[15] G. Salton, J.Allan and C. Buckley, “Approach to Passage Retrieval in Full Text Information Systems,” Proc. of SIGIR’93, pp.49-58, 1993.

[16] H. Shoji, H. Hori, “S-Conart: an interaction method that facilitates concept articulation in shopping online,” AI & Society, vol.19, pp.65-83, Spring Verlag, 2005.

[17] H. Shoji, M. Mori and M. Matsushita, “Interaction design that facilitates concept articulation for Internet users whose needs is vague,” Journal of SOFT, vol.15, no.5, pp.515-524, 2003.

[18] K. Sugiyama, K. Hatano, M. Yoshikawa and S. Uemura, “Adaptive Web Search Based on User's Implicit Preference,” DEWS2004, 5-B-4, March 2004.

[19] R.S.Taylor, “Question-negotiation and Information Seeking in Libraries,” College & Research Libraries, 29(3), pp.178-194, 1968.

[20] M.D.Williams, F.N. Tou, R.Files, A.Henderson and T.Malone, “Cognitive Science in Interface Design,” Proc. of CogSci’82, pp.82-85, 1982.