# Prototyping of Task-Oriented Mobile Navigation System with Real Scale Mobile Services

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**ABSTRACT**

Because present methods for mobile service navigation are insufficient to guide users efficiently to the services they need, the authors have been investigating a task-oriented menu, which enables users to search for mobile internet services not by category but by what they want to do. Construction of the task-oriented menu is based on a task ontology modeling method which supports descriptions of user activities, such as task execution and defeating obstacles encountered during the task. Since a prototype within a limited domain and task proved its efficiency for navigating novice users, this paper introduces the next step toward the realization of the task-oriented menu system. We have built task model of the mobile users which covered about 97% of the assumed situations of mobile internet services. Then we reorganized "contexts" in the model and designed a menu hierarchy from the view point of the task. We have linked the designed menu to the set of actual mobile internet service sites included in the i-mode service operated by NTT docomo, consists of 5016 services. Among them, 4817 services are properly connected to the menu. This paper introduces a real scale task-oriented menu system for mobile service navigation with some findings in the process of the prototyping.

**KEY WORDS**

Web Technologies, Mobile internet services, Knowledge-based Systems, Task Ontology, Modelling Mobile Users

## 1. Introduction

While they provide many mobile internet services via mobile handsets in Japan, such as online shopping, mobile banking, and news services, current methods for mobile service navigation have proven insufficient to guide users efficiently to the mobile internet services they need. To solve this problem, the authors have been investigating a task-oriented menu which enables users to search for services by "what they want to do" in certain problem-solving situations, instead of by "name of category" [1]. On this first prototype system, Naganuma proved that the task-oriented menu system has ability to navigating novice users to the mobile services they want faster than conventional domain oriented menu system. The first prototype system mentioned in [1], however, was a limited one. In terms of task and domain knowledge, the first prototype assumed only limited situations, thus limited services were built in the menu system.

To extend the first prototype menu system to the real scale one, we need to investigate two issues. The first one is how to enhance scalability. The second one is how to develop a menu system with real scale on the basis of the investigation about the scalability. The authors discussed these two issues and developed a new menu system with real scale for navigating users to the mobile services they want, which is linked to a real scale of mobile services consisting of about 9,000 services. We have described about the user modeling issues in [3]. This paper describes design and development process of the new menu system.

## 2. Task-Oriented Menu for Mobile Service Navigation

Fig. 1 shows the process of service selection using a task-oriented menu on the first prototype system [1]. First, the most abstract task candidates are shown on the mobile phone (Fig. 1 left). A user selects one of them (e.g. "Go to a department store") to solve current problem (e.g., "need to buy clothes"). Then, tasks and/or subtasks associated with each task are unfolded and displayed under the task nodes (Fig. 1 center). Finally, services associated with the task selected by the user are shown, and each of them leads to access to the actual service (Fig. 1 right).

As shown in this example, the task-oriented menu is easy to use for novice users of mobile internet services. By just selecting what he/she wants to do in the real world from the menu, he/she will be led to a service for solving the current problem. Knowledge about the hierarchy of the domain-oriented menu labeled like "hobbies", "local info", "life" and so on, is not necessary.

Although such a generic task hierarchy looks like the hierarchical structure of the category-based menus of today, there are fundamental differences. In certain cases, it is possible to label a concept with a noun instead of a verb or action. It is acceptable to label a mobile internet service that sells tickets as "Ticketing" or "Buy a ticket",

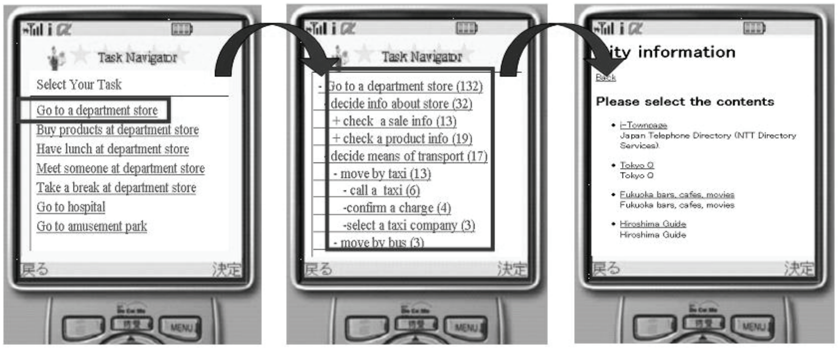



Fig.1 Task oriented menu (The first prototype by Naganuma[1])

for example. In the same manner, abstract tasks can be labeled with nouns. Although it seems that any concept can be labeled by both verbs and nouns, it is a hasty generalization. Such a generalization may lead to the misunderstanding that we just followed the process used by the designer of the category-based menu in classifying the mobile internet services, thus introducing an abstract hierarchy of the tasks.

An important point is that the difference between "Ticketing" and "Buy a ticket" is just the expression of the label. The concepts are the same task. We focus on the concept and essential characteristics of the mobile user's task. Comparing them at the conceptual level, a category-based classification of objects is totally different from a task-based one in terms of its structure.

In the case of category-based classifications today, generally speaking, the boundary or definition of each category becomes vague or implicit. Classification of an object or a concept heavily depends on the intention of the designer who developed the menu. The categories "Hobbies" and "Shopping" are both located at the top level of the Japanese i-mode menu, for example. A mobile internet service that sells cars is classified in the former if the designer considers driving a car as a hobby. On the other hand, the service is classified in the shopping category if the designer focuses on the commercial aspect of the service rather than its object.

On the other hand, in classification of actions from the viewpoint of tasks, the boundary or definition of each category becomes more explicit. Since the criteria for the classification, such as pre-conditions, processes, and effects of the action, appear in both the label of the category and the classified concepts, it is easy to find the location of a new concept in a hierarchy which is classified based on task. For the same reason, it is easy to add a new concept to the task-based classification. A service that sells cars is classified in a sub-category of the task "Buy", whether driving a car is a hobby or not.

For the reasons described so far, task-based categories are more suitable for the classification of mobile services. On this point, Naganuma [1] conducted a user test involving nine adult subjects to confirm the effectiveness of a task-oriented menu system and evaluate the process used to find services for problem-solving purposes in terms of process functionality. Subjects were divided into three groups according to their experience of mobile internet services: 1) subjects using mobile internet services every day, 2) subjects using mobile internet services a few days a week, and 3) subjects with no experience in using mobile internet services.

Subjects were asked to retrieve appropriate services to given problems by using the task-oriented menu system, a keyword-type full-text search system newly developed for the experiment, and a major commercial directory-type menu system.

Analyzing the results by the user types, only the task-oriented menu system allowed non-expert users to find the appropriate services with the same success rate as experienced users. The results show that the task-oriented menu system is effective for mobile internet service navigation.

## 3. Issues on Building Real-Scale Task Oriented Menu

For realization of task-oriented menu system in real scale, we have to tackle two issues: (1) Scalability of the system and (2) Building a task-oriented menu system with real scale. For the first issue, the authors have identified four kinds of scalabilities to be satisfied [2][3]: (a) Coverage for domains of mobile services (b) Granularity of user modeling (c) Coverage for mobile services in real world (d) Coverage for mobile users' situations in which they rely on mobile services. For the item (a) and (b), we have already proposed a new ontology-based modeling method which is named OOPS (abbreviation of "Ontology-based Obstacle, Prevention and Solution).

Fig. 2 represents a process of building an OOPS model. The dotted rectangle labeled (1) corresponds to the basic model of users' activities. It is described by instantiating generic models or ontologies. Description of the OOPS model starts from the task at the level of large granularity. Next, ways to achieve the task are linked, and each of the ways consists of a sequence of sub-tasks. Our "way" is similar to the "method" of CommonKADS [4] and "how to bundle" of the Business Process Handbook [5]. Following this process, the task of large granularity is decomposed into sub-tasks via ways. Area (1) in Fig. 2 represents that a task "Move to a theme park" is achieved by three ways. Among them, the way "Move by driving my own car" consists of three sub-tasks, "Go to the parking space", "Drive from home", and "Park the car at the parking lot".

We have designed and developed an ontology which covers users' daily tasks and necessary domain knowledge. Modeling method based on the ontology solves complicated domain modeling (i.e., (a)) and gives guidelines for granularity of the task modeling (i.e., (b)). The modeling method supports descriptions of users' activities and related knowledge, such as how to solve

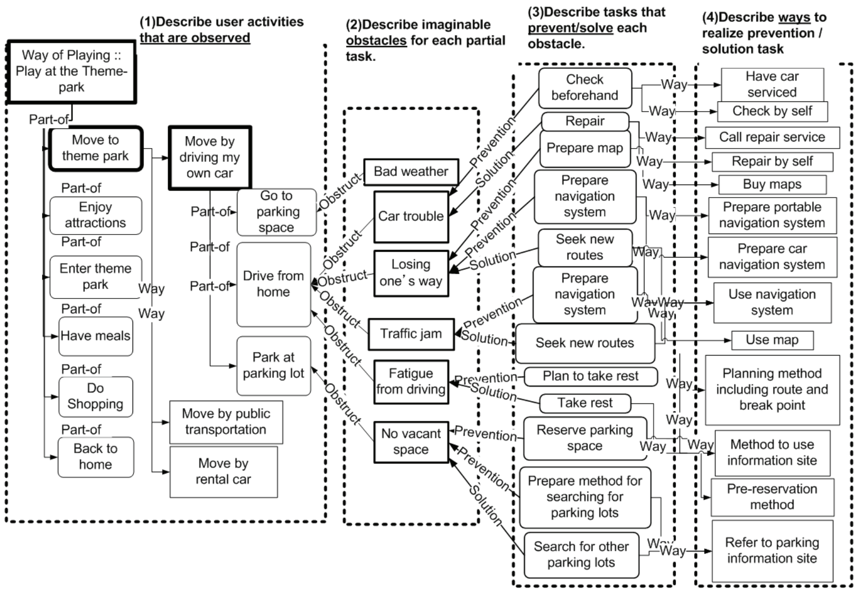



**Fig. 2 The process of building OOPS models.**

problems that the users encounter and how to prevent or solve them on the spot.

By experiments in [3], OOPS modeling method showed performance that promotes generation of idea for modeling users' daily activities. Further details are described in [3].

## 4. Prototyping Real-Scale Task-Oriented Menu

In this research, we concentrated on the issue (2) as well as scalability issues of (c) and (d). For testing the coverage of mobile services and mobile users' situations (item (c) and (d)), a new menu system with real scale is definitely needed.

### 4.1 Analysis of User Activities

To make such a system, analysis of the user activities in a wide range of domains is required. For such analysis, we have applied the OOPS modeling method to "Tourism" domain which covers a broader spectrum of actions from traveling around and consuming money to staying at a hotel. We have evaluated the coverage of the OOPS model by comparing situations assumed and represented in the model which we developed on tourism setting with those situations assumed to be supported by current mobile services.

We have tested coverage of the model by a full set of mobile services which are available at the official sites of NTT docomo in 2004. Among about 5,000 officially authorized service sites, excluding entertainment services sites (Games, ring-tone downloading, etc), there are 2,732 sites that consist of 9,162 specific services inside. We analyzed a situation for each of the 9,162 services. Among them, our OOPS user model covered about 98% of the typical situations assumed by the mobile service sites, and just 199 services (2.17% of the 9, 162 official services) were not covered by the situations represented by our OOPS model.

### 4.2 Development of New Prototype System

Based on the OOPS user model, we developed a menu system with real scale. Fig.3 depicts our environment for developing the task-oriented menu, which is based on an environment by NTT docomo for building i-appli (applications for i-mode mobile handsets). On the left part of the figure, the menu we designed is displayed hierarchically.

Fig.4 depicts the first two levels of the menu. The OOPS model on tourism domain consists of 5 tasks. At first, we built a menu hierarchy where the 5 tasks are at the top level("Move", "Have meal", "Have fun", "Buy" and "Stay overnights"). Those at the second level (17 items) have how users achieve the tasks, those at the third level (97 items) have subtasks which consist of methods, those at the fourth level (112 items) have obstacles which can occur when users do subtasks and those at the fifth level (445 tasks) have tasks which can prevent or solve obstacles such as "Go to somewhere", "Have meal", "Draw cash", "Buy things", and so on. As a whole, the menu consists of 5 levels at the deepest level.

The menu hierarchy enables users to search the mobile internet services they need if they select task, method, subtask, obstacle, and prevention/solution task in order.

Then we implemented the menu system and assigned all of the officially authorized service sites. Fig.5 shows statistics about mobile services. As a result, 96% of 5,016 mobile internet services were allocated to the menu with


Fig.3 Environment for developing task-oriented menu

Menu top
- Move
    - On foot
    - By public transportation
    - By taxi
    - By car
    - By rent-a-car
- Have meal
    - At a restaurant
    - Take out
    - Cook by self
- Have fun
    - By sight seeing
    - By playing at a theme park
    - By watching sports/play/etc.
- Buy
    - In a town
    - By internet shopping
    - By auction
- Stay over nights
    - Stay at a hotel
    - Stay at friends

**Fig.4 : First two levels of the menu**

real scale properly (Fig.5 (a)).

Although the entire menu contained 445 tasks, no mobile service is allocated to 100 tasks (Fig.5, (b)). If we develop a new mobile service for such tasks, it will be a new business opportunity. Furthermore, issues on usability still remain. For example, 11 % of task menu items are linked to more than 50 services. A cause of this is that today's mobile services are biased to limited tasks like "know weather forecast", "get movie information", and so on. Also we plan to do other usability tests without limitations of task and domain.

### 4.2 Separation of Prevention and Solution Tasks

The authors have considered that there are two situations when users need mobile services. The one is the situations where users want to prevent problems they encountered, and the other is the situations where they want to solve problems. We should have clearly divided the two situations and applied the result to the menu hierarchy. For example, when users who want to move by train cannot take it because the seats are not available and they

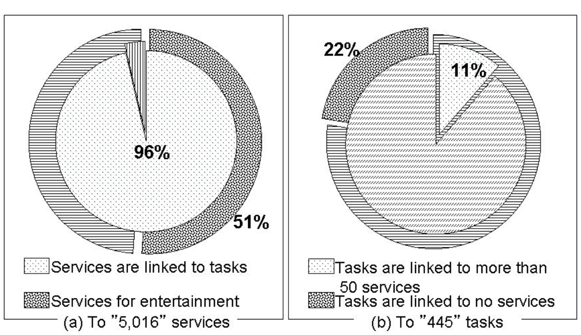



**Fig.5 Statistics about service contents**

select the node "No seat available", we can find the prevention task "Make a reservation" and the solution task "Change transportation". When the problem "no seat available";has occurred already, however, users would be upset because they cannot make a reservation for the seats after they have been fully booked. This means the menu hierarchy should show the node "Make a reservation" before the problem occurs.

Therefore we have developed the menu system where users can select "before problems" or "after problems" at the first step, following which they can find services which suit their situation. For the example mentioned above, when users select the node "Seat not available" they can find the prevention task "Make a reservation" if they choose "before problems" and the solution task "Change transportation" if they choose "after problems" at the first step.

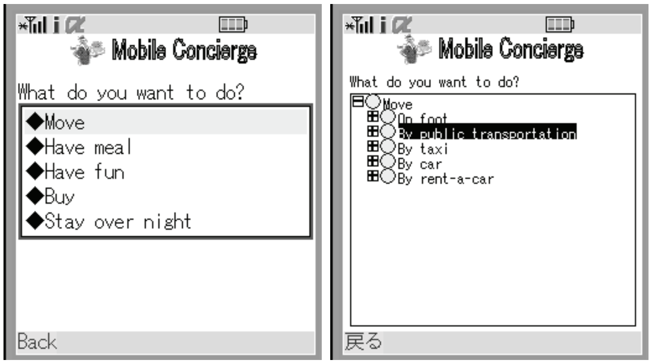
### 4.3 Process of Mobile Service Navigation

Fig.6 shows screen shots of the developed system. When a user selects one of them (e.g. "Move") to achieve the current goal (e.g., "go to a shop"), methods which can achieve the task are unfolded. By selecting an item among the menu, tasks and subtasks associated with each task are unfolded and displayed under the task nodes. Finally, at the deepest level of the menu, each of the menu items is linked with a URL of an internet service like "City map service".

Suppose a scenario that a user wants to go to a shop by public transportation system. Fig.6 depicts a sample process of service selection using screen shots of the menu system of the latest version. First, the most abstract task candidates are shown on the mobile phone (Fig.6, Upper-left). Since the user wants to go to the shop by public transportation system, he/she selects one of them (e.g. "Move") to achieve the current goal (go to a shop). Then, five methods which can achieve the task "Move" are unfolded (Fig.6 Upper-right). By selecting the second item among the menu (e.g., "By public transportation"), tasks and/or subtasks associated with each task are unfolded and displayed under the task nodes (Fig.6, Lower-left). Selecting tasks further, plausible obstacles for the subtasks and their solution tasks are unfolded (Fig.6 Lower-right). The user might lose his/her way to a ticket station, for example. In that case, selecting such a troublesome situation among the menu items, solutions for the trouble are unfolded (e.g., "Find a ticket information" and "Seek for a route map" in Fig.6). Finally, services associated with the task selected by the user are shown, and each of them leads to access to the actual service.

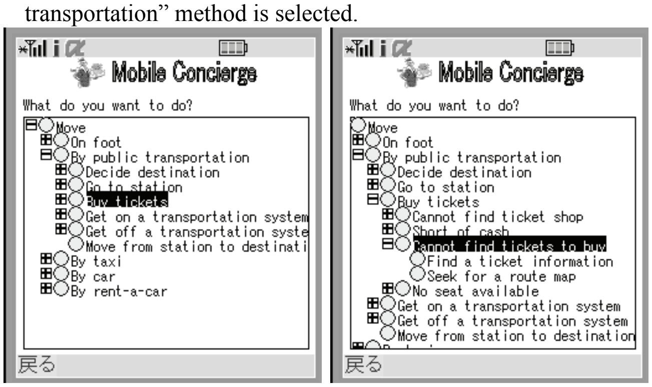
### 4.4 Design Review by Experts

Our new prototype menu system is now under the design review by experts of mobile services. Compared to the original menu system prototyped by Naganuma [1], they positively point out followings.




(Left)Top menu: “Move” task is selected by user.

(Right) Five methods for “Move” are unfolded and “By public transportation” method is selected.




(Left)Subtasks of “move by public transportation” are unfolded.

(Right) Plausible obstacles for the subtasks and their solution tasks are unfolded.

**Fig.6： Sample screen shots**

(1) Granularity of the menu has become uniform. Since original menu was an ad hoc one, granularities of some menu items were coarse and others were fine. As a result, understandability of the menu has become better.

(2) Since the new menu system is composed of finer grained menu items, users who have definite purpose (e.g., go to a department store to buy cloths) will be guided more easily to the target information services.

(3) Those services which are not utilized before are “revealed” and are able to access now. Some television companies, for example, provide information about recipes introduced within their TV programs. Since their sites have been in the “TV” category before, some users should miss the recipes because they cannot imagine TV companies provide such recipes. New menu system guides to the recipes by “Have meal (task) > Cook by self (method) > Look for recipes (sub-task)”. Then links for recipes are listed including those provided by the TV companies.

## 5. Related work

Boreum et al. investigated which factors of mobile internet services are important for users [6]. They interviewed people from three countries, Japan, Korea, and Finland, which have mature mobile internet service markets. According to their analysis, both the "logical order of the menu" and "meaningful classification of the contents" are considered to be important by many subjects from the three countries. The results validate our approach for improving the menu system and classification of the contents by user tasks, which should contribute to user satisfaction.

To satisfy users' needs, many researchers today focus on better composition of existing mobile internet services. Our modeling method, which focuses on better analysis of users' needs, is able to strengthen the research explained in the following. Hierarchical Task Network planning (a general explanation is given in [7], and applications for web services are described in [8]) supports how to divide and conquer a web user's "problem", which resembles our task decomposition process in OOPS modeling. In the process of composing web services, Motahari-Nexhad [9] proposes how to identify mismatches of the interfaces and protocols between two services to be composed. Domingue [10] describes how to cope with heterogeneous interaction patterns with the framework of IRS-III, and Ashri [11] discusses the interaction protocols in their experience of IRS-II. In such an organization process, alignment of the ontologies behind the services is necessary. Omelayenko [12] proposes a method for mapping meta-ontologies among web services, and Ehrig [13] describes a machine-learning method for an initial stage of ontology alignment. Tsz-Chiu Au [14] points out that it is unrealistic to assume that the information provided by the web services is static in many cases. They propose another framework to deal with volatile information, taking a ticket reservation service problem as an example.

These studies, however, do not consider the contents of the mobile internet services. In contrast, our approach starts from analyzing users' activities, including problematic situations which require mobile internet services. We then design the menu system for user navigation based upon the user model. Most research on web services implicitly assumes that web browsing is done on desktop computers; thus, the time and cost involved in searching and evaluating the answers are not of much concern. On the other hand, in the case of our mobile internet service problem, users need prompt answers. Thus, we pay attention to navigating users directly from the obstacles which they face to the proper service which is the source of the answer. We leave evaluation of the answers to the users themselves.

Masuoka proposed a Task Computing framework and built a ubiquitous environment which provides more than 100 web services [15]. The web services are described by OWL-S, and the environment changes dynamically. The ubiquitous environment is unique because it deals with dynamic changes such as sudden appearance/ disappearance of clients/services, like the real world.

MIT's Process Handbook Project [5] deals with knowledge models about businesses. It focuses on modeling business activities and has a taxonomy of basic business activities. However, the method for building the model is implicit, and confusion of task concepts with way concepts occurs with some models. One of the models, "buy in a store", consists of a task concept "buy" and a way concept "in a store", for example. Such confusion lowers the generality of the model, and does not meet our requirements.

In the field of the human–computer interactions, although there are many studies about web interfaces, there are not so many studies specific to mobile phones. James [16] compares the efficiency of two text input methods used on mobile phone: multitap and prediction. Kamvar [17] analyzed search patterns of a search engine specifically designed for mobile internet services on a large scale. The search patterns resembled those of desktop search engines. The results show that mobile internet services are still not organized well for mobile users. The users rely on search engines, as they do on desktop computers, since they cannot reach the necessary services. As mentioned in section 1, basically task-oriented menu system navigates users along with their necessity of the services, thus not so much depends on search technologies.

## 6. Conclusion and Future work

This paper introduced our research on the task-oriented menu system with real-scale mobile internet services in it. Now the system is under the design review by experts and they have given positive comments for it. We plan to do field test by general users of mobile phones in longer term. Furthermore, we plan to improve user interface for the task-oriented menu system. First, it is unrealistic to replace everything with a task-oriented style; rather, integration of a search engine and/or domain-oriented classification will be necessary for some tasks. For example, the task "buy" deals with millions of items which require conventional search technologies.

Secondly, we are designing “shortcut” menus for some frequently accessible services. The menu hierarchy has some subtasks which frequently appear under different tasks. Such subtasks are possible to be carried out as not only subtasks associated with each task but also independent tasks. For example, if users who want to draw cash to buy train tickets intend to search services about ATM information, in the current menu system, they must select “Move”, “By public transportation”, “Buy tickets”, “Short of cash”, “Draw cash” and “Search ATM” step by step. Although the task oriented menu system can support users to search for the ATM services to solve problems, the shortcut menu should be a good help for users because the services for drawing cash are necessary in many other situations. Therefore, we have been trying to define the problems which happen frequently and build the shortcut menu for such services.

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