Collaboration Projects

Service Intermediation Technologies Assisting Users' Daily Lives

Working toward the implementation of mobile terminals that can assist mobile users in their daily lives, we are currently conducting research on a system that is able to lead users to services suited for their action objectives [1]. Users' service usage patterns are accumulated in a knowledge database, which is then utilized to allow users to locate a suitable service simply by selecting individual tasks. This research was conducted jointly with the Mizoguchi laboratory (Professor Riichiro Mizoguchi), the Department of Knowledge Systems, Division of Intelligent Systems Science, the Institute of Scientific and Industrial Research, Osaka University.

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1. Introduction

The usage of Internet technologies in mobile terminals has become widespread. The total number of mobile terminals with support for Internet Protocol (IP) communication diffused in Japan had reached approximately 77 million as of August 2005 [2]. Moreover, the services provided via mobile terminals continue to increase, and ubiquitous services using close-range wireless technologies such as wireless LAN, Bluetooth™*1 and Radio Frequency IDentification (RFID) are expected to become a reality in the near future.

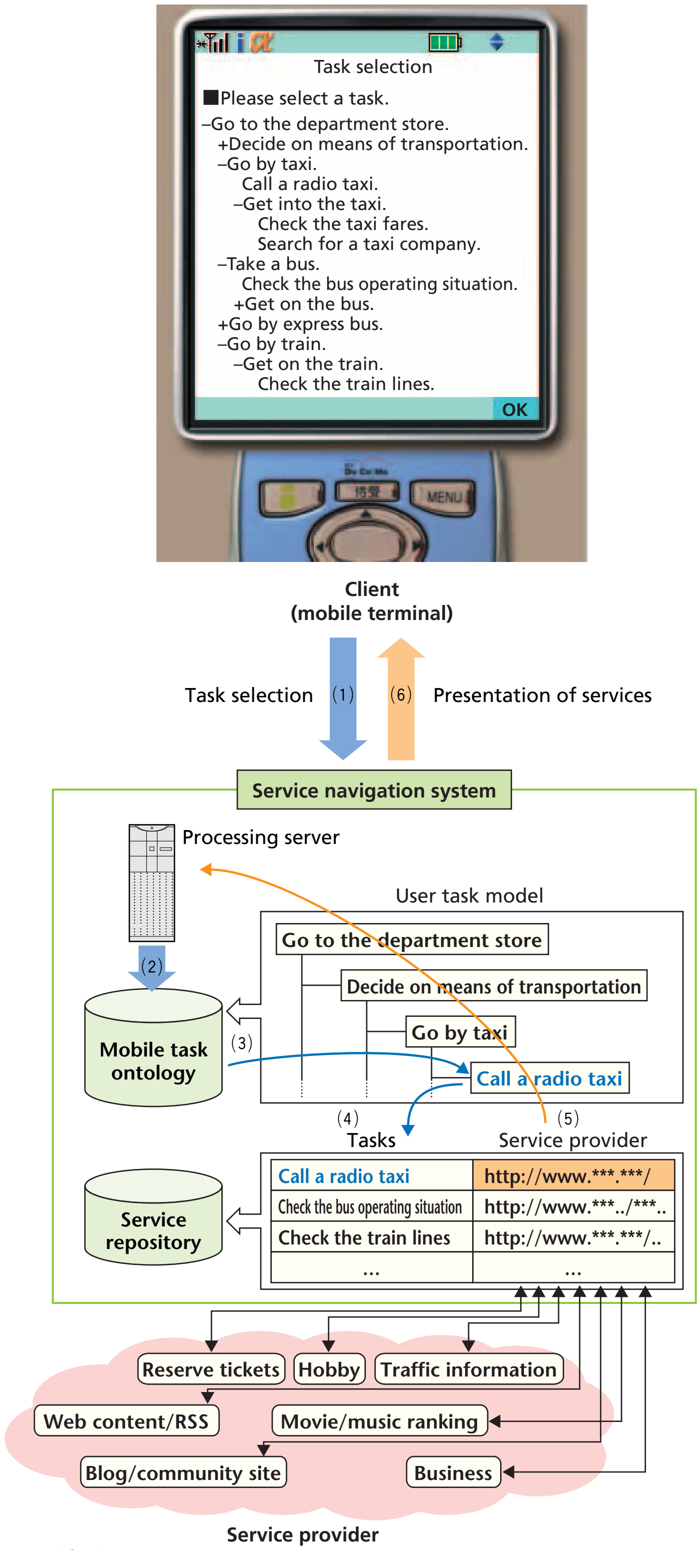
However, as the number of services increases, it also becomes necessary to learn how to use search systems and advanced operations in order to access suitable services. For this reason, general users have begun to experience difficulties in finding the right services available on the networks. For example, when using directory search services that handle Web content on the Internet, there are cases where users cannot find the intended services or categories due to an overwhelming number of categories, menu structures that are different from what users expect, or ambiguous category classifications such as "others." In case of keyword search services as well, there are cases where combinations of many keywords must be entered before the intended information can be found. The influence of these problems is considered to become even more serious in mobile environments.

To address these problems, we are carrying forward research aiming to implement a service navigation system that intermediates appropriate services according to the daily usage patterns of each individual mobile user. With this service navigation system, even users who do not know that particular services exist or are not familiar with search services will be able to find suitable services simply by selecting what they want to do.

Figure 1 shows the concept of the service navigation system. The mobile task ontology is a database that accumulates the user actions (tasks) by modeling them as searchable and reusable knowledge. The service repository is a database that accumulates service functions associated with tasks and URLs of the respective service providers. A user accesses the service navigation system from the mobile terminal and selects an appropriate task among the options presented by the mobile task ontology. Then, the service repository extracts services associated with the task selected by the user and presents these to the user.

In order for this service navigation to increase the opportunities to assist users, it is essential to analyze and model the user actions sufficiently well to ensure that the mobile task ontology is rich enough. Therefore, efficient construction of the mobile task ontology and improvement of its coverage, generality and reusability are important. Keeping these points in mind, we derive models of the procedures to identify various user actions in mobile environments and related services for the purpose of expanding the range of the mobile task ontology. This article presents the examination results of methods to simplify the analysis tasks by classifying user actions according to specific

*1 Bluetooth™: A registered trademark of Bluetooth SIG, Inc. in the United States.



RSS: Rich Site Summary

Figure 1 Concept of service navigation system

features when modeling them and improving coverage, and reusability of the mobile task ontology.

2. Background of the Research

Ontology is originally a philosophical term meaning "systematic theory related to existence" (i.e., what it means to exist). In computer science, an ontology is defined as "things and how they can be composed in order to make basic sense in a human world view and described in such a way that computers and humans can share understanding" [3]. Moreover, in the Semantic Web*2 context [4] [5], utilization of ontologies is promoted as a means to define meta-data of Web documents*3 [6]. Through the use of ontologies, it becomes possible to achieve advanced search functions that interpret the meanings of meta-data and inter-operability of meta-data added by various service providers.

Task ontologies refer to a type of ontologies constructed based on user actions and are defined as "the theory of concepts and relations existing in the process of problem solving extracted independently for each area and organized accordingly" [3]. We consider that by constructing appropriate task ontologies for mobile users operating in mobile environments (mobile task ontologies), it becomes possible to describe the process of problem solving that these mobile users require and associate this knowledge with corresponding services [7].

At this point, it should be pointed out that conventional studies on artificial intelligence can be divided into "form-oriented research" and "content-oriented research." Form-oriented research deals with the logics (knowledge representation) and inference of knowledge processing, while content-oriented research deals with the expression methods or the modeling of knowledge itself. Until now, form-oriented research has been the main approach, but demands for content-oriented research is increasing lately. This is because many unsolved issues remain in the knowledge processing methods that can actually be used today. For example, not only knowledge processing such as inference in form-oriented research, but also content-oriented modeling of knowledge becomes important to solve problems involved in reuse of knowledge, along with the communication

*2 Semantic Web: An attempt to implement Web information search and integration based on meanings, by adding unified semantics (meanings) to Web content.

*3 Meta-data: Data specifying attributes and other information related to target data.

required for multiple agents to collaborate, integration of different media information performed based on knowledge, development of large-scale knowledge databases and common-sense databases, and knowledge sharing by standardization of knowledge. As a result, ontology engineering was developed as a methodology, a basic research area and a technology for accumulating various results of applying formal theories in content-oriented research. Ontology engineering is the foundation for construction of models of the actual world, and provides design rational for knowledge base construction, kernel conceptualization of the world of interest, strict definitions of meanings of basic concepts as well as sophisticated technologies and theories enabling accumulation of knowledge [3].

3. Examination of Mobile Task Ontologies Construction

3.1 Issues

Implementing the service navigation system requires modeling of typical mobile user actions and advance accumulation of these in the mobile task ontology. One of the ways of modeling "mobile user actions" is that several people exchange ideas and unify them by taking the target range of ideas and generality into consideration. There is, however, the problem that the quality and quantity of ideas depends on the experience and skills of the discussion participants. Thus, it is necessary to systematize the process of modeling user actions in order to address various specific conditions in mobile environments.

3.2 Segmentation of Tasks

When analyzing the user actions, listing up actions related to high-level concepts such as "seeing a movie in a movie theater" without setting any guideline is difficult because the concept may in general involve a wide range of component tasks and actions. For this reason, a systematic methodology for subdividing a concept into component actions is required.

We thus examined applying the methodology used in the context of functional ontologies to analyze the user actions [8] [9]. Functional ontologies describe functions of machines and artifacts in plants and factories in a hierarchical structure. We consider it is possible to stratify and describe user actions by converting these "functions" into "user actions." We then break down the user actions into individual elements and clarify each action. For example, in the case of "seeing a movie in a movie theater," we may extract sub-task models that constitute the overall action such as "go to the movie theater," "decide which movie to see," "buy the ticket," "have dinner after the movie," "go home" and so forth. Then, the segmentation and analysis processes may be repeated recursively for each sub-action. In this way, individual sub-task models from "go to the movie theater" to "go home" are assembled in order and the overall task model of "seeing a movie in a movie theater" can be constructed by integrating these sub-actions.

With the methodology above, we believe that it is possible to specify the problem coverage through an analysis of user actions and improve the coverage of the task models. Moreover, we consider that the applicability and reusability of each task model is increased by analyzing individual actions subdivided into generic task models.

3.3 Classification of Tasks

In general, the user actions may not be uniform in nature. For example, an original goal, such as "go to a destination by a train," is likely to be accompanied by preventive actions such as "set the clock alarm" so that the user will not miss the departure time, as well as incidental actions to address problems that occur along the way, such as "transfer to another train because the train stopped due to an accident." If actions with different natures are to be analyzed at the same time, actions focusing on the original goal become mixed up with actions that do not have direct relations to the original goal, which means that the problem coverage becomes ambiguous and the analysis becomes difficult. In mobile environments, in particular, users encounter a wide variety of conditions, which means that it is highly important not only to classify actions based on the original goal but preventive and coping action models, and enrich the task models with a wide range of selections for each category.

For this reason, we propose to use a methodology of classifying auxiliary functions in the functional models [10]. This methodology provides a framework to distinguish functions that are essentially necessary to achieve a certain goal (essential functions) and other additional auxiliary functions, and describe potential problems and auxiliary functions for preventing the problems from occurring. We believe that using this methodology allows to enhance the coverage and reusability of the task models by classifying user actions according to their nature so that they can be analyzed individually. The task models are classified into the following four types of natures before analysis [7].

1) Action: Go to a movie theater, eating food, go shopping
2) Plan an action: Check the direction, write shopping memo
3) Prepare for possible problems occurring in an action: Prepare extra money, check the weather forecast, inspect a car
4) Address problems actually occurring in an action: Withdraw surcharge from ATM, repair a car

By using the classification method above, user actions can be analyzed efficiently according to their natures, and a sufficient coverage of the task models can be secured. Moreover, the characteristics and coverage of the task models are determined, thereby improving the applicability and reusability of the models.

4. Conclusion

This article indicated issues arising when searching for helpful mobile services in our everyday lives, aiming at realization of mobile terminals that can assist mobile users in their daily lives. In order to address these issues, this article explained technologies that intermediate suitable services according to the daily life patterns of individual mobile users and presented an overview of the methodologies of constructing task ontologies, which form the core of this technologies.

We were able to advance deliberations on methods to improve the coverage and reusability of the mobile task ontologies by handling user actions according to their natures when modeling individual user actions and the procedure of searching for services related to them in mobile environments, and succeeded in taking the first step toward realization of the new service intermediation mechanism.

In the future, we plan to examine methods for describing task ontologies corresponding to diversified user actions, aiming at further upgrading of the mobile task ontology.

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Abbreviations

IP: Internet Protocol
RFID: Radio Frequency IDentification
RSS: Rich Site Summary