Task Model and Task Ontology for Intelligent Tourist Information Service

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Abstract

This paper presents a task model and task ontology based on travelers' tasks, and an intelligent tourist information service system using them. With the recent advances in Internet and mobile technologies, there has been an increase in the use of intelligent tourist information services via the Web and mobile systems. In addition, many ontologies have been introduced in tourist domain to provide various intelligent tourist information services. However, only a few studies have been undertaken from the perspective of specific tour services for travelers' generic tasks and activities. Thus, we considered generic tasks and task ontology based on travelers' perspectives, and intelligent tourist information services using them. Therefore, we propose 1) a task model of travelers' perspective based on their needs and activities, 2) a task ontology using the generic tasks, their activities, relations, and properties, and 3) an intelligent tourist information system using task ontology based on various tasks and activities of travelers. The system consists of Tourist Contents Service (TCS) and Task-Orient Menu Service (TMS) parts, and can provide various intelligent tourist information services through task-oriented menus.

Keywords: *Task-Oriented Menu Service, Intelligent Tour Service, Task Model, Task Ontology, Domain Ontology*

1. Introduction

With the recent advances in the Internet and mobile technologies, information on tourist accommodations, transportation, shopping, food, festivals, and attractions has become more readily available. As a result, planning vacations and package tours is much easier. Tourism has become a highly competitive business all over the world. Competitive advantage is driven increasingly by advances and innovation in information technology [1]. Many studies have introduced a variety of tourist information systems for disparate purposes. These systems provide integrated heterogeneous travel information and recommended tourist attractions according to user profiles and travelers' preferences. The information is obtained from various web sites, and the systems are designed for pedestrian travelers using mobile systems in local areas. In addition, there are many studies on the ontological approach to intelligent tourist information services.

Typical studies on intelligent mobile tourist information services using an ontological approach include studies on the Ontology-based Intelligent Tourism Information System, the Virtual Travel Agent System for M-Tourism, the Mobile Tourist Information System with Identifying Zones, the Intelligent Ontology Agent-based Tourist Guiding system iJADE

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FreeWalker, the Ubiquitous Infrastructure for a Tour-guiding System, the Matching Service of Traveler for Group Package Tours and the Ubiquitous Tourist Assistant System (UTAS) [1, 2, 3, 5, 7, 8, 11, 12]. Most ontological studies on travel have focused on upper-level or domain ontologies for tourist attractions, travel agents, package tours or user profiles, and they have constructed systems for tourist information, tour recommendation or travel agents by using that ontology and various databases providing tourist content.

However, there have only been a few task ontology studies based on travelers' tasks. Task ontology describes the reasoning concepts and their relationships within given tasks for a specific domain, for example, diagnosis, monitoring, scheduling, and designing. Mizoguchi et al. (1995) proposed task ontology for the reuse of problem-solving knowledge. Task ontology consists of four kinds of concepts: 1) generic nouns, 2) generic verbs, 3) generic adjectives, and 4) other concepts to the task. Generic nouns represent the roles and generic verbs represent the activities in the problem solving process, and generic adjectives modify the objects [20]. Typically, Ikeda et al. (1998) presented Conceptual LEvel Programming Environment (CLEPE) as an implemented system based on Task ontology [21]. Fang (2007) proposed a graphical model that shows activities, inputs, outputs, controls and mechanisms for representing task ontologies: the TTIPP framework [22]. Martins et al. (2008) introduced task knowledge that involves sub-task decomposition and the knowledge roles that are involved in task fulfillment in task ontology [23]. In the tourist information service domain, typical studies of task ontology for travelers' activities include the following: two ontologies for wayfinding with multiple transportation modes (Timpf 2002), task models and task ontology in map-based mobile guides (Hunolstein et al. 2003), tourist information for realizing adaptive mobile GI services in the pedestrian navigation domain (Zipf et al. 2006), a task-oriented menu system based on the Ontology-based Obstacle, Prevention and Solution (OOPS) modeling method (Sasajima et al. 2007) [15, 16, 17, 19]. However, most studies have focused on travelers' specific activities and knowledge, not users' general activities. There have been few studies on the tourist information service using task ontology constructed from generic tasks of travelers' perspective.

Therefore, we propose a task model based on travelers' needs and activities, a task ontology based on the task model, and 3) Intelligent Tourist Information Service using Task Ontology (ITISTO) system using them for various intelligent tourist information services. In Section 2, we discuss related studies concerning ontology as well as existing tourist information systems that incorporate the ontological approach and task ontology of human activities. In Section 3, we introduce domain ontology in the tourist domain, design for a task model based on travelers' perspective. In section 4, we introduce a task ontology based on the model. In Section 5, we propose the ITISTO using task ontology, which consists of Task-oriented Menu Service (TMS) and Tourist Contents Service (TCS). In Section 6, we draw our conclusions.

2. Related Works

Ontology, in the present context, was originally suggested in 1992 by Tom Gruber who defined it as "a specification of a conceptualization." The word seems to generate a lot of controversy in discussions about artificial intelligence (AI). It has a long history in philosophy, in which it refers to the subject of existence in the sense that it describes the concepts and relationships that can exist for an agent or a community of agents. This definition is consistent with but more general than, the usage of ontology as a set of concepts. The representational primitives are typically classes, attributes, and relationships, and their definitions include information on their meaning and constraints on their logically consistent application [10].

Top-level ontology describes general concepts and provides a correspondingly high-level model of the world using the ontological constructs provided by meta-ontology. Domain ontology describes the vocabulary related to a generic domain. The concepts introduced in top-level ontology are further specialized. Task ontology describes a generic task or activity, such as the process of booking a package tour, including the flight and, perhaps, a rental car. Application ontology is a combination of domain and task ontologies. The concepts of application ontology correspond to the roles played by domain objects in performing certain activities [6, 8, 20].

With regard to tourist information systems, a variety of studies have been proposed that follow an ontological approach. In the area of tourism, Tomai et al. (2005) presented ontology-assisted decision making in trip planning using two separate ontologies, one for user profiles and the other for tourism information [9]. Jakkilinki et al. (2005) introduced an ontology-based intelligent tourism-information system using tourism domain ontology [7]. Lam et al. (2006) introduced an ontology-based agent framework for semantic Web service (Ontia iJADE) and upper-level ontology using structural information from a number of websites pertaining to Hong Kong. In addition, they developed an Intelligent Ontology Agent-based Tourist Guiding System (iJADE FreeWalker) in 2007 and introduced an Ontology-based Intelligent Mobile system for tourist guidance in 2008 [2]. Lee (2007) presented a semantic Web service for tourism information over the mobile Web and an ontology model Place-Attraction-Resource-Activity (PARA) [18]. Wang et al. (2008) introduced an intelligent ontology, Bayesian network-based semantic approach for tourism, and developed an ontology-based intelligent recommendation system for tourism that allows for integration of heterogeneous online travel information and recommends tourist attractions to users based on information from more than 40 Chinese websites and attractions in Beijing and Shanghai [4]. Kanellopoulos (2009) introduced an ontology-based system for intelligent matching of travelers' needs for Group Package Tours (GPT) with a Web portal service for travelers living in Europe. The primary information sources in this system are travel agencies, travel agency-related news, and package tour requests [8]. Song et al. (2008) presented an ontology-based intelligent agent system for a tour package service [5]. Chiu et al. (2009) presented a multi-agent information system (MAIS) and a Collaborative Travel Agent System (CTAS) employing semantic Web technologies for effective organization of information resources and service processes [1]. Barta et al. (2009) introduced an alternative approach to covering the semantic space of tourism by integrating modularized ontologies, and developed core Domain Ontology for Travel and Tourism (cDOTT) [6]. Most of the ontologies mentioned above were upper or domain ontologies for tourism and travelers, such as taxonomies and static knowledge of the tourist domain, to classify tourist attractions, travel agents, traveler's profiles or package tours, and most tourist information systems have been developed to provide information and tour package services for specific attractions.

Task ontology studies on the tourist domain and the tour services using travelers' tasks have been introduced. Typically, Timpf (2002) presented two ontologies for wayfinding with multiple transportation modes in an urban area based on the perspectives of the traveler and the public transportation system. The ontology could be used as a basis for decision-making processes to be used in simulations of human wayfinding. The activity of wayfinding was divided into three levels: 1) activity level, 2) action level, and 3) operation level [19]. Hunolstein et al. (2003) presented the task models in map-based mobile guides and task ontology, and they introduced five high-level tasks: thematic areas, navigation and wayfinding, localization and orientation, proximity and event, and general information-seeking and identification [16]. Zipf et al. (2006) presented several approaches to realizing adaptive mobile GI services in the domain of pedestrian navigation and tourist information,

and they included context and user-awareness proactive tips, personalized tour planning, and adaptive maps using ontology [17]. Sasajima et al. (2007) presented a task-oriented menu based on the task ontology modeling method called Ontology-based Obstacle, Prevention, and Solution (OOPS), which supports the description of user activity and related knowledge, such as how to solve problems and accident-prevention methods in mobile Internet services. In addition, they introduced a framework for a real scale task-oriented menu system for mobile service navigation using SNS applications in 2010 [15]. However, the task ontology studies for the tourist domain were models of specific user tasks and activities having some restricted situations: wayfinding, map-based mobile guides, mobile GI services, a task-oriented menu system for mobile service navigation, etc. There have only been a few studies on generic tourist information services using task ontology based on travelers' generic activities.

3. Task Model based on Traveler's Perspective

To obtain users' generic tasks and construct a task model of travelers' perspective, first, we investigated travelers' needs and activities in various cases based on their viewpoints both before and during their trip. Second, we defined the upper tasks, and third, divided sub-tasks (sub-actions) on the basis of their specific activities. Thus, we introduce domain ontology in the tourist information domain and a task model based on travelers' perspectives.

Figure 1. Ten main classes and subclasses of domain ontology for the tourist information domain

3.1. Domain Ontology for Tourist Information

We introduce domain ontology for the tourist information domain, which contains concepts and relations for tourist content. It consists of 10 main classes of tourist information: Accommodation, Food, Shopping, Attractions, History/Culture, Festival/Event, Transportation, Weather, Entertainment and Location [14]. The classes of that ontology have subclasses pertinent to the local area, as shown Figure 1, and for all subclasses of main classes, they have "is-a" relationships. Those subclasses have instances, properties, restrictions and relations among classes or their instances. Most of the main classes and their subclasses were defined based on the tourist service content of the TISB and the ontologies of Tormai et al. (2005), Lam et al. (2007) and Wang et al. (2008) [2, 4, 9, 13, 14].

The Location class contains five subclasses: Road/Street, Bus, Subway, GPS Coordinates, and Zone. The instances of Food, Shopping, Accommodation, Attractions, Entertainment, Transportation, History/Culture and Festival/Event subclasses have relationships with those of the Location class. Figure 2 schematically illustrates the relations and properties between instances of the Accommodation class and the Location classes. The ellipse shape represents a class or subclass, and the lozenge shape represents instances of them. The Location class has the instances road/street IDs, bus/subway IDs, GPS latitude and longitude, and zone IDs, for identifying a location in the local area. For example, the instance LOTTE Hotel Busan of the Five-Star Hotel subclass has relationships with the following instances of those subclasses of Location class: Bus IDs (05319, 05189, 05190, 05190, et al.), Subway IDs (Sub_L1_Seomyeon, Sub_L2_Seomyeon), Zone ID (Busanjin-gu) and GPS latitude and longitude (129-3-28, 35-9-31). For more specific content for instances of ontology, it has semantic links with records/files in the database system to maintain consistency between instances of ontology and records/files in the database.

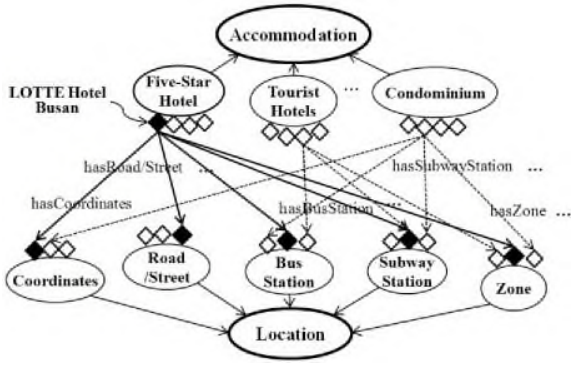

Figure 2. Relations and properties between instances of Accommodation and Location classes

3.2. Generic Tasks based on Travelers' Perspective

To design a task model based on travelers' perspectives, first, we investigated travelers' needs and activities for various cases using travelers' viewpoints both before and during trip. Generally, travelers before a trip want the following tourist information: transportations (airplane/train/bus) or tickets to the destination, the traveling expenses, the attraction nearby, the weather, etc. During the trip, they want to know/do real-time information/actions on-site tour as follows: the most famous restaurant nearby, the price of one ticket to the event (opera), move to the hotel, confirm the reservation, etc. With them, we could obtain their all possible specific actions, defined generic tasks and rules, and could construct task ontology based on travelers' perspectives for the tourist information service domain. Table 1 shows the basic concepts and verbs for travelers' needs and activities. The concepts are Accommodation, Transportation, Information, Sightseeing, Food and Shopping. For each concept, we can generate tasks to satisfy travelers' needs and activities. For example, the concept of Accommodation can combine with the verbs: Search, Reserve, Move, Compare, Have and Recommend, and generate the tasks: "Search Accommodation", "Compare Accommodation", "Move Accommodation", etc. For more specific tasks, can generate sub-tasks with combination of specific objects and the verbs: "Search Hotel", "Reserve Hotel", "Move to

Hotel from Here", "Have Food in Hotel", etc. However, we excluded some verbs (Walk, Drive, Get on/off, etc.) to construct possible tasks for tourist information services.

Table 1. Concepts and their Activities for Travelers' Needs

Concepts	Activities
Accommodation	Search, Reserve, Move, Compare, Have, Recommend, etc.
Transportation	Search, Move, Buy, Walk, Get on/off, Transfer, Time, etc.
Information	Search, Upload, Send, Receive, Recommend, Compare, etc.
Sightseeing	Search, Walk, Drive, Move, Compare, Photograph, Recommend, etc.
Food	Search, Reserve, Move, Order, Compare, Recommend, etc.
Shopping	Search, Buy, Move, Compare, Event, Recommend, etc.

Table 2 shows the tasks and their possible sub-tasks for the Accommodation concept. In the table, the words within round brackets are objects for the tasks, which are selective terms divided by slashes, and the prepositions are used as connector between objects and parameters. The objects are used from concepts or instances of the domain ontology. However, because it cannot be combined all kinds of verbs and objects in the real-world tourist information system, we used only six verbs: Search, Compare, Reserve, Move, Have and Pay, for construction of sub-tasks, and all possible objects for those verbs from the domain ontology.

Table 2. Tasks and Sub-tasks with Objects for Accommodation Concept

Tasks	Sub-Tasks and Objects
Search Accommodation	- Search (hotel/condominium/lodging) nearby/in (here/zone/city) - Compare (price/room/service/meal) for (accommodations selected) - Search (location/facility/package) for (accommodations selected) - Search (attraction/shop/restaurant/transportation/etc.) nearby
Reserve Accommodation	- Reserve (accommodation) from (check-in-date) to (check-out-date) - Confirm the reservation for (accommodation) - Cancel reservation for (accommodation)
Move Accommodation	- Move by (taxi/bus/subway/train) from (here/source) to (destination) - Search transportation from (here/source) to (destination) - Search (price/distance/travel-time/timetable) for (taxi/bus/subway/train) from (here/source) to (destination) - Buy a ticket for (taxi/bus/subway/train) from (here/source) to (destination)
Have food in Accommodation	- Search restaurant (nearby/in) (here/location) - Search (meal/price/service/location) for (restaurant) - Reserve (restaurant) - Compare (meal/price/service/location) for (restaurants)

For example, if a businessman in Hong Kong has a plan to visit Busan in Korea for three days and two nights for meeting at a convention center near Haeundae Beach in Busan, Korea, he will search for a round-trip plane ticket from Hong Kong to Busan and nearby hotels, make reservation, and search transportation from the airport to the hotel. If he arrives at the airport in Busan, he wants to know the best way (cheapest/fastest/nearest) to travel taxi/bus/train/subway/drive) to the hotel. During the trip, he wants to know/do a variety of

information/actions for attractions/foods/restaurants/shops/events near Haeundae (or Busan), take transportation, make reservations, go shopping, tour the sites, have food, and so on. Thus, he/she can generate the specific tasks by combination of the verbs and the objects in real time.

3.3. Construction Tasks' Rules with Activities and Objects

With the possible activities and objects, we can construct the generic sub-tasks based on travelers' perspective. The definitions of tasks' rules are as follows.

Task ::= <Activity>'_'<Object>
Activity ::= (Six verbs: Search, Reserve, Move, Compare, Have and Recommend}
Object ::= <Concept>|<Instance>[<Connector>][<Terms>][< Parameter>]
Concept ::= (Concepts of domain ontology}
Instance ::= (Instances of domain ontology}
Connector ::= (Nearby, In, From, To, By, etc.}
Terms ::= (Nearby, In, Here, etc.}
Relation ::= [<Properties>] between [<Task>] and [<Task>]
Properties ::= 'has_'<Task>
Parameter ::= [<Object>][<Term>]

Terms within angled brackets represent semantic concepts of task, those within brace are instance terms of their concepts, those in square brackets are optional objects or instances, and those in single quotation marks are strings. Task consists of Activity and Object for generic tasks with '_', Activity contains six verbs, Object consists of Concept or Instance of domain ontology, Connector, Terms or Parameter. The Concepts and Instances are from those of domain ontology, Connectors are placed between Object and Term (or Parameter), Terms are context-awareness terms: nearby, in, here, there, etc. Relations are among tasks with parameters, Properties are constructed with 'has_' and Task, and Parameters are from concepts and instances of domain ontology. For example, if a traveler wants to search for a famous restaurant near the Westin Hotel at Haeundae Beach in Busan, he/she searches restaurants using the tourist information system, makes a reservation in the restaurant, move to there, and has food. In these cases, we can generate the sub-task for each process as follows: (Search}<Restaurant> nearby (Westin Hotel} at (Haeundae Beach}, (Reserve}(Donbo-Jung} at (7 PM}, (Move} by (taxi} from (Here} to (Donbo-Jung}. Thus, more specific sub-tasks can be generated using that definition rule with the verbs and objects. And then, we can construct task ontology with them for the intelligent tourist information service system and apply them to task-oriented tour service menus.

4. Task Ontology

Task ontology is a system of vocabulary for describing a problem-solving structure of the task domain independently. It describes the concepts and relations among them in a given task [20]. To construct task ontology of a specific domain, it is first required to investigate and analyze the user needs and activities to define the tasks. Second, defines the main tasks and their activities must be defined, divided into specific tasks. Then, task ontology is constructed with a hierarchical task structure having concepts and relations among them. In some cases, it contains an inference hierarchy combined with a task structure.

For task ontology of the tourist information service domain, first, we defined six main concepts for task ontology: Accommodation, Transportation, Information, Sightseeing, Food and Shop, and their relationships among them are as shown in Figure 3. The Transportation concept has relationships with Shop, Sightseeing, Accommodation, and Food concepts with a

property "hasTransportationTask", and the "Information" concept has relationships to the other concepts with a property "hasInformationTask". The Sightseeing concept of task ontology has connections to Attraction, Festival/Event and History/Culture of domain ontology, and Information concept of task ontology has tasks for all concepts of domain ontology. Their sub-concepts consist of specific verbs, objects and constraints (parameters).

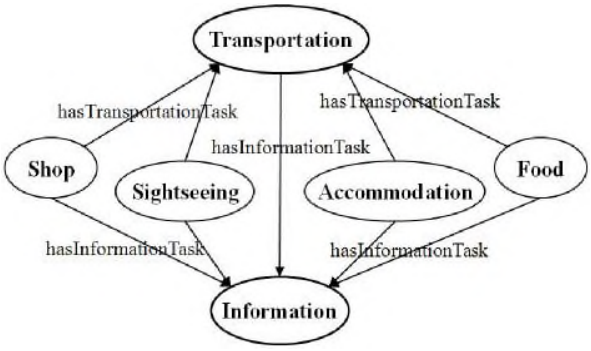

Figure 3. Relationships among Six Main Concepts of Task Ontology

According to construction rule of sub-tasks, we can define sub-concepts (sub-tasks) for each concept with the objects and verbs (activities) defined in the task model. The subconcepts of Accommodation are constructed with travelers' activities (verbs) and sub-concepts/instances of Accommodation in domain ontology. The sub-concepts of Food and Shop in task ontology are also constructed in the same way. Those of Sightseeing concept are constructed from concepts/instances for the Attraction, Festival/Event and History/Culture in domain ontology, and those of Information concept are constructed with all concepts/instances in domain ontology. The Transportation concept also consists of subconcepts from transportation of domain ontology.

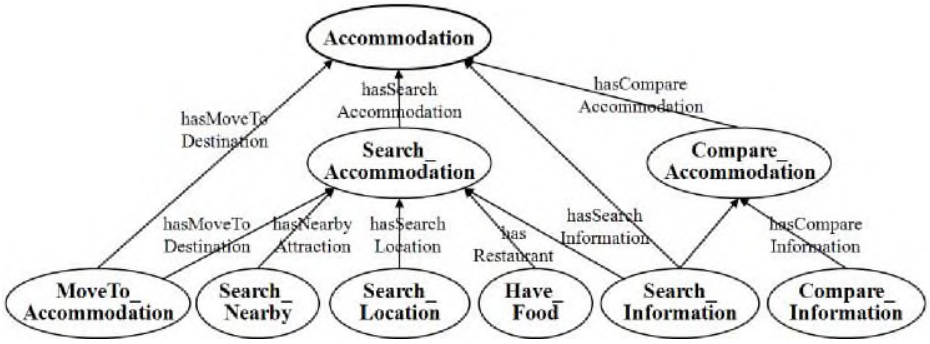

Figure 4. Sub-concepts of Accommodation Concept and their Relationships

Then we defined the properties, restrictions, and relationships among them. Figure 4 shows the sub-concepts that represent a phrase with a verb and a noun (concept or object), in the Accommodation concept. The Accommodation concept contains sub-concepts "Search_Accommodation", "Compare_Accommodation", "MoveTo_Accommodation", etc. "Search_Accommodation" has "MoveTo_Accommodation", "Search_Nearby", "Search_Location", etc. "MoveTo_Accommodation" and "Search_Information" are sub-

concepts of the "Accommodation" as well as the "Search_Accommodation" concept, and they have relationships each other with properties.

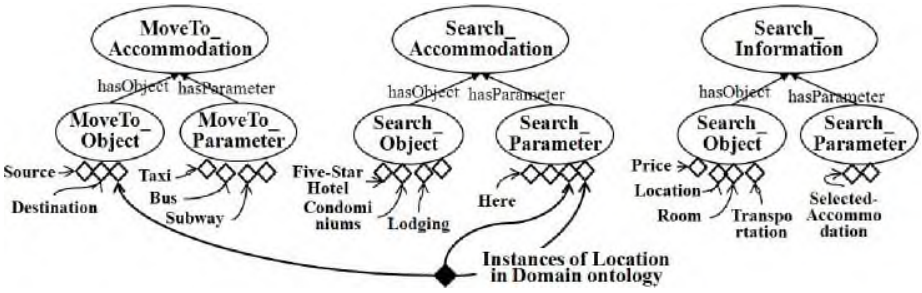

Figure 5. Sub-concepts and Instances for each Concept with Relationships

Figure 5 shows the sub-concepts and their instances for each concept with relationships. The lowest child concepts have instances of the object and parameter for each concept, and most instances are obtained from those of domain ontology or terms by users' selection. The "MoveTo_Accommodation" concept has sub-concepts "MoveTo_Object" and "MoveTo_Parameter". Instances of the former are "Source" and "Destination", and those of the latter are "Taxi", "Bus", "Subway", etc. To generate specific tasks, the instance "Source" is obtained from those of domain ontology or terms by users' selection (Here or the Hotel selected). Thus, it has links between instances of concepts in task ontology and those of domain ontology. Figure 6 shows semantic links of instances between task ontology and domain ontology. The instances "Source" and "Destination" of the "MoveTo_Object" concept can be obtained from those of "Accommodation", "Attraction", "Location", etc. of domain ontology. And instances of "MoveTo_Parameter" can be obtained from instances of the "Location" concept in domain ontology. Therefore, we can generate the tasks for tourist information services using the instances of specific concepts in task ontology and those of domain ontology, and then we can construct a task-oriented menu using them.

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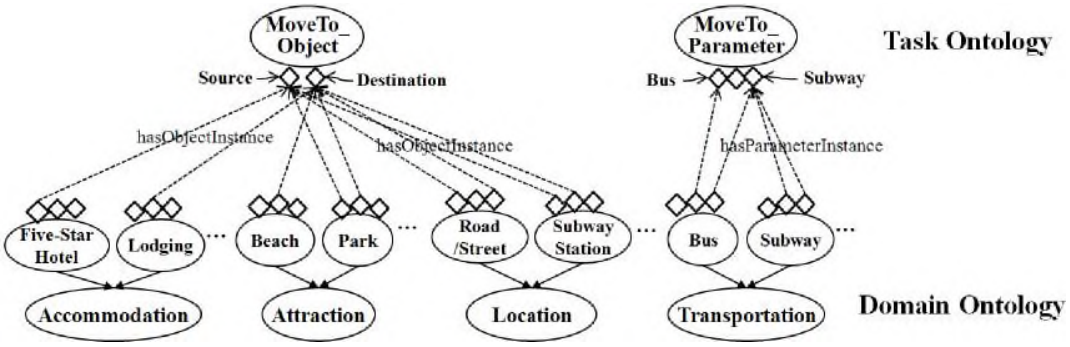

Figure 6. Links between Instances of Concepts in Task Ontology and those of Domain Ontology

5. Intelligent Tourist Information Service Using Task Ontology

Most menu views for tourist information services were domain-oriented using domain ontology, not task-oriented, and they did not considered user needs and activities. A task-

oriented menu enables users to search for services based on "what they want to do" rather than by "name of category". Construction of such a task-oriented menu is based on a task ontology which supports the description of user activity such as task execution and the solving of problem encountered during the task [15]. We introduce a design for an Intelligent Tourist Information System using Task Ontology (ITISTO) based on various travelers' perspectives. The system consists of Task-oriented Menu Service (TMS) and Tourist Content Service (TCS) using task ontology and domain ontology. The TMS maintains task ontology and generates task menu with travelers' tasks using task- and domain ontologies, for intelligent tourist information services to clients, and the TCS is used for maintenance of domain ontology for the tourist information domain and the database system. We represent the task-oriented menu using task- and domain ontologies and the domain-oriented menu using domain ontology. Figure 7 displays ITISTO system architecture, representing the roles of each subsystem and the relationships among TMS, TCS, clients, ontologies and database.

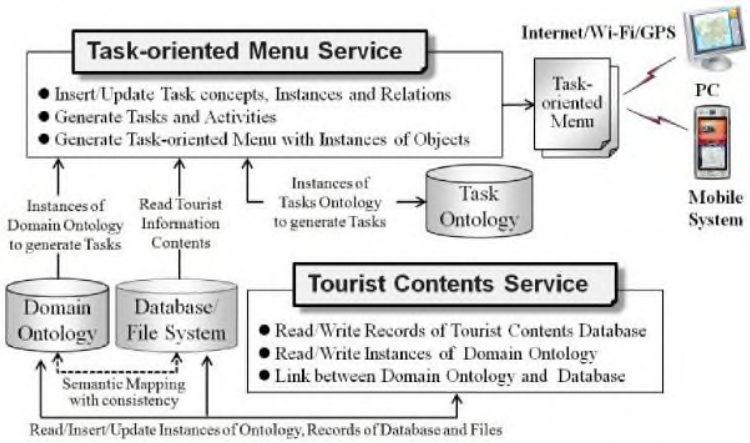

Figure 7. ITISTO System Architecture with Ontologies and Database

5.1. Tourist Contents Service System

The TCS system maintains tourist content in the domain ontology and database: 1) reads/writes instances of tourist content from (to) the domain ontology, 2) read/insert/update records of tourist content database, and 3) maps between instances of domain ontology and records of database. The TCS system maintains consistency between instances of domain ontology and records of the database with key values. Thus, the TCS system contains two components: an ontology maintenance part and a database maintenance part. Figure 8 shows a diagram of the relationships among the ontology maintenance part and database maintenance in the TCS system. The ontology maintenance part maintains the concepts, instances, relations and properties of domain ontology for the tourist information. It reads/inserts them for tourist contents from (to) the ontology, and it uses semantic mapping between instances of domain ontology and records/files of database with keys. If an instance for a tourist attraction is added to the domain ontology, first, it inserts an instance to a relevant subclass of the ontology, and defines relationships and properties among instances of the other classes. Second, it finds records of database or files to link, and it links them to that instance with key values of records as properties. The database maintenance part maintains the schemes of the database, and not only records of contents tables, but also articles/pictures/video files for tourist content. When information for a tourist attraction is added to the database, it inserts a

record for that attraction into the relevant tables, and generates a key value for that record to link an instance of the relevant subclass of the domain ontology, in order to maintain consistency. All of the specific tourist content and related files are stored in the database and file systems.

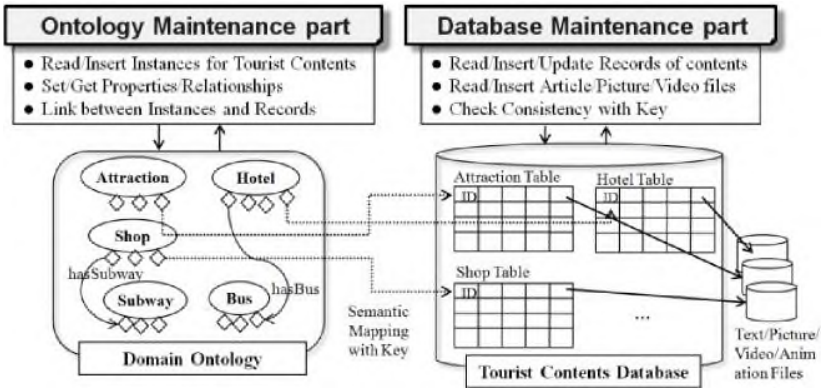

Figure 8. Diagram of Roles and Relations among Ontology Maintenance and Database Maintenance Parts of the TCS System

5.2. Task-Oriented Menu Service

We introduced the task model for tourist information services based on travelers' needs and activities, and we presented the task ontology using six main concepts, their sub-concepts and hierarchy relationships. With them, we can construct a task-oriented menu for various intelligent tourist information services. Therefore, we introduce a procedure to construct a task-oriented menu for specific tasks based on travelers' needs and activities using task ontology and the task model. First, the system shows the upper menu with six main concepts. Second, if a user selects an item among them, the child menu is generated using sub-concepts and their instances in task ontology from the verbs and those of domain ontology. Three kinds of menu can be generated: 1) using only sub-concepts of task ontology, 2) using instances of objects and parameters of concept in task ontology, and 3) with only instances of domain ontology or database records. Figure 9 shows a main menu and sub menus for the Accommodation concept.

Figure 9 shows task-oriented menus using concepts and their instances of task ontology. Menu (a) shows a list of main concepts, menus (b) and (f) are generated from sub-concepts and instances of task ontology, and menu (e) shows the instances retrieved from domain ontology or databases. Menus (c), (d), and (h) are constructed using instances of objects and parameters from those of domain ontology to do some tasks of the Accommodation concept in task ontology. Menu (c) shows a list for "Search Accommodation" which consists of instances of Accommodation concept of domain ontology and users' context-awareness terms (Nearby, user's location, etc.) to search accommodation. Thus, to obtain instances of "Search Accommodation" concept, the "Search_Object" is fulfilled for "Search_Accommodation" as like menus (c) and (e). And, it obtains instances of "Search_Parameter" are from those of the Transporation concept of domain ontology, as shown menu (g).

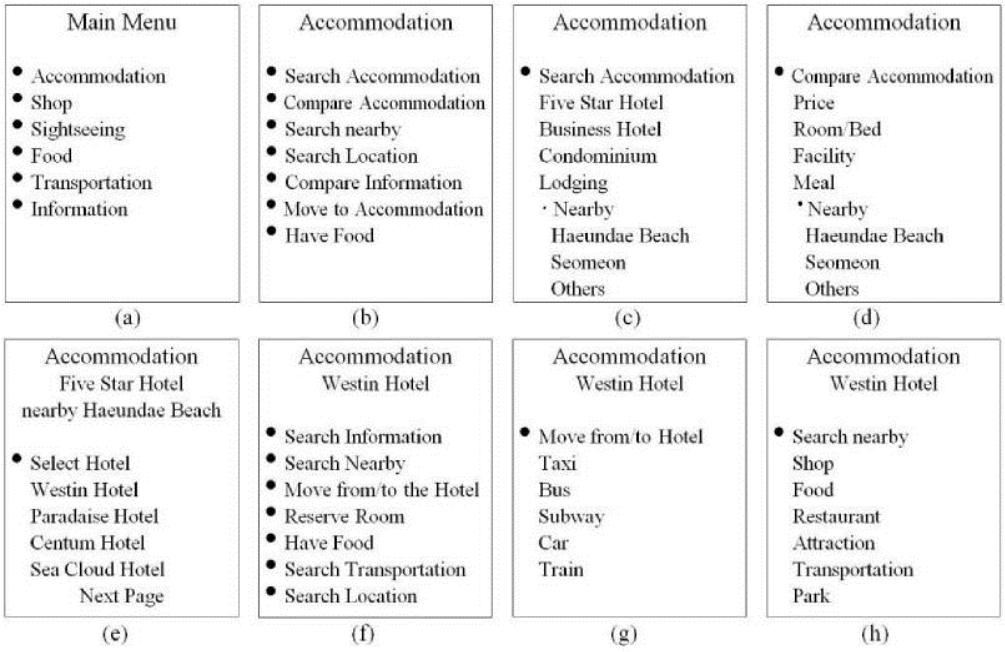

Figure 9. Task-oriented Menus using Concepts and their Instances of Task Ontology

However, if it is constructed with a domain-oriented menu and a traveler wants to search for an accommodation, it first shows menus by category of the Accommodation concept of domain ontology: Five-Star Hotel, Tourist Hotel, Business Hotel, Condominium, Lodging, etc., and he selects a class of accommodation and options in that category. Then, he selects menus of other categories (concepts) to obtain more specific information for that selected accommodation or for transportation, foods, attractions, etc. Figure 10 shows domain-oriented menus for each main concept using domain ontology. Therefore, the task-oriented menu can provide efficient and intelligent tourist information services for various travelers' needs based on travelers' perspectives, which are constructed using concepts, instances, relations of task ontology and domain ontology, as well as records from various databases.

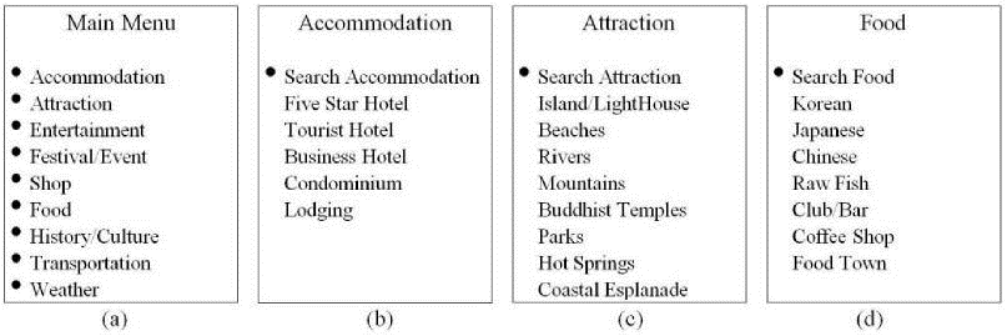

Figure 10. Domain-oriented Menus using Concepts and their Instances of Domain Ontology

5. Conclusions

We introduced a task model based on travelers' perspectives using traveler's needs and activities, and a task ontology by using the task model for intelligent tourist information services. In addition, we proposed an Intelligent Tourist Information System using Task Ontology (ITISTO) for various travelers' activities and viewpoints using the task- and domain ontologies. The system consists of TMS and TCS to maintain the system for various interactive tourist information services. Thus, the ITISTO can provide a task-oriented menu for intelligent tourist information services using the concepts, instances, properties and relations of task ontology, and those of domain ontology with semantic links, for various travelers' needs and activities. And we compared them with domain-oriented menus by domain ontology based on system's perspective, not users' perspectives, and showed more intelligent than those of the existing tourist information services. Therefore, ITISTO is an intelligent tourist information service model centered on travelers' needs and adopting an ontological approach.

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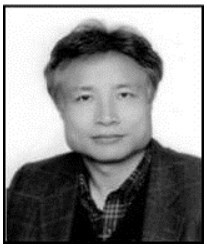

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