Application of Ubiquitous Web Technologies to Home Information Appliances

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ABSTRACT
The present paper describes our ongoing research project on application of ubiquitous Web technologies to home information appliances. The technological elements of our project are (1) Web service framework for managing home information appliances, (2) voice control of home information appliances via personal robot and (3) ontology for task modeling and user guidance. These methods are following / extending existing standards of W3C.

1. INTRODUCTION
In recent years, many home appliance manufactures are developing information appliances which can connect to a home network and/or the Internet via LAN interfaces. According to this development, some standardized protocols for interconnection are designed in several groups, such as ECHONET, HAVi, DLNA, etc.

These efforts mainly put emphasis on the remote control of information appliances (e.g. record reservation of DVD recorder via a cell phone) or the cooperation between appliances (e.g. energy conservation by human sensor and light control). The research on usability of these complex information appliances has just started.

Our project focuses on the usability and maintenance aspects of these new technologies. We apply several ubiquitous Web technologies to the domain of controlling information appliances. In order to implement easy access to these equipments for everybody, including child and elderly person, we focus on voice interaction for controlling information appliances.

The following of this paper explains our approach and future works.

2. Web service framework for managing home information appliances
We implemented home information appliance simulator using Web service framework [1]. All the home electronic devices which are controlled by the dialogue agent, which is explained in Section 3, have an ability of remote control interface by Web service. In other words, each device can be regarded as a Web service provider which opens a controllable interface for changing internal state via SOAP message exchange. SOAP protocol functions as an envelope for XML message between networked devices. SOAP guarantees interconnections between heterogeneous networked devices. In addition, an UDDI (Universal Description, Discovery and Integration) server at the home network provides collaboration (discovery of services and exchange of WSDL (Web Services Description Languages) information for Web services) between networked devices. Service providers, such as video recorder or intelligent microwave oven, register their functions and interface descriptions in order to call such functions as if remote procedures call. On the other hand, service requester, i.e. a dialogue agent who is a representative of user, searches the service at the UDDI server. Basic structure of Web service is shown in Figure 1.

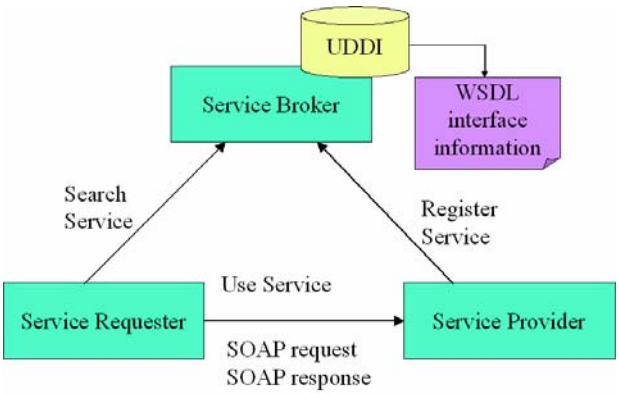

Figure 1. Basic Web service architecture.

We apply such general network service framework to small scale home network as illustrated in Figure 2.

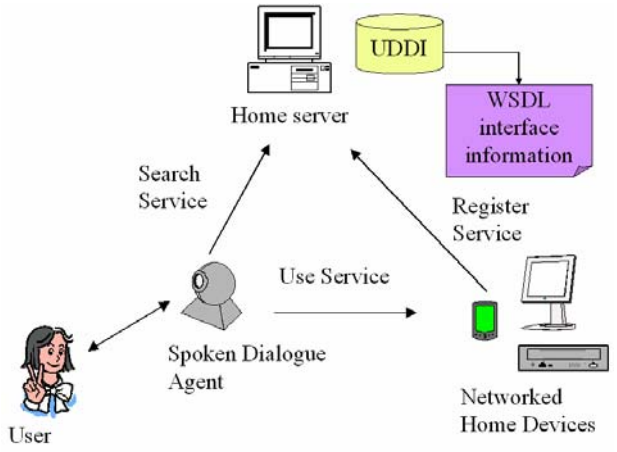

Figure 2. Web service for home network.

3. Voice control of home information appliances via personal robot

For the interaction description of spoken dialogue agent, we designed multimodal interaction description language, called MIML (Multimodal Interaction Markup Language) [2]. The feature of this language is three-layered description of agent-based interactive systems.

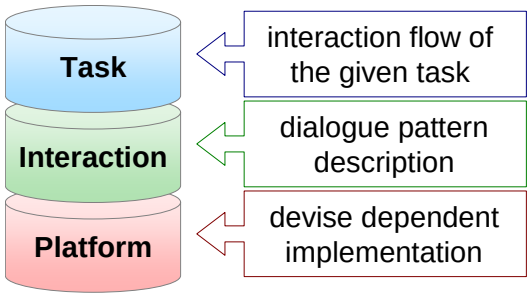

Figure 3. Three layered description in MIML.

The high-level description is a task definition that can construct typical agent-based interactive task easily. The middle-level description is an interaction description that defines agent's behavior and use's input at the granularity of dialogue segment. The low-level description is a platform dependent description that can override pre-defined function in interaction description. The connection between task-level and interaction-level is realized by generation of template from the task level. The connection between interaction-level and platform-level is realized by binding mechanism of XML.

The MIML specification of high-level task markup language and middle-level interaction description language, which is multimodal extension of VoiceXML are shown below.

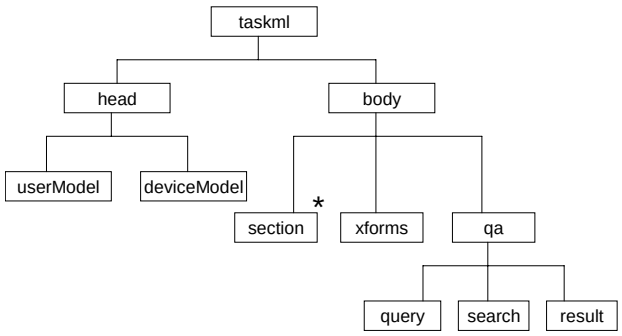

Figure 4. Task Markup Language.

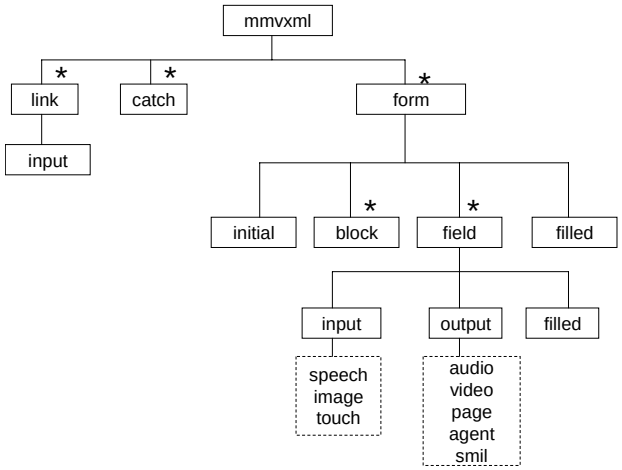

Figure 5. Interaction Markup Language.

Using this language, developers can easily implement a user interface to information appliances by writing one task description, few interaction description (e.g. one for agent-based interaction, one for small remote control devices) and platform dependent implementations for each communication devices (if the pre-defined default binding is not suitable for the target interaction).

4. Ontology for task modeling and user guidance

In our system, the knowledge source of interaction is represented by OWL (Web Ontology Language). We define 5 types of ontology for task modeling and user guidance.

1. device ontology
   Classifying home information appliance in order to model the target domain. Example is shown below.

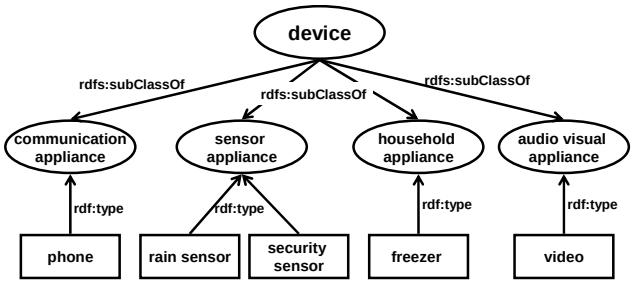

Figure 6. Device ontology.

2. function ontology
   Identifying function of each device.
3. operation ontology
   Describing operation steps corresponding to the function.
4. manual ontology
   Conceptual explanation of each device for helping naive user.
5. conditional ontology
   Representing dependency between devices / device and environment.

For each interaction, the dialogue manager of the agent (defined by taskml and mmvxml) refers to these ontology and find out the user's target appliance, guide the operation and acquiring attribute values for each operation. The history of the selected function is stored to function ontology for individual users. It is used for the user modeling information that represents which setting the user likes and what operation the user knows.

5. CONCLUSIONS

In the present paper, we described our ongoing research project on application of ubiquitous Web technologies to home information appliances. In the present implementation, user can interact with several interactive agents, such as MsAgent or Galatea toolkit [3] on PC screen.

In the future, we plan to evaluate the usability of this service framework via dialogue experiment for several task settings.

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