Abstract Interface Technique for Home Network Management

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Abstract

Many kinds of home appliances that can be operated via networks are going to appear on the market, but when they are connected to home networks, users will find them complicated to manage and operate. To overcome this problem, we are developing an easier method of operating home appliances that lets users operate appliances via abstract concepts that are comprehensible to humans such as "make the room cooler". Moreover, in the step of converting the abstract request from a user into real actions, the optimum means can be chosen dynamically, taking into consideration the user and the location and state of home appliances.

1. Introduction

Home networks will consist of many kinds of home appliances such as network appliances, audiovisual devices, white goods, and PC-related appliances. When they are connected to home networks, users will find them complicated to manage and operate. To overcome this problem, at NTT Access Network Service Systems Laboratories, we have been studying an easier method that will enable users to operate appliances via abstract concepts that are comprehensible to humans such as "make the room cooler".

Conventional techniques for operating home appliances force users to specify particular home appliances, operations, and protocols. When we consider the development of home network management applications in such a situation, it is clear that we will need information about all target home appliances, such as types and protocols. This places a heavy responsibility on the application layer, which makes it difficult for application service providers (ASPs) to develop home network management applications that can provide services to a large number of unspecified homes. This is thought to be one of the obstacles preventing the expansion of the home network market.

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2. Purpose and features of our work

2.1 Purpose

We aim to overcome the problem described above by providing an abstract interface technique for home network management [1] as an easier method of operating home appliances. **Figure 1** shows the concept of applications using this technique. We consider services that can be supplied to users by home appliances operated via networks as target applications, such as home network management, home security, and home energy management. To make abstract requests that are comprehensible to humans, we provide ASPs with target objects that are specially designed for each of the above services and that are abstracted as being useful and comprehensible to humans, instead of operating home appliances directly. We think that, by using these target objects, ASPs can operate home appliances without detailed information about the target appliances.

2.2 Features

In this section, we explain the features of our work. First we explain the target objects in detail using **Fig. 2**. The target objects are provided as Abstract Service Objects equipped with Abstract Service Methods,

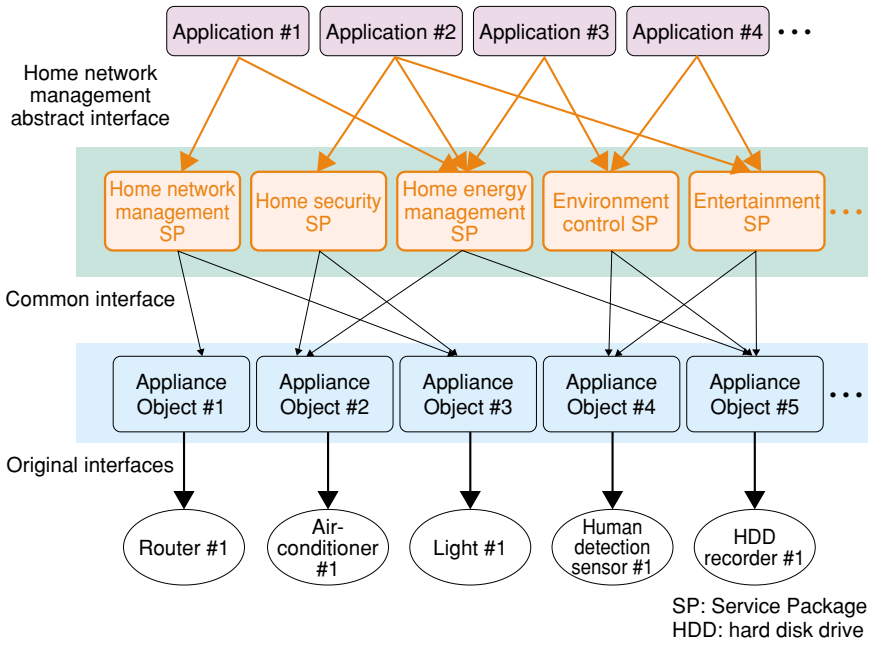

Fig. 1. Position of home network management abstract interface.

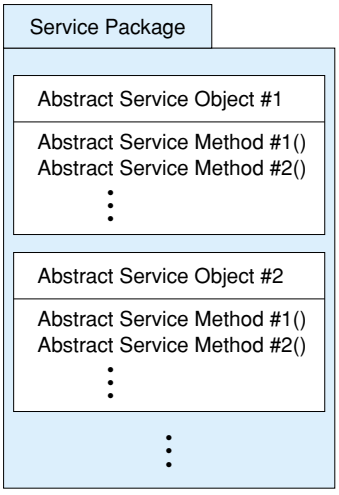

Fig. 2. Format of a Service Package.

and these are packed into individual Service Packages defined in terms of each target service. These abstract objects will be prepared with several degrees of abstraction to respond to various demands from ASPs. As a result, ASPs will be able to provide desired services more easily by selecting and using objects that meet their demands.

Next we explain the differences between our work and previous work. Some previous studies have aimed at abstract operation, but most of them statically assign one abstract request to one method of achieving it. However, our approach can provide a service flexibly by dynamically selecting the method taking into consideration the user and the location and state of home appliances, which should extend the application field.

3. Abstract interface technique

3.1 Overall design

This section describes the overall design of the abstract interface technique for managing home networks using **Fig. 3**.

(1) Appliance Object

This is an operation object that provides an environment in which we can operate home appliances without the individual protocols used for each appliance but with common protocols that are independent of them. Once an Appliance Object receives an operating request based on the common protocol, it forms this request into requests based on the individual protocol and sends them to the original home appliance with the individual protocol through wrapper modules.

(2) Appliance Manager

Home appliances frequently change their properties such as power state, operating mode, and location. Therefore, this information must be managed for the service to be efficient. The Appliance Manag-

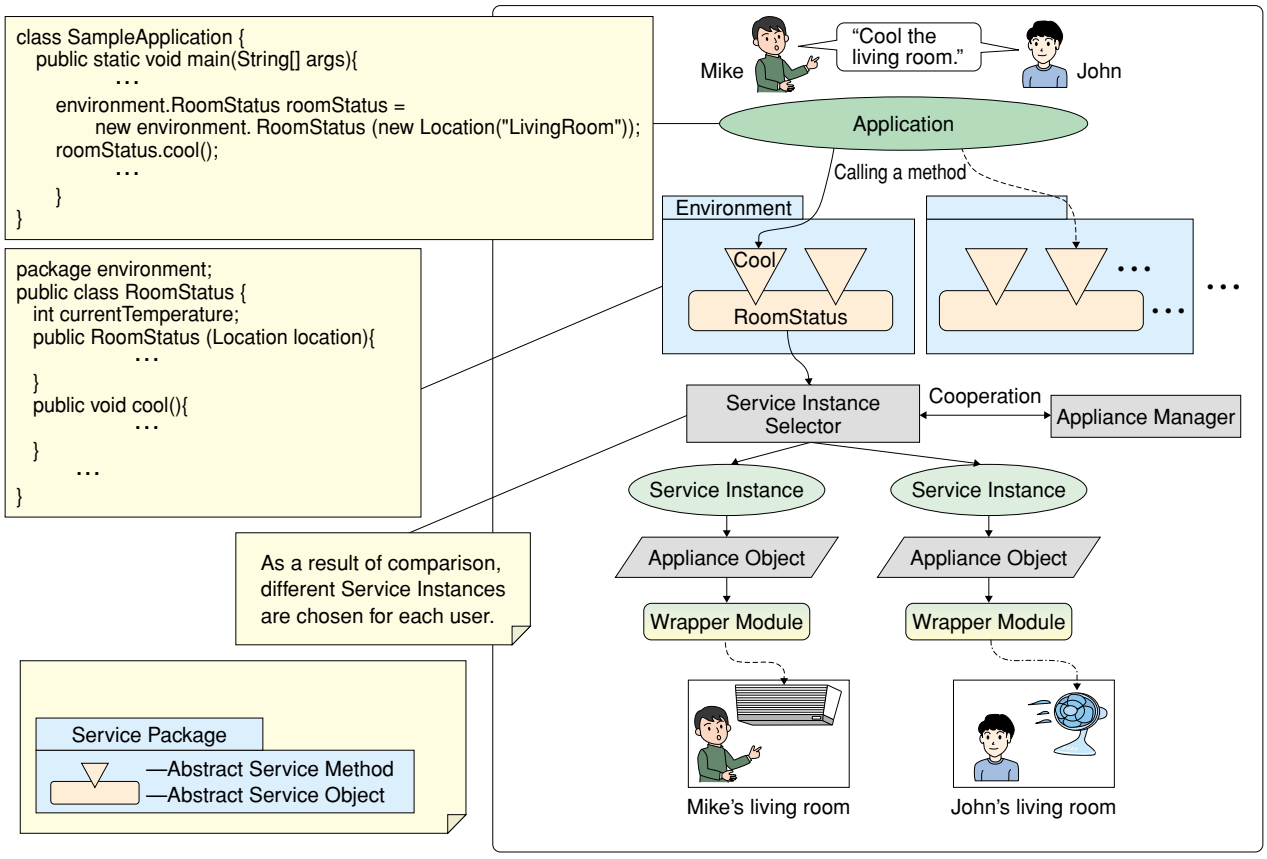

Fig. 3. Overall design and example of home network management abstract interface.

er collects and records such home appliance information.

(3) Service Instance

This plays an important role in converting an abstract request into a specific practical means. It has the specific practical means as an executable program designed to specify home appliances and operations that can satisfy the corresponding abstract request. It can satisfy an abstract request that involves multiple home appliances and Service Instances. Furthermore, it can operate home appliances through Appliance Objects without being aware of the individual protocols. Thus, we do not need to prepare multiple Service Instances to satisfy the same abstract request for each individual protocol. A Service Instance has attributes that are needed to relate to a corresponding abstract request and information about appliances that are needed to examine if it can be executed before it has been executed. Based on the generalization that there are multiple means of satisfying one abstract request, we are examining the other attributes that a Service Instance should have and which can be used when selecting the optimum means for each user from them.

(4) Service Instance Selector

To satisfy an abstract request, it is necessary to retrieve Service Instances that correspond to that abstract request, examine whether or not the Service Instances are executable by comparing information about appliances needed by this Service Instance with that of available appliances in the home network, and invoke its practical means. When an abstract request is called, the Service Instance Selector always receives the abstract request and executes the above processing steps.

3.2 Example

In this section, we use Fig. 3 to explain in detail the process that begins when an application receives an abstract request from a user and ends when home appliances start running in order to meet this abstract request, using an "environment control service" as an example. Here, we define the "environment" package as a Service Package, the "RoomStatus" object as an

Abstract Service Object, and “cool” as an Abstract Service Method. Several means of meeting the abstract request can be considered, such as “starting an air-conditioner in cooling mode” and “turning on a fan”. These means are prepared as Service Instances in advance. Two people (Mike and John) make the abstract request “cool the living room” through the application. There is an air-conditioner in Mike’s living room and a fan in John’s living room. The program fragments written in JAVA language in Fig. 3 are shown as a practical example. The process after a request has been made is shown below.

First, the applications call for the “cool” method of the “RoomStatus” object in the “environment” package. The Service Instance Selector retrieves Service Instances that correspond to this method and finds the above two Service Instances. It compares the appliance information possessed by each Service Instance with that possessed by the Appliance Manager. Based on this comparison, the Service Instance that uses an air-conditioner is selected for Mike’s request whereas the Service Instance that uses a fan is selected for John’s request. Finally, each Service Instance is executed and the corresponding home appliances are operated through Appliance Objects. Through the above steps, it is possible to meet an abstract request taking into consideration the user and the location and state of home appliances.

4. Conclusions

This article introduced the home network management abstract interface technique which lets users operate appliances without detailed information about the target appliances but in a manner that is comprehensible to humans. However, there are some remaining problems that need to be solved such as a conflict, well known as a feature interaction, which occurs when two or more services are interested in the same appliance or environment simultaneously. We will continue our studies to solve these problems.

Our final aim is to have more ASPs enter the market for home network service, providing more attractive home network services to users.

Reference

[1] K. Tsuchikawa, K. Katayama, and F. Ito, “Study of Operation of Home Appliances by Abstract Service,” IEICE Society Conference 2004, B-7-38, 2004 (in Japanese).

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