Context Aware Approach for Smart Homes

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Abstract: Smart Homes is a classic example of ubiquitous computing. It includes several of intelligent home appliances capable of sensing the home’s occupants and their current state, and providing appropriate services to them. The term context-aware systems are defined as one that can adapt according to its location of use, the collection of nearby people and objects, as well as the changes to those objects over time over the course of the day. There are various approaches to context-aware systems for smart homes as described in the paper below. It is an emerging new topic in the smart home arena.

Keywords: Context-aware, CBR, smart homes, CCBR, ubiquitious computing.

1 Introduction: The smart home environment is highly characterized by heterogeneity with many systems that need to interoperate and perform their tasks efficiently. With rapid growth of services, applications and devices in smart home environment, the interoperability factor seems still elusive. This is due to the nature of smart home as distributed architecture that needs certain degree of interoperability and interoperation for managing heterogeneous systems comprising of different platforms.[1]

These heterogeneous systems are developed in isolation and consist of different operating systems, different programming platform and different tier of services. There is need for a mechanism that could make the heterogeneous systems ‘talk’ each other and interoperate in an efficient manner regardless of operating platform. Context awareness is emphasized in order to provide automatic services in smart home.[2]

2 Context-Aware Computing: The context aware systems refer to context of use, and adapt their behavior accordingly. Such systems are a component of a ubiquitous computing or pervasive computing environment. Three important aspects of context are: (1) where you are; (2) who you are with; and (3) what resources are nearby. Although location is a primary capability, location-aware does not necessarily capture things of interest that are mobile or changing. Context-aware in contrast is used more generally to include nearby people, devices, lighting, noise level, network availability, and even the social situation; e.g., whether you are with your family or a friend from school.

3 Case based reasoning: The Case based reasoning is the reasoning method which solves the problem “In the first phase, we don’t know exactly about the key processes and their interdependencies in smart home’s context”. The context’s contents in smart home are described in this method. Also, case representation, case storage and
similarity calculation are discussed in smart home’s context awareness.

Mark Weiser has described us an environment named Ubiquitous computing, which aims to “Enhance computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user” [1]. If the home system wants to dynamically adapt its behaviors according to the user’s activities and environments, awareness of the user’s activities and environment are required. Many researchers have focused on context-aware architecture and context-aware applications [2, 3]. Automatically collecting the context information and reacting in ways that fit in with the environment are the main design goals of the context-aware system. Machine learning, data mining, and intelligent decision algorithm with context information are the key technologies to implement context-aware in home environment. CBR (case based reasoning) is an approach targeting problem resolution in domains where little information is known about the key processes and their interdependencies. For context aware in smart home, at the beginning, we don’t know the interdependency among appliances and services. And also, there is no theory to identify the context situation. But awareness can be obtained by retrieving and adapting the solutions to previous scenarios.

CBR is such a problem solving technique that reuses previous cases and experiences to find a solution for current problems. L.D. Xu et, al. discuss the CBR’s advantages and the process of the CBR and provide an application that uses CBR to judge the AIDS [11]. W.C. Chen et, al. discuss the features that can delegate the case [4]. They propose a framework to mining the features by using machine learning methods. W. J. Yin et, al. use the joint of genetic learning approach and case-based learning, solving job-shop scheduling problems [5]. The similarity calculation is defined based on DNA matching. D. Grosser et, al. use case-based reasoning (CBR) to predict the object oriented software’s stability [6]. K. Li et, al. introduce time function as the adjustable factors in similarity measuring [7].

3.1 Context in Smart Home: Smart home sometimes means automated home. Some used cases are as follows: “At noon, Mr. Lee enters the living room; the room temperature is 30 degreeC , the air condition will automatically turn on to decrease the temperature. At the same time, the TV is turned on and the news report channel is tuned.” “At 23:00, Mrs. Park leaves living room and enters bedroom, the air condition and TV in the living room are turned off. The light in bedroom is turn on, and just the brightness to low.” Although the above scenarios seem to be relatively simple, it would be challenging to achieve these “simple” scenarios in the real home environment. The purpose of context aware is “right situations do right things”.

The basic of the commonsense reasoning and context awareness is the understanding of current state. But there are many situations TV, AC and light might encounter. For adjusting TV channel: some persons like news, some like sports. Sometime TV stations provide comedy, sometime TV stations provide sitcom. And some program fits
living room, and some program fits bedroom, and so on. For switching the AC: some like warm or cool, some like turn on AC while sleep or not, some like wind, and so on. It almost means impossible for the system designer to envision all possible contexts before the system deployment. The home system will sometimes perform in unexpected and undesirable ways inevitably and thus disappoint the home occupant. A common learning algorithm also can’t solve this problem because a training set will not contain examples of appropriate decisions for all possible contextual situations.

3.2 Content of context: Context is usually classified into three categories: environment, user’s activity, and user’s physiological states [8]. Each category has its own subcategories. In the beginning, our context information model will be simple and idiographic. We don’t deal with abstract concepts. We assume that context information can be simplified into a collection of discrete facts and events with numeric parameters. According to the above analysis, there may be different TV programs at different time and different devices in different rooms. Occupants’ habits are also different. So, the context in smart home can be classified into three dimensions: (1) time, (2) environment, and (3) person. In each category, there are several entities as shown in Table 1. As occupants deal with a large amount of information, context information is modeled hierarchically.

<table>
<thead>
<tr>
<th>Table 1: Content Categories and Entities in Smart Home</th>
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<tbody>
<tr>
<td><strong>Time</strong></td>
</tr>
<tr>
<td>time</td>
</tr>
<tr>
<td>second, minute, hour, day, week, month</td>
</tr>
<tr>
<td>sequence</td>
</tr>
<tr>
<td>Event occurring, sequence</td>
</tr>
<tr>
<td>location</td>
</tr>
<tr>
<td>Bedroom, bedroom, kitchen, dining</td>
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</table>
In CBR system, database is used to store cases. Case is organized into related tables. As classical CBR system, there are phases from case retrieving, to case reusing and to case storage. The original data is generated by sensors. After sensor data is structured, similarity can be calculated. The best match set is retrieved from case database. Using 1-NN or K-NN strategies, new solution is gained. For smart home, the users have no interface to modify the solution. Smart home system uses one of the candidate solutions to set the TV channel, AC temperature and light brightness. If users adjust TV channel, AC temperature and light brightness, the case will adopt the input values as users’ revising. In Fig 2, users’ modifications are expressed as AC action, lamp action and TV action. Thus, case adaptation is achieved.

**Demerits of CBR:** The basic assumption of CBR, “similar problems have similar solutions”. In this assumption, one context case has only one solution to the corresponding activity. However, this assumption is ineffective in some cases when selecting the appropriate actions for the certain context if that context consists of many corresponding activities. In addition, CBR approach still confront the problems as lacking of cases, managing abundant cases in the context aware applications which are highly scalable, open and computing capability limited.

### 4 CCBR: Chaining CBR method:

This paper proposes chaining case based reasoning (CCBR) as the reasoning method which solves the vagueness of traditional case based reasoning (CBR) approach “In the certain case with more than one solution, we don’t know which solution or activity will be chosen to satisfy user’s needs in smart home’s context”. The context’s contents in smart home are described in this paper. Also, we introduce the framework of context awareness based on CCBR, and discuss the case representation, case adaptation, and similarity computation in detail. Our proposed CCBR integrated into the virtual smart home environment acquires knowledge about user actions that are recorded to determine their preferences and then simultaneously activates the devices with predefined setting.

### 4.1 CCBR: CHAINING CASE-BASED REASONING:

In the context of CCBR, four important issues need to be addressed: the definition, case representation, case organization and case matching.

### 4.2 Context:

In ubiquitous computing, the basic notion is context. Context might be considered as a collection of information which characterizes the interaction between a user and the application. Time, location, temperature, lighting, sound and activity are examples of contextual information or context. There exist various definitions of context. Shilit et al [9] define context as where you are, whom you are with, and what resources are nearby. They define context elements such as the Computing context, User context, and Physical context. Chen et al [10] define context as the set of environmental states and settings that either determines an application’s behavior or in which an application event occurs and is interesting to the user. Chen et al. added the time context to the Shilit et al. definitions. Likewise, in our approach, the context information is converted to
the high level context from raw data, and then can be simplified into a collection of numeric parameters. According to the above analysis, there may be different TV programs at different time and different devices in different rooms. Occupants’ habits are also different. So, the context in smart home can be classified into four dimensions: (1) time, (2) environment, (3) person and (4) activity. Beside four dimensions, to ensure the correct usage of “context information”, we divide context information into two types as follows:

**Independent context:** the context information has no relationship to other contexts.

**Dependent context:** the context information has more than one relationship to other contexts.

4.3 Definition of CCBR: In CBR, the primary knowledge source is not generalized rules but a memory of stored cases recording specific prior episodes. Chaining case-based reasoning (CCBR) takes a very different view. CCBR reasoning is often modeled as a process that draws conclusions by chaining together generalized cases. The CCBR approach is based on two essential things of the world. The first thing is that the world is regular: similar problems have similar solutions. Consequently, solutions for similar prior problems are a useful starting point for new problem-solving. The second one is that the sequences of problems an agent encounters tend to reoccur. Consequently, future problems are likely to be similar to current problems. When two natural things meet, it is worthwhile to remember and reuse current reasoning: chaining case-based reasoning is an effective reasoning strategy. The CCBR method is a simple but reliable approach to solve the limitation problem of the traditional CBR method. We also analyze the advantages when using this approach for a smart home. In addition, we proposed the context-awareness framework based on CCBR and the implementation in a virtual smart home environment. However, our work bases on the improvement of the basic assumption in CBR. Thus, this work just strengthens the CBR approach and shows the effectiveness in some cases. Though the achievements are relatively promising, further experiments are required to confirm them. In the implementation part, our test-bed for smart home is only concept and virtual environment. But rapid development of hardware, software and the emerging ubiquitous paradigm make it possible to realize a transition from virtual space to real space. Hence, in future works, we plan to evaluate this approach and integrate this reasoning component to the real experiment room that we already built.

5 Conclusion: Thus we have studied the CBR and CCBR approach for smart home automation. The above paper envisages the advantages of CCBR and demerits of CBR method.

References:


About The Author:

Ms V.Kavitha M.E., is working as Senior Lecturer in the E & TC department from D.Y.Patil College of Engineering, Pune. She has completed Masters in Embedded Systems from College of Engineering, Guindy, Anna University, and graduate from Velammal Engineering College in Electronics and Communication Engineering .Her interests are in Distributed Computing .She has got 6 years of teaching experience.