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Ontology-based Data Semantic Management and Application in IoT- and Cloud-Enabled Smart Homes

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Abstract

The application of emerging technologies of Internet of Things (IoT) and cloud computing have increasing the popularity of smart homes, along with which, large volumes of heterogeneous data have been generating by home entities. The representation, management and application of the continuously increasing amounts of heterogeneous data in the smart home data space have been critical challenges to the further development of smart home industry. To this end, a scheme for ontology-based data semantic management and application is proposed in this paper. Based on a smart home system model abstracted from the perspective of implementing users' household operations, a general domain ontology model is designed by defining the correlative concepts, and a logical data semantic fusion model is designed accordingly. Subsequently, to achieve high-efficiency ontology data query and update in the implementation of the data semantic fusion model, a relational-database-based ontology data decomposition storage method is developed by thoroughly investigating existing storage modes, and the performance is demonstrated using a group of elaborated ontology data query and update operations. Comprehensively utilizing the stated achievements, ontology-based semantic reasoning with a specially designed semantic matching rule is studied as well in this work in an attempt to provide accurate and personalized home services, and the efficiency is demonstrated through experiments conducted on the developed testing system for user behavior reasoning.

Keywords: smart home, IoT and cloud computing, data semantic fusion, ontology data storage, semantic reasoning.

1. Introduction

Smart home running on a platform for a family house has seen significant development in recent decades by utilizing the continuous development of advanced technologies, such as network communication and automatic control. Effectively integrating various relevant functional subsystems for home life, smart homes attempt to provide more humanized services and make home life more comfortable, safe and energy efficient by acquiring and applying knowledge about its occupants and surroundings [1].

Recently, in contrast to traditional home automation being seen as having a lack of abundant applications, the emerging technological advances of IoT which are perfectly suitable for smart homes have helped to foster further developments and applications for smart homes [2, 3]. In IoT-based smart homes, various transmission technologies, e.g., GPRS, 3G/4G for remote access, Bluetooth, ZigBee, WiFi, UWB and 6lowpan for interior access, can be extensively utilized to achieve the interconnection, interworking, inter-operation and combined operations of heterogeneous home devices and components. In particular, these new IoT-enabled devices and components can support new efficient and fully integrated services that leverage the existing ubiquitous and pervasive communication and computing facilities characterizing the home

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