Chapter 8
Evaluation of Quality of Context Information in U-Health Smart Homes

José Bringel Filho
University of Evry Val d'Essonne (UEVE), France

Nazim Agoulmine
University of Evry Val d'Essonne (UEVE), France

ABSTRACT

Ubiquitous Health (U-Health) smart homes are intelligent spaces capable of observing and correctly recognizing the activities and health statuses of their inhabitants (context) to provide the appropriate support to achieve an overall sense of health and well-being in their inhabitants' daily lives. With the intrinsic heterogeneity and large number of sources of context information, aggregating and reasoning on low-quality raw sensed data may result in conflicting and erroneous evaluations of situations, affecting directly the reliability of the U-Health systems. In this environment, the evaluation and verification of Quality of Context (QoC) information plays a central role in improving the consistency and correctness of context-aware U-Health applications. Therefore, the objective of this chapter is to highlight the impact of QoC on the correct behavior of U-Health systems, and introduce and analyze the existing approaches of modeling, evaluating, and using QoC to improve its context-aware decision-making support.

INTRODUCTION

Two main factors are pushing towards the development and deployment of U-Health smart homes: 1) the worldwide increase of people that require for daily care (e.g., elders, people with chronic diseases or disabilities) that comes with an increase need for human costly services to assist them; 2) health providers and government's willingness to reduce the high costs for assisting them in specialized hospitals and institutions. In the specific case of world population ageing, recent studies[1] show that the growth rate of older population (1.9%) is significantly higher than that of the total population

DOI: 10.4018/978-1-4666-0888-7.ch008

(1.2%). For instance, the older U.S. population is numbered in 39.6 million (2009)[2], about one in every eight Americans (12.9%), and it will be about 72.1 million in 2030.

The development of U-Health and Ambient Assisted Living (AAL) systems (Belbachir, et al., 2010) is an important action to enable people requiring continuous care to live independently in their own homes (Kim, et al., 2010). See in Orwat (2010) a survey with a large number of U-Health solutions. Recent advances in wireless technologies (e.g., Bluetooth, RFID, ZigBee, 3G, 4G), in sensors/actuators (Dengler, et al., 2007; Matthews, et al., 2007) (e.g., unobtrusive physiological sensors), and the convergence of home broadband access with the Digital TV (DTV) (Oliveira, et al., 2010) expand the usage span of U-health systems in real scenarios. Unobtrusive physiological sensors (Adami, et al., 2003; Hagler, et al., 2010; Matthews, et al., 2007) and mobile technologies can be integrated to monitor human biological conditions for remote diagnostic of diseases (Dongsoo, et al., 2009), detect falls (Sixsmith, 2004), to treat life-threatening situations (Bottazzi, et al., 2006; Fry, 2005), to improve quality of life and to lower health care costs (Wang, et al., 2010). For instance, a elderly can be continuously monitored by a sensor-rich jacket[3] (e.g., blood pressure, heart rate, SpO_2[4], CO[5], breath rate) that communicates with a smartphone (e.g., via Bluetooth, Wifi) to send the collected data to a remote monitoring system using a 3G connection. This physiological information can yet be combined with data sensed from the environment (e.g., motion sensor, location sensor, thermometer) and in-home objects that interact with inhabitants (e.g., home appliances, sensor-rich chairs[6] and mattress[7]) in order to recognize their activities, providing accurate remote medical assistance (e.g., verifying if the patient is following correctly the medical advices and detecting abnormal behaviors). Indeed, U-Health systems can actively contribute to identify and prevent life-threatening situations, reducing the number of chronic disease deaths (Orwat, et al., 2008). Another possible application scenario of U-Health system is the health monitoring of communities for emergency preparedness and governance decision-making support, such as the control of outbreaks and epidemics (Oliveira, et al., 2010).

However, the success of such systems is closely linked to their ability to correctly determining the patient's activities and their critical biological conditions, named *health context*, for providing medical staff reliable information to take context-aware decisions. Based on Dey's definition of context (Dey, 1999) and on our definition previously presented in (Oliveira, et al., 2010), we define health context *as any information that can be used to characterize the situation of monitored people and the environment around them, which is considered relevant for the decision-making support in U-Health systems*. In fact, due to the nature of sensor-based long-term monitoring environments, health context is inherently imperfect since it may be incorrect, ambiguous, inconsistent, or unknown (Henricksen, 2002). This problem is intensified mainly by the large amount of sensors and context providers distributed in the environment with possibly different quality levels (Buchholz, et al., 2003; Filho, et al., 2010). In addition, aggregating, deriving, and reasoning on low-quality raw sensed data may reach conflicting and erroneous higher-level health status (Filho, et al., 2010). Also, the quality of context information may be reduced by applying privacy control on private context data in order to enforce ethical guidelines (Jantunen, et al., 2010) and to protect the privacy of patients (Filho, et al., 2010; Layouni, et al., 2009; Sheikh, et al., 2008).

Therefore, U-Health systems should be able to assess the Quality of Context information (Buchholz, et al., 2003) and verify its multi-dimensional aspects (e.g., precision, correctness, up-to-dateness) before using it. This is to reduce the probability of propagating errors in the reasoning and decision-making support of U-Health context-aware applications. Providing

Related Content

Lose It!
Michael Dohanand Joseph Tan (2011). *International Journal of Healthcare Information Systems and Informatics (pp. 60-65).*
www.irma-international.org/article/lose/53480

A Reconfigurable Supporting Connected Health Environment for People with Chronic Diseases
Abbes Amira, Naeem Ramzan, Christos Grecos, Qi Wang, Pablo Casaseca-de-la-Higuera, Zeeshan Pervez, Xinheng Wangand Chunbo Luo (2015). *Healthcare Informatics and Analytics: Emerging Issues and Trends (pp. 332-352).*
www.irma-international.org/chapter/a-reconfigurable-supporting-connected-health-environment-for-people-with-chronic-diseases/115123

Quality Assurance and Evaluation of Healthcare Reform Initiatives: Strategy for Improving the Quality of Health Care Services in Public Health Care Units, Management Model that Allows the Providing of High Quality Health Care and Efficient Brand-Building
Anna Beata Rosiekand Krzysztof Leksowski (2011). *International Journal of Healthcare Delivery Reform Initiatives (pp. 42-53).*
www.irma-international.org/article/quality-assurance-evaluation-healthcare-reform/72306

The Effects of Confidentiality on Nursing Self-Efficacy with Information Systems
Diane Lendingand Thomas W. Dillon (2007). *International Journal of Healthcare Information Systems and Informatics (pp. 49-64).*
www.irma-international.org/article/effects-confidentiality-nursing-self-efficacy/2211

Fujitsu HIKARI, a Healthcare Decision Support System based on Biomedical Knowledge
Boris Villazon-Terrazas, Nuria Garcia-Santa, Beatriz San Miguel, Angel del Rey-Mejías, Juan Carlos Muria, Germán Seara, Blanca Renesesand Victor de la Torre (2018). *International Journal of Privacy and Health Information Management (pp. 26-49).*
www.irma-international.org/article/fujitsu-hikari-a-healthcare-decision-support-system-based-on-biomedical-knowledge/211975