Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 112 (2017) 683–692

Procedia Computer Science

www.elsevier.com/locate/procedia

International Conference on Knowledge Based and Intelligent Information and Engineering Systems, KES2017, 6-8 September 2017, Marseille, France

Ontology-based system for patient monitoring with connected objects

Ahlem Rhayem*[a], Mohamed Ben Ahmed Mhiri[a], Mayssa Ben Salah[a], Faiez Gargouri[a]

[a]*Miracl Laboratory, Technopark of Sfax : Tunis Road Km 10 BP. 242, 3021 Sfax, Tunisia*

Abstract

The enormous exploitation of connected objects for patient monitoring becomes a source of a huge quantity of health data. This data can be badly expressed, understood, and exploited by other systems and devices. Additionally, the huge amount of connected objects embeds with resource-constrained devices (sensors, actuators, RFIDS, etc.) are also challenging. Consequently, semantic representation of both medical connected objects and their data becomes important. Furthermore, the semantic reasoning of this data requires the definition of diverse rules in order to provide adequate and efficient results. This paper suggests two main contributions. The first one focuses on the semantic representation of both the medical connected objects and their data by proposing a HealthIoT ontology. The second contribution is proposed to provide practical backup to the use of this ontology. In fact, an IoT Medicare system is proposed to evaluate the HealthIoT ontology.

Peer-review under responsibility of KES International

Keywords: Connected objects, healthcare, ontology, semantic reasoning, IoT Medicare system

1. Introduction

The emergence of the Internet of Things Technology in the Healthcare domain requires a massive quantity of medical devices connected to the internet. These objects referred to as the *Internet of Medical Things (IoMT)*[1]. Thereby, IoMT transforms the medical field from an episodic, reactive, disease-focused, fragmented, and hospital-centered field to a proactive, preventive, focus on well-being and quality of life, patient-centered and interoperable field. Internet of Things can be considered as a solution for early intervention and prevention, for example, in the context of a patient with Alzheimer disease, the monitoring device can detect any health problem and send an alert to emergency responders or family members. Indeed, it provides an adequate treatment for the patients suffering from chronic disease. It also helps them to monitor their states. Consequently, with the exponential growth of the medical connected objects, a massive quantity of data is captured during a predefined period. This data is very heterogeneous

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000.
E-mail address: ahlemrhayem@gmail.com

[1] http://www.huffingtonpost.com/josh-stein/the-emergence-of-the-inte_b_6801714.html

1877-0509
Peer-review under responsibility of KES International
10.1016/j.procs.2017.08.127

in source and format, which bring on several problems. In this paper, we will focus mainly on the following problems:
How to represent the semantics of both connected objects, the health care domain and their relationship to each other?
How to exploit this representation to facilitate the analysis of the detected vital signs and the proposition of an adequate treatment?
How to facilitate the access and the exploitation of this data by patients and doctors?
Semantic technologies play a primordial role by proposing a semantic representation of a domain knowledge and by applying a reasoning processs to infer hidden knowledge. In this paper, we make two main contributions as follows.

- first, we propose a semantic-based approach start by the data collection and preprocessing step, follow by the knowledge extraction and semantic modeling of this knowledge and finish with the semantic reasoning step.
- second, we describe an IoT Medicare system that integrates the HealthIoT ontology, which illustrates the effectiveness of the proposed approach for ontology building and evaluation.

The rest of this paper is organized as follows. in section 2 we provide an overview about the semantic representation in the IoT domain and, especially, for the healthcare field. Section 3 presents the HealthIoT ontology. Then, the section 4 describes the proposed system that integrates the developed ontology.

2. Related Work

Using semantic web technologies in the Internet of Things domain, gives rise to the birth of a new appellation (SWoT: Semantic Web of Things)[1]. Among of the most referenced works, we can cite the SSN ontology[2]allows representing the semantic interoperability of sensor networks, the IoT-O ontology[3] aims to represent the semantics of the sensing and the actuating devices as well as their related information (life cycle, energy, service). Ma et al[4] proposed an OntoIoT framework that aims to describe the real world entity (object, sensors, etc.) the spatial and the temporal dimensions of these entities, the detected data and event etc. These works have been interested more on the IoT domain knowledge representation in general. In the next subsection, we state some works that are proposed to represent the semantic of the IoT domain knowledge in the context of the health care domain.

2.1. Semantics for IoT Healthcare application

Several works have proposed an ontology-based solution to provide an appropriate service for patients. Galopin et al in[5] have developed a clinical decision support system for the management of patients with multiple chronic disorders. They applied an ontological modeling and reasoning of clinical practice guidelines (CPGs) contents. Moreover, Sherimon et al[6] has proposed an Onto Diabetic system to assess the risk factors and to provide appropriate treatment for diabetic patients. This work applies OWL2 rules on the modeling and implementation of clinical guidelines and the reasoning process of the Onto Diabetic system.

These works suffer from several limitations; in fact, they are based on patients medical record and clinical practice guidelines without taking into account the emergence of new technologies in the healthcare domain as IoT technology. However, we can note that some other related works have focused on this issue. Ramon et al[7] suggested a CDSS (Clinical Decision Support System) allow to estimate the risk of cardiovascular disease. They have proposed a conceptual model to integrate recommendations to patients and a reasoning engine based on OWL and SWRL rules to detect the cardiovascular risk using SCORE (Systematic Coronary Risk Evaluation) method. It uses a mobile phone and a bluetooth sensor to monitor the blood pressure. In addition, Hristoskova et al[8] defined an ontology based ambient intelligence framework supporting real-time remote monitoring of patient diagnosed with congestive heart failure. This framework aims to provide (1) personalized medication for patients and (2) an intelligent and emergency alerting of the dedicated physician. Lasierra et al[9] developed an architecture for monitoring patients at home. Two layers compose this architecture: a conceptual layer that define an ontology to unify the management procedure and integrate incoming data from various sources, and a communication layer that is based on REST web service (WS) to access and exchange information modeled by the ontology.
In the above-mentioned works we notice some gaps that we resume them in three main points: