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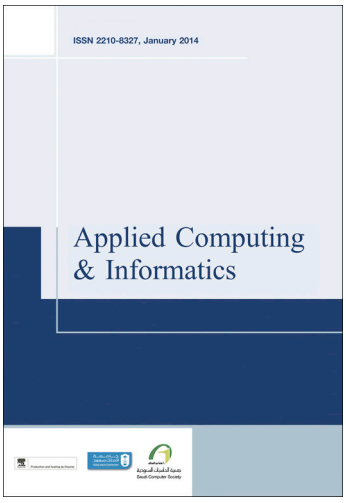

Original Article

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CAMeOnto: Context Awareness Meta Ontology Modeling

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Abstract— In order to model a context and adapt it to any domain, it is necessary an ontology that captures generic concepts to a higher level. The context model must provide mechanisms to extend the specific information of a context in a hierarchical manner. In this paper, we propose CAMeOnto, an ontology with these characteristics, based on the principles of 5Ws: who, when, what, where and why. CAMeOnto is used by CARMiCLOC, a reflective middleware for context-aware applications, and is instantiated in several case studies, in order to test how CAMeOnto works correctly and can reason to infer information about the context.

Keywords—Context-Awareness; Ontologies, Meta Ontologies, Context Modeling.

I. INTRODUCTION

In a smart environment, users want to be automatically provided with services. For that, it is required an appropriate contextual information: user's situation, location, time, devices existing in the environment, among other things. Nowadays, there are several domains where it is required the modeling of the context, such as: Internet of Things (IoT), Internet of Everything (IoE), Virtual Reality (VR), Recommendation Systems, and Intelligent Transport Networks like Vehicular Ad hoc NETworks (VANET).

Different challenges exist in the area of the Context Awareness. For example, in Intelligent Transport Systems (ITS) a VANET component requires the identification of effective context information [1]. In VR, IoT and IoE the main challenges are the privacy and the lacks of modeling of social issues [2] [3].

The use of ontologies for expressing context is advantageous because they can express the different characteristics of the context. Examples of context aware modeling based on Ontology are presented in [4] [5], which present the emergent concept "Semantic Web of Things" (SWoT) [6] [7]. SWoT is the combination of five elements: human (such as users, service providers), machines (such as computer), physical things (such as sensors or devices), abstract things (such as data, information or services), and the working environment (such as the Ad hoc network, the Sensor Network, or the Web).

In [8] was presented CARMiCLOC, a reflective middleware for context-aware applications in the cloud, which offers various services for context-aware systems, among which is found the modeling. The context modeling is proposed using ontologies, because it is a technique that gains force as a standard, due to its semantic expressiveness and interoperability [8]. In this way, in this work we propose the modeling of the context ontology of CARMiCLOC.

Our ontology must be used by the services of CARMiCLOC to represent the context, to reason about it, to be shared, among other things, without the use of sophisticated tools and processes. This ontology is called CAMeOnto, which is an ontology that allows the modeling of the context, so that it can be used by the set of services of CARMiCLOC in order to allow the autonomy of the context-aware applications, so that they can discover it, analyze it, and based on it, make decisions. Our ontology provides a simple context modeling based on the 5Ws (who, when, what, where and why), with sufficient information about the context to reason and learn from it.

The organization of the paper is the following: Section 2 presents the relative works to this research, section 3 presents the theoretical aspects, the section 4 presents CAMeOnto, and finally, the section five presents the results and the conclusions.

II. RELATIVE WORKS

In this section, we will present the state of the art related to the Context Aware Computing and the Context modeling.

In [9], Alegre presents an investigation about the context-aware systems and their applications, and illustrates how the systems understand the situations, provide services and adaptive their functionalities for very specific needs. Alegre presents different aspects related to the state of the art of Context-Awareness Systems (CASs), for example: 1) the methodologies used for the development of CASs, 2) the challenges and techniques to construct CASs, 3) and the conceptualization of CASs. It also presents the directions and challenges that should be considered in the future researches regarding context-aware computing. Especially, in the Engineering of the context aware systems, he defines the following investigations: principles of design of the Human-Computer Interaction, Architectural Patterns, Paradigms of programming, methodological supports, among others.

With respect to the Context modeling, Perera exposes in [10] that there is not a standard for context modeling. In [9] [10], Alegre and Perera, respectively, show the most common techniques used for context modeling. Alegre exposes that each technique has some advantage. For example, the ontology-