Future Generation Computer Systems 35 (2014) 39–48

Contents lists available at ScienceDirect

Future Generation Computer Systems

journal homepage: www.elsevier.com/locate/fgcs

Convergence agent model for developing u-healthcare systems

Haeng-Kon Kim

School of Information Technology, Catholic University of Daegu 712702, Republic of Korea

HIGHLIGHTS

- We have developed a u-healthcare agent system with the mobile collaboration framework.
- Synergetic interaction between ubiquitous computing and the mobile devices.
- Convergence u-healthcare agent system progression monitors patient health conditions.
- Designed the EDI interface under the OSGi which support home healthcare connection.
- We evaluate the functionality and effectiveness of mobile agent with example cases.

ARTICLE INFO

Article history:
Received 8 May 2012
Received in revised form
24 October 2013
Accepted 27 October 2013
Available online 8 November 2013

Keywords:
u-healthcare
Convergence model
Agent UML modeling
Mobile embedded system
U-healthcare frameworks

ABSTRACT

Ubiquitous networking, the interlinking of computers, consumer electronics, automobiles, home appliances, medical equipment, transportation systems, animals and plants through an overlapping of electronic spaces and physical spaces, is expected to provide an environment that enhances our lives through improved convenience, efficiency and safety in all areas.

Today's healthcare industry emphasizes safety, efficiency, patient-oriented approach, timeliness and balance. u-healthcare makes it possible to safely deliver appropriate services from any location at any time. To explain the emergence of u-healthcare, one must invoke, first of all, progress in IT and medical technology, and then the desire and willingness on the part of health care institutions to adopt the new service concept and increased health care demand. Digitalization of information, introduction of broadband communication and leaps made in healthcare technology in recent years have provided the technological capacity necessary for the achievement of u-healthcare.

Based on recently reached theoretical results, integrating u-healthcare environments in virtual organizations, we proposed a methodology for the design and implementation of u-healthcare, linking the distributed mobile agents with medical entities into a convergence and collaborative environment. Despite the challenges in implementing and deploying u-healthcare, the advantages of ubiquitous healthcare are enabled by our smart model for the soft computing endowed ubiquitous. The strength of our approach is that it relates to u-healthcare a system which consists of its dual character emerging from the synergetic interaction between ubiquitous computing techniques and the mobile devices in convergence manner. We have developed a set of initial healthcare agent services on the mobile collaboration framework. We evaluate the functionality and effectiveness of our convergence mobile agent, whether the platform can manage services based on the model and whether the results of u-healthcare services discovery could satisfy user's requirements with example cases.

1. Introduction

Multi-agent Systems enable cloning of real-life systems into autonomous software entities with a 'life' of their own in the dynamic information environment offered by today's Cyberspace. The u-healthcare agent has emerged as a business paradigm from the need for flexible open reconfigurable models able to emulate the market dynamics in the networked economy [1], which necessitates that strategies and relationships evolve over time, changing with the dynamic business environment. Ubiquitous computing integrates computation into the environment, rather than having computers which are distinct objects. This means that individual physical environment is a share and exchange of information that are collected data from the devices, sensors and desktop computer over wireless network [2]. Recently, research in ubiquitous computing is towards the development of an application environment able to deal with the mobility and interactions of both users and devices [3–5]. In these studies, collaboration is a very important application of information technology, especially for a u-healthcare environment. With the fast development of mobile computing, wireless mobile networks

E-mail address: hangkon@cu.ac.kr.

0167-739X/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.future.2013.10.025

and mobile devices are becoming widely used in both commercial and academic organizations. Collaboration turns out to be much more useful in a mobile network [6]. The convergence agent model for u-healthcare systems provides the conceptual infrastructure for describing agents and goal-based agent relationships. These models enable the specification of agent architectures and multi-agent systems, respectively. However, we also require appropriate practical models for agent construction to provide a clear path from the abstract agent models of convergence agent model for u-healthcare systems to their implementation. Therefore, we need to extend convergence agent model for u-healthcare systems in a more practical direction, while basing this extension on the existing abstract agent models [7].

In ubiquitous environments, which involve an even greater number of computing devices, with more informal modes of operation, this type of problem will have rather serious consequences. In order to solve these problems when they arise, effective multi-agent systems are required. In our works, we have developed many different multi-agent systems last couple of years [4–6].

In this paper, we describe a convergence agent model for u-healthcare systems. These systems allow the system or computing device itself to recognize and identify u-healthcare domain problems arising, without depending on administrators.

The existing systems consist of a 5-step process, including Monitoring, Translation, Analysis, Diagnosis and Feedback. This architecture has various drawbacks. These drawbacks are presented as follows.

- Because the existing system is a log-based system, if an error or problem arising in a component does not generate a log event, it cannot heal the problem or error.
- Increased log file sizes and frequency.
- The wastage of resources (such as 'RAM', 'CPU', etc.).
- A lot of dependency on the administrator and vendor.

Consequently, in this paper, we propose a multi-agent system based proactive u-healthcare system which incorporates several functions designed to resolve the problems mentioned above, namely (i) the minimization of the resources required through the use of a single process (Monitoring Agent), (ii) the use of a Meta Policy which offers different healing strategies according to the components situation, 'Emergency', 'Alert', 'Error' and 'Warn' for the sake of rapid and efficient mobile u-healthcare agents. The proposed system is designed and implemented in the form of a prototype, in order to prove its effectiveness through experimentation.

At the conceptual infrastructure level, convergence agent model for u-healthcare systems provides a model for constructing agents which, at the specification artifact level, can enable the specification of agent architectures that can then find practical implementation at the lowest level. We begin by briefly reviewing the convergence agent model for u-healthcare systems as three different layers to make ease to design and implement the u-healthcare systems and explain how it can be viewed as a descriptive system specification. In addition, u-healthcare specific data in dynamic environment requires some elements of non-standard processing and computation, in order to make the system more flexible and robust. Then we introduce alternative views of software architecture structure and behavior that facilitate the practical development of agent systems for u-healthcare systems. We consider each in turn, showing how such systems are constructed with components based around a central agent shell. The paper ends with an example system, based on AUML (Agent Unified Modeling Language), and shows how these three views offer different perspectives on agent systems development [8]. The models are transformed using mappings that are defined separately for the primary model and each of the aspects. Horizontal separation of concerns is realized by modeling crosscutting features separately as aspects. The proposed system consists of multi-agent that analyzes the log context, error events and resource status in order to perform u-healthcare multi-agent self-healing and self-diagnosis. To minimize the resources used by the convergence adapters manner which monitor the logs in an existing system and the context of the logs generated by the different system u-healthcare agent components.

2. Related works

2.1. Convergence model

The convergence model acts as a foundation for the overall research objective of developing a design process and visual modeling language for handling crosscutting concerns in software design. It also provides a structure for comparing existing aspect-oriented modeling approaches. In the model, an aspect-oriented modeling process involves two major steps. The first step is the creation of two types of models: a core model depicted in UML diagrams and an aspect model depicted with a UML-based aspect modeling language. The second step is the production of an integrated model of the software system [9]. A core model represents the functional concerns of an application. An aspect model encapsulates model elements related to crosscutting concerns, which are to be integrated with the core model. In this framework, the definition of a join point is generalized to refer to an element in the core model, both structural and behavioral, that may be selected for extension, deletion, or modification. Similarly, a pointcut and an advice is a specification, in terms of both structure and behavior, for selecting join points, and for indicating the extension, deletion, or modification to be made at the selected join point, respectively. The UML diagrams selected for the proposed aspect modeling language are the class and sequence diagrams for modeling structural and behavioral crosscutting concerns respectively. More importantly, unlike earlier aspect modeling approaches that incorporate aspect-oriented concepts in UML, they extend UML in an aspect-oriented way [10]. These selected approaches are divided into two fundamental categories according to how the integrated model is produced. In the first category, the production of the integrated model involves two logical steps (Fig. 1(a)). The first step is to capture join points according to the pointcut in the aspect model. The pointcut identifies the selected join points and any contextual elements needed for convergence, in particular for behavioral crosscutting concerns. Capturing join points involves searching the core model for elements that satisfy the selection criteria in the pointcut. The second step is generating the integrated model according to the advice in the aspect model [11]. In the second category, there is a parameterized model (Fig. 1(b)) that is represented by templates with parameters which act as placeholders for model elements. The template must be instantiated by binding the parameters to arguments. This creates the bound model where the parameters are replaced with actual model elements. The bound and core models are then composed or integrated to produce the integrated model. Composition rules may be specified to guide the convergence, for example, to merge or override model elements with the same name in both models or to remove elements from the core model. For this second category, there is no pointcut to specify join point selection. Instead, the selected join points are explicitly stated by listing them as the arguments in the parameter binding.

In this paper, we present the aspect model and core model to make an integrated model as a final goal. This will reflect the future model of intensive ubiquitous systems. Convergence model is used in conjunction with the MDA (Model Driven Architecture) and