CAMI - An Integrated Architecture Solution for Improving Quality of Life of the Elderly

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Abstract. The increasing ageing population worldwide imposes some new challenges to the society like the provision of dependable support while facing a shortage in the numbers of caregivers, increased health costs and the emergence of new diseases. As such there is a great demand for technologies that support the independent and safe living of the elderly and ensuring that they are not socially isolated. Ambient Assisted Living (AAL) technologies have thus emerged to support the elderly people in their daily activities, while removing the need of caregivers being always physically present in order to look after the elderly. The current AAL systems are intelligent enough to take critical decisions in emergency situations like a fall, fire or a cardiac arrest, hence the elderly can live safely and independently. In this abstract, we describe our solution that aims at integrating all relevant functionalities of an AAL system, based on feedback collected from representative users. This work is carried out in the European Union project called CAMI (Artificially intelligent ecosystem for self-management and sustainable quality of life in AAL).

1 Introduction

The independent and safe living of the ageing population worldwide is one of the major concerns of the present society [1]. Although there are individualized Ambient Assisted Living (AAL) solutions that provide fall detection and alarms, health-care monitoring and communication to caregivers, home monitoring, assisted robotics etc., there are few that can work as integrated solutions for AAL by delivering all the necessary functionalities, and none that relies on models that are analyzed for their quality-of-service attributes as well as correct functionality [2].

Based on the above, we formulate the following research questions: (Q1) How to integrate the various functionalities of the AAL system in a modular manner, to ensure flexibility and reuse, along with incorporating user preferences?, and (Q2) How to provide evidence for quality of service?

M.U. Ahmed et al. (Eds.): HealthyIoT 2016, LNICST 187, pp. 141–144, 2016.
DOI: 10.1007/978-3-319-51234-1_23

To answer such questions, we have developed CAMI, a fully integrated architectural solution for Ambient Assisted Living, which incorporates the major functionalities of AAL systems, like health-data monitoring and sharing, supervised physical exercising, fall detection and fall alarms, smart home facilities, intelligent reminding and activity planning, and multi-modal user interfacing (graphic and vocal based UI), including the use of a robotic telepresence unit. The highlight of CAMI is its highly modular architecture, employing both local and cloud-based processing approaches. It follows a micro-service based approach, using message passing and inter-service communication in order to ensure flexibility. The CAMI solution will reconcile the increased demand for care in the current ageing society with limited resources, by supporting an efficient and sustainable care system. CAMI will be extensively tested and validated with end-users during our AAL 3-year EU project, which includes partners from 5 countries: Romania, Sweden, Denmark, Switzerland, and Poland [3].

2 Applications of CAMI

CAMI is an integrated solution supporting elderly adults with diabetes, cardiac diseases and mild cognitive impairments. The integrated CAMI functionalities are summarized below. (i) *Health care monitoring*: Health data are collected for preventive health measurements and monitoring vital signs; (ii) *Fall detection*: Fall detection sensors are used to detect falls and raise alarms; (iii) *Computer supervised physical exercises*: Advises the user to increase the level of physical activity; (iv) *Personalized, intelligent and dynamic program management*: Medication plans, daily, weekly and monthly program planning compliance and reminding; (v) *Report and communication to health professionals*: Health data communicated to both professional and informal caregivers; (vi) *Demand-oriented, personalized information and services*: Accessible through vocal and gesture-based interfaces.

3 Current Results

During the first year of the CAMI project, we have obtained the following results that address some of the issues mentioned in Sect. 1:

1. **Extensive user involvement:**
   - Primary (elderly), secondary (caregivers) and tertiary (third party organizations) users are involved throughout the project, from user requirements, through validation of concepts and functionality, to usability tests and field trials.
   - Shadowing and self-documentation methods have been used to acquire comprehensive data about the users, including body language, pace and timing in order to give a full picture of the world from the user's point of view. Differences and similarities in user requirements in Poland, Romania and Denmark are revealed by involving six users from each country. An important common aspect is the user's positive attitude towards accepting and using new technologies.

- A multinational survey with 105 primary and 58 secondary users has been performed in Denmark, Romania and Poland. The primary users group is composed of 49 males and 56 females respondents, i.e., 26 from Denmark, 42 from Romania and 37 from Poland. The secondary users group comprises 22 professional caregivers and 36 informal caregivers. The survey has identified both the requirements and the acceptance of the users for the CAMI components: (i) social interaction desired by 90% of the respondents, 67% accept Internet for this; (ii) 44% are interested in physical and cognitive games; (iii) 80% accept a mobile screen and 50–65% accept a robot.

2. **Modular architecture based on open source components and artificial intelligence:**
   We have designed a highly modular and configurable architecture based on micro services, which includes the following units: sensors, data collector, robotic telepresence, mobile phone, CAMI box containing a voice command manager, decision support systems, security and privacy modules etc., and cloud services. Points 1 and 2 address the research question Q1, of the Introduction.
3. **Current development:**
   The development of the CAMI components has started in parallel with the integration of: (i) Linkwatch, the intelligent platform for medical data collection and monitoring of patients in their homes (by CNet, Sweden), (ii) OpenTele, the open source Danish platform for health monitoring, (iii) Tiago, a service robot by Pal robotics, and Pepper the emotional robot by SoftBank, (iv) A multimodal gateway (by Eclexys, Switzerland), etc.

4 Future Work

Planned future work for CAMI includes the architectural modeling in an architecture description language, and the application of analysis and verification techniques such as simulation, model checking and statistical model checking to ensure functional correctness and critical QoS. These contributions target research question Q2. We will also continue with the development of micro services, implementation of interaction episodes, user testing and feedback. We also envision user premises field trials during the third year of the project.

Acknowledgements. Under the EU project AAL-2014-1-08, this work is supported by a grant of the Romanian National Authority for Scientific Research and Innovation, Danish Agency for Science, Technology and Innovation, Swedish Governmental Agency for Innovation System, Polish National Centre for Research and Development, and Swiss Federal Officer for Professional Education and Technology.

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