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ScienceDirect

Procedia CIRP 21 (2014) 117 – 122

www.elsevier.com/locate/procedia

24th CIRP Design Conference

Platform architecture empowering health and safe Product Service Systems for specific target groups

Giuseppe Landolfi[a], Marino Alge[a], Andrea Bettoni[a,*], Luca Canetta[a], Paolo Pedrazzoli[a], Donatella Corti[a]

[a]*University of Applied Scineces and Arts of Southern Switzerland, Manno CH-6928, Switzerland*

* Corresponding author. Tel.: +41-58-666-6567; fax: +41-58-666-6571. *E-mail address:* giuseppe.landolfi@supsi.ch

Abstract

Nowadays social phenomena like ageing, the increase of obese people and diabetic people and the major sensitivity towards disabled introduce new social requirements for advanced products such as customized work and sport wear. This opens up opportunities for offering bundles of products and services that, relying on embedded sensors, allow the user to constantly monitor and intelligently handle biometric data related to his/her health conditions. In this paper, the platform architecture that supports the provision of such Product Service System is presented mainly focusing on its components and the functionalities they deliver. Possible usage extents and benefits of the proposed solution are analyzed so as to emphasize how the well-being of special target groups can be improved.

Selection and peer-review under responsibility of the International Scientific Committee of "24th CIRP Design Conference" in the person of the Conference Chairs Giovanni Moroni and Tullio Tolio

Keywords: Product Service System, distributed software architecture, specific target groups, personalized goods, wearable biometric monitoring systems.

1. Introduction

Demographic changes, with the simultaneous increase in many countries of elderly proportion and life expectancy, coupled with the significant growth of some diseases, such as obesity and diabetes, are posing new challenges to the single person as well as to the entire society [1]. This is amplified by the appearance of new lifestyles, such as the "active elderly", as well as new issues, such as the need of ensuring the wellbeing of workers who are expected to retire later than in the past. The modifications of the health systems, calling for an increase of delocalized medical treatments and monitoring [2] along with the desire of ageing people for self-sufficient and self-determined lifestyles are further emphasizing these trends.

Technological innovations, especially those related to the Internet of Things [3], allow to effectively face these challenges. In order to meet this set of emerging requirements exploiting the technological advances, innovative business models along with Product Service Systems (PSS) have to be developed, ensuring the fruitful collaboration of a multitude of partners.

Aim of this paper is to address these emerging needs by proposing a platform architecture that, extending to this field the PSS concept, allows the combined use of product (sensors embedded in clothes/shoes) and services (collection and use of data) to generate value for the user. More specifically, the proposed solution introduces innovative services that can be provided thanks to the design and development of specific products, integrating miniaturized embedded systems for collecting and managing biometric data during leisure and professional activities. The social effect of this PSS is further stressed by the possibility to customize the system to individual needs.

The developed services ensure both the synchronous and asynchronous use of the collected information. The software architecture is such that the information is not only available to the end user of the system, but data can be accessible to third parties (i.e. doctors, service providers) who, in turn, can generate a feedback for the user (i.e. medical treatments)

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doi:10.1016/j.procir.2014.03.187

The considered fields of application are work-wear and sport-wear goods. An example of the final result expected out of the whole project this research piece belongs to is a sock that allows real-time measurement of feet plantar pressure for obese workers involved in heavy-duty activities. In the case, the offered PSS includes: the sock itself, the embedded plantar pressure sensors and the apps enabling the real-time monitoring for avoiding overload and ensuring correct behavior in the long term thanks to historic data profiling and analysis.

The paper, after a brief review of the PSS concept, will present the conceptual framework for the provision of a bundle of personalized services for special target groups and work-wear and sport-wear products. After that the description of the Data Integration Platform (DIP) and the Smartphone Application architecture is introduced.

2. Product Service Systems (PSS)

The offer of a bundle of products and services is a common trend in several sectors looking forward strengthening the competitive position by diversifying the offer. This phenomenon is often referred to as servitization as it was first named by [4] and is expected to bring financial, marketing and strategic benefits thanks to the integration of value added services in the product's offer [5-7]. An extensive review of literature about servitization is provided in [8]. A research field that is often associated to the servitization process is the one related to the Product Service Systems (PSS) that emphasizes the shift from selling products to selling functions while fulfilling the customer's demand with less environmental impact. A PSS is a specific type of value-proposition (business model) that focuses on fulfilling a final need, demand or function [9]. A classification of different types of PSS has been proposed by [10] or [11] which distinguish between product-oriented PSS, use-oriented PSS and result-oriented PSS.

Even though the servitization concept was initially developed in the business-to-business environment, its logic can be extended to the consumer products and to the social arena. Claiming that existing methods and tools cannot readily assist manufacturers of consumer products to implement PSS, [12] proposes a methodology to develop PSS for consumer products. The PSS is a valuable strategy for reorientation of the production and consumption processes of society as stated in [13]: according to them, the use of PSS can act as a human obesity treatment that requires a systematic awareness of available alternatives to meet the individual needs. They also point out the usefulness of customization in the form of services based on specialized knowledge and skills to get a successful strategy.

An even more society-oriented use of PSS is described in [2] where they analyze whether point-of-care devices can be the core product of a product service system. In particular, they focus on glucometers and investigate what are the informatics requirements to develop a PSS providing point-of-care devices based services. The main service offered to customer is the possibility to translate stand-alone biological data into meaningful information that can be interpreted to enable and support the health management. The application of the PSS concept to devices for health care is quite recent and its exploration is of paramount importance from the social sustainability point of view. By addressing this gap, the paper focuses on a software architecture meant to enable a PSS in the work-wear and sport-wear sectors.

3. The conceptual framework

When developing a Product Service System (PSS), such as the one presented in this paper, several elements need to be integrated at different levels to allow service provision. On the one hand, there are the wearable sensor devices meant to acquire the biometric data and to feed them to the system while, on the other hand, there are services applications which can be synchronous, like real-time monitoring, or asynchronous, like browsing of historical data, that exploit this information for providing support and control in everyday activities.

By exploiting the Internet of Thing approach, communication between devices and applications of several kinds will enable the provision and use of data within the system. To this end a layer for handling and storing such data and for managing the interactions of the connected components is required between devices and applications.

This section is meant to sketch the overall system architecture, describing the above mentioned components and their interactions.

The high level of definition of the system architecture, depicted in Fig. 1, gives an overview of these components with a description of their main responsibilities and their relationships within the system.

The main purpose of this diagram is to show how peripheral systems such as sensors, services and production systems can interact with a centralized platform.

In the proposed solution, the Data Integration Platform (DIP) is the central component meant to supervise the overall system, acquiring sensors and biometric scanner data, providing means in order to monitor remote status of health parameters, to provide an efficient management of sensors feedback information, to drive the production process of personalized goods and to host a suitable data model for the representation of the acquired data.

A description of specific requirements, data models and software structures, identifying the main involved components, needed interfaces and exchanged data, follows in the next sections.

The here proposed software architecture is meant to be a formalization of the software modules, their responsibilities and relationships.