Improving Context-awareness in Healthcare through Distributed Interactions

Juan E. Garrido, Víctor M.R. Penichet, María D. Lozano

Computer Science Research Institute, University of Castilla-La Mancha, Albacete, Spain
juanenrique.garrido@uclm.es
Computer Systems Department, University of Castilla-La Mancha, Albacete, Spain
{victor.penichet, maria.lozano}@uclm.es

Abstract. Context-aware systems represent an adequate tool for healthcare environments. The capability to offer needed information and functionality based on user's context allows to create adequate working atmospheres for medical staff. However, current technology supports the possibility to increase the customization level towards the improvement of the user interaction. This paper describes a remarkable step forward into the concept of context-aware with a comprehensive solution: Ubi4Health. The solution enhances the context-awareness ability by the adaptation of the user experience with the appropriate device, interface and interaction mechanism based on the existing context.

Keywords: healthcare, ubiquity, context-awareness, dui, hci.

1 Introduction

Medical staff has to manage complex situations [1, 2] what implies to: work with professionals of different fields; reach agreement; perform multiple tasks; deal with frequent contingencies what requires a constant adjustment of their actions because the dynamic work [3]; and keep in mind some pending tasks [4].

Aforementioned conditions can be improved through context-aware [5] and ubiquitous [2] systems. Users can work without thinking about the system which is responsible for adapting itself to existing conditions any time and circumstance. Generally speaking, context-aware systems adapts itself to offer functionality and information that user needs based on the context. However, current technological possibilities give a change of going a step forward. The context offers valuable information, such as physical capabilities of the user, which can be used to determine the appropriate interaction mechanism. In this sense, the distribution of multiples interactions ways around the working environment represents an adequate option to start the path of context-awareness improvement.

The distribution of interaction mechanisms is directly related with multidevice environments. The possibility to interact with multiple devices offers more interaction ways. But also, it helps to continue improving the context-aware capabilities. The users can interact with specific devices according with their needs such as mobility

conditions in healthcare [6]. At the same time, a multidevice environment adds a new possibility of improvement for context-aware systems: the use of distribution of user interfaces. As users are provided with a wide range of devices, the system can adapt the interface to the hardware and again, to users' context.

Taking all the above into account, authors have developed an ubiquitous and context-aware comprehensive solution deployed in healthcare centres, named Ubi4Health [7]. The solution supports from task management, alert notification mechanism, falls and fainting detection to a rehabilitation assistant. This paper describes how Ubi4Health generates a novel context-aware environment for users (employees, patients and residents). The contribution appears through the use of distributed interaction mechanisms, a multidevice environment and appropriate user interfaces to adapt the system to user's context. These elements allow users to have an experience adapted to their needs at information and functionality level but also, to the way they interact with the system. Studied related works [6] [8, 9, 10] offer solutions to specific fields as Ubi4Health does inside its modules. However, non of them considers context-awareness as more than adapting data and functionality capabilities.

Following section summarizes the way Ubi4Health improves healthcare conditions thanks to support a novel evolution of context-awareness. Finally, remarkable conclusions are shown.

2 Ubi4Health: Improving and Making Progress on Traditional Context-aware Systems

Ubi4Health is a novel, context-aware and ubiquitous comprehensive solution to enhance working conditions of healthcare environments. The solution is developed modularly and each module is related to a specific domain (Fig. 1): (1) *tasks module* to manage tasks (alerts are tasks with high priority); (2) *rehabilitation module* to improve specific rehabilitation processes; and (3) *KFF (Kinect for Falls and Fainting) system* to automatically detect anomalous situations around the environment.

The context-awareness in Ubi4Health represents a remarkable contribution. The system offers functionality and information based on user's context. However, the objective has been to go a step forward. To that end, three features and capabilities are use together: *distributed multimodality*, *multidevice* and the *distribution of user interfaces*.

Firstly, Ubi4Health disposes of a complete set of interaction mechanisms distributed over the healthcare environment (Fig. 1). On the one hand, the solution allows users to interact with traditional mechanisms (keyboard, mouse and touchscreen). These offer the possibility to work with tasks and rehabilitation modules regardless the circumstance. However, there are situations in which it is needed to make use of other interaction ways to help during the user experience. In tasks module there is a role named operator. This role has to control the completion of the tasks, the adequate staff distribution and the assignment of alerts. As a result, the information to be manage is huge. Therefore, Ubi4Health incorporates the use of users' gaze to interact with the operator. In this way, the system is able to know where the user is looking at in

order to identify loss of information in unattended displays. The system adapts its behaviour and aspect to user's context as it generates notifications to assist the perception of information [11].

Movement based interaction is an essential element. In rehabilitation module, this interaction allows patients to complete their therapies at home. The system analyses patient's movements and automatically guides and monitors. Also, this mechanism offers medical staff the possibility to define exercises to be performed by patients. In concrete, medical staff must generate therapies, defined as postures repetitions. The postures can be created through a 3D designer but also, by the movement of the medical staff. Not only this, in KFF System, the solution uses movement interaction to continuously analyse patient's/residents' postures. The objective is to detect falls and fainting what helps to preserve patient care.

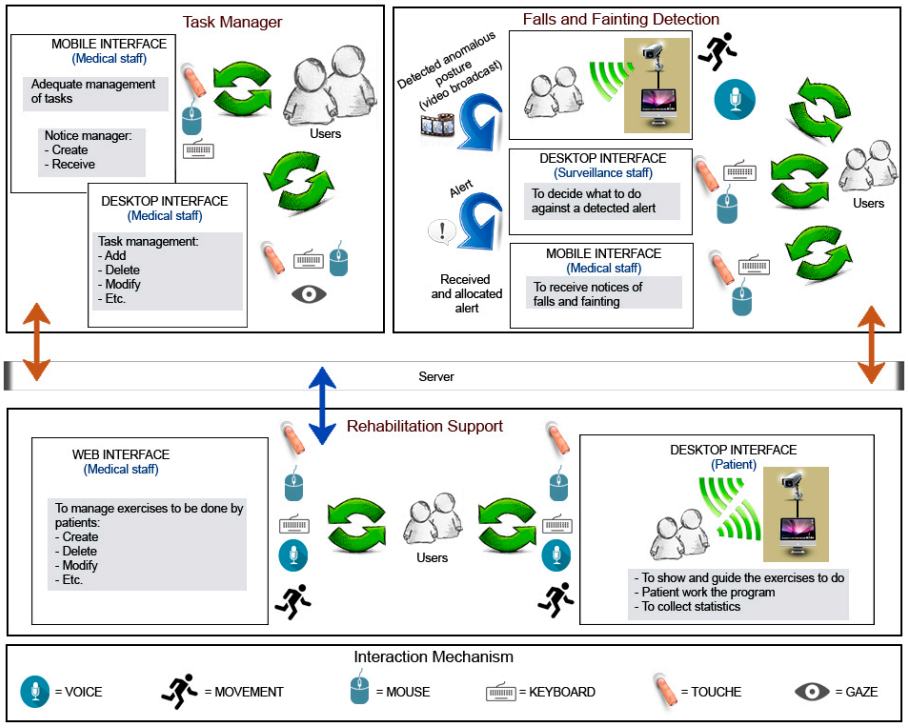

Fig. 1. Interfaces and interaction mechanisms of Ubi4Health

The distributed multimodality offered in Ubi4Health is completed with the user's voice. The solution contains the possibility to control via voice some interfaces. This fact helps in those situations in which the use of hands or the whole body is a complicated task. An example appears during the rehabilitation process. If a patient is doing an exercise, the voice seems to be a good option to control the system.

Described multimodality goes together with an important infrastructure which generates the second feature related to context-awareness improvement: the use of a wide

device set. Ubi4Health offers pcs, laptops, tablets, PDAs, mobile phones and also, Kinect cameras, web cameras and touchscreens. The result is the capacity to adapt the use of the solution to the adequate device based on user's needs. For example, task module considers two user's type with role employee who present different mobility needs. Firstly, there are users who are constantly in movement such as a doctor. They have to work with comfortable devices to be carried with them and also, to be used at any place and time. Ubi4Health offers them with mobile phones, tablets or PDAs. The other type of users has no movement needs, named operator. They are offered with a pc but with a peculiarity, a multidisplay setting. The main reason comes from the fact to work with a big amount of information from different domains.

The last feature of Ubi4Health related to context-awareness is the distribution of interfaces (Fig. 1). The modularity has implied the use of different interfaces for different components of the solution. This fact adds another level of customization to different needs and objectives. In addition, one of the interfaces is a distributed user interface, the one related to tasks and oriented to operators. As these users have to manage big quantities of information, the related interface is deployed over three monitors to support three domains to analyse.

3 Conclusions and Future Work

Healthcare environments compose an important research source on which to apply efforts to improve working conditions. Medical staff has to be able to address complex situations where mobility, multidisciplinary and dynamic features appear as constraints. Under these conditions, an adequate way to help users is to offer a system for they daily day with the capacity to adapt itself according to their needs. On this basis, this paper has presented Ubi4Health, a comprehensive solution for healthcare environments, focusing on the contribution related to context-awareness. The solution supports users with adequate and needed information and functionality based on their current context. However, the use of multiple devices, distributed interaction mechanisms and user interfaces, has allowed to go a step forward. A novel scenario appears, Ubi4Health is able to reach an improved level of user experience. Based on user's context, the solution provides employees and patients the adequate device, user interface and way to interact with it at the time.

There are interesting future works around the presented context-aware issue. Currently, authors consider the possibility to extend the devices implied. For instance, wearable devices entail an interesting way with which Ubi4Health can increase its mobile capabilities and interaction ways.

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