



Perspectives of human factors in designing elderly monitoring system



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ABSTRACT

This paper studies the perspectives of human factors in the context of an elderly monitoring system. Such a system is designed to continuously monitor older adults and support them with various services. It also helps the caregiver with on-the-spot updates based on elderly monitoring. However, how the elderly and human caregiver perceive and interact with such system as an integral part of it, can greatly influence their understanding of the purpose and usefulness of the system. In this paper, we highlight several core functions of an elderly monitoring system and show how human factors can influence the design of the system. Experimental results show improvements with respect to efficiency, effectiveness and user satisfaction.

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1. Introduction

In the current demographics, older adults constitute a large proportion of world population and they often suffer from cognitive and physical impairments. As a result, we witness a significant growth in elderly nursing facilities that assist older adults through caregiver intervention. While such caregiver-based assistance is necessary, burden on the caregivers also remains a concern (Garlo, O'Leary, Van Ness, & Fried, 2010; LaVela, Johnson, Miskevics, & Weaver, 2012; McVicar, 2003) that degrades the quality of support the older adults receive. With the advancement of sensing and communication technology, there have been visible initiatives in designing assistive healthcare systems such as an elderly monitoring system (Hossain & Ahmed, 2012; Tseng & Lu, 2013), which can help the caregiver to keep an watchful eye on the elderly and provide several services in different situations, thus reducing some burden the caregivers face. Clearly such a system involves many stakeholders including elderly, caregivers, emergency personnel and so on. Hence it is important that these systems are designed by considering human in the loop, which is addressed by the human factors principles (Salvendy, 2012).

The area of human factors focuses on interactions among people, system and their environment that contributes to improve the quality of human well being and system performance (iea). With respect to healthcare context, the need to characterize these interactions has been well recognized by many researchers (Carayon et al., 2006; Duffy, 2010; Hignett, Carayon, Buckle, & Catchpole, 2013; Or et al., 2009) in order to meet the emerging needs of the older people and support them in different settings. Fig. 1, adapted from (Carayon

et al., 2006), shows how users (i.e. elderly and caregiver) are integral part of an elderly care system, especially when such a system is interactive with different user groups. Furthermore, such interaction is not simply using the system functionality in an explicit manner, rather it involves automatic and semi-automatic interaction with the instrumented elderly care environment. Fig. 1 also indicates that due to the mismatches among the five elements of the system, i.e. technology and tools, tasks, persons, organization, and environment, many issues relevant to human factors arise (Or et al., 2009). Proper application of human factors principles is the way forward to address these issues.

Human factors principles aim for effectiveness, efficiency, and user satisfaction in the design of artifacts and devices. This is specially important in the design of healthcare products that are useful and usable by the elderly population. Although such importance has been identified by many (Duffy, 2010; Hignett et al., 2013), there are still some gaps in the adoption of human factors principles in healthcare systems (Gurses, Ozok, & Pronovost, 2012). In particular, as the main goal of an elderly monitoring system is to facilitate the interaction among different stakeholders along with continuous monitoring of the elderly, we believe more attention should be paid to the people who are intended to benefit from such a system.

This paper studies the perspectives of human factors in the context of designing an elderly monitoring system. Toward this, it first discusses the different human factors issues relevant to some primary requirements of such system. It then presents an example of an elderly monitoring system and briefly describes the system components. Later it shows how the different human factors consideration influence the design of such a system. Few experiments have been performed that shows the effectiveness and usefulness of the system.

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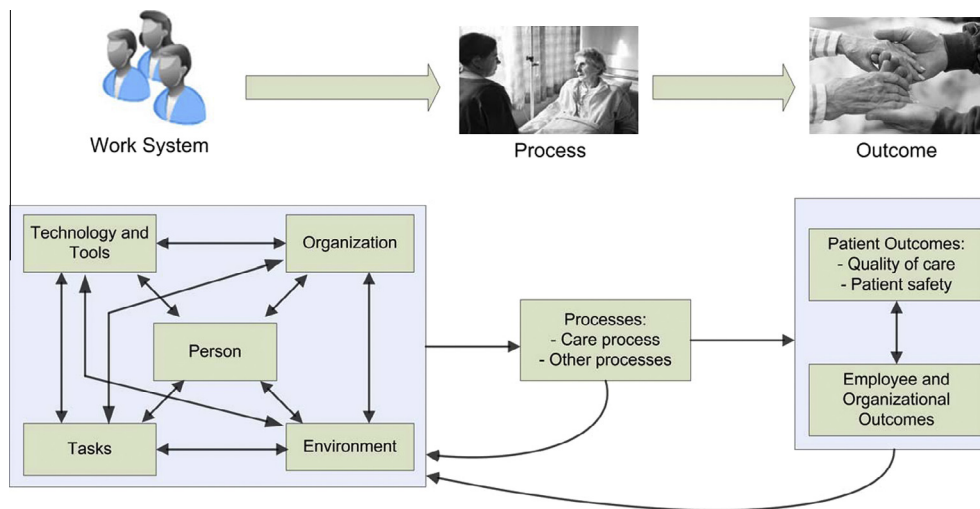


Fig. 1. Analytical framework for human factors in the healthcare facility.

2. Human factors perspectives in elderly monitoring system

An elderly monitoring system is designed to offer many functionalities that are carried out either by the elderly patients, the caregiver or the system itself. Several researchers (Haux, Howe, Marschollek, Plischke, & Wolf, 2008; Koch et al., 2009; Or et al., 2009) have highlighted a variety of such functions. In the following, we describe three most relevant functions and several human factors issues associated to these functions.

- Emergency detection and alarm.
- Information and media service access.
- Interaction and communication.

2.1. Emergency detection and alarm

This function is performed by the instrumented environment where the elderly lives. Usually such an environment is equipped with different sensors and actuators devices (de Ruyter & Pelgrim, 2007; Hossain & Ahmed, 2012; Tseng & Lu, 2013). The sensor-based system continuously monitor the elderly to identify events of interest such as detecting falls. Several human factors are associated with this function. For example, how and when the system should report the detection of an abnormal event is a concern. Depending on the severity of the event, the system should generate alarm and inform the caregiver or other emergency personnel when required. Care should also be given in selecting the appropriate delivery channel through which the emergency situation will be reported, such as controlling the environmental lighting condition, sending SMS or vibrating a wrist band the caregiver might wear.

In a technology-augmented environment, privacy often becomes an important concern (Miskelly, 2001) due to the use of pervasive technology for continuous monitoring. Hence, it is critical that the emergency detection and alarm function of the system adopts privacy-preserving techniques (Moncrieff, Venkatesh, & West, 2008) for improved user satisfaction without compromising the actual monitoring task.

2.2. Information and media service access

Accessing information and media services is one of the primary functions the elderly and caregiver perform (Alpay et al., 2004; Haux et al., 2008; Or et al., 2009). The requested information may vary from health information to medication dosage to dietary

information to a wide range of media services for entertainment. Often older adults struggle to find the right information and have concerns over the use of technology (Wagner, Hassanein, & Head, 2010). However, recent study shows positive attitudes of the elderly towards technology and technology-driven services (Mitzner et al., 2010).

Human factors central to information access lies on how the information is accessed by the elderly and caregiver. The elderly may find it difficult to consume various information due to the way it is presented (e.g. color, font size, screen) or may be overburdened with excessive information. Several context-aware mechanisms (Bricon-Souf & Newman, 2007; Kleinberger, Becker, Ras, Holzinger, & Müller, 2007) can be used to help elderly get relevant information within the right context. User interface also plays a major role on how the elderly perceive the information, especially when elders suffer from various down syndrome or other diseases. Various usability heuristics (Nielsen, 2005) should be applied when facilitating information access to the elderly.

2.3. Interaction and communication

It is fundamental to provide interaction and communication facility within the context of elderly monitoring system. Interaction in this domain is not merely simple human–computer interaction, rather it involves complex human–environment interaction. The premise of elderly monitoring system is a smart instrumented environment consisting of myriad sensor and actuator devices. Hence, different types of interaction with the environment can occur, namely explicit interaction, automatic interaction and semi-automatic interaction (Hossain & Ahmed, 2012). Through explicit interaction the elderly and caregiver may access system functionality by using system-provided interfaces. The automatic interaction is performed by the system itself, which can invoke several services for the user based on the identification of predefined context. In semi-automatic interaction, the system and user can jointly perform a tasks that is needed by the user.

Communication functionality (Or et al., 2009) is another important aspect of elderly monitoring system as it aims to facilitate communication between multiple parties including elderly, caregiver, external service provider, emergency personnel and so on. Effective and efficient communication is vital for elderly care in different scenarios. For example, in case of a fall detection, the caregiver should be notified without delay so as to take appropriate actions.

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