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Review

Context awareness in health care: A review

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ABSTRACT

Background: Health care systems will integrate new computing paradigms in the coming years. Context-awareness computing is a research field which often refers to health care as an interesting and rich area of application.
Aim: Through a survey of the research literature, we intended to derive an objective view of the actual dynamism of context awareness in health care, and to identify strengths and weaknesses in this field.
Methods: After discussing definitions of context, we proposed a simple framework to analyse and characterize the use of context through three main axes. We then focused on context-awareness computing and reported on the main teams working in this area. We described some of the context-awareness projects in health care. A deeper analysis of the hospital-based projects demonstrated the gap between recommendations expressed for modelling context awareness and the actual use in a prototype. Finally, we identified pitfalls encountered in this area of research.
Results: A number of opportunities remain for this evolving field of research. We found relatively few groups with such a specific focus. As yet there is no consensus as to the most appropriate models or attributes to include in context awareness. We conclude that a greater understanding of which aspects of context are important in a health care setting is required; the inherent sociotechnical nature of context-aware applications in health care; and the need to draw on a number of disciplines to conduct this research.

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1. Introduction

Health care will evolve as new technologies are adopted. Even if it is difficult to predict what the future hospital will be, aspects such as context awareness will help health care professionals to shift part of their activities to machines. Reinvention of health care [1] is complex. In this paper, we aim to outline difficulties and possible solutions in the area of context awareness in health care.

Even with the ongoing increase in hospitals use of computerized tools (e.g. powerful hospital information systems, connected laboratory results) these tools are not sufficient and new technologies should support a new way of envisaging the future hospital. The future intelligent hospital will be deeply different from the current one. The introduction of future tools leads to challenging research problems [2–9]. First, such an evolution requires new technologies and new architectures to implement secure and reliable systems. It requires the identification and evaluation of what could be done, for what purpose and how this could be implemented. It could also induce new social or political problems in relation to privacy concerns or acceptance of such systems.

Our focus is on identification, evaluation and implementation of new tools or services for the communication and the cooperation of health care professionals.

Communication between health care professionals represents a large part of their activity [10,11]. This communication, direct or indirect, ranging from laboratory results to complex consultation and advice, is important and useful but at the same time induces many interruptions. This complicates the cognitive activity of the health care providers. Cooperation of health care professionals is indispensable to care, but problems with transmission of information between them still induce breakdowns in communication [12,13]. Errors, which sometimes lead to the death of a patient, have been described in US hospitals [14], and obviously exist in all hospitals.

Cooperation between health care professionals can be increasingly mediated through computerized platforms (e.g. hospital-GP intermediation platforms, homecare coordination platforms, etc.). These coordination tools will integrate new mobile tools and propose new communications abilities [15]. In particular, current technologies allow the introduction of context awareness in every day activities.

Context awareness is a concept that has been described for some time, but technologies (e.g. wireless technologies, mobile tools, sensors, wearable instruments, intelligent artifacts, handheld computers) are now available to support the development of applications. Such technologies could help health care professionals to manage their tasks while increasing the quality of patient care. Nevertheless, new technologies impact the communication between agents. In his paper "Interaction design", Coiera [16] presents a framework for the design of interactions between human and computational agents working in organizations. He describes the impact of a new interaction class (in this discussion, a class that would include context-awareness applications) within an organization. The introduction of a new interaction class will impact the level of interaction and communication by agents in terms of costs and benefits to individuals. When designing new interaction classes, one aim is to ensure optimization of benefit versus cost to individuals.

Health care systems could integrate context-awareness computing, not only to explore new tools but to propose useful and acceptable systems.

Intensive care units (ICU's) contain complex health care situations and are a challenging area for such systems. A number of researchers have underlined this context of work as particularly relevant to the evaluation of complex tools assisting the cooperation between workers [17–19]. The medium term perspective of our research is the definition of a set of requirements for the use of context-awareness tools in the ICU.

Our preliminary work consists of the review of context awareness in health care, and is presented in this paper.

1.1. *Aim of the paper*

Through a survey of the existing literature in context-awareness computing, we intend to discuss the most relevant research relating to health care.

Section 2 presents a brief state of art on what is context, then proposes a framework for the analyses of the context representation, in order to perform this review of the context-awareness projects in health care. Section