

Attention-Based Health Monitoring

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ABSTRACT

The application of mobile technologies for health monitoring has garnered great attention during the last years. The sensors together with a mobile device form a personal area network that monitors the patient's health status. It gives advice to the patient, adjusts the environmental conditions according to the patient's needs, and in the case of an emergency, notifies the patient's doctor or the corresponding medical center. In the current work the authors present a new attention-based architecture for health monitoring emphasizing on the identification of attention seeking and dangerous health states. The experimental results indicate that the proposed architecture responds very fast to the changes of the patient's biosignals and accurately in decisions concerning the patient's health status.

Keywords: Artificial Agents, Biosignals, Context-Awareness, Health Monitoring, Mobile Technologies

INTRODUCTION

In recent years, mobile technologies are increasingly permeating in every aspect of our personal lives. The key advantage of mobile applications over the desktop ones is the combination of the mobility with 24/7 multi connectivity in order to deliver contextualized functionalities (Emmanouilides, 2013). There is a wide range of m-applications and m-market is expected to be worth \$25 billion by the end of 2015 (ABI research, 2010). The use of mobile devices to provide health information, known as "m-health", has gained great attention for supporting

public health and clinical care (Krishna, 2009; Kaplan 2006). Such applications to existing health care delivery and monitoring systems offer great promise for improving the quality of life (Kahn, 2010). They allow healthcare professionals to monitor the health condition of a patient and to act upon indications of an abnormal state at any time and at any place (Broens, 2007).

These applications offer context-aware responses (Unhelkar & Murugesan, 2010) for their patients by automatically adapting to their changing contexts (Hong, 2009). Context aware systems are able to adapt their operations to the

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current context without explicit patient intervention and thus aim at increasing usability and effectiveness by taking environmental context into account (Baldauf, 2007). Context is any information that can be used to characterize the situation of an entity, while an entity can be a person, place or object that is relevant to the interaction between patients and application, including location, time, activities, and the preferences of each entity (Dey, 2001). Mobile devices are typically equipped with sensors that enable the development of context-aware software applications (Liu, 2011).

The context data capturing is very important when designing context-aware systems since it predefines the architectural style of the system at least to some extent (Baldauf, 2007). Several frameworks have been proposed that capture context information from sensors or high level models of context information (Devaraju, 2007).

Chen (2004) states three different context acquisition methods. The first method refers to direct sensor access where the sensors are integrated into the devices and the client software collects the desired information directly from these sensors. The second method includes middle-ware infrastructure that facilitates the low-level sensing details. The context acquisition middle-ware is built into the hosting device that the context-aware application is operated. The third method allows multiple access to remote data resources by introducing a context server and overcomes the drawbacks of the limited computing resource.

Chronic diseases, on the other hand, are increasing in global prevalence and seriously threaten developing countries' ability to improve the health of their populations. Although often associated with developed nations, the presence of chronic disease has become the dominant health burden in many developing countries (Nugent, 2008). The use of mobile technologies in health monitoring has improved sufficiently the quality of patients' life since the most approaches of telecare (May, 2010; Rogers, 2011) are cost-effective (Mistry, 2012) and assumed that the patient is permanently situated in a particular location. Furthermore, all

biosignals were transmitted in a raw form to the medical center, thus increasing the related costs due to continuous usage of telecommunication channels and numerous processing units, for either patients or medical centers.

In this work we utilize an attention-based model inspired from the human brain and present a novel health monitoring approach. The attention-required states are identified through irregular patterns and the agent behavior is adapted accordingly. Attention based models were used extensively in computer vision (Oliva & Torralba, 2006), image (Stentiford, 2004) and video compression (Itti, 2004; Tsapatsoulis, 2007) and text. Despite its fitness to control systems, attention was very rarely used in control-based applications (Kasderidis & Taylor, 2003) and especially in health monitoring. Our approach shows the potential of attention based agents toward this direction.

The remainder of the paper is organized as follows: We begin by introducing the patient monitoring problem. The architecture of an attention-driven artificial agent is then presented, followed by implementation issues concerning the proposed agent architecture. After, simulations and experimental results are presented. Finally, conclusions are drawn and further work hints are given.

THE PATIENT MONITORING PROBLEM

In many circumstances artificial agents would have to monitor their patients and decide on behalf of them for their welfare. To facilitate intelligent decision-making the agents should be able to adapt their monitoring strategy according to the context of the patient. For instance, due to (mainly) power and communication limitations sensors could not be continually polled in their highest sampling rate. This leads to the problem of limited information for effective decision-making. The controlling agents then have to adaptively monitor their patients by increasing or decreasing the sampling rates of the various sensors involved. We define this

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