Pervasive Sensing and M-Health:
Vital Signs and Daily Activity Monitoring

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Abstract. Recent advances in pervasive sensing, mobile, and pervasive computing technologies have led to deployment of new smart sensors and smart sensor networks architectures that can be worn or integrated within the living environment without affecting a person's daily activities. These sensors promise to change vital signs and motor activity monitoring from snapshot mode to continuous monitoring mode, enabling clinicians, therapists but also accompanying persons of elderly or people with chronic diseases or disabilities to provide healthcare services based on remote continuous monitoring of the patient, pervasive health monitoring or pervasive healthcare. Using computer resources expressed by networks of servers, storage applications and Web services health monitoring and healthcare might be rapidly provisioned and released with minimal management effort or service provider interaction by using computational intelligence and Semantic Web.

A brief literature review on healthcare challenges, the deployment of unobtrusive sensors that may be used as part of pervasive sensing systems for vital signs and daily motor activity monitoring, mobile health applications and pervasive computing for pervasive health monitoring and pervasive healthcare are presented in this chapter. The chapter encompasses examples of unobtrusive sensors for health and motor activity monitoring as well as Android OS and iPhone mobile applications from Apps Store for vital and sensory function test, emergency, stress management, brain activity management, nutrition, and physical exercises. Mobile healthcare architectures developed with the contribution of the authors for vital signs and motor activity remote monitoring as well as for indoor air quality monitoring and alert on respiratory distress, which includes wearable devices (wrist worn device) and sensors integrated in objects such as walker and wheelchair are also presented in this chapter.

The presented pervasive sensing and pervasive computing approaches for health monitoring and care underscore the capabilities of this kind of systems to assure more closely coordinated forms of health and social care provision as well as personalized healthcare for better quality of life.

Keywords: pervasive sensing, mHealth, cardiorespiratory assessment, motor activity, pervasive computing.

1 Introduction

The combination of reducing birth rate with increasing life expectancy has raised the need to urgently address aging population pressure on healthcare systems. This healthcare "time bomb" has accelerated the growth in pervasive distributed healthcare technologies that should reduce health interventions costs and improve quality of care for elderly. Strong evidences exist now showing that declining the disability among the elderly for the past several decades [1] was mainly related with improved medical technology and behavioural changes. As is known, disability is closely tied to medical spending, so that reductions in disability can lead to an offset in public and private medical costs. For instance, the United State of America spends $250 billion annually, or 2.5 per cent of the gross domestic product (GDP), on medical care for the elderly [1]. Furthermore, the new health information technology (HIT) for elderly enables a paradigm shift from the established centralized healthcare model to a pervasive, user-centred and preventive overall health management.

Across the developed world, we are witnessing the healthcare environment changing towards integrated and shared care, in which besides the responsibility of health professionals and other caregivers, each individual has the responsibility in managing the issues related with their health. This vision of the future healthcare system may be mainly achieved by deployment of pervasive health monitoring and pervasive healthcare technologies that may allow more closely coordinated forms of health and social care provision as well as personalized medicine. Pervasive healthcare (PH) is an emerging field with considerable technological breadth that is expected to have a strong impact for the quality and efficiency of healthcare. This field is still a nascent one, with a good deal of exploratory research [2]. Pervasive healthcare may be defined from two perspectives: i) as the application of pervasive computing technologies for health care, and ii) as making health care available everywhere, anytime and to anyone [3]. The pervasive healthcare applications include pervasive health monitoring, intelligent emergency management system, pervasive healthcare data access, and ubiquitous mobile telemedicine. Pervasive health monitoring and pervasive healthcare combine various type of health information technologies as: mobile health (see section 4. mHealth), personal health records (PHRs), patient centered medical home (PCMH), e-Patient (health consumer who uses the Internet to gather information about a medical condition of particular interest to him, and who uses electronic communication tools - including Web 2.0 tools - in coping with medical conditions, see http://en.wikipedia.org/wiki/E-patient), eHealth Collaborative (community wide health information exchanges, e.g. www.maehc.org). For large adoption of these technologies, researches and pilot deployment should emphasize the added value to health and social care, the cost-effectiveness of implementation, the security and the privacy of patient health data storage and communication, as well as 'clinical proof-of-concept'.

Sensor-enhanced health information systems may provide subject-centered services in a semantically interoperable environment (see section 5. Pervasive Computing). Smart sensors technology has been identified as a strong asset for