Unobtrusive Smart Sensing and Pervasive Computing for Healthcare

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Abstract - The world's population is ageing fast. According to the United Nations the median age for all world countries will rise from 28 now to 38 by 2050. Also, is estimated that by 2050, the population over 60 years will increase worldwide from 11% to 22%, a higher percentage (33%) of elderly population will be in developed countries. In this context, the governments and private investors are working to increase efficiency and quality of healthcare, searching for sustainable solutions to prevent expenditure increasing on healthcare related with higher care demands of elderly people. Instrumented environments, pervasive computing and deployment of a seemingly invisible infrastructure of various wired and/or wireless communication networks, intelligent interactions between health professionals, informal caregivers and assessed peoples, are nowadays investigated in various research institutions and healthcare system.

Recent advances in the development of sensing solutions for vital signals and physical rehabilitation monitoring will be presented in this tutorial. Will be discussed the features characterizing: i) sensing, acquisition and processing modules embedded in clothes and/or accessories (e.g. smart wrist worn) or in wheelchair and walkers for vital signs and motor activity assessment; ii) cardiac and respiratory assessment - the studies on cardiac sensing accuracy estimation and artefacts influence on cardiac function sensing through capacitive coupled electrocardiography, electromechanical film sensor and microwave Doppler radar ballistocardiography, reflective photo-plethismography; iii) blood pressure, heart rate variability and autonomic nervous system activity estimation based on virtual sensors included in wearable or object embedded device; iv) daily activity signals acquisition and processing through microwave motion sensor, MEMS inertial measurement units, infrared multi-point motion sensors; v) *theragames* based on motion sensing and recognition. Several methods for diagnosis and therapy monitoring, as time frequency analysis, principal component analysis and pattern recognition of motion signals with application to gait rehabilitation evaluation will described. Using a set of metrics that are calculated using the information delivered by the unobtrusive sensors for motion capture, objective evaluation of rehabilitation session effectiveness can be performed. The developed work under project Electronic Health Record for Physiotherapy promoted by Fundação para Ciência e Tecnologia, Portugal, for developing new solutions such as serious games for physiotherapy characterized by natural user interface will be also presented. Results concerning the testing of the implemented serious game for physical rehabilitation as so as the metrics validations using sensing devices as inertial measurement units will be also considered.

Unobtrusive smart sensing and pervasive computing for health monitoring and physiotherapy interventions may allow better assessment and communication between health professionals and clients, and increase likelihood of development and adoption of best practice based on adoption of evidence-based techniques and technologies.