Smart sensor architecture for vital signs and motor activity monitoring of wheelchair' users

Publisher: IEEE

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Abstract:
The development of a smart sensor architecture for health status monitoring and daily motor activity of wheelchair users is considered. Modularity of solution and compatibility of the architecture with IEEE1451 standard for smart sensors were part of the requirements. Thus the work presents a microcontroller-based platform compatible with IEEE 1451.4 standard for vital signs and motor activity assessment of wheelchair users. The identification of the wheelchair user is done using the LF RFID technology through a RFID reader connected to the platform. The signals from unobtrusive sensors embedded in the wheelchair characterized by plug-and-play and auto-identification capabilities are acquired and primary processed at the platform level and transmitted using IEEES02.15.4 wireless communication protocol to a server application implemented in a host PC. Referring to the embedded sensors considered in the present approach, photoplethysmography, skin conductivity, and ballistocardiography are used for cardiorespiratory assessment while a 3D accelerometer is used for motor activity assessment. Elements of human-machine-interface (HMI) implementation and several experimental results are included in the paper.

Published in: 2012 Sixth International Conference on Sensing Technology (ICST)

Date of Conference: 18-21 Dec. 2012 **INSPEC Accession Number:** 13325526

Date Added to IEEE *Xplore*: 14 February 2013 **DOI:** 10.1109/ICSensT.2012.6461663

ISBN Information:

ISSN Information:

Publisher: IEEE

Conference Location: Kolkata, India

Contents

In the last years the necessity to reduce the hospitalization costs and to allow proactive and preventative care led to a set of developments in the field of home health monitoring. Such systems, denominated vital signs monitors, usually include blood pressure, heart rate, oxygen saturation, and temperature measurement [1]. The data from the monitors are sent to a clinical server allowing for early identification of clinical needs, adjustments to the treatment plan and medications, reducing emergency room visits and unplanned hospitalizations. The complexity of this kind of systems, especially the measurement procedure that imply the active participation of the users, conducts to undesired induced stress when no clinical staff is present or, even worst, when the patient avoids using of the vital signs monitor. In these conditions, unobtrusive embedded vital signs monitors associated with daily used objects represent interesting alternative solutions [2]. Our group has been developing a set of smart objects for vital signs and motor activity assessment of elderly people or related to rehabilitation and mobility assessment, as part of different prototypes of smart wheelchairs [3] [4] and smart walkers [5] [6]. In all developed prototypes, the hardware component of the smart objects can be characterized by the existence of different biomedical sensors, inertial sensors, force sensors and specific conditioning circuits. To assure modular and flexible solutions the vital signs and motor activity sensors can be assembled in plug-and-play modules containing the appropriate conditioning circuits, the sensor information in electronic format and a standard bus for data communication in a standard format. Several solutions regarding “plug-and-play” smart sensors are reported as prototypes or as commercial solutions [7] [8] [9].