IEEE 1451.4 embedded smart sensors architecture for wheelchair user monitoring

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Abstract:
The design and implementation of a microcontroller based platform compatible with IEEE 1451.4 standard for high performance unobtrusive accurate cardio-respiratory and motor activity estimation of wheelchair users are presented in this paper. The platform is a multi-sensor architecture that includes sensors with plug-and-play and auto-identification capabilities, a RFID reader that is used to identify the wheelchair user, and RFID tags mounted in critical regions of the indoor habitat. The acquired data from the smart sensor channels are delivered through Bluetooth communication or wired serial communication to a host computer that includes a server application associated with IEEE 1451.4 TEDS management and display of the measured data. Elements of human-machine-interface (HMI) implementation and several experimental results are included in the paper.

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Contents

In the past years, various electronic health records systems [1] have been developed in many countries to cope with demographic developments, social changes, and the rising costs of health and social care. Some of the systems were implemented in the framework of pervasive healthcare systems [2] as a more effective and cheaper way for clinical assessment. 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]. 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. Considering the complexity of the prototype sensing but also the necessity to develop solution characterized by high modularity and interoperability, it would be advantageous for biomedical and motor activity sensors to be assembled in plug-and-play modules containing the conditioning electronics, 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 presented in literature [6] [7], the IEEE 1451.4 standard being the most appropriate for the present applications. There exist some commercial implementations based on this standard, such as Futek's IEEE 1451.4 compatible torque sensors [8] and Transducers Techniques load cells [9]. The IEEE 1451.4 based system implementation is commercially available from E-Sensors that uses 1-wire protocol to implement IEEE 1451.4 compatible temperature sensors. The plug-and-play modules would allow developing auto-configurable unobtrusive health monitoring systems provided with the chosen standard bus and managed by standard software. The main problem is related to the choice of a suitable standard, universally accepted, that can be used with different types of sensors embedded in the smart wheelchair for vital signs and motor activity monitoring.