V. Bianchi, F. Grossi, G. Matrella, I. De Munari, P. Ciampolini. Fall detection and gait analysis in a smart-home environment. Gerontechnology 2008; 7(2):73. Falls are a leading cause of injuries and deaths among older adults. Risk factors of falls include abnormal balance and gait[1]. Gait analysis may prefigure a fall, as well as gauge the stage of a disease like Parkinson[2]. A sensor, capable of gait evaluation and fall detection has been integrated in an assistive smart-home system[3]. **Methods** The wearable peripheral consists of a small board, which includes a MEMS tri-axial accelerometer and a wireless transceiver, compliant with ZigBee/IEEE802.15.4 standard. A single microcontroller takes care of both the ZigBee stack management and of local analysis of acceleration data. A lightweight sensor has been designed, suitable for being worn on the belt, and low power design techniques has been adopted to preserve battery life. On-board data analysis is carried out, to minimize power-hungry wireless communication. Both acceleration and orientation data are extracted from the single accelerometer data stream and simple algorithms are used by the microcontroller to detect abnormal gait and falls. Fall detection is obtained by searching for combined acceleration and tilt peaks[4], whereas gait 'quality'[5] is evaluated by looking at the trunk sway. Self-calibration of the vertical direction is carried out, to keep results independent of the actual sensor wearing orientation. Integration in the home control network permits sensor data to be logged and profiled, allowing for detection of slow drifts of the gait quality and for correlation with further environmental or personal information to adaptively recalibrate the sensor parameters, to provide prompt localization of the fallen person or automatically switch on the lights along the walking path. **Results and discussion** A first prototype of the wearable smart sensor has been fabricated, which features small size (5x5cm) and low power consumption. To calibrate acceleration thresholds, tilt angles and timing of the algorithm, several accidental falls were simulated. Regardless of accidental accelerations due to jumps, stair climbing, sitting or bending all the falls were eventually detected and no false alarm was issued. Radio communication enables the system supervisor to issue alarm messages within 3 seconds from the fall, forwarding alerts to caregivers or family members through LCD panels, wireless PDA's or cell phones, or over the internet. Evaluation of the trunk sway is used instead to infer staggering gait. A number of test were carried out, and reliable detection of staggering was demonstrated. In Figure 1, some of the sensor's outputs are reported. For simplicity, accelerations are not shown and only the computed angles are reported, referring to a simulated sequence of events: initially the sensor bearer sits, then (after 0.5 min) he begins to walk normally. At 1.5 min he begins to stagger, and the sensor raises the staggering flag. Eventually (at 2.5 min) a fall is simulated, and the fall alarm is received by the system supervisor. The simple, yet effective, algorithms which have been devised are suitable for system-on-chip implementation. A monolithic version of the sensor integrates several MEMS devices together with dedicated control circuitry. It will allow for a significant leap in device size and power consumption and will be used as the core of a multifunctional wearable platform, fully integrated into a monitoring and assistive home system.

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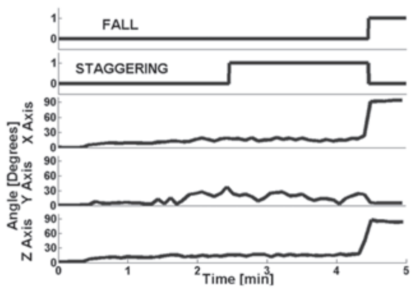

Figure 1 sensor's sample outputs