L. Quagliarella, N. Sasanelli, G. Belgiovine. A fall and loss of consciousness wearable detector. Gerontechnology 2008; 7(2):191. Falls are a major cause of death and serious injury among older persons. After falling, more than 20% of elderly people remain on the ground for an hour or more and half of them die within 6 months, even if no direct injury from the fall has occurred[1]. We developed and validated a device for automatically detecting a fall with a loss of consciousness (FLoC) by means of an accelerometer sensor and an automatically activated alarm call. **Methods** Ten young healthy adults (33.6±1.2yrs) and 10 healthy elderly subjects (75.8±3.2yrs) were recruited and asked to give their written informed consent before undergoing tests. The young subjects performed 200 simulated FLoCs and 60 simulated Non Common Activities (NCAs), whereas the elderly subjects performed 200 Activities of Daily Living (ADL). Each FLoC simulation was performed onto a large crash mat, starting from an upright position. The NCA tests consisted of two kinds of movements presenting impacts, trunk rotations, and immobility. The ADL-related tests included: (i) walking forward; (ii) going down one step; (iii) sitting down in a kitchen chair; (iv) sitting down and lying down on a bed; (v) bending forward to pick up an object from the floor. A triaxial accelerometer (two ±10 g MEMS accelerometers orthogonally mounted) was placed on the subjects' belt, and connected to a wearable data-logger (SARI)[2]. The signals were recorded at 8-bit resolution with a 100-Hz sampling frequency for 120s and were processed in Matlab (The Mathworks). All tests were subdivided into a Training Set (TS) and a Verification Set (VS), made of the same number of tests as well as of the same percentages of FLoCs, NCAs and ADLs. **Results and discussion** A FloC was characterised by the impact of the body against the ground, the lying position, and the subject immobility. The presence of acceleration spikes is the distinctive sign of the impact phase. Since in some ADLs the acceleration modulus peaks and the Cranium-Caudal Component (CCC) peaks are higher than in FloCs, an acceleration-peak based method cannot be used. The mean value of the acceleration CCC; the mean value of the jerk CCC; and the peak of the rectified value of the jerk CCC were analysed using a threshold-based method. The threshold values were devised for each of the three parameters through Receiver Operating Characteristic (ROC) curves. The best performance parameter was the peak of the rectified value of the jerk CCC (*Table 1*). After the impact, a threshold-based method was adopted to detect both the lying position and the subject's immobility. The two threshold values were obtained by statistical analysis of the mean value of the acceleration CCC and the mean value of the rectified jerk CCC in a 60 s time window after the impact. The method proposed is able to correctly identify all FloCs and ADLs using only one channel of the triaxial accelerometer. The promising results obtained prompted us to start a long-term monitoring of the activities of daily living in elderly people implementing the detection algorithm into a miniaturized version device.

References

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Table 1 Impact thresholds as calculated in a time window of 6.1s in a lying position and immobility threshold values were devised at 99th percentile of the parameter distribution in a windows of 60 s after impact

Event	Parameter	Mean (SD)	Threshold values	FLoC Sensitivity	ADL Specificity	NCA Specificity
	Acc. mean value	0.27 (0.23) g	0.81 g	100%	7%	23%
Impact	Rect. jerk peak	$6.6 \cdot 10^{-3}$ ($4.1 \cdot 10^{-3}$) g/s	$1.4 \cdot 10^{-3}$ g/s	100%	47%	33%
	Rect. jerk mean[a]	$2.6 \cdot 10^{-4}$ ($0.9 \cdot 10^{-4}$) g/s	$3.5 \cdot 10^{-4}$ g/s	100%	57%	75%
Lying	Acc. mean[b]	0.02 (0.14) g	0.35 g	100%	100%	97%
Immobility	Rect. jerk mean[e]	$5.1 \cdot 10^{-5}$ ($2.5 \cdot 10^{-5}$) g/s	$11.0 \cdot 10^{-5}$ g/s	100%	100%	100%
c+d+e		TS		100%	100%	75%
c+d+e		VS		100%	100%	63%