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Data Article

A dataset for the development and optimization of fall detection algorithms based on wearable sensors



Valentina Cotechini, Alberto Belli, Lorenzo Palma, Micaela Morettini, Laura Burattini*, Paola Pierleoni

Department of Information Engineering, Università Politecnica delle Marche, Ancona, Italy

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ABSTRACT

This paper describes a dataset acquired on 8 subjects while simulating 13 types of falls and 5 types of Activities of Daily Living (ADL), each repeated 3 times. In details, data includes 4 simulated falls forward (falling on knees ending up lying, ending in lateral position, ending up lying, ending up lying with recovery), 4 backward (falling sitting ending up lying, ending in lateral position, ending up lying, ending up lying with recovery), 2 lateral right (ending up lying, ending up lying with recovery), 2 lateral left (ending up lying, ending up lying with recovery), and 1 syncope. Simulated ADL are: lying on a bed then standing; walking a few meters; sitting on a chair then standing; go up or down three steps; and standing after picking something. Data were acquired using a MARG sensor, a wearable multisensory device tied to the subject's waist, that recorded time-variations of the subject's acceleration and orientation (expressed through the yaw, pitch and roll angles). These data can be useful in the development and test of algorithms to automatically identify and classify fall events. Fall detection systems are particularly useful when a subject is alone and not able to stand up after a fall, since an automatic alarm can be sent remotely to receive proper help.

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* Corresponding author.

E-mail addresses: vcotechini@gmail.com (V. Cotechini), abelli@univpm.it (A. Belli), l.palma@univpm.it (L. Palma), m.morettini@univpm.it (M. Morettini), l.burattini@univpm.it (L. Burattini), p.pierleoni@univpm.it (P. Pierleoni).

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Specifications table

Subject area	<i>Bioengineering of movement</i>
More specific subject area	<i>Fall detection</i>
Type of data	Graph, video
How data was acquired	Wearable MARG (Magnetic Angular Rate and Gravity) sensor integrating a magnetometer (HMC5883L, Honeywell, USA), an accelerometer (ADXL345, Analog Devices, USA) and a gyroscope (ITG-3200, InvenSense Inc., USA).
Data format	Raw and analyzed
Experimental factors	Raw data from sensors and analyzed data obtained from data fusion algorithm.
Experimental features	Healthy young subjects simulating 13 falls (4 forward, 4 backward, 2 lateral right, 2 lateral left, 1 syncope) and 5 actions of daily living, while wearing MARG devise.
Data source location	Sensor Network and Internet of Things laboratory, Department of Information Engineering, Università Politecnica delle Marche, Ancona, Italy
Data accessibility	Data is with this article
Related research article	P. Pierleoni, A. Belli, L. Palma, M. Pellegrini, L. Pernini, S. Valenti, A High Reliability Wearable Device for Elderly Fall Detection, IEEE SENSORS JOURNAL VOL. 15 NO. 8 (2015) 4544-53 [1]

Value of the data

This kind of data could be useful:

- to develop algorithms to automatically identify and classify a fall event;
- to test and compare already existing fall-detection algorithms;
- to develop alarm systems for falls occurring at home especially among people (like elderly) who might be unable to seek for help;
- to support future studies on biomechanics of human fall.

1. Data

The proposed dataset is the only one that provides a complete set of data detected through a MARG sensor placed at the waist of the subject representing the most comfortable and least invasive position for wearing a sensor. Moreover, compared to other datasets in the literature [2], it is the only one that presents a complete set of falls including syncope also defined as backwards fall against a wall.

Data are organized in two main directories, *Fall* and *ADL* each containing several folders as depicted in Fig. 1; each path ends with three folders, *FileTXT* and *Graph* (as represented for *ADL/Lying&Stand* only), containing the data files of each subject, and *TrainingVideo*, containing files .mp4.

The files inside *FileTXT* are called $Si_j.txt$, where $i = 1,2...8$ indicates the subject, and $j = 1,2,3$ indicates the repetition. Each .txt file is composed of 14 columns, separated by semi column, that represent the timeseries of the following parameters listed in the first row:

- 1st column is time in seconds (s);
- 2nd to 4th columns contain acceleration along x, y and z axes (acc_x , acc_y , acc_z) expressed in gravitational acceleration g ($1 g = 9.80665 m/s^2$);
- 5th to 7th columns contain angular rate with respect to x, y and z axes (gyr_x , gyr_y , gyr_z), expressed in degree per second ($^\circ/s$);
- 8th to 10th columns (mag_x , mag_y , mag_z) contain the Earth's magnetic field along x, y and z axes, expressed in Gauss (G), $1 G = 1 \times 10^{-4} T$ (Tesla);
- 11th column contains the Signal Vector Magnitude (SVM) of the acceleration in g, computed as the square root of the sum of squared acceleration components;
- 12th to 14th columns contain orientational yaw, pitch and roll angles around z, y and x axes, respectively, expressed in degree ($^\circ$).

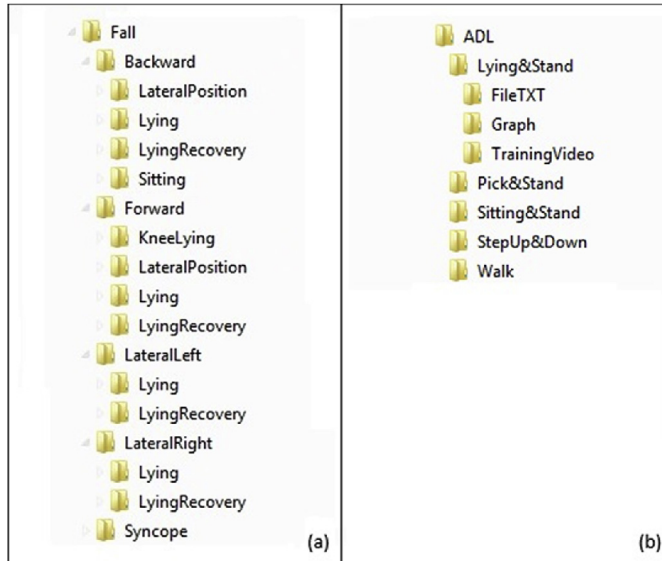


Fig. 1. Data folders organization.

The length of recordings is variable among different subjects, trials and repetitions; thus, the number of rows in each .txt file varies accordingly.

The files inside *Graph* are called $S_i_j.jpg$, where $i = 1, 2, \dots, 8$ indicates the subject, and $j = 1, 2, 3$ indicates the repetition. Each .jpg file contains two subplots; the upper plot represents the SVM of the acceleration over time, while lower plot represents the trend of the pitch and roll angles over time.

The files inside *TrainingVideo* show how to simulate a specific fall or Activities Daily Living (ADL). Overall, there are 432 .txt files, 432 .jpg files and 18 .mp4 files.

2. Experimental design, materials and methods

The experiment was performed on 8 healthy volunteers (6 males and 2 females, from 22 to 29 years old) and was carried out in accordance with the Declaration of Helsinki. Each subject signed an informed written consent before participating.

The experimental protocol was proposed by Noury et al. [3] and previously used in Refs. [1,4] and partially in Ref. [5] to simulate realistic scenarios of falls and ADL. After a proper video training, each subject has simulated, for 3 times, 13 types of falls and 5 types of ADL as reported in Table 1. Specifically, 4 simulated falls are forward (falling on knees ending up lying, ending in lateral position, ending up lying, ending up lying with recovery), 4 backward (falling sitting ending up lying, ending in lateral position, ending up lying, ending up lying with recovery), 2 lateral right (ending up lying, ending up lying with recovery), 2 lateral left (ending up lying, ending up lying with recovery), and 1 syncope. Simulated ADL are lying on a bed then standing, walking a few meters, sitting on a chair then standing, go up or down three steps, and standing after picking something.

Each subject has worn an elastic belt on which was fixed, through adhesive Velcro, the device described in Ref. [1], including a MARG sensor inside a hard-plastic box. The MARG sensor integrates 3-axis HMC5883L magnetometer (Honeywell, USA, with resolution of 4 mG in ± 8 G fields), ADXL345 accelerometer (Analog Devices, USA, with resolution of 4 mg/LSB in ± 16 g range) and ITG-3200 gyroscope (InvenSense Inc., USA, with resolution of 14.375 LSBs per $^\circ/s$ in $\pm 2000^\circ/s$ range). A proper data fusion algorithm applied to the raw signals of the three sensors [6] was used in Ref. [1] to compute yaw, pitch and roll angles representing the subject's orientation, i.e. subject's rotation around the z, y and x axis, respectively.

Table 1

Classification of the simulations performed in the experiment.

FALL	Forward	falling on knees ending up lying ending in lateral position ending up lying ending up lying with recovery
	Backward	falling sitting ending up lying ending in lateral position ending up lying ending up lying with recovery
	Lateral right	ending up lying ending up lying with recovery
	Lateral left	ending up lying ending up lying with recovery
	Syncope	slipping against a wall ending up sitting lying on a bed then standing walking a few meters sitting on a chair then standing climbing three steps standing after picking something
ADL		

Falls were performed safely with the supervision of support staff on a 15 cm thick mattress.

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Transparency document

Transparency document associated with this article can be found in the online version at <https://doi.org/10.1016/j.dib.2019.103839>.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dib.2019.103839>.

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