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Data Article

Kinetic data simultaneously acquired from dynamometric force plate and Nintendo Wii Balance Board during human static posture trials



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ABSTRACT

Data provided with this article are relative to kinetic measures from standing posture trials in eye open and eye closed conditions of 15 healthy subjects, acquired from a dynamometric force plate and a Nintendo Wii Balance Board (NBB). Data have been originally collected for a research project aimed at evaluating the reliability of low-cost devices in clinical scenarios. Raw data from the force plate include three ground reaction force components, center of pressure trajectories and torque around the vertical axis. Raw data from the NBB consist of vertical component of the ground reaction force measured by each of the four device sensors. Processed data consist of synchronized center of pressure time-series from both devices, referred to the force plate reference frame. Data were acquired simultaneously from the devices, allowing a direct comparison between the kinetic measures provided by the gold-standard for posture analysis (dynamometric force plate) and a low-cost device (NBB). Utility of present data can be twofold: first they can be used to assess the overall quality of the NBB signals for posturographic analysis by a direct comparison with the same signals acquired from the gold-standard device for kinetic measurement. Secondly, data from the dynamometric force plate can be used *per se* to evaluate different kind of parameters useful to assess balance capabilities, also by comparing data from different sensorial conditions (eye open versus eye closed).

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Specifications Table

Subject	Biomedical Engineering
Specific subject area	Low cost devices for balance and posture analysis
Type of data	MATLAB data files (.mat) Excel file (.xlsx)
How data were acquired	Dynamometric platform (Bertec H4060) Nintendo Wii Balance Board
Data format	Raw data Processed data
Parameters for data collection	Data were acquired from 15 healthy young adults (8 males, 7 females, age 23.3 ± 3.0 years, weight 67.4 ± 9.7 kg, height, 1.68 ± 0.09 m) without any musculoskeletal or neurological disease which can affect posture and balance maintenance.
Description of data collection	Subjects maintained their posture upon a Nintendo Wii Balance board placed on a dynamometric force plate, mounted flush with the floor. Each subject performed two posture trials in an eyes open and eyes closed condition. Each trial lasted at least 30 s. Kinetic data were simultaneously acquired from the two devices.
Data source location	Movement Analysis Laboratory Department of Information Engineering Università Politecnica delle Marche Ancona Italy
Data accessibility	Data are within the article

Value of the Data

- Data are useful to support the investigation of low-cost devices for posture analysis, which could be used in clinical environments for a smart evaluation of balance capabilities in different kind of population.
- Researchers can benefit from these data to check and analyze the quality of the Nintendo Wii Balance Board force signals and derived measures by a direct comparison with the gold-standard device for posture analysis.
- These data can be used to compare the quality of the Nintendo Wii Balance Board for kinetic measures made during motor tasks different from the unperturbed balance maintenance.
- An additional value of these data is that they were acquired simultaneously from the two devices, allowing a direct comparison between a low-cost device and the gold-standard device for kinetic measures.

1. Data

The dataset provided with this article contains data simultaneously acquired during unperturbed standing posture trials in 15 healthy and young subjects (male/female ratio 8/7, age 23.3 ± 3.0 years, weight 67.4 ± 9.7 kg, height, 1.68 ± 0.09 m) from a dynamometric force plate (FP, Bertec, H4060, Fig. 1A) and a Nintendo Wii Balance Board (NBB, Fig. 1B). All the 15 volunteers performed the standing trial in an eye-open and an eye-closed condition but for two subjects the data streamed from the NBB failed to be correctly saved and stored, hence resulting not available for further analysis. Therefore, for the eye-closed condition, data relative to a subset of 13 individuals can be found in the proposed dataset. The dataset consists of two different files: the first is a .xlsx file, named "Subjects_data", where the anthropometric data of each subject (S_1, \dots, S_{15}) are reported, i.e. gender, age, weight and height. The second file is a .mat file, named "Dataset_posture.mat", containing the posture trial data acquired from both devices.

The .mat file consists of four different structure files: RawDataEO, RawDataEC, SincDataEO and SincDataEC, where the suffix EO indicates structures containing data acquired during the eye open trials while EC stands for the structure where data acquired in the eye closed trials are reported. Each of the 4 structures contains another structure with data relative to each considered subject; therefore, as reported above, the eye open structures (RawDataEO and SincDataEO) are made by 15 different structures, while the eye closed structures (RawDataEC and SincDataEC) consist in 13 different structures. Each subject structure is named according with the nomenclature reported in the "Subjects_data.xlsx" file, from S_1 to S_{15} .

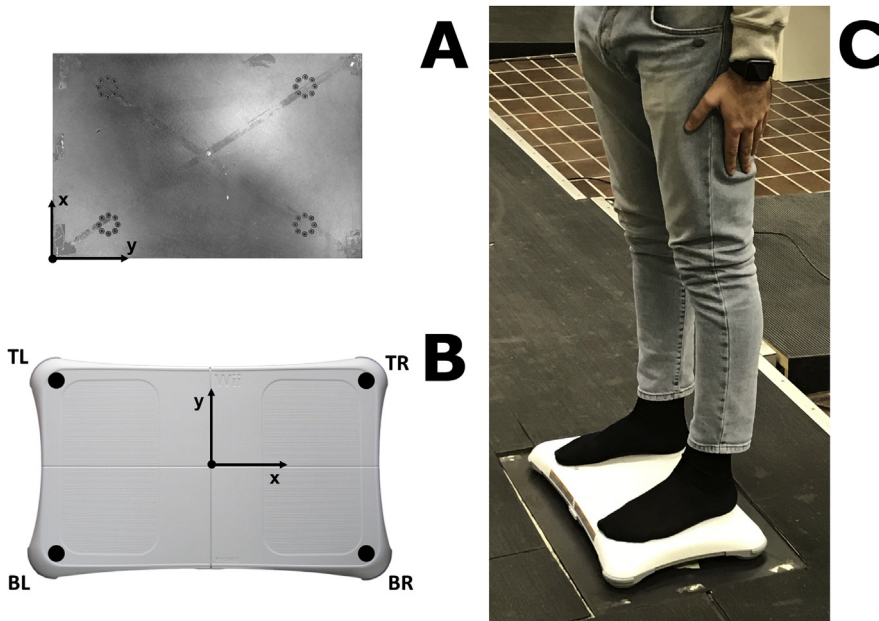


Fig. 1. Dynamometric platform (A) and Nintendo Wii Balance Board (B) reference frames. TL, TR, BL and BR indicate the Nintendo Wii Balance Board sensors. In panel C, the experimental setup is reported, where the subject maintains its upright stance while standing on the NBB, placed upon the FP.

Each subject structure includes two MATLAB matrices, the first one, named “DP”, contains raw data acquired from the dynamometric force plate while in the second one, named “NWBB” there are the raw signals from the NBB. In RawData structures, the DP matrix contains six data columns: in the first one there are the time stamps (ms), while columns two, three and four contain the anterior-posterior (AP), medial-lateral (ML) and vertical components of the ground reaction force (N). Center of pressure (CoP) displacement (mm) in AP and ML directions is in the fifth and sixth columns, referred to the dynamometric force plate reference frame (Fig. 1A). The last column contains the torque (N·mm) around the platform vertical axis. The NWBB matrix has six columns, organized as follows: in the first one there are the time stamps of the acquisition (s). In the second column is reported the vertical ground reaction force component, corresponding to the average of the measures of the four NBB sensors. The third and fourth columns store the vertical force values (N) measured by the top left and right sensors (TL and TR, Fig. 1B), while the fifth and sixth columns contain vertical force values from bottom left and bottom right sensors (BL and BR, Fig. 1B). It is important to note that NBB sensors are able to measure only the vertical component of the ground reaction force and not also the two planar components, along the x and y axes (Fig. 1B).

In the SincData structures, the DP and NWBB matrices have two columns where the CoP displacement in the AP and ML directions is reported (first and second column, respectively). CoP data of both devices are temporally synchronized with a sampling rate equal to 500 Hz, low-pass filtered with a cut-off frequency of 15 Hz and referred to the FP reference frame (Fig. 1A).

2. Experimental design, materials, and methods

All testing procedures for each volunteer were performed within a single day. The dynamometric force plate (Bertec H4060, dimension 40×60 cm) was used as the gold-standard reference for kinetic measurements, mounted flush with the laboratory floor. The Nintendo Wii Balance Board (dimension 23.8×43.3 cm) was placed on top of the dynamometric FP and each subject stood barefoot on the NBB surface, with the feet within the rectangular borders imprinted on the NBB surface. Subjects were instructed to stand with their arms on the sides of the body and to remain as still as possible for the entire

duration of the task (Fig. 1C). Each posture trials lasted at least 30 s. Each volunteer signed written informed consent prior the beginning of the test and the experimental procedures were approved by the local expert committee.

FP data were acquired by means of a professional movement analysis system (Elite, BTS-Bioengineering, Italy) with a sampling rate of 500 Hz, while NBB data were streamed through Bluetooth and collected by a free software (<https://wiimotephysics.codeplex.com>). NBB raw signals were also visually checked by the examiner and in case of glitches or artifacts the trial was aborted and repeated. The latter procedure resulted in completely clean data, without any amplitude spike or sample leakage, as also assessed by a further data examination before proceeding with the post-processing. NBB data presented time jitter and an inconsistent sampling rate for all the four sensors, close to 100 Hz [1,2] and therefore they were linearly interpolated in order to obtain proper time-series with $500 \text{ samples} \cdot \text{s}^{-1}$, following what was reported in [3,4].

For each posture trial, the center of pressure was calculated and provided in SincData structures, representing a central feature for further analysis regarding balance capabilities and posture control [3,5,6]. CoP displacement for the FP were provided directly from the acquisition system and therefore they were reported in RawData structures (see Data section). However, due to the presence of the NBB upon the FP surface, the CoP trajectories of the FP needed to be recomputed by taking into account the thickness of the NBB. From raw FP data, the CoP displacement in both x and y directions was computed by the acquisition system from the following relations:

$$\text{CoP}_x = -\frac{M_y + h \cdot F_x}{F_z} \quad (1)$$

$$\text{CoP}_y = \frac{M_x + h \cdot F_y}{F_z} \quad (2)$$

where M_x and M_y represent the torques on the x and y axis respectively; F_x , F_y and F_z represent the ground reaction force components on the x, y and vertical axis and h stands for the thickness (mm) above the top surface of any material covering the force plate. Therefore, by using (1) and (2), the center of pressure trajectories for both axes have been recomputed with a value of h equal to the NBB height (55 mm). Due to the experimental setup, the x axis represents the AP direction and conversely the y axis the ML one (Fig. 1A). From raw NBB data, the center of pressure displacement was computed as follows:

$$\text{CoP}_x = \frac{L_x}{2} \cdot \frac{T_R + B_R - T_L - B_L}{T_L + T_R + B_L + B_R} \quad (3)$$

$$\text{CoP}_y = \frac{L_y}{2} \cdot \frac{T_L + T_R - B_L - B_R}{T_L + T_R + B_L + B_R} \quad (4)$$

where T_L , T_R , B_L and B_R are the vertical ground reaction force component measured by the four NBB sensors and L_x and L_y are the length of the NBB in the x and y dimensions (Fig. 1B). Due to the experimental setup, the x axis represents the ML direction and the y axis the AP one. All the center of pressure trajectories were expressed in mm. Onset of the measurements were synchronized following [3] and the NBB CoP trajectories were referred to the FP reference frame. It is worth noticing that the latter computation does not prevent to use present data to analyse CoP trajectories as time-series referenced to the mean CoP, as commonly performed in the majority of posture and balance related studies [4,5,7]. CoP time-series for both FP and NBB were low-pass filtered by a second-order, linear-phase Butterworth filter, with a cut-off frequency of 15 Hz.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dib.2019.105028>.

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