

Transitions of loaded and unloaded walking dataset

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The dataset was acquired at the Lauflabor Locomotion Laboratory of the Technical University of Darmstadt, Germany.

The dataset is used and partly described in **Electromyography (EMG) based feature selection for detecting movement effort in human-in-the-loop optimization of lower limb exoskeletons**

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The dataset was also used in: **Exploring surface electromyography (EMG) as a feedback variable for the human-in-the-loop optimization of lower limb wearable robotics**

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Some of the text in this documentation is taken from these two articles.

General information:

The dataset was collected to investigate muscle responses under different loaded walking conditions (0kg, 2kg, 4kg, 8kg). Thirteen participants (age: 27 ± 5 years; height: 1.82 ± 0.07 m; body mass: 81 ± 11 kg) took part in the experiment. Data were recorded while participants walked on an instrumented treadmill at a constant speed of $1.3 \text{ m}\cdot\text{s}^{-1}$ (ADAL-WR, HEF Tecmachine, Andrézieux-Boutheon, France). Surface electromyography (EMG) signals were acquired bilaterally from seven muscles: rectus femoris, vastus lateralis, gluteus maximus, biceps femoris, tibialis anterior, gastrocnemius lateralis, and soleus. EMG data were collected using a wireless system (Trigno Avanti, Delsys, Natick, MA, USA), with sensor placement following SENIAM guidelines (www.seniam.org). EMG signals were sampled at 1925.9 Hz. Each EMG sensor also incorporated a triaxial gyroscope sampling at 148 Hz to measure three-dimensional angular velocity. In addition, one EMG sensor including the IMU was mounted on each dumbbell (left and right) to capture times with and without additional weight. Vertical GRFs were

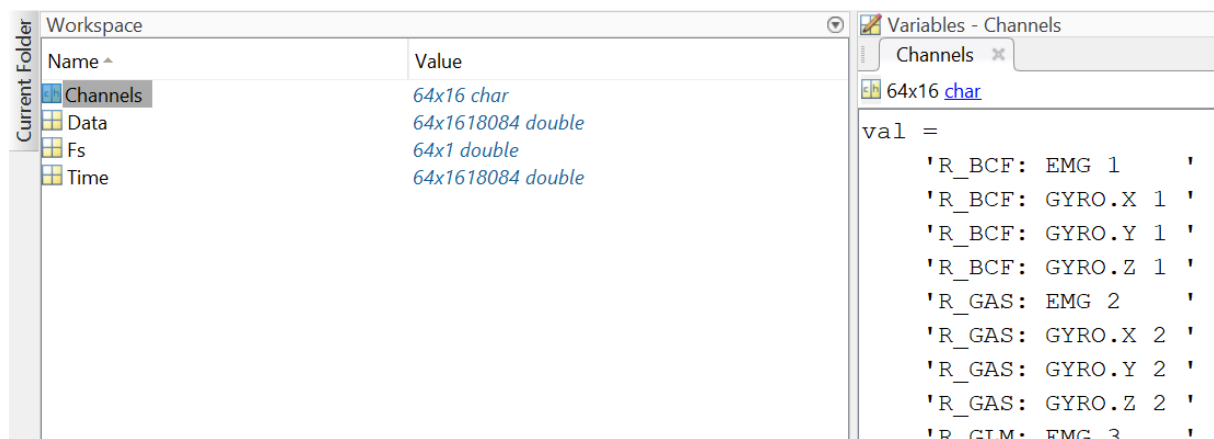
recorded for the right and the left limb (100Hz) from the instrumented dual force plate treadmill (ADAL-WR, HEF Tecmachine, Andrezieux-Boutheon, France).

The first session was always designated as a warm-up session. Subsequently, three weighted walking sessions were performed in a balanced and randomized order. During these sessions, participants carried weights of 1, 2, or 4 kg in each hand, corresponding to total carried masses of 2, 4, and 8 kg, respectively.

After beginning each session walking without weights, participants were instructed every 40 s—while continuing to walk—to either pick up or release a pair of weights from a platform positioned in front of the treadmill at navel height. Instructions were provided via an acoustic metronome. In total, 21 consecutive intervals of 40 s were completed over a duration of 14 min, comprising 10 repetitions of weight pickup and 10 repetitions of weight release in each of the three weighted sessions. Thus, each session includes phases with and without weight. Further details of the experimental protocol are available in the associated publications.

The dataset is organized into participant-specific folders labeled S01 to S13. Each participant folder contains two subfolders, **EMG** and **FRC**, which store muscle activity and ground reaction force data, respectively. Within each subfolder, four files are provided: Warmup.mat, WEI2.mat, WEI4.mat, and WEI8.mat, corresponding to the warm-up and the three weighted walking sessions. For ground reaction force data, filenames include the prefix frc_.

The EMG files include:



The screenshot shows the MATLAB workspace and variables windows. The workspace window displays the following table:

Name ^	Value
Channels	64x16 char
Data	64x1618084 double
Fs	64x1 double
Time	64x1618084 double

The variables window shows the 'Channels' variable with the following value:

```
val =  
'R_BCF: EMG 1      '  
'R_BCF: GYRO.X 1  '  
'R_BCF: GYRO.Y 1  '  
'R_BCF: GYRO.Z 1  '  
'R_GAS: EMG 2      '  
'R_GAS: GYRO.X 2  '  
'R_GAS: GYRO.Y 2  '  
'R_GAS: GYRO.Z 2  '  
'R_GLM: EMG 3      '
```

The variable **Channels** contains the channel names, with electromyography signals identified by the prefix *EMG* and inertial measurement unit (IMU) gyroscope signals (GYRO) labeled by their respective axes (X, Y, and Z). The suffixes R and L denote the right and left limbs, respectively. In addition, one EMG sensor (IMU) was mounted on each dumbbell carried in the left and right hands, labeled L_WEI and R_WEI.

The variable **Data** contains the recorded signals expressed in millivolts (mV).

The variable **Fs** specifies the sampling frequency of each channel in hertz (Hz). EMG signals were sampled at 1925.9 Hz, while IMU gyroscope data were sampled at 148.1 Hz.

The screenshot shows the MATLAB workspace with variables: ans (1x100 double), Channels (64x16 char), Data (64x1618084 double), Fs (64x1 double), and Time (64x1618084 double). The variable viewer for Fs shows a 64x1 double array with values: 1, 1.9259e+03, 148.1481, 148.1481, 148.1481, 1.9259e+03, 148.1481, 148.1481, 148.1481, 1.9259e+03, 148.1481.

Index	Value
1	1
2	1.9259e+03
3	148.1481
4	148.1481
5	148.1481
6	1.9259e+03
7	148.1481
8	148.1481
9	148.1481
10	1.9259e+03
11	148.1481

The variable Time contains the time in seconds.

The GRF file include:

The screenshot shows the MATLAB workspace with variables: fs (100), FzL (84000x1 double), and FzR (84000x1 double). The variable viewer for FzR shows an 84000x1 double array with values: 1, 411.6188, 412.5448, 416.2952, 413.7377, 416.2756, 406.5833, 418.1650, 411.2607.

Index	Value
1	1
2	411.6188
3	412.5448
4	416.2952
5	413.7377
6	416.2756
7	406.5833
8	418.1650
9	411.2607

The variable **fs** represents the sampling frequency and is set to 100 Hz. The variables

FzR and FzL contain the vertical ground reaction forces (in N) of the right and left limbs, respectively. These forces were measured using an instrumented treadmill equipped with two force plates, one located beneath each side of the treadmill.

The screenshot shows the MATLAB workspace with variables: subject_age (1x13 double), subject_age_mean (27.3077), subject_age_std (4.6972), subject_gender (1x13 cell), subject_height (1x13 double), subject_height_mean (1.8208), subject_height_std (0.0671), subject_id (1x13 double), subject_weight (1x13 double), subject_weight_mean (81.3846), and subject_weight_std (11.3324). The variable viewer for subject_info shows a 1x13 double array with values: 1, 30, 39, 30, 24, 29, 31, 27, 24, 25, 27, 22, 21, 26.

Index	Value
1	1
2	30
3	39
4	30
5	24
6	29
7	31
8	27
9	24
10	25
11	27
12	22
13	21
14	26

The Subject_Info.m contains the subject information including age, gender, body height, body weight and ID (1 to 13 as found for folders).

Be aware, sometimes participants might step partly on the wrong forceplate during walking.