**Datasets for Bilateral Lower-Limb Neuromechanical Signals in Able-Bodied and Impaired Individuals with Wearable and Ambient Sensors**

**(BLISS)**

**Overview of file structures and formats**

The data is organized by subjects according to their identification code (*e.g.* AB2930). In each subject folder, there are three folders: “Raw Data,” “Processed Data,” and “Features”, accompanied by a supplementary “Gait Analysis” folder that compares the test subject’s gait parameters with respect to normative gait parameters produced by other works. The “Raw Data” folder contains in CSV format the raw data from each gait bout. These are divided into: Analog\_raw (contains raw sensory stream from wearable IMUs and EMGs) and Force\_Motion\_raw (contains raw sensory stream of force plate readings plus IOR lower body marker locations with respect to the lab’s motion capture fixed frame).

Details of “Analog\_raw” file organization are described below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Filename +****Header definitions** | **SubjectID\_Trial\_GaitBoutNumber\_Analog\_raw.csv**Time:Reading time stamp (unit: seconds)MuscleName\_EMG 1:Raw sensory EMG stream of the muscle ‘MuscleName’ (unit: millivolts)MuscleName\_ACC $δ$:Raw sensory accelerometer stream of the sensor attached above muscle ‘MuscleName’ along sensor axis $δ$ in terms of gravitational acceleration (unit: g)MuscleName\_GYRO $δ$:Raw sensory gyroscope stream of the sensor attached above muscle ‘MuscleName’ about sensor axis $δ$ (unit: rad/sec.)Mode (Gait Activity):

|  |  |
| --- | --- |
| Ground-Level Walking: 1phase (Gait Phase of Ground-Level Walking):

|  |
| --- |
| LR (Loading Response): 1 |

 |
| MST (Midstance): 2 TS (Terminal Stance): 3 |
|  PSW (Pre-swing): 4 | SW (Swing): 5 |
|  |  |

 |
| **Columns****A** | Time stamps in seconds |
| **Column****B-DB** | Raw EMG and IMU data |
| **Column****DC-DD** | Gait Mode and Gait Phase |

Details of “Force\_Motion\_raw” file organization are described below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Filename +****Header definitions** | **SubjectID\_Trial\_GaitBoutNumber\_Force\_Motion\_raw.csv**Time:Reading time stamp (unit: seconds)plate N F$δ$:Raw force reading of plate number ‘N’ along axis $δ$ of the lab fixed frame (unit: Newton)plate N M$δ$:Raw moment reading of plate number ‘N’ about axis $δ$ of the lab fixed frame (unit: Newton.meter)plate N COP$δ$:Raw center of pressure location of plate number ‘N’ along axis $δ$ with respect to the lab’s fixed frame (unit: millimeter)MarkerName $δ$:Marker $δ$ coordinates with respect to the lab fixed frame associated with body location ‘MarkerName’ defined according to the IOR lower body model (unit: millimeter)MarkerName residual:Residual error associated with ‘MarkerName’ (unit: millimeter)Mode (Gait Activity):

|  |  |
| --- | --- |
| Ground-Level Walking: 1phase (Gait Phase of Ground-Level Walking):

|  |
| --- |
| LR (Loading Response): 1 |

 |
| MST (Midstance): 2 TS (Terminal Stance): 3 |
|  PSW (Pre-swing): 4 | ISW (Initial Swing): 5 |
|  MSW (Mid-swing): 6 | TSW (Terminal Swing): 7 |

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| **Columns****A** | Time stamps in seconds |
| **Column****B-DM** | Force plate/Markers data |
| **Column****DN-DO** | Gait Mode and Gait Phase |

The “Processed Data” folder contains in CSV format the post-processed analog sensor values and processed body motion variables (body joint kinematic and kinetic states, center of masses, centers of pressure and motion capture recorded gait events).

Details of “Analog\_processed” file organization are described below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Filename +****Header definitions** | **SubjectID\_Trial\_GaitBoutNumber\_Analog\_processed.csv**Time:Reading time stamp (unit: seconds)MuscleName\_EMG 1:Processed sensory EMG stream of the muscle ‘MuscleName’ (unit: millivolts)MuscleName\_ACC $δ$:Processed sensory accelerometer stream of the sensor attached above muscle ‘MuscleName’ along sensor axis $δ$ in terms of gravitational acceleration (unit: g)MuscleName\_GYRO $δ$:Processed sensory gyroscope stream of the sensor attached above muscle ‘MuscleName’ about sensor axis $δ$ (unit: rad/sec.)Mode (Gait Activity):

|  |  |
| --- | --- |
|  Ground-Level Walking: 1phase (Gait Phase of Ground-Level Walking):

|  |
| --- |
| LR (Loading Response): 1 |

 |
| MST (Midstance): 2 TS (Terminal Stance): 3 |
| PSW (Pre-swing): 4 | SW (Swing): 5 |

 |
| **Columns****A** | Time stamps in seconds |
| **Column****B-DB** | Processed EMG and IMU data |
| **Column****DC-DD** | Gait Mode and Gait Phase |

Details of “Body\_Motion\_processed” file organization are described below.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Filename +****Header definitions** | **SubjectID\_Trial\_GaitBoutNumber\_Body\_Motion\_processed.csv**Time:Reading time stamp (unit: seconds)L\_COP\_rt\_LFT $δ$:Center of pressure $δ$ coordinate of the left foot with respect to the left ankle local frame (unit: meter)l\_foot\_CG\_rt\_LFT $δ$:Left foot center of gravity $δ$ coordinate with respect to the left foot ankle joint (unit: meter).R\_COP\_rt\_RFT $δ$:Center of pressure $δ$ coordinate of the right foot with respect to the right ankle local frame (unit: meter)r\_foot\_CG\_rt\_RFT $δ$:Right foot center of gravity $δ$ coordinate with respect to the right foot ankle joint (unit: meter).JointName Ang\_Acc $δ:$$δ$ component of Angular acceleration of joint ‘JointName’ (unit: degree/second squared)JointName Ang\_Vel $δ:$$δ$ component of Angular velocity of joint ‘JointName’ (unit: degree/second)JointName Angles $δ:$$δ$ component of Angular displacement of joint ‘JointName’ (unit: degrees)JointName Moment $δ:$$δ$ component of internal torque of joint ‘JointName’ (unit: Newton.meter per kilogram)JointName Power $δ:$$δ$ component of mechanical power of joint ‘JointName’ (unit: Watts/kg)Mode (Gait Activity):

|  |  |
| --- | --- |
| Ground-Level Walking: 1phase (Gait Phase of Ground-Level Walking):

|  |
| --- |
| LR (Loading Response): 1 |

 |
| MST (Midstance): 2 TS (Terminal Stance): 3 |
|  PSW (Pre-swing): 4 | SW (Swing): 5 |
| Gait Events: |
| **LHS:** Left heel strike**LLR:** Left loading response**LMS:** Left mid-stance**LOFF:** event of left foot leaving force plate area | **LON:** event of left foot stepping on the force plate area for the first time**LTO:** Left toe-off**LTS:** Left terminal stance |
| **RHS:** Right heel strike**RLR:** Right loading response**RMS:** Right mid-stance**ROFF:** event of right foot leaving force plate area | **RON:** event of right foot stepping on the force plate area for the first time**RTO:** Right toe-off**RTS:** Right terminal stance |

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| **Columns****A** | Time stamps in seconds |
| **Column****B-DW** | Body kinematics/kinetics data |
| **Column****DX-DY** | Gait Mode and Gait Phase |
| **Column****DZ-EM** | Gait event timings in seconds |

The “Feature” folder contains in CSV format the features extracted from windows of sensory streams of IMU (raw) and EMG (process). The windows are 50 ms wide and the extraction is repeated three different times with around 17 ms delay between each file. Details of file organization are described below.

|  |  |
| --- | --- |
| **Filename** | **SubjectID\_Features.xlsx** |
| **File** | 0ms = No delay17ms = 17 ms relative shift33ms = 33 ms relative shift50ms = 50 ms relative shift |
| **Column A-ACZ** | FeaturesMAV: mean absolute valueWL: waveform lengthZC: number of zero-crossingsSS: number of slope sign changesAR coeff n: autoregressive model coefficient number ‘n’Std\_dev: standard deviation |
| **Column ADA-ADB** | Mode (Gait Activity):

|  |  |
| --- | --- |
| Ground-Level Walking: 1phase (Gait Phase of Ground-Level Walking):

|  |
| --- |
| LR (Loading Response): 1 |

 |
| MST (Midstance): 2 TS (Terminal Stance): 3 |
|  PSW (Pre-swing): 4 | SW (Swing): 5 |

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The “Gait Analysis” folder contains consistency graphs of body joint motion compared against normative data from the literature (displayed as an average ensemble profile), filtered EMG data displayed as EMG envelopes and a pdf containing gait temporal and spatial data for the subject.

\*\*NAN value in a CSV file means empty. This occurs when the physical value does not occur yet. For example, the center of pressure of each foot is a value that only occurs when the associated foot is in contact with the ground. If the foot is not in contact at a certain time instant the default value is NAN. Another example is angular acceleration of a joint, which is computed through double difference of the angles data, which leaves two NAN spots at the very beginning of the gait bout for acceleration, since at least two values have to exist before acceleration could be computed. Same applies to joint velocity where at least one value has to exist before velocity could be computed. In general, NAN means empty or ‘doesn’t exist’