Abstract

This dataset includes continuous tri-axial accelerometer and gyroscope data collected from healthy adults over seven days in a free-living environment. The primary goal of this study is to understand naturalistic head-turning behavior by analyzing head kinematics, sensor compliance, and data reliability. The data were collected using Axivity AX6 sensors and processed to extract daily metrics of head movement and physical activity. This dataset supports research into natural head motion monitoring.

Participants

Number: 24 healthy individuals

Age: Mean 29 ± 6.79 years

Sex: 15 female, 9 male

Health Status: All participants reported no known neuromotor or vestibular impairments.

Data Collection

- **Device**: Axivity AX6

- **Sensors**: Tri-axial accelerometer and gyroscope

- **Sampling Rate**: 100 Hz

- **Wear Location**: Three IMUs (Axivity Ax6, Newcastle, UK) were attached to the participant: one behind the right ear just superior to the mastoid process, one on the thoracic spine at the level of the T2 vertebra spinous process, and one on the lumbar region at the level of the L2-L4 vertebra spinous processes.

- **Protocol**: Participants were instructed to wear the sensor continuously for 7 days during all waking hours in their normal environment. No specific tasks were assigned.

Data Structure

- **Raw Data Directory**: `Data/`

  - Each participant's folder follows the format: `Data/S01`, `Data/S02`, ..., `Data/S24`

- **File Format**: `.cwa` (Axivity proprietary format)

- **Processed Data Directory**: `Data/Preprocess/`

  - Contains `.mat` files for each participant and day (e.g., `S01/Day1/data.mat`)

- **Naming Convention**: Folder name = Subject ID, each `data.mat` includes a day's worth of data

Preprocessing

Data preprocessing is performed using the MATLAB script `preprocessScript.m`, which:

1. **Resamples** data using `resampleAxivity`

2. **Initial Reorientation** using `reorientAxivityInitial` (final alignment done later)

3. **Day Splitting** using `sortIntoDays` to segment data into individual 24-hour blocks

4. **Saves** `.mat` files per subject and day in `Data/Preprocess/`

Each `.mat` file includes the segmented, resampled, and initially reoriented IMU data for that day.

Data Analysis
Analysis is done using the `dataAnalysisScript.m`, which:

Purpose

This MATLAB script performs automated processing of daily IMU data collected using Axivity AX6 sensors worn on the head, neck, and waist. It extracts features related to **step count**, **sensor wear time**, **head turns**, and **head-on-trunk coordination** across multiple days and participants.

Key Features Extracted

- **Step Detection** using McCamley's method from vertical acceleration

- **Sensor Reorientation** using rotation matrices derived from walking bouts

- **Head Turn Detection** using filtered gyroscope data (Z-axis)

- **Wear Time Estimation** from signal activity

- **Head-on-Neck and Head-on-Trunk Coordination** during turning

- **Day and Weekday Metadata** stored for each processed day

Input

- Preprocessed daily `.mat` files for each participant (output of `preprocessScript.m`)

  ○ Path format: `Data/Preprocess/S01/Day1/data.mat`, etc.

- Each file contains tri-axial accelerometer and gyroscope data sampled at 100 Hz.

How It Works

1. **Subject Selection**: Choose participants interactively from a list.

2. **Data Loading**: Loads all daily `.mat` files per subject.

3. **Step Count**: Uses vertical acceleration to detect steps for each sensor.

4. **Wear Time**: Calculates duration of valid signal (wear time) for each day.

5. **Sensor Calibration & Rotation**:

   ○ Estimates walking bouts to compute rotation matrices

   ○ Applies matrices to align accelerometer and gyroscope axes

6. **Head Turn Detection**:

   ○ Filters gyroscope Z-axis

   ○ Detects turns based on amplitude and velocity thresholds

7. **Head-on-Trunk Coordination**:

   ○ Compares head motion to neck and waist during turns

   ○ Outputs coordination counts per day

8. **Metadata**: Adds weekday name and signal duration

9. **Output**: Saves all extracted metrics and metadata to a single `.mat` file per subject in `Data/Process/`

Output

- Saved per participant as: `Data/Process/S01/data.mat`

- Contains:

   ○ `stepData`: Step timestamps per sensor

   ○ `turnData` and `turnDataCali`: Head turns before/after reorientation

   ○ `headOnNeckCount` and `headOnTrunkCount`: Coordination during turns

   ○ `timeData`: Wear time, day length, and weekday

   ○ `individual`: Daily turn counts