Dataset Instructions

1 Introduction

GaitVibe is a dataset that leverages ambient floor vibrations to conduct gait analysis. The vibration data were collected through floor mounted geophones that passively measures the movement of the floor induced by human footsteps. It does not require users to carry devices or step on the sensors and is perceived as privacy-friendly for gait analysis in daily living. This is the first dataset of ambient floor vibrations for gait analysis, and covers multiple gait ground truths based on clinical gold standards, including spatial and temporal gait parameters, gait kinematics (joint angles), and gait kinetics (ground reactions forces/pressure), as shown in Figure 1. Moreover, the dataset contains both typically developing gait (normal walking) and three commonly observed abnormal gaits simulated by the participants under professional guidance, including flexed knee gait, toe-walking gait, and gait with foot drag. the GaitVibe dataset aims overcome the practical challenges of daily gait monitoring by bridging the floor vibration-based gait monitoring approach with the clinical gold standard.

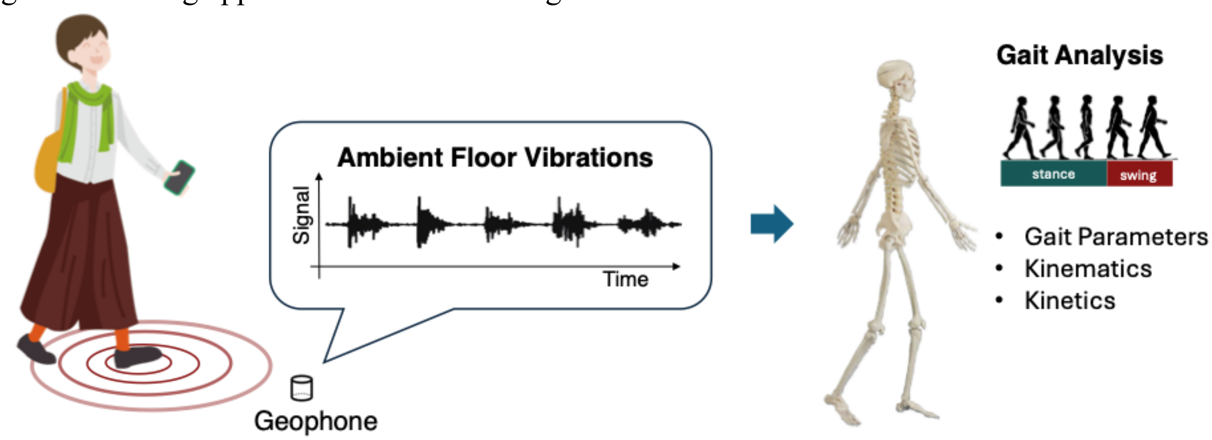


Figure 1: Gait analysis using ambient floor vibrations in daily living.

2 Experiment Design

The experiment involves two stages, each targeting a specific set of gait metrics, as summarized in Figure 2. Stage 1 focuses on typically developing gait and aims to estimate gait parameters. Stage 2 focuses on comparing normal and abnormal gaits and aims to estimate detailed kinematic and kinetic metrics from gait-induced floor vibrations.

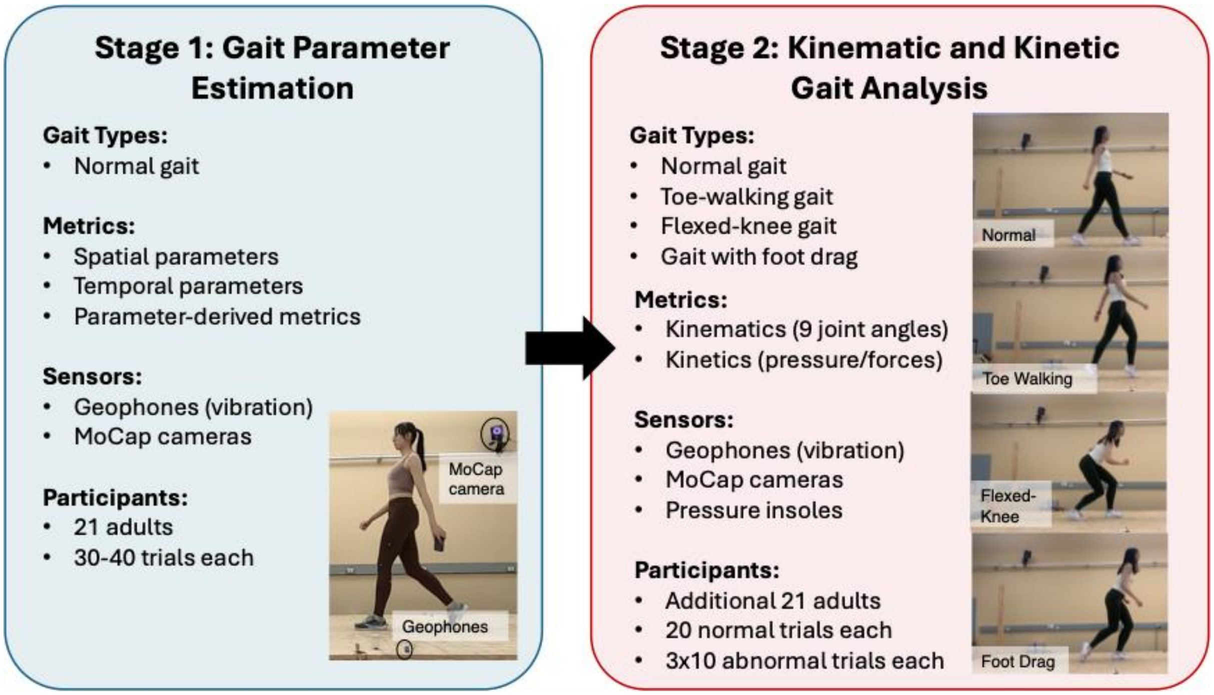
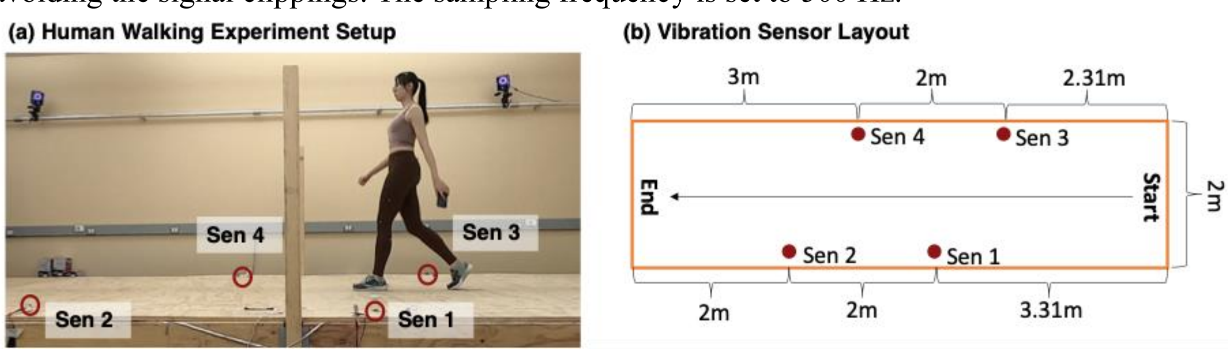


Figure 2: The two-stage experiment design.

3 Vibration Sensor Layout

The ambient floor vibration data are collected using four SM-24 geophone sensors deployed around a 7-meter-long walkway, as shown in Figure 3. Due to the small magnitude of footstep-induced vibrations, the sensors are connected to operational amplifiers (op-amp) to increase the signal amplitude. The gain of the amplifiers is set empirically by preliminary walking experiments and choosing the gain that maximizes the amplitude of the vibration signals while avoiding the signal clippings. The sampling frequency is set to 500 Hz.



4 Ground Truth

The ground truth gait parameters and the kinematic metrics (joint angles) are recorded using the Vicon Nexus Software. The setup includes 10 infrared cameras mounted on the metal bars on the wall around the capture space. The sampling frequency is 100 Hz, and the MoCap system automatically reconstructs the moving trajectory of the 16 reflective markers placed using the

Vicon Lower Body Model
(https://help.vicon.com/space/Nexus216/11605140/Lower+body+modeling+with+Plug-in+Gait).

The ground truth kinetic metrics (forces and pressures) are recorded by Moticon OpenGo pressure insoles (https://moticon.com/opengo/sensor-insoles). The data is acquired by wirelessly connecting the insole with a mobile app named OpenGo (see a sample pair of the insole and the kinetic measurements in Figure~\ref{fig:moticon}). The system operates at a self-selected sampling frequency of 100 Hz. This data is not synchronized with the vibration and MoCap measurements due to the barrier between different commercial platforms. The raw data are the plantar pressure measurements of the 16 pressure sensors embedded in left and right insoles, respectively.

5 File Structure

```
GaitVibe
├─ Stage 1_Gait Parameter Estimation
│   ├─ P1
│   │   ├─ ⋮
│   │   └─ P1 walk 40.csv
│   ├─ ⋮
│   └─ P21 ─ ⋮
├─ Stage 2_Kinematic and Kinetic Gait Analysis
│   ├─ P1
│   │   ├─ Vibe_MoCap
│   │   │   ├─ ⋮
│   │   │   ├─ P1 walk 20.csv
│   │   │   ├─ ⋮
│   │   │   ├─ P1 toe walk 10.csv
│   │   │   ├─ ⋮
│   │   │   ├─ P1 flex knee 10.csv
│   │   │   ├─ ⋮
│   │   │   └─ P1 drag 10.csv
│   │   └─ Pressure Insole
│   │       ├─ walk.txt
│   │       ├─ flex knee.txt
│   │       ├─ toe walk.txt
│   │       ├─ foot drag.txt
│   │       └─ P1.go
│   ├─ ⋮
│   └─ P21
│       ├─ Vibe_MoCap ─ ⋮
│       └─ Pressure Insole ─ ⋮
├─ Participant Info.xlsx
├─ Instructions.pdf
└─ MATLAB Scripts
    ├─ data loader
    ├─ data plotter
    └─ feature extractor
```

6 Quick Starter

Step 1: Download and extract the .zip files.

Step 2: Convert .csv into organized .mat files.

If you’d like to read one .csv file, use MATLAB script “read_vicon_by_file.m”.
If you’d like to read multiple .csv file from the same person, use MATLAB script “read_vicon_by_person.m”, which can iteratively call “read_vicon_by_file.m” and output a .mat file with organized trial data for that person.

Step 3: Data visualization.

You may visualize the mocap data using “plot_extract_cycle_angles.m” to read the .mat file (e.g., P1.mat) from **Step 2**. Similarly, you may visualize the vibration data using “plot_vibedata.m” to read the .mat file (e.g., P1.mat) from **Step 2**.

7 Prior Studies using this Dataset

- **Gait parameter estimation:** https://pubmed.ncbi.nlm.nih.gov/38676114/

  Dong Y, Noh HY. Ubiquitous Gait Analysis through Footstep-Induced Floor Vibrations. Sensors (Basel). 2024 Apr 13;24(8):2496. doi: 10.3390/s24082496. PMID: 38676114; PMCID: PMC11053483.

- **Foot-floor contact modeling:** https://ascelibrary.org/doi/10.1061/JENMDT.EMENG-7639
  Dong, Y., Wu, Y., Kim, S. E., Schadl, K., Rose, J., & Noh, H. Y. (2025). Modeling foot–floor interactions during walking for normal and abnormal gaits. Journal of Engineering Mechanics, 151(1), 04024100.

- **Gait abnormality detection:** https://ieeexplore.ieee.org/document/10556733
  Dong, Y., Kim, S. E., Schadl, K., Huang, P., Ding, W., Rose, J., & Noh, H. Y. (2024). In-home gait abnormality detection through footstep-induced floor vibration sensing and person-invariant contrastive learning. IEEE Journal of Biomedical and Health Informatics, 28(12), 7054-7067.

- **Joint motion estimation:**
  https://www.sciencedirect.com/science/article/abs/pii/S0022460X25004249
  Dong, Y., Kim, S. E., Rose, J., & Noh, H. Y. (2025). Physics-informed graphical modeling of human-structure interactions for gait and motion analysis. Journal of Sound and Vibration, 119351.