Activity Recognition with Accelerometer Data

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1. Introduction

This assignment explores motion sensing and human activity recognition using smartphone inertial data. An iPhone 12 equipped with a triaxial accelerometer and gyroscope was used to collect raw sensor data while performing four basic activities: sitting, standing, walking, and running. The project consists of three parts: (1) Visual inspection and feature extraction for activity recognition, (2) Step-count estimation from walking data, and (3) Pose estimation using accelerometer and gyroscope fusion.

2. Part 1 – Activity Recognition

Raw accelerometer data were collected and visualized for four activities.

Figure 1 – Sitting (hand)

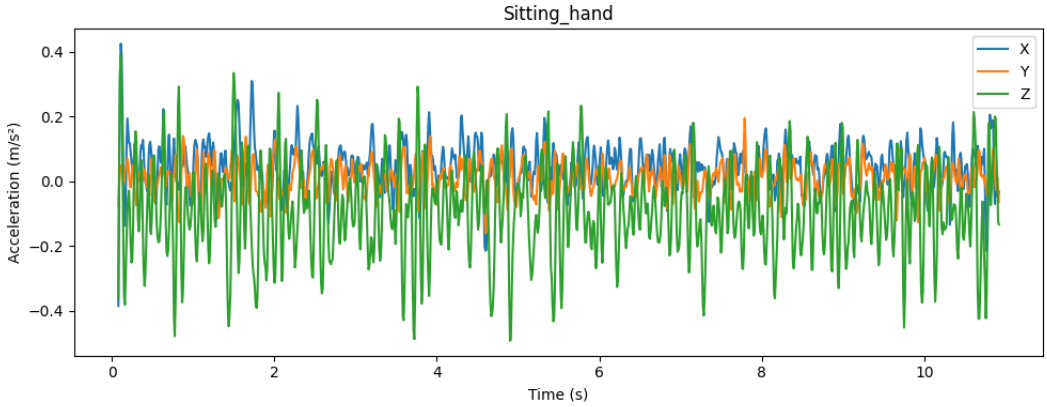


Figure 2 – Standing (hand)

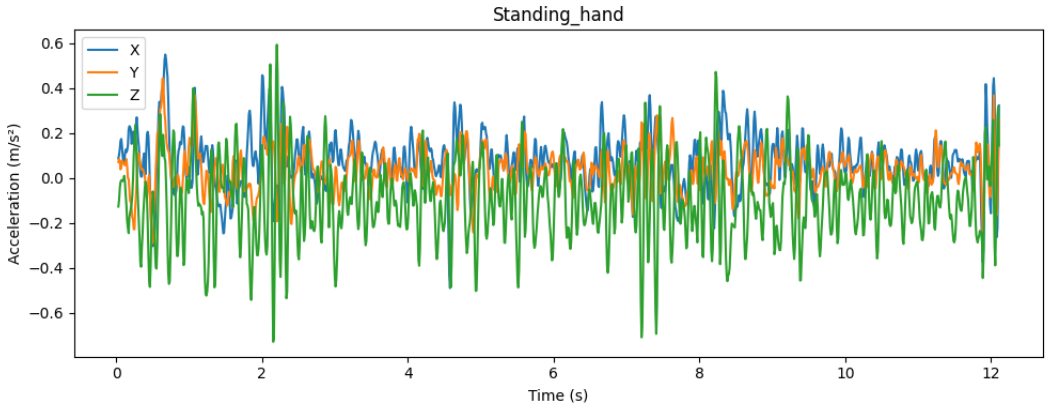


Figure 3 – Walking 1

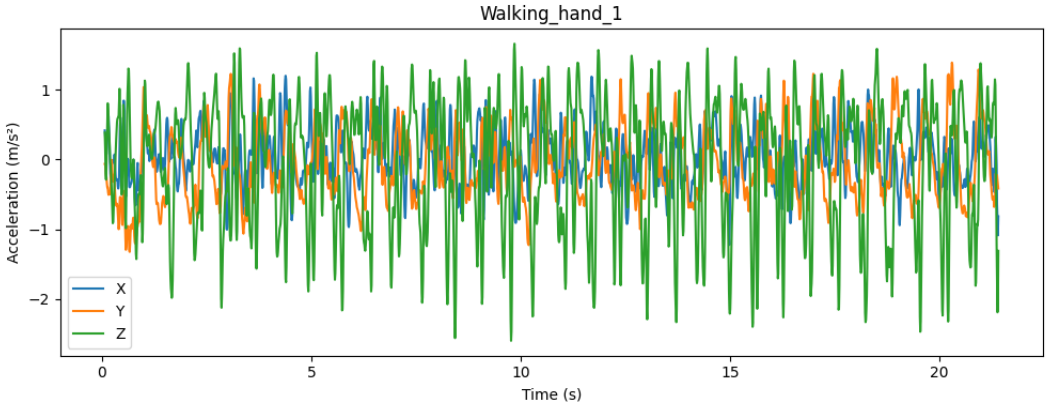
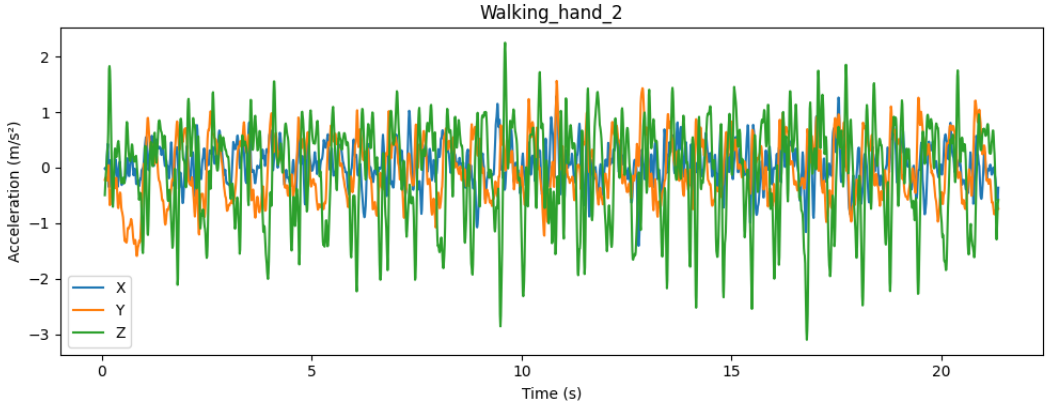


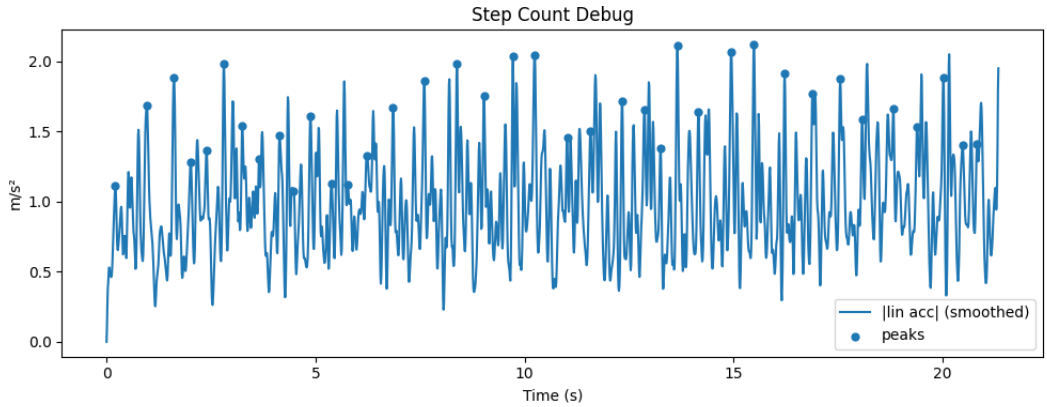
Figure 4 – Walking 2



Activity	Mean (m/s²)	Std	Max	Min	Peak Count
Sitting	0.167	0.094	0.578	0.007	194
Standing	0.231	0.129	0.783	0.013	188
Walking 1	1.022	0.447	2.663	0.055	239
Walking 2	0.986	0.447	3.194	0.014	246

3. Part 2 – Step Counting

Step count was estimated using a custom pipeline implemented in Python without library shortcuts.

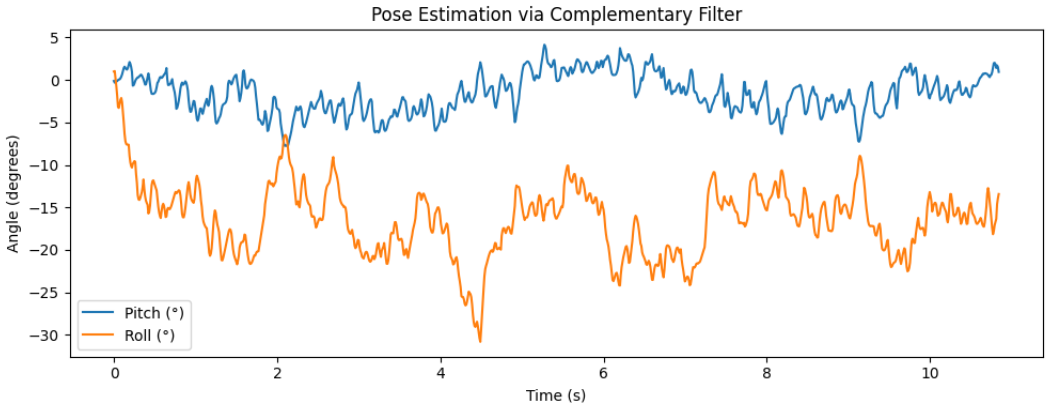


Dataset	Sampling Rate (Hz)	Duration (s)	Steps	Cadence (SPM)
Walking 1	99.35	21.34	38	106.8

Walking 2	99.35	21.28	42	118.4

4. Part 3 – Pose Estimation (Extra Credit)

Pose was estimated using a complementary filter combining accelerometer and gyroscope data.



Dataset	Sampling Rate (Hz)	α	Duration (s)	Pitch Range (°)	Roll Range (°)
Sitting (hand)	99.3	0.98	11.0	–10 → +4	–30 → –5

5. Conclusions

The experiments demonstrate that simple IMU-based methods can effectively capture and classify human motion. Statistical features (mean, standard deviation, peak count) distinguish static vs. dynamic activities. The custom step counter achieved 106–118 SPM, consistent with normal walking cadence. The complementary filter yielded stable pitch/roll estimates at 99 Hz without magnetometer data, showing its suitability for embedded sensing platforms.