Pedometer and step detection

FizziQ activity · High school · 30 min

Scan to open in FizziQ

Walking 50 steps with the smartphone accelerometer, students read the three-phase signature of each step in FizziQ and compare the peaks with the pedometer count.

Learning objectives

- Record and analyze the acceleration pattern generated during walking using the smartphone accelerometer
- Identify the characteristic three-phase pattern of each step in the acceleration data
- Compare the accelerometer step count with the FizziQ pedometer and a manual count
- Understand the signal processing principles behind step detection algorithms
- Investigate how walking speed affects the acceleration pattern and step frequency

Instruments and sensors

Absolute acceleration · Pedometer · Accelerometer

Materials

- Smartphone with the FizziQ application
- A clear, open space to walk (at least 20 meters for stride length calibration)
- FizziQ experience notebook
- Note: the protocol remains adaptable to any comparable motion-sensing tool.

Protocol

1. Open FizziQ and select the Accelerometer sensor. Choose absolute acceleration for an overall motion signal.
2. Place the smartphone in your front trouser pocket or hold it firmly against your hip. The position should remain consistent throughout the experiment.
3. Start recording in FizziQ and walk 50 steps at a normal, comfortable pace. Count each step carefully.
4. Stop recording. Examine the acceleration graph. You should see regular oscillations with each step producing a distinct peak.
5. Count the number of acceleration peaks on the graph and compare with your manual step count of 50. They should approximately match.
6. Measure the average step frequency by dividing the number of steps by the total recording time. Normal walking frequency is 1.5-2.5 Hz.
7. Now use FizziQ's Duo mode to record the accelerometer and pedometer simultaneously.
8. Walk another 50 steps at normal pace. Compare the pedometer count with your manual count and with the number of acceleration peaks.
9. Repeat the experiment walking at a slow pace (about 1 step/second) and then at a fast pace (about 3 steps/second). Compare the acceleration patterns.
10. For each pace, note the peak acceleration amplitude, step frequency, and whether the pedometer correctly counted all steps.
11. Investigate what happens when you shake the phone or walk irregularly (stopping and starting). Does the pedometer register false steps?
12. Estimate your stride length by walking a known distance (e.g., 20 meters) and dividing by the number of steps. Calculate how many steps are in one kilometer.

Expected results

At normal walking pace, the accelerometer should show regular oscillations with peak amplitudes of 12-18 m/s^2 (including the 9.81 m/s^2 gravity component) and a frequency of about 1.7-2.0 Hz. The pedometer should agree with the manual count within ±2-5% for normal walking. At slow walking speeds, the pedometer may miss steps because the acceleration peaks are smaller and may fall below the detection threshold. At very fast walking or running speeds, the pedometer may undercount due to peaks that merge. Shaking the phone may produce false counts. Typical stride length is 0.6-0.8 m, yielding approximately 1250-1650 steps per kilometer.

Questions

- What are the three phases of the acceleration pattern during a single step?
- Why does the pedometer sometimes miss steps at very slow walking speeds?
- How does a step detection algorithm distinguish between a real step and random phone movement?
- Why does the acceleration signal contain both a constant component (gravity) and oscillating components?
- How could you improve the pedometer algorithm to reduce false counts?
- What information would you need in addition to step count to estimate the total distance walked?

Going further

- Compare pedometer accuracy when the phone is in different positions: pocket, hand, backpack, armband
- Investigate whether running produces a different acceleration pattern than walking
- Calculate your walking speed from the step frequency and stride length, and compare with GPS speed
- Design a simple step detection algorithm: count peaks that exceed a threshold acceleration value
- Compare the FizziQ pedometer with a commercial fitness tracker and evaluate their relative accuracy