# Validation of an accelerometer-based approach to quantify gait events

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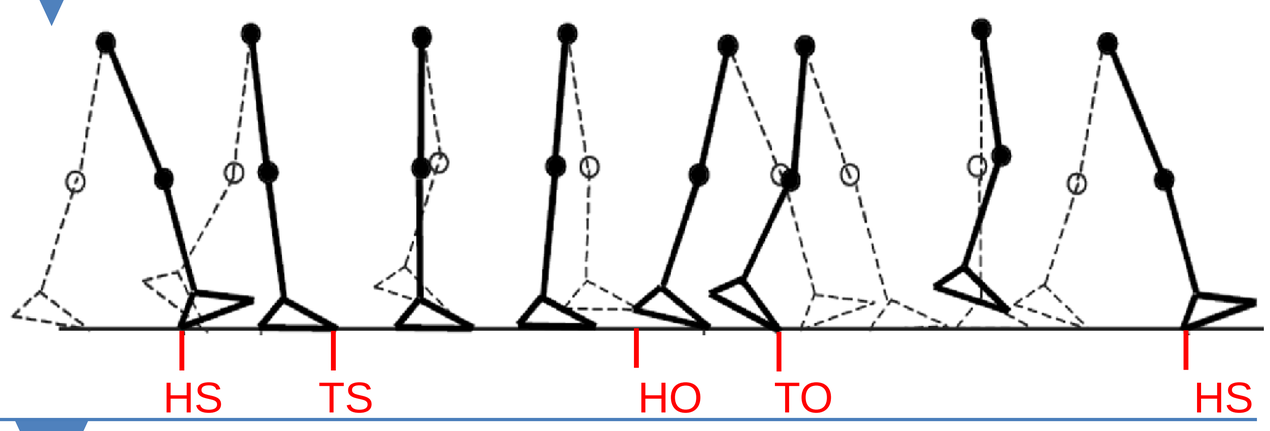
**Abstract**: Researchers rarely provide solid performance and validation information about their acceleometer-based approaches to human gait analysis. We present here a novel signal processing and analysis algorithm that automatically extracts four consecutive fundamental events of walking: heel strike (HS), toe strike (TS), heel off (HO), and toe off (TO). In addition, we validate this accelerometer-based technique by comparing these extracted gait events with those obtained by a kinematic 3D analysis system and a force plate, used as gold standards.

## I. The fundamental gait events

HS ▶ Heel strike
TS ▶ Toe strike
HO ▶ Heel off
TO ▶ Toe off

➡ automatically extracted by **a novel signal processing and analysis algorithm.**

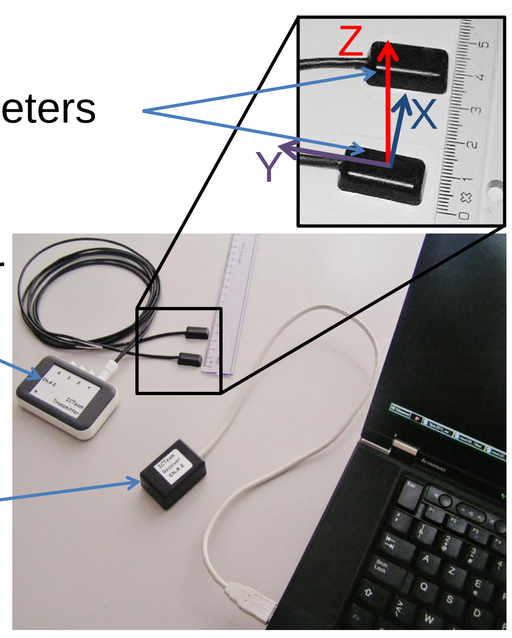



## II. Our accelerometer-based system (acquisition and processing)

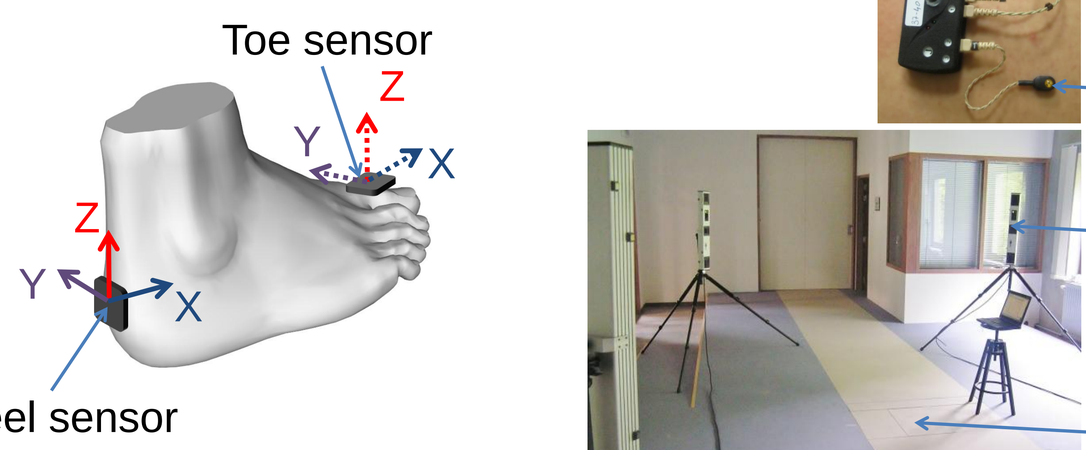
3-axis accelerometers

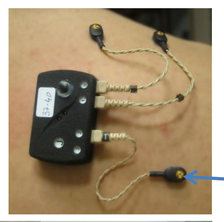
Transmitter module

Receiver module




## III. Our validation system



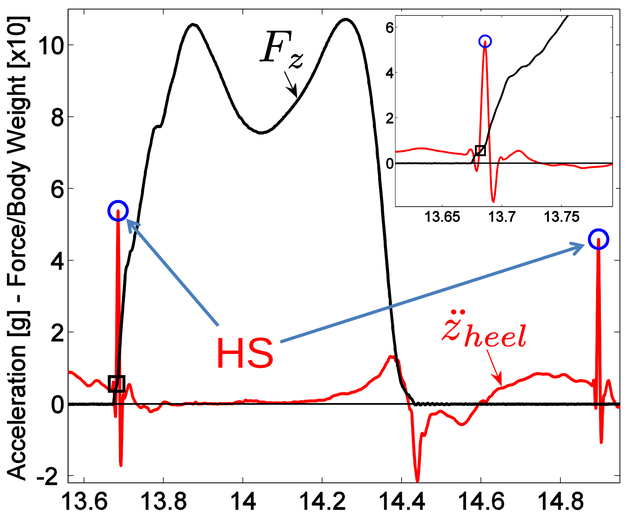



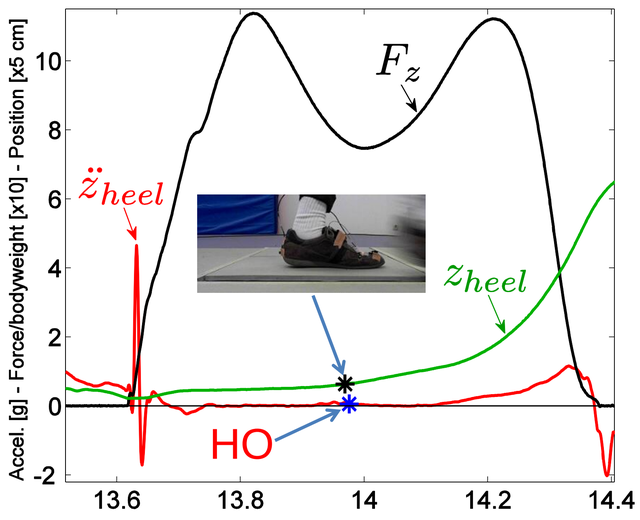
Active marker

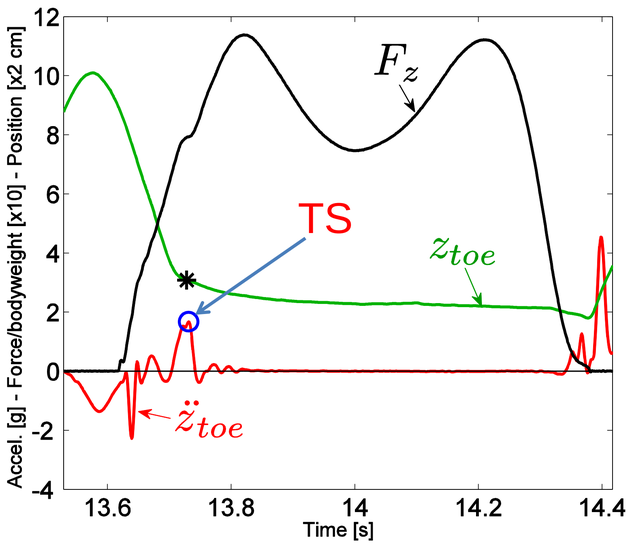
3D Codamotion unit

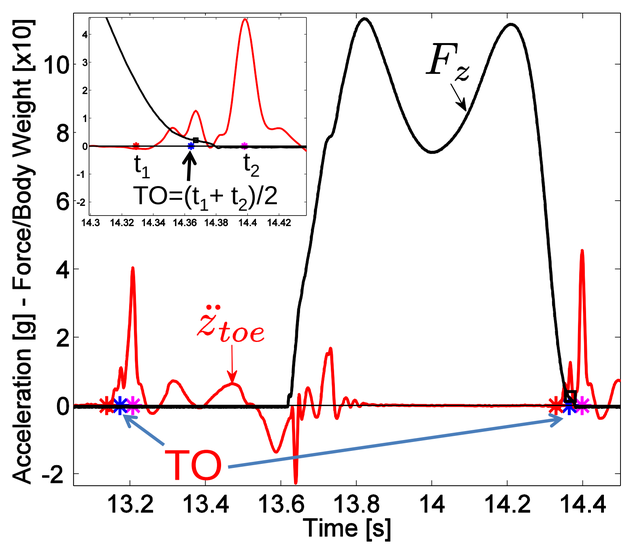
Force plate (integrated into the track)

## IV. Example of processing and analysis of accelerometer signals




$\ddot{z}_{heel}$: vertical heel acceleration. $z_{heel}$: vertical heel position. $F_z$: vertical ground reaction.
$\ddot{z}_{toe}$: vertical toe acceleration. $z_{toe}$: vertical toe position.

## V. Performance

| | Mean (ms) | Std. Dev (ms) |
|---|---|---|
| $HS_{accel} - HS_{ref}$ | 1.29 | 7.15 |
| $TS_{accel} - TS_{ref}$ | – 4.17 | 10.87 |
| $HO_{accel} - HO_{ref}$ | – 3.70 | 14.51 |
| $TO_{accel} - TO_{ref}$ | – 1.79 | 11.78 |

Mean (accuracy) and std. dev. (precision) of the difference between the gait events obtained by the developed accelerometer-based approach and those determined by the gold standard methods – Gait data of 7 healthy volunteers (up to 247 trials).

## VI. Potential for valorization

- Neurology, rehabilitation, geriatrics, orthopedics.
- Sport and motion capture.