Signals from real-world falls

Objective measurement of real-world fall events by using body-worn sensor devices can improve the understanding of falls in older people and enable new technology to prevent, predict, and automatically recognize falls. However, relative to the required recording time, these events are rare and hence challenging to capture. Therefore, the FARSEEING (FAll Repository for the design of Smart and sElf-adapaive Environments prolonging INdependent livinG) consortium and associated partners established a meta-database of signals from real-world falls. Until the end of 2014, 397 falls were measured and reported. This includes falls data from several settings and disease groups, mainly geriatric rehabilitation, Parkinson’s disease, cerebellar and sensory ataxia. Seventy-five per cent of the falls were measured with a sampling rate of 100 Hz with devices including at least accelerometers and gyroscopes. To date more than 100 of these real-world falls have been validated and finally processed for data analyses. The observed signal patterns showed a high heterogeneity and differed considerably from those of simulated falls. Preliminary analyses of the available real-world falls data with two different fall-detection approaches using wavelets as well as temporal and mechanical thresholds considerably improved the detection performance. The FARSEEING consortium will continue to increase the number of measured real-world falls in the meta-database beyond the end of the project. External users can request data access on the FARSEEING website.
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\textbf{Signals from real-world falls}

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Why do we need falls signals?

Why do we need signals from real-world falls?

What is the problem with real-world falls?

How can we solve the problem?

What did we learn from real-world falls so far?
Why do we need fall signals?

- **Objective data:**
  - to better understand fall risk factors
  - to better understand fall mechanics
  - to verify fall reports

- **Fall prevention**

- **Short-term fall prediction**

- **Fall detection**

→ **Inertial sensors (accelerometers, gyroscopes, magnetometers)**
Real-world versus simulated (in lab) falls

(a) Real-world fall phase

(b) Simulated fall phase
Real-world falls compared with simulated falls


* $P < 0.05$ (exact Wilcoxon test)
**Problem: how to measure fall signals?**

Fall incidence in healthy older adults (65 years and older): **0.33 per PY**

- Measure 3 persons each over 1 year to get 1 fall
- Based on 1 week measurement capability of sensor devices

- **156** measurement cycles to get 1 fall
- **15600** measurement cycles to get 100 falls
Solution: Meta-database

Real-world fall meta-database

- **subject characteristics**
  - age
  - gender
  - disease
  - functional status
  - ...

- **fall characteristics**
  - date & time
  - fall direction
  - verification
  - outcome
  - ...

- **technical characteristics**
  - type of sensor
  - sample rate
  - sensor site
  - duration
  - ...

- **Fall signals**
  - accelerometer
  - gyroscope
  - magnetometer
Example of a real-world fall

Device: Samsung Galaxy S3
Sample rate: 100 Hz
Range: ±20 m/s²
Mean profile of 100 real-world falls

![Graph showing the mean profile of 100 real-world falls.](image-url)
Wavelet based fall detection

AUC = 0.92 (95% CI:0.85-0.99)
Sensitivity: 0.93 (0.85-1.00)
Specificity: 0.88 (0.86-0.90)

Vertical and horizontal velocity

- **Maximum PPV:**
  - Sensitivity: 0.91
  - Specificity: 0.99
  - PPV: 0.78

- **Sensitivity set to 95%:**
  - Sensitivity: 0.95
  - Specificity: 0.97
  - PPV: 0.64

- **Specificity set to 95%:**
  - Sensitivity: 0.96
  - Specificity: 0.95
  - PPV: 0.50

Bourke A et al. Real-world fall temporal and kinematic variables for fall detection algorithm development for the L5 location. Abstract to the ICAMPAM 2015 [submitted]
Conclusions

- Real-world falls are needed!

- Real-world falls meta-database is available

Next steps:
- Use and share the available data
- Fall recording in further populations
- Standardized evaluation of fall detection algorithms

Technology in the prediction, detection and prevention of falls
24th - 25th March 2015, Stuttgart, Germany
http://www.eufallsfest.eu/
More information and data access application:
http://farseeingresearch.eu/

Thanks for your attention!