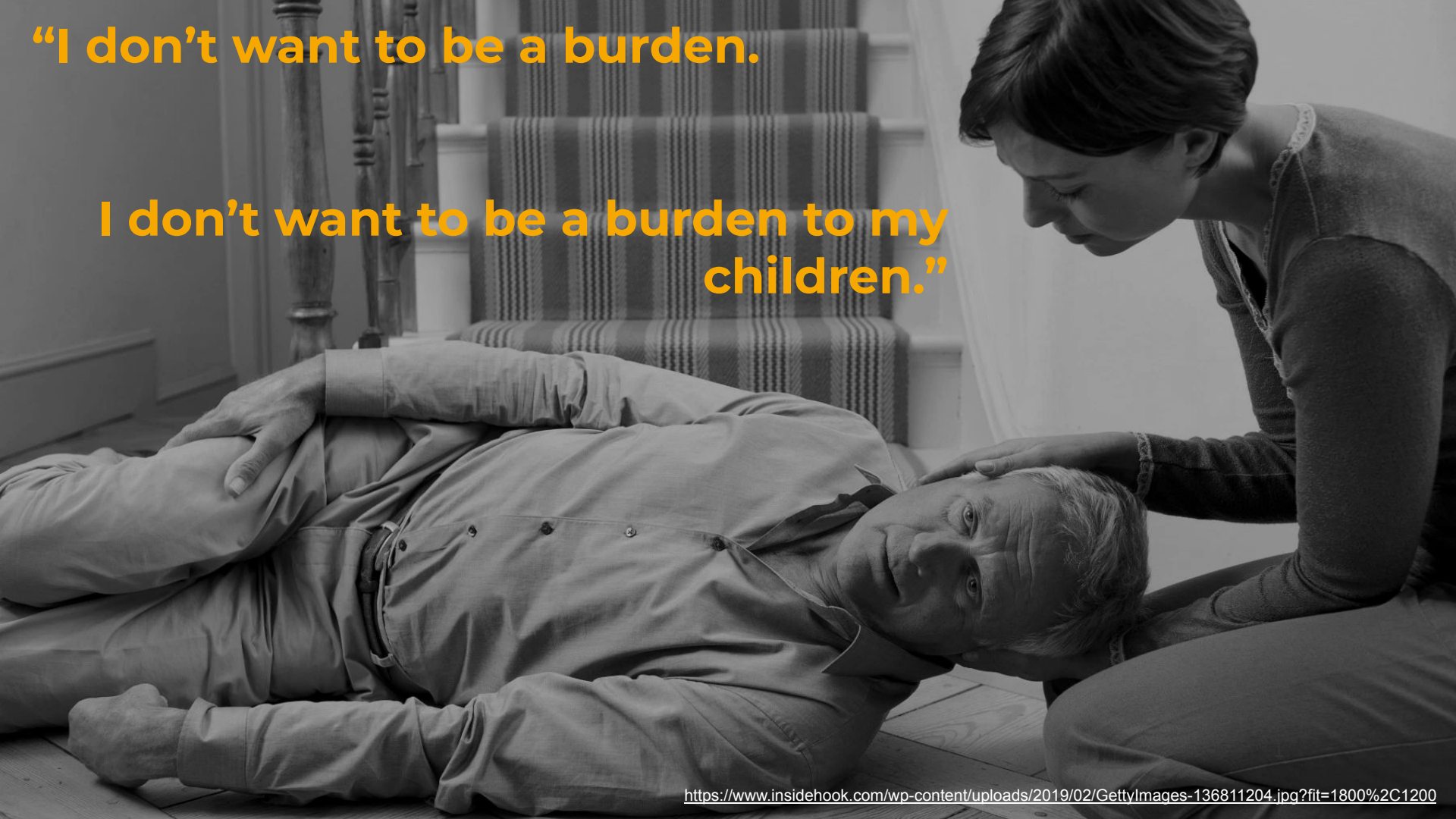


**“I don’t want to be a burden.**

**I don’t want to be a burden to my  
children.”**



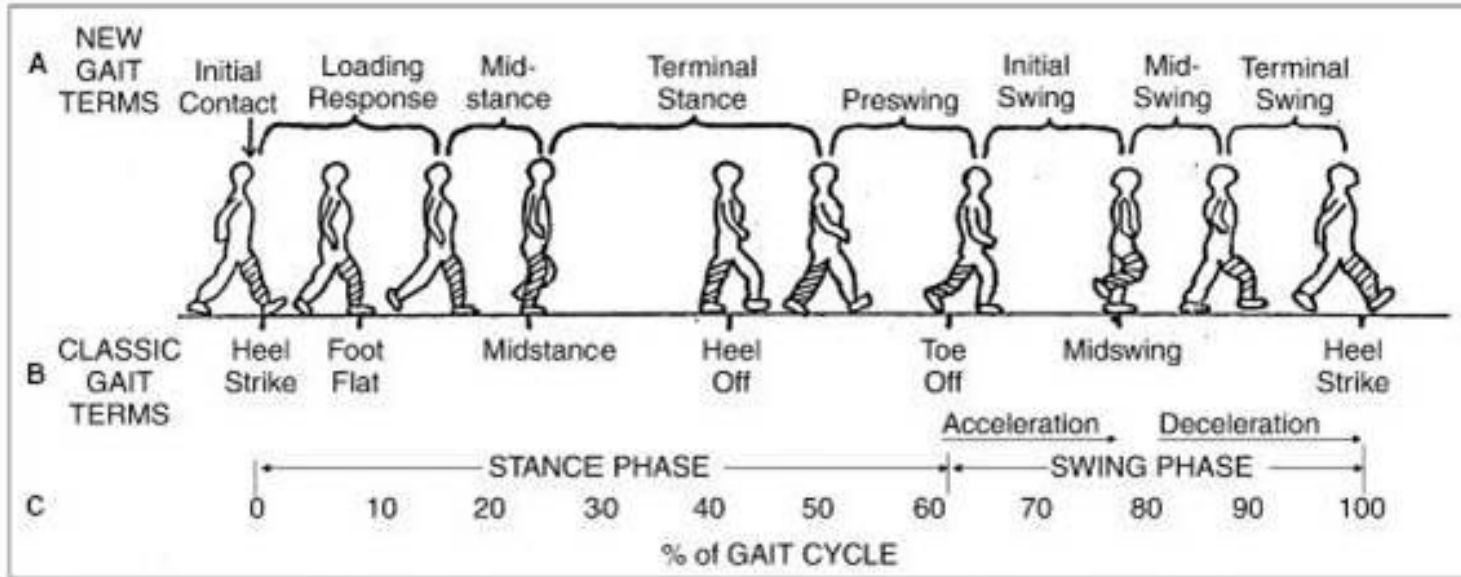


# Gait Analysis for Elderly

## Using Wearable Sensors to Detect Gait Abnormalities

Team 6  
Leonardo Hübscher, Martin Gerstmaier, Dennis Kipping  
Connected Healthcare ST 2019

# What is Human Gait?

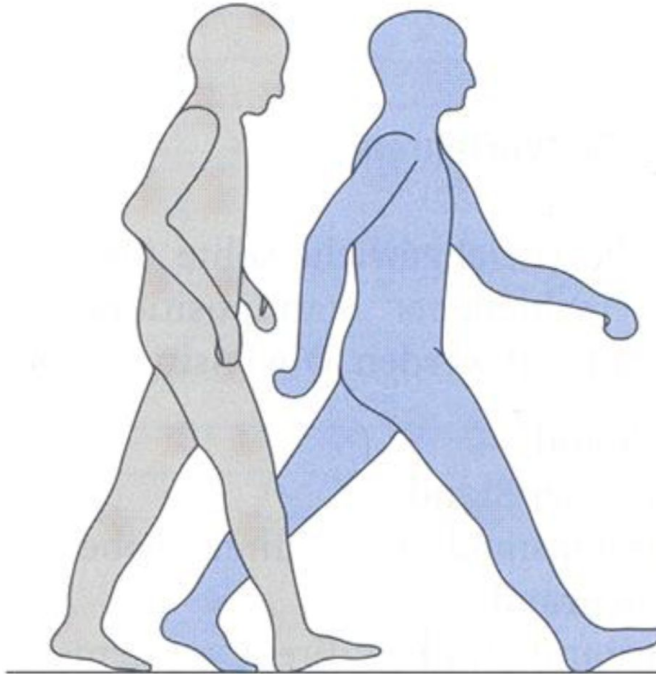


## Gait Analysis for Elderly

Team 6

Chart 3

# Gait of Elderly People



- slower walking speed
- reduced step length
- sipping foot
- lower amplitudes when swinging arms
- reduced activity
- overall feeling of weakness

**Gait Analysis for Elderly**

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Chart 4





## Gait Analysis

<https://www.airforcemedicine.af.mil/News/Photos/iqphoto/2000204368/>

# What is Gait Analysis?

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- systematic study of human locomotion
- discover gait phases and events
- applications:
  - prevention of orthopaedic issues or health issues
  - rehabilitation
  - sports analysis
  - health diagnosis

**Gait Analysis for  
Elderly**

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Chart 6

# Current Practices - Gait Laboratories



multi-camera  
infrared system

force platforms

- + high precision
- expensive,  
immobile

**Gait Analysis for  
Elderly**

Team 6

Chart 7

# Current Practices - Clinical assessment



<https://www.flickr.com/photos/salforduniversity/14439337151>



<https://www.businessinsider.com/redesigned-seattle-nike-store-offers-gait-analysis-2015-8?IR=T>

**Gait Analysis for Elderly**

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Chart 8

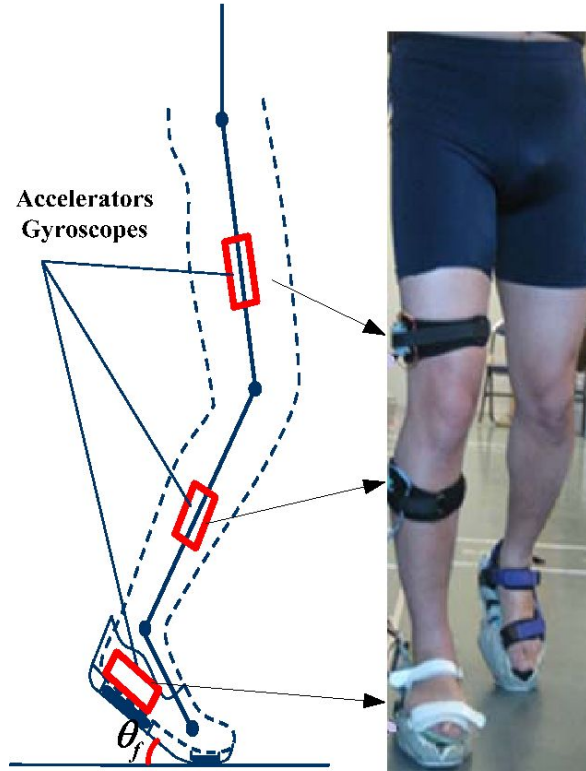


# New Practices: Wearable Sensors

- more cost efficient
- mobile
- “unobtrusive” monitoring
- popular: insoles for runners



<https://runvi.io>



source: Gait Analysis Using Wearable Sensors, Tao et al (2012)

**Gait Analysis for Elderly**

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Chart 9

# One more thing...

Proposal

# Smart Insoles



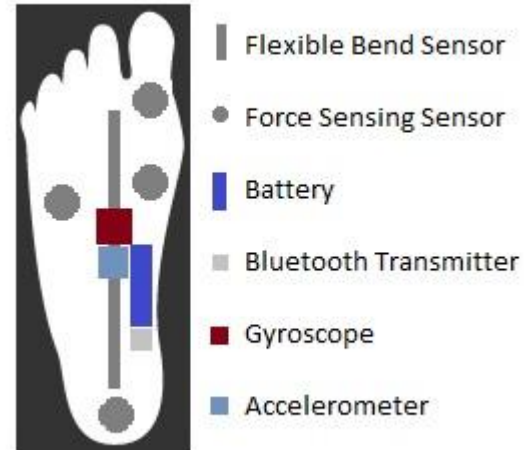
<https://footpressureidiabeticfootulcersmartinsole.wordpress.com/2016/01/21/diabetic-foot-ulcer-foot-pressure-measurement-smart-insole/>

**Gait Analysis for Elderly**

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Chart 11

# Smart Insoles



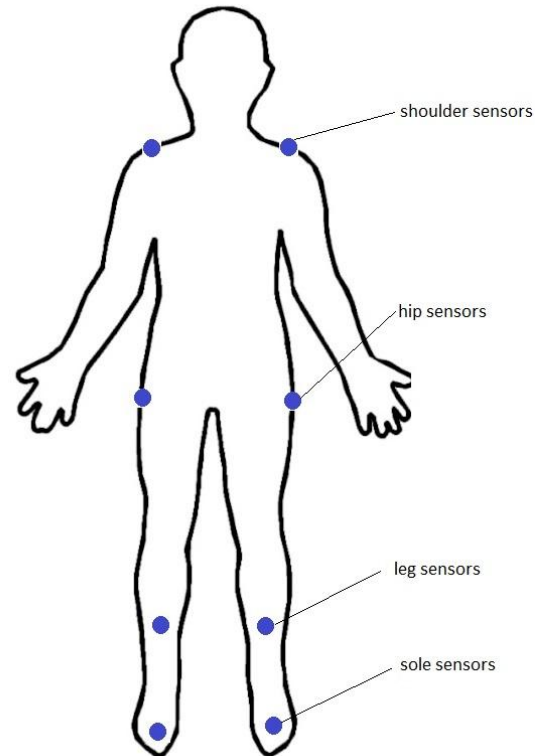
## Gait Analysis for Elderly

Team 6

Chart 12

<https://footpressurein diabetic foot ulcers smart insole.wordpress.com/2016/01/21/diabetic-foot-ulcer-foot-pressure-measurement-smart-insole/>

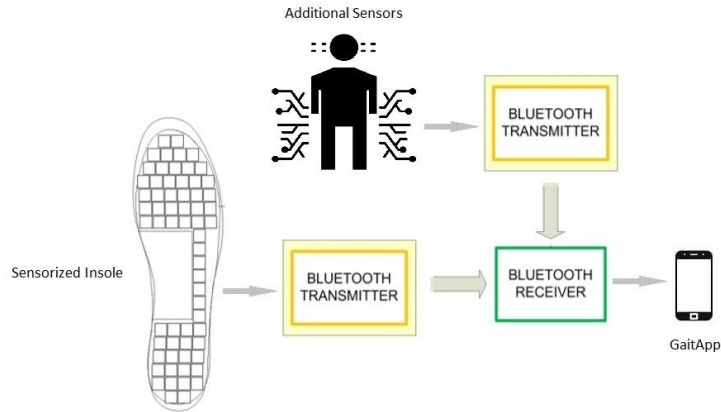




## Gait Analysis for Elderly

Team 6

Chart 13

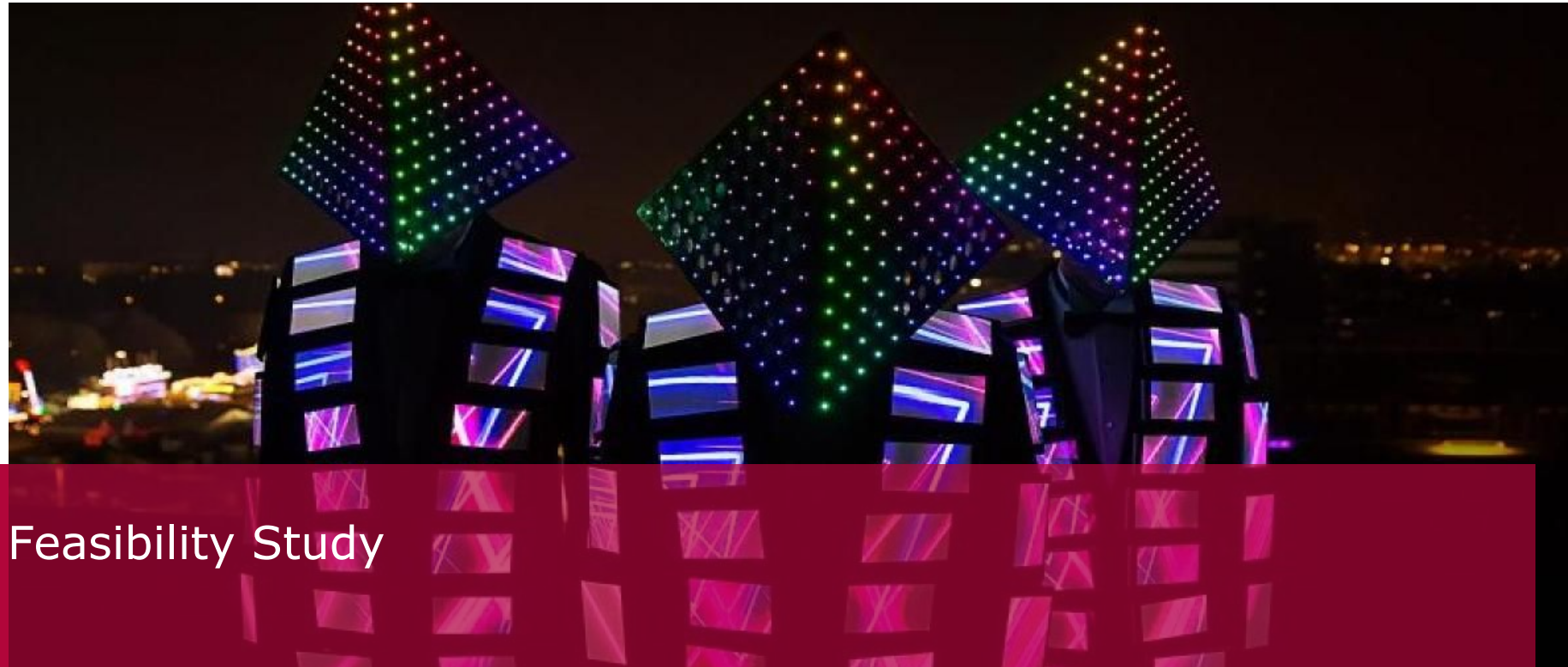


- devices connected through an app
- passive, long-time monitoring in daily life
- visualize a person's gait completely
- easy doctor analysis
- predict problems and better treatment of diagnosed issues
- GaitCloud

**Gait Analysis for Elderly**

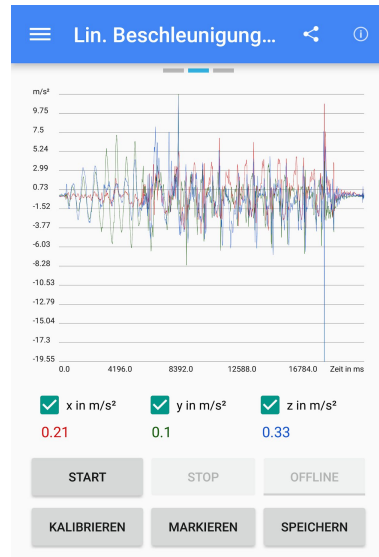
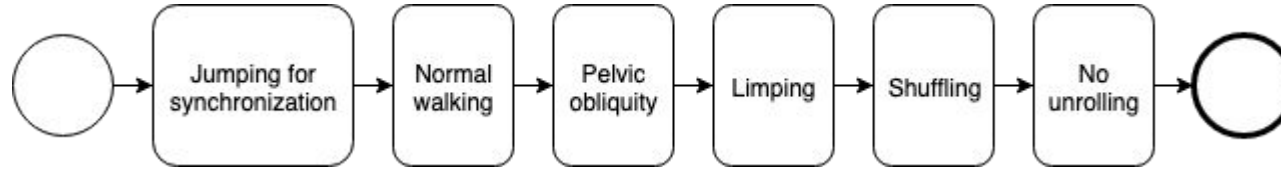
Team 6

Chart 14



## Feasibility Study

# Feasibility Study Setup



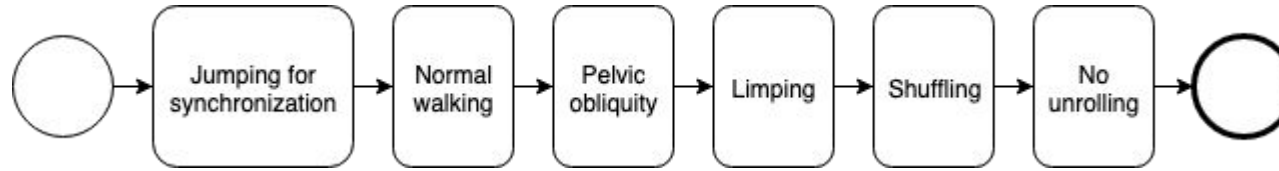
**Gait Analysis for Elderly**

Team 6

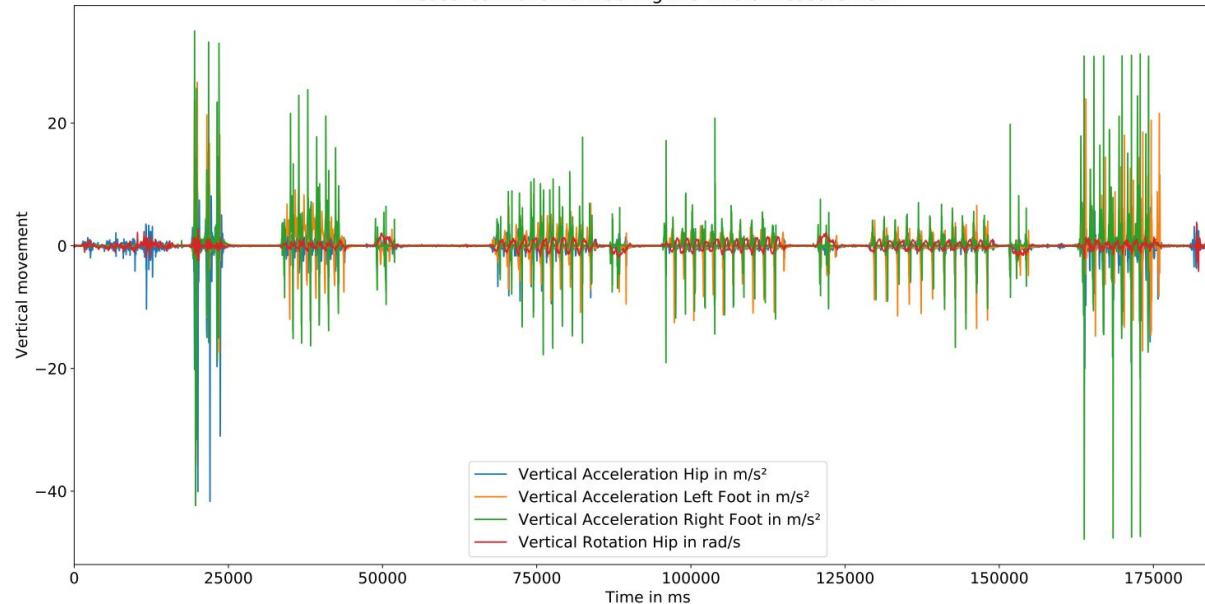
Chart 16



# Results of the Study



Measured movement during the whole measurement

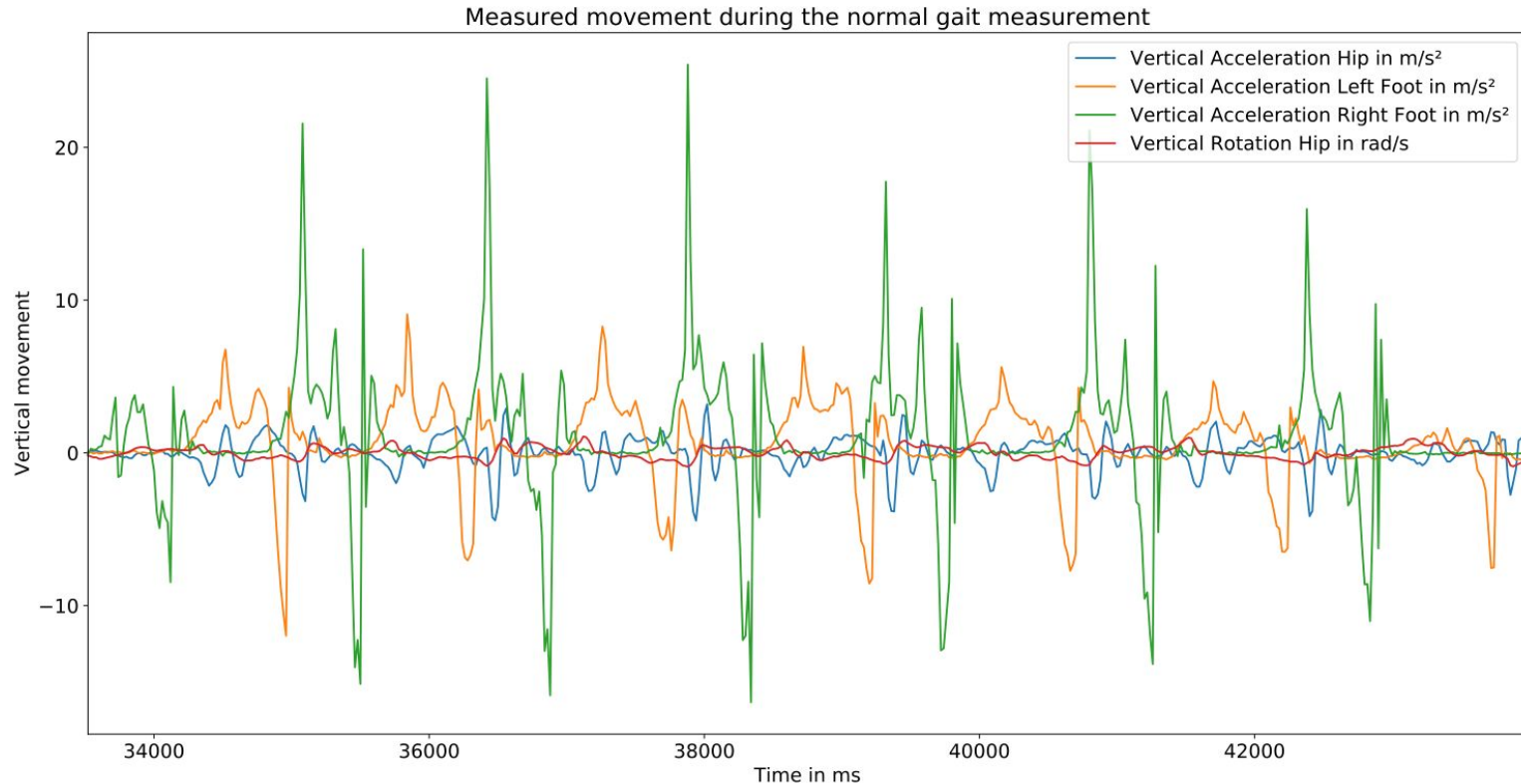


**Gait Analysis for Elderly**

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Chart 17

# Results of the Study

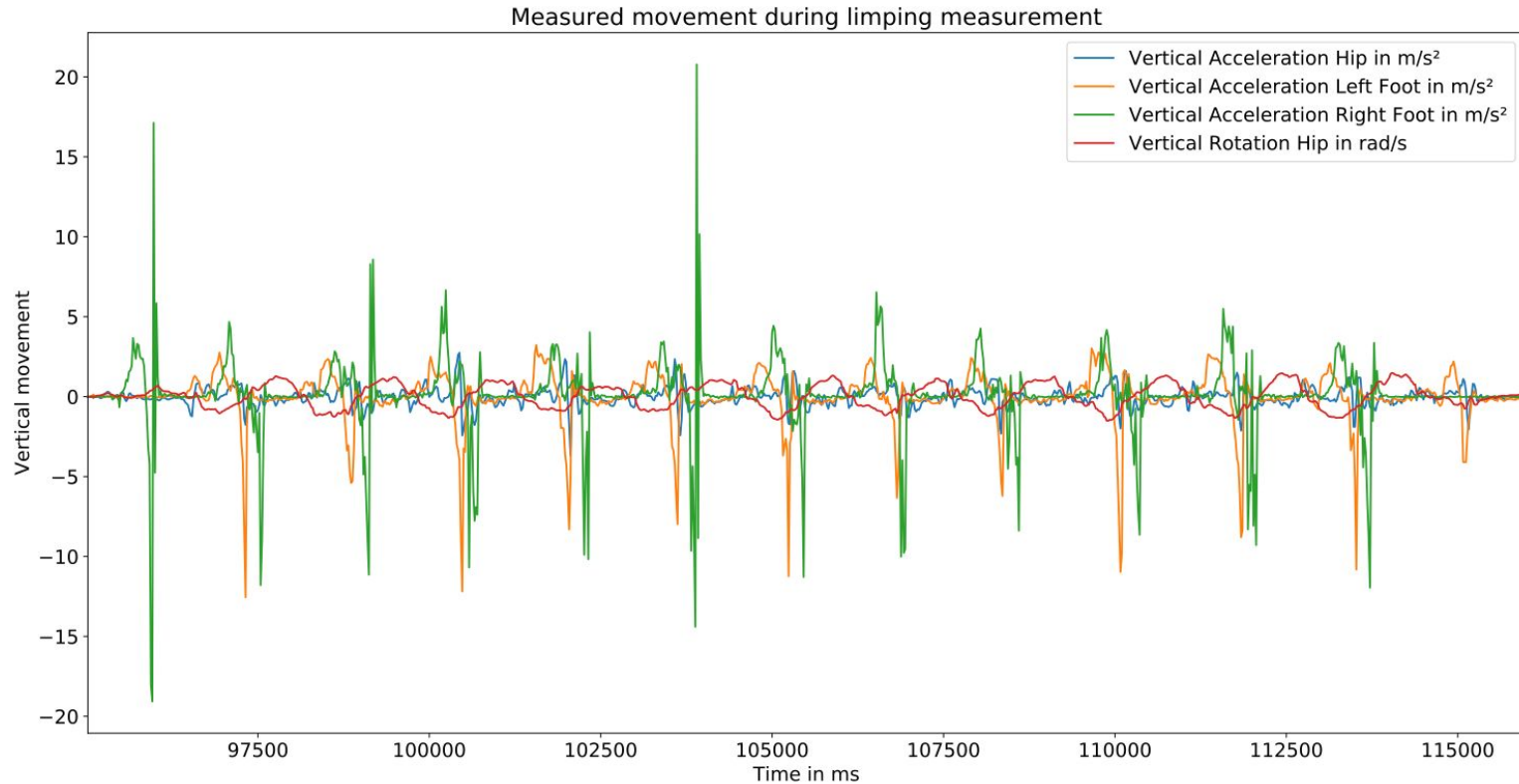


**Gait Analysis for Elderly**

Team 6

Chart 18

# Results of the Study

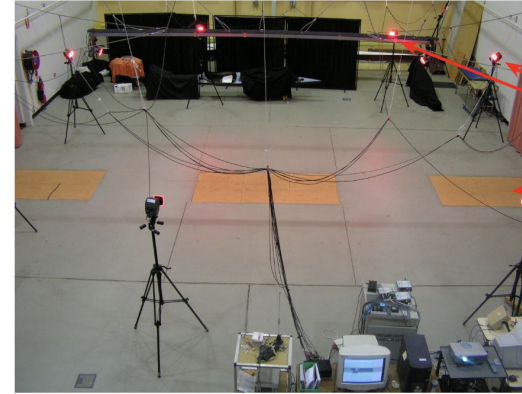
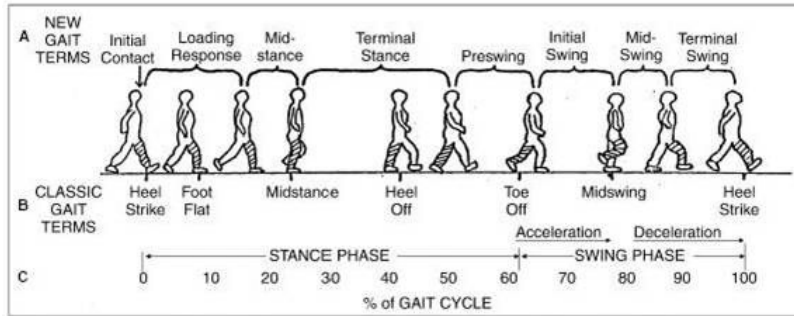


**Gait Analysis for Elderly**

Team 6

Chart 19

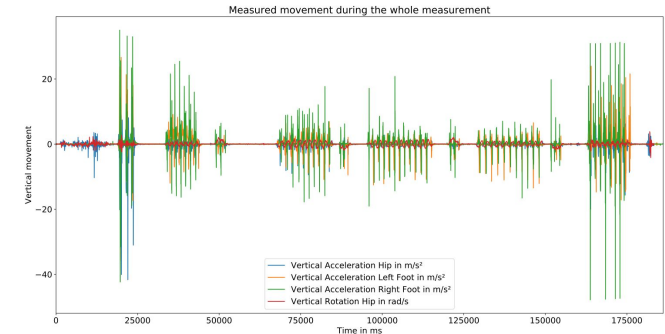
# Conclusion



multi-camera  
infrared system

force platforms

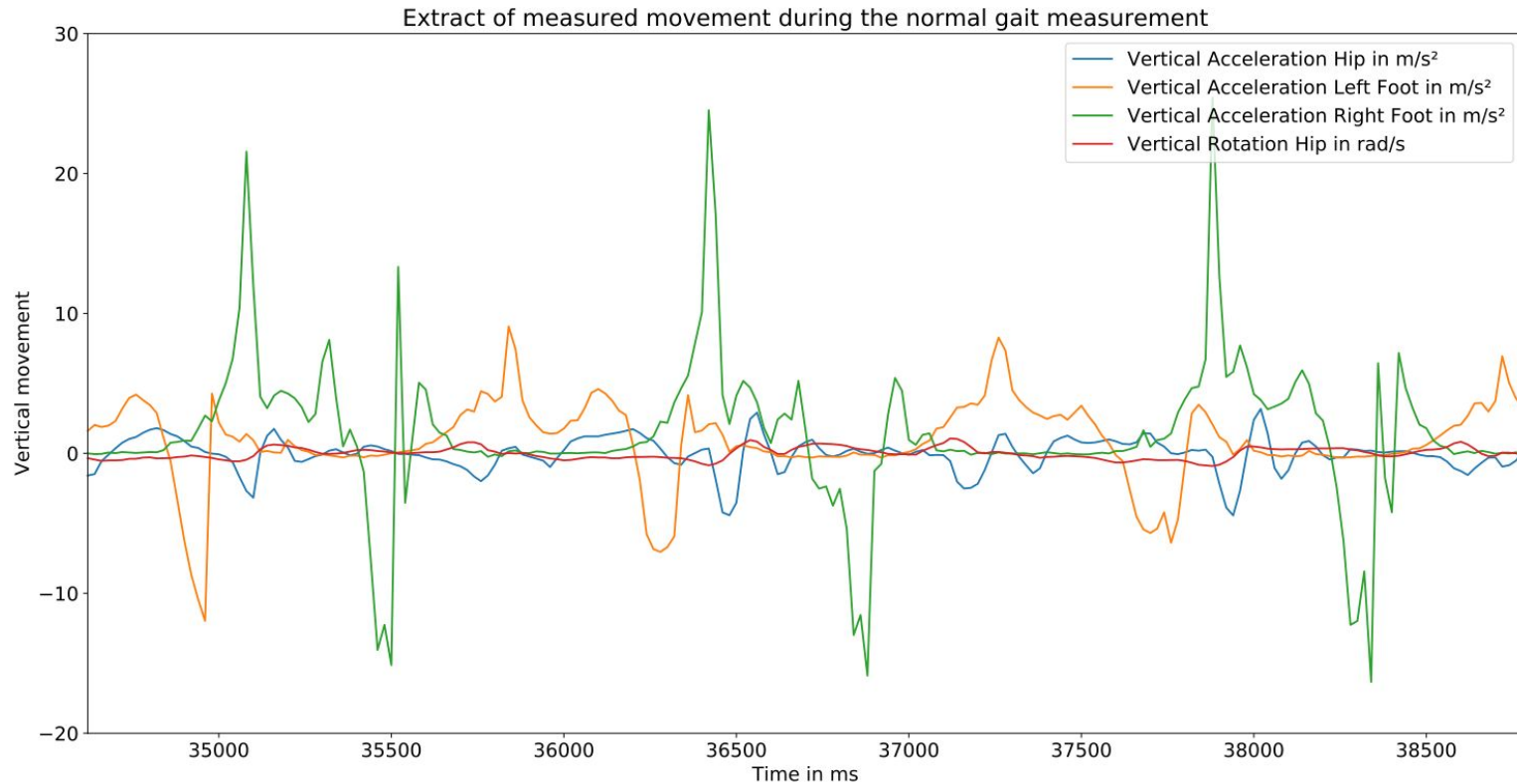
+ high precision  
- expensive,  
immobile





# Appendix

# Results of the Study

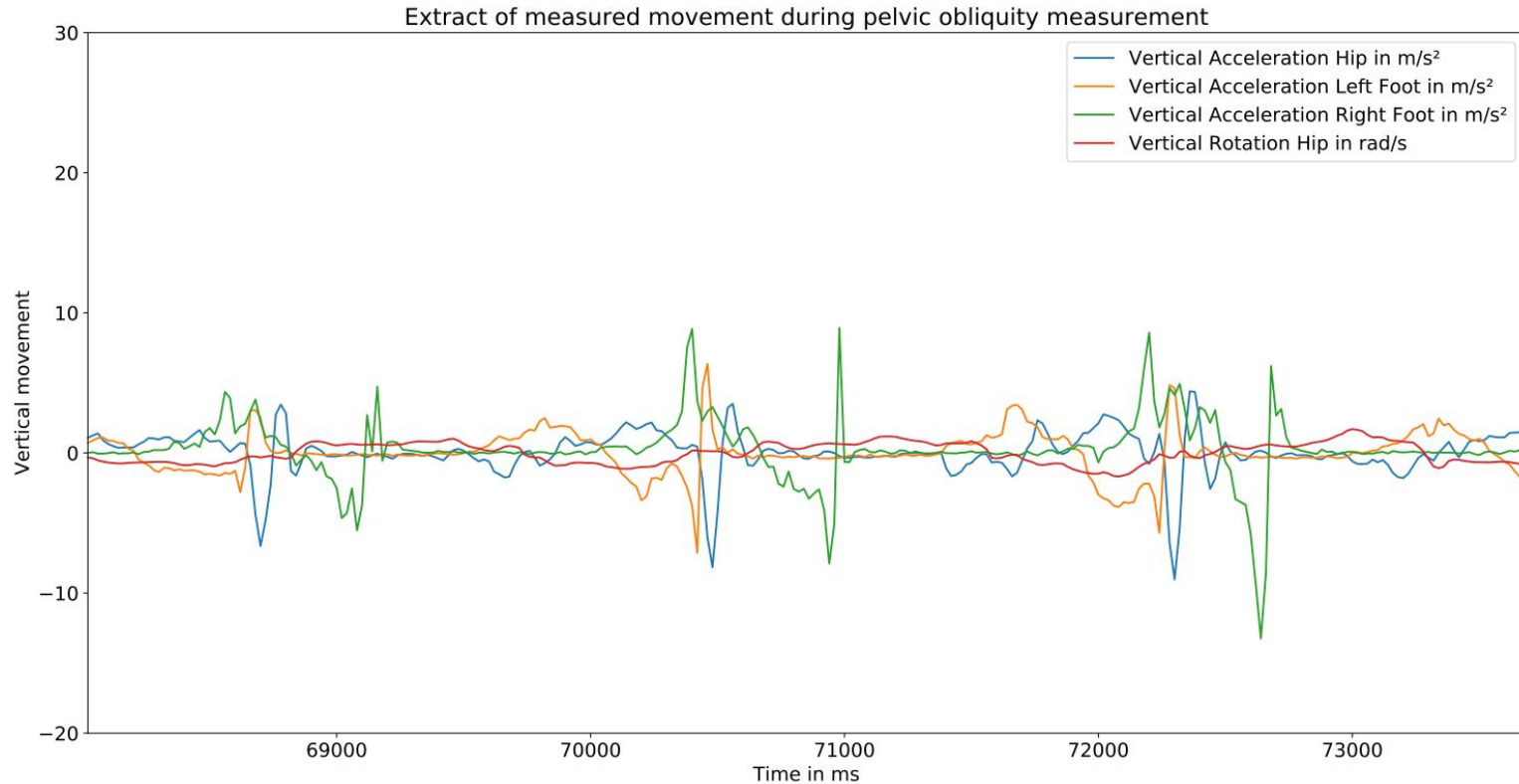


**Gait Analysis for Elderly**

Team 6

Chart 22

# Results of the Study



**Gait Analysis for Elderly**

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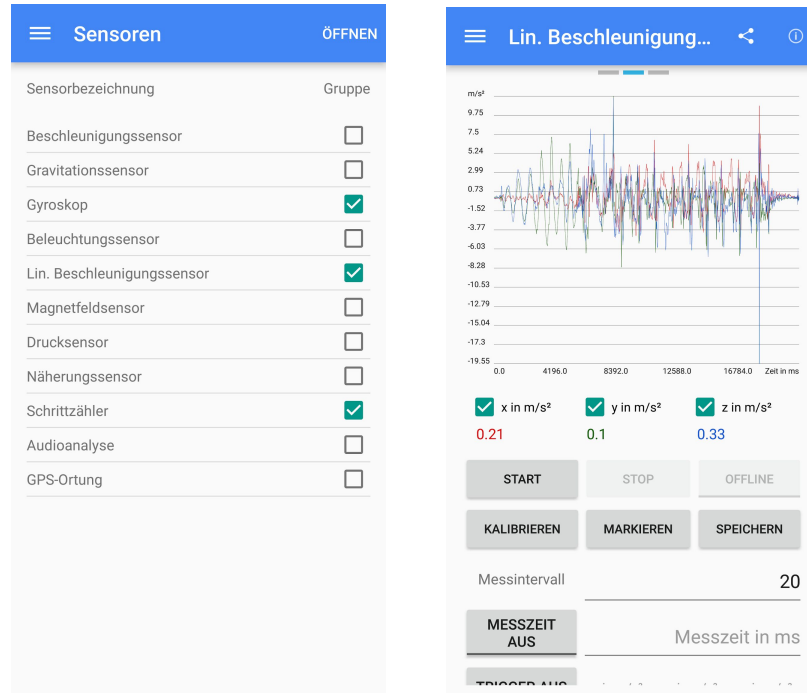
Chart 23





# Feasibility Study Setup

- custom app for measurements: SensorMax



**Gait Analysis for Elderly**

Team 6

Chart 25

# Agenda

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- Human Gait
  - What is Human Gait?
  - Gait Abnormalities
  - Gait of Elderly People
- Gait Analysis
  - What is Gait Analysis?
  - Current Practices
    - Doctor
    - Laboratory
    - Insoles and Sensors
- Proposal
  - Insole
  - GaitSet
- Feasibility Study
  - Study Setup
  - Results
- Conclusion
- Learnings and Outlook
- 

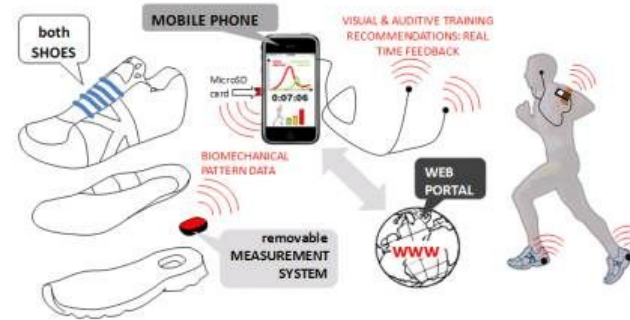
**Gait Analysis for  
Elderly**

Team 6

Chart 26

# New Practices: Wearable Sensors

- very popular: insoles for runners
- mostly acceleration & pressure sensors



<http://runsafer.eu>



<https://runvi.io>



<https://arion.run>



<https://www.digitsole.com>

## Gait Analysis for Elderly

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Chart 27

# Results of the Study

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- synchronization and interpretation of multiple measurement points feasible
- combination of sensors allows for more interpretation than acceleration alone
- different walking styles distinguishable
- patterns for training to identify gait abnormalities

**Gait Analysis for Elderly**

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Chart 28