DZHK

DEUTSCHES ZENTRUM FÜR
HERZ-KREISLAUF-FORSCHUNG E.V.

Alignment of Multi-Sensor Data: Adjustment of Sampling Frequency and Time Shifts

Marcus Vollmer

Institute of Bioinformatics, University Medicine Greifswald

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Outline

1. Multi-Sensor Data

What is multi-sensor data?

Multisensor data fusion, PK Varshney
Electronics & Communication Engineering Journal, 1997

Multisensor data fusion refers to the acquisition, processing and synergistic combination of information gathered by various knowledge sources and sensors to provide a better understanding of a phenomenon.

- Improved system reliability and robustness
- Extended coverage
- Increased confidence
- Shorter response time
- Improved resolution

Research team

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Wissen lockt. Seit 1456

Universitätsmedizin GREIFSWALD

Research team

MONTEXAS 4.0
Exzellente Montage In der Industrie 4.0

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

ESF Europäischer Sozialfonds für Deutschland

Europäische Union

Zusammen. Zukunft. Gestalten.

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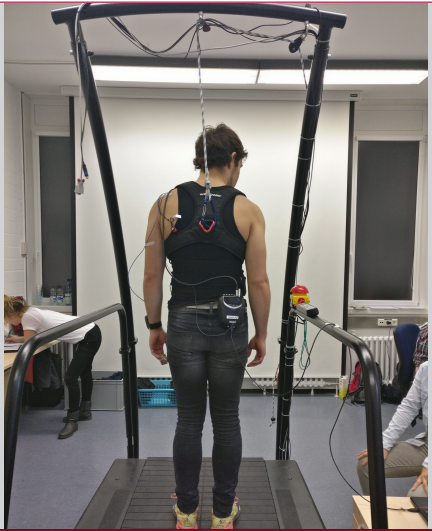
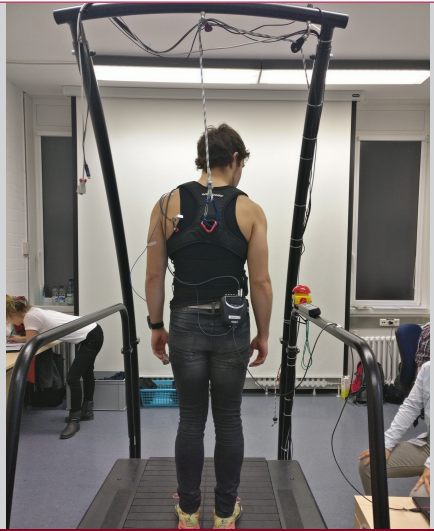
Experimental setup



Experimental setup

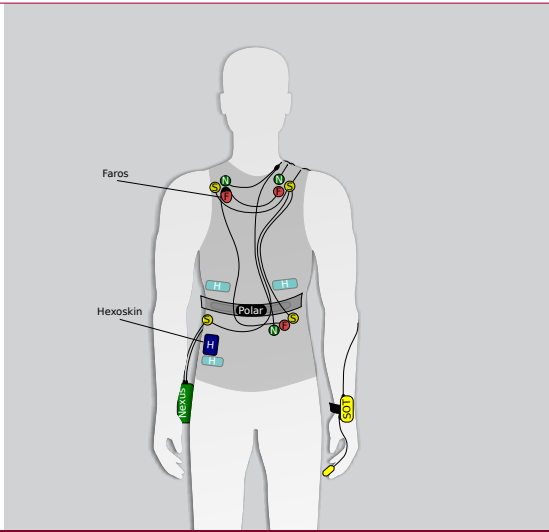


- 5 min standing rest
- 5 min walking on treadmill (1.2 m/s)
- cognitive test (2-back audio test)
- 5 min walking on treadmill (1.2 m/s, 15% gradient)

In between: NASA Task Load Index to measure individual strain

Experimental setup

- EMotion Faros 360° | 1000 Hz
- SOMNOtouch NIBP | 512 Hz
- NeXus-10 MKII | 8192 Hz
- Polar RS800 Multi | 1000 Hz
- Hexoskin Smart Shirt | 256 Hz



Experimental setup

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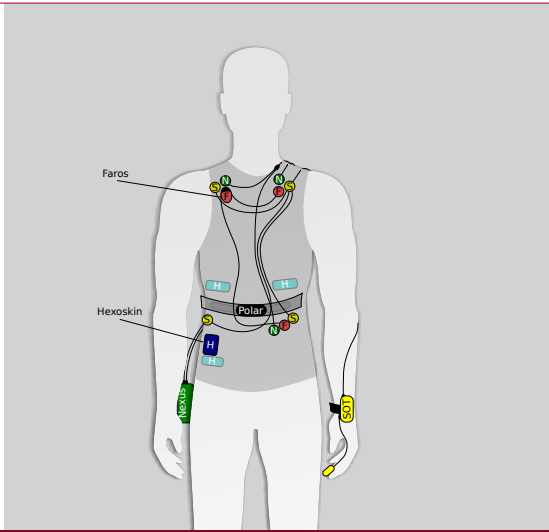
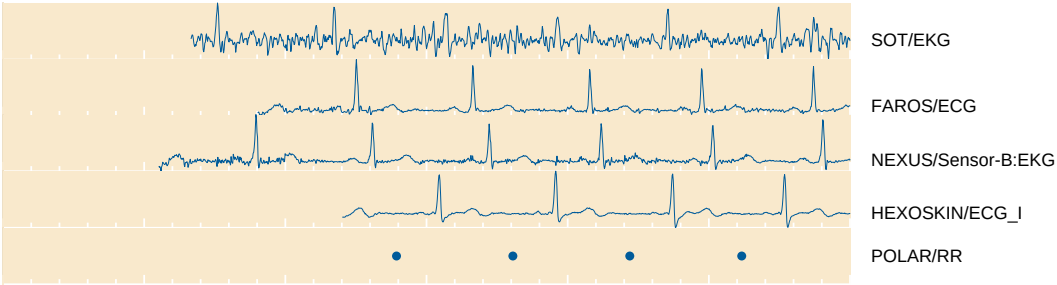


2. Adjustment of Time Shifts

Different starting time



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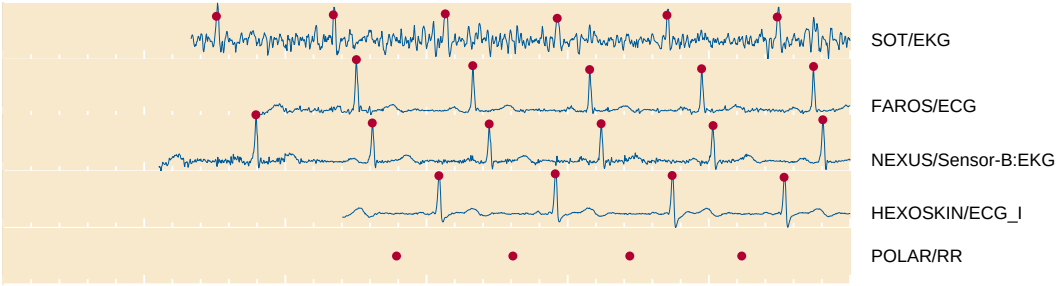

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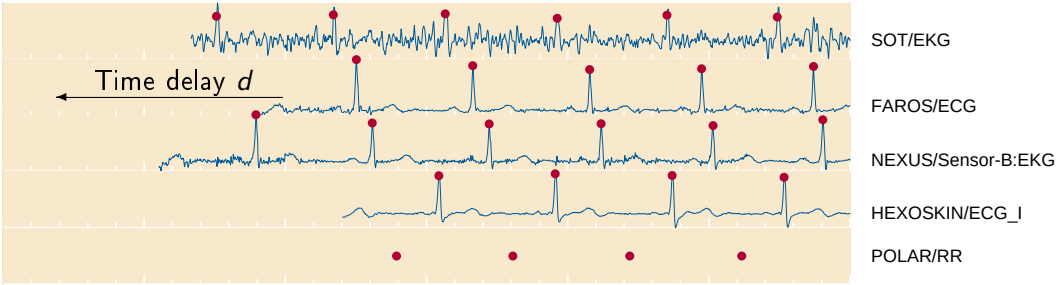
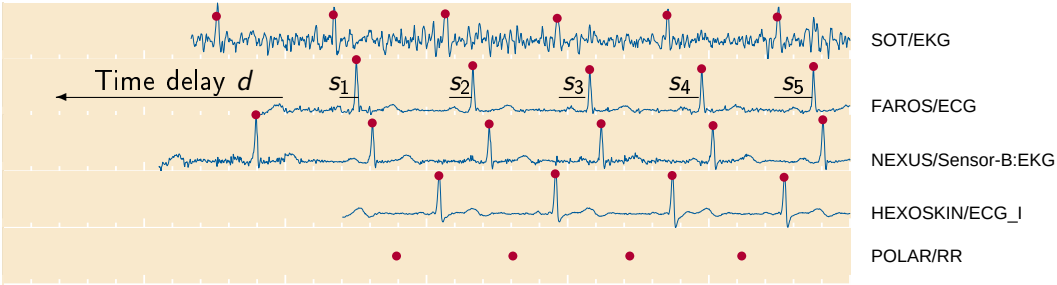
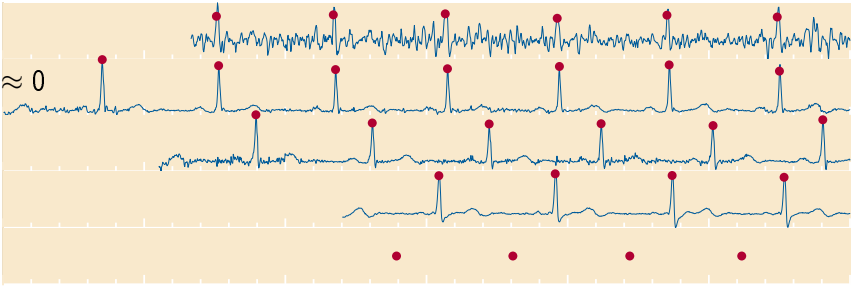


Different starting time

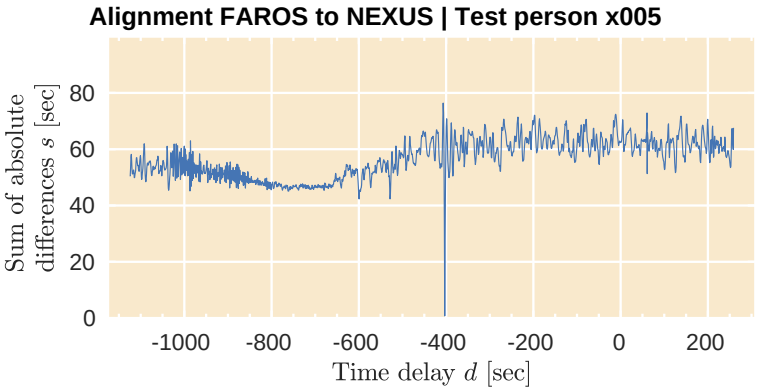


Different starting time

$$\sum_i |s_i| \approx 0$$



Adjustment using ECG annotations



3. Correction of Sampling Frequency

Why should I adjust sampling frequencies?

- User manual says 1000 Hz
  Expect an imprecise clock signal (quartz crystal): **+0.01%**

  In 24h-measurement we assume to collect 1000*24*60*60 = 86.400.000 samples
  Actually given the impreciseness we observe 86.408.640 samples

  8.640/1000 Hz = 8.64 s

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- Without adjustment wrong conclusions can be concluded:

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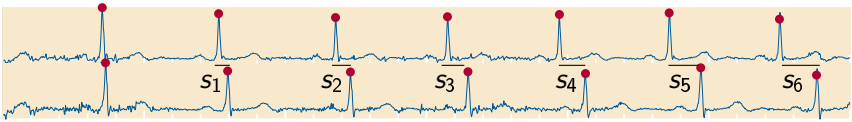
- Without adjustment wrong conclusions can be concluded:

  "The heart rate increased subsequent to the accident."
  "The heart rate increased just before the accident."

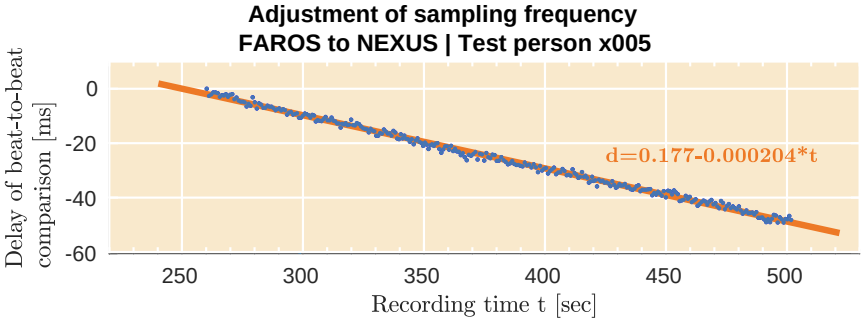
Linear adjustment of sampling frequencies



- Pairwise differences s_i are linear decreasing or increasing with time

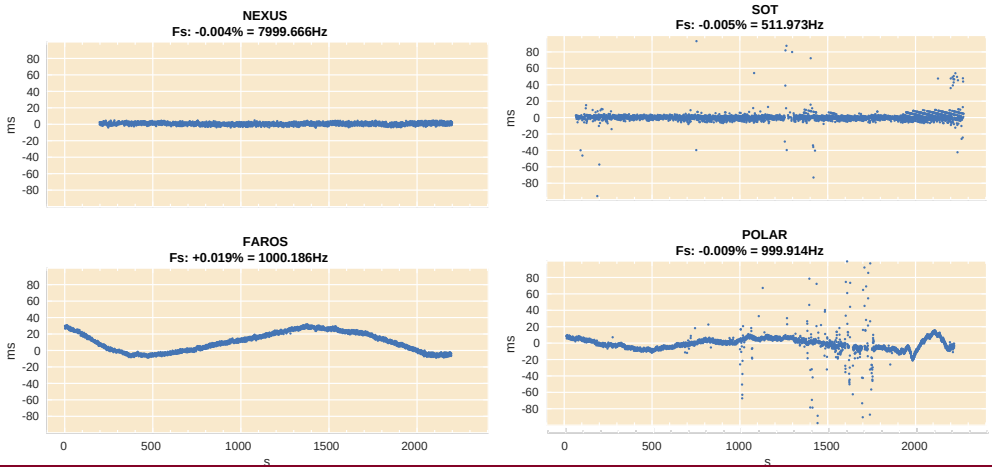
Linear adjustment of sampling frequencies

Fs_correct = Fs*(1-'Slope of robust regression fit')



Is a linear adjustment sufficient?

Hexoskin as reference:



4. Perspectives

Benefits from multi-sensor data

Well aligned signals

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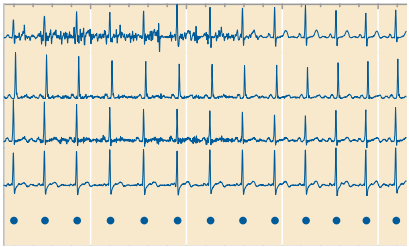
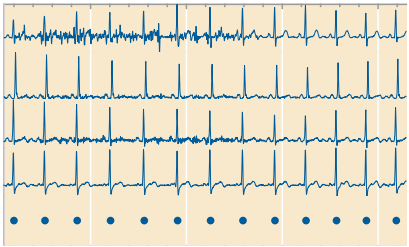
Well aligned signals



- Quality assurance
- Increased confidence
- Backup signals
  (low signal quality, signal loss)
- Use of full signal variety
  (body movement, temperature, respiration)

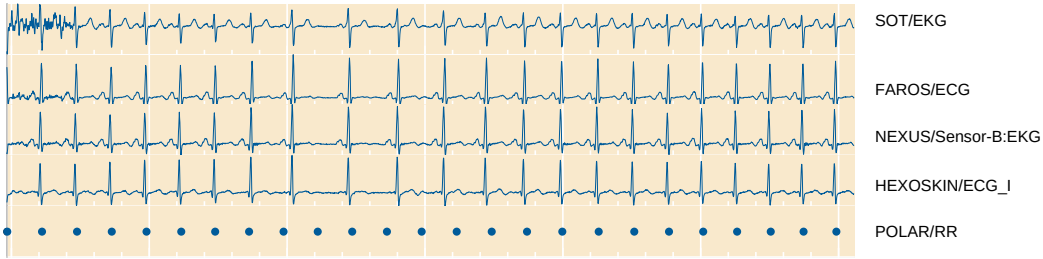
Benefits from multi-sensor data

Well aligned signals



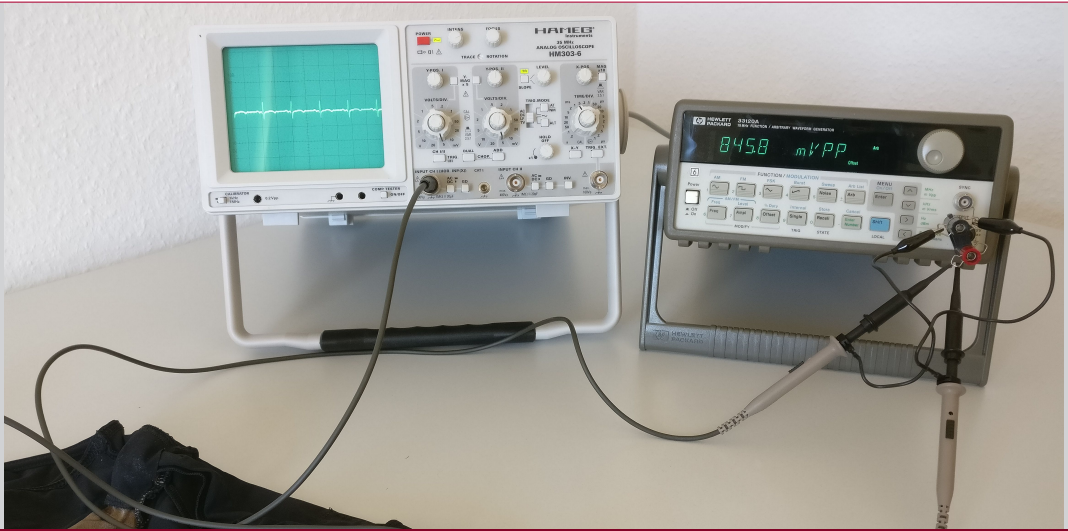
- Quality assurance
- Increased confidence
- Backup signals
  (low signal quality, signal loss)
- Use of full signal variety
  (body movement, temperature, respiration)
- Comparison of manufacturers heart rate estimation
- Extraction of realistic noise
- Verification/accuracy of Polar RR Intervals

Benefits from multi-sensor data



- Verification/accuracy of Polar RR Intervals

Future experiments



Thank You for
Your Attention!