Comparing inter beat and inter pulse intervals from ECG and PPG signals

COMPARING INTER BEAT AND INTER PULSE INTERVALS FROM ECG AND PPG SIGNALS

M.M. Nano*†‡, G.B. Papini*†‡, P. Fonseca*‡, R. Vullings*, S. Overeem*†, and J.W.M. Bergmans*‡, R.M. Aarts*‡

*Dept of Electrical Engineering, Eindhoven University of Technology, De Zaale, 5612 AZ Eindhoven, The Netherlands
† Sleep Medicine Centre Kempenhaeghe, Sterkselseweg 65 5591 VE Heeze, The Netherlands
‡ Philips Research, High Tech Campus, 5656 AE Eindhoven, The Netherlands

Email: M.M.Nano@tue.nl

Introduction

Heart rate (HR) monitoring is crucial in several clinical fields. The gold standard technique for measuring HR dynamics is electrocardiography (ECG). However, photoplethysmography (PPG) is becoming a reliable alternative to ECG for long-term monitoring, because of its unobtrusiveness. Studies have shown that cardiac features, such as HR variability, can be accurately calculated both from ECG and wrist-worn PPG measurements [1], [2]. However, the correspondence of beat-to-beat intervals (RR) from ECG and PPG pulse-to-pulse intervals (PP) has not been widely studied, especially during sleep where lower number of body movement artifacts are present.

Our research investigates the correspondence between RR and PP for three landmarks on the PPG waveform.

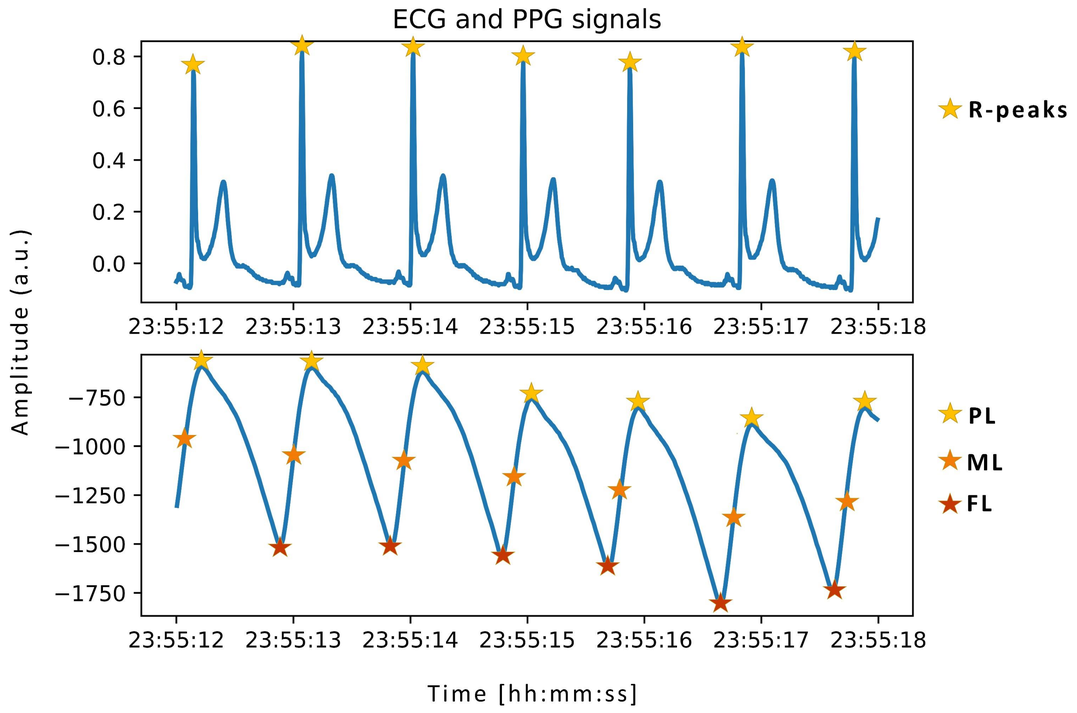
Methods

Data

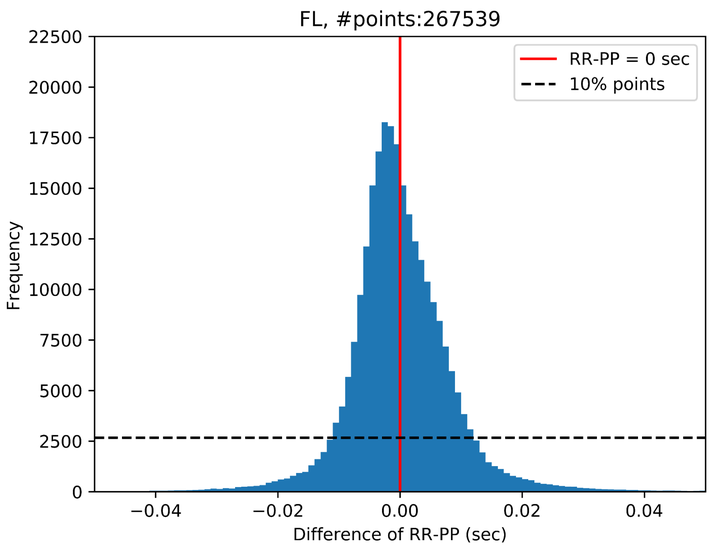
10 overnight sleep recording of 6 healthy subjects (age: 50.5 ± 8.46 y, 2 males) using ambulatory PSG for lead II ECG recordings and wrist-worn PPG sensor

Analysis

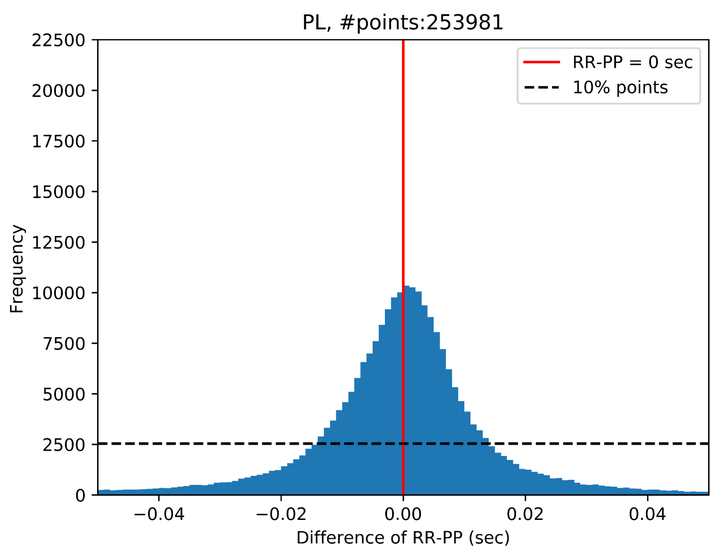
- ECG and PPG synchronization (time and frequency offset)
- R-peaks detection
- Pulse-landmarks (foot (FL), peak (PL), maximum gradient of the rising slope (ML)) detection
- R-peaks and pulse-landmarks considered a match when detected within a 125ms window in order to account for pulse transmit time (PTT) changes
- Comparison of the distributions of the RR-PP differences



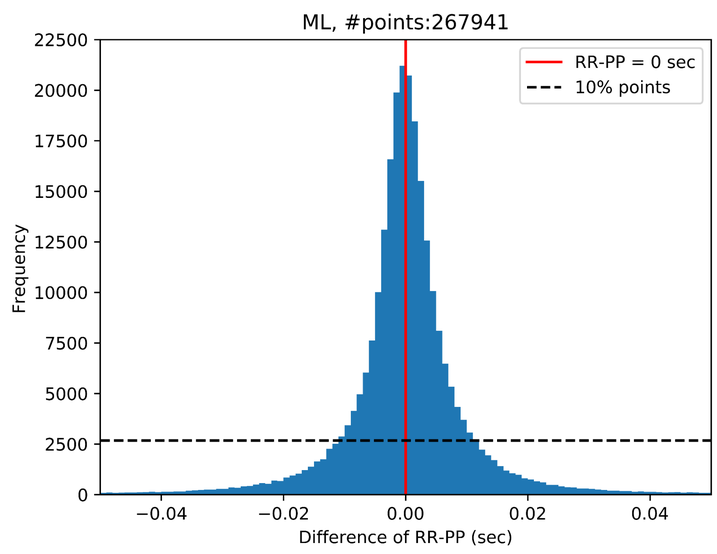
Results



mean ± sd: 0.3 ± 19 ms
skewness: 0.048



mean ± sd: 1.8 ± 39 ms
skewness: -0.046



mean ± sd: 0.3 ± 18 ms
skewness: -0.014

Conclusion

Maximum gradient of the rising slope landmarks deliver the lowest average difference to R-peaks, and the lowest trigger jitter and skewness

References

[1] A. Schäfer and J. Vagedes, “How accurate is pulse rate variability as an estimate of heart rate variability?: A review on studies comparing photoplethysmographic technology with an electrocardiogram,” *Int. J. Cardiol.*, vol. 166, no. 1, pp. 15–29, 2013.
[2] J. van Andel, C. Ungureanu, R. Aarts, F. Leijten, and J. Arends, “Using photoplethysmography in heart rate monitoring of patients with epilepsy,” *Epilepsy Behav.*, vol. 45, pp. 142–145, 2015.