Camera based Heart Rate and Heart Rate Variability Estimation

Graduate

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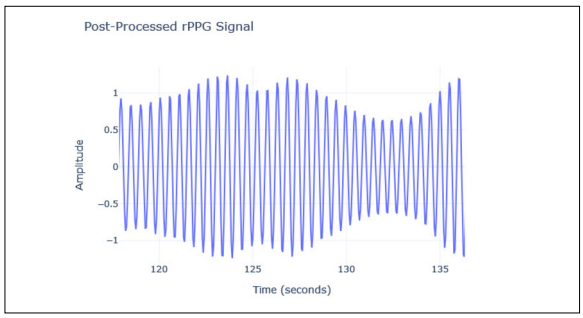
Introduction: This thesis develops a camera-based heart rate (HR) and heart rate variability (HRV) estimation application, integrating an optional ANT+ chest strap for accuracy evaluation. HR correlates with physical exertion, while HRV indicates stress load. The thesis explores two remote photoplethysmography (rPPG) methods and implements a pipeline using face skin pixel intensity values to extract the HR and HRV. Results are displayed on a dynamically updating dashboard. The application consists of seven synchronised, threaded modules and accepts prerecorded videos or a live webcam stream as input for HR and HRV estimation.

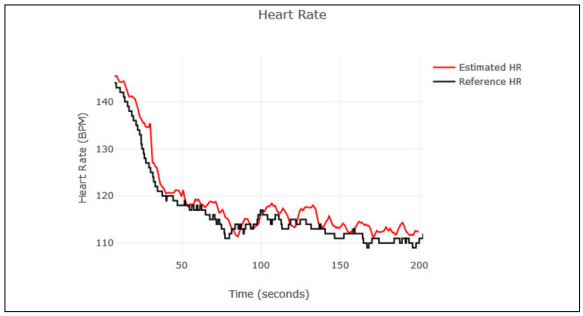
Approach / Technology: The application implements a pipeline for HR and HRV estimation, featuring a dashboard that displays results with an adjustable time delay based on user settings. The process begins with a region of interest selection, using color channel means and utilising the POS rPPG method for signal extraction. Head motion is extracted as well. After rhythmic noise suppression the signal is post processed and yields HR and HRV. Accuracy is assessed against a reference system and evaluated with a correlation plot, including additional error metrics. Measurements are saved in a CSV file. For evaluation the live dashboard and a dataset of 4 individuals in 4 different situations were used. The four situations are: Resting, Talking, Rotation, and Post Workout.

Result: Results highlight the significant impact of lighting and movement, particularly non-head movements (e.g., Talking), on measurement quality. Evaluating the results showed great potential in the method but proves to still be very sensitive to the surrounding environment and conditions. Some inter-individual variation was also found. To confidently use the application further improvements and calibrations are needed, as described in the thesis. Overall, the best results were recorded during Resting and Rotation. Resting had a MAE HR of 1.89 bpm and a MAE HRV of 21.16 ms. All in all the baseline for a promising measurement method was built and showed that it is possible to use camera based estimations for instantaneous HR and HRV measurements.

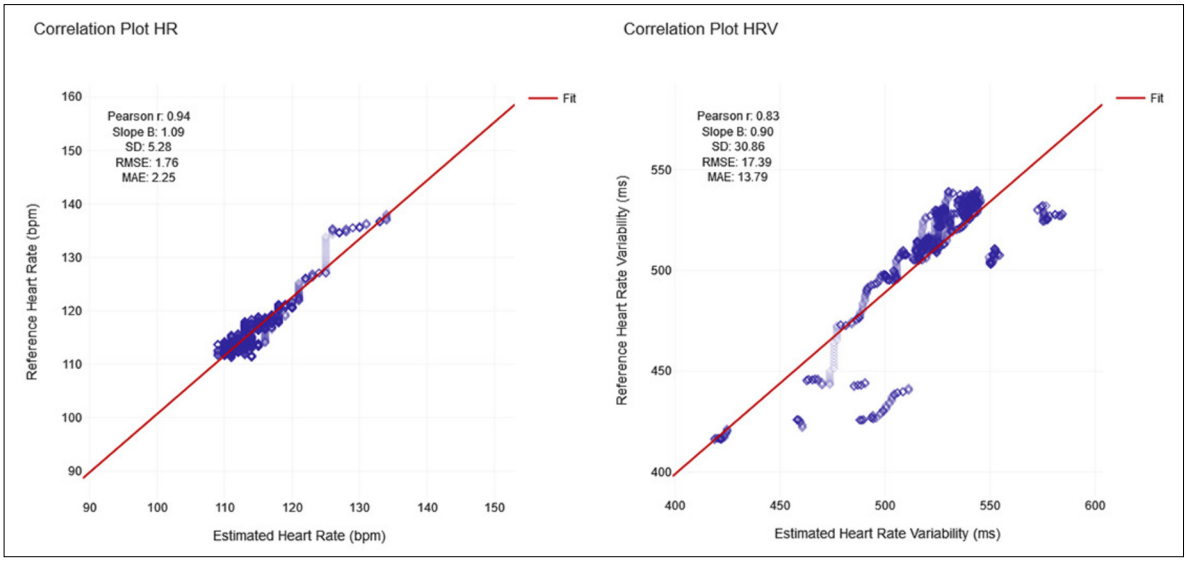
Example of a Post-Processed rPPG Signal
Own presentment



Heart Rate and Heart Rare Variability evaluation. Post workout measurement
Own presentment



Heart Rate and Heart Rare Variability correlation with reference measurement, time shift was removed.
Own presentment



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Subject Area
Artificial Intelligence, Image Processing and Computer Vision, Digital Signal Processing

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