A Database of Synchronously Recorded Electrocardiograph, Phonocardiograph, Photoplethysmograph and Accelerometer Signals at Different Heart Rates

Jovana Petrovic[1], Predrag Tadić[2], Marija Ivanović[1], Maša Tiosavljević[2], Vladimir Atanasoski[1], Aleksandar Lazović[1], Ljupčo Hadžievski[1], Arsen Ristić[3], Vladan Vukčević[3]

[1] Vinča Institute of Nuclear Sciences, University of Belgrade
[2] School of Electronic Engineering, University of Belgrade
[3] Faculty of Medicine, University of Belgrade

Introduction: Motivated by the challenge of finding a screening-compatible method for early heart failure (HF) detection, we have revised polycardiography using modern sensing technology. Following the ECS recommendations and recent findings regarding the HF assessment during or after stress, respectively, we conducted a SensSmartTech study to test the polycardiographic assessment under stress induced by activity. Here, we report on the study results and the generated database.
Method: The SensSmartTech database was recorded by a multiparametric sensor system at rest (3 recordings per subject) and during relaxation after activity (several recordings per subject). The data were synchronously acquired from an electrocardiograph (ECG), phonocardiograph (PCG), accelerometer (ACC) and two photoplethysmographs (PPG) at the carotid and brachial arteries. They were generated from 18 females and 14 males with an average age of 34.6 ± 9.1 years.
Results: The database contains 338 30-sec signals represented by ten channels each: 4 ECG, 4 PPG, 1 PCG and 1 ACC channel. HRs are in the range of 58-170 bpm, rendering a total of 17817 heartbeats. The original signals (to be made open source) contain respiration, motion artefacts and electromyographic noise.
Data analysis, including the baseline-wonder removal, showed < 1 dB deterioration in signal-to-noise ratio obtained after activity compared to that measured at rest. The automated beat-by-beat detection of electric and mechanical fiducial points (Q, R and J in ECG, 1st and 2nd heart sounds, the onset, systolic and diastolic peaks, and incisure in PPGs) presents a possibility for automated extraction of systolic time intervals (HF biomarker) and blood pressure. Taking the ECG as a reference, HR was estimated with 2 bpm RMSE from PPG and 3 bpm RMSE from ACC.
Conclusion: The SensSmartTech database may also be useful for investigating cardio-respiratory coupling, HR variability and denoising algorithms, and correcting QT and systolic time intervals for HR.