

Evaluation of Methods for Estimation of Respiratory Frequency from the ECG

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The influence of breathing on the ECG allows the estimation of respiration rate when only this signal is available. Several techniques have been proposed in literature. We compared five different methods in order to evaluate their performance under different conditions. We selected methods based on Heart Rate Variability (HRV), modulation of QRS morphology (amplitude and area), and changes on the Angle of Mean Electrical Axis (AMEA). The spectral combination of them was also studied. Methods were evaluated with signals recorded to 20 patients in different body positions and breathing patterns (free and paced breathing). Recordings doing exercise were also considered to evaluate the robustness against noise. In addition, Fantasia database was also used. Correlation in both time and frequency together with relative error between real and estimated breathing rate were computed. The modulation of QRS amplitude gave the lowest relative error for free breathing with median (mad)=0.98% (17.22%). AMEA (1.33% (22.23%)) and QRS area (1.42% (23.02%)) performed slightly worse. For paced breathing, spectral combination resulted in the lowest relative error (0.63% (2.87%)). HRV showed a good performance during paced breathing, error of 0.89% (5.80%), but gave a high relative error (39.82% (24.60%)) when breathing was free. Regarding computer complexity HRV was the best method while spectral combination required was the worst because requires previous calculations of all remaining methods. The best results were obtained for the leads placed in the middle of the chest close to V1 and V2. Recordings measured in supine positions had lower relative errors than seated or standing recordings. When the ECG noise was high due to motion artifact, the methods did not give satisfactory performance.