

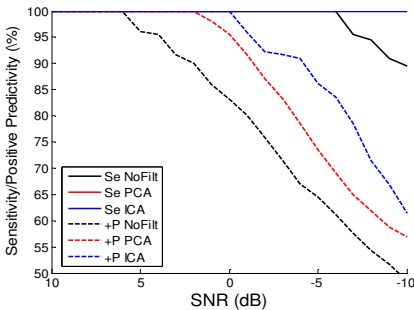
PCA and ICA applied to Noise Reduction in Multi-lead ECG

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The performance of PCA and ICA in the context of cleaning noisy ECGs in ambulatory conditions was investigated. With this aim, ECG with artificial motion artifacts were generated by combining clean 8-channel ECG with 8-channel noise signals at SNR values ranging from 10 down to -10 dB. For each SNR, 600 different simulated ECGs of 10-second length were selected. 8-channel PCA and ICA were applied and then inverted after selecting a subset of principal/independent components (PC/IC). Initially, the optimal component subset was considered. In order to evaluate the performance of PCA and ICA algorithm, the output of a beat detection algorithm was used. The beat detector was applied to both the output signal after PCA and ICA filtering and to the signal before filtering. The detections were compared with the annotations obtained before adding the noise in order to calculate the Sensitivity (Se) and Positive Predictivity (+P).

In terms of Se, the beat detector had a good performance with Se=100% down to -6dB. Applying both PCA and ICA yielded to a Se of 100% for all SNR values studied. When +P was considered, +P was 100% down to 6dB. Below that value, it dropped down to 83.09% at 0dB and 48.81% with SNR=-10dB. Applying PCA, yielded to an improvement for all SNR values (+P=95.45% for SNR=0dB; +P=56.87% for SNR=-10dB). However, ICA filtering gave a higher improvement in +P for all SNR values (+P=100.00%



Beat detection output after applying PCA and ICA and with no filtered.

for SNR=0dB; +P=61.38% for SNR=-10dB). An automatic method for selecting the components was implemented using half of the dataset (300 signals per SNR) and evaluated in the second half. Both PCA and ICA gave an improvement as compared to no filtering, over all SNR values. ICA had a better performance (SNR=-10dB, improvement in +P of 2.32% for PCA and 7.28% for ICA).