

Detection of Power-Line Interferences in ECG signal using Frequency-Domain Analysis

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ECG signals can be seriously distorted by power-line interference (PLI), the electromagnetic interference of power-line cables. This contamination can lead to imprecise measurements of the ECG wave durations and amplitudes. Therefore, the accuracy of the ECG analysis can be significantly reduced. The aim of this study was to develop and test a PLI detection algorithm, including the automatic recognition of the correct frequency and evaluating their level of interference. This enables an appropriate filtering whenever needed. In the presence of PLI the power spectral density (PSD) will consist of a true ECG part and a part caused by PLI. The latter has the shape of narrow peaks in the PSD at certain frequencies corresponding to the basis frequency, 50 Hz and 60 Hz, and/or its harmonics. The PSD is computed using Welch's method with an appropriate window size compromising on variance reduction of the PSD estimation and frequency resolution. The part of the PSD relating to an estimate of the underlying ECG is removed to single out the PLI components. Afterwards, a robust peak detection algorithm is applied to the residual PSD in order to identify all possible basis frequencies and their harmonics. To explore the capabilities of this method, first pure sinusoidal interferences were imposed to real, recorded ECG signals. Placed at the basis frequencies those interferences could be detected if they had amplitudes of around 10 V. However, when located at the harmonics the interferences could be detected even with 5-6V. Finally, the performance of the detection algorithm was validated with more than 12000 ECG signals of 10 second length and numerous sampling rates recorded in different countries. Some of them featured PLI and some of them did not. The detection results are very promising with a total false positive rate of 0.1%.