Cepstral Based Approach for Online Quantification of ECG Quality in Freely Moving Subjects

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ECG tracings recorded during spontaneous behaviour may include periods of signal loss or artefacts. Thus, it is advisable that during online ECG monitorings, data segments of poor quality are automatically detected and discarded to avoid analysing meaningless data. To address this issue, we developed an algorithm for online quantification of ECG quality designed for running on microprocessors with low computational power, and able to work with any ECG derivation, independently from the shape of ECG waves. The algorithm measures the ECG quality by calculating the relative weight of periodic patterns with period in the physiological range of cardiac intervals. The method is based on the calculation of the ECG power cepstrum on a running window of 10 s. The cepstrum is the Fourier spectrum of the logarithm of the power spectrum. Typically, the ECG spectrum shows peaks at multiples of the fundamental harmonic (equal to the mean heart rate in the running window). In this case, the log-spectrum appears as a more regular oscillation. Thus, the spectrum of the log-spectrum (i.e., the ECG Cepstrum) shows a large peak in the physiological band of the mean cardiac interval (from 0.25 to 2.0 s). If ECG waves are absent or largely corrupted by noise, a cepstral peak should not appear in this band. We defined the ECG quality index (QI) as the ratio between the cepstral power in the physiological band, and in a noise band selected between 0.1 and 0.25 s. The method was applied on two overnight ECG recordings of different quality. When QI$<$1, the algorithm discarded the ECG running window because of its too poor quality. The algorithm classification of ECG signal of acceptable quality (99.8% and 60% respectively of the whole recording) was very similar to the visual classification performed by a human operator (100% and 67%).