Recognition of Diagnostically Useful ECG Recordings: Alert for Corrupted or Interchanged Leads

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The upgrade of mobile phones with applications for acquisition, preprocessing and transmitting the patient's electrocardiogram (ECG) to a hospital unit would be of great benefit for prevention against the most frequent mortality caused by heart failure. This idea is promoted by the Computing in Cardiology Challenge 2011, which encourages the development of algorithms for analysis of the ECG quality within a few seconds, aiming to warn about diagnostically unacceptable recordings with common problems during ECG acquisition, such as misplaced electrodes, poor skin-electrode contact, external electrical interference, and artifact resulting from patient motion.

The algorithm presented in this study is participating in the Challenge Event 1 (closed source, open data). The software is developed in Matlab environment, analyzing the standard 12-lead ECG of 10 seconds. After QRS onset/offset detection, the following procedures for ECG quality estimation are applied:

- Detection of power line interference by estimation of the outputs of two band-pass filters around 50 Hz and 60 Hz;
- Detection of saturation in the leads' dynamics;
- Detection of steep and high-amplitude artifacts;
- Detection of baseline wander by estimating the output of 1 Hz low-pass filter;
- Detection of electromyographic (EMG) artifacts and other high-frequency noises by analysis of the output of 35 Hz high-pass filter;
- Detection of low amplitude lead (<150μVp-p);
- Detection of misplaced electrodes by analysis of the QRS-T waveforms distributions in all leads using two independent tests – one for chest leads and the second for peripheral leads.

Positive detection in any of the above procedures is considered as a warning for unacceptable quality of the ECG recording.

The training of the algorithm is performed using the Challenge Learning Set "A", including 1000 ECG recordings with full diagnostic bandwidth (0.05 - 100) Hz, sampled at 500 Hz, 5 μV/LSB resolution. Considering the reference annotations of the training database, specificity of 92.4 % (correctly recognized 560 out of 606 acceptable ECGs) and sensitivity of 90.1 % (correctly recognized 355 out of 394 unacceptable ECGs) are obtained. Using the Testing Set "B" with 500 ECGs, a preliminary score of 0.832 is given for the first entry of the algorithm in Event 1 challenge.