Epileptic seizure detection based on wrist Photoplethymography (PPG): detection of noise segments

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Background:

The aim of the global project is to develop a wearable seizure detection system based on the integration of Electroencephalogram and Cardiorespiratory information. In a first step, the Heart Rate (HR) is investigated measured by wrist-worn Photoplethysmography (PPG). A disadvantage of PPG is the presence of motion artifacts, which will lead to poor specificity in seizure detection. In order to reduce these false alarms, the noise segments should be detected and reconstructed.

Materials & Methods:

The data, used in this experiment, consists of 24-hour recordings of 9 patients, recorded in UZ Gasthuisberg with Empatica E4 (wrist PPG and trixial Accelerometry (ACC)) and Faros(ECG). The data is split in 7s segments. Each segment is labeled as clean or noisy by quantifying and comparing the HR extracted from ECG (reference) with the HR from PPG. For each segment, variance, first-/second-/third-largest peak of the spectrum, and spectral Shannon entropy are extracted in addition to other 8 features proposed in literature. Moreover, 20 ACC-derived features are calculated. A linear least-squares support-vector machine is proposed to classify the segments to a clean or noisy segment within a leave-one-patient-out approach. A backwards wrapper is applied for feature selection on PPG- and ACC-derived features.

Results and Conclusions:

The mean sensitivity and specificity (PPG/ ACC) are respectively 73.0.3 ± 18.71 /53.69 ± 19.36 and 84.65 ± 6.81/87.96 ± 6.35, showing ACC has lower sensitivity. To the best of our knowledge, this is the first study to combine these PPG-features, compare PPG- and ACC-performances and validate these features in an objective way on long-term epilepsy data.