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Meeting Abstract

Quality assessment for multimodal biosignals acquired intraoperatively

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Text

Introduction: The assessment of biosignal suitability for further analysis is one of first steps in digital signal processing [1]. This represents a relevant part of multimodal analysis. When multiple biosignals are recorded in parallel, several sources of artifacts (e.g., motion artifacts, inadequate electrode contact, power-line interference [2]) might affect them in different ways [1]. The rejection of signal segments with low suitability is required to make sure further analysis works in appropriate manner [1], [3]. There are already methods for signal quality assessment but the majority are focused on signal type or based on physiological assumptions (e.g, reasonable heart rate range). However, for multimodal analysis, agnostic methods of signal types are required.

Methods: General state-of-the-art heuristic methods were implemented for signal quality assessment. They were applied for feature extraction and included maximum and minimum values (out-of-range), standard deviation of upper and lower envelopes, and zero-crossing rate which can be applied to multimodal signals. This methodology is based on variations of signal values with time; a corrupted signal would present more unexpected changes in those features than a "good-quality" signal. Analysis was applied in ten-second windows with five-second overlapping to different signals acquired in parallel: electrocardiographic (ECG), and photoplethysmographic (PPG) signals. Signals of freely-available VitalDB were used [4]: 2694 hours for the whole dataset.

Four physiological rules [5] were applied to ECG and PPG, and assumed as ground true: if one or more rules are broken in a window, this is assumed as bad quality. The four above-described features were computed for ECG and PPG, resulting in eight features. For training, dataset was balanced bearing in mind the number of instances belonging to the classes according to physiological indicators for ECG at one instance, and PPG at another. The reason for that is corrupted signals are not always presented at the same time since they are recorded with different sensors. Later, an artificial neural network was implemented: 25 neurons in hidden layers, logistic activation function, and SGD optimizer. The area under the ROC curve (AUC) and F1-score (F1) were carried out as performance metrics.

Results: Outcomes balancing the number of physiological quality indices for PPG: F1=0.85, AUC=0.93, and for ECG: F1=0.88, AUC=0.96. In addition, an analysis was carried out by averaging ECG and PPG features. Outcomes with combined features balancing the number of physiological quality indices for PPG: F1=0.81, AUC=0.90, and for ECG: F1=0.84, AUC=0.92. By visually analysing results, we observed they presented a low rate of rejection of good quality signals.

Conclusion: The proposed methodology allowed parallel discrimination of good-bad quality segments in ECG-PPG signals. This presents potential for generalization which might be useful for rejection of low-quality segments in multimodal analysis including different biosignal types. Averaging features from eight to four showed certain loss of performance but at the same time reduces computational cost, which might be important when dealing with higher number of signals. In future work, the proposed methodology will be used as a preliminary step in estimating continuous blood pressure from ECG and PPG.

The authors declare that they have no competing interests.

The authors declare that an ethics committee vote is not required.

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