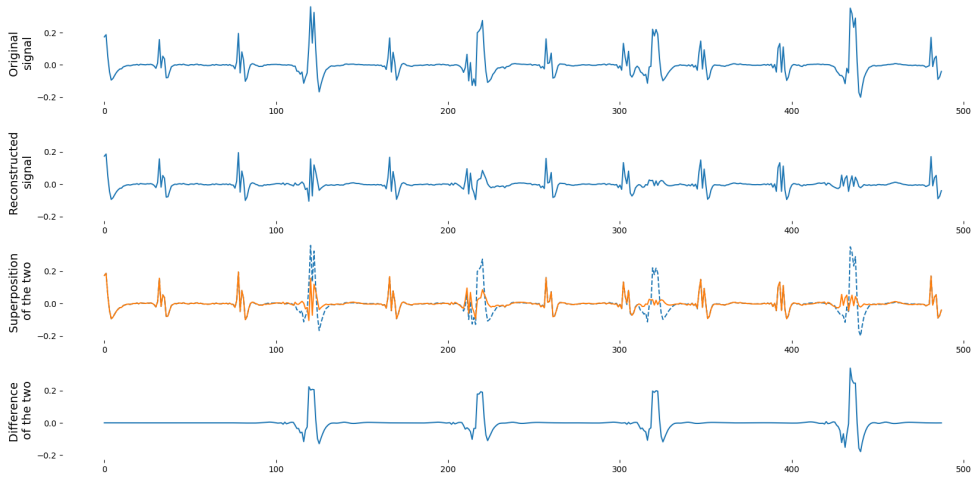
Far-field Intracardiac Electrograms Removal Enables Highly Reliable Automatic Cycle Length Estimation During Atrial Arrhythmias



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Objective: To determine whether far-field-removed electrograms allow for higher cycle length estimation performance, and reliable real-time diagnostic assistance.

Methods: We implemented a time-frequency (wavelets) approach to separate and adaptively remove far-field, ventricle-originating components of locally recorded bipolar electrograms extracted from 120 procedures of atrial tachycardia/fibrillation ablation, keeping useful near-field signal even in superposition cases. We used simultaneous endocavitary-surface ECG recordings to segment the endocavitary coronary sinus signal into multiple time-frequency components identified as “far-field” because of their simultaneous occurrence with identifiable surface ECG-recorded events (QRS). Then, we amalgamated those components into footprints of the far-field for each lead and time-frequency level to subtract them in the likewise identified “far-field” (see Figure). Finally, we used those reconstructed signals to estimate a cycle length in a streaming real-time manner (2 seconds batch, activity detection with a wavelet domain thresholding method and an adaptive covariance Kalman Filter for cycle length estimation) on a database and extracted performance scores based on human adjudications of cycle length (annotated by seven human operators on segments averaging 10-sec epoch). We tested the hypothesis that in comparison with human Gold Standard adjudications, far-field removed electrograms would yield higher algorithmic performance levels than non-far-field removed electrograms, making it reliable for real-time diagnostic assistance in an operating room environment.

Results: The algorithm’s performance, with far-field removal, achieved a mean absolute difference (averaged by procedures to alleviate differences in annotations length) of 6.9 ms (standard deviation 11.8). By contrast, the algorithmic performances without far-field removal were markedly worst (MAD: 20.9 ms, standard deviation 73.1)

Conclusions: Removal of far-field potentials from intracardiac electrograms lead to highly reliable automatic cycle length estimation, hence usable in real-time in an operating room environment, which may not be reliable without.