Multi-task Deep Neural Network for Intracardiac Activity Reconstruction in Atrial Fibrillation

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Aims: Efforts to understand atrial arrhythmias emphasize identifying fibrillation drivers, but lack of standardized clinical definitions and limitations in invasive mapping hinder precise localization. ECG Imaging offers a non-invasive alternative, aiding pre-procedural planning and enhancing ablation precision. However, traditional ECGI techniques present several limitations, such as noise susceptibility or parameter tuning sensitivity. This work proposes a data-driven framework for intracardiac activity characterization as an alternative to traditional ECGI tools to study Atrial Fibrillation (AF).
Methods: We propose to reconstruct the electrical activity in the atria using body surface potentials with a two-branch deep neural network. As a novelty, the two branches are optimized jointly: feature extraction from surface potentials serves as a complementary task, which enhances the main task, intracardiac signal reconstruction. The network is trained with realistic computer simulations: 76 AF cardiac electrograms and 10 torso geometries are used to create pairs of intracardiac-surface pairs for validation. Mean Squared Error (MSE) and Spearman correlation are used to assess the estimated signals.
Results: The validation results demonstrate optimal RMSE values of 0.34 and a correlation coefficient of 0.54, indicating a 47% improvement over previous work and 32% enhancement over average Tikhonov (gold standard) correlation results. High-frequency components are better recovered, leading to improved signal morphology.
Conclusion: These encouraging findings suggest the potential use of this kind of network for challenging arrhythmia characterization, as it outperforms the gold-standard results.

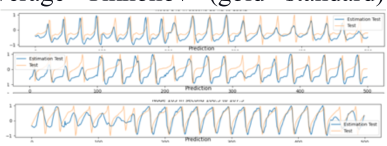

Figure 1. EGM Reconstruction. In orange, test signal, in blue reconstructed signal.