CT-Scan Free Neural Network-Based Reconstruction of Heart Surface Potentials from ECG Recordings

Kamil Bujnarowski, Pietro Bonizzi, Matthijs Cluitmans, Ralf Peeters, Joel Karel

Maastricht University, Maastricht, The Netherlands

Aims: With the use of CT-scans and mathematical/geometric models of the human body, ECG-Imaging can translate body surface recordings into epicardial potentials which can provide advanced diagnostic information of the heart activity, especially for specific heart conditions such as arrhythmia. However, CT scans imply a certain level of radiation, and is a procedure which may not be available as an option for all patients. This study investigates the use of a CT-scan-free machine learning model trained on body surface recordings to reconstruct the corresponding heart surface potentials. This approach could be used as a preliminary diagnostic tool before more thorough examination is performed.

Methods: An encoder-decoder structure is proposed as an approach which encodes body surface potentials into latent representations before using them as input to be decoded into epicardial potentials, without the use of geometric information obtained from a CT-scan. Using data from an ECG-Imaging experiment performed on dogs, a proof of concept is created by predicting the general waveforms of 98 heart surface electrodes based on 168 body electrodes.

Results: Both mean square error (MSE) and average Pearson correlation between reconstructed and recorded heart surface potentials were measured on all windows in train and test sets, with MSE 0.332 ± 0.442mV and mean correlation 0.19 ± 0.17 on the training set and MSE 0.763 ± 0.336mV and mean correlation 0.11 ± 0.10 on the testing set.

Conclusion: Although still containing relevant morphological differences in the testing windows, this method shows promise in reconstructing the waveforms and some of the characteristic features of the heart potential signals such as QRS complexes, and their duration. Most of the error seems to be concentrated in reconstructing the correct magnitude and elements that are not consistent throughout the dataset.

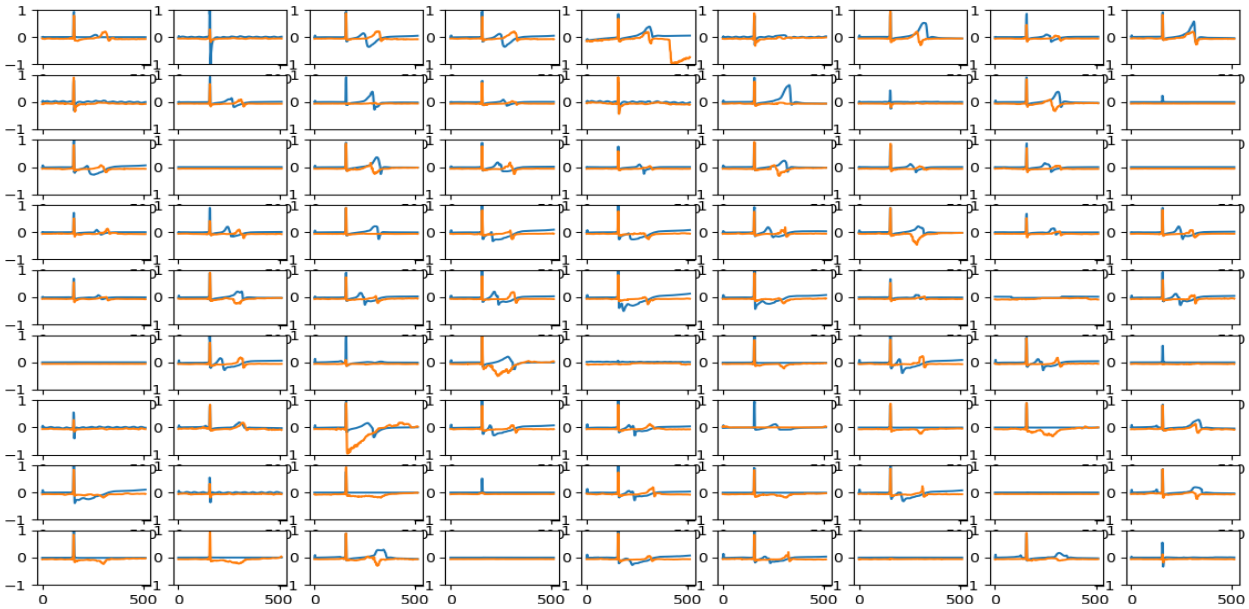

Figure 1: Ground Truth signal (blue) and Network Reconstruction (orange) of 81 out of 98 heart surface electrodes from latent representation of 168 body surface electrodes. Results from test set.