T-Wave Alternans Estimation with Manifold Learning

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Introduction. ECG imaging (ECGI) allows the analysis of T-wave alternans (TWA), a risk predictor for sudden cardiac death, from a spatial-temporal perspective. This analysis has the potential to address some of the issues associated with TWA estimation. However, conventional estimation methods assess each signal individually, considering only the temporal information provided by ECGI. To overcome this limitation, this study presents new TWA estimation approaches based on Manifold Learning (MnL), which can leverage both the temporal and spatial information contained in ECGI data. **TWA estimation**. Firstly, the signals were detrended and high-frequency noise was eliminated. After that, T-waves were segmented, and templates for both even and odd T-waves were created. Finally, TWA was estimated with the temporal method (TM) or with MnL. The MnL methods used included principal component analysis (PCA), a linear method, and an autoencoder (AE) architecture, a non-linear method. In both cases, the transformation to project the original data into a lower-dimensional space was computed using a training test, and then applied to a test set. **Experiments and Results**. The ECGI database used in this work comprises epicardium and torso ECGI data from eight patients with long QT syndrome and three control subjects, provided by Rudy's Lab (Washington University in St. Louis). The experiments allow visualization of the embedded spaces generated by PCA and the AE, when original data were reduced to from one to nine dimensions. The reconstruction error (RE) of the MnL outputs are also computed. **Conclusion**. Our results suggest that, according to the TM TWA estimations, the signals with higher TWA are concentrated in specific areas of the latent spaces generated by the MnL techniques. Additionally, the small REs demonstrate the high quality of the embedded spaces in almost all cases.

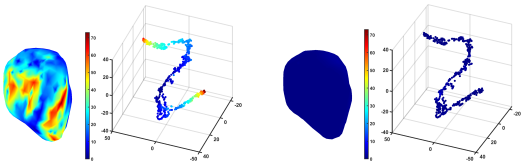

Figure 1. Latent space generated by PCA with original data reduced to six dimensions, in a patient epicardium, with colors according to the TM TWA estimation (left) and the reconstruction error (right).