

# A Hybrid Model of Maximum Margin Clustering Method and Support Vector Regression for Solving the Inverse ECG Problem

Mingfeng Jiang\*, Jiafu Lv, Chengqun Wang, Wenqing Huang, Ling Xia and Guofa Shou

**Abstract:** Compared to body surface potentials (BSPs) recordings, myocardial transmembrane potentials (TMPs) can provide more detailed and complicated electrophysiological information. Noninvasively reconstructing the TMPs from BSPs constitutes one form of the inverse problem of ECG. In this study, the inverse ECG problem is treated as a regression problem with multi-inputs (BSPs) and multi-outputs (TMPs), which will be solved by the support vector regression (SVR) method. Maximum margin clustering (MMC) is a recent large margin unsupervised learning approach that has often outperformed conventional clustering methods, which can be implemented by the iterative SVR method. In this paper, the MMC approach is adopted to cluster the training samples (different time instant BSPs), and the individual SVR model for each cluster is then constructed. For each testing sample, find the cluster to which it belongs, and then use the corresponding SVR model to reconstruct the TMPs. To build an effective SVR model, the hyper-parameters of SVR are set carefully by using the genetic algorithm (GA) method. Based on our previously developed realistic heart-torso model, the EDL source model method is applied to generate the dataset (358 different BSPs and TMPs) for training and testing the SVR model. When reconstructing the TMPs over the testing samples, the experiment results show that SVR method combined with maximum margin clustering method can perform better than the single SVR method in solving the inverse ECG problem, leading to a more accurate reconstruction of the TMPs. According to the evaluation indexes Relative Error (RE) and Correlation Coefficient (CC), the performances of the reconstructed TMPs by using the proposed method can always converge to a smaller RE and a higher CC on the testing samples than that by the single SVR method.

**Keywords:** inverse ECG problem; Maximum Margin Clustering; support vector regression; transmembrane potentials