Greedy Selection of the Torso Electrodes for the Solution of Inverse Problem with a Single Dipole

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When measuring body surface potentials some of the electrodes may be nonfunctional, preventing signals from those electrodes to be used in the inverse problem. Viewing the transfer matrix as a linear operator we investigate the relevance of electrode sets for solving the inverse problem without prior analysis of the measured signals.

Body surface potential measurements in 128 and 192 electrodes from one patient-specific dataset (Bratislava) and two torso tank experimental datasets (Bordeaux, Utah), respectively, with known position of the ventricular stimulation were used as a testbed to analyze solutions of the inverse problem with a single dipole. Preferable electrode sets were constructed incrementally using singular value decomposition of the transfer matrix. In particular, given an optimality criterion, starting from the initial set of four best electrodes, the electrode set was incrementally enlarged with a single electrode at a time in a greedy manner. We tested four optimality criteria based on the transfer submatrix corresponding to the selected electrodes: 1) minimized condition number, 2) maximized product of singular values, 3) maximized sum of singular values and 4) joint criterion 1 and 2. For each criterion, the accuracy of inverse solution was determined by the localization error (LE).

In general, similar results were obtained using all four criteria. For Bratislava, the best results were achieved applying criterion 4, with LE decreasing to 7.48mm using only 10% of the electrodes, Interestingly, LE with all electrodes used was 15.96mm, suggesting beneficial effects of the sparsity enforcement in the electrode space. For Bordeaux and Utah, the best results were obtained using criterion 1 and 3, with LE 10.91mm (9% electrodes) and 14.15mm (11% electrodes), respectively. Beneficial effects of electrode sparsity on the LE were observed here as well. The best improvement in localization was observed for the more complex patient-specific Bratislava data.

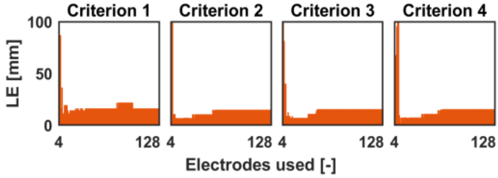

Figure: The LE obtained on Bratislava dataset using the selected electrode sets (by applying criteria 1-4) and containing 4-128 electrodes.