A Threshold Method for Computing Activation Maps from Reconstructed Transmembrane Voltages

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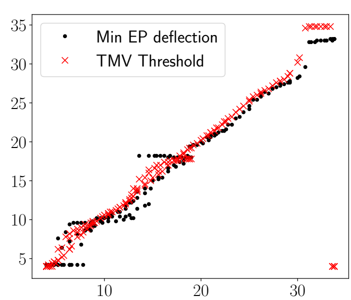
ECGi allows to non-invasively recover activation maps from temporal body surface potential maps (BSPM). The usual workflow consists in solving an inverse problem and recovering the extracellular potential (EP) or the transmembrane voltage (TMV) on the epicardial surface at several instants. Then, the recovered EP or TMV are post-processed to extract activation times (ATs) and compute the activation map. Typically, ATs are detected via the maximal deflection on the temporal or spatial derivative of the signal. However, this method can generate artificial lines of block (ABL) in the map, which may falsely indicate a pathology. Consequently, several potentially complex algorithms have been developed in the past years to smooth the recovered activation maps.

We propose a very simple threshold method to compute raw ATs from recovered TMV and compare it to the deflection methods. By avoiding the use of any derivative, this method reduces ABLs, and ensures greater stability for the ATs, in presence of noise on the BSPM data.

Simulated data are used as reference, so that the true ATs are known. From simulated BSPMs, we compute the EP and TMV on the epicardium using a classical regularized least-square formulation. Then both time of maximal deflection of the EP derivative, and time of threshold crossing of the TMV are computed for each point of the epicardium. The threshold is set at the mid value of the depolarization phase in the action potential. The ATs computed with both methods are then compared to the truth.



Example of ATs (ms) recovered with the deflection and threshold methods, plotted as function of true ATs.

Preliminary 2D results show the absence of ABL in the activation maps computed with the threshold method. In contrast, the use of a derivative in the deflection method introduces ABLs. Moreover, the threshold method produces ATs that are more robust to gaussian noise in the BSMP data.