

Sensitivity Analysis of Electrocardiogram Features to Computational Model Input Parameters

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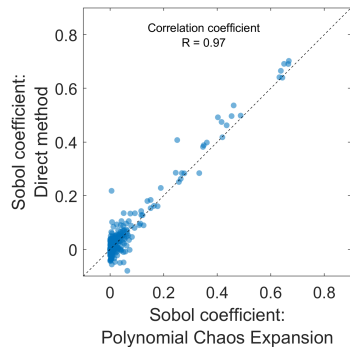
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Aim: Cardiac models of electrophysiology generating simulated electrocardiogram (ECG) signals are an increasingly valuable tool for both personalised medicine and understanding cardiac pathologies. Knowledge of how simulation parameters affect clinical features of the simulated ECG is crucial. This study used sensitivity analysis (SA) methods to determine the impact of cardiac model input parameters on measured ECG R peak amplitudes.

Method: A ventricular model was used to generate QRS complexes. Twelve input parameters relating to stimulation sites were varied according to a Saltelli sampling scheme, resulting in 14000 simulated signals. Each QRS complex was appended to a generic P-wave, generated using a non-corresponding atrial model, creating a complete heartbeat as required by ECG feature extraction software. R amplitude was calculated using two methods: ECG feature extraction software (ECGdeli), and finding the absolute maximum of the signal. First order Sobol coefficients were calculated using two SA methods: direct numerical evaluation of integrals and polynomial chaos expansion (PCE).

Results: Sobol coefficients calculated using PCE and direct methods were in good agreement (correlation coefficient 0.97, see Figure). The agreement between the ECGdeli and maximum methods for determining R amplitude varied depending on which ECG lead was considered. Correlation coefficients ranged from 0.70 (lead aVR) to 1.00 (leads aVL, V4, V5, V6).

Conclusion: Sensitivity analysis provides valuable information about the relationship between simulated ECG morphology and cardiac model input parameters. This provides valuable insight on the quality of the simulated signals and can allow for more nuanced patient-specific simulation changes.



Correlation between PCE and direct Sobol coefficients.