Particle Filter Tracking of Complex Stochastic Systems Applied to In SilicoWavefront Propagation

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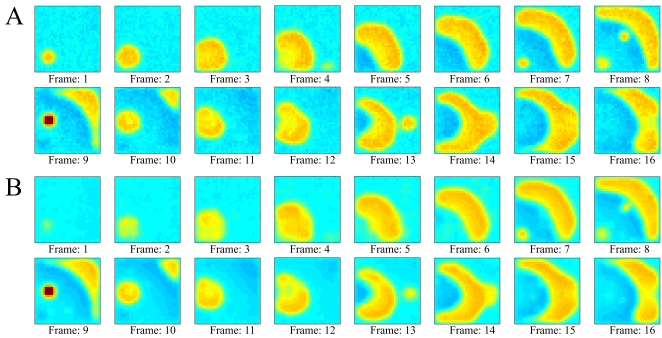
Aims: To track cardiac wavefronts generated by ectopic stimuli using Bayesian filtering (particle filters).

Methods: A high dimensional tracking system based on the FithzHugh-Nagumo (FH-N) equations emulating the biological excitation and propagation dynamics of the action potential across cardiac cells is proposed. The modified FH-N model tracks the electric cardiac wavefronts on a tissue, emulating an approximated atrial fibrillation scenario. Bayesian tracking is achieved with two particle filter (PF) schemes: a sequential Auxiliary PF (APF) and a parallelized method, Independent APF (IAPF).

Results: The numerical results of the two examples, involving both estimation errors and running times, provide numerical evidence that support the theoretical findings.

Conclusions: We were able to track random ectopic activity in a interconnected network resembling atrial tissue. We used Bayesian filtering algorithms and took advantage of new parallelized methods for speeding up computation times.



A: Wavefront propagation with random stimuli causing focal discharges. **B:** Tracking of the IAPF (M = 10, N = 5000) for the same simulation. The IAPF detects and tracks the random stimuli, providing a fine estimation of the evolution of the complex dynamical system.