Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/ynimg

A data-driven framework for neural field modeling

D.R. Freestone [a,b,c,*,1], P. Aram [d,1], M. Dewar [c,e], K. Scerri [f], D.B. Grayden [a,b], V. Kadirkamanathan [d]

[a] Department of Electrical and Electronic Engineering, University of Melbourne, Melbourne, VIC, Australia
[b] The Bionic Ear Institute, East Melbourne, VIC, Australia
[c] Institute for Adaptive and Neural Computation, University of Edinburgh, Edinburgh, UK
[d] Department of Automatic Control and Systems Engineering, University of Sheffield, Sheffield, UK
[e] Department of Applied Physics and Applied Mathematics, Columbia University, New York, NY, USA
[f] Department of Systems and Control Engineering, University of Malta, Msida, MSD, Malta

ARTICLE INFO

Article history:
Received 23 November 2010
Revised 18 January 2011
Accepted 9 February 2011
Available online xxxx

Keywords:
Neural field model
Nonlinear estimation
Intracortical connectivity
Nonlinear dynamics

ABSTRACT

This paper presents a framework for creating neural field models from electrophysiological data. The Wilson and Cowan or Amari style neural field equations are used to form a parametric model, where the parameters are estimated from data. To illustrate the estimation framework, data is generated using the neural field equations incorporating modeled sensors enabling a comparison between the estimated and true parameters. To facilitate state and parameter estimation, we introduce a method to reduce the continuum neural field model using a basis function decomposition to form a finite-dimensional state-space model. Spatial frequency analysis methods are introduced that systematically specify the basis function configuration required to capture the dominant characteristics of the neural field. The estimation procedure consists of a two-stage iterative algorithm incorporating the unscented Rauch–Tung–Striebel smoother for state estimation and a least squares algorithm for parameter estimation. The results show that it is theoretically possible to reconstruct the neural field and estimate intracortical connectivity structure and synaptic dynamics with the proposed framework.