Assessment of reduced-order unscented Kalman filter for parameter identification in 1-dimensional blood flow models using experimental data

By: Caiazzo, A (Caiazzo, A.)[1]; Caforio, F (Caforio, Federica)[2]; Montecinos, G (Montecinos, Gino)[3]; Muller, LO (Muller, Lucas O.)[4,5]; Blanco, PJ (Blanco, Pablo J.)[4,5]; Toro, EF (Toro, Eluterio F.)[2]

View ResearcherID and ORCID

INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN BIOMEDICAL ENGINEERING
Volume: 33
Issue: 8
Article Number: e2843
DOI: 10.1002/cnm.2843
Published: AUG 2017
Document Type: Article
View Journal Impact

Abstract

This work presents a detailed investigation of a parameter estimation approach on the basis of the reduced-order unscented Kalman filter (ROUKF) in the context of 1-dimensional blood flow models. In particular, the main aims of this study are (1) to investigate the effects of using real measurements versus synthetic data for the estimation procedure (i.e., numerical results of the same in silico model, perturbed with noise) and (2) to identify potential difficulties and limitations of the approach in clinically realistic applications to assess the applicability of the filter to such setups. For these purposes, the present numerical study is based on a recently published in vitro model of the arterial network, for which experimental flow and pressure measurements are available at few selected locations. To mimic clinically relevant situations, we focus on the estimation of terminal resistances and arterial wall parameters related to vessel mechanics (Young's modulus and wall thickness) using few experimental observations (at most a single pressure or flow measurement per vessel). In all cases, we first perform a theoretical identifiability analysis on the basis of the generalized sensitivity function, comparing then the results owith the ROUKF, using either synthetic or experimental data, to results obtained using reference parameters and to available measurements.

Keywords

Author Keywords:blood flow; finite volume method; Kalman filter; 1-dimensional model; parameter estimation

KeyWords Plus:PULSE-WAVE PROPAGATION; SYSTEMIC ARTERIAL TREE; IN-VITRO MEASUREMENTS; ONE-DIMENSIONAL MODEL; EXPERIMENTAL VALIDATION; NETWORK MODEL; HEMODYNAMICS; SIMULATIONS; VESSELS; SURGERY

Author Information

Reprint Address: Caiazzo, A (reprint author)

WIAS Berlin, Mohrenstr 39, D-10117 Berlin, Germany.

Addresses:

+ [1] Leibniz Inst Forsch Verbund Berlin eV, Weierstrass Inst Appl Anal & Stochast WIAS, Berlin, Germany
+ [2] Univ Trento, Lab Appl Math, DICAM, Trento, Italy
+ [3] Univ Chile, Ctr Math Modeling, Santiago, Chile
+ [4] Lab Nacl Comp Cient, Petropolis, Brazil

[5] Inst Nacl Ciencia & Tecnol Med Assistida Comp Cie, Petropolis, Brazil

E-mail Addresses:caiazzo@wias-berlin.de

Funding

Funding Agency	Grant Number
CNPq	
FAPERJ	
FONDECYT	3160743

View funding text

Publisher

WILEY, 111 RIVER ST, HOBOKEN 07030-5774, NJ USA

Journal Information

- **Impact Factor:** Journal Citation Reports

Categories / Classification

Research Areas: Engineering; Mathematical & Computational Biology; Mathematics

Web of Science Categories: Engineering, Biomedical; Mathematical & Computational Biology; Mathematics, Interdisciplinary Applications