Conference Proceedings of the Society for Experimental Mechanics Series

Series Editor

Tom Proulx
Society for Experimental Mechanics, Inc.,
Bethel, CT, USA

For further volumes:
<http://www.springer.com/series/8922>

H. Sezer Atamturktur • Babak Moaveni • Costas Papadimitriou
Tyler Schoenherr
Editors

Model Validation and Uncertainty Quantification, Volume 3

Proceedings of the 32nd IMAC, A Conference and Exposition
on Structural Dynamics, 2014

Editors

H. Sezer Atamturktur
Civil Engineering Department
Clemson University
Clemson, SC, USA

Costas Papadimitriou
Department of Mechanical and Industrial
Engineering
University of Thessaly
Volos, Greece

Babak Moaveni
Department of Civil and Environmental
Engineering
Tufts University
Medford, MA, USA

Tyler Schoenherr
Sandia National Laboratories
Albuquerque, NM, USA

ISSN 2191-5644 ISSN 2191-5652 (electronic)
ISBN 978-3-319-04551-1 ISBN 978-3-319-04552-8 (eBook)
DOI 10.1007/978-3-319-04552-8
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014931235

© The Society for Experimental Mechanics, Inc. 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Model Validation and Uncertainty Quantification, Volume 3 represents one of the eight volumes of technical papers presented at the 32nd IMAC, A Conference and Exposition on Structural Dynamics, 2014, organized by the Society for Experimental Mechanics, and held in Orlando, Florida, February 3–6, 2014. The full proceedings also include volumes on Dynamics of Coupled Structures; Nonlinear Dynamics; Dynamics of Civil Structures; Structural Health Monitoring; Special Topics in Structural Dynamics; Topics in Modal Analysis I; and Topics in Modal Analysis II.

Each collection presents early findings from experimental and computational investigations on an important area within structural dynamics. Model Validation and Uncertainty Quantification (MVUQ) is one of these areas.

Modeling and simulation are routinely implemented to predict the behavior of complex dynamical systems. These tools powerfully unite theoretical foundations, numerical models, and experimental data which include associated uncertainties and errors. The field of MVUQ research entails the development of methods, with associated metrics, for the rigorous test of model prediction accuracy and robustness considering all relevant sources of uncertainties and errors through systematic comparisons against experimental observations.

The organizers would like to thank the authors, presenters, session organizers, and session chairs for their participation in this track.

Clemson, SC, USA
Medford, MA, USA
Volos, Greece
Albuquerque, NM, USA

H. Sezer Atamturktur
Babak Moaveni
Costas Papadimitriou
Tyler Schoenherr

Contents

1	Calibration of System Parameters Under Model Uncertainty	1
	Ghina N. Absi and Sankaran Mahadevan	
2	On the Aggregation and Extrapolation of Uncertainty from Component to System Level Models	11
	Angel Urbina, Richard G. Hills, and Adam C. Hetzler	
3	Validation of Strongly Coupled Models: A Framework for Resource Allocation	25
	S. Atamturktur and G. Stevens	
4	Fatigue Monitoring in Metallic Structures using Vibration Measurements	33
	D.C. Papadioti, D. Giagopoulos, and C. Papadimitriou	
5	Uncertainty propagation in Experimental Modal Analysis	41
	Bart Peeters, Mahmoud El-Kafafy, Patrick Guillaume, and Herman Van der Auweraer	
6	Quantification of Prediction Bounds Caused by Model Form Uncertainty	53
	Lindsey M. Gonzales, Thomas M. Hall, Kendra L. Van Buren, Steven R. Anton, and François M. Hemez	
7	Composite Fuselage Impact Testing and Simulation: A Model Calibration Exercise	67
	Lucas G. Horta, Mercedes C. Reaves, Karen E. Jackson, Martin S. Annett, and Justin D. Littell	
8	Noise Sensitivity Evaluation of Autoregressive Features Extracted from Structure Vibration	79
	Ruigen Yao and Shamim N. Pakzad	
9	Uncertainty Quantification and Integration in Multi-level Problems	89
	Chenzhao Li and Sankaran Mahadevan	
10	Reliability Quantification of High-Speed Naval Vessels Based on SHM Data	99
	Mohamed Soliman and Dan M. Frangopol	
11	Structural Identification Using Response Measurements Under Base Excitation	107
	Suparno Mukhopadhyay, Raimondo Betti, and Hilmi Luş	
12	Bayesian FE Model Updating in the Presence of Modeling Errors	119
	Iman Behmanesh and Babak Moaveni	
13	Maintenance Planning Under Uncertainties Using a Continuous-State POMDP Framework	135
	Roland Schöbi and Eleni Chatzi	
14	Achieving Robust Design through Statistical Effect Screening	145
	Kendra L. Van Buren and François M. Hemez	
15	Automated Modal Parameter Extraction and Statistical Analysis of the New Carquinez Bridge Response to Ambient Excitations	161
	Yilan Zhang, Moritz Häckell, Jerome P. Lynch, and Raimund Rolfes	

16	Evaluation of a Time Reversal Method with Dynamic Time Warping Matching Function for Human Fall Detection Using Structural Vibrations	171
	Ramin Madarshahian, Juan M. Caicedo, and Diego Arocha Zambrana	
17	Uncertainty Quantification of Identified Modal Parameters Using the Fisher Information Criterion	177
	Eric M. Hernandez and Néstor R. Polanco	
18	Modal Parameter Uncertainty Quantification Using PCR Implementation with SMIT	185
	Minwoo Chang and Shamim N. Pakzad	
19	Excitation Related Uncertainty in Ambient Vibration Testing of Bridges	195
	Kirk A. Grimmelsman, James D. Lindsey, Ryan T. Dufour, and James T. Norris	
20	Experiment-Based Validation and Uncertainty Quantification of Coupled Multi-Scale Plasticity Models ...	203
	Garrison Stevens, Sez Atamturktur, Ricardo Lebensohn, and George Kaschner	
21	Model Calibration and Uncertainty of A600 Wind Turbine Blades	215
	Anders T. Johansson, Andreas Linderholt, and Thomas Abrahamsson	
22	Validation Assessment for Joint Problem Using an Energy Dissipation Model	229
	Adam Hetzler, Angel Urbina, and Richard Hills	
23	A Bayesian Damage Prognosis Approach Applied to Bearing Failure	237
	Zhu Mao and Michael Todd	
24	Sensitivity Analysis of Beams Controlled by Shunted Piezoelectric Transducers	243
	G. Matten, M. Collet, S. Cogan, and E. Sadoulet-Reboul	
25	A Principal Component Analysis (PCA) Decomposition Based Validation Metric for Use with Full Field Measurement Situations	249
	Randall Allemang, Michael Spottswood, and Thomas Eason	
26	FEM Calibration with FRF Damping Equalization	265
	Thomas J.S. Abrahamsson and Daniel C. Kammer	
27	Evaluating Initial Model for Dynamic Model Updating: Criteria and Application	279
	Qingguo Fei and Dong Jiang	
28	Evaluating Convergence of Reduced Order Models Using Nonlinear Normal Modes	287
	Robert J. Kuether, Matthew R. Brake, and Mathew S. Allen	
29	Approximate Bayesian Computation for Finite Element Model Updating	301
	F.A. DiazDelaO, H.M. Gomes, and J.E. Mottershead	
30	An Efficient Method for the Quantification of the Frequency Domain Statistical Properties of Short Response Time Series of Dynamic Systems	307
	M. Brehm and A. Deraemaeker	
31	Quantifying Uncertainty in Modal Parameters Estimated Using Higher Order Time Domain Algorithms ..	317
	S. Chauhan	
32	Testing and Model Correlation of a Plexiplate with a Water Boundary Condition	327
	C.D. Van Karsen, J.P. De Clerck, and S. Dhabe	
33	Detection of Stress-Stiffening Effect on Automotive Components	335
	Elvio Bonisoli, Gabriele Marcuccio, and Stefano Tornincasa	
34	Approach to Evaluate Uncertainty in Passive and Active Vibration Reduction	345
	Roland Platz, Serge Ondoua, Georg C. Enss, and Tobias Melz	
35	Project-Oriented Validation on a Cantilever Beam Under Vibration Active Control	353
	Qintao Guo, Rongmei Chen, and Zhou Jin	

36	Inferring Structural Variability Using Modal Analysis in a Bayesian Framework	363
	H.M. Gomes, F.A. DiazDelaO, and J.E. Mottershead	
37	Including SN-Curve Uncertainty in Fatigue Reliability Analyses of Wind Turbines	375
	Jennifer M. Rinker and Henri P. Gavin	
38	Robust Design of Notching Profiles Under Epistemic Model Uncertainties	383
	Fabien Maugan, Scott Cogan, Emmanuel Foltête, Fabrice Buffe, and Gaëtan Kerschen	
39	Optimal Selection of Calibration and Validation Test Samples Under Uncertainty	391
	Joshua Mullins, Chenzhao Li, Sankaran Mahadevan, and Angel Urbina	
40	Uncertainty Quantification in Experimental Structural Dynamics Identification of Composite Material Structures	403
	Marcin Luczak, Bart Peeters, Maciej Kahsin, Simone Manzato, and Kim Branner	
41	Analysis of Numerical Errors in Strongly Coupled Numerical Models	409
	Ismail Farajpour and Sez Atamturktur	
42	Robust Expansion of Experimental Mode Shapes Under Epistemic Uncertainties	419
	A. Kuczkowiak, S. Cogan, M. Ouisse, E. Foltête, and M. Corus	