Jin-Song Pei (Jinsong Pei)

Associate Professor
The University of Oklahoma
School of Civil Engineering & Environmental Science
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EDUCATION

Columbia University, New York, NY
Doctor of Philosophy in Civil Engineering and Engineering Mechanics, October 2001
Dissertation: "Parametric and Nonparametric Identification of Nonlinear Systems"
Advisor: Professor Andrew W. Smyth
Master of Philosophy in Civil Engineering and Engineering Mechanics, May 2000

Nanyang Technological University, Singapore
Master of Engineering, July 1997
Thesis: "Behaviour of Steel Fibre Reinforced Concrete Slabs"
Advisor: Professor Tat-Seng (Francis) Lok

Xi'an Jiaotong University, Xi'an, China
Bachelor of Engineering, July 1989
Major: Structural Engineering

PROFESSIONAL EXPERIENCE

California Institute of Technology, Pasadena, CA
Visiting Research Associate, Department of Civil Engineering, October 2009 – May 2010
Topic: Bayesian System Identification using Nonlinear Hysteretic Models
Host: Professor James L. Beck

Duke University, Durham, NC
Visiting Faculty, Department of Civil and Environmental Engineering, June – August 2009 &
June – August 2010
Topic: Control of Inhomogeneous Semiactive Systems
Host: Professor Jeffrey T. Scruggs

The University of Oklahoma, Norman, OK
Associate Professor (with Tenure), School of Civil Engineering and Environmental Science, July
2008 – Present

Assistant Professor, School of Civil Engineering and Environmental Science, July 2002 – June 2008
Graduate Faculty Member (M3 Status*), School of Electrical and Computer Engineering, October 1, 2005 – Present
*The M3 privileges include: (a) teaching graduate courses, (b) serving on master's committees, (c) serving on doctoral committees, (d) chairing master's committees, and (e) chairing doctoral committees

Weidlinger Associates Inc., Cambridge, MA
Engineer, January - June 2002

Columbia University, New York, NY
Research Assistant, 1998 - 2001

Indeco Consultants, Division of Civil & Structural Engineering, Singapore
Civil/Structural Engineer, 1996 - 1998

Nanyang Technological University, Singapore
Technical Coordinator, July 1996

Construction & Development Corporation, Division of Real Estate, Xiamen, China
Project Executive/Assistant Engineer, 1989 - 1994

CURRENT RESEARCH INTERESTS

Dr. Pei's research interests center on modeling nonlinear dynamical systems. This topic is inherently challenging; however, it is necessary in that it has broad utility in many engineering disciplines, including engineering mechanics, smart structures, robotics, mechatronics, structural control, structural health monitoring, damage detection, and earthquake engineering. Dr. Pei focuses on theoretical development and numerical analysis for data processing and nonlinear system identification.

Dr. Pei transfers and adapts the physical concepts and mathematical theories underlying memristors and memcapacitors (especially the latter), originally developed for electrical engineering, to the field of engineering mechanics by developing a theoretical and computational framework for nonlinear dynamical systems. She investigates the state event location technique for piecewise smooth nonlinear hysteretic models (i.e., hybrid dynamical systems) leading to greatly improved computational efficiency. Dr. Pei also works on constructive methods for the initialization of artificial neural network (ANN) in function approximation. The research objective is to develop an insightful process of designing ANN architectures, which includes making choice of initial values of weights and biases and the number of hidden nodes, with a final goal of having good generalization capability of trained neural networks. Dr. Pei studies Field Programmable Gate Array (FPGA)-based computation to develop embedded algorithms for wireless structural health monitoring and damage detection; time-frequency analysis is the focus of this study. Dr. Pei has experienced the complexity of system identification when dealing with real-world data (e.g., some earthquake measurements from the Vincent Thomas Bridge). She performs system identification to challenging real-world aged systems such as partially damaged precast prestressed concrete girders from the I-244 Bridge in Tulsa, Oklahoma.

Keywords: nonlinear dynamical system, nonlinear hysteresis, nonlinear system identification, memristor/memristive system theory, memcapacitor/memcapacitive system theory, piecewise smooth model, hybrid dynamical system, function approximation, artificial neural network, constructive initialization method, FPGA-based computation, embedded algorithm, time-frequency analysis, structural health monitoring, damage detection, structural dynamics, and earthquake engineering

PUBLICATIONS
The names of student co-authors are underlined.

Journal Papers (19):

19. "Understanding memristors and memcapacitors in engineering mechanics applications", **Pei, J.S.**, Wright, J.P., Todd, M.D., Masri, S.F. and Gay-Balmaz, F., *Nonlinear Dynamics*, to appear

18. "Demonstration and validation of constructive initialization method for neural network to approximate nonlinear function in engineering mechanics applications", **Pei, J.S.**, and Masri, S.F., *Nonlinear Dynamics*, published online in December 2014

17. "Mapping some functions and four arithmetic operations to multilayer feedforward neural networks", **Pei, J.S.**, Mai, E.C., Wright, J.P., and Masri, S.F., *Nonlinear Dynamics*, 71(1-2), 371-399, 2013

16. "Solving dynamical systems involving piecewise restoring force using state event location", Wright, J.P., and **Pei, J.S.**, *ASCE Journal of Engineering Mechanics*, 138(8), 997-1020, 2012

15. "Experimental and code analyses for shear design of AASHTO prestressed concrete girders", Martin, R.D., Kang, T.H.-K., and **Pei, J.S.**, *PCI Journal*, Winter 2011

14. "Linking system identification to nonlinear dynamic simulation under OpenSees - some justifications and implementations", Piyawat, K., and **Pei, J.S.**, *ASCE Journal of Engineering Mechanics*. 135(11), 1213-1226, November 2009

13. "Embedded algorithms within an FPGA to classify nonlinear single-degree-of-freedom systems", Jones, J.D., and **Pei, J.S.**, *IEEE Sensors Journal – Special Issue on Sensor Systems for Structural Health Monitoring*, 9(11), 1486-1493, November 2009

12. "An experimental investigation of applying Mica2 Motes in pavement condition monitoring", **Pei, J.S.**, Ivey, R.A., Lin, H., Landrum, A.R., Sandburg, C.J., Ferzli, N.A., King, T., Zaman, M.M., Refai, H.H and Mai, E.C., *Journal of Intelligent Material Systems and Structures*, 20, 63-85, January 2009

11. "Constructing multilayer feedforward neural networks to approximate nonlinear functions in engineering mechanics applications", **Pei, J.S.**, and Mai, E.C., *ASME Journal of Applied Mechanics*, 75, November 2008

10. "An experimental investigation of the data delivery performance of wireless sensing units composed of off-the-shelf components for structural health monitoring", **Pei, J.S.**, Kapoor, C., Graves-Abe, T.L., Sugeng, Y.P., and Lynch, J.P., *Journal of Structural Control and Health Monitoring*, 15 (4), 471-504, 2008

9. "Deterministic excitation forces for simulation and identification of nonlinear hysteretic SDOF systems", **Pei, J.S.**, and Piyawat, K., *ASCE Journal of Engineering Mechanics*, 134(1), 35-48, 2008

8. "An FPGA-based smart wireless sensing unit for structural health monitoring", Kapoor, C., Graves-Abe, T.L., and **Pei, J.S.**, *an invited paper* to *Smart Structures and Systems*, Techno Press, 3(1), 69-88, 2007

7. "A new approach to designing multilayer feedforward neural network architectures for modeling nonlinear restoring forces: Part II - Applications", **Pei, J.S.**, and Smyth, A.W., *ASCE Journal of Engineering Mechanics*, 132 (12), 1301-1312, 2006

6. "A new approach to designing multilayer feedforward neural network architecture for modeling nonlinear restoring forces: Part I - Formulation", **Pei, J.S.**, and Smyth, A.W., *ASCE Journal of Engineering Mechanics*, 132 (12), 1290-1300, 2006

5. "Mapping polynomial fitting into feedforward neural networks", **Pei, J.S.**, Wright, J.P., and Smyth, A.W., *Computer Methods in Applied Mechanics and Engineering*, 194 (42-44), 4481-4505, 2005

4. "Analysis and modification of Volterra/Wiener Neural Networks for identification of nonlinear hysteretic dynamic systems", **Pei, J.S.**, Smyth, A.W., and Kosmatopoulos, E.B., *Journal of Sound and Vibration*, 275 (3-5), 693-718, 2004

3. "System identification of the Vincent Thomas suspension bridge using earthquake inputs", Smyth, A.W., **Pei, J.S.**, and Masri, S.F., *Journal of Earthquake Engineering & Structural Dynamics*, 32, 339-367, 2003

2. "Flexural behavior of steel fiber reinforced concrete", Lok, T.S., and **Pei, J.S.**, *ASCE Journal of Materials in Civil Engineering*, 10 (2) 86 –97, 1998

1. "Impact resistance and ductility of steel fibre reinforced concrete panels", Lok, T.S., and **Pei, J.S.**, *Transactions of Hong Kong Institute of Engineers*, 3(3), 7-16, 1996

Refereed Publication in Civil Engineering Conference Proceedings (1):

1. "Elastic deflections of concrete slabs reinforced with different types of steel fibers", Lok, T.S., and **Pei, J.S.**, *Recent Developments in Deflection Evaluation of Concrete*, ed. Nawy, E.G., ACI Special Publication-161*, 267-284, 1996

Refereed Publications in Computer Science Conference Proceedings (3):

3. "Toward constructive methods for sigmoidal neural networks – function approximation in engineering mechanics applications", **Pei, J.S.**, Wright, J.P., Masri, S.F., Mai, E.C., and Smyth, A.W., *2011 International Joint Conference on Neural Networks*, San Jose, CA, July 31 – August 5, 2011 (presenter)

2. "Neural network initialization with prototypes - function approximation in engineering mechanics applications", **Pei, J.S.**, Mai, E.C., Wright, J.P., and Smyth, A.W., Proceedings of *International Joint Conference on Neural Networks 2007 (IJCNN'07)*, IEEE Catalog Number 07CH37922C, ISBN 0-4244-1380-X, oral presentation, Orlando, FL, August 12-17, 2007 (presenter)

1. "Neural network initialization with prototypes - a case study in function approximation", **Pei, J.S.**, Wright, J.P., and Smyth, A.W., Proceedings of *International Joint Conference on Neural Networks 2005 (IJCNN'05)*, IEEE Catalog Number 05CH37662, ISBN 0-7803-9048-2, 1377 – 1382, poster presentation (absent due to a visa problem), Montreal, Canada, July 31 - August 4, 2005

Technical Reports (4):

4. "Structural identification of a real-world shear-critical prestressed concrete highway bridge", Tang, P.F., **Pei, J.S.**, Smyth, A.W., and White, L.W., *DTRT-06-G-0016*, Oklahoma Transportation Center, August 2012
3. "A demonstration of low-cost reliable wireless sensor for health monitoring of a precast prestressed concrete bridge girder", **Pei, J.S.**, Ibrahim, T.S., Sarangan, V., Liu, J., Tang, L., Lin, H., Wijesinghe, P.B., Pham, P.L., *OTC-9-05-20A-20B*, Oklahoma Transportation Center, March 2009
2. "Validation of 'smart dust' sensor network for pavement condition monitoring", **Pei, J.S.**, Ivey, R.A., Lin, H., Landrum, A.R., Sandburg, C.J., Ferzli, N.A., King, T., Zaman, M.M., Refai, H.H., and Mai, E.C., *OTC-22*, Oklahoma Transportation Center, March 2009
1. "Rating precast prestressed concrete bridges for shear", **Pei, J.S.**, Martin, R.D., Sandburg, C.J., and Kang, T.H.-K., *ODOT SPR ITEM 2186*, Oklahoma Department of Transportation, December 2008

EXTERNAL RESEARCH FUNDING

12. "Understanding the Behavior of Prestressed Concrete Girders after Years of Service", *the Oklahoma Department of Transportation (ODOT)*, October 2013 – September 2016, $366,726, co-PI, 45% individual credit
    (PI: Royce W. Floyd, CEES, OU)
11. "Structural identification of a real-world shear-critical prestressed concrete highway bridge", *the Oklahoma Transportation Center (OTC)*, June 2009 – May 2012, $300,000, PI, 50% individual credit
    (Co-PI: Luther W. White, Math, OU)
10. "Wireless sensor packaging for monitoring of highway bridges", *the Oklahoma Center for the Advancement of Science & Technology (OCAST)*, September 2007 – August 2011, $300,000, PI, 40% individual credit
    (Co-PIs: Tamer S. Ibrahim, ECE, OU, and Musharraf M. Zaman, CEES, OU)
9. "FPGA and microprocessor-based smart wireless sensing with embedded nonlinear algorithms for structural health monitoring", *NSF* Standard Grant (CMS 0626401), September 2006 – August 2011, $245,000, sole PI
8. "Rating precast prestressed concrete bridges for shear", *the Oklahoma Department of Transportation (ODOT)*, October 2005 – December 2007, $192,837 (including one supplement grant), sole PI
7. "A demonstration of low-cost reliable wireless sensor for health monitoring of a precast prestressed concrete bridge girder", *the Oklahoma Transportation Center (jointly funded by the FHWA and Oklahoma DOT)*, June 2006 – December 2007, $80,000, PI, 34% individual credit
    (Co-PIs: Tamer S. Ibrahim, ECE, OU, and Venkatesh Sarangan, CS, OSU)
6. "'Smart Dust' sensor network for intelligent pavement maintenance", *the Oklahoma Transportation Center (jointly funded by the FHWA and Oklahoma DOT)*, OTC-22, March 2005 - September 2006, $95,000, PI, 34% individual credit
    (Co-PIs: Hazem H. Refai, ECE, OU, and Musharraf M. Zaman, CEES, OU)

5. "Handling noise-contaminated data and nonunique identification results in wireless sensor networks for structural health monitoring", *NSF* SGER (CMS 0332350), August 2003 – January 2005, $30,000, sole PI

4. "New vision for built environment- integration of nanotechnology into civil engineering undergraduate curriculum", *NSF*, NUE, January 2007 – December 2008, $25,000 individual credit, co-PI
(PI: Wei Zheng, Jackson State University)

3. "Deployment and integration of instructional shake tables using the NEES cyberinfrastructure", *NSF* CCLI, September 2006 – August 2010, $10,000 individual credit, Senior Personnel
(PI: Shirley J. Dyke, Washington University in St. Louis)

2. "REU in sustainable technologies for infrastructure and the environment source of support", *NSF* REU, March 2006 – February 2009, $8812.80 individual credit, Participant
(PI: Keith A. Strevett, CEES, OU)

1. "Doctoral fellowships in sustainable technologies for civil and environmental systems", US Department of Education, March 2003 – August 2007, $15,866.88 individual credit, Participant
(PI: Randall L. Kolar, CEES, OU)

INTERNAL RESEARCH FUNDING

3. "Civil data-centric integrations for structural health monitoring and beyond", *Junior Faculty Research Program, the Vice President for Research, the University of Oklahoma*, March 2006, $6,000, PI

2. "Validation of 'Smart Dust' sensor network for pavement condition monitoring", *Research Council, the University of Oklahoma*, May 2004, $6,000, PI
(Co-PIs: Hazem H. Refai, ECE, OU, and Musharraf M. Zaman, CEES, OU)

1. "Fusion of sensors, sensed data and physical modeling", *Junior Faculty Research Program, the Vice President for Research, the University of Oklahoma*, March 2004, $6,000, PI

TEACHING AND ADVISING EXPERIENCE

The University of Oklahoma, Norman, OK
Instructor
CEES 1213 *Computer Applications in CEES*, Fall 2012, Fall 2013, and Fall 2014
CEES 2113 *Statics*, Fall 2010
CEES 3403 *Materials (with Lab Sessions),* Spring 2005, Spring 2006, Spring 2007, Spring 2008, Spring 2009, Spring 2012, Spring 2013, Spring 2014, and Spring 2015
CEES 3414 *Structural Analysis (with Four Credit Hours)*, Fall 2004, Fall 2005, Fall 2006, Fall 2007, Fall 2008, and Fall 2012
CEES 4663 *Introduction to Matrix Methods in Structural Analysis*, Spring 2015
CEES 5653 *Advanced Mechanics of Solids*, Fall 2003, Fall 2005, Fall 2010, Spring 2012, and Spring 2014
CEES 5683 *Structural Dynamics*, Spring 2003, Spring 2004, Spring 2006, Spring 2008, Spring 2009, Spring 2011, and Fall 2014
CEES 5783 *Design of Reinforced Concrete II*, Fall 2002, and Fall 2003

The University of Oklahoma, Norman, OK
Graduate/Undergraduate Advisor
Ph.D. Student in Structural Engineering (1):
Soroush Mohammadzadeh
Ph.D. Student in Electrical Engineering (1):
Peng F. Tang
Master's Students in Civil Engineering with Thesis Option (5):
Yusheng Su, Randy D. Martin, Colby J. Sandburg, Yohanes P. Sugeng, and Krisda Piyawat
Master's Students in Electrical Engineering with Thesis Option (2):
Jonathan D. Jones, and Chetan Kapoor
Honors Undergraduate Researcher in Civil Engineering (1):
Eric C. Mai
Honors Undergraduate Researcher in Electrical Engineering (1):
Kyle A. Roeschley
Undergraduate Researchers in Other Disciplines (4):
Johnny F. Cardenas, Keith R. Hurdelbrink II, Richard A. Ivey, and Adam Blackwell
Undergraduate Researchers in Civil Engineering (10):
Kyle R. Renevier, Randy D. Martin, Even R. Ludwig, Mallory L. Moore, Christopher A. Davis, Rory Victor, Aaron R. Landrum, Shannon L. Norton, Colby J. Sandburg, and Anh P. Nguyen
NSF REU Students from a Metrology Program in Industrial Engineering at OU (9):
Werner J. Stiegler, Archith Ramkumar, Olatunde Osholake, Erin Hurt, Adam Heriba, Richard A. Ivey, Oluwaseun Harrison, Melissa Lindner, and Elizabeth Henry
NSF REU Students from a Civil Engineering Program at OU (7):
Peter H. Fobel, Ronald Adomako, Sarah B. Ferguson, Joseph C. Howell, Sarah Zimmermann, Craig Borchard, and Kaitlin J. Neville

Columbia University, New York, NY
Lecturer, *Mechanics of solids*, Fall 2000 and Spring 2001
Teaching Assistant, *Advanced design of steel structures*, Spring 1999/2000/2001
Teaching Assistant, *Advanced design of concrete structures*, Spring 2001
Teaching Assistant, *Design projects*, Spring 2000
Teaching Assistant, *Structural design projects*, Fall 1999
Teaching Assistant, *Design of buildings, bridges and spacecraft*, Spring 1999
Teaching Assistant, *Mechanics of solids*, Fall 1998

Nanyang Technological University, Singapore
Teaching Assistant, *In-House Practical Training*, 1995/1996
Teaching Assistant, *Laboratory sessions for mechanics of solids & construction materials*, 1994-1996