Jian-Xun Wang

Curriculum Vitæ (January 7, 2018)

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RESEARCH INTERESTS

Computational Fluid Dynamics, Turbulence Modeling, Intracranial Dynamics, Inverse Modeling, Data Assimilation, Machine Learning

EDUCATION

Ph.D., Aerospace Engineering 05/2017
Virginia Tech, USA

- Committee members: Dr. Heng Xiao*, Dr. Christopher J. Roy, Dr. Robert Weiss, and Dr. Lin Ma
- GPA: 3.71/4.00

M.S., Ocean Engineering 12/2016
Virginia Tech, USA

- GPA: 3.71/4.00

M.S., Mechanical Engineering 07/2013
Harbin Institute of Technology, P.R. China

- GPA: 90.7/100.0
- Outstanding Graduate Student of Heilongjiang Province

B.S., Naval Architecture and Ocean Engineering 06/2011
Harbin Institute of Technology, P.R. China

- GPA: 84.2/100.0
- Outstanding Graduate Student of Harbin Institute of Technology

ACADEMIC EXPERIENCE

Postdoctoral Scholar 08/2017 to present
Dept. of Mechanical Engineering, University of California, Berkeley, USA

Research Affiliate 08/2017 to present
Dept. of Aerospace and Mechanical Engineering, University of Notre Dame, USA

Visiting Scholar 05/2017 to 08/2017
Dept. of Mechanical and Aerospace Engineering, MST, USA

Visiting Scholar 06/2016 to 07/2016
Center For Turbulence Research, Stanford University, USA

Research Assistant 08/2013 to 05/2017
Dept. of Aerospace and Ocean Engineering, Virginia Tech, USA

RESEARCH PROJECTS

Physics-Informed Machine Learning for Predictive Turbulence Modeling
Advised by Dr. Heng Xiao
Collaborators: Dr. Julia Ling (Sandia National Labs), Dr. Gianluca Iaccarino (Standford University), Mr. Jinlong Wu (Virginia Tech)
(11/2015 to present)

- Proposed a Physics-Informed Machine Learning (PIML) approach to improve RANS modeling. Excellent prediction performance of Reynolds stresses and their propagated mean flow field have been demonstrated among different flows.
- Conducted a priori assessment of PIML prediction confidence

Reducing and Quantifying Model-Form Uncertainty in RANS Simulations
Advised by Dr. Heng Xiao
Collaborator: Dr. Roger Gahnem (University of Southern California), Dr. Christopher J. Roy (Virginia Tech), Mr. Jin-Lon Wu (Virginia Tech)
(12/2014 to present)

- Proposed a data-driven, physics-based approach to quantify and reduce model-form uncertainties in RANS simulations.
- Proposed a random matrix (RMT) approach for quantifying model-form uncertainties in RANS simulations with the maximum entropy.
- Proposed a multi-fidelity approach for propagating input uncertainties in presence of model-form uncertainties for CFD applications.

Inverse Modeling for Systems with Complex Physics/Structures
Advised by Dr. Heng Xiao
Collaborator: Dr. Robert Weiss (Virginia Tech)
(05/2014 - Present)

- Proposed an inverse modeling scheme for systems with complex physics/structures based on ensemble Kalman method.
- Applied the proposed scheme to model turbulent flows though complex structures.
- Applied the proposed scheme on inversion of tsunami characteristics from sediment deposits.

Investigate Hybrid LES/RANS Framework
Advised by Dr. Heng Xiao
Collaborator: Dr. Patrick Jenny (ETH Zurich)
(10/2014 to 04/2015)

- Investigated a resolution evaluation criterion based on the ratio between turbulent length-scales and grid spacing within in the context of dynamic resolution evaluation in hybrid LES/RANS simulations.
- The hybrid LES/RANS framework is modified to address the difficulty on accurately enforcing componentwise Reynolds stress consistency and to better exploit the advantage of more RANS turbulence models.

PUBLICATIONS ([Google Library] & [ResearchGate])

Peer-Reviewed Journal Articles (Published or Accepted)

1. **J.-X. Wang**, T. Hui, H. Xiao, and R. Weiss. Inferring tsunami flow depth and flow speed from sediment deposits based on Ensemble Kalman Filtering. *Geophysical Journal International*, 212(1), 646-658, 2018, DOI:10.1093/gji/ggx435

2. **J.-X. Wang**, C. J. Roy and H. Xiao. Propagation of input uncertainty in presence of model-form uncertainty: a multi-fidelity approach for CFD applications. *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part B: Mechanical Engineering*, 4(1), 011002, 2018. DOI: 10.1115/1.4037452

3. **J.-X. Wang**, J.-L. Wu, and H. Xiao. A Physics Informed Machine Learning Approach for Reconstructing Reynolds Stress Modeling Discrepancies Based on DNS Data. *Physical Review Fluids*, 2(3), 034603, 1-22, 2017. DOI: 10.1103/PhysRevFluids.2.0346032017

4. H. Xiao, **J.-X. Wang** and Roger G. Gahnem. A random matrix approach for quantifying model-form uncertainties in turbulence modeling. *Computer Methods in Applied Mechanics and Engineering*, 313, 941-965, 2017. DOI: 10.1016/j.cma.2016.10.025

5. J.-L. Wu, **J.-X. Wang**, H. Xiao, J. Ling. A Priori Assessment of Prediction Confidence for Data-Driven Turbulence Modeling, *Flow, Turbulence and Combustion*, 99 (1), 1-22, 2017. DOI: 10.1007/s10494-017-9807-0

6. **J.-X. Wang**, H. Xiao. Data-driven CFD modeling of turbulent flows through complex structures. *International Journal of Heat and Fluid Flow*, 62 (B): 138-149, 2016. DOI: 10.1016/j.ijheatfluidflow.2016.11.007

7. **J.-X. Wang**, R. Sun, H. Xiao. Quantification of uncertainty in RANS models: A comparison of physics-based and random matrix theoretic approaches. *International Journal of Heat and Fluid Flow*, 62 (B): 577-592, 2016. DOI: 10.1016/j.ijheatfluidflow.2016.07.005

8. **J.-X. Wang**, J.-L. Wu, and H. Xiao. Incorporating prior knowledge for quantifying and reducing model-form uncertainty in RANS simulations. *International Journal of Uncertainty Quantification*, 6 (2): 109-126, 2016. DOI:10.1615/Int.J.UncertaintyQuantification.2016015984.

9. H. Xiao, J.-L. Wu, **J.-X. Wang**, R. Sun, and C. J. Roy. Quantifying and reducing model-form uncertainties in Reynolds averaged Navier-Stokes equations: a data-driven, physics-informed, Bayesian approach. *Journal of Computational Physics*, 324, 115-136, 2016. DOI: 10.1016/j.jcp.2016.07.038

10. H. Tang, **J.-X. Wang**, R. Weiss and H. Xiao. TSUFLIND-EnKF inversion model applied to tsunami deposits for estimation of transient flow depth and speed with quantified uncertainties. *Marine Geology*, 2016, In press. DOI: 10.1016/j.margeo.2016.11.009

11. H. Xiao, **J.-X. Wang** and P. Jenny., An implicitly consistent formulation of a dual-mesh hybrid LES/RANS method. *Communications in Computational Physics*, 21(2), 570-599, 2017. DOI: 10.4208/cicp.220715.150416a

12. J.-L. Wu, **J.-X. Wang**, and H. Xiao. A Bayesian calibration-prediction method for reducing model-form uncertainties with application in RANS simulations. *Flow, Turbulence and Combustion*, 97, 761-786, 2016. DOI: 10.1007/s10494-016-9725-6

13. H. Xiao, **J.-X. Wang** and P. Jenny. Dynamic evaluation of mesh resolution and its application in hybrid LES/RANS methods. *Flow, Turbulence and Combustion*, 93(1), 141-170, 2014. DOI: 10.1007/s10494-014-9541-9

14. G.-N. Chu, S. Yang, and **J.-X. Wang**. Mechanics condition of thin-walled tubular component with rib hydroforming. *Transactions of Nonferrous Metals Society of China*, s280-s286. S2, 2012, DOI: 10.1016/S1003-6326(12)61720-8

15. **J.-X. Wang**, G.-N. Chu, C.-L. Yu, G.-X. Wang, and H.-B. Gui, General study on prediction of welding distortion of construction in naval architecture. *Ship Engineering*, S2, 2011. (In Chinese)

16. G.-X. Wang, Z.-K. Hu, H.-B. Gui, P.-P. Xia, **J.-X. Wang**. Strength calculation of SL151 crane ship and structural strengthening program. China Shiprepair. 2012;4:019. (In Chinese)

Peer-Reviewed Journal Articles (In Revision or Under Review)

1. **J.-X. Wang**, J.-J. Huang, L. Duan, H. Xiao. Improvement of Reynolds stresses for high-Mach-number compressible flows using machine learning and DNS database. Submitted to *AIAA Journal*, 2017 (Under review). Available upon request vtwjx@vt.edu

2. **J.-X. Wang**, J.-L. Wu, J. Ling, G. Iaccarino, H. Xiao. Toward a complete framework of Physics-informed machine learning for predictive turbulence modeling. Submitted to *Flow, Turbulence and Combustion*, 2017 (Under review). Available at Arxiv:1701.07102

3. H. Xiao, J.-L. Wu, **J.-X. Wang**, and E. G. Paterson. Are discrepancies in RANS modeled Reynolds stresses random? Submitted to *Journal of Fluid Mechanics*, 2016 (Under review). Available at Arxiv:1606.08131

4. J.-L. Wu, **J.-X. Wang**, and H. Xiao. Quantifying model form uncertainty in RANS simulation of wing-body junction flow. Submitted to *Flow, Turbulence and Combustion*, 2016 (In revision). Available at Arxiv:1605.05962

Peer-Reviewed Conference Articles

1. **J.-X. Wang**, J.-L. Wu, J. Ling, G. Iaccarino and H. Xiao. Towards a Complete Framework of Physics-Informed Machine Learning for Predictive Turbulence Modeling. In *Center for Turbulence Research (Stanford University). Proceedings of the Summer Program*, 2016.

2. J. Huang, L. Duan, **J.-X. Wang**, R. Sun and H. Xiao. High-Mach-Number Turbulence Modeling using Machine Learning and Direct Numerical Simulation Database. In *AIAA SciTech*, 2017.

3. H. Xiao, J.-L. Wu, **J.-X. Wang**, and E.G. Paterson. Physics-Informed Machine Learning for Predictive Turbulence Modeling: Progress and Perspectives. In *AIAA SciTech*, 2017.

4. J.-L. Wu, **J.-X. Wang**, H. Xiao and E.G. Paterson, Visualization of High Dimensional Turbulence Simulation Data using t-SNE, In *AIAA SciTech*, 2017.

Invited Talks

1. **J.-X. Wang**, Physics-Informed, Data-Driven Framework for Model-Form Uncertainty Estimation and Reduction in RANS Simulations, Invited Seminar at Aerospace and Mechanical Department, *University of Notre Dame*, South Bend, Indiana, Mar. 7-9, 2017.

Conference Presentations and Abstracts

1. **J.-X. Wang**, C. Zhang, L. Duan., H. Xiao. Inferring Pre-shock Acoustic Field From Post-shock Pitot Pressure Measurement. *American Physical Society 70th Annual DFD Meeting*. Denver, Colorado, Nov. 20-22, 2017. (Contributed talk)

2. **J.-X. Wang**, J.-L. Wu, H. Xiao. A Data-Driven Approach to Quantify and Reduce Model-Form Uncertainty in Turbulent Flow Simulations. *SIAM Computational Science and Engineering Conference 2017*. Atlanta, Georgia, March 3rd, 2017. (Mini symposium talk)

3. **J.-X. Wang**, J.-L. Wu, H. Xiao, Reducing RANS Model Error Using Random Forest, *American Physical Society 69th Annual DFD Meeting*, Portland, Oregon, Nov.20-22, 2016. (Contributed talk)

4. **J.-X. Wang**, H. Xiao. A Random Matrix Approach for Quantifying Model-Form Uncertainties in Turbulence Modeling. *SIAM Uncertainty Quantification*. Lausanne, Switzerland, April 5-8, 2016. (Mini symposium talk)

5. **J.-X. Wang**, H. Xiao. A multi-model approach for uncertainty propagation and model calibration in CFD applications. *SIAM Computational Science and Engineering Conference 2015*. Salt Lake City, Utah, March 14-18, 2015. (Contributed talk)

6. **J.-X. Wang**, J.-L. Wu, H. Xiao. Reducing RANS Model Uncertainties Based on Random Forest. *Fall Fluid Mechanics Symposium 2016*. Blacksburg, Virginia, November 16, 2016. (Contributed talk)

7. **J.-X. Wang**, H. Xiao. Accounting for model discrepancies in uncertainty propagation with a multi-model strategy: proof of concept for CFD applications. *Fall Fluid Mechanics Symposium 2014*. Blacksburg, Virginia, November 11, 2014. (Contributed talk)

8. J.-L. Wu, **J.-X. Wang**, H. Xiao, Quantifying the Discrepancy in RANS Modeling of Reynolds Stress Eigenvectors System, *American Physical Society 69th Annual DFD Meeting*, Portland, Oregon, Nov.20-22, 2016.

9. H. Xiao, J.-L. Wu, **J.-X. Wang**, J. Ling, A Physics-Informed Machine Learning Framework for RANS-based Predictive Turbulence Modeling, *American Physical Society 69th Annual DFD Meeting*, Portland, Oregon, Nov.20-22, 2016.

10. J.-L. Wu, **J.-X. Wang**, H. Xiao, Model-Form Uncertainty Quantification in RANS Simulation of Wing-Body Junction Flow, *American Physical Society 68th Annual DFD Meeting*, Boston, Massachusetts, Nov.3-5, 2015.

11. H. Xiao, J. L. Wu, **J.-X. Wang**, R. Sun, C. J. Roy. Quantifying Model Form Uncertainties in Reynolds-Averaged Navier Stokes Equations: An Open-Box, Physics-Informed, Bayesian Approach, in the *13th US National Congress on Computational Mechanics (USNCCM 13)*, San Diego, California. July 26-31, 2015.

12. H. Tang, **J.-X., Wang**., R. Weiss, and H. Xiao.,TSUFLIND-EnKF: Inversion of tsunami flow condition with quantified uncertainty, *2015 YCSEC meeting*, Newark, De, 27-29 July, 2015.

13. H. Tang, **J.-X., Wang**., R. Weiss, and H. Xiao., Inversion of tsunami characteristics: Estimation of transient flow depth and speed with quantified uncertainties, *2014 AGU Fall meeting*, San Francisco, California, Dec.13-17, 2014.

SCHOLARLY REVIEWS

- Reviewer for *SIAM/ASA Journal on Uncertainty Quantification*
- Reviewer for *Computers and Geosciences*
- Reviewer for *Asian Journal of Control*

TEACHING EXPERIENCE

Master Thesis Supervisor 2016
Virginia Tech

- Aldo Gargiulo, Master of Science, 03/2016 - 11/2016, (Supervisor)

Teaching Assistant 2013 - 2016
Virginia Tech

- AOE4154: Aerospace Engineering Laboratory, Fall 2016, (Instructor)
- AOE4334: Ship Dynamics, Fall 2016, (Teaching Assistant)
- AOE4214: Ocean Wave Mechanics, Spring 2015, (Teaching Assistant)
- AOE2204: Introduction to Ocean Engineering, Fall 2014, (Teaching Assistant)
- AOE4244: Marine Engineering, Spring 2014, (Teaching Assistant)
- AOE2204: Introduction to Ocean Engineering, Fall 2013, (Teaching Assistant)

AWARDS

- 2017 Travel grant for USACM Thematic Workshop on Uncertainty Quantification and Data-Driven Modeling.
- 2016 Summer Program Fellowship, Center For Turbulence Research (CTR) at Stanford University
- 2016 SIAM Student Travel Award for SIAM Conference on Uncertainty Quantification (UQ16)
- 2015 Student Travel Grant for Rocky Mountain Summer Workshop on Uncertainty Quantification, University of Colorado Denver
- 2013 Pratt Fellowship, Virginia Tech
- 2013 Outstanding Graduates of Heilongjiang Province (Top 3%)
- 2013 Excellent MSc. Thesis (1^{st} place)
- 2012 National Graduate Fellowship in China (Top 1%)
- 2011 Outstanding Graduates of Harbin Institute of Technology (Top 5%)
- 2008/2009/2010/2011 People's Scholarship
- 2008/2009/2010/2011 Excellent Social Work Scholarship
- 2010 Excellent Leader of Harbin Institute of Technology
- 2009 Excellent League Member of Harbin Institute of Technology
- 2008 Outstanding Social Activist of Harbin Institute of Technology
- 2008 Excellent Association Worker
- 2007 Progress Scholarship