Jincheng Zhang

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Research Interests

- Renewable energy, e.g. modelling, prediction, simulation, and control of wind and ocean energy systems
- Machine learning, e.g. supervised learning, probabilistic learning, generative adversarial learning, reinforcement learning, operator learning, and physics-informed machine learning
- AI for fluid dynamics (including ML-based modeling, prediction, and simulations of complex fluid flows)
- CFD, control engineering, large-scale numerical simulations, and uncertainty quantification.

Working Experience

- **Assistant Professor**, The University of Warwick, 03/2024–present
- **Research Fellow**, The University of Warwick, 07/2021–02/2024
  Funded by the EPSRC project (EP/S000747/1): EPSRC Supergen ORE (Offshore Renewable Energy) Hub. Working on offshore renewable energy (including wind and wave).
- **Marie Skłodowska–Curie Early Stage Researcher**, The University of Warwick, 2018–2021
  Funded by EU Horizon 2020 MSCA ITN project ConFlex - Control of flexible structures and fluid-structure interactions.

Education

- **PhD in Engineering, The University of Warwick, 2021**
  Research on the development of machine learning-based modelling, prediction, and control methods for complex fluid/structural systems and their applications on wind turbines/farms.
  Supervisor: Prof. Xiaowei Zhao
- **MSc in Mechanical Engineering, Tsinghua University, 2018**
  Research on the uncertainty quantification of turbulence and transition models using data-driven methods.
  Supervisor: Prof. Song Fu.
- **Diplôme d'Ingénieur (Dipl. Ing.), CentraleSupélec, 2018**
- **BSc in Mechanical Engineering, Tsinghua University, 2015**

Research Grants

EU Horizon Europe HORIZON-RIA Project - Smart, Aware, Integrated Wind Farm Control Interacting with Digital Twins (ICONIC), Co-I, valued at 6.28million Euros, 12/2023–11/2027

Research Skills

- Solid knowledge of machine learning including supervised learning, probabilistic learning, physics-informed machine learning, generative adversarial learning, and reinforcement learning.
- Solid knowledge of renewable energy technology including wind turbine/farm modelling & control, wind & wave prediction, and wave energy converter modelling.
- Extensive experience in large-scale numerical simulations on high-performance computing clusters and solid knowledge of computational fluid dynamics.
- Experience in uncertainty quantification of computer models.
- Fluent in Python, C, Fortran, R, and Matlab.

Journal Publications

[1] J. Zhang and X. Zhao, Digital twin of wind farms via physics-informed deep learning, Energy Conversion and Management 293 (2023) 117507.
This paper developed the first wind farm flow digital twin which can predict the in situ spatiotemporal wind field covering the entire wind farm capturing the wake interactions between wind turbines.

[2] J. Zhang, X. Zhao, D. Greaves, and S. Jin, Modeling of a hinged-raft wave energy converter via deep operator learning and wave tank experiments, Applied Energy 341 (2023) 121072.

[3] R. Li, J. Zhang, X. Zhao, D. Wang, M. Hann, and D. Greaves, Phase-resolved real-time forecasting of three-dimensional ocean waves via machine learning and wave tank experiments, Applied Energy 348 (2023) 121529.

[4] J. Zhang, X. Zhao, S. Jin, and D. Greaves, Phase-resolved real-time ocean wave prediction with quantified uncertainty based on variational Bayesian machine learning, Applied Energy 324 (2022) 119711.
This paper achieved, for the first time, the real-time nonlinear wave prediction with quantified uncertainty (including both aleatory and model uncertainties). The predictable zone was also predicted without assuming linear waves for the first time.

[5] R. Li, J. Zhang, and X. Zhao, Multi-fidelity modeling of wind farm wakes based on a novel super-fidelity network, Energy Conversion and Management 270 (2022) 116185.

[6] R. Li, J. Zhang, and X. Zhao, Dynamic wind farm wake modeling based on a bilateral convolutional neural network and high-fidelity LES data, Energy 258 (2022) 124845.

[7] J. Zhang and X. Zhao, Three-dimensional spatiotemporal wind field reconstruction based on physics-informed deep learning, Applied Energy 300 (2021) 117390.

[8] J. Zhang and X. Zhao, Spatiotemporal wind field prediction based on physics-informed deep learning and LIDAR measurements, Applied Energy 288 (2021) 116641.
This paper is the first work exploring physics-informed deep learning approach for wind energy applications. It has attracted huge interest from both academia and industry.

[9] J. Zhang and X. Zhao, Wind farm wake modeling based on deep convolutional conditional generative adversarial network, Energy 238 (2021) 121747.

[10] J. Zhang and X. Zhao, Machine-learning-based surrogate modeling of aerodynamic flow around distributed structures, AIAA Journal 59 (3) (2021) 868-879.

[11] H. Dong, J. Zhang, and X. Zhao, Intelligent wind farm control via deep reinforcement learning and high-fidelity simulations, Applied Energy 292 (2021) 116928.

[12] J. Zhang and X. Zhao, A novel dynamic wind farm wake model based on deep learning, Applied Energy 277 (2020) 115552.
This paper developed the first deep learning based dynamic wind farm wake model.

[13] J. Zhang, X. Zhao and X. Wei, Reinforcement learning-based structural control of floating wind turbines, IEEE Transactions on Systems, Man, and Cybernetics: Systems (2020), DOI: 10.1109/TSMC.2020.3032622.

[14] J. Zhang and X. Zhao, Quantification of parameter uncertainty in wind farm wake modeling, Energy 196 (2020) 117065.

[15] J. Zhang and S. Fu, An efficient approach for quantifying parameter uncertainty in the SST turbulence model, Computers & Fluids 181 (2019) 173-187.

[16] J. Zhang and S. Fu, An efficient Bayesian uncertainty quantification approach with application to k-ω-γ transition modeling, Computers & Fluids 161 (2018) 211-224.

Conference Publications

[C1] J. Zhang, X. Zhao, and X. Wei, Data-driven structural control of monopile wind turbine towers based on machine learning, Proceedings of the 21st IFAC World Congress, Berlin, July 2020.
[C2] R. Li, J. Zhang, and X. Zhao, Deep learning-based wind farm power prediction using Transformer network, Proceedings of the 2022 European Control Conference (ECC), London, July 2022.

Preprints

[1] R. Li, J. Zhang, and X. Zhao, Long-distance and high-impact wind farm wake effects revealed by SAR: a global-scale study, arXiv preprint arXiv:2311.18124, 2023.
[2] R. Li, J. Zhang, and X. Zhao, Wake effects of offshore wind farm clusters revealed by SAR and WRF, arXiv preprint arXiv:2312.13942, 2023.

Service

Reviewer for the following journals: Computers & Fluids, AIAA Journal, Engineering Applications of Computational Fluid Mechanics, Applied Energy, IET Renewable Power Generation, Atmospheric Measurement Techniques, IEEE Transactions on Automation Science and Engineering, Scientific Reports, ACM Computing Surveys, APL Machine Learning.

Internships & Placements

• Visiting researcher, Department of Aeronautics, Imperial College London, 5/2019–7/2019. Working on wind turbine/farm wakes with Prof. Rafael Palacios and Prof. Michael Graham.

• Research internship at the Aalto Science Institute, Aalto University, Helsinki, Finland, 7/2015–9/2015. Working on the literature surveys and analysis of specific examples in isostatic systems.

Teaching Experience

• Co-supervising three PhD students – Rui Li, Yubo Huang and Jierao Dai
• Teaching Assistant on the undergraduate course “Linear Algebra II”, Tsinghua University, 2017.

Invited Talks & Seminars

• Supergen ORE Hub Webinar Series - AI-Based Modelling, Digital Twin, and Control for Offshore Wind Energy, 28 November 2023, https://vimeo.com/889564187?share=copy.

• WinGrid Scientific Conference: AI-based Modelling, Control and Digital Twin of Wind Farms, 05 October 2023, https://www.wingrid.org/wingrid-scientific-conference-ai-based-modelling-control-and-digital-twin-of-wind-farms-dr-jincheng-zhang-university-of-warwick/.