

Dule Shu

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EDUCATION

Carnegie Mellon University

Doctor of Philosophy in Mechanical Engineering

Pittsburgh, PA

2024.5

(anticipated graduation)

Pennsylvania State University

Master of Science in Electrical Engineering

University Park, PA

2018.5

Selected Coursework: Real Analysis, Convex Optimization, Stochastic Optimization, Math Logic, Applied Stochastic Processes, Pattern Recognition, Linear Control Systems

Harbin Institute of Technology

Bachelor of Engineering in Automation

Harbin, China

2007.7

Undergraduate Thesis: Linear Matrix Inequalities for Robust Controller Design

SKILLS

Methods and Techniques: Developing Deep Learning Models (*Generative AI*: Denoising Diffusion Probabilistic Models, Vector-Quantized Variational Auto-Encoder, Generative Adversarial Network, Transformers; *Scientific Computing*: Neural PDE Solvers, Physics-informed Neural Network; *Information Security*: Active Learning, Adversarial Attack Simulation)

Development Tools: Python, PyTorch, MATLAB

PhD RESEARCH

Carnegie Mellon University

Deep Learning for Reduced Computational Complexity in Simulating Partial Differential Equations (PDEs)

Pittsburgh, PA

2022.5 – 2024.5

- Developed a super-resolution neural network model for fluid flow data using a denoising diffusion probabilistic model for robustness on out-of-distribution low-res input.
- Developed a deep learning model for spatial reconstruction of incomplete fluid flow data using a vector-quantized generative adversarial network for improved numerical stability and accuracy.
- Collaborated with labmates to develop a Transformer-based neural PDE solver which implements axial factorized kernel integral to reduce the computational complexity.
- Collaborated with labmates to develop a deep learning surrogate model simulating PDE in a learned latent space for a reduced computational cost.

ADDITIONAL RESEARCH EXPERIENCE

Carnegie Mellon University

Deep Generative Models

Pittsburgh, PA

2019.8 – 2022.4

- Developed a deep generative model to synthesize 3D mesh objects for evaluating a design cycle consisting of synthesis and physics-based validation.
- Developed a generative adversarial network to evaluate the threat of synthesized attacks against network intrusion detection systems with minimal use of training data by active learning.
- Conducted a pilot study which investigates STEM learners' ability to decipher AI-generated video created by a face-swapping generative model.
- Developed a generative adversarial network for multi-modal data encryption to demonstrate the viability of deep generative methods in steganography.

Pennsylvania State University

Research assistant in the DARPA FUN Design program

University Park, PA

2018.8 – 2019.5

- Collaborated with labmates to develop computational tools for the generation and evaluation of 3D designs.

Graduate student advisor for Penn State Advanced Vehicle Team in EcoCAR3

2015.8 – 2018.5

- Developed a method for road-anomaly detection using contours of sum-of-square polynomials.
- Developed a switch control algorithm for vehicle path planning modeled as a finite-transition system using linear temporal logic.

ACADEMIC PROJECTS

Carnegie Mellon University

Pittsburgh, PA

Course project for Learning Based Image Synthesis Final (16726)

2022.1 – 2022.5

- A Study of Deep Learning-based 3D Point Clouds Reconstruction.
(project webpage: <https://www.andrew.cmu.edu/course/16-726-sp22/projects/dules/project/>)

PUBLICATIONS (Selected)

- Shu, D., Li, Z., & Farimani, A. B. (2023). A physics-informed diffusion model for high-fidelity flow field reconstruction. *Journal of Computational Physics*, 478, 111972.
- Li, Z., Shu, D., & Farimani, A. B. (2023). Scalable Transformer for PDE Surrogate Modeling. *NeurIPS 2023*.
- Li, Z., Patil, S., Shu, D., & Farimani, A. B. (2023, October). Latent Neural PDE Solver for Time-dependent Systems. In *NeurIPS 2023 AI for Science Workshop*.
- Shu, D., Doss, C., Mondschein, J., Kopecky, D., Fitton-Kane, V., Bush, L., & Tucker, C. (2021, July). A Pilot Study Investigating STEM Learners' Ability to Decipher AI-generated Video. In *2021 ASEE Virtual Annual Conference*.
- Doss, C., Mondschein, J., Shu, D., Wolfson, T., Kopecky, D., Fitton-Kane, V. A., ... & Tucker, C. (2023). Deepfakes and scientific knowledge dissemination. *Scientific Reports*, 13(1), 13429.
- Shu, D., Leslie, N. O., Kamhoua, C. A., & Tucker, C. S. (2020, July). Generative adversarial attacks against intrusion detection systems using active learning. In *Proceedings of the 2nd ACM workshop on wireless security and machine learning* (pp. 1-6).
- Shu, D., Cong, W., Chai, J., & Tucker, C. S. (2020, July). Encrypted rich-data steganography using generative adversarial networks. In *Proceedings of the 2nd ACM Workshop on Wireless Security and Machine Learning* (pp. 55-60).
- Shu, D., Cunningham, J., Stump, G., Miller, S. W., Yukish, M. A., Simpson, T. W., & Tucker, C. S. (2020). 3d design using generative adversarial networks and physics-based validation. *Journal of Mechanical Design*, 142(7), 071701.
- Cunningham, J. D., Shu, D., Simpson, T. W., & Tucker, C. S. (2020). A sparsity preserving genetic algorithm for extracting diverse functional 3D designs from deep generative neural networks. *Design Science*, 6, e11.
- Shu, D., Lagoa, C., & Cleary, T. (2017, October). A sum-of-squares polynomial approach for road anomaly detection using vehicle sensor measurements. In *Dynamic Systems and Control Conference* (Vol. 58288, p. V002T17A004). American Society of Mechanical Engineers.
- Shu, D., & Lagoa, C. M. (2017, February). A linear temporal logic-based approach for vehicle motion planning. In *2017 IEEE International Conference on Mechatronics (ICM)* (pp. 25-30). IEEE.

CONFERENCES / PRESENTATIONS (Selected)

- Shu, Dule, Li, Zijie. "Robust Reconstruction of High-Fidelity Fluid Field Using Physics-informed Diffusion Model." *APS DFD*, Washington, DC, Nov 20, 2023. Poster.
- Li, Zijie, Shu, Dule. "Scalable Transformer for PDE Surrogate Modeling." *NeurIPS*, New Orleans, LA, Dec 12, 2023. Poster.
- Shu, Dule. "A Pilot Study Investigating STEM Learners' Ability to Decipher AI-generated Video." *ASEE Virtual Annual Conference*, Virtual, 2021. Presentation.
- Shu, Dule. "Generative Adversarial Attacks Against Intrusion Detection System Using Active Learning." *ACM WiSec*, Virtual, 2020. Presentation.

TEACHING ASSISTANT EXPERIENCE

Carnegie Mellon University

Pittsburgh, PA

Teaching assistant

2022.9 – 2022.12

- Taught weekly recitation for Dynamic Systems and Control (24352).

Pennsylvania State University

Pittsburgh, PA

Lab assistant

2017.8 – 2018.5

- Taught the lab session of Electronic Circuit Design I (EE 310) to help undergraduate students on designing and building electronic circuits.