JIANGCE CHEN

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EDUCATION

Carnegie Mellon University, PA, USA.
Postdoctoral Fellowship *Jan 2023- Present*

University of Connecticut, CT, USA
Ph.D. in Mechanical Engineering *May 2023*
M.S in Computer Science and Engineering *December 2021*

Beihang University, Beijing, China *July 2014*
B.E, Aircraft Design and Engineering.
B.S, Applied Mathematics.

HONORS & FELLOWSHIPS

Postdoctoral Fellowships of Manufacturing Future Institute, CMU *January 2023*
Second Place in Graduate Research Competition, UConn ME Department *May 2020*
CT IN4SPIRE Project *April 2019*
Honorable Mention, Mathematical Contest In Modeling *2013,2014*
2nd Prize in the 23th Fengru Idea competition *2013*
Zhang Zixiong Fluid Mechanics Scholarship *2013*

PATENTS

All patent applications are in processing, except when mentioned otherwise.

Method and System to Automatically Generate Self-Supporting Net-Part-Boundary, or Intra-Part, Modifications for Hybrid. **Jiangce Chen**, Morad Behandish, Matt Patterson

Method of Electrowetting for Drop-on-demand Metal Additive Manufacturing. **Jiangce Chen**, Horea T. Ilies (US-20230391079-A1)

PAPERS AND CONFERENCES

Journal Articles

Chen, J., Khrenov, M., Jin, J., Narra, S.P., McComb, C., (2024) Data-Driven Inpainting for Full-Part Temperature Monitoring in Additive Manufacturing. *Journal of Manufacturing Systems*

Chen, J., Xu, W., Baldwin, M., Nijhuis, B., Boogaard, T.V.D., Gutiérrez, N.G., Narra, S.P. and McComb, C. (2024) Capturing Local Temperature Evolution during Additive Manufacturing through Fourier Neural Operators. *Journal of Manufacturing Science and Engineering*

Chen, J., Pierce, J., Williams, G., Simpson, T.W., Meisel, N., Prabha Narra, S. and McComb, C. (2024). Accelerating Thermal Simulations in Additive Manufacturing by Training Physics-Informed Neural Networks With Randomly Synthesized Data. *Journal of Computing and Information Science in Engineering*, pp.1-14.

Chen, J., Baldwin, M., Narra, S.P. and McComb, C. (2024) Multi-lattice Topology Optimization via Generative Lattice Modeling. *Journal of Mechanical Design* (In press)

Behzadi, M, Ilies, H, Zaffetti, P., **Chen, J.**, Zeidner, L. (2024) Spatial Packaging and Routing Optimization of Complex Interacting Engineered Systems. *Journal of Mechanical Design* (In press)

Behzadi, M. M., **Chen, J.**, & Ilies, H. T. (2023). Taming Connectedness in Machine-Learning-Based Topology Optimization with Connectivity Graphs. Computer-Aided Design, 103634.

Chen, J., Ilies, H. T., and Ding, C. (2022). Graph-Based Shape Analysis for Heterogeneous Geometric Datasets: Similarity, Retrieval and Substructure Matching. *Computer-Aided Design*, 143, 103125.

Chen, J., and Ilieş, H. T. (2020). Maximal disjoint ball decompositions for shape modeling and analysis. *Computer-Aided Design*, 126, 102850.

Zhao, Y. P., **Chen, J.**, Yuan, Q., and Cheng, C. (2016). Microcrack connectivity in rocks: a real-space renormalization group approach for 3D anisotropic bond percolation. *Journal of Statistical Mechanics: Theory and Experiment*, 2016(1), 013205.

Conferences

Chen, J., Baldwin, Narra, S.P. and McComb, C. (2024) Multi-lattice topology optimization with lattice representation learned by generative models, *IDETC/CIE* 2024

Chen, J., Xu, W., Baldwin, M., Nijhuis, B., Boogaard, T.V.D., Gutiérrez, N.G., Narra, S.P. and McComb, C. (2023) Capturing Local Temperature Evolution during Additive Manufacturing through Fourier Neural Operators, *IDETC/CIE* 2023

Chen, J., Khrenov, M., Jin, J., Narra, S.P. and McComb, C. (2023) Toward Post-Superficial Temperature Monitoring During Additive Manufacturing through Data-Driven Inpainting, *Solid Freeform Fabrication Symposium* 2023

Chen, J., Patterson, M, Mirzendehdel A. M., Behandish, M. (2022) Automatic Shape Modification for Self-Supporting Structures in Additive Manufacturing, *IDETC/CIE* 2022

Chen, J., Ilies, H. T. (2020) Maximal Disjoint Ball Decompositions for Shape Modeling and Analysis, *The Symposium on Solid and Physical Modeling (SPM).*

Chen, J., Ilies, H. T. (2018) Mathematical Abstractions for Engineering Design and Manufacturing. *SIAM/GD 19 PROGRAM.*

Articles under review

Chen, J., Xu, W., Xu, Z., Gutiérrez, N.G.,Narra, S.P. and McComb, C. (2024) Enforcing Strict Local-dependency for Neural Operators with Data Decomposition. *Journal of Computational Physics*

TEACHING EXPERIENCE

Teaching Assistant, ME department, University of Connecticut

- *Design of Machine Elements* ME3227 (Fall 2017)
- *Analysis and Design of Mechanism* ME3224 (Spring 2018)
- *Design of Machine Elements* ME3227 (Fall 2021)
- *Mechanical Vibrations* ME3220 (Spring 2022)

Responsibilities

- Lecture recitation sessions twice a semester
- Hold office hours
- Design practice questions for midterm and final exams
- Grade homework, quizzes, and exams, and report common mistake to the instructor

Presentations in conferences

- *Solid and Physical Modeling*, 2020, Online
- *IDETC/CIE* 2022, St. Louis, Missouri
- *IDETC/CIE* 2023, Boston, MA
- *Solid Freeform Fabrication Symposium* 2023, Austin, TX
- *IDETC/CIE* 2024, DC, USA

MENTORING EXPERIENCE

Undergraduate Students

- Jiayi Jin (Summer 2023)
  - Project: Data-Driven Inpainting for Full-Part Temperature Monitoring in Additive Manufacturing
  - Current Position: Ph.D. student in Mechanical Engineering Department, University of Wisconsin–Madison
- Samuel Green (Summer 2023)
  - Project: Exploring the replicate-adapt-optimise spectrum in the design of a human-powered race vehicle
  - Current Position: B.S. student in Mechanical Engineering Department, Carnegie Mellon University

Ph.D. Students

- Zeda Xu (Spring 2024)
  - Project: AI Tutor Based on Adaptive Control of Thought
  - Current Position: Ph.D. student in Mechanical Engineering Department, Carnegie Mellon University
- Martha Baldwin (Fall 2023)
  - Project: Multi-lattice Topology Optimization
  - Current Position: Ph.D. student in Mechanical Engineering Department, Carnegie Mellon University
- Wenzhuo Xu (Spring 2023 - Fall 2023)
  - Project: Adaptive Data Scoping for Physics-informed Neural Networks
  - Current Position: Ph.D. student in Mechanical Engineering Department, Carnegie Mellon University
- Mohammad M. Behzadi (Spring 2022 - Fall 2022)
  - Project: Packing and Routing Optimization for Complex System Design
  - Current Position: Ph.D. student in Mechanical Engineering Department, University of Connecticut

RESEARCH EXPERIENCE

Postdoctoral Research *January 2023 - Present*
Carnegie Mellon University Supervised by Dr. Chris McComb and Dr. Sneha Prabha Narra
Multi-lattice topology optimization for additive manufacturing

- Conducted simultaneous optimization of macro-scale topology and meso-scale structural lattice layout.
- Employed a Variational Autoencoder to encode the geometric characteristics of lattices into a low-dimensional vector space.
- Implemented the Fourier Neural Operator to enhance the connectivity between adjacent cells.

Fast thermal simulation for additive manufacturing

- Developed a dataset capturing temperature evolution across complex geometries
- Implemented a data-driven model utilizing the Fourier Neural Operator to accurately track local temperature changes during the Additive Manufacturing (AM) process.
- Demonstrated enhanced geometric generalizability compared to prior methods, achieving computation speeds three orders of magnitude faster than the traditional finite element method.

Full-field temperature monitoring during additive manufacturing

- Monitored temperature distribution throughout parts during the fabrication process using a hybrid framework
- Integrated boundary temperatures from in-situ sensors with a data-driven model based on Graph CNNs to derive comprehensive field temperature mapping across the part.
- Developed a methodology capable of constructing real-time temperature digital twins for AM-fabricated parts, enhancing monitoring precision and operational efficiency.

Doctoral Research *August 2017 - January 2022*
University of Connecticut Supervised by Dr. Horea Ilies

Geometry interchangeability check among CAX systems

- Established a novel representation scheme, Maximal Disjoint Ball Decomposition (MDBD), facilitating the conversion from commonly used representations, including boundary representation and point clouds.
- Ensured uniqueness of MDBD for a given domain, invariant under rigid body transformations, reflections, and uniform scaling, while maintaining stability and robustness against minor boundary modifications.
- Applied MDBD as a proxy representation for solid modeling in CAX systems, proving effective for various tasks including shape similarity measurement, collision detection, packing optimization, and de-featuring.

CAD model structure features recognition

- Developed graph analysis tools that utilize MDBD for shape analysis tasks, ensuring consistent results across all valid geometric representations.
- Proposed a graph kernel based on random walks, leveraging the hierarchical structure of MDBD, which operates with linear time complexity.
- Implemented a graph clustering technique combining an Adversarially Regularized Variational Graph Autoencoder with KMeans to segment geometric models within an unsupervised learning framework.
- Established a sub-structure matching method that supports novel, robust, and representation-agnostic feature recognition algorithms, surpassing traditional shape descriptors in versatility and power.

Quasi-conformal triangle mesh morphing

- Established a method utilizing sphere packings on Riemannian manifolds, capitalizing on sphere tangency to construct continuous quasi-conformal maps. This approach ensures maps remain close to conformal throughout the deformation without needing a predefined target surface.
- Demonstrated the practical application of this method in the conceptual design and control of a soft robotic gripper. The gripper employs linear actuators and spherical joints in a triangular arrangement, optimizing functionality through strategic deformations.

Optimization of 3D Spatial Packaging for Interconnected Systems (SPI2)

- Addressed the SPI2 challenge, a prevalent layout design issue in compactly-assembled engineering systems, through an innovative optimization framework using Maximal Disjoint Ball Decomposition (MDBD). This method enhances the arrangement of interconnected systems with components of arbitrary shapes.
- The framework pioneers the exploration of designs in higher-dimensional Euclidean spaces, facilitating the conceptualization of 3D system layouts within 4D spaces and beyond, thus broadening the possibilities for complex spatial configurations.

Automatic shape modification for additive manufacturing

- Developed a method to minimize the use of sacrificial material in near-net shape AM parts through targeted shape modifications.
- Formulated the problem as a shape optimization task that conservatively adjusts vertex coordinates to reduce original geometry changes, while preserving the manifold nature of the model and adhering to overhang angle constraints.
- This discrete approach provides distinct advantages over continuous function-based methods, offering enhanced flexibility to meet specific user requirements for different regions of a part.

Method of electrowetting for drop-on-demand additive manufacturing

- Demonstrated the application of the electrowetting method to precisely control droplet size in drop-on-demand AM techniques by altering the contact angle at the three-phase contact line.
- Engineered a novel droplet generation approach that exclusively utilizes electrowetting, eliminating the need for driving pressure waves.
- The design's simplicity positions it as an ideal candidate for the next generation of drop-on-demand AM systems, featuring a compact cluster of independently controlled printheads.

Other Research Experience

Development of Shape Modification Method for Additive Manufacturing

Research Intern — *May 2021 - September 2021*
Palo Alto Research Center — Supervised by Dr. Morad Behandish

- Initiated and developed a method that modifies the shape of parts to satisfy the constraints of Additive Manufacturing;
- Optimized the computation efficiency of the method so that it could deal with a realistic model on a normal laptop within a couple of minutes;
- Documented the work that leads to the draft of research paper and patent.

Microcrack connectivity in rocks: a real-space renormalization group approach for 3D anisotropic bond percolation

Research Assistant — *September 2014 - September 2015*
Chinese Academy of Sciences, Institute of Mechanics — Supervised by Dr. Zhao Ya-Pu

- Conducted a research on Microscale Mechanism of Fracture-Network Connectivity and Desorption Transportation of Shale Gas
- Explored the intricate behaviors impacting gas release and flow in shale formations, contributing to enhanced models of gas extraction efficiency.

SERVICE

Session Chair

- IDETC/CIE 2024, DC

Reviewer (Journals)

- Additive Manufacturing
- Journal of Mechanical Design
- Journal of Computing and Information Science in Engineering
- Journal of Computer-Aided Design
- Journal of Computer in Industry
- Nature Communication

Reviewer (Conferences)

- IDETC/CIE Conference 2024, DC
- IDETC/CIE Conference 2023, Boston, MA