Yijiang Huang

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Areas of specialization

Robotic fabrication, Task and motion planning, Computational design and optimization.

Education

9/2018 - 9/2022 **Ph.D. in Building Technology, MIT (Advisor: Caitlin Mueller)** **Cambridge, MA**
Department of Architecture
- Dissertation: "Algorithmic planning for robotic assembly of building structures"
- MIT Presidential Fellowship (2018)

9/2016 - 5/2018 **Master of Science in Building Tech., MIT (Advisor: Caitlin Mueller)** **Cambridge, MA**
Department of Architecture
- MIT Presidential Fellowship (2016)

9/2012 - 5/2016 **Bachelor of Science, University of Science and Technology of China** **Hefei, China**
Major in Mathematics and Applied Mathematics

Research Experience

1/2023 - Now **ETH Zurich, Computational Robotics Group** **Zurich, Switzerland**
Postdoctoral fellow: work on task and motion planning for cooperative assembly by mobile robot systems (ongoing, advised by Stelian Coros).

9/2016 - 8/2022 **MIT, Digital Structures Group** **Cambridge, US**
Graduate research assistant: developed task and motion planning algorithms for robotic assembly and tested them on real-world robot systems in various physical scales; collaborated with researchers at MIT, Princeton, and ETH Zurich; published results in journal and presented findings at academic conferences and seminars; led instructions and contributed to the developments of various courses and workshops.

6/2019 - 8/2019 **ETH Zurich, Gramazio & Kohler Research Group** **Zurich, Switzerland**
Guest researcher: integrated assembly planning algorithms to the open-source COMPAS-FAB framework; led hands-on workshops about the developed software.

2/2015 - 6/2016 **USTC, Geometry and Graphics Computing Lab** **Hefei, China**
Undergraduate research assistant: developed a constrained graph decomposition algorithm to enable efficient search of robotic printing sequence; developed a customized robotic spatial printing hardware system to validate the proposed algorithm; led a team of three undergraduate students to develop the project and published results at SIGGRAPH Asia.

Publications

* indicates authors contributed equally.

Journal Papers

Y. Huang, C. Garrett, I. Ting, S. Parascho, C. Mueller (2021). **Robotic additive construction of bar structures: Unified sequence and motion planning**. *Construction Robotics*, vol. 5, pp. 115-130

Y. Huang, C. Garrett, C. Mueller (2018). **Automated sequence and motion planning for robotic spatial extrusion of 3D trusses**. *Construction Robotics*, vol. 2, no. 1-4, pp. 15-39.

K. Tam, D. Marshall, M. Gu, J. Kim, **Y. Huang**, J. Lavallee, C. Mueller (2017). **Fabrication-aware structural optimisation of lattice additive-manufactured with robot-arm**. *International Journal of Rapid Manufacturing*, vol. 7, no. 2-3, pp. 120-168.

Y. Huang, J. Zhang, X. Hu, G. Song, Z. Liu, L. Yu, L. Liu (2016). **Framefab: Robotic fabrication of frame shapes**. *ACM Transactions on Graphics (TOG)*, 35(6), 224.

Conference Papers

Y. Huang, V.P.Y. Leung, C. Garrett, F. Gramazio, M. Kohler, C. Mueller (2021). **The new analog: A protocol for linking design and construction intent with algorithmic planning for robotic assembly of complex structures**. *Proceedings of ACM Symposium on Computational Fabrication*, 2021.

Y. Huang, L. Alkhayat, C. De Wolf, C. Mueller (2021). **Algorithmic circular design with reused structural elements: Method and Tool**. *Proceedings of the international FIB symposium of Conceptual Design of Structures*, 2021.

C. Garrett*, **Y. Huang***, T. Lozano-Pérez, C. Mueller (2020). **Scalable and Probabilistically Complete Planning for Robotic Spatial Extrusion**. *Proceedings of Robotics: Science and Systems (RSS)*, virtual, 2020.

F. Amtsberg*, **Y. Huang***, D. Marshall, K. Gata, C. Mueller (2020). **Structural upcycling: Matching digital and natural geometry**. *Proceedings of Advances in Architectural Geometry*, Champs-sur-Marne, France, 2020.

R. Arora, A. Jacobson, T. Langlois, **Y. Huang**, C. Mueller, W. Matusik, A. Shamir, K. Singh, D. Levin (2019). **Volumetric Michell trusses for parametric design & fabrication**. *Proceedings of the ACM Symposium on Computational Fabrication*, 2019.

L. Tessmer, **Y. Huang**, C. Mueller (2019). **Additive Casting of Mass-Customizable Bricks: Workflow for Design and Robotic Fabrication**. *Proceedings of the 39th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA)*, Austin, Texas, 21-26 October, 2019.

Y. Huang, J. Carstensen, L. Tessmer, C. Mueller (2018). **Robotic extrusion of architectural structures with nonstandard topology**. *Proceedings of Robotic Fabrication in Architecture, Art and Design (RobArch)*, 2018.

Y. Huang, J. Carstensen, C. Mueller (2018). **3D truss topology optimization for automated robotic spatial extrusion**. *Proceedings of International Association for Shell and Spatial Structures (IASS)*, Boston, MA, 2018.

L. Yu, **Y. Huang**, Z. Liu, S. Xiao, L. Liu, G. Song, Y. Wang (2016). **Highly Informed Robotic 3D Printed Polygon Mesh: A Novel Strategy of 3D Spatial Printing**. *Proceedings of the 36th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA)*, Ann Arbor 27-29 October, 2016, pp. 298-307.

Preprints

J. Chen, J. Li*, **Y. Huang***, C. Garrett, D. Sun, C. Fan, A. Hofmann, C. Mueller, S. Koenig, B. Williams (2021) **Cooperative Task and Motion Planning for Multi-Arm Assembly Systems**. *arXiv:2203.02475.*

M. Tarek and **Y. Huang** (2022). **Simplifying deflation for non-convex optimization with applications in Bayesian inference and topology optimization**. *arXiv: 2201.11926.*

Conference abstracts

Y. Huang and Mohamed Tarek (2021). **TopOpt.jl: Truss and Continuum Topology Optimization, Interactive Visualization, Automatic Differentiation and More**. In: *14th World Congress of Structural and Multidisciplinary Optimization (WCSMO-2021).*

Selected Software

COMPAS-FAB (30 forks, 90 stars, click for github link)
Contributor: a Python package for the COMPAS Framework that facilitates the planning and execution of robotic fabrication processes.

pybullet_planning (11 forks, 77 stars, click for github link)
Contributor: a Python package based on the pybullet physics simulation engine to provide collision checking, kinematics, and motion planning for robotics research.

ikfast_pybind (5 forks, 22 stars, click for github link)
Author: a Python package for analytical robot kinematics.

conmech (1 forks, 11 stars, click for github link)
Author: a Python package for linear elastic analysis of spatial trusses and frames.

TopOpt.jl (21 forks, 112 stars, click for github link)
Contributor: a Julia package for flexible topology optimization on continuum and truss domains.

*Open-source code is **available on my website** for most of the publications above.*

Awards

9/2016, 9/2018 **MIT Presidential Fellowship** **MIT**
Funding for tuition and living stipend of one academic year, awarded to around 110 new graduate students each year, selected by the Deans and Heads of Departments at MIT.

9/2014 - 6/2016 **Outstanding Undergraduate Student Scholarship** **USTC, China**
500 RMB yearly

Professional Service

Reviewer for: Construction Robotics (2018-2022), ACM SIGGRAPH (2019), ACM SIGGRAPH Asia (2020), ACM Symposium of Computational Fabrication (2020,2021).

Teaching Experience

Fall 2019-2021 **Computational Structural Design and Optimization (4.450)** **MIT**
Teaching assistant ($\approx$ 25 students per year, semester-long graduate course): led weekly office hours and monitored student final projects; developed new assignments and lectures to reflect recent developments and tools in optimization and fabrication; guest lecture on optimization algorithms and discrete and combinatorial optimization. (with C. Mueller)

Spring 2018 **Design for Robotic Assembly (4.S48)** **MIT**
Co-instructor (12 students, semester-long graduate course): designed, organized, and presented a new project-based course on architectural design for robotic assembly. Students learned the basic principles of programming an industrial robotic arm and explored creative usage of the technology. Their final projects questioned the physical precision of robots, engaged in playful human-robot interactions, and produced bespoke geometries. (with C. Mueller and J. Lavallee)

7/2020 **Kintsugi, Upcycling, and Machine Learning (4.181)** **MIT**
Co-instructor (12 students, three-week-long workshop): gave lectures and led tutorial sessions. Students used the optimal matching tool developed in my research to design new assemblies from recycled materials. (with C. Mueller, D. Marshall, D. White)

10/2019 **Design Modeling Symposium Workshop** **Berlin**

Co-instructor (14 students, two-day-long workshop): gave lectures and tutorials for this workshop on "fabrication-informed design of robotically assembled structures". Students used the planning system developed in my research to compute robot trajectories to assemble structures they designed. (with S. Parascho, G. Wartinger, C. Mueller)

10/2018 **Structural Upcycling workshop** **MIT**

Co-instructor (≈ 10 students, two-week-long workshop): developed computational design workflow for designing structures that reuse recycled tree branches (with F. Amtsberg, D. Marshall, K.M. Gata, C. Mueller)

7/2017 **Parametric Architectural Design Workshop** **Tsinghua University, Beijing**

Teaching Assistant (13 students, one-week-long workshop): mentored students on the design and construction of full-scale, load-bearing bridges, using generative computational design tools that link architectural expression with structural performance. (with C. Mueller)

7/2016 **Parametric Architectural Design Workshop** **Tsinghua University, Beijing**

Teaching Assistant (≈ 12 students, one-week-long workshop): mentored students on the use of industrial robots to cut customized wood notches for the assembly of a human-scale reciprocal wood vault. (with L. Yu and Z. Liu)

Anonymous Teaching Feedback

Fall 2019-2021 **Computational Structural Design and Optimization (4.450)** **MIT**

A sample of anonymous feedback about my teaching assistantship is gathered below, where each quotation corresponds to a different student:

"Yijiang has been the best TA I have had at MIT. He's thoughtful and thorough in his responses and feedback and seems to have a true passion for the material. Couldn't have succeeded in this course without him."

"Yijiang had a very challenging job as a (sole) TA to ∼31 students! He was always responsive over email and Piazza. It's nice to know that no matter what, I could count on getting an answer to any question that came up. Yijiang is also very kind and thoughtful, and I was never worried to ask him questions in class. Great TA."

"Yijiang is the best TA that I've ever had. He is so helpful and so passionate about the subject. He is so approachable and he answers questions so quickly and in such an understandable manner."

"Amazing TA. I've learnt a lot from Yijiang and he definitely goes out of his way to help us, be it during or out of class. Really fortunate to have him as the teaching assistant for the class."

Mentoring Experience

8/2021 **Summer Geometry Institute** **MIT**

Research mentor: planned, prepared, and mentored a week-long research project for four undergraduate students (1 ME, 2 CS, 1 Math) on design optimization via shape morphing. (with C. Mueller)

8/2020 **HerCodeCamp** **MIT**

Mentor: mentored four female-identified high-school students on a two-week-long code camp to build a ping-pong game in Python. (with N. Sultanum)

2017 **Undergraduate Research Opportunities Program (UROP)** **MIT**

Research mentor: advised semester-long research projects with the following undergraduate students (with C. Mueller):
- Thomas Cook (Senior, EECS): "Industrial robot's planning and simulation"
- Kodiak Brush (Senior, MechE): "Thermal hotend design for robotic printing"
- Khanh Nguyen (Sophomore, MechE): "portable 3D printing control system design"

Press

5/2022 **MIT engineers build load-bearing structures using tree forks instead of steel joints**
Dezeen, written by Rima Sabina Aouf (click to see archived version)

3/2022 **Using nature's structures in wooden buildings**
MIT News, written by Nancy W. Stauffer (click to see archived version)

Invited Seminar Talks

10/2022 **Algorithmic planning for robotic assembly of building structures** **EPFL**
Research talk at Prof. Mark Pauly's group, EPFL

11/2021 **Algorithmic circular design** **MIT**
Research talk at Prof. Justin Solomon's group

11/2021 **Automated planning for large-scale robotic construction** **MIT**
Research talk at Prof. Stefanie Mueller's group

10/2020 **Scalable planning for robotic spatial extrusion** **Virtual**
Research talk at the DigitalFUTURES Young series: Robotic Fabrication 3

6/2020 **Scalable and probabilistically complete planning for robotic printing** **TU Darmstadt**
Research talk at the Intelligent Autonomous Systems Seminar, hosted by Prof. Jan Peters

9/2019 **Robotic spatial assembly: Sequence and motion planning** **MIT**
Guest lecture at Modeling and Analysis of Structures (1.571), hosted by Dr. Gordana Herning

4/2019 **Sequence and motion planning for robotic spatial extrusion** **Boston University**
Research talk at the AIR Seminar of the Hariri Institute of Computing, hosted by Prof. Emily Whiting

3/2018 **Robotic assembly planning: towards construction-driven geometry guidance** **Zurich**
Research talk at Disney Research Zurich, hosted by Prof. Moritz Bächer

3/2018 **Robotic assembly planning: towards construction-driven geometry guidance** **Zurich**
Research talk at the Institute of Technology in Architecture, ETH Zurich

11/2017 **3D graph decomposition for efficient construction sequence searching** **MIT**
Research talk at the Simple Person's Applied Math Seminar (SPAMS)

11/2017 **Robotic assembly planning: towards goal-driven geometry diagnosis** **MIT**
Research talk at the Computer Graphics Seminar

4/2017 **Robotic Motion Planning Platform for Spatial Truss Fabrication** **MIT**
Research talk at Prof. Brian Williams's group