Beichen Li

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Education

Massachusetts Institute of Technology — Cambridge, MA
Ph.D. in Computer Science — Aug 2018 – present

- GPA: 5.0/5.0 (Minor: Economics)
- **Coursework:** Advanced Computer Graphics, Shape Analysis, Theory of Computation, Hardware Architecture for Deep Learning

Massachusetts Institute of Technology — Cambridge, MA
M.S. in Computer Science — Aug 2018 – Jun 2021

Tsinghua University — Beijing, China
B.Eng. in Computer Science and Technology — Aug 2014 – Jun 2018

- GPA: 3.91/4.0, Rank: 3/180

Experience

Research Assistant, Computational Design and Fabrication Group, MIT CSAIL – Cambridge, MA — Aug 2018 – present

- **Advisor:** Prof. Wojciech Matusik
- Adapted a pre-trained large vision-language model to generate procedural physics-based rendering (PBR) materials from single images through supervised fine-tuning
- Developed a differentiable procedural material modeling library, *DiffMat*, to match the appearance of procedural materials against real-world flash photos by optimizing the node parameters
- Developed a learning-accelerated computational pipeline to automatically discover 3D-printable microstructures with an optimal trade-off between stiffness and toughness

Research Intern, 3D Graphics Group, Adobe Research – Cambridge, MA — May 2023 – Aug 2023

- **Mentor:** Dr. Yiwei Hu
- Generated a large-scale procedural material dataset with over 10M paired images and material graphs to pre-train a Transformer-based model for image-conditioned procedural material generation
- Fine-tuned the pre-trained model on real-world flash photos using reinforcement learning to improve the visual quality of the generated materials

Research Intern, 3D and Immersive Group, Adobe Research – San Jose, CA (Remote) — May 2020 – Aug 2020

- **Mentor:** Dr. Miloš Hašan and Dr. Kalyan Sunkavalli
- Trained an RNN-based variational autoencoder to generate novel procedural material graphs from a dataset of exemplar materials

Team Leader, Student Supercomputing Team, Tsinghua University – Beijing, China — Nov 2017 – Jun 2018

- **Mentor:** Prof. Jidong Zhai
- Led a team of 6 students to participate in the ASC, ISC, and SC international student cluster competitions
- Benchmarked and optimized the performance of scientific applications (e.g., LINPACK, MASNUM, and MrBayes) on many-core CPU/GPU architectures

Research Intern, CMU Robotics Institute – Pittsburgh, PA — Jun 2017 – Sep 2017

- **Mentor:** Prof. Stelian Coros
- Implemented an interactive framework to co-optimize the motion and design parameters of 3D-printable robotic creatures based on sensitivity analysis and the adjoint method
- Developed an interactive demo to compare the efficiency of different gradient-based optimization algorithms

Undergraduate Research Assistant, Graphics and Geometric Computing Group, Tsinghua University – Beijing, China — Feb 2017 – Jun 2018

- **Advisor:** Prof. Shi-Min Hu
- Co-developed a real-time indoor scene reconstruction system on a mobile robot platform with heterogeneous sensors to enhance the accuracy and robustness of tracking
- Co-implemented an alternative indoor scene reconstruction workflow by stitching reconstructed 3D panoramas from three robot-mounted, unsynchronized, in-place-rotating RGB-D cameras

Publications

Procedural Material Generation with Reinforcement Learning — Dec 2024

Beichen Li, Yiwei Hu, Paul Guerrero, Miloš Hašan, Liang Shi, Valentin Deschaintre, Wojciech Matusik

ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPH Asia 2024

Computational Discovery of Microstructured Composites with Optimal Stiffness-Toughness Trade-Offs — Feb 2024

Beichen Li, Bolei Deng, Wan Shou, Tae-Hyun Oh, Yuanming Hu, Yiyue Luo, Liang Shi, Wojciech Matusik

Science Advances

AutODEx: Automated Optimal Design of Experiments Platform with Data- and Time-Efficient Multi-Objective Optimization — Dec 2023

Yunsheng Tian, Pavle Vanja Konaković, ***Beichen Li***, Ane Zuniga, Michael Foshey, Timothy Erps, Wojciech Matusik, Mina Konaković Luković

NeurIPS 2023 Workshop on Adaptive Experimental Design and Active Learning in the Real World

End-to-End Procedural Material Capture with Proxy-Free Mixed-Integer Optimization — Aug 2023

Beichen Li, Liang Shi, Wojciech Matusik

ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPH 2023

End-to-End Learning of 3D Phase-Only Holograms for Holographic Display — Aug 2022

Liang Shi, ***Beichen Li***, Wojciech Matusik

Light: Science and Applications

Data-Efficient Graph Grammar Learning for Molecular Generation — Mar 2022

Minghao Guo, Veronika Thost, ***Beichen Li***, Payel Das, Jie Chen, Wojciech Matusik

International Conference on Learning Representations (ICLR) 2022 – Oral Presentation

Designing Composites with Target Effective Young's Modulus using Reinforcement Learning — Oct 2021

Aldair E. Gongora*, Siddharth Mysore*, ***Beichen Li****, Wan Shou, Wojciech Matusik, Elise F. Morgan, Keith A. Brown, Emily Whiting

ACM Symposium on Computational Fabrication (SCF) 2021 – "*" indicates equal contribution

Learning Human-Environment Interactions using Conformal Tactile Textiles — Mar 2021

Yiyue Luo, Yunzhu Li, Pratyusha Sharma, Wan Shou, Kui Wu, Michael Foshey, ***Beichen Li***, Tomás Palacios, Antonio Torralba, Wojciech Matusik

Nature Electronics – Cover Article

Towards Real-Time Photorealistic 3D Holography with Deep Neural Networks — Mar 2021

Liang Shi, ***Beichen Li***, Changil Kim, Petr Kellnhofer, Wojciech Matusik

Nature

MATch: Differentiable Material Graphs for Procedural Material Capture — Dec 2020

Liang Shi, ***Beichen Li***, Miloš Hašan, Kalyan Sunkavalli, Tamy Boubekeur, Radomír Měch, Wojciech Matusik

ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPH Asia 2020

Noise-Resilient Reconstruction of Panoramas and 3D Scenes using Robot-Mounted Unsynchronized Commodity RGB-D Cameras Jul 2020

Sheng Yang, ***Beichen Li***, Yan-Pei Cao, Hongbo Fu, Yu-Kun Lai, Leif Kobbelt, Shi-Min Hu

ACM Transactions on Graphics (TOG)

Physical Realization of Elastic Cloaking with a Polar Material Mar 2020

Xianchen Xu, Chen Wang, Wan Shou, Zongliang Du, Yangyang Chen, ***Beichen Li***, Wojciech Matusik, Nassar Hussein, Guoliang Huang

Physical Review Letters

Learning to Fly: Computational Controller Design for Hybrid UAVs with Reinforcement Learning Jul 2019

Jie Xu, Tao Du, Michael Foshey, ***Beichen Li***, Bo Zhu, Adriana Schulz, Wojciech Matusik

ACM Transactions on Graphics (TOG) – Proceedings of ACM SIGGRAPH 2019

HeteroFusion: Dense Scene Reconstruction Integrating Multi-Sensors May 2019

Sheng Yang, ***Beichen Li***, Minghua Liu, Yu-Kun Lai, Leif Kobbelt, Shi-Min Hu

IEEE Transactions on Visualization and Computer Graphics (TVCG)

Interactive Co-Design of Form and Function for Legged Robots using the Adjoint Method Jan 2018

Ruta Desai, ***Beichen Li***, Ye Yuan, Stelian Coros

International Conference on Climbing and Walking Robots (CLAWAR) – Best Paper (2nd) Award

Patents

Computational Discovery of Microstructure Designs Nov 2022

Beichen Li, Wan Shou, Wojciech Matusik

Number: US20220374569A1

Projects

DiffMat: PyTorch-Based Differentiable Material Graph Library for Procedural Material Capture GitHub: mit-gfx/diffmat

- Implemented differentiable versions of commonly-used procedural material nodes in Adobe Substance 3D Designer (including complex nodes like *Pixel Processor* and *FX-Map*) using PyTorch
- Implemented a mixed-integer optimization algorithm to co-optimize the continuous and discrete node parameters in procedural material graphs for matching real-world flash photos
- Accelerated the forward execution of texture generator nodes by >100x using the Taichi programming language
- Tools Used: Python, Adobe Substance 3D Designer

Awards and Fellowships

Ernst A. Guillemin Artificial Intelligence and Decision Making Thesis Award Jun 2022

MIT Department of Electrical Engineering and Computer Science (EECS)

Outstanding Graduate of Tsinghua University Jun 2018

Tsinghua University

Outstanding Graduate of Beijing Jun 2018

Beijing Municipal Commission of Education

ISC Student Cluster Competition Champion Jun 2017, Jun 2018

HPC-AI Advisory Council

ASC Student Supercomputer Challenge Champion May 2017, May 2018

Asia Supercomputing Community (ASC)

National Scholarship 2016, 2017
Ministry of Education of China

Service

Reviewer, ACM SIGGRAPH, ACM SIGGRAPH Asia, ICRA

Teaching Assistant, MIT 6.839 Advanced Computer Graphics Fall 2021
- Developed and graded assignments, held office hours, and provided feedback on student projects

Web Developer, MIT Sidney-Pacific Graduate Community 2020 – 2021
- Participated in feature development and bug fixing for the community website

Technical Skills

Languages: Python (PyTorch, Hugging Face), C++ (OpenMP, CUDA), MATLAB, HTML/CSS, LaTeX

Software: Adobe Creative Cloud (Illustrator, Premiere Pro, Substance 3D Designer), Blender, Visual Studio Code, Git, Overleaf