

Yafei Ou

Postdoctoral Scholar, Department of Electrical and Computer Engineering, University of Alberta

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Research Fields: Surgical Robotics and Simulation, Robot Learning (Reinforcement and Imitation Learning), Virtual Reality and Digital Twin

Education

- 2021.09 – 2025.08 **Ph.D. in Control Systems, University of Alberta**, Edmonton, Canada
- Thesis: Enhancing Surgical Task Autonomy Through Simulations and Robot Learning
 - Supervisor: Prof. Mahdi Tavakoli
 - China Scholarship Council (CSC) Scholarship (PhD) recipient
 - Alberta Innovates Graduate Student Scholarship (AI GSS) recipient
- 2017.09 – 2021.06 **B.Eng. in Mechanical Design, Manufacturing and Automation, University of Electronic Science and Technology of China (UESTC)**, Chengdu, China
- GPA: 3.98/4.00
 - China National Scholarship recipient

Work Experience

- 2025.10 – present **Postdoctoral Scholar**, University of Alberta – Edmonton, Canada
- Leading development of GPU-accelerated surgical simulators supporting real-time deformable object interaction and ultrasound simulation for robot learning
 - Designing and training reinforcement learning (RL) and vision-language-action (VLA) agents for autonomous surgical tasks
 - Contributing to open-source surgical simulation frameworks used by multiple research projects

Selected Projects

Most of my projects are part of the CRESSim research initiative ([project website](#))

- 2025.10 – present **GPU-Accelerated Parallel Robot Learning Simulation Environment for Surgical Suturing Using Position-Based Dynamics (PBD) and Material Point Method (MPM)**
- Designing and implementing a parallel PBD-MPM suturing simulator enabling GPU-accelerated parallel RL training
 - Training autonomous suturing policies in simulation and transferring them to real surgical robotic systems (*sim2real*)
- 2025.04 – present **CRESSim-Ultrasound: Simulating Ultrasound Images in Real-Time with Tissue Deformation for Robot Learning**
- Developing a CUDA-based library for real-time ultrasound image synthesis (60+ FPS) coupled with MPM-based soft tissue deformation
 - Training end-to-end ultrasound scanning policies directly from image observations in simulation and transferring them to real robotic ultrasound systems
- 2024.09 – 2025.03 **CRESSim-MPM: An Open-Source Library for GPU-Accelerated MPM Simulation with Soft Tissue Cutting and Suturing**
- Developed a real-time, GPU-accelerated Material Point Method (MPM) library for deformable soft tissue simulation with high performance and extensibility
 - Implemented robust surgical cutting and suturing algorithms supporting topological changes in soft bodies

- 2023.06 – 2024.09 **Learning Autonomous Surgical Irrigation and Suction from High-Fidelity Simulators**
- Developed CRESSim, an open-source surgical robot learning simulator based on Unity and PhysX 5 for the da Vinci Research Kit (dVRK)
 - Implemented screen-space fluid rendering for simulating irrigation and suction with fluid mixing, achieving 250+ FPS
 - Trained RGB image-based end-to-end RL policies for autonomous surgical irrigation and suction in simulation and transferred them to real surgical robot hardware
- 2022.10 – 2023.06 **Real-World Surgical Robot Reinforcement Learning with Human Intervention**
- Applied human-in-the-loop RL methods to real-world surgical robot tasks on the dVRK to reduce failures during training
 - Achieved autonomous endoscopic camera control through direct real-world robot learning

Publications

- 2026.02 **Learning from imperfect demonstrations in a surgical training task** ([link](#))
Y. Hu, **Y. Ou**, A. Sieben, Z. Samadikhoshkho, B. Zheng, J. Jin, M. Tavakoli
Biomedical Signal Processing and Control
- 2025.06 **Learning autonomous surgical irrigation and suction with the da Vinci Research Kit using reinforcement learning** ([link](#))
Y. Ou, M. Tavakoli
IEEE Transactions on Automation Science and Engineering
- 2025.06 **Virtual attention points: Bridging human movement characteristics and dexterous robot motion generation** ([link](#))
A. Soleymani, **Y. Ou**, X. Li, M. Tavakoli
Robotics and Autonomous Systems
- 2025.10 **CRESSim-MPM: A material point method library for surgical soft body simulation with cutting and suturing** ([link](#))
Y. Ou, M. Tavakoli
2025 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- 2025.01 **From decision to action in surgical autonomy: Multi-modal large language models for robot-assisted blood suction** ([link](#))
S. Zargarzadeh, M. Mirzaei, **Y. Ou**, M. Tavakoli
IEEE Robotics and Automation Letters
- 2024.12 **Autonomous soft-tissue needle steering using reinforcement learning guided by human input** ([link](#))
Y. Ou, M. Tavakoli
Journal of Medical Robotics Research
- 2024.09 **Hands collaboration evaluation for surgical skills assessment: An information theoretical approach** ([link](#))
A. Soleymani, M. Tavakoli, F. Aghazadeh, **Y. Ou**, H. Rouhani, B. Zheng, X. Li
IEEE Transactions on Medical Robotics and Bionics
- 2024.07 **Autonomous blood suction for robot-assisted surgery: A sim-to-real reinforcement learning approach** ([link](#))
Y. Ou, A. Soleymani, X. Li, M. Tavakoli
IEEE Robotics and Automation Letters
- 2024.04 **A realistic surgical simulator for non-rigid and contact-rich manipulation in surgeries with the da Vinci Research Kit** ([link](#))
Y. Ou, S. Zargarzadeh, P. Sedighi, M. Tavakoli
2024 21st International Conference on Ubiquitous Robots (UR)
- 2024.04 **Iterative learning for gravity compensation in impedance control** ([link](#))
T. Li, A. Zakerimanesh, **Y. Ou**, B. Armin, M. Tavakoli
IEEE/ASME Transactions on Mechatronics

- 2023.12 **Robot learning incorporating human interventions in the real world for autonomous surgical endoscopic camera control** ([link](#))
Y. Ou, S. Zargarzadeh, M. Tavakoli
Journal of Medical Robotics Research
- 2023.04 **Towards safe and efficient reinforcement learning for surgical robots using real-time human supervision and demonstration** ([link](#))
Y. Ou, M. Tavakoli
2023 International Symposium on Medical Robotics (ISMR)
- 2023.03 **Sim-to-real surgical robot learning and autonomous planning for internal tissue points manipulation using reinforcement learning** ([link](#))
Y. Ou, M. Tavakoli
IEEE Robotics and Automation Letters

Honors & Awards

- 2024.09 – 2025.08 **Stephen and Olga Anhill Graduate Scholarship in Electrical and Computer Engineering**
University of Alberta. CAD \$12,000
- 2023.09 – 2025.08 **Alberta Innovates Graduate Student Scholarship (AI GSS)**
Alberta Innovates. CAD \$31,000/year for 2 years (received CAD \$12,000/year as a supplementary top-up due to holding another major award)
- 2021.09 – 2025.08 **China Scholarship Council (CSC) Ph.D. Scholarship**
China Scholarship Council (CSC). CAD \$26,400/year for 4 years
- 2024 **Floyd Derkat Graduate Award in Artificial Intelligence and Machine Learning**
University of Alberta. CAD \$5,000
- 2018 **China National Scholarship**
Ministry of Education (China). CNY ¥8,000

Selected Talks, Workshops & Service

Conference Organization: Exhibitions Co-Chair, IEEE RAS/EMBS 11th International Conference on Biomedical Robotics and Biomechatronics (BioRob), 2026.

Workshop Organization: Organizer, *AI-Driven Surgical Autonomy: From Realistic Simulation to Real World*, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2025.

Workshop Organization: Organizer & Speaker, *Practical Applications of Robotics and AI in Modern Healthcare*, Robotics & Intelligent Systems Expo (RISEx), 2025.

Workshop Organization: Organizer & Speaker, *Bridging Surgical Robotics and AI*, Alberta Robotics & Intelligent Systems Expo (RISE), 2024.

Teaching: Teaching Assistant, *Robotics: Modelling, Planning and Control*, University of Alberta, 2023.

Reviewing Service: Ad hoc reviewer for IEEE Robotics and Automation Letters (RA-L), International Journal of Robotics Research (IJRR), IEEE Transactions on Medical Robotics and Bionics (T-MRB), IEEE International Conference on Robotics & Automation (ICRA), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).

Skills

General-Purpose Programming: C++, C#, Python, MATLAB, C

Graphics, Simulation & GPU Programming: Unity, CUDA, PhysX, HLSL, OpenGL

Robotics: ROS, Robotics Toolbox for MATLAB/Python, OpenCV

Control System Design and Simulation: MATLAB, Simulink

Machine Learning: PyTorch, scikit-learn, ONNX