Yilin CAI

Phone:(+1) 412-758-7271
Email: yilincai@andrew.cmu.edu
Website: http://yilincai.weebly.com
LinkedIn: www.linkedin.com/in/yilin-cai-0a3665180/

EDUCATION

2021.09-2023.05 **Carnegie Mellon University (CMU),** Pittsburgh, USA
- *Master of Science in Robotic Systems Development, School of Computer Science*

2016.09-2020.06 **Shanghai Jiao Tong University (SJTU)**, Shanghai, China
- *BEng in Mechanical Engineering,* 2020 Excellent Bachelor Thesis (Top 1%)
- Tsien Hsue-shen Honor Program (Top 5%), Overall GPA: 88.47/100

PUBLICATIONS & PATENTS

- **Y. Cai**, S. Huang, Z. Zhang, et al., "Bioinspired Rotation Microneedles for Accurate Transdermal Positioning and Ultraminimal-Invasive Biomarker Detection with Mechanical Robustness.," *spj-Research*. vol. 2022, p. 9869734, 2022.
- Ren, Z., **Cai, Y.,** Rathinam, S., Maxim, L., Choset, H., (2023, Feb). "Trajectory Optimization Warm-Started by Multi-Objective Graph Search with Application to Planning for Navigation in Complex Terrains," AAAI Conference on Artificial Intelligence (Under Review)
- Lyu, S., Wülker, C., Pan, Y., Jayaraman, A. S., Zheng, J., **Cai, Y**., & Chirikjian, G. S. (2019). Cross-Modal Fusion Between Data in SAXS and Cryo-EM for Biomolecular Structure Determination. *arXiv preprint arXiv:1908.03306*
- **Cai Yilin**, Dang Jiaqiang, An Qinglong, Chen Ming, Valve core working edge burr form reconstruction method based on white light confocal in-situ measurement: *CN Patent, CN109648400B. 2020-07-20*. (Authorized) *[Google Patent]*
- Ding Zhiyuan, **Cai Yilin**, Xu Hao, Li Chengyuan, Huang Pengsheng, Guo Weizhong, Wearable three-degree-of-freedom human body auxiliary outer mechanical arm: *CN Patent, CN 110561403A. 2019-09-02 [Google patent]*
- Weidong Chen, Xiaojie Ai, Anzhu Gao, **Cai Yilin,** Incision type continuum robot based on crossed bending beam structure: *CN Patent, CN N 113456231 A. 2021-10-01 [Google Patent]*

RESEARCH EXPERIENCE

2021.10-2022.05 **Biorobotics Lab** at CMU, Research Assistant, *Supervisor: Prof. Howie Choset*

- Project: **High Articulated Robot Probe for Minimum Invasive Surgery (Medical Snake)**
- Proposed statics modeling of discrete joint surgical probes with tendon-based stiffening by including the internal friction effect, which is used for predicting the payload capacity and payload optimal planning
- Designed the control framework of the medical snake to achieve follow-the-leader motion using two concentrically driven segmented tubes that alternate between locking and advancing each segment
- Design the tension tensing mechanism for the robot actuation tendons and achieved tension control

- Project: **Trajectory Optimization Warm-Started by Multi-Objective Graph Search**
- Proposed an algorithm for trajectory planning by combining Pareto-optimal path set and round-robin optimization
- Validated the feasibility of the planned trajectory for dynamic mobile robot system, with >50% lower cost than baseline

2022.02-2022.05 **The Air Lab** at CMU, Research Assistant, *Supervisor: Prof. Sebastian Scherer*

- Project: **Learning-based Visual Odometry (VO) for Dynamic Environment**
- Proposed a novel supervised learning-based VO leveraging the interdependence among camera ego-motion, optical flow and motion segmentation
- Introduced an iterative framework to jointly refine the camera ego-motion estimation and the dynamic object segmentation, which achieved improvement of 27.7% over SOTA VO solutions in real-world

2020.09-2021.06 **Institute of Medical Robotics** at SJTU, Research Assistant

- Project: **Robotic Bronchoscope System for Diagnosis of Peripheral Pulmonary Nodules**
- *Supervisor: Prof. Weidong Chen*
- Designed and developed a surgical robot system for transbronchial lung biopsy, integrating radial endobronchial ultrasound (rEBUS) and probe-based confocal laser endomicroscopy (pCLE) for simultaneous diagnosis
- Established teleoperation control of the robotic assisted bronchoscope with Omega7
- Developed inverse kinematics algorithm for a contact-aided continuum manipulator with anisotropic bending shapes

- Project: **A Steerable Cross-axis Notched (SCAN) Continuum Manipulator for Surgical Robots**
- *Supervisor: Prof. Anzhu Gao, Prof. Guang-Zhong Yang*
- Proposed a cross-axis notched continuum manipulator to address the trade-off between stiffness and range of motion
- Modelled the manipulator's statics by cross-aixs flexural pivots along with the FEM validation
- Validated the superiority in range of motion and stiffness by experiments and FEM comparison [link to paper]

2019.09-2020.07 **iDesign Lab** at SJTU, Bachelor's Thesis

- Project: **Design and Development of a Novel Rotating Microneedle System**
- *Supervisor: Prof. Zhinan Zhang, Prof. Xianting Ding*

- Introduced rotation to microneedle design for drug delivery, achieving accurate penetration with low insertion force
- Established theoretic model of microneedle load-bearing criteria and model of needle-skin interaction force
- Clarified the skin resistance force and dynamic surface deformation during microneedle penetration by a combination of theory, FEM simulation and experiments; Designed a robot-assisted rotating microneedle insertion system
- Won the 2020 Excellent Bachelor Thesis (Top1%) of SJTU; Selected into '2020 Collection of Outstanding Graduation Design' by China Mechanical Education Union of Excellent Engineers (the only one in SJTU)

2019.07-2019.10 **Robot and Protein Kinematics Lab** at National University of Singapore, Research Student

- *Supervisor: Dr. Gregory S. Chirikjian*

- Project: **Data Fusion of SAXS and Cryo-EM for Biomolecular Structure Determination**
  - Implemented cross-modal fusion algorithm between small angle X-ray scattering (SAXS) and Cryo-electron microscopy (EM) data in Fourier space, reducing the max error of 3D density map reconstruction by 80%
  - Proposed discrete approximation method in multi admissible roots selection, improving efficiency by 5 times
  - Built a 2D and 3D model by Gaussian Mixture Model and conducted reconstruction experiment; Applied fusion to real biological macromolecule reconstruction of Nucleosome-Chd1 generated from Protein Data Bank (PDB)
  - The results were displayed at the 2019 NYC Computational Cryo-EM Summer Workshop
- Project: **Position Estimation of Subsea Pipelines Based on Bayesian Fusion on Lie Groups**
  - Introduced stochastic finite element on Lie Groups to model the prior distribution of pipelines under random forces

WORK EXPERIENCE

2021.06-2021.09 **Ronovo Surgical Co.,Ltd**, Shanghai,

- Robot Control Engineer Intern
  - Established the robotic surgery simulation environment and designed the surgical workflow of Hysterectomy
  - Developed the robot trajectory planning and collision detection algorithm for optimizing the robots' set-up position

COMPETITION & PROJECTS

2018.09-2019.01 **Widely adaptive Wearable Supernumerary Robotic Limbs (SRL) with Virtual Reality**, Team leader of course project

- Designed ergonomic structure of a wearable SRL including two 3-DOF robotic arms and grippers which provides two additional arms to increase the range of motor skills available to the user
- Developed motion planning algorithms for three control systems: (1) Voice command based on inverse kinematics solution; (2) Angle-displacement mapping form controller's minor angle change to real motion; (3) Teleoperation

2018.05-2018.12 **China VEX Robotics Competition (VEX U Group)**, Core member

- Designed the whole mechanical structure of a robot including drivetrain, four-bar linkage and object manipulator
- Initiated an autonomous driving program which allows the robot to accurately record and automatically reproduce any movement under previous manual control; finished collecting and ejecting balls, lifting caps and climbing steps in 45s

EXTRACURRICULAR ACTIVITIES

2019.01-2020.01 **Tooling Intelligent (Start-up),** *Strategy Director, Start-up team, Shanghai*

- Developed the business plan, promoting the startup to establish and obtain investment intention
- Formulated marketing strategies for company development, prominent in National College students' start-up plan

2017.03-2018.03 **Baiyan Poetry Society,** *President, SJTU*

- Compiled and published the first modern poetry collection in SJTU: 'The Intention of the Camphor Tree: Selected Poems of Baiyan Poetry Society (2010-2017), Josue Press', which became the university's representative original work
- Produced and starred a pioneering experimental poetic movie 'Camphor Rhapsody', attracting 10k+ views
- Ran the 'Poetry Society Revitalization Plan' and organized weekly activities including Anonymous Poetry Criticism's Night, Poetry Movie's Night and Christmas Eve Poetry Reading, facing over one thousand students

SELECTED HONORS & AWARDS

2017.10 • National Scholarship (**Top 0.2%** nationwide)
2020.07 • Graduation with honor: College Graduate Excellence Award of Shanghai (**Top 5%**)
2019.10 • Overseas Research Scholarship Class A (**Top 10** in SJTU)
2019.08 • Golden Prize in "Internet+" Innovation and Entrepreneurship competition (**Top 1%** nationwide)
2018.10 • Bronze Medal of 2018 China VEX Robotics Competition VEX U Group (**Rank 3rd**)
2018.10 • Kwang-Hua Scholarship (**Top 5%** in SJTU)
2018.04 • Meritorious Winner in Mathematical Contest in Modeling 2018 (**Top 10%** worldwide)

SKILLS

- **Programming:** C++ (Qt, VTK), Python, MATLAB(Simulink)
- **Technical:** ROS, SolidWorks, UG, ABAQUS, ANSYS, Arduino, LaTeX, Origin, LabVIEW, Blender