Siyuan (Sylvester) Zhang

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Education

Columbia University August 2024 ~ Jun 2026(Expected)
MS in Mechanical Engineering (Robotics and Control), *Department of Mechanical Engineering*

- **Advanced Master Research Program**, Advisor: Prof. Hod Lipson

Sun Yat-sen University August 2020 ~ Jun 2024
BE in Aeronautical and Astronautical Engineering, *School of Aeronautics and Astronautics*

Research Interest

Self-Reproducing Robot, Rehabilitation Exoskeleton, Soft Robotics, Bio-Inspired System, Robotic Material, Modular Robotics

Publication

- Zhang, S., Lipson, H. (2025). Helical Genesis: An Intelligent Self-Reproducing Robot Evolving from 2-D lattices into 3-D DNA-Inspired Architectures. *Manuscript in Preparation.*
- Zhang, S., Zhang, Y., Lyu, J., & Agrawal, S. K. (2025). From Structural Design to Dynamics Modeling: Control-Oriented Development of a 3-RRR Parallel Ankle Rehabilitation Robot. *Manuscript in Preparation.*
- Zhao, Y., Zhu, J., Zhang, J., Zhang, S., Shao, M., Chai, Z., ... & Zhang, J. (2025). Enhancing Grasping Diversity with a Pinch-Suction and Soft-Rigid Hybrid Multimodal Gripper. ***IEEE Transactions on Robotics***.
- Ma, K., Zhang, J., Sun, R., Chang, B., Zhang, S., Wang, X., ... & Zhang, J. (2024). Synergizing Structural Stiffness Regulation with Compliance Contact Stiffness: Bioinspired Soft Stimuli-Responsive Materials Design for Soft Machines. ***Advanced Engineering Materials***, *26*(10), 2400461.
- Zhao, Y., Zhang, J., Zhang, S., Zhang, P., Dong, G., Wu, J., & Zhang, J. (2023). Transporting dispersed cylindrical granules: An intelligent strategy inspired by an elephant trunk. ***Advanced Intelligent Systems***, *5*(10), 2300182.

Research Experience

Design of An Intelligent Self-Reproducing Robot Jan 2025 ~ Present
Advisor: Hod Lipson *Columbia University*

- Designing DNA-inspired modular self-replicating robots, enabling 3D–2D folding via magnetic coupling and 6-DOF actuation.
- Implemented a six-stage pipeline from concept to prototype for scalable, autonomous robotic swarms with reinforcement learning.

Development of a 3-RRR Parallel Ankle Rehabilitation Robot Jan 2025 ~ Present
Advisor: Sunil K. Agrawal *Columbia University*

- Developing a wearable 3-RRR parallel mechanism to improve portability and motion freedom in ankle rehabilitation robot compared with traditional design.
- Designed and simulated inverse kinematics and Jacobian-based control, enabling precise motion tracking for multi-axis ankle support.
- Integrating therapist-inspired assistance/resistance modes, currently under validation for customizable rehabilitation strategies.

Pinch-Suction and Soft-Rigid Hybrid Multimodal Gripper Apr 2023 ~ Apr 2024
Advisor: Prof. Jianing Wu, Prof. Jinxiu Zhang *Sun Yat-sen University*

- Designed a soft-rigid hybrid gripper with multiple manipulation modes, enabling effective handling of objects of varying sizes and weights to address the limited adaptability of conventional grippers.
- Integrated gripping and suction mechanisms to increase stability and controllability during object manipulation.
- Enabled grasping diversity across weight (0.2 g–10 kg), fragility (jelly to aluminum), scale (0.46 mm–0.55 m), and shape (poorly pinchable/sackable), outperforming conventional grippers.

Bioinspired Stiffness-Regulating Materials for Soft Machines Jun 2023 ~ Jan 2024
Advisor: Prof. Jianing Wu, Prof. Jinxiu Zhang *Sun Yat-sen University*

- Developed elastomer-SMA composite structures with Joule-heat stiffness regulation to address the compliance-load trade-off in soft robotics.
- Characterized dynamic stress-strain responses and rapid stiffness switching through systematic material testing.
- Applied the material to adaptive grippers and wearable prototypes, enabling enhanced load bearing and versatility.

Elephant Trunk Inspired Soft Gripper May 2022 ~ Jun 2023

Advisor: Prof. Jianing Wu, Prof. Jinxiu Zhang *Sun Yat-sen University*

- Proposed and prototyped a pneumatic gripper inspired by elephant trunk mechanics to tackle the challenge of manipulating irregular and granular object.
- Optimized actuation pressures and deformation profiles through ANSYS and SOLIDWORKS simulations.
- Achieved >90% grasp success rate and 50% faster operation time compared to baseline grippers in experimental validation.

Project experience

Design and Gait Optimization of a Quadruped Spider Robot for Robotics Studio Sep 2024 ~ Dec 2024

Advisor: Prof. Hod Lipson *Columbia University*

- Designed a 4-legged robotic system with 2 DOF per leg, powered by 8 servomotors (240° range) and controlled via a Raspberry Pi. Created a parametric CAD model in SOLIDWORKS, converted it to a URDF file, and optimized the robot's gait using PyBullet simulations and parallel hill climber algorithms.
- Implemented control algorithms in Python to actuate servos, enabling sim-to-real to optimize walking patterns.
- Built and tested the prototype operating 3D printing for rapid iterations, attaining a final walking speed of 29 cm/s.

Design of a Bionic Flapping-Wing Robot Inspired by Birds Sep 2022 ~ Dec 2023

Advisor: Prof. Zhenbo Lu *Sun Yat-sen University*

- Developed a lightweight, foldable, and low-noise flapping-wing robot inspired by small birds, integrating principles of bionics.
- Devised and simulated the mechanical model using SOLIDWORKS and ANSYS, modifying structural performance and aerodynamics.
- Implemented a closed-loop control system to achieve stable and controlled flight.

Design of a Foldable, Adhesive Crawling CubeSat for Space Station Operations Mar 2022 ~ Aug 2023

Advisor: Prof. Jinxiu Zhang, Jianing Wu *Sun Yat-sen University*

- Led a team of 5 in designing a spider-inspired CubeSat with foldable claws, mechanical legs, and detection modules for surface inspection, debris removal, and damage repair.
- Optimized mechanical structure through SOLIDWORKS and explored electrostatic adsorption for secure attachment in space environments.
- Attained 3rd prize in the IAF-CSA Space Universities CubeSat Challenge 2.0 for innovative design and engineering solutions.

Teaching Experience

Graduate Teaching Assistant | Columbia University: Robotics Studio | Advisor: Hod Lipson 2025 Spring

- Contributed to robotics teaching and curriculum development, integrating python algorithm/ embedded systems to support 30+ students in hands-on robotic projects across undergraduate and graduate levels.

Professional Experience

Insta360 Jan 2024 ~ Mar 2024

Structural Design Engineer Intern

- Conducted requirements analysis to translate product specifications into feasible structural designs, ensuring functionality, manufacturability, and cost-effectiveness.
- Constructed and finalized detailed 3D models and mechanical drawings operating Creo.
- Collaborated on prototyping and testing of product structures, improving design iterations and efficiency.

Sun Yat-sen University | Aeromodelling Club Mar 2022 ~ Sep 2022

Mechanical & Aerodynamic Engineer

- Created and improved aerodynamic models for enhanced flight performance using principles of fluid mechanics and material engineering.
- Built and tested prototypes, improve structural stability and reduce performance inefficiencies through iterative development.
- Cooperated with a team to complete projects and participate in competitions, ensuring effective collaboration and technical execution.

Technical Skills

- Programming: Python, C, MATLAB, C++, ROS, Linux, Arduino IDE
- Software: Auto CAD, MATLAB, ANSYS, SOLIDWORKS, PTC Creo, CATIA, NX CAD
- Engineering Techniques: FEA, DFM, DFA, FA, DOE, GD&T
- Manufacturing Techniques: FDM 3D Printing, Stereolithography (SLA), Laser Cutting, CNC Machining