Tianyi Bi

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Academic Background

Southern University of Science and Technology (SUSTech) 09/2023-Present
Bachelor of Engineering in Robotics Expected in 06/2027

Publications

Jiaqi Yin, **Tianyi Bi**, Wenzeng Zhang*, "SPARK Hand: Scooping-Pinching Adaptive Robotic Hand with Kempe Mechanism for Vertical Passive Grasp in Environmental Constraints", ***2025 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2025) [Hangzhou, China]***.

10.1109/IROS60139.2025.11246150

Research Experience

Manipulation with Visuo-Tactile Sensing: UniVTAC Framework Simulation and Multi-Modal Data Pipeline Validation
Advisor: Prof. Hong Zhang SUSTech 11/2025-04/2026

- ✓ **Innovation point:** Deployed and trained the UniVTAC visuo-tactile manipulation framework in a dual parallel gripper simulation environment, built an end-to-end multi-modal data processing pipeline, designed a task-phase-aware dynamic attention routing mechanism, and completed policy training with **quantified simulation success rate validation** for contact-rich manipulation tasks.
- ✓ **Completed Work:**
  1. **Attention Router**: Implemented phase-aware **dynamic weight allocation** (approach / contact / manipulation) to adaptively fuse vision and tactile modalities.
  2. **Validation:** Achieved ~94% simulation success rate on specific task via modality ablation studies; analyzed convergence curves.
  3. **Survey**: Reviewed VLA architectures (**Lingbot-VA, WAM**) and video world models for temporal modeling; deep exploration terminated due to direction adjustment (dexterous hand migration not pursued).

SPARK Hand: Scooping-Pinching Adaptive Robotic Hand with Kempe Mechanism for Vertical Passive Grasp in Environmental Constraints **Shenzhen, China**
Advisor: Prof. Wenzeng Zhang in X-institute, Tsinghua University 10/2024-05/2025

- ✓ **Innovation point:** Developed an **underactuated** morphologically intelligent robotics finger that leverages **kinematic constraints** to acieve passive mode-switching between pinching and scooping, significantly reducing the computational complexity of grasping policies in contact rich environments.
- ✓ **Workload:**
  1. **Kinematic Synthesis & Trajectory Planning**: Conducted analytical forward/inverse kinematics for a multi-link Kempe mechanism to synthesize a strict vertical linear fingertip trajectory, providing a deterministic geometric prior for high-precision tactile interactions.
  2. **Task-Space Constraint Design**: Utilized a parallelogram linkage to ensure **constant end-effector orientation**; performed Jacobian analysis to verify the mechanical advantage and **force transmission efficiency** during surface-contact manipulation.
- ✓ **Results:** Published the results on ***2025 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2025) [Hangzhou, China].***

Tactile-UMI: Multi-Modal Handheld Tactile Gripper with Force Feedback **Shenzhen, China**
Advisor: Prof. Haoang Li, HKUST(GZ) 04/2026-Present

- ✓ **Project Objective:** Designed an integrated handheld tactile interaction device combining **VR spatial positioning, servo motor actuation, force-feedback control, and multi-modal perception.** providing a hardware foundation for remote robotic fine manipulation and addressing the pain points of traditional grippers lacking tactile feedback and poor **human-machine interaction**.

- ✓ **Completed Progress:**
  1. Led 3 core prototype iterations (Damiao v2.3.2 → Lingzu v3.0 → Odin Radar integrated); resolved initial inconsistent gripper jaw defect and motor-handheld angular misalignment bug.
  2. Completed full system integration of VR positioning, servo drive, 5-channel tactile sensors and visual camera; temporarily fixed 1.4-6.4 gripper position mapping.
- ✓ **Future Roadmap:** Implement VR trigger-based force feedback control,and will complete new PCB adaptation and full functional validation of all 5-channel tactile sensors, Establish hardware monitoring for stable unstructured-environment operation

Competition Experience

The 2025 ASME Student Mechanism & Robot Design Competition (ASME SMRDC 2025) **Anaheim, CA, USA**

Position: Group Member / Advisor: Prof. Wenzeng Zhang, Tsinghua University 17/08/2025-20/08/2025

- ✓ **Workload:**
- ✓ Led R&D of 6 classic mechanism-based innovative gripper prototypes, cracked the core challenge of **grasping ultra-thin objects** on smooth planes to simplify complex grasping; achieved stable closed-loop grasping across environments via kinematic optimization, integrated **passive compliance** & rotation mechanisms to drastically improve motion robustness, and expanded possibilities for future fine manipulation in unstructured scenarios**.**
- ✓ **Results:**
  1. Awarded **1st Place (Global Champion)** in the Undergraduate Track of the 2025 ASME Student Mechanism and Robot Design Competition.

2025 ABU-Robocon: Design of Robot for Basketball Match **Shenzhen, China**

Position: Group Member / Advisor: Prof. Chenglong Fu, Prof. Wende Ke, SUSTech 10/2024-Present

- ✓ **Innovation point:** to address the stability problem of shooting launch through engineering and mechanism optimization in a robotic team project.
- ✓ **Workload:**
  1. Designed two schemes, namely conveyor belt and pushing launch, for basketball throwing.
  2. Cooperated with the Embedded Systems Team to determine the placement of LiDAR sensors and batteries, as well as the wiring layout.
  3. Tested Dispersion Landing Points and Improving Shooting Hit Rate Solutions.
- ✓ **Results:**
  1. Second Prize in the National Finals of Robocon Competition.
  2. First Prize in the National Skills Challenge Competition.

2026 RoboMaster University Championship (RMUC) **Shenzhen, China**

Position: Group Member 10/2025-Present

- ✓ **In-Progress Work:**
- ✓ Optimized the engineering robot's forward motion sequence and lightweight design of its spherical wrist, upper arm and forearm to enhance motion flexibility and load efficiency for high-intensity competition; Independently designed the gripper end effector's transmission scheme and mechanical structure per the season's new rules, optimizing drive motor selection and parameter matching to ensure gripping accuracy and response speed

CUMCM: Modeling and Analysis of the Laws of Motion of the Bench Dragon Based on Physical Models

Position: Team Leader / Advisor: Department of Mathematics, SUSTech 05/09/2024-08/09/2024

Developed a 2D rigid-body mathematical model in **MATLAB** to analyze bench dragon motion. By applying coordinate transformations and differential equations, I optimized turnaround paths and established safety protocols, including collision detection and maximum speed limits, to enhance the activity's spectacle and security. Finally earn the **Provincial Third Prize** in China Undergraduate Mathematical Contest in Modeling (CUMCU).