Chunxiang Wang

Ph.D. student in robotics ETH Zürich; MPI-IS.	Webpage: https://wchunxiang.github.io/ Email: wchunxiang@student.ethz.ch

RESEARCH INTERESTS & SKILLS

Soft Robotics	Computer Vision	Robotic Control
- Design (material, structure…)	- Medical imaging (X-ray, Ultrasound, photo-acoustic)	- Robotic systems (Closed-loop control integrating medical imaging with robotic arm manipulation)
- Fabrication (3D printing, molding, micromanipulation…)	- Object tracking (detection, segmentation, tracking)	- Optimal filtering (e.g. Adaptive Kalman Filter, Particle Filter.)
- Mechanical model (dynamics…)	- Image processing	- Path planning
- Magnetic actuation (electromagnet, permanent magnet…)	- Generative models (Diffusion model, VAE)	- Robotic micromanipulation

EDUCATION

- Ph.D. in Information Technology and Electrical Engineering, 2021.09 – 2025.10.
Department of Information Technology and Electrical Engineering, **ETH Zürich**, Zürich, Switzerland.
Department of Physical Intelligence, Max Planck Institute for Intelligent Systems (**MPI-IS**), Stuttgart, Germany.
Advisor: Prof. **Metin Sitti** (NAE Member, USA).

- M.Sc. in Control Science and Engineering, September 2019 – June 2021.
School of Astronautics, Harbin Institute of Technology (**HIT**), Harbin, China.
Advisor: Prof. **Huijun Gao** (NSFDYS Recipient, China).
IELTS: 7.5/9.0.

- B.Eng. in Automation, September 2015 – June 2019.
School of Astronautics, Harbin Institute of Technology (**HIT**), Harbin, China.
Advisor: Prof. **Huijun Gao** (NSFDYS Recipient, China).
GPA: 93.75/100.

PUBLICATIONS

- Wang, Chunxiang, et al. "Heterogeneous multiple soft millirobots in three-dimensional lumens." *Science Advances* 10.45 (2024): eadq1951. (*featured article*)

- Wang, Chunxiang, et al. "In situ sensing physiological properties of biological tissues using wireless miniature soft robots." *Science advances* 9.23 (2023): eadg3988.

- Wang, Chunxiang, et al. " MicroSyn-X: Synthetic data-driven tracking and robotic deployment of miniature medical devices via X-ray imaging." *Nature Machine Intelligence* (2025): under submission.

- Wang, Chunxiang, et al. "Synthetic data-assisted millirobotic navigation via ultrasound imaging." *IEEE/ASME Transactions on Mechatronics* (2024): Accept.

- Wang, Chunxiang, et al. "Daniosense: automated high-throughput quantification of zebrafish larvae group movement." *IEEE Transactions on Automation Science and Engineering* 19.2 (2021): 1058-1069.

- Hong, Chong, et al. "Wireless flow-powered miniature robot capable of traversing tubular structures." *Science Robotics* 9.88 (2024): eadi5155.

- Sun, Mengmeng, et al. "Versatile, modular, and customizable magnetic solid-droplet systems." *Proceedings of the National Academy of Sciences* 121.32 (2024): e2405095121.

- Wu, Yingdan, et al. "Wireless soft millirobots for climbing three-dimensional surfaces in confined spaces." *Science Advances* 8.21 (2022): eabn3431.

- Zhang, Gefei, et al. "Visual-based contact detection for automated zebrafish larva heart microinjection." *IEEE Transactions on Automation Science and Engineering* 18.4 (2020): 1803-1813.

- Zhuang, Songlin, et al. Robotic Micromanipulation of Zebrafish Larva. Springer Nature Switzerland, 2023.

Peer Reviewer

IEEE/ASME Transactions on Mechatronics (T-Mech), IEEE Transactions on Cybernetics, IEEE International Conference on Robotics and Automation (ICRA), and Research.

Projects

1. Robotic deployment of miniature medical devices via X-ray imaging (July, 2024 - June, 2025)
Challenges: Deploying miniature medical devices (MMDs) is difficult due to low-quality X-ray imaging, occlusion, and labor-intensive manual control.
Current gaps: Lack of X-ray MMD data and automated robotic system for MMD deployment in complex anatomical environments.
Contributions: Developed the first framework to generate synthetic labeled X-ray MMD data, learning-based algorithms to localize millimeter-scale robots, real-time robotic control of MMDs (robotic arm and C-arm fluoroscopy), and released the first X-ray MMD dataset.

2. Multi-magnetic millirobots control in 3D spaces (Dec., 2022 – May, 2024)
Challenges: Controlling multiple magnetic miniature robots in 3D, fluid-filled anatomical environments is challenging due to global magnetic field effects and complex environmental interactions.
Current gaps: Existing control methods are limited to 2D or static settings, rely on precise fabrication or complex setups, and cannot independently control many robots under physiological conditions.
Contributions: Developed a shape-adaptive multirobot control framework leveraging resistance heterogeneity and magnetic field planning, enabling independent navigation of over 5 soft robots in complex 3D lumen networks with pulsatile flow for multi-site medical interventions.

3. Miniature medical robot navigation via ultrasound imaging (Sep., 2022 - June, 2024)
Challenges: Wireless miniature robots are difficult to track and navigate in noisy, low-contrast ultrasound images, and manual probe adjustments are labor-intensive.
Current gaps: Existing methods lack robustness in realistic anatomical environments and suffer from data scarcity.
Contributions: Developed a real-time ultrasound-based navigation framework using synthetic data to train detection models and a dual-robotic arm system for automated ultrasound tracking.

4. Soft robot for sensing tissue properties (Sept., 2021 – Nov., 2022)
Challenges: Sensing deep-tissue physiological properties (adhesion, pH, viscoelasticity) is crucial for understanding development and disease progression but is technically difficult due to limited access and resolution.

Current gaps: Medical imaging and flexible sensors either have shallow sensing depth, low signal-to-noise ratio, or require invasive procedures; robotic capsules are bulky and limited in navigating tight or collapsed tissue regions.
Contributions: Developed a magnetic, wireless, millimeter-scale soft robot system (electromagnetic coils and robots with functional patches) integrated with ultrasound/X-ray imaging to noninvasively sense deep-tissue properties. Given magnetic signals and extracted robot shapes, mechanical model and optimization-based solvers are utilized to estimate adhesion and viscoelasticity at high precision.

5. Robust multi-object tracking in crowded and occluded scenes (Dec., 2018 – July, 2020)
Challenges: Tracking larval zebrafish in groups is critical for genetics, drug discovery, and behavior research, but remains difficult due to small size, transparency, similar appearance, frequent occlusions, and discontinuous swimming kinematics.
Current gaps: Existing adult fish trackers fail on larvae due to frequent identity switches and visual similarity. Real-time tracking is hindered by computational cost (e.g., idTracker.ai) or poor occlusion handling (e.g., ZebraZoom). Motion discontinuity and transparency break appearance- and motion-based approach to tackle occlusions.
Contributions: Developed DanioSense, a lightweight, real-time, high-accuracy (>97%) larval tracking system using a pretrained CNN and centerline extraction for occlusion resolution, an adaptive Kalman filter for handling abrupt movements, and enriched vector outputs for detailed behavioral statistics, all capable of online use and generalizable to other fish-like animals.

6. Micromanipulation system for zebrafish larvae (Sept., 2018 – July, 2021)
Challenges: Automated micro-injection in zebrafish larvae is difficult due to the need for variable magnification, the nearly invisible glass pipette tip, complex skin textures, and the 3D structure of the heart. Existing visual systems struggle with accurate targeting and reliable tracking under these conditions. Manual injection remains common but is labor-intensive and inconsistent.
Current gaps: Most prior work focuses on embryos or cells, with little progress on automating heart injection in larvae. No current systems effectively handle dynamic focusing, robust pipette tracking, or precise 3D heart localization. These limitations hinder scalability in biomedical research using zebrafish larvae.
Contributions: Participated in developing a visual-based system for automated larval heart injection. Key methods include fast coarse-to-fine auto-focusing, dynamic ROI-based pipette tracking, non-invasive object capture, and a two-stage in-plane and out-of-plane heart detection strategy.

For more information, please refer to papers and the webpage (https://wchunxiang.github.io/projects/).

Awards & Honors

- **Max Planck Fellowship**. 2021. Max Planck Society, Germany.
- **Best Graduation Thesis.** 2021. Postgraduate School of HIT (Top 1% within HIT)
- **Outstanding Undergraduate Award.** 2021. Postgraduate School of HIT (Top 10% within HIT)
- **First-class Postgraduate Scholarship.** 2020. Postgraduate School of HIT (Top 10% within HIT)
- **First-class Special Scholarship.** 2019. Postgraduate School of HIT (Top 2% within HIT)
- **Best Graduation Thesis.** 2019. Undergraduate School of HIT (Top 2% within HIT)
- **Outstanding Undergraduate Award.** 2019. Undergraduate School of HIT (Top 10% within HIT)

- Second prize of National University Student Social Practice and Science Contest on Energy saving and Emission Reduction. 2018. Ministry of Education of the People's Republic of China

- National Encouragement Scholarship. 2018.
Ministry of Education of the People's Republic of China (Top 10% within HIT)

- National Special Scholarship. 2017.
Ministry of Education of the People's Republic of China (Top 10% within HIT)

- Best Learner Award. 2016. Undergraduate School of HIT (Top 1% within HIT).
The award is bestowed upon the student who achieves the highest GPA within their corresponding school.

- First Class of People's Scholarship. 2015, 2019. Undergraduate School of HIT (Top 3% within HIT)