Shuzhe Zhang

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Education

Northwestern University — Evanston, IL
M.S. in Electrical Engineering · GPA 3.93/4.00 · Advisor: Sam Kriegman — *Sept 2025 – Present*

Dalian Maritime University — Dalian, China
B.S. in Electronic Information Engineering · GPA 4.01/5.00 — *Sept 2021 – Aug 2025*

Publications

S. Zhang, X. Zhu, Y. Qian, Q. Wang. "S^2-HWM: Sparse Event-Structured Hierarchical World Model for Long-Horizon Surgical Robot Manipulation." Under review at AAAI 2027. Poster at the ELSR Workshop, IEEE/RSJ IROS 2026. arXiv:2608.13103.

Z. Guo, M. Li, **S. Zhang**, S. Kriegman. "Creating Manufacturable Blueprints for Coarse-Grained Virtual Robots." Under review at ICRA 2027. Poster at the Co-Design Workshop, IEEE/RSJ IROS 2026. arXiv:2603.13582.

Z. Guo*, **S. Zhang***, B. Li, M. Li, S. Kriegman. "Evolving Dexterous Robots from Scratch." In preparation, targeting ICLR 2027. (*equal contribution)

H. Deng, **S. Zhang**, X. Wang, T. Han, Y. Ye. "USD-YOLO: An Enhanced YOLO Algorithm for Small Object Detection in Unmanned Systems Perception." *Applied Sciences* 15(7):3795, 2025. DOI.

Research Experience

Xenobot Lab, Northwestern University — Evanston, IL
Research Assistant · Advisor: Sam Kriegman — *Dec 2025 – Present*

Dexterous Manipulator Co-Design

A learned latent design space lets dexterous manipulator morphologies be evolved from scratch.

- Proposed SPaCE, a spherical-projection autoencoder that embeds manipulator morphologies on a unit hypersphere and trains the embedding with contrastive learning, yielding a smooth latent space in which morphologies can be evolved directly.
- Designed a deliberately simple, highly diverse voxel-based design space—a palm with grown appendages—and used it to generate two million manipulators for training the latent model.
- Implemented the co-design pipeline end to end: generation, simulation training in Isaac Lab, fabrication on Dynamixel servos, and fine-tuning on the physical hand—closing the loop from design to real-world manipulation.

Related publication: *Evolving Dexterous Robots from Scratch*

Sim-to-Real Robot Fabrication

A four-stage pipeline converts evolved virtual robots into manufacturable, assembly-ready blueprints.

- Contributed to a four-stage pipeline that turns coarse-grained virtual robots—evolved in a latent design space, or hand-drawn as voxel "sketches"—into assembly-ready blueprints without manual CAD redesign.
- The pipeline converts rigid and soft voxels into meshes, then resolves manufacturing constraints one solver at a time—motor placement along each joint axis, cavities for the controller and battery, and geodesic wire tunnels through the body—before exporting multi-material 3D-printing files.
- Across 1,000 randomly sampled designs, 67% passed every solver stage; an evolved tripedal design was printed, assembled, and walked under its simulation-trained policy with zero-shot transfer.

Related publication: *Creating Manufacturable Blueprints for Coarse-Grained Virtual Robots*

Assistive & Rehabilitation Robotics Lab (argallab), Northwestern University & Shirley Ryan AbilityLab — Chicago, IL

Research Assistant · Advisor: Brenna Argall — *Sept – Dec 2025*

Shared-Control Evaluation for Powered Wheelchairs

User studies evaluate a shared-control driving-assistance system on a LUCI-equipped powered wheelchair.

- Administered the sessions of an IRB-approved user study of REACT, a shared-control assistance algorithm on a LUCI-equipped powered wheelchair: set up the driving course, brought up the system, monitored participant safety, and logged sensor streams, collisions, task times, and questionnaires across multiple driving tasks and control interfaces.
- Maintained and debugged the wheelchair's ROS 2 stack—sensing, control, and data logging—keeping it reliable across sessions.

HCI Lab, Shenzhen Institutes of Advanced Technology, CAS — Shenzhen, China

Research Intern · Advisor: Yinling Qian — *Dec 2024 – Present*

World Model for Surgical Manipulation

A hierarchical world model learns a few discrete task events from latent dynamics without hand-specified stages, and plans sparse-reward, long-horizon surgical manipulation over them rather than primitive steps.

- Long-horizon surgical manipulation gives sparse rewards and interaction changes at irregular moments, structure that step-by-step world-model imagination leaves implicit and hand-specified task stages fail to align with; learned a small set of event boundaries directly from the latent state trajectory, with no stage labels, and made them the unit of high-level planning.
- The events serve two roles: an event-level manager updates its latent goal only when an event fires while a primitive-step worker acts under that goal, and the events cut trajectories into variable-duration segments on which a transition model predicts the next boundary state, duration, and accumulated reward; chaining these predictions gives the manager a value target beyond the primitive imagination horizon.
- Raised success on a long-horizon surgical manipulation task from 76.0% with flat DreamerV3 to 98.7%, a 22.7-point gain, and held 88.0% vs. 65.3% when the object is dropped mid-task.

Related publication: *S^2-HWM: Sparse Event-Structured Hierarchical World Model for Long-Horizon Surgical Robot Manipulation*

Bone Tumor Osteotomy Planning

Constraint-aware deep learning automates pelvic bone-tumor resection planning with guaranteed margins.

- Existing automated osteotomy planners either optimize geometry alone, blind to anatomy and surgical access, or learn to regress cutting planes with no guarantee that they clear the tumor; combined learned anatomical priors with a hard, analytically enforced safety margin so that every proposed plane is guaranteed tumor-safe.
- A PointNet++-style network extracts per-point anatomical and tumor-proximity priors from CT point clouds; a teacher–student model distills them into planning cues (contact, peeling, invasion direction); a planner then samples candidate planes, translates each analytically to the required margin, and ranks the safe set by bone-block, sacroiliac-joint, and surgical-approach feasibility.
- On 20 clinical pelvic osteosarcoma cases, achieved 100% target-margin coverage on the recommended planes versus 93.3% for geometry-only ranking, and raised the minimum margin from 62.8 mm to 98.0 mm while preserving sacroiliac-joint clearance.

Honors & Awards

- Outstanding Student Scholarship, Dalian Maritime University
- Dean's List, Dalian Maritime University

Technical Skills

Languages: Python, C/C++, MATLAB
Tools: PyTorch, ROS / ROS 2, Isaac Sim / Isaac Lab / Isaac Gym, MuJoCo, PyBullet, 3D Slicer