Haoyu Shen

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Education

- **Boston University** Expected Aug 2026 – May 2031
  Ph.D. in Systems Engineering *Boston, MA*
- **Carnegie Mellon University** Aug 2023 – May 2025
  Master of Science in Mechanical Engineering – Research; GPA: 3.94/4.00 *Pittsburgh, PA*
  - **Coursework:** Advanced Robotics, Computer Vision, Machine Learning, Robot Autonomy, Optimal Control
- **Southern University of Science and Technology** Aug 2019 – June 2023
  Bachelor of Engineering in Robotics Engineering; GPA: 3.77/4.00 *Shenzhen, China*
  - **Coursework:** Robotics, Artificial Intelligence, Control Theory, Mechanical Design, Mathematical Logic

Publications

- **LV-DOT: LiDAR-visual dynamic obstacle detection and tracking for autonomous robot navigation** [pdf] 2025
  Zhefan Xu*, Haoyu Shen*, Xinming Han, Hanyu Jin, Kanlong Ye, Kenji Shimada
  *Submitted to IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**) 2026.*
- **NavRL: Learning Safe Flight in Dynamic Environments** [pdf] 2025
  Zhefan Xu, Xinming Han, Haoyu Shen, Hanyu Jin, Kenji Shimada
  *IEEE Robotics and Automation Letters (**RA-L**) 2025.*
- **Intent Prediction-Driven Model Predictive Control for UAV Planning and Navigation in Dynamic Environments** [pdf] 2025
  Zhefan Xu*, Hanyu Jin*, Xinming Han, Haoyu Shen, and Kenji Shimada
  *IEEE Robotics and Automation Letters (**RA-L**) 2025.*

Technical Skills

- **Languages:** C/C++, Python, Shell, Java, Julia, Matlab, CUDA, LaTeX
- **Robotics:** SLAM, Robot Kinematics & Dynamics, Path Planning, BLDC Motor Motion Control
- **ML Frameworks & Libraries:** OpenCV, NumPy, Scikit-Learn, PyTorch, TensorFlow, Issac Gym
- **Technologies & Tools:** Ubuntu, ROS & ROS2, Git, Docker, Jupyter, WSL, Vim
- **Mechanical Design & Manufacture:** CAD, SolidWorks, 3D Printing, Laser Cutting, CNC Machining

Experience

- **Zhejiang University** | *FAST Lab* Feb 2026 – Present
  Research Assistant – Advisor: Prof. Fei Gao *Hangzhou, China*
  - **Communication-Denied Navigation:** Developing decentralized coordination algorithms for drone swarms to maintain robust flight and formation in communication-denied and GPS-denied environments.
  - **LiDAR-based Perception:** Implementing high-efficiency, LiDAR-only perception pipelines for real-time obstacle avoidance and swarm state estimation in complex, unstructured spaces.
- **CMU CERLAB** | *UAV Group* Oct 2023 – Feb 2026
  Research Assistant – Advisor: Prof. Kenji Shimada *Pittsburgh, PA*
  - **LV-DOT Framework:** Developed a multimodal perception framework utilizing ensemble strategies and Kalman Filters for dynamic obstacle tracking. Deployed on **NVIDIA Jetson Orin NX** for custom UAVs and **Unitree Go2** robots.
  - **Full-Stack Field Test:** Designed a **2.0kg** 3D LiDAR quadrotor with stable **30Hz** LIO localization. Validated system robustness during a **tunnel inspection field test** in Japan, benchmarking against SOTA baselines.
  - **Cross-Platform Migration:** Migrated the entire navigation pipeline from **ROS1 to ROS2**, ensuring high-performance real-time execution on limited computational edge devices.
- **ARES (Association of Robotic Engineers at SUSTech)** Feb 2020 – Aug 2022
  Team Leader & Mechanical Engineer – Advisor: Prof. Yiming Rong *Shenzhen, China*
  - **Robot R&D Leadership:** Led a multidisciplinary team for National **ROBOCON**. Managed full-cycle R&D for high-mobility quadruped robots and defense platforms with topology-optimized structures.
  - **Control Vision:** Implemented **FOC** for BLDC motors and developed adaptive white balance algorithms to enhance the robustness of autonomous target recognition in varied lighting environments.

Projects

- **3D Vision Rendering (CMU 16-825)**| *PyTorch, CUDA* Jan 2025 – May 2025
  Software Engineer – Advisor: Prof. Shubham Tulsiani *Pittsburgh, PA*
  - **3D View Generation:** Generated textured, multi-angle 3D views from object models using **PyTorch3D**.
  - **Neural Rendering:** Developed a differentiable pipeline implementing neural volume/surface rendering (**NeRF**, **VolSDF**) for improved visualization.
  - **Gaussian Splatting & Diffusion:** Integrated a 3D Gaussian splatting pipeline with SDS-based diffusion optimization to refine image and mesh quality in custom scenes.
  - **Point Cloud Processing:** Built a **PointNet**-based model for efficient point cloud classification and segmentation with enhanced local feature integration.
- **Autonomous Obstacle Avoidance UAV (CMU 16-745)** | *MPC, OSQP* Jan 2024 – May 2024
  Software Engineer – Advisor: Prof. Zachary Manchester *Pittsburgh, PA*
  - **MPC Formulation:** Minimized the reference tracking error and control effort, subject to quadrotor state, dynamic constraint, and obstacle constraint.
  - **Cost Optimization:** Applied the ellipsoid obstacle constraint for distance calculation and decreased the computational cost.
- **Vision-based Human-Computer Interaction Game (CMU 24-678)** | *Python* Sep 2023 – Dec 2023
  Software Engineer – Advisor: Prof. Kenji Shimada *Pittsburgh, PA*
  - **Object Recognition:** Implemented and deployed a learning-based hand gesture recognition algorithm on Intel RealSense **D435**, integrated with a real-time interactive video game GUI.
- **Battlecity Remastered (CMU 24-780)** | *C++, OpenGL* Sep 2023 – Dec 2023
  Software Engineer – Advisor: Dr. Soji Yamakawa *Pittsburgh, PA*
  - **Software Development:** Built 4 kinds of tank modules with accessible interfaces and various features based on **C++** and **OpenGL**.
- **Vehicle Control in Simulation (CMU 24-677)** | *Python, Webots* Sep 2023 – Dec 2023
  Software Engineer – Advisor: Prof. Ding Zhao *Pittsburgh, PA*
  - **Modern Control:** Designed a discrete-time infinite-horizon **LQR** controller to guide a vehicle in tracking a loop trajectory, achieving a maximum tracking error of **6.59m** and an average tracking error of **0.44m**.
- **Undergraduate Capstone: Unmanned Surface Vehicle** | *Design, ROS, LiDAR* Dec 2022 – Jun 2023
  Full Stack Engineer – Advisor: Prof. Wende Ke *Shenzhen, China*
  - **Systems Development:** Built an independently designed dual-propeller differential-driven USV platform (**1m** length, **0.48m** width, **0.14m** hull depth) which is versatile, highly extensible, based on **ROS2 Humble** and achieved a stable cruising speed goal of 1m/s.

Teaching Experience

- **Computer Vision for Engineers (CMU 24-678)** Sep 2024 – Dec 2024
  Course Assistant *Pittsburgh, PA*
  - Conducted weekly office hours, providing support in computer vision concepts and Python coding.
  - Reviewed and graded computer vision assignments and quizzes.
  - Reviewed course **Piazza** and provided support and comments for question posts.

Honors and Awards

- **Best Poster of 2025 Master's Research Symposium** May 2025
  Department of Mechanical Engineering, CMU *Pittsburgh, PA*
- **Merit Student Scholarship (Second Class: 2022; Third Class: 2020, 2021)** 2020 – 2022
  Southern University of Science and Technology *Shenzhen, China*
- **Third Prize (Team Leader), The 21st CURC ROBOCON** Aug 2022
  National Robotics Competition *Shenzhen, China*
- **First Prize (Team Leader), Robocom Robot Developer Competition** Dec 2021
  National Competition *Shenzhen, China*
- **Third Prize (Mechanical Lead), The 20th CURC ROBOCON** Aug 2021
  National Robotics Competition *Shenzhen, China*