Yung-Ching Sun

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Education

University of Michigan, Ann Arbor Aug. 2024 - May 2026

M.S. in Electrical and Computer Engineering, Robotics track (GPA: 4.0/4.0) *Ann Arbor, MI*

- Recipient of the Rackham International Student Fellowship for the 2025-2026 academic year.
- Coursework: Mathematics for Robotics, Robotic System Laboratory, Intro to Algorithmic Robotics, Mobile Robotics, Self-Driving Cars, Special Topics: Action and Perception, Advanced Multi-Robot Systems.

National Taiwan University Sep. 2019 - Jun. 2023

B.S.E. in Mechanical Engineering and B.S. in Physics (Major GPA: 3.94/4.3, GPA: 3.64/4.3) *Taipei, Taiwan*

- Coursework: Computer Vision, Digital Control System, System Dynamics, Automatic Control, Applied Electronics.

Research Experience

Robotics and Optimization for Analysis of Human Motion Laboratory Feb. 2025 — Present

Graduate Research Assistant, Advisor: Prof. Ram Vasudevan *Ann Arbor, Michigan*

Physically Grounded, Interactable 3D Scene Reconstruction

- Leading a research project by coordinating a cross-level research team (undergrad and PhD students) with diverse expertise, driving research direction, system development, and experiments design toward a first-author submission.
- Proposed a physically accurate digital twin reconstruction framework by combining 3D Gaussian Splatting-based scene reconstruction, multi-modal LLM-based physical property reasoning, and robot-environment interactions.
- Developed the framework in NVIDIA Isaac Sim/Lab with a Franka arm and TidyBot and trained RSL-RL, Diffusion Policy, and OpenVLA policies with the digital twins to demonstrate real-to-sim-to-real transfer capability.

Real-to-Sim Underwater Stereo Reconstruction for Real-Time SLAM

- Built training and evaluation pipelines for underwater stereo depth models by developing modular data processing, augmentation, and self-supervised training workflows, enabling efficient and reproducible model training.
- Reduced underwater stereo depth estimation end-point error (EPE) from 13.34 m to 1.99 m by adapting in-air stereo networks with underwater artifact augmentation, simulated data, and self-supervised learning.
- Established benchmarking pipelines with SOTA stereo models, including FoundationStereo and IGEV++, providing systematic and quantitative evaluation of depth estimation and downstream SLAM performance in underwater scenes.

3D Active Scene Reconstruction via Bayesian Kernel Inference Semantic Mapping

- Investigated and analyzed key research gaps in uncertainty-aware safe robot exploration and 3D scene reconstruction, benchmarking SOTA representations including BKI Maps, ConvONet, NeRF, 3D Gaussian Splatting, and Scene Graphs.
- Developed a frontier-based 3D exploration system for a differential-drive mobile robot using ROS2 and Gazebo simulator, fusing IMU, LiDAR, and RGB-D measurements to actively reconstruct 3D scene with uncertainty via BKI Mapping.
- Demonstrated the critical role of physical factors in enabling robust mapping and localization through ablation studies on varying physical properties and terrains, with analysis of planned path, tracking error, and reconstruction quality.

Barton Research Group Jan. 2025 — May 2025

Graduate Research Assistant, Advisors: Prof. Kira Barton, Prof. Dawn Tilbury *Ann Arbor, Michigan*

Autonomous Inspection and Mobile Manipulation with the Spot Robot in Manufacturing Environments

- Developed an AprilTag-free, vision-based autonomous operation system for Boston Dynamics' Spot with a 6-DOF arm, integrating onboard RGB-D perception, custom vision models, arm kinematics, and frame transformations within the Spot SDK to enable autonomous localization, navigation, and manipulation in cluttered industrial environments.
- Trained and deployed YOLO11-based object detection and orientation estimation models using 300+ real-world images from robot-mounted cameras to mitigate camera domain shift, achieving up to 96% accuracy for robust manipulation.
- Analyzed safety-aware motion planning strategies for mobile manipulators, jointly considering navigation and arm operation constraints to support safe autonomy in dynamic, human-shared manufacturing environments.
- Presented the work at the Late-Breaking Results and the Workshop on The Future of Intelligent Manufacturing at ICRA 2025, recognized as the Runner-up fo the Best Poster Award.

Advanced Control Laboratory, Intelligent Robotics Group Sep. 2022 — Aug. 2024
Undergraduate Researcher, Advisors: Prof. Li-Chen Fu *Taipei, Taiwan*

Autonomous Monitoring and Navigation for Elderly Support Robots in Long-term Care Facilities

- Developed an Elderly Care Robot system with ROS, aimed at monitoring and supporting elders' physical and mental well-being, with the goal of future implementation in long-term care facilities.
- Integrated SLAM, navigation algorithms, machine learning, and computer vision techniques (including real-time human detection and tracking with YOLOv8 and BoT-SORT, facial and emotion recognition with DeepFace, pose estimation with MediaPipe, and GPT-4 API) to enhance the robot's autonomous capabilities.

Institute of Astronomy and Astrophysics, Academia Sinica Jul. 2022 — Jul. 2024
Undergraduate Researcher, Advisors: Dr. Hsien Shang, Dr. Chien-Chang Yen *Taipei, Taiwan*

High-Performance Gravitational Solver Optimization with Adaptive Mesh Refinement

- Developed C++ code for computational astrophysics algorithms and refined the code for better efficiency.
- Explored the Sparse Fast Fourier Transform algorithm to optimize the Adaptive Mesh Refinement (AMR) calculation.
- Optimized gravitational computation with AMR algorithm, reducing time complexity from $O(N^4)$ to $O(N^2 log^2 N)$, achieving a maximum computational time improvement of 204x compared to the GPU-accelerated direct method.

Work Experience

Advanced Rocket Research Center Jul. 2021 — Sep. 2021
Rocket Avionics Hardware Engineer Intern *Hsinchu, Taiwan*

- Developed STM32 Flash memory control code for optimal data storage during rocket operations.
- Conducted systematic tests to ensure the circuit board components' functionality and performance.

Teaching Experience

Advanced Control Laboratory, National Taiwan University Sep. 2023 — Jul. 2024
Research Mentor, Research Projects on Mobile Robots *Taipei, Taiwan*

- Mentored a UCSB undergraduate in an international summer undergraduate research program, teaching foundational mobile robotics knowledge and development tools, and guiding him from no experience to complete a mobile robot SLAM and navigation project using ROS and Gazebo.
- Guided an NTU undergraduate (now a Robotics Master's student at Georgia Tech) on a research project involving developing an elderly care social mobile robot.

Department of Mathematics, National Taiwan University Sep. 2022 — Apr. 2023
Teaching Assistant, Math 1209/4006/4007/4008 Calculus (General Math)/(1)/(2)/(3) *Taipei, Taiwan*

- Led recitation sessions for 130+ students, elucidated complex concepts, guided problem solving in math, provided detailed explanations, held weekly office hours, and graded assignments and examinations.
- Received 4.51/5.0 in the teaching evaluation, with student feedback praising dedication and responsiveness.

Publications, Preprints, and Workshop Papers

[1] Bagoren, O.*, Isaacson, S.*, Sundar, S., **Sun, Y.C.**, et, al. "SurfSLAM: Sim-to-Real Underwater Stereo Reconstruction for Real-Time SLAM." *arXiv preprint arXiv:2601.10814 (2026).*

[2] **Sun, Y.C.***, Stadinger, S*, et, al. "Key Capabilities of Autonomous Mobile Platforms for Maintenance and Monitoring in Manufacturing Environments." *Late-Breaking Results & Workshop on The Future of Intelligent Manufacturing, IEEE International Conference on Robotics and Automation (ICRA), May 2025*

[3] Yen, C.C., **Sun, Y.C.**, et, al. "A Hybrid Acceleration for Self-Gravity Calculation in Infinitesimally Thin Disks with Adaptive Mesh Refinement." *The Astrophysical Journal Supplement Series.* (Under review.)

Papers In Preparation (with Projected Venue)

[1] **Sun, Y.C.**, Isaacson, S., Bagoren, O., Vasudevan, R., et, al. "Physically Accurate 3D Reconstruction via Interactive Estimates Refinement" *IEEE/RSJ International Conference on Intelligent Robots and Systems, 2026.* (In preparation.)

Selected Projects

3D Gaussian Splatting Scene Reconstruction for Autonomous Driving Oct. 2025 — Dec. 2025

- Performed a comparative study of 3D Gaussian Splatting-based scene reconstruction methods for autonomous driving, quantitatively and qualitatively benchmarking Street Gaussians, OmniRe, and GaussianSTORM on real-world datasets.
- Developed evaluation pipeline on Waymo and nuScenes datasets using PSNR, SSIM, and LPIPS metrics, identified key trade-offs and failure cases, and proposed actionable improvements.

Rapid Motor Adaptation (RMA) for RL-Based Quadruped Locomotion Sep. 2025 — Nov. 2025

- Built a two-phase Rapid Motor Adaptation (RMA) pipeline for Unitree Go1 quadruped locomotion in MuJoCo/Brax with JAX-based simulation by extending RLS-RL PPO to consume privileged observations and learn an environment latent, enabling adaptation beyond naive domain randomization.
- Trained a teacher-student adaptation module via DAgger-style distillation, promoting sim-to-real transfer capabilities, enabling robust locomotion on unseen rough terrains without privileged information at deployment.

Semantic-Aware Visual SLAM for Dynamic Environments Mar. 2025 — May 2025

- Designed a modular, real-time dynamic SLAM system by extending ORB-SLAM3 with dynamic features detection and masking, enabling robust real-time camera tracking in dynamic environments.
- Developed dynamic detection and masking pipelines using FastSAM, YOLO11n-seg, and optical flow analysis, removing open-vocabulary dynamic features, and improving localization accuracy in dynamic scenes.
- Achieved up to a 97.34% reduction in absolute trajectory error (ATE) by systematically benchmarking against ORB-SLAM3 and DynaSLAM, validated on TUM and Bonn dynamic RGB-D datasets.

Autonomous Exploration and SLAM for an Unmanned Ground Vehicle Mar. 2025 — May 2025

- Developed wheel-speed PID and pure pursuit motion controllers for a differential-drive mobile robot, achieving < 3 cm posiitonal error and $< 15°$ heading error after completing two laps of a 7.308 m trajectory.
- Implemented a 2D LiDAR-based SLAM system using occupancy grid mapping and Monte Carlo localization, fusing LiDAR, odometry, and IMU data to achieve a 0.0369 m RMS pose error.
- Integrated SLAM, A* algorithm, and frontier-based exploration to enable autonomous navigation, mapping, and localization in previously unknown environments.

Vision-Based Manipulation with an RGB-D Sensor and 5-DOF Arm Jan. 2025 — Mar. 2025

- Built an end-to-end vision-guided robotic manipulation system using ROS2, a Realsense L515 RGB-D Sensor, and a 5-DOF RTX200 robotic arm, enabling autonomous perception-to-action pipelines.
- Improved 3D perception accuracy for manipulation by reducing depth estimation error from 4.5 mm to 0.375 mm through camera calibration and homography transformation, achieving an autonomous pick-n-place position error of 3.79 mm.
- Developed end-to-end autonomous block sorting, aligning, and stacking pipelines by integrating OpenCV-based detection (shape, size, color), robotic kinematics (FK/IK), and motion planning, enabling precise and repeatable manipulation tasks.

3D Reconstruction from Road Marker Feature Points Feb. 2023 — Jun. 2023

- Designed advanced solutions using Python and OpenCV to enhance the perception system of autonomous vehicles.
- Developed algorithms to identify key feature points from road markers via the vehicle's onboard RGB cameras.
- Reconstructed 3D point clouds of road markers through camera calibration and homography transformation, fusing point clouds from multiple viewpoints, and optimized the error rate from 0.4 to 0.2.

Honors and Awards

Rackham International Student Fellowship, *Rackham Graduate School, University of Michigan* Nov. 2025

Undergraduate Research Scholarship, *Institute of Astronomy and Astrophysics, Academia Sinica* Sep. 2022

Technical Skills

Programming/Software: C/C++, Python, MATLAB/Simulink, C#, LabView

Hardware: Raspberry Pi 5, RGB-D camera, 2D/3D LiDAR, Boston Dynamics Spot, Kinova, RX200 robotic arm

Simulators: NVIDIA Isaac Sim/Lab, Habitat Sim/Lab, PyBullet, ManiSkill, MuJoCo Playground, Gazebo

Tools/Packages: ROS, ROS2, Git, Docker, Linux, OpenCV, PyTorch, JAX, Eigen, CVXPY, CasADi, GTSAM