Shiming Liang

Robotics Engineer

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Education

University of Pennsylvania — *Philadelphia, PA*

MSE in Robotics — *Estimated May 2024*

- **Current GPA:** 3.96/4.00

Huazhong University of Science and Technology — *Wuhan, Hubei*

BEng in Mechanical Engineering — *Jun 2022*

- **GPA:** 3.94/4.00

Skills

Coding	**C++**, **Python**, **MATLAB** on **Linux** and **Windows** (data structures & algorithms, multi processing/threading, network protocols, OpenCV, Eigen3, PyTorch, scikit-learn), revision control with **Git**, **ROS** (rviz, Gazebo, MoveIt, slam_toolbox, pf, tf), **IDE** (VSCode)
Robotics	**rigid body dynamics** (quadrotors, automobiles, robotic arms), **state estimation** (image processing, sensor calibration, Kalman/Particle filter, SLAM), **controller design** (PID, LQR, MPC, policy gradient, DQN), **planning** (A*, RRT*, Vehicle Routing Problem, Orienteering Problem, trajectory generation), **deep learning** (LSTM, Transformer, CNN), **optimization** (LP, QP, evolutionary algorithm), **sensors** (LiDAR, camera, IMU, mo-cap), **CAD** (AutoCAD, Solidworks, Siemens NX), **fabrication** (3D printing, milling, lathing)
Misc	communication, problem-solving, technical writing (LaTeX), time management, collaboration, initiative, inclusive, Microsoft Office

Work Experience

University of Pennsylvania — *Philadelphia, PA*

Research Assistant at the GRASP Lab — *May 2023 - Present*

- Lead the development of a decision support system for geological surveys, to find paths that maximize information gain with constrained total cost.
- Prepare for submission: *An Efficient Indicator-based Evolutionary Algorithm for Path Planning in Geological Surveys.* S Liang, S Manjanna, MA Hsieh.
- Formulate the task as the NP-hard multi-objective orienteering problem (MOOP) - to find the set of paths satisfying the total cost constraint such that no alternative path improves any objectives without worsening others.
- Conducted comprehensive research on MOOP literature, focusing on effective algorithmic designs and standard metrics for comparison.
- Propose an evolutionary algorithm that employs multi-objective quality indicators to evaluate path quality and tabu search to reduce repeated efforts.
- Demonstrate that the proposed algorithm yields highly competitive results compared to two state-of-the-art algorithms.

University of Pennsylvania — *Philadelphia, PA*

Teaching Assistant for *Advanced Robotics* and *Mechanical & Mechatronic Systems* — *Aug 2023 - Present*

- Mentor students on circuit analysis, dynamical systems, rigid body dynamics, path/trajectory planning, and state estimation.
- Create and revise course documents to preserve knowledge, cover common questions, and reduce ambiguity.
- Communicate weekly with teachers and students to provide updates on student progress, address concerns, and coordinate teaching efforts.

Wuhan Yifi Laser Equipment Co., Ltd. — *Wuhan, China*

Robotics Engineer Intern — *Jul 2021 - Sep 2021*

- Develop a scan-plan-weld pipeline for an industrial robot with a welder and a laser profiler to boost the efficiency of handling varying parts.
- Calibrate the poses of the tools in the end-effector frame by solving dedicated least square problems for each tool.
- Generate the end-effector trajectory subject to the geometric constraints of the flat welding position.
- Automate the pipeline and shorten the commissioning time to one-tenth of the original pipeline, which involves manual programming.

Projects

F1TENTH Autonomous Racing — *Philadelphia, PA*

University of Pennsylvania — *Jan 2024 - Present*

- Build, program, and drive a 1/10th scale autonomous race car with Hokuyo LiDAR, VESC, and NVIDIA's Jetson onboard.
- Implement geometric path tracking methods such as Pure Pursuit and the Stanley Method to guide the vehicle along a path.
- Generate the minimum time race line with alternating optimization on the path and the speed profile, where the path minimizes a weighted sum of the length and accumulated curvature subject to the track specifications, and the velocity profile maximizes speed subject to the acceleration constraints.
- Implement an RRT*-based local planner to avoid dynamic obstacles while tracking the optimal trajectory for overtaking in head-to-head races.
- Manage the team project codebase with Git using the personal branching workflow.

Quadrotors Visual Inertial Odometry with Unscented Kalman Filter — *Philadelphia, PA*

University of Pennsylvania — *Feb 2023 - Jun 2023*

- Independently develop a state estimation stack for quadrotors with the unscented Kalman filter fusing observations of an IMU and a stereo camera.
- Calibrate the IMU parameters by fitting the IMU measurements to the motion capture system (Vicon) measurements with linear regression.
- Process the image stream with OpenCV to rectify images, extract & match descriptors, and discard outlier descriptor pairs with the RANSAC algorithm.
- Implement the unscented Kalman filter (UKF), incorporating the quadrotor dynamics and the observations from the IMU and stereo camera.
- Demonstrate the superiority of the UKF over the classic error state Kalman filter in terms of estimation error and robustness against noise.

Dynamic Path Replanning for Quadrotors with Limited Sensor Range — *Philadelphia, PA*

University of Pennsylvania — *Feb 2023 - Jun 2023*

- Design a dynamic path planning scheme where the quadrotor replans its future path as more information about the environment is acquired.
- Implement a geometric nonlinear controller for trajectory tracking by decomposing the system into attitude, position, and motor controllers.
- Implement the A* search to generate a feasible path on the fly when an obstacle is found on the original path.
- Extract sparse waypoints with the Ramer–Douglas–Peucker algorithm and generate the dynamically feasible trajectory minimizing the accumulated snap.
- Test the scheme in the simulation where its performance is comparable to the baseline planner with global information.