Patrick Li-Yu Lo

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EDUCATION

The Hong Kong Polytechnic University *Sep '22 - Aug '24*
M.Phil. in Robotics & Control, GPA: 3.77/4.3, Presidential Fellowship Scheme
Department of Aeronautical and Aviation Engineering
Thesis: On Improving the Adaptivity of Controllers and Estimators for Mobile Robots in Challenging Operational Conditions

The Hong Kong Polytechnic University *Sep '17 - Jun '21*
B.Eng. (1st Honour), GPA: 3.75/4.3
Department of Aeronautical and Aviation Engineering
Thesis: Vision-based Navigation of Quadrotor UAV

University of Queensland, Australia *Feb '20 - Jul '20*
Academic Exchange
Department of Aerospace Engineering

EMPLOYMENT

The Hong Kong University of Science and Technology *Jul '21 - Jul '22*
Research Assistant
Hong Kong Center for Construction Robotics
Projects: CV-based Construction Logistics Monitoring System; Controller Design for Prefabrication Components Installation.
Duties: Conducted literature review on adversarial training; performed data augmentation; conducted image pre-processing; co-designed auxiliary hardware setup for better image captures; coded in Arduino & PyTorch.

RESEARCH PUBLICATIONS

- **Lo, L. Y.**, Y. Hu, B. Li, C.-Y. Wen, and Y. Yang, "An Adaptive Model Predictive Control for Unmanned Underwater Vehicles Subject to External Disturbances and Measurement Noise," Accepted to 14th IEEE Asian Control Conference (ASCC), 2024. *Links*: pdf, code.
- **Lo, L. Y.**, B. Li, C.-Y. Wen, and C.-W. Chang, "Experimental Non-Robocentric Dynamic Landing of Quadrotor UAVs with On-Ground Sensor Suite," Accepted to IEEE Transactions on Instrumentation and Measurement (TIM), 2024. *Links*: pdf, code.
- **Lo, L. Y.**, B. Li, C.-Y. Wen, and C.-W. Chang, "Landing a Quadrotor on a Ground Vehicle without Exteroceptive Airborne Sensors: A Non-Robocentric Framework and Implementation," in 2023 IEEE 26th International Conference on Intelligent Transportation Systems (ITSC). IEEE, 2023, pp. 6080–6087. *Links*: pdf.
- **Lo, L. Y.**, C. H. Yiu, Y. Tang, A.-S. Yang, B. Li, and C.-Y. Wen, "Dynamic Object Tracking on Autonomous UAV System for Surveillance Applications," Sensors, vol. 21, no. 23, p. 7888, 2021. Editor's Choice Article. *Links*: pdf, code.

AWARDS & SCHOLARSHIP

- First Runner-up of UAV Challenge, 2023 & 2024 IEEE International Conference on Unmanned Aircraft Systems (ICUAS). *Links*: web 2023, web 2024.
- PolyU Presidential Postgraduate Fellowship Scheme ('22 - '24).
- Dean's list of PolyU Faculty of Engineering: '17/18, '18/19 & '20/21.
- PolyU Undergraduate APEC Entry Scholarship ('17 - '21).

SELECTED PROJECT

Relative State Estimation for Non-Inertial Control Systems *Sep '22 - Aug '24*
We study the relative state estimation problem for the feedback loop of non-inertial control systems (e.g., ground-centralized UAV-UGV heterogeneous teams) based on visual measurements, control input signals, and observed disturbance.

- **Main modules:** Investigated the unknown input problem in Kalman filters; designed adaptive extended state observer to extract the real input; fused the lump disturbance and control input into the prediction model of IEKF; performed stability analysis in the sense of Lyapunov for the observer.
- **Tools:** C++/Python in ROS, Gazebo, PX4, Docker.

Observer-based MPC for Unmanned Underwater Vehicle *Aug '23 - Mar '24*

We designed a novel error-state extended state observer subject to physical sensor models for adaptive nonlinear UUV MPC.

- **Main modules:** Investigated the IMU model and ESKF; applied Fossen's UUV equation to design the prediction model; integrated the lump disturbance into the prediction model; performed stability analysis in the sense of Lyapunov for both observer and controller.
- **Tools:** C++/Python in ROS, Gazebo, Acados/Casadi, BlueROV2 SITL, Docker.
- **Achievements:** Paper accepted at *2024 IEEE Asian Control Conference*.

Towards Non-Robocentric Dynamic Landing for Quadrotor UAVs *Jul '22 - Aug '23*

We proposed a novel sensing configuration for the UAV dynamic landing problem where no airborne exteroceptive sensors were used.

- **Main modules:** Carried out stereo camera image processing; proposed IEKF-based state estimator on SE(3); designed kinematic and dynamic constrained trajectory with differential flatness & minimized jerk; coded PID outer-loop flight controller; conducted heterogeneous UAV-UGV hardware system design and physical experiments in VICON.
- **Tools:** C++/Python in ROS, Gazebo, OSQP, PX4, Docker.
- **Achievements:** Paper published in *2023 IEEE International Conference on Intelligent Transportation System*; extended version accepted to *IEEE Transactions on Instrumentation and Measurement*; knowledge transferred (partial) to *HKSAR Environmental Protection Department*.

Vision-based Navigation of Quadrotor UAV *Aug '20 - May '21*

We worked on a fully autonomous UAV with SLAM, dynamic object tracking, path planning, trajectory generation, and controller modules. The team specifically focused on SLAM and dynamic object tracking.

- **Main modules:** Conducted CNN training for object detection; carried out stereo camera image processing; proposed EKF-based state estimator for object tracking; proposed visual-dynamic sensor fusion with TCN/LSTM models to solve the unknown input problem.
- **Tools:** C++/Python in ROS, Gazebo, Darknet, OpenCV DNN, PyTorch, GTSAM, PX4.
- **Achievements:** 2 papers were published in *Sensors* and *Aerospace* as an undergraduate RA; Github repo received ∼100 stars.

CORE SKILLS & KNOWLEDGE

- **State Estimation:** EKF, Graph-SLAM, Extended State Observer, Sensor-Fusion, Stereo Camera, LiDAR, IMU, Lie Theory.
- **Control & Optimization:** UAV & UUV Dynamic Analysis, Optimal Control, Nonlinear Control Theory, Trajectory Generation, Convex Optimization, Machine Learning.
- **Software/Hardware:** ROS in C++/Python, Gazebo, PyTorch, GTSAM, Acados, Docker, PX4 (& SITL), BlueROV2 (& SITL).
- **Links:** Project Pages, Learning Notes.

OTHERS

- **Languages**: English (IELTS 7.5), Mandarin (Native), Cantonese (Proficient), Taiwanese (Proficient).
- **Services**: Reviewer of IEEE Transactions on Mechatronics; IEEE Sensor Journal; 2023 IEEE International Conference on Intelligent Transportation System.
- **Volunteering**: Student ambassador of PolyU ('19-'21); Student/Teaching Assistant at HeartFire Education Service, China (Dec '19), African Evangelistic Enterprise, Rwanda (Jun '19), Royal University of Phnom Penh, Cambodia (May - Jun '18).