

FU ZHENGYU

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RESEARCH INTERESTS

I am broadly interested in **optimal control**, **control theory**, and **applied optimization** with applications to agile robotics systems such as **legged robots**.

EDUCATION

The Hong Kong University of Science and Technology

Hong Kong

BSc in Integrative Systems and Design (ISD) & Computer Engineering (CPEG)

Expected Jun 2023

- GPA: 3.86/4.3 (Top **1%** in the first major; top **2%** in the second major)
- Relevant Coursework: Introduction to Robotics, Control System Design, Optimal Control
- Awards & Scholarships: Dean's List, University's Scholarship of Continuing Undergraduate Students, HKSAR Government Scholarship Fund - Talent Development Scholarship

ETH Zürich

Zurich, Switzerland

Invited visiting student at Robotic Systems Lab (RSL)

Sep 2021 – May 2022

- Grade: 6/6
- Supervisor: Prof. Marco Hutter, Dr. Farbod Farshidian

Carnegie Mellon University

Pittsburgh, United States

Robotics Institute Summer Scholars (RISS)

Jun 2022 – Aug 2022

- Supervisor: Prof. Zachary Manchester

PUBLICATION

- Yang, S., Zhang, Z., **Fu, Z.**, and Manchester, Z., *Cerberus: Low-Drift Visual-Inertial-Leg Odometry For Agile Locomotion*, 2023 IEEE International Conference on Robotics and Automation (ICRA) **Under review**
The preprint is available at <https://arxiv.org/abs/2209.07654>

RESEARCH EXPERIENCE

Primal-Dual Augmented Lagrangian Solver for Model Predictive Control

REx Lab, CMU

Robotics Institute Summer Scholar (RISS)

Jun 2022 – Aug 2022

- Proposed a numerical implementation of a primal-dual formulation of the augmented Lagrangian in C++, which was two times faster than the state-of-the-art QP solver, OSQP, in solving constrained control problems of planar drones.
- Implemented a blockwise LDL factorization routine with BLAS in C, which exploited the sparsity of the optimal control problems. The blockwise LDL solver was accelerated by using vector instructions provided by modern CPUs and outperformed the state-of-the-art sparse LDL solver - QDLDL - when the given state and input cost matrices were diagonal and sparse, and linearised dynamics matrices were moderately sparse.
- The RISS presentation is available at <https://www.youtube.com/watch?v=9xK1cLN08k8>
- The RISS paper is available at <https://bit.ly/risspapeer>

Optimal Control Solvers for Legged Robots

RSL, ETH Zurich

Bachelor Thesis Student

Sep 2021 – May 2022

- Implemented a parallelizable QP solver named Proportional-Integral Projected Gradient under the nonlinear MPC framework of OCS2, which verified the feasibility of boosting control frequency by parallel computing. For more information, please see my Bachelor thesis at <https://bit.ly/rslthesis> (Note: OCS2 is a C++ toolbox tailored for Optimal Control for Switched Systems)

- Revised the parallelization scheme of the backward pass of differential dynamic programming (DDP) in OCS2, which improved the performance by 18%. The pull requests (PRs) are merged into the main branch, and the toolbox is available at <https://github.com/leggedrobotics/ocs2>

Motion Planning for Mobile Robots

Department of ECE, HKUST

Undergraduate Research Assistant

Jun 2020 – Aug 2021

- Proposed an MPC approach to solve the motion planning problem with chance constraints on the collision probability for mobile robots. When Gaussian process noise is assumed, the problem is simplified to find the lowest possible re-planning frequency that can satisfy the chance constraints. A real-world experiment using iterative LQR as the MPC solver can be viewed at <https://youtu.be/XL8FVjdYE0M>
- Implemented graph-based formation controllers for mobile robots in Gazebo. A demonstration can be viewed at http://fu-zhengyu.xyz/relative_formation/

PROJECTS EXPERIENCE

State Estimation, Planning and Control for Quadrotors

Department of ECE, HKUST

Software Engineer (Coursework)

Mar 2021 – Jun 2021

- Implemented a feature-based Visual-Inertial-Odometry (VIO) using the Extended Kalman Filter.
- A minimum snap trajectory was generated offline and tracked online by a quadrotor in a moderately convoluted indoor environment.
- A real-world experiment can be viewed at <http://fu-zhengyu.xyz/quadrotor/>

Control for Industrial Manipulators

Hong Kong Centre For Logistics Robotics

Software Engineer (Internship)

Jan 2021 – Feb 2021

- Implemented a ros2_control-compatible hardware interface for NACHI MZ25 manipulator in ROS2 Foxy.
- A demonstration can be viewed at <https://youtu.be/Z5zkLPai2QI>

RoboMaster Robotics Competition

Robotics Team, HKUST

Software Engineer

Oct 2018 – Sep 2019

- Designed and implemented a quaternion-based attitude controller for a two-axis stabilizer using PID.
- Implemented a forward kinematics solver and the entire control stack for a Mecanum mobile platform.
- Maintained the team's CI/CD pipeline and wiki.
- Primary code reviewer for the infantry robot codebase.
- More information can be found at <https://fu-zhengyu.xyz/#robotics-section>

ACTIVITIES & LEADERSHIP

Engineering Student Ambassador (ESA)

School of Engineering, HKUST

Student Ambassador

May 2020 – May 2021

- Worked as a student representative of the School of Engineering to introduce engineering through interacting with prospective students, parents, scholars, and the general public.
- My profile can be viewed at <https://seng.hkust.edu.hk/about/student-ambassadors/6316>

TEACHING EXPERIENCE

Mechatronic Systems Design with Embedded Computing

Department of ECE, HKUST

Teaching Assistant

Feb 2021 – May 2021

- Designed lab manuals and programming exercise to help students to learn Arm®-based microcontrollers.
- Led a lab class for ten undergraduate students

SELECTED AWARDS

- 2019 RoboMaster International qualification tournament, RoboMaster 1st Prize
- 2016 RoboCup Junior Rescue Line International Competition in Leipzig, Germany 1st Prize

SKILLS

Programming	(Well-experienced in) C++, C, Python, MATLAB, ROS; (Capable of) Julia, JavaScript
Mechanical	CAD software (Rhino, Solidworks, Fusion 360), Physical prototyping (CNC, Laser cutter, water jet)