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 **quadrupeds** and **quadrotors.**

EDUCATION

The Hong Kong University of Science and Technology **Hong Kong**

BSc in Integrative Systems and Design (ISD) & Computer Engineering (CPEG) Expected Jun 2023

- Current CGA: 3.86/4.3 (Rank 1 of 18)
- Awards & Scholarships: Dean's List, University's Scholarship of Continuing Undergraduate Students (Top 10% of all UG students), HKSAR Government Scholarship Fund - Talent Development Scholarship, HKSAR Government Scholarship Fund - Reaching Out Award

ETH Zurich **Zurich, Switzerland**

Invited visiting student at Robotic Systems Lab (RSL) Sep 2021 – May 2022

- Grade: 6/6
- Bachelor thesis title: Comparative Study on Optimal Control Solvers for Robotics
- Supervisor: Prof. Dr. Marco Hutter, Dr. Farbod Farshidian

Carnegie Mellon University **Pittsburgh, United States**

Robotics Institute Summer Scholars (RISS) Jun 2022 – Aug 2022

- Supervisor: Prof. Dr. Zachary Manchester

PUBLICATIONS

- 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**
  A preprint is available at https://arxiv.org/abs/2209.07654

RESEARCH EXPERIENCES

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 OSQP in solving dynamically constrained control problems of planar drones.
- Implemented a block-wise LDL routine in C with BLAS, which exploited the sparsity of the optimal control problems. The block-wise LDL was superior to QDLDL when the linearised dynamics matrices with moderate size were densely populated, even though state and input cost matrices were diagonal.
- The RISS presentation is available at https://www.youtube.com/watch?v=9xK1cLN08k8
- The RISS paper is available at https://bit.ly/risspaper

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 (PIPG) under the nonlinear MPC (NMPC) 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

PROJECTS EXPERIENCES

State Estimation, Planning and Control for Quadrotors — **Department of ECE, HKUST**
Software Engineer (Coursework) — Mar 2021 – Jun 2021

- Implemented a feature-based Visual Odometry (VO) with ROS integration.
- By using the Extended Kalman Filter (EKF), the estimated states from the VO were fused with the data from the on-board IMU to obtain better performance.
- 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 on http://fu-zhengyu.xyz/quadrotor/

Control of 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 on https://youtu.be/Z5zkLPai2QI

Multi-agent System Control — **Department of ECE, HKUST**
Undergraduate Research Assistant — Jun 2020 – Aug 2021

- Implemented an iterative linear quadratic regulator (iLQR) with MPC to control differential wheeled robots. A demonstration can be viewed on https://youtu.be/XL8FVjdYE0M
- Implemented graph-based formation controllers in ROS Melodic and verified the controllers in a simulated environment in Gazebo. A demonstration can be viewed on http://fu-zhengyu.xyz/relative_formation/

IMU-based Motion Capture System — **HKUST**
Software Engineer — Mar 2020 – Jun 2020

- The posture of the human arm was estimated based solely on two IMUs attached to the forearm and elbow respectively. A quaternion-based complementary filter was deployed to offset cumulative drift.
- The captured motion was sent to a computer via a wire connection and was displayed in real time by a humanoid skeleton in Unity.
- More details are presented at https://fu-zhengyu.xyz/imu/

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 on https://seng.hkust.edu.hk/about/student-ambassadors/6316

TEACHING EXPERIENCES

Mechatronic Systems Design with Embedded Computing — **Department of ECE, HKUST**
Teaching Assistant — Feb 2021 – May 2021

- Designed lab manuals and programming exercise to familiarise students with Arm®-based microcontrollers.
- In charge of leading laboratory sessions

AWARDS & CERTIFICATIONS

- 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)