# Hongzhe Yu

| **Google Scholar** | **Github** | **Email:** hyu419@gatech.edu |

**RESEARCH**    **Probabilistic Robotics**

- Modeling robotics problems (underactuated systems, hybrid systems, partially observed systems) uncer uncertainties using principled probabilistic framworks (Bayesian inference, stochastic control, Stochastic safety) and developing efficient algorithms

**Data-driven Optimal Control via Dynamic Mode Decomposition (DMD)**

- Leveraging Koopman theory to formulate optimal control in the space of measure as convex optimization

**EDUCATION**

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| **Georgia Institute of Technology**, | Ph.D. in Robotics | January 2021 – |
| **Georgia Institute of Technology**, | M.S. in Computer Science | March 2025 |
| **École Centrale de Lyon**, | Diplôme d'ingénieur | January 2021 |
| **Shanghai Jiao Tong University**, | M.S in Mechanical Engineering | March 2020 |
| **Shanghai Jiao Tong University**, | B.S in Mechanical Engineering | June 2017 |

**RESEARCH EXPERIENCE**

**Probabilistic Recheability of Stochastic Systems**     Jan. 2024 –

Advisor: *Dr. Yongxin Chen*

- Study the contraction theory and its relation to stochastic trajectory deviations
- Proposed a sharp probabilistic bound on stochastic trajectory deviations from its deterministic counterpart
- Applied this bound to systems with time- and state-dependent contraction metric, such as robot manipulator system

**Stochastic Control for Systems with Partial State Observations**     Jan. 2024 –

Advisors: *Dr. Yongxin Chen*, *Dr. Takashi Tanaka (UT-Austin)*

- Study stochastic optimal control problems with partial and noisy state observations.
- Solve the particle filtering problem for a stochastic partial state observation history using a path-integral-control-based particle filtering to get state estimation.
- One paper is submitted under review.

**Stochastic Control for Hybrid Systems**     Jan. 2024 –

Advisors: *Dr. Yongxin Chen*,   *Dr. Arron Johnson (CMU)*

- Model and solve stochastic control problems for contact-rich systems.
- Control the state covariance for hybrid systems with linear flows.
- Optimal stochastic control for hybrid systems with nonlinear flows.
- Two papers are submitted under review.

**Variational motion planning**     Dec 2021 –

Advisor: *Dr. Yongxin Chen*, *Georgia Tech*

- Formulate stochastic motion planning as Gaussian Variational Inference and developed natural gradient descent based GVI algorithm to solve it.
- Studied the underlying sparse factor graph of the inference problem, implemented a sparse Gaussian variational inference algorithm which promotes parallelization.
- Presented an open-sourced implementation in C++. Results outperformed a baseline planning algorithm (GPMP2, paper of the year IJRR in 2018) pertaining to solution robustness.
- On-going projects on acceleration of the algorithm and mixture-Gaussians for multi-modal trajectory optimization, KL-proximal GVI motion planning.

**Covariance Control for nonlinear systems**     *Jan 2021 – June 2022*

Advisor: *Dr. Yongxin Chen*, *Georgia Tech*

- Developed a proximal gradient algorithm to solve the covariance control problem for nonlinear control-affine dynamical systems.

- Conducted experiments in comparison with existing methods. The algorithm is significantly faster than convex optimization-based algorithms.

**Data-driven optimal control using Koopman operators** *Mar 2021 – Aug 2023*
Advisors: *Dr. Yongxin Chen*, *Georgia Tech*;  *Dr. Umesh Vaidya*, *Clemson University*
- Formulated the optimal control problem in the measure space using Koopman operator.
- The Optimal control problem is solved as a semi-definite programming (SDP).

**Collaborative aerial transportation** *June 2019 – Sep 2019*
Advisor: *Dr. Changliu Liu*, *Robotics Institute, CMU*
- Investigated the problem of collaborative transportation using flying robots.
- Built a simulation environment with multiple flying robots and a common payload to be transported. Implemented basic trajectory optimization for the quadrotors.   [CODE]

**Navigation via imitation learning** *Aug 2018 – May 2019*
Advisor: *Dr. Wei Dong*, *School of Mechanical Engineering, SJTU*
- Implemented an imitation learning-based indoor navigation on a UGV robot.
- Investigated the effectiveness of different environment representations.
- Built a simulated environment in ROS Gazebo and conducted the hardware experiments.

**Sensor Coverage and Swarm Control** *Sept 2017 – Dec 2018*
Advisor: *Dr. Wei Dong*, *School of Mechanical Engineering, SJTU*
- Built a centralized swarm control and communication framework for palm-sized Micro Aerial Vehicles (MAVs).
- Conducted hardware experiments to verify an effective coverage control algorithm. [VIDEO]

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| **FELLOWSHIP AND GRANTS** | Eiffel Scholarship Award | € 1300 / Month, 2yrs | 2015-2017 |

*Fellowship designed to support future decision-makers among science and engineering fields, Top 1% of all foreign applicants.*

**AWARDS AND HONORS**

China National Scholarship                                                     2018
*Highest honor, 0.2% China nationwide.*
INESA Group Scholarship                                                        2013
*Top 1% in ME Department.*

**REFEREED JOURNAL PUBLICATIONS**

[1] **Hongzhe Yu**, Zhenyang Chen, Yongxin Chen. Covariance Steering for Nonlinear Control-affine Systems. Accepted to AIMS Mathematics journal.   [PDF]

[2] **Hongzhe Yu**, Yongxin Chen. A Gaussian variational inference approach to motion planning. *IEEE Robotics and Automation Letters (RA-L)*, vol. 8, no. 5, pp. 2518-2525, May 2023.   [PDF]

[3] **Hongzhe Yu**, Joseph Moyalan, Umesh Vaidya, Yongxin Chen. Data-driven optimal control of nonlinear dynamics under safety constraints. *IEEE Control Systems Letters (L-CSS) with ACC option*, vol. 6, pp. 2240-2245, 2022.   [PDF]

[4] Gang Chen*, **Hongzhe Yu**\* (co-first author), Wei Dong, Xinjun Sheng, Xiangyang Zhu, Han Ding. What should be the input: Investigating the environment representations in sim-to-real transfer for navigation tasks. *Robotics and Autonomous Systems*, 2022 Jul 1;153:104081.   [PDF]

**REFEREED CONFERENCE PUBLICATIONS**

[5] Zhenyang Chen, **Hongzhe Yu**, Yongxin Chen. Efficient Belief Road Map for Planning Under Uncertainty. In: *The IEEE International Conference on Robotics and Automation (ICRA)*, under review.   [PDF]

[6] **Hongzhe Yu**, Joseph Moyalan, Umesh Vaidya, Yongxin Chen. Data-driven optimal control under safety constraints using sparse Koopman approximation. In: *The IEEE International Conference on Robotics and Automation (ICRA)*, 2023.   [PDF]

[7] **Hongzhe Yu**, Joseph Moyalan, Duvan Tellez-Castro, Umesh Vaidya, Yongxin Chen. Convex optimal control synthesis under safety constraints. In: *IEEE Conference on Decision and Control (CDC)*, Austin, TX, USA, 2021, pp. 4615-4621.   [PDF]

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| **PRE-PRINT SUBMISSIONS** | [8] **Hongzhe Yu**, Diana Frias Franco, Aaron M. Johnson, Yongxin Chen. Path Integral Control for Hybrid Dynamical Systems. Under review. [PDF] |
| | [9] **Hongzhe Yu**, Diana Frias Franco, Aaron M Johnson, Yongxin Chen. Optimal Covariance Steering of Linear Stochastic Systems with Hybrid Transitions. Under review. [PDF] |
| | [10] **Hongzhe Yu**, Yongxin Chen. Stochastic Motion Planning as Gaussian Variational Inference: Theory and Algorithms. Under Review. [PDF] |
| | [11] Kenta Hoshino, **Hongzhe Yu**, Takashi Tanaka, Yongxin Chen. A Fully Observable Control Approximation Algorithm for Partially Observed Control Problems via Path Integral Control. Under review. [PDF] |
| | [12] Zinuo Chang*, **Hongzhe Yu*** (co-first author), Patricio Vela, Yongxin Chen. Accelerating Gaussian Variational Inference for Motion Planning Under Uncertainty. Under review. [PDF] |

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| **INVITED TALKS** | *'Planning, Control, and Inference for Robotic Systems under Uncertainties'* | |
| | At the Locomotion Seminar led by prof. Aaron M. Johnson, CMU | 2025 |
| | *'Data-driven optimal control of nonlinear dynamics under safety constraints'* | |
| | At the Intelligent Control Lab led by prof. Changliu Liu, CMU | 2022 |

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| **ACADEMIC SERVICE** | Journal Review Services | IEEE T-AC, T-RO, RA-L, IFAC Automatica |
| | Conference Review Services | IEEE ACC, ICRA, IFAC MTNS |

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| **TEACHING ASSISTANCE** | Control System Design and Analysis | Georgia Tech | Fall 2023 |
| | Dynamics and Control Lab | Georgia Tech | Spring 2024 |
| | System Dynamics and Vibration | Georgia Tech | Spring 2025 |

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| **MENTORING** | M.S. Capstone Project Mentor | AE, Georgia Tech | Spring 2024 - Spring 2025 |
| | M.S. Capstone Project Mentor | ECE, Georgia Tech | Spring 2024 - Spring 2025 |
| | M.S. Capstone Project Mentor | ECE, Georgia Tech | Spring 2023 - Spring 2024 |
| | Undergraduate Research Mentor | AE, Georgia Tech | Spring 2024 - Spring 2025 |

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| **PROFESSIONAL EXPERIENCE** | **XYZ Robotics**, Shanghai                                                          *May 2020 – Aug 2020* |
| | Research intern in robot task planning |

- Studied the theory of behavior tree and its conversions with the state machine method.
- Did extensive survey and comparison study on existing open-source implementations; Implemented a python version of behavior tree for the customized needs in the company.

**IFSTTAR, Paris**, Paris                                                          *Apr 2017 – Jul 2017*
Multi-body Dynamics Analysis Software Development

- Internship on multi-body real-time simulation (Matlab) software (VOCO) amelioration for wheel-rail force analysis for trains and dynamics simulation for train motion, including UI, data visualization and data management
- Made adjustments to the software's log system.
- The software was licensed to ESI Group with a value of EUR 2,500 per year
- **Highly rated (5.0/5.0 overall performance), a letter of appreciation from the supervisor to Ecole Centrale de Lyon**

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| **COURSE AND UNIVERSITY PROJECTS** | Fixed wing aerial photography          Shanghai Jiao Tong University          Shanghai     2013 |
| | *National Undergraduate Innovation Training* |

- Fixed-wing UAV photography achieving all-terrain taking off and wide-angle aerial photographing.
- Mechanical design for a 3-axis Pan/ Tilt system embedded in a fixed-wing UAV model.
- **National Excellent Project Award.**

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| **SKILLS** | **Programming**: C/C++, Python, Matlab |
| | **Tools**: Pytorch, ROS, Optimization solvers (CVX, YALMIP, sostools, etc.), JAX |

**Languages**: Proficient in English, French, and Chinese

HOBBIES           Violin, soccer (core player for SJTU and ECL soccer team), traveling, reading.