Hongzhe Yu

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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

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. 2025 –
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 (Purdue University)*

- 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*

- 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*

- 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 sensor data 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]

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**, Yongxin Chen. Stochastic Motion Planning as Gaussian Variational Inference: Theory and Algorithms. Accepted to IEEE Transactions on Robotics. [PDF]

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

[3] **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]

[4] **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]

[5] 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

[6] 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]

[7] **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]

[8] **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]

PRE-PRINT SUBMISSIONS

[9] **Hongzhe Yu**, Diana Frias Franco, Aaron M. Johnson, Yongxin Chen. Path Integral Control for Hybrid Dynamical Systems. Under review. [PDF]

[10] **Hongzhe Yu**, Diana Frias Franco, Aaron M Johnson, Yongxin Chen. Optimal Covariance Steering of Linear Stochastic Systems with Hybrid Transitions. 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]

[13] Liqian Ma, Zishun Liu, **Hongzhe Yu**, and Yongxin Chen. Safety Verification of Stochastic Systems under Signal Temporal Logic Specifications. Under review.

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

JOURNAL REVIEW SERVICES

IEEE Transactions on Automatic Control
IEEE Transactions on Robotics
IFAC Automatica
IEEE Robotics and Automation Letters

CONFERENCE REVIEW SERVICES

IEEE American Contorl Concerence
IEEE International Conference on Robotics and Aautomation
IFAC Mathematical Theory of Networks and Systems

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

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

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**

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.**

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.