XU SHANG

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RESEARCH INTEREST

My research interests lie in **control** and **path planning**. Specifically, I'm interested in realizing safe motion planning and control for **high-order systems with uncertainties** (e.g., multi-agents systems, and connected and autonomous vehicles in mixed traffic systems).

EDUCATION

University of California San Diego   Sept. 2023 – Present
Advisor: *Prof. Yang Zheng*   *La Jolla, CA, USA*
Ph.D. in Electrical and Computer Engineering (In Progress)

University of Michigan   Sept. 2019 – May 2021
Master in Mechanical Engineering   *Ann Arbor, MI, USA*
GPA: 4.0/4.0
Relevant Coursework: Mechatronics System Design, Robot Kinematics & Dynamics, Nonlinear Programming, Linear Systems Theory, Nonlinear System & Control, Hybrid Systems, and Connected Vehicles

Shanghai Jiao Tong University   Sept. 2015 – Aug. 2019
University of Michigan – Shanghai Jiao Tong University Joint Institute   *Shanghai, China*
B.S. in Mechanical Engineering
GPA: 3.7/4.0
Relevant Coursework: Control of Dynamic Systems, Dynamics & Vibrations, Automotive Engineering, Biomedical Instrumentation, and Linear Algebra

RESEARCH EXPERIENCE

Scalable Optimization and Control Lab, UC San Diego   Sept. 2023 – Present
Ph.D. Student, Advisor: *Prof. Yang Zheng (Dept. of ECE)*   *La Jolla, CA, USA*
Conducting research in data-driven control and autonomous vehicles

- Developed a novel decentralized robust data-driven predictive control method to smooth traffic flow which increases safety, decreases computational cost and requires less pre-collected data
- Compared different approaches for solving the robust optimization problem and provided an efficient computation method for real-time implementation
- Proposed a new framework for comparing and summarizing extended data-enabled predictive control methods

Autonomous Systems & Intelligent Machines Lab, Virginia Tech   Jan. 2022 – Aug. 2023
Research Assistant, Advisor: *Prof. Azim Eskandarian (Dept. of MechE)*   *Blacksburg, VA, USA*
Conducting research in collision avoidance and mitigation for autonomous vehicles

- Proposed a new artificial potential function and combined it with model predictive control to realize collision avoidance and mitigation(protecting the human-occupied part of the vehicle) for autonomous vehicles
- Tested the controller in 192 cases among 8 general scenarios in simulation and implementing it for the one-tenth scale car in Robot Operating System
- Compared with results obtained from Hamilton-Jacobi reachability and genetic algorithm
- Developing learning-based safe controller for multi-vehicles collision avoidance and mitigation
- Solving sensor synchronization issues for cameras in the full-scale autonomous vehicle

Safe Autonomous Systems Lab, UC San Diego — June 2022 – Sept. 2022

Visiting Researcher, Advisor: *Prof. Sylvia Herbert (Dept. of MechE)* — *La Jolla, CA, USA*

Conducting research in efficiently constructing control barrier function with input constraints

- Constructed control barrier function based on artificial potential function with input constraints
- Implemented sum of square optimization to optimize the control barrier function iteratively and get larger control invariant set
- Solving path planning problem with combined control barrier functions and desired velocity profile

Biped Robotics Lab, University of Michigan — Jan. 2020 – July 2021

Graduate Research Assistant, Advisor: *Prof. Jessy Grizzle (Dept. of EECS)* — *Ann Arbor, MI, USA*

Conducting research in comparing the performance of different simulators and different low-level tracking methods for biped robots

- Implemented a walking controller in C++ for a biped robot and validated it in simulation (MuJoCo and Simscape Multibody) and hardware
- Added a low-level passivity control method to decrease the tracking error
- Combined invariant extended Kalman filter with the controller in Robot Operating System to decrease the error in velocity tracking
- Developed UDP communication structure in C++, Python, and MATLAB to simplify communication between controllers and simulators for validation and efficiency

Safe Autonomous Landing, University of Michigan — Sept. 2020 – Dec. 2020

Course Research Project, Advisor: *Prof. Necmiye Ozay (Dept. of EECS)* — *Ann Arbor, MI, USA*

Conducting research in reachability analysis with system uncertainty

- Generated zonotopes by using zonotope reachability analysis tool(Cora)
- Took zonotopes as constraints of non-linear optimization problems to avoid collision with obstacles
- Improved the performance of trajectory optimization by using path planner to decide way points

Active Materials & Intelligent Structures Lab, Shanghai Jiao Tong Univ. Sept. 2017 – Sept. 2018

Undergraduate Research Assistant, Advisor: *Prof. Yanfeng Shen (Dept. of MechE) Shanghai, China*

Conducting research in meta-materials

- Pinpointed the location and potential damage of the structure by analyzing wave properties
- Designed meta-materials and eliminated special frequency waves with ANSYS

PUBLICATIONS

Xu Shang, Yang Zheng. "Smoothing Mixed Traffic with Robust Data-driven Predictive Control for Connected and Autonomous Vehicles." *American Control Conference (ACC)*, 2024, (In Press), https://arxiv.org/abs/2310.00509

Xu Shang, Shahabedin Sagheb, and Azim Eskandarian. "Safe Planning with Game-Theoretic Formulation, Reachability Analysis and Reinforcement Learning." *IEEE International Automated Vehicle Validation Conference (IAVVC)*, 2023

Xu Shang and Azim Eskandarian. "Emergency Collision Avoidance and Mitigation Using Model Predictive Control and Artificial Potential Function." *IEEE Transactions on Intelligent Vehicles*, http://arxiv.org/abs/2211.06574

PATENT

Yaping Xu, MinRen Hu, Shuangyan Yang, Shuyi Wang, Duwang Yu, **Xu Shang** and Yuqi Wang. "AR technology application into drawing target outline in CT simulation"

TEACHING EXPERIENCE

Graduate Teaching Assistant, Virginia Tech   Jan. 2022 – Dec. 2022
Control Engineering, Robotics & Automation   *Blacksburg, VA, USA*

- Responsibilities included leading robotics labs, holding office hours and grading lab reports

Undergraduate Teaching Assistant, Shanghai JiaoTong University   Feb. 2019 – Apr. 2019
Materials for Energy Conversion   *Shanghai, China*

- Responsibilities included leading mechanical labs, holding office hours and grading assignments

WORK EXPERIENCE

NIO, Automobile company   Sept. 2021 – Dec. 2021
Software Engineer Intern   *Shanghai, China*

- Built communications between vehicle CAN, Lidar and Camera
- Combined the data from Lidar and Camera to get the road condition
- Adjusted the height of air suspension automatically for different road conditions which could improve the performance of the vehicle

Petoi, Quadruped Robot Start-Up Company   Sept. 2021 – Dec. 2021
Volunteered Partner   *Shanghai, China*

- Built simulators for the quadruped robot "Bittle" in Isaac Sim
- Wrote a tutorial and generated videos for how to simulate the quadruped robot "Bittle"

Biomedical Manufacturing & Design Lab, University of Michigan   Sept. 2019 – Dec. 2019
Lab Assistant   *Ann Arbor, MI, USA*

- Designed complicated PCB circuit with Eagle
- Designed test platform in AutoCAD and tested different embedded electronic elements to find the best choice

Rockwell Automation   May 2019 – June 2019
Software Testing Engineer Intern   *Shanghai, China*

- Tested functionalities of the transformer control software

TECHNICAL STRENGTHS

Programming	C++/C, MATLAB, Javascript, Python
Robotics	ROS, MuJoCo, Isaac Sim
Design	CATIA, Unigraphics NX, LabView, AutoCAD, ANSYS, Eagle
Languages	Chinese(Native), English(Fluent)

AWARDS

Outstanding Graduates Award of Shanghai, 2019
Capstone Design Golden Award, "Automotive Excavator", 2018
John Wu&Jane Sun Blastoff Scholarship, 2018, 2017

VOLUNTEER WORK AND OTHER ACTIVITIES

Volunteer teaching group   Sept. 2019 – Dec. 2019
Taught physics and soccer for middle school students   *SanHe, YunNan, China*

Shanghai Jiao Tong University racing team   Mar. 2018 – Aug. 2019
Designed and repaired the carbon outer shell   *Shanghai, China*

U of Michigan – Shanghai Jiao Tong Univ. Joint Institute Soccer Team   Sept. 2015 – Aug. 2019
Champion of freshmen cup, Third place in campus cup   *Shanghai, China*

U of Michigan – Shanghai Jiao Tong Univ. Joint Institute Debate Team   Sept. 2015 – Aug. 2017
Third place in freshmen cup, Best debater in semi-final   *Shanghai, China*