

GAO TANG

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EDUCATION

University of Illinois at Urbana-Champaign

August 2019 - Present

Ph.D. in Computer Science

Prior to this I spent three years at **Duke University** (2016-2019)

Tsinghua University

Sep 2010 - June 2016

Bachelor and Master in Aerospace Engineering

PROJECTS

Robot-Assisted Corneal Surgery

Sep 2016 - Present

The major task is to implement the motion planning component for a robotic system designed for corneal surgery. I have to design a feedback controller that plans how to insert a needle into human cornea. The deformation of the cornea is considered and a model predictive controller is designed.

Data-Driven Trajectory Optimization

Feb 2017 - Present

The main goal is to accelerate nonlinear optimization by data. I study how to use pre-computation to reliably and efficiently solve optimization problems. I start from nearest-neighbor approach and then gradually move to deep networks. The dataset discontinuities has to be reasoned about for accurate learning. I extensively use clustering algorithms and deep network libraries. This has been applied in a physical quadcopter system and various simulation environments.

Bi-Level Optimization

Sep 2018 - Present

This project studies how to use convex structures in nonconvex optimization problems. In many problems nonconvexity comes from a subset of variables. We explore how to fix them, solve the remaining variables by convex optimization, and use its information to perform gradient descent. We apply this to the drone and ground vehicle problems.

The 8th Global Trajectory Optimization Competition

May 2015 - Jun 2015

We have to compete with other teams to design a space mission within 4 weeks. The problem is designed by JPL. We have to simultaneously design the orbits of 3 spacecraft in order to map space radio sources. Essentially it is a global optimization problem with many constraints. We get the 2nd prize out of 36 register teams.

SKILLS

Programming

Python, C++, Matlab, Fortran

Machine Learning

scikit-learn, PyTorch, TensorFlow, reinforcement learning experience

Optimization

Nonlinear and convex solvers, Convex optimization theory

Optimal Control

Develop Python libraries for trajectory optimization and learning

RESEARCH INTEREST

Motion Planning

Sampling-based and optimization-based planning

Machine Learning

Explore data-driven motion planning

Nonlinear Optimization

Explore structures for efficient and reliable solvers

TEACHING EXPERIENCE

I served as Teaching Assistance at Duke for *ECE 383 Introduction to Robotics and Automation* for two semesters. I held weekly office hours and occasionally gave lectures.

SELECTED PUBLICATIONS

1. Problem-Optimum Learning in Robotics

Gao Tang, Kris Hauser; A data-driven indirect method for nonlinear optimal control. Intelligent Robots and Systems (IROS), 2017 IEEE/RSJ International Conference on

Gao Tang, Kris Hauser; Learning Trajectories for Real-Time Optimal Control of Quadrotors. Intelligent Robots and Systems (IROS), 2018 IEEE/RSJ International Conference on

Gao Tang, Kris Hauser; Discontinuity-Sensitive Optimal Control Learning by Mixture of Experts. International Conference on Robotics and Automation (ICRA) 2019 (arXiv:1803.02493)

2. Bi-Level Optimization

Weidong Sun, **Gao Tang** (equal contribution), Kris Hauser; Fast UAV Trajectory Optimization using Bilevel Optimization with Analytical Gradients. submitted to IEEE Transactions on Robotics (arXiv:1811.10753)

Gao Tang, Weidong Sun (equal contribution), Kris Hauser; Time-Optimal Trajectory Generation for Dynamic Vehicles: A Bilevel Optimization Approach. Intelligent Robots and Systems (IROS), 2019 IEEE/RSJ International Conference on

3. Problem Convexification

Gao Tang, Fanghua Jiang; Fuel-Optimal Low-Thrust Trajectory Optimization Using Indirect Method and Successive Convex Programming, IEEE Transactions on Aerospace and Electronic Systems. Vol. 54, Issue 4, 2018.

Fanghua Jiang, **Gao Tang**, Junfeng Li; Improving low-thrust trajectory optimization by adjoint estimation with shape-based path, Journal of Guidance, Control, and Dynamics, Vol. 40, No. 12, 2017

4. Interplanetary Mission Design by Optimization

Gao Tang, Fanghua Jiang; Capture of Near-Earth Objects with Low-Thrust Propulsion and Invariant Manifolds, Astrophysics and Space Science, 361 (1), 10, 2016

5. Global Trajectory Optimization Competition

Gao Tang, Hongwei Yang, Fanghua Jiang, et. al. GTOC8: Results and methods of TEAM 3-Tsinghua University, Proceedings of the AAS/AIAA Space Flight Mechanics Meeting, 2016

SELECTED AWARDS

Outstanding master graduate student at Tsinghua University, 2016

Graduate student national scholarship at Tsinghua University, 2015