Akshay Jaitly

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I develop new classes of optimization solvers that exploit problem structure and rigorous geometric representations of complex mathematical problems, with applications to robotics and autonomous systems.

Interests -- Optimization, Algebraic Geometry, Motion Planning, Switched Systems, Underactuated Control
Skills -- C++, Python, Drake, PyTorch, ROS 2, Matlab, CasADI, Git, OpenCV, Eigen

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Experience

MARCH 2025 - PRESENT

Aerial Control and Perception Lab. WPI - *Visiting Researcher*

- Leading to submissions in **ICRA** & **IJRR**.
- Created a new, speedy, solver for the **Trust Region Problem** with proof of convergence.
- Introduced a new, "**Orthogonal Trust Regions Problem**"(Orth-TRP) with similar, exploitable, structure. The OrthTRP is directly applicable to training neural networks, performing contact-implicit optimization, etc. We utilize it for collision avoidant trajectory optimization (in drones) in our current work.
- Created new parameterizations of free space, allowing trajectory optimization to be solved as an Orth-TRP, faster than established methods.

JUNE 2024 - MARCH 2025

Mitsubishi Electric Research Labs (MERL) - *Optimization and Intelligent Robotics*

- Single Level Collision detection For Trajectory Optimization
  - Outperformed other state-of-the-art methods like DCOL (Tracy et all).
  - Led to a publication in **IROS** '25 and a **patent**. See "Publications" for specific contributions.
- Learning Traffic for Elevator Scheduling
  - Learning based Multi-variate time-series prediction with improved synthetic data generation.

Dynamic-programming based algorithm to perform optimal job scheduling.

MAY 2023 - AUGUST 2023

Boston Dynamics - *Spot Manipulation Software Engineering Intern*

- Contributed services for Gripper Cameras incorporated in the Spot 4.0 software release.
- Worked with image processing & legged control techniques to enhance camera calibration.

AUGUST 2023 - MAY 2024

Autonomous Loco-Manipulation Systems Group. WPI - *Research*

- Worked on Galileo (see "Publications"), a software library enabling pseudo-spectral optimization for legged robot motion planning.
- This work (>60 stars) was used in other projects, including HURON (humanoid robots) and BiQu (quadrupedal robot loco-manipulation).

Education

2020 - 2024

Worcester Polytechnic Institute (WPI); Masters & Bachelors of Science *in Robotics Engineering*

B.S. Thesis - BiQu Quadrupedal Robot

M.S. Thesis - Polytopic Action-Set and Motion Planning with Learned Representations of Behaviors

Publications

“Planning through Collision-Free Ellipsoidal Corridors With Orthogonal Trust Region Problems”, *Jaitly, A. Arrizabalaga, J. Li, G* (Submitted to ICRA 26)

- Created new parameterizations of free space, where trajectories were described using the cartesian product of hyper-spheres.
- Created a new optimization algorithm tailored to optimization in such feasible sets **(Orth-TRP solver).**
- Traditional algorithms rely on using Quadratic Programs to solve for trajectories through polytopes of collision free space. Experimentally, our new solver solved for optimal trajectories faster than the comparable QPs.

“Analytic Conditions for Differentiable Collision Detection in Trajectory Optimization”, *Jaitly, A. Jha, K D. Ota, K. Shirai, Y.* (IROS 25)

- This work introduced differentiable conditions that can be embedded as algebraic constraints in a trajectory optimization problem to simultaneously find and enforce constraints on the distance between bodies.
- Notably, we introduced new **approximate semi-algebraic representations of polytopes** to relax non-smooth complementarity constraints that come with similar methods.

“PAAMP: Polytopic Action-Set and Motion Planning for Long Horizon Dynamic Motion Planning via Mixed Integer Linear Programming”, *Jaitly, A. Farzan, S.* (IROS 24) -- https://arxiv.org/abs/2403.10924

- By approximating the set of dynamically feasible actions a system can undergo, this work introduced a Mixed-Integer Linear Programming (MILP) approach to motion planning.
- We introduced a heuristic to effectively search integer values in the given MILP based on geometric analysis of the approximated set.

“Galileo: An Efficient Pseudospectral Collocation Framework for Legged Robots”, *Chandler, E. Jaitly, A. Agheli, M.* (ICRA @40) -- https://arxiv.org/abs/2409.12465

- Galileo is an open source library implementing pseudospectral collocation to solve for legged robot locomotion.
- We solved hopping, trotting, and jumping motions on Boston Dynamics’ Atlas, WPI’s Huron, and Unitree Go1.

“A MILP-Based Framework for Coordinated Multi-Agent Motion Planning and Collision Avoidance in Constrained Environments”, *Farzan, S. Jaitly, A. Cline J.* (CASE 25) -- https://arxiv.org/abs/2506.21982

- We investigate the application of PAAMP to Multi-Agent Pathfinding, where feasible agent actions are represented with polytopic sets.

Selected Projects

LLAMA-Q: A C++ Library to Abstract and Generalize Robot Control

MIT THINK award finalist; Granted a presentation slot at MakerFaire 2020.

- Meant to enable high-level experimentation with robots on microcontrollers for hobbyists.
- Wrote Gradient Descent and SQP optimizers from scratch to develop generic kinematics solvers.
- Worked on robots like the cable actuated “WireBot”, where it enabled rapid prototyping.

Degen_vert2lcon: A MATLAB library to find the Convex Hull of points that lie in an affine subspace

-- https://github.com/Akshay5312/degen_vert2lcon

- Published on MATLAB file exchange, this addressed limitations of existing methods for finding convex hulls.

Drake (contributor) -- https://github.com/RobotLocomotion/drake

- Contributor on Drake, an open source library (>3.5 k stars) for simulation, control, and optimization.
- Contributions include enabling visualization of arbitrary convex shapes and methods to scale hyper-ellipsoids.
- Contributions were made, in part, to support my work with contact aware motion planning.

BasicLinearAlgebra (contributor)-- https://github.com/tomstewart89/BasicLinearAlgebra

- Contributor on BLA, an open source library (> 200 stars) for linear algebra on microcontrollers.
- Contributed methods for differentiation, advanced initialization, and support for vector-valued functions.

Galileo (see publications) -- https://github.com/echandler5956f/Galileo

Task Allocation for Data Mules in Intermittent Networks of Robots (team)

- Led the development of a distributed optimizer for task allocation in intermittent networks.
- Sped up the task of coming to consensus by leveraging clock synchronization.

Teaching

NuVu High School

- I was invited to develop curricula for and teach semester-long courses relating to Linear Algebra, applied math, and Robotics to students in 7th - 12th grades.
- I oversaw the completion of various student projects, including implementation of satellite localization algorithms and prosthetics development.

Mentor, Curious Cardinals

- Built curriculum on kinematics, microcontrollers, etc for Curious Cardinals, a startup out of Stanford.

STEMpump

- Directed new projects for STEMpump, a student-led education service with over 85k students worldwide. This included overseeing pedagogy and new course development.

Curriculum Development for the Experiential Robotics Platform

- Worked with teachers specializing in English as a Second Language (ESL) courses to develop curriculum for an affordable hands-on robotics platform (XRP). The XRP project has been used to teach robotics worldwide.

I am a U.S Citizen, and thus am authorized to work in the U.S.