# **Akshay Jaitly**

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I study how mathematically challenging problems can be **formulated to expose exploitable structure** and solved through **new optimization methods**. By uniting geometric insight with scalable algorithms, I aim to enable real-time autonomy and planning, including in navigation, cooperative manipulation, and autonomous construction for space exploration.

Interests -- Optimization, Geometry, Motion Planning, Switched Systems, Combinatorics, Navigation, Manipulation
Skills -- C++, Python, Drake, PyTorch, ROS 2, Matlab, CasADI, Git, OpenCV, Eigen

## **Selected Publications**

"Trajectory Planning Using Safe Ellipsoidal Corridors as Projections of Orthogonal Trust Regions", Jaitly, A. Arrizabalaga, J. Li, G (Submitted to ICRA 26)

- Formulated the Orthogonal Trust Region Problem (Orth-TRP), a new convex optimization class extending the classical TRP.
- Overcame time-allocation and discretization limits of polytopic corridor planners with continuous ellipsoidal parameterizations.
- Achieved faster runtimes and smoother quadrotor trajectories than state-of-the-art methods on benchmark tasks.

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

- Introduced Minimum-Offset-To-Touch (MOTT) conditions, embedding collision constraints as smooth algebraic equalities.
- Developed semi-algebraic polytope approximations to eliminate non-smooth complementarity constraints.
- Enabled single-level trajectory optimization with significantly reduced runtime compared to DCOL.

"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

- Developed Polytopic Action Sets as convex approximations of feasible actions. This conceptually extended existing Graph of Sets methods to formulate motion planning as a Mixed Integer Linear Program.
- We introduced methods 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) -- <a href="https://arxiv.org/abs/2409.12465">https://arxiv.org/abs/2409.12465</a>

- Created Galileo, an open-source pseudospectral collocation framework for legged locomotion.
- Introduced a new transcription method optimizing directly on manifolds (e.g., SE(3), quaternions).
- Demonstrated 50Hz MPC trajectories for Atlas, HURON, and Unitree Go1, enabling real-time dynamic maneuvers.

# **Experience**

MARCH 2025 - PRESENT

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

- Led independent research on novel optimization formulations (Orth-TRP) and applied them to safe quadrotor planning, resulting in ICRA '26 and IJRR submissions.
- Designed and proved convergence of new Trust Region Problem solvers.
- Collaborated closely with the PI and graduate peers to integrate methods into the lab's planning stack.

JUNE 2024 - MARCH 2025

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

- Single Level Collision Detection For Trajectory Optimization
- o Outperformed other state-of-the-art methods like DCOL (Tracy et all) for collision detection in an optimization program.
- 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.
  - Developed a Dynamic-programming based algorithm to perform optimal job scheduling.

## **Boston Dynamics** - Spot Manipulation Software Engineering Intern

- Designed and deployed code on Spot 4.0, shipped in the production release.
- These include calibration algorithms for Spot's gripper cameras, utilizing computer vision and control methods to improve perception robustness on a deployed legged platform.

AUGUST 2023 - MAY 2024

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

- Co-created Galileo, an open-source pseudospectral optimization framework for legged robots.
- Extended pseudospectral methods to optimize directly on manifolds (SE(3), quaternions), enabling real-time 50Hz MPC for humanoid and quadruped robots.
- Released Galileo to the community (>60 stars), demonstrating commitment to open science and reproducibility.

## **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

# **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.

#### **Drake** (contributor)

- 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.

<u>Degen vert2lcon</u>: A MATLAB library to find the Convex Hull of points that lie in an affine subspace -- MATLAB library for computing convex hulls of points in affine subspaces; published on MATLAB File Exchange to address gaps in existing convex geometry methods.

<u>BasicLinearAlgebra</u> (contributor) -- Added support for differentiation, advanced initialization, and vector-valued functions to a C++ library (>200 stars) enabling efficient linear algebra on microcontrollers.

Galileo (see publications)

# **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.