

Shubham Singh

A roboticist skilled in dynamic locomotion, optimization, estimation, controls & effective communication. Interests- Model Predictive Control, Optimization-based-control, Dynamics, Kinematics

Education

- Expected **PhD in Aerospace Engineering, The University of Texas at Austin, TX**
Aug'23 Relevant Courses: Human Centered Robotics, Optimal Control Theory, Statistical Estimation
2016 **MS in Aerospace Engineering, Purdue University, IN**
2014 **B.Tech in Mechanical Engineering, Delhi Technological University, India**

Research/Work Experience

- May –Aug'22 **Robotics Research Intern, Flexiv Robotics, CA**
- Benchmarked a novel contact-aware MPC force controller on a 7-DoF manipulator for polishing/sanding applications
- Simulation using PyBullet, GramPC, Pinocchio, and communication using the LCM tool.
- Skills used- Trajectory Optimization, Model Predictive Control, C++, Python
- June'20– **Data Scientist, AI Research Lab, Dell, Austin**
July'20 - Worked towards automation of Data-Driven Data Centers
- Skills used- Reinforcement Learning, Deep Learning, Tensorflow, DockerHUB
- August'18– **Graduate Research Assistant, The University of Texas at Austin**
- Theoretical and algorithmic contribution to the dynamic modeling of robots using Featherstone's Spatial-Vector Algebra
- Developed for the first time, the analytical expressions for first/second-order derivatives of Inverse/Forward dynamics for modeling robotic motion, new algorithms provide upto 5x speed-up over state-of-the-art Automatic Differentiation approach
- Working on developing model-based control algorithms for legged robots. Contributed novel algorithms to open-source C++ library [Pinocchio](#)
- Motion planning for the Mini Cheetah using the simplified quadruped model
- Used TOWR C++library for motion-planning of HyQ quadruped model
- Skills used- Trajectory Optimization (CasADi), Spatial Vector Algebra, C++, Fortran
- June'15– **Graduate Research Assistant, Rapid Design of Systems Lab, Purdue University**
December'17 - Implementing indirect trajectory optimization methods for Hypersonic mission design
- Skills used- Trajectory Optimization, Control Theory, MATLAB
- June'13– **Summer Research Intern, Turbulence Research Lab, University of Toronto**
August'13 - Skills used- LABview, Hardware/software integration

Publications

1. **Singh, S.**, Russell, R. P., & Wensing, P. M., *A Multi-Shooting Differential Dynamic Programming for Hybrid Systems using Analytical Derivatives*, Under-Review at 2023 IEEE Humanoids. [Pre-print](#)
2. **Singh, S.**, Russell, R. P., & Wensing, P. M., *On Second-Order Derivatives of Rigid-Body Dynamics: Theory & Implementation*, Conditionally Accepted, IEEE Transactions on Robotics, 2023. [Pre-print](#)
3. **Singh, S.**, Russell, R. P., & Wensing, P. M., *Analytical Second-Order Partial Derivatives of Rigid-Body Inverse Dynamics*, 2022 IEEE/RSJ IROS, pp. 11781-11788. [Pre-print](#), [Code](#) **Finalist for IEEE Model-Based TC Award 2022.**
4. **Singh, S.**, Russell, R. P., & Wensing, P. M., *Efficient Analytical Derivatives of Rigid-Body*

Dynamics using Spatial Vector Algebra., in IEEE RA-L, vol. 7, no. 2, pp. 1776-1783, April 2022, presented at ICRA 2022. [Pre-print](#), [Code](#) **Honourable Mention for IEEE RA-L 2022.**

5. Russell, R., **Singh, S.**, & Wensing, P. (2019). *Advancing the Runtime and Robustness of Differential Dynamic Programming*. Workshop: Toward Online Optimal Control of Dynamic Robots, ICRA, Montreal, Canada.
6. **Singh, S.**, & Grant, M. (2018). *The use of Homotopy Analysis Method for indirect trajectory optimization*. Scitech AIAA, Kissimmee, Florida. [Paper](#)
7. O'Neill, W., Guariniello, C., Das-Stuart, A., Mall, K., **Singh, S.**, & Delaurentis D., (2017). *Application Of A Top Down System-of Systems Approach To Enable Human Mars Exploration Missions*. IAC, Adelaide, Australia. [Paper](#)
8. **Singh, S.** (2016). Applications of the homotopy analysis method to optimal control problems. Purdue University. [Thesis](#)
9. **Singh, S.**, & Zunaid, M. (2014). Numerical Study of the Generic Sports Utility Vehicle Design with a Drag Reduction Add-On Device. Journal of Computational Engineering, Hindawi. [Paper](#)

Achievements & Awards

March, Sept'22 **IEEE RAS Travel Award (ICRA, IROS 2022)**, *IEEE, RAS*
Feb, Sept'22 **UT Austin Graduate Professional Travel Award**, *Graduate School, UT Austin*
August'21, **Warren A. and Alice L. Meyer Endowed Scholarship in Engineering**, *Cockrell School of Engineering Scholarship, UT Austin*
July'22 *School of Engineering Scholarship, UT Austin*
May'17 **AIAA Graduate Mission Design Competition 2016-17** , *Third Place for Mid-Tier Defense Against Hypersonic Glide Vehicles (Team-Lead, Purdue University)*
June'13 **MITACS Globalink Scholarship, Canada**, *University of Toronto*
May'11 **Merit Scholarship**, *Delhi Technological University*

Professional Activities/Volunteering

2022 **Reviewer**, *ICRA 2023, RA-L*
2023 **Reviewer**, *IJHR, IROS 2023*

Skills

, *Programming Skills:*

- **Fortran 90/77 (Libraries-BLAS,MKL), C++(Libraries-Eigen, STL), Python**
- **Mathematica, Maple:** Symbolic Manipulators
- **SOLIDWORKS, CATIA, Pro-Engineer, AutoCAD:** CAD Tools
- **STK-AGI, MATLAB & Simulink, LATEX:** Engineering/Type-setting Software

, *Technical Skills:*

- Expertise Optimization (IPOPT/SNOPT), Dynamic Locomotion, Machine/Reinforcement Learning, ROS, Physics simulation engines (PyBullet), Version control (Git), CI/CD, Debugging/Troubleshooting, Docker, LCM, IMU, microcontrollers, gRPC, cloud computing.

, *Non-Technical Skills:*

- Public Speaking and Effective Communication- Member of UT Science Toastmasters

References

1. Dr. Ryan P. Russell (Ph.D. Supervisor)- Professor, The University of Texas at Austin.
2. Dr. Patrick M. Wensing - Assoc. Professor, University of Notre Dame.
3. Dr. Xiyang Yeh (Intern Supervisor) - Flexiv Robotics, CA.