

# Shubham Singh

A roboticist skilled in Dynamic Locomotion, Optimization, Estimation, Sensor Fusion, Model Predictive Controls, Dynamics, & Kinematics.

## Education

- 2023 **PhD in Aerospace Engineering, The University of Texas at Austin, TX**
- 2016 **MS in Aerospace Engineering, Purdue University, IN**
- 2014 **B.Tech in Mechanical Engineering, Delhi Technological University, India**

## Research/Work Experience

- Aug'23 – **Locomotion Control Engineer, [Shift Robotics](#), TX**
  - Design of Gait Control Software ([Shift OS](#)) for Moonwalkers
  - Skills used- Classical Control, Estimation, Biomechanics, C/C++, Python, Git
- May – Aug'22 **Robotics Research Intern, [Flexiv Robotics](#), CA**
  - Benchmarked a novel contact-aware MPC force controller on a 7-DoF manipulator
  - 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](#)**
- Aug'23
  - 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
  - Worked 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
  - 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., *Analytical Second-Order Derivatives of Rigid Contact Dynamics: Application to Multi-Shooting DDP*, 2023 IEEE-RAS Humanoids, Austin, TX. [Paper](#)
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. [Paper](#), [Code](#) **Finalist for IEEE Model-Based TC Award 2023.**

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. [Paper](#), [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
- 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*

## Academic Reviewing (Web-of-Science)

- Journals (8) , *IEEE RA-L ('22,'23)*, *IJHR ('23, '24)*, *Multibody System Dynamics ('23)*
- Conf. (9) , *IROS ('22,'23)*, *ICRA ('22,'23,'24)* *Humanoids ('23)*

## 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, ROS, Physics engines (PyBullet), Version control (Git), Debugging/Troubleshooting.

, *Non-Technical Skills:*

- Public Speaking and Effective Communication- Member of UT Science Toastmasters
- Peer Mentor at Blank Stuttering Institute, UT Austin

## 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.