Shubham Singh

✉ singh281@utexas.edu
🌐 shubhamsingh91.github.io
in singh281
⌥ shubhamsingh91

A roboticist skilled in dynamic locomotion, optimization, estimation, and controls. Interests- Model Predictive Control, Optimization-based-control, 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
- System Design & adding features to the Gait Control Algorithm for Moonwalkers
- Skills used- Modern & Classical Control, Estimation, C/C++, Python, Biomechamics, Git

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*
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
- 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
- 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* , Accepted 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 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. 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, July'22	**Warren A. and Alice L. Meyer Endowed Scholarship in Engineering**, *Cockrell 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

Journals (6)	, *IEEE RA-L ('22,'23), IJHR ('23), 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, 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.