Balakumar Sundaralingam, Ph.D.

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Staff Research Scientist at NVIDIA Research working across GPU-accelerated motion planning, optimization, control, perception, and robot learning, with 35+ peer-reviewed publications and 15+ patents and patent applications. Creator and technical lead of cuRobo, a broadly adopted open-source motion-generation library. Mentors interns, students, and collaborators toward publications at top robotics venues, and partners with engineering teams to translate robotics research into production-ready, maintainable systems.

Technical Profile

Motion & Control	Real-time motion generation, collision-free whole-body planning for high-DoF robots/humanoids, trajectory optimization, MPC
CUDA Robotics	GPU-native kinematics, inverse dynamics, collision checking, signed-distance fields, numerical optimization
3D Perception	GPU TSDF/ESDF mapping, depth fusion, real-time reconstruction
Robot Learning	Diffusion-based planning & grasping, learned value functions, imitation-learning data generation, language-guided behavior
Deployment & Systems	Research-to-product translation, real-time CUDA/C++ & TensorRT deployment, open-source libraries, ROS integration
Software & Platforms	Python, C++, CUDA, PyTorch, Warp, TensorRT, ROS; manipulators, dexterous hands

Research Experience

Staff Research Scientist — NVIDIA Research
Robotics Research — 2020–Present

- Created and lead cuRobo, an open-source library that formulates global motion planning as GPU-parallel trajectory optimization; achieved 60x faster planning, 6x lower jerk, and 25% faster motion time. Adopted across academic and industrial robotics projects worldwide.
- Led cuRoboV2, extending the framework to dynamics-aware whole-body motion for high-DoF robots and humanoids; achieved 99.7% success under full payload and 99.6% collision-free IK on humanoids.
- Developed a fast, memory-efficient GPU TSDF/ESDF perception pipeline that fuses depth, meshes, and primitives into real-time distance fields for collision-aware planning.
- Built the multi-year CUDA robotics foundation underlying cuRobo and cuRoboV2, including batched kinematics, inverse dynamics, signed-distance fields, collision checking, and parallel numerical optimization.
- Partnered with product and engineering teams to translate cuRobo into deployable robotics software, including cuMotion, Isaac ROS integrations, Isaac Lab/Isaac Mimic motion augmentation, perception-aware pick-and-place, and motion-planning benchmarking.
- Mentored 10+ Ph.D. interns, university students, and engineering interns across robotics research and product-facing engineering, with work published at CoRL, RSS, ICRA, IROS, and RA-L.
- Set technical direction for GPU-accelerated motion generation and collaborated on robot-learning and control research (diffusion-based planning, learned value functions, visual grasping, and language-guided behavior), aligning research with deployable robotics.

Robotics Research Intern NVIDIA Research
Perception for Manipulation 2018
Advisors: Prof. Dieter Fox, Dr. Nathan Ratliff, Dr. Ankur Handa, Prof. Stan Birchfield

- Formulated a tactile force-estimation research problem through discussions with senior researchers, combining robot-interaction data collection with geometry-aware neural-networks for BioTac fingertip sensors.
- Built robot experimental infrastructure as a founding intern in the lab, supporting tactile sensing, object pose estimation, and manipulation experiments.
- Integrated the data collection paradigm and neural network into a highly accurate tactile force-estimation model, resulting in an ICRA 2019 paper selected as a **finalist for the Best Manipulation Paper award**.
- Helped accelerate related intern projects on object pose estimation, visuo-tactile state/force inference, and learning latent dynamics for tactile servoing, contributing to one CoRL and two ICRA papers.

Research Assistant University of Utah
Dexterous Manipulation 2015–2020
Advisor: Prof. Tucker Hermans

- Developed algorithms for dexterous in-hand manipulation of unknown objects using multi-fingered robotic hands.
- Designed and validated kinematic trajectory-optimization methods for in-hand object reposing without object dynamics models, including 500 real-world experiments with YCB objects.
- Developed tactile inference methods for estimating in-hand object dynamics using factor-graphs.
- Set up robot hardware and software infrastructure for manipulation experiments across dexterous hands, grasping, tactile inference, and benchmarking projects.
- Collaborated with Ph.D. colleagues and an undergraduate student on grasping, manipulation benchmarking, and human-humerus robotics projects, contributing to publications across RSS, ICRA, T-RO, Autonomous Robots, RA-L, RAM, and PLOS ONE.

Education

University of Utah Salt Lake City, UT, USA
Ph.D. in Computing (Robotics) 2014–2020

SASTRA University Thanjavur, TN, India
B.Tech in Mechatronics, First class with distinction 2009–2013

Honors & Awards

1. RA-L Best Paper Award, 2022: *Geometric Fabrics: Generalizing Classical Mechanics to Capture the Physics of Behavior*
2. CoRL Oral Presentation, 2021: *STORM: An Integrated Framework for Fast Joint-Space Model-Predictive Control for Reactive Manipulation*
3. ICRA Best Paper in Robot Manipulation Finalist, 2019: *Robust Learning of Tactile Force Estimation through Robot Interaction*

Publications

Peer-reviewed Articles

1. Grasp-MPC: Closed-Loop Visual Grasping via Value-Guided Model Predictive Control, J. Yamada, A. Murali, A. Mandlekar, C. Eppner, I. Posner, and B. Sundaralingam, *2026 IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, 2026.
2. GraspGen: A diffusion-based framework for 6-DoF grasping with on-generator training, A. Murali, B. Sundaralingam, Y.-W. Chao, W. Yuan, J. Yamada, M. Carlson, F. Ramos, S. Birchfield, D. Fox, and C. Eppner, *2026 IEEE International Conference on Robotics and Automation (ICRA)*, IEEE, 2026.
3. VT-Refine: Learning Bimanual Assembly with Visuo-Tactile Feedback via Simulation Fine-Tuning, B. Huang, J. Xu, I. Akinola, W. Yang, B. Sundaralingam, R. O'Flaherty, D. Fox, X. Wang, A. Mousavian, Y.-W. Chao, *et al.*, *9th Annual Conference on Robot Learning*, 2025.
4. Avoid Everything: Model-Free Collision Avoidance with Expert-Guided Fine-Tuning, A. Fishman, A. Walsman, M. Bhardwaj, W. Yuan, B. Sundaralingam, B. Boots, and D. Fox, *9th Annual Conference on Robot Learning*, 2025.
5. Dynamic non-prehensile object transport via model-predictive reinforcement learning, N. Jawale, B. Boots, B. Sundaralingam, and M. Bhardwaj, *2025 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3647–3653, IEEE, 2025.
6. Inference-time policy steering through human interactions, Y. Wang, L. Wang, Y. Du, B. Sundaralingam, X. Yang, Y.-W. Chao, C. Pérez-D'Arpino, D. Fox, and J. Shah, *2025 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 15626–15633, IEEE, 2025.
7. DiffusionSeeder: Seeding Motion Optimization with Diffusion for Rapid Motion Planning, H. Huang, B. Sundaralingam, A. Mousavian, A. Murali, K. Goldberg, and D. Fox, *8th Annual Conference on Robot Learning*, 2025.
8. Ready, Set, Plan! Planning to Goal Sets Using Generalized Bayesian Inference, J. Pavlasek, S. R. Lewis, B. Sundaralingam, F. Ramos, and T. Hermans, *Conference on Robot Learning*, pp. 3672–3686, PMLR, 2023.
9. VaPr: Variable-Precision Tensors to Accelerate Robot Motion Planning, Y.-S. Hsiao, S. K. S. Hari, B. Sundaralingam, J. Yik, T. Tambe, C. Sakr, S. W. Keckler, and V. J. Reddi, *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 6304–6309, IEEE, 2023.
10. cuRobo: Parallelized collision-free robot motion generation, B. Sundaralingam, S. K. S. Hari, A. Fishman, C. Garrett, K. Van Wyk, V. Blukis, A. Millane, H. Oleynikova, A. Handa, F. Ramos, *et al.*, *2023 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 8112–8119, IEEE, 2023.
11. DexTreme: Transfer of agile in-hand manipulation from simulation to reality, A. Handa, A. Allshire, V. Makoviychuk, A. Petrenko, R. Singh, J. Liu, D. Makoviichuk, K. Van Wyk, A. Zhurkevich, B. Sundaralingam, *et al.*, *2023 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 5977–5984, IEEE, 2023.
12. RGB-only reconstruction of tabletop scenes for collision-free manipulator control, Z. Tang, B. Sundaralingam, J. Tremblay, B. Wen, Y. Yuan, S. Tyree, C. Loop, A. Schwing, and S. Birchfield, *ICRA*, pp. 1778–1785, IEEE, 2023.
13. Geometric Fabrics: Generalizing Classical Mechanics to Capture the Physics of Behavior, K. Van Wyk, M. Xie, A. Li, M. A. Rana, B. Babich, B. Peele, Q. Wan, I. Akinola, B. Sundaralingam, D. Fox, B. Boots, and N. D. Ratliff, *IEEE Robotics and Automation Letters*, vol. 7, no. 2, pp. 3202–3209, 2022, **Best Paper Award RA-L 2022**.
14. Learning Perceptual Concepts by Bootstrapping from Human Queries, A. Bobu, C. Paxton, W. Yang, B. Sundaralingam, Y.-W. Chao, M. Cakmak, and D. Fox, *IEEE Robotics and Automation Letters*, 2022.
15. DefGraspSim: Physics-based simulation of grasp outcomes for 3D deformable objects, I. Huang, Y. Narang, C. Eppner, B. Sundaralingam, M. Macklin, R. Bajcsy, T. Hermans, and D. Fox, *IEEE Robotics and Automation Letters*, pp. 1–1, 2022.
16. Correcting Robot Plans with Natural Language Feedback, P. Sharma, B. Sundaralingam, V. Blukis, C. Paxton, T. Hermans, A. Torralba, J. Andreas, and D. Fox, *Proceedings of Robotics: Science and Systems*, 2022.
17. Model Predictive Control for Fluid Human-to-Robot Handovers(*equal contribution), W. Yang*, B. Sundaralingam*, C. Paxton*, I. Akinola, Y.-W. Chao, M. Cakmak, and D. Fox, *ICRA*, 2022.

18. HandoverSim: A Simulation Framework and Benchmark for Human-to-Robot Object Handovers, Y.-W. Chao, C. Paxton, Y. Xiang, W. Yang, B. Sundaralingam, T. Chen, A. Murali, M. Cakmak, and D. Fox, *ICRA*, 2022.
19. Interpreting and predicting tactile signals for the SynTouch BioTac, Y. S. Narang, B. Sundaralingam, K. V. Wyk, A. Mousavian, and D. Fox, *The International Journal of Robotics Research*, vol. 40, no. 12-14, pp. 1467–1487, 2021.
20. STORM: An Integrated Framework for Fast Joint-Space Model-Predictive Control for Reactive Manipulation, M. Bhardwaj, B. Sundaralingam, A. Mousavian, N. D. Ratliff, D. Fox, F. Ramos, and B. Boots, *Proceedings of the 5th Conference on Robot Learning*, vol. 164 of *Proceedings of Machine Learning Research*, pp. 750–759, PMLR, 08–11 Nov 2022, **Selected for Oral Presentation (6.5% acceptance rate)**.
21. Sim-to-Real for Robotic Tactile Sensing via Physics-Based Simulation and Learned Latent Projections (*equal contribution), Y. Narang*, B. Sundaralingam*, M. Macklin, A. Mousavian, and D. Fox, *ICRA*, 2021.
22. Replicating dynamic humerus motion using an industrial robot, K. Aliaj, G. M. Feeney, B. Sundaralingam, T. Hermans, K. B. Foreman, K. N. Bachus, and H. B. Henninger, *PLOS ONE*, vol. 15, pp. 1–23, 11 2020.
23. In-Hand Object-Dynamics Inference using Tactile Fingertips, B. Sundaralingam and T. Hermans, *IEEE Transactions on Robotics*, 2021.
24. Multi-Fingered Grasp Planning via Inference in Deep Neural Networks, Q. Lu, M. V. der Merwe, B. Sundaralingam, and T. Hermans, *IEEE Robotics & Automation Magazine*, 2020.
25. Joint Space Control via Deep Reinforcement Learning, V. Kumar, D. Hoeller, B. Sundaralingam, J. Tremblay, and S. Birchfield, *2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 3619–3626, 2021.
26. Learning Continuous 3D Reconstructions for Geometrically Aware Grasping, M. V. der Merwe, Q. Lu, B. Sundaralingam, M. Matak, and T. Hermans, *ICRA*, 2020.
27. Robust Learning of Tactile Force Estimation through Robot Interaction, B. Sundaralingam, A. Lambert, A. Handa, B. Boots, T. Hermans, S. Birchfield, N. Ratliff, and D. Fox, *ICRA*, 2019, **Finalist for Best Paper in Robot Manipulation Award**.
28. Joint Inference of Kinematic and Force Trajectories with Visuo-Tactile Sensing, A. Lambert, M. Mukadam, B. Sundaralingam, N. Ratliff, B. Boots, and D. Fox, *ICRA*, 2019.
29. Learning Latent Space Dynamics for Tactile Servoing, G. Sutanto, N. Ratliff, B. Sundaralingam, Y. Chebotar, Z. Su, A. Handa, and D. Fox, *ICRA*, 2019.
30. Benchmarking In-Hand Manipulation(*equal contribution), S. Cruciani*, B. Sundaralingam*, K. Hang, V. Kumar, T. Hermans, and D. Kragic, *IEEE Robotics and Automation Letters*, 2019.
31. Relaxed-rigidity constraints: kinematic trajectory optimization and collision avoidance for in-grasp manipulation, B. Sundaralingam and T. Hermans, *Autonomous Robots*, 2019.
32. Deep Object Pose Estimation for Semantic Robotic Grasping of Household Objects, J. Tremblay, T. To, B. Sundaralingam, Y. Xiang, D. Fox, and S. Birchfield, *CoRL*, 2018.
33. Geometric In-Hand Regrasp Planning: Alternating Optimization of Finger Gaits and In-Grasp Manipulation, B. Sundaralingam and T. Hermans, *ICRA*, 2018.
34. Planning Multi-Fingered Grasps as Probabilistic Inference in a Learned Deep Network, Q. Lu, K. Chenna, B. Sundaralingam, and T. Hermans, *ISRR*, 2017.
35. Relaxed-Rigidity Constraints: In-Grasp Manipulation using Purely Kinematic Trajectory Optimization, B. Sundaralingam and T. Hermans, *Robotics: Science and Systems (RSS)*, 2017.

Patents & Patent Applications

1. Generating grasp poses for controlling robots using diffusion models, A. Murali, Y.-W. Chao, C. Eppner, B. Sundaralingam, F. T. Ramos, and D. Fox, Apr. 30 2026. US Patent App. 19/266,798.
2. Model predictive control with learned value functions for robot grasping, B. Sundaralingam, A. U. Mandlekar, A. Murali, and J. Yamada, Apr. 23 2026. US Patent App. 19/359,492.
3. Techniques for closed-loop code generation for robot control, V. Blukis, A. Zook, S. Birchfield, B. Sundaralingam, and J. Tremblay, Apr. 9 2026. US Patent App. 19/249,912.

4. Interactive cost corrections with natural language feedback, B. Sundaralingam, P. Sharma, C. J. Paxton, V. Blukis, T. Hermans, and D. Fox, Dec. 23 2025. US Patent 12,502,789.
5. Robot motion generation on enhanced computer processors, S. K. S. Hari and B. Sundaralingam, Oct. 30 2025. US Patent App. 18/646,456.
6. Reactive interactions for robotic applications and other automated systems, W. Yang, B. Sundaralingam, C. J. Paxton, M. Cakmak, Y.-W. Chao, D. Fox, and I. Akinola, Oct. 28 2025. US Patent 12,454,050.
7. Simulating physical interactions for automated systems, Y.-W. Chao, Y. Xiang, W. Yang, D. Fox, C. Paxton, B. Sundaralingam, and M. Cakmak, Sept. 2 2025. US Patent 12,403,589.
8. Seeding motion optimization with diffusion for rapid motion planning, B. Sundaralingam, H. Huang, A. Mousavian, A. Murali, and D. Fox, Aug. 28 2025. US Patent App. 18/899,363.
9. Techniques for robot control using multi-modal user inputs, Y. Wang, B. Sundaralingam, X. Yang, Y.-W. Chao, C. P. D'ARPINO, and D. Fox, Aug. 7 2025. US Patent App. 18/665,271.
10. Techniques for robot control using neural implicit value functions, A. Murali, B. Sundaralingam, C. Yun-Chun, D. Fox, and G. Animesh, June 3 2025. US Patent 12,318,935; continuation app. 19/219,934.
11. Techniques for differentiable deep object pose estimation, J. Tremblay, S. Birchfield, V. Blukis, B. Sundaralingam, S. Tyree, and B. Wen, Mar. 27 2025. US Patent App. 18/608,804.
12. Geometric policy fabrics for accelerated learning in robotics systems, platforms, and applications, N. D. Ratliff, K. Van Wyk, A. Handa, V. Makoviichuk, Y. Guo, J. Xu, T. LUM, B. Sundaralingam, and J. LIU, Mar. 13 2025. US Patent App. 18/646,312.
13. Collision-free motion generation, B. Sundaralingam, S. K. S. Hari, A. H. Fishman, C. R. Garrett, A. J. Millane, E. Oleynikova, A. Handa, F. T. Ramos, N. D. Ratliff, K. Van Wyk, *et al.*, Apr. 25 2024. US Patent App. 18/200,347.
14. Training machine learning models using simulation for robotics systems and applications, A. Handa, A. D. Allshire, D. Fox, J.-F. V. Lafleche, L. Jingzhou, V. Makoviichuk, Y. S. Narang, A. V. Petrenko, R. Singh, B. Sundaralingam, *et al.*, Mar. 21 2024. US Patent App. 18/448,049.
15. Techniques for controlling robots within environments modeled based on images, B. Sundaralingam, S. Birchfield, Z. Tang, J. Tremblay, S. Tyree, B. Wen, Y. Yuan, and C. Loop, Feb. 29 2024. US Patent App. 18/168,482.
16. Method for assessing the quality of a robotic grasp on 3D deformable objects, I. Huang, Y. S. Narang, C. Eppner, B. Sundaralingam, M. Macklin, T. R. Hermans, and D. Fox, Sept. 5 2023. US Patent 11,745,347.
17. Concept training technique for machine learning, A. Bobu, B. Sundaralingam, C. J. Paxton, M. Cakmak, W. Yang, Y.-W. Chao, and D. Fox, May 11 2023. US Patent App. 17/982,401.
18. Robotic tactile sensing, Y. S. Narang, B. Sundaralingam, K. Van Wyk, A. Mousavian, M. Macklin, and D. Fox, 2022. US Patent App. 17/213,062.
19. Force estimation using deep learning, S. Birchfield, B. Boots, D. Fox, A. Handa, N. Ratliff, B. Sundaralingam, and A. Lambert, Sept. 24 2020. US Patent App. 16/358,485.

Preprints

1. Diff-DOPE: Differentiable Deep Object Pose Estimation, J. Tremblay, B. Wen, V. Blukis, B. Sundaralingam, S. Tyree, and S. Birchfield, *arXiv preprint arXiv:2310.00463*, 2023.
2. Meta-Policy Learning over Plan Ensembles for Robust Articulated Object Manipulation, C. Chamzas, C. Garrett, B. Sundaralingam, L. E. Kavraki, and D. Fox, *arXiv preprint arXiv:2307.04040*, 2023.
3. Neural motion fields: Encoding grasp trajectories as implicit value functions, Y.-C. Chen, A. Murali, B. Sundaralingam, W. Yang, A. Garg, and D. Fox, *arXiv preprint arXiv:2206.14854*, 2022.

Technical Reports

1. cuRoboV2: Dynamics-Aware Motion Generation with Depth-Fused Distance Fields for High-DoF Robots, B. Sundaralingam, A. Murali, and S. Birchfield, *arXiv preprint arXiv:2603.05493*, 2026.

2. cuRobo: Parallelized Collision-Free Minimum-Jerk Robot Motion Generation, B. Sundaralingam, S. K. S. Hari, A. Fishman, C. Garrett, K. V. Wyk, V. Blukis, A. Millane, H. Oleynikova, A. Handa, F. Ramos, N. Ratliff, and D. Fox, 2023.

Invited Talks & Panels

1. Industry Panelist, RoboARCH Workshop at ICRA 2025: *Academia–Industry Collaborations: How Can Industry Support Research and How Can This Research Be Translational? What Is the View from Industry?*
2. Industry Alumni Talk, University of Utah Graduate Program Open House, 2025: *Why Pursue a Ph.D.? Perspectives on Graduate Research and Industry Careers*
3. Guest Lecture, University of Washington CSE 571: AI-Robotics, Spring 2024: *Motion Generation for Manipulation*
4. NVIDIA GTC 2024: *cuRobo: A CUDA-Accelerated Robot Motion Generation Toolkit*
5. Benchmarking Manipulation Workshop at ICRA 2019: *Building an In-Hand Manipulation Benchmark*

Academic Service

Associate Editor

1. IEEE Robotics & Automation Letters 2024
2. IEEE International Conference on Robotics and Automation [2021, 2022, 2023]

Reviewer

1. IEEE International Conference on Robotics and Automation [2017, 2019, 2020, 2021, 2022, 2023]
2. IEEE/RSJ International Conference on Intelligent Robots and Systems [2019, 2020, 2021]
3. IEEE-RAS International Conference on Humanoid Robots [2017]
4. International Symposium on Robotics Research [2019]
5. International Conference on Learning Representations [2021]
6. Neural Information Processing Systems (NeurIPS) [2021]
7. Conference on Robot Learning [2018, 2020, 2022]
8. Elsevier Mechanisms and Machine Theory
9. IEEE Robotics and Automation Letters
10. IEEE Transactions on Robotics