

Balakumar Sundaralingam

🌐 [balakumar-s.github.io](https://github.com/balakumar-s) · [in](#) balakumar-s

Education

University of Utah

Ph.D. Computing (Robotics)

Salt Lake City, UT, USA

2014 - 2020

Thesis: “Kinematic Planning and Dynamics Inference for In-Hand Manipulation”

Committee: Tucker Hermans(**advisor**), John Hollerbach, Srikumar Ramalingam, Vivek Srikumar, and Kris Hauser(University of Illinois at Urbana-Champaign).

SASTRA University

B.Tech in Mechatronics, First class with distinction

Thanjavur, TN, India

2009 - 2013

Research/Work Experience

Senior Research Scientist

Robot Manipulation, Research Scientist(2020-2022)

Manager: Prof. Dieter Fox

NVIDIA

2020-Present

- Researched a novel model predictive control framework for manipulators that leverages sampling based optimization and GPU compute for fast collision-free motion generation.
- Mentored interns on various research projects related to robotic manipulation.
- Organized internal talks and contributed to conferences via reviewing and associate editor roles.

Research Assistant

Dexterous Manipulation

Mentor: Prof. Tucker Hermans

University of Utah

2015-2020

- Dissertation research focuses on multi-fingered in-hand manipulation of unknown objects.
- Researched & empirically validated a kinematic trajectory optimization scheme for reposing a grasped object via in-hand manipulation without requiring object dynamics knowledge.
- Explored estimation of object dynamics in-hand leveraging tactile sensing and inference in a factor graph.

Robotics Research Intern

Perception for Manipulation

Mentors: Prof. Dieter Fox, Dr. Ankur Handa, Dr. Nathan Ratliff, Prof. Stan Birchfield

NVIDIA

Summer 2018

- Researched a novel data collection paradigm for tactile sensors, enabling excitation of sensor dynamics and accurate measurement of small scale forces.
- Developed a neural network architecture that encodes the geometry of the tactile sensor signals.
- Integrating the novel data collection paradigm and geometric neural network resulted in a highly accurate force estimation model for the BioTac sensor. This research was a **finalist for the Best Manipulation Paper award at ICRA 2019**.
- Collaborated with researchers working on projects related to object pose estimation, state estimation via tactile force sensing, and learning from demonstration for tactile servoing.

Graduate Assistant

Reactive Collision Avoidance, Mentor: Prof. Kam K. Leang

University of Utah

2014-2015

- Built holonomic mobile robot platform with 2D LIDAR and investigated local minima problems existent with state-of-the art reactive collision avoidance methods.

Undergraduate Thesis

SASTRA University

Mapping by LIDAR Scan Matching, Mentor: Prof. Prem S.

2012-2013

- o Implemented and extended line extraction algorithms (Split and Merge methods) to perform mapping by iterative line matching between LIDAR scans.
- o Setup data collection pipeline for the Pioneer3AT robot to analyze existing mapping methods.

Honors & Awards

- o Finalist for Best Manipulation Paper award at ICRA 2019.
- o Selected for Oral presentation at CoRL 2021.

Invited Talks

1. University of Utah Robotics Seminar 2019
2. Utah Deep learning meetup 2019
3. Benchmarking Manipulation workshop at ICRA 2019

Journal Articles

1. B. Sundaralingam and T. Hermans, Relaxed-rigidity constraints: kinematic trajectory optimization and collision avoidance for in-grasp manipulation, *Autonomous Robots*, 2019
2. S. Cruciani*, B. Sundaralingam*, K. Hang, V. Kumar, T. Hermans, and D. Kragic, Benchmarking In-Hand Manipulation(*equal contribution), *IEEE Robotics and Automation Letters*, 2019
3. Q. Lu, M. V. der Merwe, B. Sundaralingam, and T. Hermans, Multi-fingered grasp planning via inference in deep neural networks, *IEEE Robotics & Automation Magazine*, 2020
4. B. Sundaralingam and T. Hermans, In-hand object-dynamics inference using tactile fingertips, *IEEE Transactions on Robotics*, 2021
5. K. Aliaj, G. M. Feeney, B. Sundaralingam, T. Hermans, K. B. Foreman, K. N. Bachus, and H. B. Henninger, Replicating dynamic humerus motion using an industrial robot, *PLOS ONE*, vol. 15, pp. 1–23, 11 2020
6. Y. S. Narang, B. Sundaralingam, K. V. Wyk, A. Mousavian, and D. Fox, Interpreting and predicting tactile signals for the syntouch biotac, *The International Journal of Robotics Research*, vol. 40, no. 12-14, pp. 1467–1487, 2021
7. 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, Geometric fabrics: Generalizing classical mechanics to capture the physics of behavior, *IEEE Robotics and Automation Letters*, vol. 7, no. 2, pp. 3202–3209, 2022
8. I. Huang, Y. Narang, C. Eppner, B. Sundaralingam, M. Macklin, R. Bajcsy, T. Hermans, and D. Fox, Defgraspsim: Physics-based simulation of grasp outcomes for 3d deformable objects, *IEEE Robotics and Automation Letters*, pp. 1–1, 2022
9. A. Bobu, C. Paxton, W. Yang, B. Sundaralingam, Y.-W. Chao, M. Cakmak, and D. Fox, Learning perceptual concepts by bootstrapping from human queries, *IEEE Robotics and Automation Letters*, 2022

Peer-reviewed Conference Papers

1. B. Sundaralingam and T. Hermans, Relaxed-rigidity constraints: In-grasp manipulation using purely kinematic trajectory optimization, *Robotics: Science and Systems (RSS)*, 2017
2. Q. Lu, K. Chenna, B. Sundaralingam, and T. Hermans, Planning multi-fingered grasps as probabilistic inference in a learned deep network, *International Symposium on Robotics Research*, 2017
3. B. Sundaralingam and T. Hermans, Geometric in-hand regrasp planning: Alternating optimization of finger gaits and in-grasp manipulation, *IEEE Intl. Conf. on Robotics and Automation*, 2018

4. J. Tremblay, T. To, B. Sundaralingam, Y. Xiang, D. Fox, and S. Birchfield, Deep object pose estimation for semantic robotic grasping of household objects, *Conference on Robot Learning*, 2018
5. B. Sundaralingam, A. Lambert, A. Handa, B. Boots, T. Hermans, S. Birchfield, N. Ratliff, and D. Fox, Robust learning of tactile force estimation through robot interaction, *IEEE Intl. Conf. on Robotics and Automation*, 2019, **Finalist for Best Paper in Robot Manipulation Award**
6. A. Lambert, M. Mukadam, B. Sundaralingam, N. Ratliff, B. Boots, and D. Fox, Joint inference of kinematic and force trajectories with visuo-tactile sensing, in *IEEE Intl. Conf. on Robotics and Automation*, 2019
7. G. Sutanto, N. Ratliff, B. Sundaralingam, Y. Chebotar, Z. Su, A. Handa, and D. Fox, Learning latent space dynamics for tactile servoing, *IEEE Intl. Conf. on Robotics and Automation*, 2019
8. M. V. der Merwe, Q. Lu, B. Sundaralingam, M. Matak, and T. Hermans, Learning continuous 3d reconstructions for geometrically aware grasping, *IEEE Intl. Conf. on Robotics and Automation*, 2020
9. Y. Narang*, B. Sundaralingam*, M. Macklin, A. Mousavian, and D. Fox, Sim-to-real for robotic tactile sensing via physics-based simulation and learned latent projections (*equal contribution), *IEEE Intl. Conf. on Robotics and Automation*, 2021
10. V. Kumar, D. Hoeller, B. Sundaralingam, J. Tremblay, and S. Birchfield, Joint space control via deep reinforcement learning, in *2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 3619–3626, 2021
11. M. Bhardwaj, B. Sundaralingam, A. Mousavian, N. D. Ratliff, D. Fox, F. Ramos, and B. Boots, Storm: An integrated framework for fast joint-space model-predictive control for reactive manipulation, in *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)**
12. W. Yang*, B. Sundaralingam*, C. Paxton*, I. Akinola, Y.-W. Chao, M. Cakmak, and D. Fox, Model predictive control for fluid human-to-robot handovers(*equal contribution), in *IEEE Intl. Conf. on Robotics and Automation*, 2022
13. Y.-W. Chao, C. Paxton, Y. Xiang, W. Yang, B. Sundaralingam, T. Chen, A. Murali, M. Cakmak, and D. Fox, Handoversim: A simulation framework and benchmark for human-to-robot object handovers, in *IEEE Intl. Conf. on Robotics and Automation*, 2022
14. P. Sharma, B. Sundaralingam, V. Blukis, C. Paxton, T. Hermans, A. Torralba, J. Andreas, and D. Fox, Correcting robot plans with natural language feedback, in *Proceedings of Robotics: Science and Systems*, 2022

Patents

1. S. Birchfield, B. Boots, D. Fox, A. Handa, N. Ratliff, B. Sundaralingam, and A. Lambert, Force estimation using deep learning, Sept. 24 2020. US Patent App. 16/358,485
2. V. C. V. Kumar, D. Hoeller, B. Sundaralingam, J. Tremblay, and S. T. Birchfield, Transformation of joint space coordinates using machine learning, May 5 2022. US Patent App. 17/176,672

Academic Service

Associate Editor

1. IEEE International Conference on Robotics and Automation [2021, 2022]

Reviewer

1. International Conference on Learning Representations [2021]
2. Conference on Robot Learning [2018, 2020, 2022]

3. Elsevier Mechanisms and Machine Theory [2020]
4. IEEE International Conference on Robotics and Automation [2020]
5. IEEE/RSJ International Conference on Intelligent Robots and Systems [2020]
6. IEEE Robotics and Automation Letters [2018, 2019, 2020]
7. International Symposium on Robotics Research [2019]
8. Pioneers workshop at Robotics: Science and Systems [2019]
9. IEEE Transactions on Robotics [2019]
10. 5th international workshop on recovering 6D object pose at ICCV [2019]

Teaching

- o Created and conducted labs for kinematics, dynamics and parameter identification on robotic platforms, mentored by **Prof. John Hollerbach**
- o Served as a teaching assistant for the following courses

Intro. to Robotics: DH parameter computation, Forward and Inverse kinematics, and trajectory smoothing with the Baxter and KUKA robots.

System Identification for Robots: Kinematic and dynamic parameter estimation of the Baxter robot links and tools.

Mechatronics: Created lab protocols using Arduino to teach undergraduates implementation of basic controllers.