

Balakumar Sundaralingam

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Education

University of Utah

Ph.D. Student in Computing: Robotics Track, Cum. GPA: 3.8/4

Salt lake city, UT, USA

2014-Present

SASTRA University

B.Tech in Mechatronics, First class with distinction, Cum. GPA: 7.8/10

Thanjavur, TN, India

2009-2013

Research Experience

Dexterous Manipulation

Research assistant, LL4MA Lab, Publications:[1-4]

University of Utah

2015-Present

Advisor: **Prof. Tucker Hermans**

- Exploring multi-fingered dexterous manipulation of objects without extensive object models.
- Leveraging gradient based optimization for joint space robot motion planning.
- Developed a kinematic trajectory optimization scheme for in-hand reposing of a grasped object, with no dropping of the object during 500 real world experiments with YCB objects.
- Explored sequence planning for reposing a grasped object by fingertip relocation and object reposing.
- Recently started working on trajectory optimization through SQP (sequential quadratic program) for stable grasping and object information inference from tactile perception.

Tactile Manipulation

Robotics research intern, NVIDIA Research, Publications:[5-8]

NVIDIA Seattle Robotics Lab

May 2018-Aug 2018

Manager: **Prof. Dieter Fox**

- Trained a neural network for supervised learning of tactile force model to map tactile signals to force, with validation on robot manipulation task ([video](#)).
- Setup ROS and Python interface for multiple robot and perception systems to enable quick prototyping of robot experiments.
- Collaborated on projects related to object pose estimation, probabilistic graphical models for state estimation and learning from demonstration for tactile servoing.

Mapping by LIDAR Scan Matching

Research Assistant, Mobile Robotics Lab

SASTRA University

2012-2013

Advisor: **Prof. Prem S.**

- Developed algorithm for estimating transformation between consecutive LIDAR scans.
- Implemented line extraction algorithms(Split and Merge methods) to extract lines from LIDAR points.
- Rigid transformation was computed by minimizing the distance between points from consecutive frames and between the extracted lines.

Development Experience (C++,Python)

Hardware platforms: Pioneer 3AT, KUKA LWR4+, Franka Panda, Baxter, Allegro hand, Reflex hand.

Robot control interface: Developed low-level real-time controllers for the [Allegro hand](#) and the [KUKA lbr4](#) robot with FRI and KDL.

Simulation: Familiar with Vrep, Gazebo and KLAMPT for simulation of [manipulators](#) and [mobile robots](#).

Signed distance library: Explored signed distance computation from RGB-D sensor data. Implemented C++ perception library to compute signed distance(GJK+EPA) between objects by convex decomposition. Coded a C++ wrapper to work with FCL, libccd and KRISLibrary for collision checking.

Trajectory optimization: Implemented collision-free motion planners for manipulators by formulating SQPs with cost terms minimizing collisions with the environment ([video](#)).

Mobile robot collision avoidance: Investigated current reactive collision avoidance methods for holonomic mobile robots. Artificial potential field and vector polar histogram algorithms were implemented with a 2D LIDAR. Optic flow of sift features between frames from a monocular camera was also implemented to detect and avoid nearby obstacles ([video](#)).

Graduate Coursework

- o Intro. to Robotics ME EN 6220
- o Intro. to Optimization ME EN 6025
- o Robot Control CS 6330
- o State Space Controls ME EN 6210
- o Motion Planning ME EN 6225
- o 3D Computer Vision CS 6420
- o Machine Learning CS 6350
- o Sys. Identification for Robotics CS 7320

Teaching Assistantships: Intro. to Robotics, Mechatronics, Sys. Identification for Robotics.

Publications

1. **B. Sundaralingam** and T. Hermans, "Relaxed-rigidity constraints: In-grasp manipulation using purely kinematic trajectory optimization," *In 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," *In ISRR*, 2017
3. **B. Sundaralingam** and T. Hermans, "Geometric in-hand regrasp planning: Alternating optimization of finger gaits and in-grasp manipulation," *In ICRA*, 2018
4. **B. Sundaralingam** and T. Hermans, "Relaxed-rigidity constraints: kinematic trajectory optimization and collision avoidance for in-grasp manipulation," *In Autonomous Robots (AuRo)*, 2018
5. J. Tremblay, T. To, **B. Sundaralingam**, Y. Xiang, D. Fox, and S. Birchfield, "Deep object pose estimation for semantic robotic grasping of household objects," *In CoRL*, 2018
6. **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," *In ICRA*, 2019
7. A. Lambert, **B. Sundaralingam**, M. Mukadam, N. Ratliff, B. Boots, and D. Fox, "Joint inference of physics-based tracking and force estimation in planar pushing," *In ICRA*, 2019
8. G. Sutanto, N. Ratliff, **B. Sundaralingam**, Y. Chebotar, Z. Su, A. Handa, and D. Fox, "Learning latent space dynamics for tactile servoing," *In ICRA*, 2019