

Balakumar Sundaralingam

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Education

University of Utah
Ph.D. Candidate in Computing: Robotics Track

Salt Lake City, UT, USA
2014-Present

SASTRA University
B.Tech in Mechatronics, First class with distinction

Thanjavur, TN, India
2009-2013

Research Experience

Dexterous Manipulation

Research assistant, Publications:[1-3,5]
Mentor: Prof. Tucker Hermans

University of Utah
2015-Present

- 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, Publications:[4,6-8]

NVIDIA Seattle Robotics Lab
May 2018-Aug 2018

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

- Trained a neural network for supervised learning of tactile force model to map tactile signals to force, with validation on robot manipulation task.
- Collaborated on projects related to object pose estimation, probabilistic graphical models for state estimation and learning from demonstration for tactile servoing.

Reactive Collision Avoidance for Quadrotors & Mobile robots

Research assistant, DARC Lab

University of Utah
2014-2015

Mentor: Prof. Kam K. Leang

- Built holonomic mobile robot platform to study collision avoidance methods.
- Explored local minima problems existent with reactive collision avoidance approaches.

Mapping by LIDAR Scan Matching

Research assistant, Mobile Robotics Lab

SASTRA University
2012-2013

Mentor: 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.
- Built 2D map of the environment leveraging the estimated transformation between LIDAR scans.

Development Experience (C++, Python)

Full Stack Development for Autonomous Dexterous Manipulation System

- Designed mounting system for attaching different end-effectors to the KUKA robot.
- Developed real-time low-level joint controllers in the OROCOS framework with robot dynamics compensation using KDL library for the KUKA lbr4 arm and the Allegro hand.
- Built in-house collision checking APIs, combining several collision checking libraries for fast and accurate signed distance measurements.
- Developed motion planning toolkit with integrations to in-house collision checking APIs, trajectory optimization through PAGMO and sampling based planning through OMPL.
- Setup perception system to detect and track the environment and the robot, enabling motion planning for real world manipulation tasks.
- Integrated multiple tactile sensors for dynamic inference through factor graphs using GTSAM framework.

Other projects

- Developed software tools to estimate Baxter robot's kinematic and dynamic parameters using measurements from vision and wrist force torque sensor.
- Prototyped human robot interaction experiments on Baxter robot.
- Built holonomic mobile robot with reactive collision avoidance system from optic flow and 2D LIDAR.

Publications

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," *ISRR*, 2017
3. B. Sundaralingam and T. Hermans, "Geometric in-hand regrasp planning: Alternating optimization of finger gaits and in-grasp manipulation," *ICRA*, 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," *CoRL*, 2018
5. B. Sundaralingam and T. Hermans, "Relaxed-rigidity constraints: kinematic trajectory optimization and collision avoidance for in-grasp manipulation," *Autonomous Robots (AuRo)*, 2019
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," **Best Manipulation Paper Finalist**, *ICRA*, 2019
7. 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 *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," *ICRA*, 2019