Balakumar Sundaralingam

🌐 balakumar-s.github.io · **in** balakumar-s

Education

University of Utah
Salt Lake City, UT, USA
Ph.D. Candidate in Computing: Robotics Track, Cum. GPA: 3.8/4
2014-Present

SASTRA University
Thanjavur, TN, India
B.Tech in Mechatronics, First class with distinction, Cum. GPA: 7.8/10
2009-2013

Research Experience

Dexterous Manipulation
University of Utah

Research assistant, Publications:[1-3,5]
2015-Present

Mentor: 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
NVIDIA Seattle Robotics Lab

Robotics research intern, Publications:[4,6-8]
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
University of Utah

Research assistant, DARC Lab
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
SASTRA University

Research assistant, Mobile Robotics Lab
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

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

Other projects

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

Skills

Specialization topics	Dexterous Manipulation, Trajectory Optimization, Contact Physics modeling, Tactile perception, Collision checking, Factor graphs, Multi-modal state inference
Familiar topics	Computational Geometry, Control theory, Robot Learning, SLAM
Hardware	Pioneer 3AT, KUKA LWR4+, Franka Panda, Baxter, Allegro hand, Reflex hand
Libraries	KDL, PCL, GTSAM, Tensorflow, PAGMO, KrisLibrary, libccd, FCL

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