Balakumar Sundaralingam

Salt Lake City UT – USA

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

Education

University of Utah   Salt lake city, UT, USA
Ph.D. Student 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, LL4MA Lab, Publications:[1-4]   2015-Present

Mentor: **Prof. Tucker Hermans**

o Exploring multi-fingered dexterous manipulation of objects without extensive object models.
o Leveraging gradient based optimization for joint space robot motion planning.
o 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.
o Explored sequence planning for reposing a grasped object by fingertip relocation and object reposing.
o 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, NVIDIA Research, Publications:[5-8]   May 2018-Aug 2018

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

o Trained a neural network for supervised learning of tactile force model to map tactile signals to force, with validation on robot manipulation task (video).
o 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

SASTRA University

Research Assistant, Mobile Robotics Lab   2012-2013

Advisor: **Prof. Prem S.**

o Developed algorithm for estimating transformation between consecutive LIDAR scans.
o Implemented line extraction algorithms(Split and Merge methods) to extract lines from LIDAR points.

Teaching Experience

I was mentored by Prof. John Hollerbach for creating and conducting lab assignments in two graduate level courses at the University of Utah.

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.

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, 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," *in **ICRA***, 2019

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).