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*
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   NVIDIA Seattle Robotics Lab
Robotics research intern, NVIDIA Research, Publications:[5-7]   *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 interface for multiple robots and perception systems to enable prototyping of robot experiments.
- Collaborated on projects related to object pose estimation, 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.**

- 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

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

Software tools: C/C++, Python, ROS, Tensorflow, Matlab, KDL, Numerical optimization, PCL.

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

- Intro. to Robotics ME EN 6220
- Intro. to Optimization ME EN 6025
- Robot Control CS 6330
- State Space Controls ME EN 6210

- Motion Planning ME EN 6225
- 3D Computer Vision CS 6420
- Machine Learning CS 6350
- Sys. Identification for Robotics CS 7320

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

Publications

1. **Balakumar Sundaralingam** and Tucker Hermans. Relaxed-rigidity constraints: In-grasp manipulation using purely kinematic trajectory optimization. *In Robotics: Science and Systems (**RSS**)*, 2017

2. Qingkai Lu, Kautilya Chenna, **Balakumar Sundaralingam**, and Tucker Hermans. Planning multi-fingered grasps as probabilistic inference in a learned deep network. *In **ISRR***, 2017

3. **Balakumar Sundaralingam** and Tucker Hermans. Geometric in-hand regrasp planning: Alternating optimization of finger gaits and in-grasp manipulation. *In **ICRA***, 2018

4. **Balakumar Sundaralingam** and Tucker Hermans. Relaxed-rigidity constraints: kinematic trajectory optimization and collision avoidance for in-grasp manipulation. *Autonomous Robots (**AuRo**)*, 2018

5. Jonathan Tremblay, Thang To, **Balakumar Sundaralingam**, Yu Xiang, Dieter Fox, and Stan Birchfield. Deep object pose estimation for semantic robotic grasping of household objects. *In **CoRL***, 2018

Publications under review

6. **Balakumar Sundaralingam**, Alexander Sasha Lambert, Ankur Handa, Byron Boots, Tucker Hermans, Stan Birchfield, Nathan D. Ratliff, and Dieter Fox. Robust learning of tactile force estimation through robot interaction. *CoRR*, abs/1810.06187, 2018

7. Giovanni Sutanto, Nathan D. Ratliff, **Balakumar Sundaralingam**, Yevgen Chebotar, Zhe Su, Ankur Handa, and Dieter Fox. Learning latent space dynamics for tactile servoing. *CoRR*, abs/1811.03704, 2018