Dhruv Mauria Saxena

https://dhruvms.github.io/

Contact Information

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Research Interests

I am interested in *motion planning* problems for high-dimensional robotic systems. My research utilises concepts and techniques from *heuristic search* and *multi-agent pathfinding* to develop planning algorithms with strong theoretical foundations and impressive real-time performance.

Education

Robotics Institute, Carnegie Mellon University, Pittsburgh, PA

Ph.D., Robotics; Advisor – Maxim Likhachev — Aug 2017 – present

Thesis Topic: Simulation-based Planning for Pick-and-Place in Heavy Clutter using Non-prehensile Manipulation
GPA: 4.05/4.00
Coursework: Intermediate Statistics; Statistical Machine Learning; Convex Optimisation; Graph Theory; Optimal Control & Reinforcement Learning

Robotics Institute, Carnegie Mellon University, Pittsburgh, PA

M.S., Robotics; Advisor – Martial Hebert — Aug 2015 – Aug 2017

Thesis: Supervised Learning of Corrective Maneuvers for Vision-Based Autonomous Flight
GPA: 4.14/4.00
Coursework: Math Fundamentals for Robotics; Machine Learning; Kinematics, Dynamic Systems and Control; Computer Vision; Statistical Techniques for Robotics; Planning, Execution, and Learning; Deep Reinforcement Learning and Control

Experience

Search-Based Planning Lab, Robotics Institute, Carnegie Mellon University

Ph.D. Candidate, Pittsburgh, PA — Aug 2017 – present

Thesis research on enabling robots to pick up and manipulate desired objects in heavy clutter, when there is no collision-free trajectory available. My work develops efficient planning algorithms that reason about pushing through movable clutter with a physics-based simulator in the planning loop.

Honda Research Institute

Research Associate, San Jose, CA — May 2019 – Aug 2019

Benchmark and model-free reinforcement learning based solution for autonomous driving in dense-traffic highway scenarios.

BIRD MURI, Robotics Institute, Carnegie Mellon University

Master's Student, Pittsburgh, PA — Sep 2015 – Aug 2017

Master's thesis research on learning recovery maneuvers for perception system failures in monocular vision-based autonomous quadrotor flight through outdoor forested areas.

HCMI Lab, Brigham Young University

Research Associate, Provo, UT — Jun 2014 – Aug 2014

Simulations for a robot swarm tracking a pollutant using Navier-Stokes fluid dynamics and a collective memory based swarm model.

Unmanned Aerial Systems - Delhi Technological University

Software Developer, Autopilot Systems, New Delhi, India — Oct 2011 – Mar 2014

Path planning, autopilot development, and systems integration for the AUVSI SUAS Competition.

Journal & Conference Papers

[1] DM Saxena, M Likhachev; *Planning for Manipulation Among Movable Objects: Deciding Which Objects Go Where, In What Order, And How*; *Accepted to* 2023 International Conference on Automated Planning and Scheduling (ICAPS).

[2] DM Saxena, M Likhachev; *Planning for Complex Non-prehensile Manipulation Among Movable Objects by Interleaving Multi-Agent Pathfinding and Physics-Based Simulation*; *Accepted to* 2023

IEEE International Conference on Robotics and Automation (ICRA).

[3] C Kessens et al.; *Human-Scale Mobile Manipulation Using RoMan*; Special Issue on Robotics Collaborative Technology Alliance (RCTA) Program. Field Robotics, 2, 1943 – 1946. [LINK]

[4] DM Saxena, T Kusnur, M Likhachev; *AMRA*: Anytime Multi-Resolution Multi-Heuristic A**; 2022 IEEE International Conference on Robotics and Automation (ICRA). [LINK]

[5] DM Saxena, MS Saleem, M Likhachev; *Manipulation Planning Among Movable Obstacles Using Physics-Based Adaptive Motion Primitives*; 2021 IEEE International Conference on Robotics and Automation (ICRA). [LINK]

[6] T Kusnur, DM Saxena, M Likhachev; *Search-based Planning for Active Sensing in Goal-Directed Coverage Tasks*; 2021 IEEE International Conference on Robotics and Automation (ICRA). [LINK]

[7] DM Saxena, S Bae, A Nakhaei, K Fujimura, M Likhachev; *Driving in Dense Traffic with Model-Free Reinforcement Learning*; 2020 IEEE International Conference on Robotics and Automation (ICRA). [LINK]

[8] S Bae, DM Saxena, A Nakhaei, C Choi, K Fujimura, S Moura; *Cooperation-Aware Lane Change Maneuver in Dense Traffic based on Model Predictive Control with Recurrent Neural Network*; 2020 IEEE American Control Conference (ACC). [LINK]

[9] A Cheng, DM Saxena, M Likhachev; *Bidirectional Heuristic Search for Motion Planning with an Extend Operator*; 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). [LINK]

[10] T Kusnur, S Mukherjee, DM Saxena, T Fukami, T Koyama, O Salzman, M Likhachev; *A Planning Framework for Persistent, Multi-UAV Coverage with Global Deconfliction*; 2019 Springer Field and Service Robotics (FSR). [LINK]

[11] A Hurwitz, M Childers, A Dornbush, DM Saxena, M Likhachev, C Lennon; *An experiment to evaluate robotic grasping of occluded objects*; SPIE Unmanned Systems Technology XX (2018). [LINK]

[12] DM Saxena, V Kurtz, M Hebert; *Learning Robust Failure Response for Autonomous Vision Based Flight*; 2017 IEEE International Conference on Robotics and Automation (ICRA). [LINK]

Workshop Papers

[1] DM Saxena, M Likhachev; *Learning Contextual Actions for Heuristic Search-Based Motion Planning*; Fourth Machine Learning in Planning and Control of Robot Motion Workshop, 2020 IEEE International Conference on Robotics and Automation (ICRA). [LINK]

[2] R Madaan, R Bonatti, DM Saxena, S Scherer; *Deep Flight: Autonomous Quadrotor Navigation with Deep Reinforcement Learning*; Workshop on Learning Perception and Control for Autonomous Flight: Safety, Memory, and Efficiency, 2017 Robotics: Science and Systems (RSS). [LINK]

Thesis

[1] *Supervised Learning of Corrective Maneuvers for Vision-Based Autonomous Flight*; Master's Thesis, Carnegie Mellon University, 2017.

Mentoring Experience

- *Research Committee Member*, Muhammad Suhail Saleem, Ph.D. (Robotics), CMU
- *Research Committee Member*, Abigail Breitfeld, Ph.D. (Robotics), CMU
- *Thesis Committee Member*, Yash Oza, M.S. (Robotics), CMU
- *Thesis Committee Member*, Rohan Zeng, M.S. (Robotics), CMU
- *Thesis Committee Member*, Allen Cheng, M.S. (Robotics), CMU
- *Summer Scholar Mentor*, Robotics Institute Summer Scholars (RISS) Program, 2016, 2018, 2020, 2022

Teaching Experience

- *Teaching Assistant*, 16-782 Planning and Decision-making in Robotics (taught by Maxim Likhachev), CMU
- *Teaching Assistant*, 16-831 Statistical Techniques in Robotics (taught by David Held), CMU

Technical Skills

- *Programming Languages:* C/C++, Python, Julia, MATLAB
- *Tools & Libraries:* ROS, Eigen, Boost, PyTorch, TensorFlow, OpenCV

Extra-Curriculars

- *Member*, CMU Explorer's Club and Explorer's Club of Pittsburgh
- *Senior RoboBanker*, RoboOrg (Robotics Institute student organization), 2016-2018
- *Intramural Sports*, Robotics Institute
- *Journal Reviewer*
  - IEEE Robotics and Automation Letters (RA-L)
  - IEEE Transactions on Automation Science and Engineering (T-ASE)
  - Artificial Intelligence (AIJ)
  - Autonomous Robots (AuRo)
- *Conference Reviewer*
  - IEEE International Conference on Robotics and Automation (ICRA)
  - IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
  - International Conference on Automated Planning and Scheduling (ICAPS)
  - International Symposium on Combinatorial Search (SoCS)
  - Workshop on the Algorithmic Foundations of Robotics (WAFR)
  - Conference on Robot Learning (CoRL)
  - AIAA SciTech
  - Robotics: Science and Systems (RSS)

References

- Maxim Likhachev, *Associate Professor, Robotics Institute, Carnegie Mellon University*, `maxim@cs.cmu.edu`
- Alireza Nakhaei, *Staff Scientist, Woven Planet*, `a.nakhaei@gmail.com`
- Martial Hebert, *Professor, Robotics Institute, Carnegie Mellon University*, `hebert@ri.cmu.edu`