Caris Moses

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Areas of specialization

Robotics • Artificial Intelligence • Machine Learning

Education

2016-2022 **PhD in Electrical Engineering and Computer Science, Massachusetts Institute of Technology**
Thesis Title: Optimistic Active Learning of Task and Action Models for Robotic Manipulation
Advisors: Leslie Pack Kaelbling and Tomás Lozano-Pérez

2014-2015 **MSc in Computer Science, Northeastern University**
Thesis Title: Multi-Agent UAV Planning Using Belief Space Hierarchical Planning in the Now
Advisors: Robert Platt and Rahul Chipalkatty (Charles Stark Draper Laboratory)

2009-2013 **BS in Mechanical Engineering, Cornell University**

Relevant Experience

2020 **Amazon Robotics, Applied Scientist Intern**
Manipulating objects in clutter is a challenging task in robotics. A common approach to picking objects in clutter is to go straight from sensor data (images and pointclouds) to potential object segmentations, then use heuristics to determine the best picking locations. While this approach can be very successful, errors in segmentation can propagate to errors in picking. My job as an intern was to incorporate state information into the pick point selection process to predict possible errors in the segmentation portion of the picking pipeline. The method I developed was able to detect roughly 90% of the segmentation errors that occurred.

2015-2019 **Charles Stark Draper Laboratory, Research Scientist**
I completed by Masters of Science as a Draper Fellow. During that time I worked on integrated task and motion planning for multi-UAV missions. These missions involved tasks such as reconnaissance, data-gathering, supplies delivery, and other mission critical tasks. The missions also had to take into account probable enemy locations, and plan feasible motions. These missions were all executed in simulation. After graduation, as a full-time employee, I continued working on projects pertaining to high level planning. One project involved coordinating several physical robotic platforms, more specifically 2 ground vehicles (Huskies) and 2 UAVs (in-house assembled hexacopters from DJI). The other project involved developing a system to enable a mobile manipulator (we were working with a PR2 robot) to perform complex long-horizon tasks. My focus was on the planning pipeline, and I developed dedicated controllers to enable the PR2 to perform various tasks such as inserting a funnel into an opening.

2017 **MUJIN, Research Scientist Intern**
Model-checking is the process of verifying desirable properties of a software system. My work at MUJIN involved using SPIN (model-checking software) to verify a PROMELA (the input language for SPIN) model. I developed the model from a state machine written in C++ for a robotic system. I also wrote the specifications of the model in linear temporal logic (LTL), which were then verified. My work also involved researching and developing methods for going directly from C++ to

PROMELA and verifiable LTL specifications.

2012 **UC San Diego, Summer Undergraduate Researcher**
During my time at UCSD I got a brand new Turtlebot up and running. By the time I left it was able to perform SLAM (simultaneous localization and tracking). I also worked on developing localization and reference tracking methods where a robot was only given several noisy heading measurements.

2011 **Cornell University, Undergraduate Researcher**
I worked in the Laboratory for Intelligent Machine Systems for 2 years while at Cornell. I assisted in developing in-house hydraulic artificial muscles. My work consisted of testing and characterizing the properties of the muscles to capture their complex operation under non-linearities such as hysteresis.

Technical skills

Programming Languages Python, MATLAB, C++, PROMELA, OCaml, Haskell
Specialized Software ROS (Robotic Operating System), Pybullet, Gazebo, PyBox2d, Drake, git, LaTeX, SolidWorks
Embedded Systems PixHawk autopilot
Other UAV pilot, machining, 3D printing

Honors & awards

2021 Accenture Fellowship
2021 MIT EECS Seth J. Teller Award for Excellence, Inclusion, and Diversity
2021 BlackAIR Summer Research Grant Program
2016 MIT University Center for Exemplary Mentoring/Sloan Scholar
2016 MIT Jerome Lemelson Fellowship
2016, 2014 Draper Fellowship
2016, 2014 National Consortium for Graduate Degrees for Minorities in Engineering and Sciences (GEM) Fellowship
2011 Engineering Learning Initiative Undergraduate Research Award
2011 Louis Stokes Alliance for Minority Participation (LSAMP) Scholar
2010 General Motors Minority Engineering and Science Scholar
2009 Cornell University John McMullen Dean Award

Publications & talks

Journal article

2012 Tiwari, R., Meller, M. A., Wajcs, K. B., Moses, C., Reveles, I., & Garcia, E. (2012), "Hydraulic artificial muscles", *Journal of Intelligent Material Systems and Structures* 23(3), 301-312

Conference Papers

2021 *Noseworthy, M., *Moses, C., *Brand, I., Kaelbling, L.P., Lozano-Pérez, T., Roy, N. (2021), "Active Learning of Abstract Plan Feasibility", *RSS.*
2020 *Moses, C., *Noseworthy, M., Kaelbling, L.P., Lozano-Pérez, T., Roy, N. (2020), "Visual Prediction of Priors for Articulated Object Interaction", *ICRA.*

2016 Moses, C. M., Chipalkatty, R., Platt, R. (2016), "Belief Space Hierarchical Planning in the Now for Unmanned Aerial Vehicles", *AIAA Infotech@Aerospace.*

Workshop Papers

2022 Moses, C., Kaelbling, L., Lozano-Pérez, T., "Learning to Plan with Optimistic Action Models", *ICRA, Scaling Robot Learning Workshop.*

2021 *Noseworthy, M., *Moses, C., *Brand, I., Castro, S., Kaelbling, L., Lozano-Pérez, T., Roy, N. (2021), "Curiosity-Driven Learning of Abstract Plan Feasibility", *ICRA, Towards Curious Robots Workshop.*

2020 Moses, C., Shi, J. (2020), "Integrating State Estimation and Perception for Picking", *IROS, Failure to Grasp Workshop.*

Blog Posts

2015 Simplebotics.com, *Writer & Editor*

Talks & Presentations

2021 Active Learning of Abstract Plan Feasibility, *MIT Technology Review's EmTech Digital Conference*

2020 Synthesis-Based Curiosity for Learning Compositional Dynamics, *Honda Curious Minded Machine Winter Seminar Series*

2020 Integrating State Estimation and Perception for Picking, *IROS Failure to Grasp Workshop*

2020 Visual Prediction of Priors for Articulated Object Interaction, *ICRA 2020*

2019 Visual Prediction of Priors for Articulated Object Interaction, *Honda Annual Program Review*

2017 Peg Insertion with Policy Search, *Google Student Research Summit*

2017 Policy Search for Robotics Application, *iAAMCS*

2016 Belief Space Hierarchical Planning in the Now for UAVs, *AIAA@ Aerospace Conference*

2012 Localization and Reference Tracking in Mobile Robots, *UC San Diego Summer Research Conference*

2012 A Quasi-Static Model for Artificial Muscles, *Region 1NE AIAA Student Conference*