Haresh Karnan

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Education

Ph.D. in Artificial Intelligence and Robotics — *The University of Texas at Austin, TX, USA*
Affiliation: Peter Stone, Learning Agents Research Group — *Aug 2018 – Present*

Thesis: Aligning Robot Navigation Behaviors with Human Interests and Preferences
Research Areas: Reinforcement Learning, Robotics, Imitation Learning, Deep Learning, Sim-to-Real
Relevant Courses: Machine Learning, Reinforcement Learning, Autonomous Robots, Deep Learning

M.S. in Robotics — *Texas A&M University, TX, USA*
Affiliation: Robert Skelton, Tensegrity Research Group — *Aug 2016 – July 2018*

Research Areas: Computer Vision, Robotics, State Estimation, Control
Relevant Courses: Probabilistic Robotics, Computer Vision, State Estimation, Artificial Intelligence

B.Tech. in Instrumentation and Control Engineering — *National Institute of Technology, Trichy, India*
Affiliation: Robotics and Machine Intelligence Club — *June 2012 – July 2016*

Relevant Courses: Data Structures and Algorithms, Neural Networks, Pattern Recognition

Work Experience

The University of Texas at Austin — *Aug 2019 – Present*
Graduate Research Assistant — *Austin, TX, USA*

- Designed state-of-the-art **sim-to-real** algorithms for the NAO humanoid soccer robots, enabling fast and robust walk on bumpy surfaces using **reinforcement learning**, significantly improving safety. **[Video]**
- Developed efficient **imitation learning** algorithms for learning from expert demonstrations on physical hardware, addressing egocentric viewpoint and embodiment mismatch between agents. **[Video]**
- Designed a **self-supervised representation learning** method for preference-aligned off-road navigation, enabling the Spot robot to autonomously hike a 3-mile trail successfully in Austin, Texas. **[Video]**
- Curated and published a large-scale dataset of demonstrations for **socially-compliant robot navigation**. Designed **inverse reinforcement learning** techniques to learn reward functions for navigation. **[Dataset]**
- Extended learned inverse-dynamics models with egocentric vision-based onboard sensing to improve the accuracy of **mobile robots navigating at high speeds** of 4m/s. **[Video]**
- **Mentored** undergraduate students with their research, and **collaborated** with faculty and other graduate students on research topics spanning reinforcement learning, imitation learning and robotics.

Amazon Robotics (Amazon Scout) — *May – Aug 2019/20/21*
Applied Scientist Intern — *Seattle, WA, USA*

- Improved localization accuracy by 32% through **contrastive visual representation learning** for weather and lighting invariant visual localization. Deployed the learned model on the Scout robot, integrating it with the existing C++ stack for real-world deployment.
- Implemented **deep learning-based keypoint features**, achieving over 55% improvement in fine pose estimation accuracy in unstructured outdoor environments while maintaining a real-time inference rate.
- Developed a novel **generative adversarial algorithm** for monocular **visual localization** on sidewalks, resulting in 30% improved accuracy, compared to an existing classical visual localization pipeline. Filed and published a patent at USPTO, highlighting innovative aspects of the approach. **[Patent] [News Coverage]**

Texas A&M University — *Aug 2016 – July 2018*
Graduate Research Assistant — *College Station, TX, USA*

- Conducted research on various topics including (1) Vision-based tracking of tensegrity robots, (2) Simulating non-linear dynamics of tensegrity robots through physics-based first-principles modeling, (3) Optimal shape control of tensegrity robots on real hardware (master's thesis). **[Video]**

Robot Competitions

RoboCup Domestic Standard Platform League *Summer 2019/20/21*
Team: AustinVilla@Home *Austin, TX, USA*

- Participated in RoboCup 2019-2022 representing AustinVilla@Home in DSPL and **won third place internationally**, placing **first among North American teams** at RoboCup 2021. **[Paper] [Video]**
- Implemented "take out the trash" task to perform autonomous cleanup of an indoor environment by the HSR robot. **[Video]**
- Built a synthetic data generation pipeline to train object detection and segmentation networks on YCB RoboCup objects.

Teaching

Teaching Assistant Intro to Programming and Numerical Optimization *Fall 2018, Spring 2019*

Technical skills

Programming Languages	Python (proficient), C++ (intermediate)
Libraries	PyTorch, PyTorch-Lightning, OpenCV, Scikit-learn
Softwares	Git, TensorBoard, MuJoCo, ROS, COLMAP, RViz

Publications

Journals (RA-L, Machine Learning)

- **Haresh Karnan**, Anirudh Nair, Xuesu Xiao, Garrett Warnell, Soeren Pirk, Alexander Toshev, Justin Hart, Joydeep Biswas, Peter Stone. "Socially Compliant Navigation Dataset (SCAND): A Large-Scale Dataset of Demonstrations for Social Navigation", *Robotics and Automation Letters, (RA-L 2022).*
- Josiah Hanna, **Haresh Karnan**, Siddharth Desai, Garrett Warnell, Peter Stone. "Grounded action transformation for sim-to-real reinforcement learning", *Springer, Machine Learning, 2021.*

Conference Proceedings (NeurIPS, IROS, ICRA)

- **Haresh Karnan**, Kavan Singh Sikand, Pranav Atreya, Sadegh Rabiee, Xuesu Xiao, Garrett Warnell, Joydeep Biswas, Peter Stone. "VI-IKD: High-Speed Accurate Off-Road Navigation using Learned Visual-Inertial Inverse Kinodynamics" *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022).*
- Pranav Atreya, **Haresh Karnan**, Kavan Singh Sikand, Sadegh Rabiee, Xuesu Xiao, Garrett Warnell, Joydeep Biswas, Peter Stone. "High-Speed Accurate Robot Control using Learned Forward Kinodynamics and Nonlinear Least Squares Optimization" *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022).*
- **Haresh Karnan**, Garrett Warnell, Faraz Torabi, Peter Stone. "Adversarial Imitation Learning from Video using a State Observer", *IEEE International Conference on Robotics and Automation (ICRA 2022).*
- **Haresh Karnan**, Garrett Warnell, Xuesu Xiao, Peter Stone. "VOILA: Visual-Observation-only Imitation Learning for Autonomous Navigation", *IEEE International Conference on Robotics and Automation (ICRA 2022).*
- **Haresh Karnan**, Siddharth Desai, Josiah Hanna, Garrett Warnell, Peter Stone. "Reinforced grounded action transformation for sim-to-real transfer", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020).*
- **Haresh Karnan**, Siddharth Desai, Josiah Hanna, Garrett Warnell, Peter Stone. "Stochastic grounded action transformation for robot learning in simulation", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2020). Joint first author.*
- **Haresh Karnan**, Siddharth Desai, Ishan Durugkar, Josiah Hanna, Garrett Warnell, Peter Stone. "An Imitation from Observation Approach to Transfer Learning with Dynamics Mismatch", *Advances in Neural Information Processing Systems (NeurIPS 2020). Joint first author.*

- **Haresh Karnan**, Raman Goyal, Manoranjan Majji, Puneet Singla, Robert Skelton. "Visual feedback control of tensegrity robotic systems", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2017).*

Patents

- Alan Atherton, Umit Batur, **Haresh Karnan**, Kishor Bhalerao, Harshavardhan Shirolkar. "Systems and methods for utilizing images to determine the position and orientation of a vehicle", *US20210240195A1.*

Magazines, Workshops, Symposiums

- Anthony Francis, et al. "Principles and Guidelines for Evaluating Social Robot Navigation Algorithms", *AAAI 2023 Spring Symposium*, **Nominated for Best Paper Award**.
- **Haresh Karnan**, Elvin Yang, Daniel Farkash, Garrett Warnell, Joydeep Biswas, Peter Stone. "Self-Supervised Terrain Representation Learning from Unconstrained Robot Experience", *Workshop on Pretraining for Robotics (PT4R), ICRA 2023.*
- Elvin Yang, **Haresh Karnan**, Garrett Warnell, Joydeep Biswas, Peter Stone. "Wait, That Feels Familiar: Learning to Extrapolate Human Preferences for Preference-Aligned Path Planning", *Workshop on Pretraining for Robotics (PT4R), ICRA 2023.*
- **Haresh Karnan**, Anirudh Nair, Xuesu Xiao, Garrett Warnell, Soeren Pirk, Alexander Toshev, Justin Hart, Joydeep Biswas, Peter Stone. "Socially CompliAnt Navigation Dataset (SCAND): A Large-Scale Dataset Of Demonstrations For Social Navigation", *Workshop on Social Navigation, ICRA 2022.*
- **Haresh Karnan**, Garrett Warnell, Xuesu Xiao, Peter Stone. "VOILA: Visual Observation-only Imitation Learning for Autonomous navigation", *ML4NAV Spring Symposium, AAAI 2021.*
- **Haresh Karnan**, Siddharth Desai, Ishan Durugkar, Josiah Hanna, Garrett Warnell, Peter Stone. "An imitation from observation approach to sim-to-real transfer", *2nd Workshop on Closing the Reality Gap in Sim2Real Transfer for Robotics, RSS 2020. Joint first Author.*
- Xuesu Xiao et al. "Autonomous Ground Navigation in Highly Constrained Spaces: Lessons Learned From the Benchmark Autonomous Robot Navigation Challenge at ICRA 2022", *Robotics and Automation Magazine, RA-M 2022.*
- Rishi Shah, Yuqian Jiang, **Haresh Karnan**, Gilberto Briscoe-Martinez, Dominick Mulder, Ryan Gupta, Rachel Schlossman, Marika Murphy, Justin W. Hart, Luis Sentis, Peter Stone. "Solving Service Robot Tasks: UT Austin Villa@ Home 2019 Team Report", *AI-HRI Symposium, AAAI 2019.*

Unrefereed Publications

- Yuqian Jiang, **Haresh Karnan**, et al. "Austin Villa@ Home 2022 Team Description Paper", *RoboCup 2022.*
- Yuqian Jiang, **Haresh Karnan**, et al. "Austin Villa@ Home 2020 Team Description Paper", *RoboCup 2020.*
- **Haresh Karnan**, Aritra Biswas, Pranav Vaidik Dhulipala, Jan Dufek, Robin Murphy. "Visual servoing of unmanned surface vehicle from small tethered unmanned aerial vehicle", *arXiv preprint arXiv:1710.02932.*

Master's Thesis

- "Design and Control of a Tensegrity Prism Manipulator", Texas A&M University College Station, July 2018.

Invited Talk

- "Learned Locomotion for Mobile Robots: Addressing Dynamics Mismatch and Utilizing Demonstrations", Google Research, June 2022.

Service

Reviewer	AAAI, RA-L, NeurIPS, ICRA, IROS, CVPR '23, ICML '23, AI-HRI.
Program Committee	IRMAS, SAC '24.