

Niranjn Kumar

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SUMMARY

The goal of my research is to build embodied agents that interactively explore and perceive the world around them. My current research focus is on learning complex interactive behaviors for high DOF legged robots. More broadly, I am interested in robot learning and interactive perception.

EDUCATION

Georgia Institute of Technology <i>PhD in Electrical and Computer Engineering, GPA 4.0/4.0</i>	Atlanta, GA Jan. 2017 – Present
Georgia Institute of Technology <i>Master of Science in Electrical and Computer Engineering, GPA 4.0/4.0</i>	Atlanta, GA Aug. 2015 – Dec. 2016
National Institute of Technology <i>Bachelor of Technology in Electrical and Electronics Engineering, GPA 8.3/10</i>	Trichy, India July. 2011 – May 2015

PUBLICATIONS

1. K. N. Kumar, I. Essa, and S. Ha. Cascaded compositional residual learning for complex interactive behaviors. *IEEE Robotics and Automation Letters*, 8(8):4601–4608, 2023
2. K. N. Kumar, I. Essa, and S. Ha. Graph-based Cluttered Scene Generation and Interactive Exploration using Reinforcement Learning. *ICRA 2022*, May 2022
3. K. N. Kumar, I. Essa, S. Ha, and C. K. Liu. Estimating Mass Distribution of Articulated Objects using Non-prehensile Manipulation. *NeurIPS Workshop on Object Representations for Learning and Reasoning (Oral)*, Dec 2020

EXPERIENCE

Graduate Teaching/Research Assistant <i>Georgia Institute of Technology</i>	Jan 2017 – Present Atlanta, GA
<ul style="list-style-type: none">• GTA for 6475 Graduate Computational Photography course• Responsibilities: Designing assignments, grading, discussions on Piazza	
Research Intern <i>Samsung Research America</i>	May 2019 – July 2019 Mountain View, CA
<ul style="list-style-type: none">• Interned at the AI center and worked on long-range video understanding using neural networks.• Built graphical representations of video to tackle few shot video classification built on top of I3D architecture.	
Research Intern <i>Nokia Bell Labs</i>	June 2018 – August 2018 New Providence, NJ
<ul style="list-style-type: none">• Interned with the Mathematics and Algorithms group at Bell labs and worked on training procedures that make neural networks robust to adversarial attacks.• Studied the effect of weight normalization techniques on the loss landscape of neural networks.	
Research Intern <i>Emory University School of Medicine</i>	Aug 2016 – Dec 2016 Atlanta, GA
<ul style="list-style-type: none">• Designed and developed a smart head-mounted eye dropper device that automatically administers eye drops.• The device has a built-in camera that tracks the drop as it falls into the user's eye with an ML model, and re-administers it in-case of failure.	

ACADEMIC PROJECTS

Learning Dynamic and agile skills for a humanoid robot via Imitation learning Feb 2023 – present

- Building a framework that utilizes a dataset obtained through human motion capture in order to train RL control policies for a Digit humanoid robot.
- Developed cross-morphological motion re-targeting to map trajectories from human to digit skeleton.

Interactive navigation with a quadruped robot Dec 2021 – Dec 2022

- Developed joint-level neural network control policies for a quadruped robot to interactively navigate an indoor environment.
- Our approach recursively builds complex skills by learning residuals on top of a library of previously learned policies using Deep RL. Our robot interactively navigates around a house, opens doors, manipulates objects and crawls under narrow spaces to reach the goal, achieving state-of-the-art results.

Object search in clutter using physical plausibility priors Aug 2020 – Aug 2021

- Developed a robotic system to efficiently discover hidden objects present in cluttered environments.
- Built a scene grammar to represent structured clutter and used it as a unifying representation to generate and rearrange structured clutter. Developed a pair of RL agents that generate and explore complex cluttered scenes by interactively rearranging and discovering hidden objects. Both these agents use Graph Neural network architectures, and generalize to an arbitrary number of objects.
- Deployed the policies trained in simulation on real cluttered scenes with a UR10 robot (sim2real) and an e-pick vacuum suction gripper.

Mass estimation of articulated objects Aug 2018 – Feb 2020

- Built RL policies to efficiently interact with articulated objects and estimate their mass distribution.
- Developed a dual-network approach to interactive perception, where a Predictor neural network minimizes estimation error and a Policy neural network selects optimal actions that reveal the maximum information.
- Deployed the learned policy on UR10 robot (sim2real), developed dynamic pushing strategies for manipulating 3D printed articulated toys and demonstrated state-of-the-art results on estimation of mass distribution.

Realistic video generation of hand-object interactions Aug 2018 – May 2019

- Trained an Image2Image Generative Adversarial Network (GAN) that generates realistic videos of hands manipulating objects.
- Collected paired data with Leap motion tracker and Intel Realsense camera to train the image generation model.

Automatic Eye-dropper Jan 2016 – Dec 2016

- Designed and built an intelligent eye-dropper that automatically administers eye drops to a patient's eye.
- Developed and implemented a machine learning based approach to classify an image of the eye as open or closed. The algorithm is light-weight and runs on a Raspberry Pi mounted within the device.
- Designed and fabricated (3D printed) an electro-mechanical system that administers medication when the eye is open and tracks the drop to ensure that it enters the eye.

Motion textures from single image Aug 2016 – May 2017

- Built an algorithm that converts a static image into an infinitely looping video texture using a neural network and user input.

GRADUATE COURSEWORK

Interactive Robot Learning
Statistical Techniques for Robotics
Mathematical Foundations for ML
Statistical Machine Learning
Control of Robotic Systems
Intro to Graduate Algorithms

Computer Vision
Advanced Computer Vision
Computational Photography
PDEs for Image Processing and CV
Digital Image Processing
Linear Systems and Control

TECHNICAL SKILLS

Languages: Python, C++

Developer Tools: Git, Docker

Libraries/Packages: NumPy, Scipy, Matplotlib, Pandas, Jupyter, OpenCV, ROS, MATLAB

Machine Learning Libraries: Tensorflow, Pytorch

Physics Libraries: Pybullet, Pydart, Issac Gym

Hardware: Vicon motion capture, Raspberry pi, MyDAQ, FPGAs, Leap motion controller

Robots: TurtleBot, UR10, Unitree A1, Quadcopters

VOLUNTEERING/ LEADERSHIP

Web Chair, Conference on Robot Learning 2023

Reviewer, Transactions on Human Robotics Interaction, IROS

Head of Spider Electronics, R&D club

Overall Coordinator, EEE Association