

# Niranjn Kumar

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## RESEARCH STATEMENT

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The goal of my research is to build embodied agents that interactively explore and improve their understanding of objects around them. My current research focus is on teaching quadruped robots explore cluttered indoor scenes. More broadly, I am interested in applying machine learning techniques to tackle problems in computer vision, robotic manipulation and quadruped locomotion.

## EDUCATION

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

## PUBLICATIONS

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1. K. N. Kumar, I. Essa, and S. Ha. Graph-based Cluttered Scene Generation and Interactive Exploration using Reinforcement Learning. *ICRA 2022*, May 2022
2. 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

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

## ACADEMIC PROJECTS

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### Searching for objects in Indoor Environments

Aug 2021 – present

- Learning control policies for a quadruped robot to interactively search for objects in an indoor cluttered environment.

### Object search in clutter

Aug 2020 – Aug 2021

- Built a scene grammar to represent structured clutter and used it as a unifying representation to generate and rearrange structured clutter.
- Developed a framework to train RL agents that generate complex cluttered scenes and then rearrange them to discover hidden objects.
- Tested the policies trained in simulation by deploying them on a real cluttered scene with a UR10 robot (sim2real).

### Mass estimation of articulated objects

Aug 2018 – May 2019

- Designed RL policies to efficiently interact with articulated objects and estimate their mass distribution.
- Developed a two-network approach to interactive perception, where a Predictor network minimizes estimation error, and a Policy network selects optimal actions that reveal the most information.
- Tested the approach with a real UR10 robot (sim2real) and 3D printed articulated toys that can have an arbitrary mass distribution.

### Realistic object manipulation video generation

Aug 2018 – May 2019

- Trained an Image2Image Generative Adversarial Network (GAN) that generates realistic videos of hands manipulating objects from motion capture data.

### Eye-dropper device

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 can run on a Raspberry Pi mounted within the device.
- Designed and fabricated an electro-mechanical system that administers medication when the eye is open and tracks the drop to ensure that it enters the eye.

### Selecting real world objects with eye gaze

Jan 2016 – May 2016

- Built a system that helps paralyzed patients select objects of interest from a scene with an eye-gaze tracker. The objects of interest are detected and tracked by using SURF features.

## GRADUATE COURSEWORK

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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

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**Languages:** Python

**Developer Tools:** Git, Docker, VS Code, Visual Studio, PyCharm

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

**Neural Network Libraries:** Tensorflow, Pytorch

**Physics Libraries:** Pybullet, Pydart, Issac Gym

**Robots:** UR10, TurtleBot, Unitree A1