Neeloy Chakraborty

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Research Statement:

As a fourth year PhD candidate at UIUC, my research goal is to develop reliable technologies to enable safer interactions between humans and automation. To do so, I have (1) designed scalable algorithms to detect anomalies in multi-agent settings, (2) developed real-time vision models to allow users to remotely control robots with fewer failures, and (3) identified hallucinations in large language model generations to proactively avoid failures in decision-making.

Interests: Anomaly and Hallucination Detection, Mobile Robot Teleoperation, Generative AI, Reinforcement Learning

Skills: Python, PyTorch, ROS, Linux, Git, PyTorch3D, C/C++, ZED Camera, OpenCV, CARLA, MATLAB, Docker, NVIDIA Jetson

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Education:

- **University of Illinois Urbana-Champaign**
  PhD in Electrical and Computer Engineering (Exp. May 2026)   GPA 3.88/4.00
  Master of Science in Electrical and Computer Engineering (2021 – 2023)   [Thesis] GPA 3.83/4.00
  Bachelor of Science in Computer Engineering (2017 – 2021)   [Thesis] GPA 3.75/4.00

Current Research Projects:

- **Hallucination Detection and Mitigation for Foundation Models in Decision-Making Tasks**   Spring 2024 –
  Advisors: Professor Melkior Ornik and Professor Katherine Driggs-Campbell   University of Illinois
  Formulating pipelines to identify hallucinations in large visual language models

- **Image Generation for Delay-Compensated Video Feeds in Mobile Robot Teleoperation**   Summer 2023 –
  Advisor: Professor Katherine Driggs-Campbell   University of Illinois
  Developing real-time image generation methods combining depth foundation models and neural rendering

Past Research Projects:

- **Co-operative Traffic Congestion Mitigation**   Spring 2022 – Spring 2024
  Advisors: Professor Cathy Wu and Professor Katherine Driggs-Campbell   University of Illinois
  Evaluating human-in-the-loop traffic congestion mitigation policies with real users in a car simulator

- **Highway Vehicle Anomaly Detection**   Fall 2021 – Spring 2024
  Advisor: Professor Katherine Driggs-Campbell   University of Illinois
  Designing frameworks for identifying anomalies on roads from multi-modal sensor data

- **Modular Embodied Agent for Alexa Arena**   Fall 2022 – Spring 2023
  Advisor: Professor Julia Hockenmaier   University of Illinois
  Leading development of an instruction-following embodied agent with action prediction and computer vision

- **Decentralized Robot Crowd Navigation**   Fall 2019 – Spring 2023
  Advisor: Professor Katherine Driggs-Campbell   University of Illinois
  Researching a novel network to guide a robot to reach a goal state while avoiding colliding with other agents

- **Koopman Models for Reinforcement Learning**   Summer 2022
  Advisors: Dr. Kaushik Balakrishnan and Dr. Devesh Upadhyay   Ford Motor Company
  Exploring benefits of combining Koopman theory with model-based RL for driving tasks

- **Hierarchical Self-Imitation Reinforcement Learning with Sparse Rewards**   Fall 2020 – Spring 2021
  Advisor: Professor Katherine Driggs-Campbell   University of Illinois
  Applying hierarchical and self-imitation learning to long horizon single-agent environments with sparse rewards

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Publications
(* and + denote equal contribution and noteworthy comments are in red)

Pre-prints:

- **N. Chakraborty***, Y. Fang*, A. Schreiber, T. Ji, Z. Huang, A. Mihigo, C. Wall, A. Almana, and K. Driggs-Campbell. "Towards Real-Time Generation of Delay-Compensated Video Feeds for Outdoor Mobile Robot Teleoperation," Under review in the IEEE International Conference on Robotics and Automation (ICRA) 2025 [Paper] [Website] **(Leading cross-departmental team of researchers with diverse skillsets)**

- **N. Chakraborty**, M. Ornik, and K. Driggs-Campbell. "Hallucination Detection in Foundation Models for Decision-Making: A Flexible Definition and Review of the State of the Art," Under review in ACM Computing Surveys (CSUR) [Paper]

- T. Ji*, **N. Chakraborty***, A. Schreiber, and K. Driggs-Campbell. "An Expert Ensemble for Detecting Anomalous Scenes, Interactions, and Behaviors in Autonomous Driving," Under review in the Sage International Journal of Robotics Research (IJRR)

- A. Hasan, **N. Chakraborty**, H. Chen, J-H. Cho, C. Wu, and K. Driggs-Campbell. "Cooperative Advisory Residual Policies for Congestion Mitigation," Under review in the ACM Journal on Autonomous Transportation Systems (JATS) [Paper]

- A. Hasan, **N. Chakraborty**, H. Chen, C. Wu, and K. Driggs-Campbell. "Lessons in Cooperation: A Qualitative Analysis of Driver Sentiments towards Real-Time Advisory Systems from a Driving Simulator User Study" [Paper]

- S. Liu, K. Hong, **N. Chakraborty**, and K. Driggs-Campbell. "Structured Graph Network for Constrained Robot Crowd Navigation with Low Fidelity Simulation" [Paper]

Conference Articles:

- P. Chang, S. Liu, T. Ji, **N. Chakraborty**, K. Hong, and K. Driggs-Campbell. "A Data-Efficient Visual-Audio Representation with Intuitive Fine-tuning for Voice-Controlled Robots," Conference on Robot Learning (CoRL) 2023 [Paper] [Website]

- A. Hasan, **N. Chakraborty***, H. Chen*, J-H. Cho, C. Wu, and K. Driggs-Campbell. "PeRP: Personalized Residual Policies for Congestion Mitigation Through Co-operative Advisory Systems," IEEE International Conference on Intelligent Transportation Systems (ITSC) 2023 [Paper] [Website] [Code]

- **N. Chakraborty***, R. Sidhu*, B. Abdullai*, H. Chen*, N. Ravi*, A. Ankur, D. Prasad, and J. Hockenmaier. "BEAST: Building an Embodied Action-prediction System with Trajectory data," Alexa Prize SimBot Challenge Proceedings 2023 [Paper] [Website] **(University team leader and top-10 finalist in inaugural Amazon SimBot Challenge)**

- S. Liu, P. Chang, Z. Huang, **N. Chakraborty**, K. Hong, W. Liang, D. L. McPherson, J. Geng, and K. Driggs-Campbell. "Intention Aware Robot Crowd Navigation with Attention-Based Interaction Graph," IEEE International Conference on Robotics and Automation (ICRA) 2023 [Paper] [Website] [Code] **(Best poster award at IROS 2023 Last-Mile Robotics Workshop)**

- **N. Chakraborty**, A. Hasan*, S. Liu*, T. Ji*, W. Liang, D. L. McPherson, and K. Driggs-Campbell. "Structural Attention-based Recurrent Variational Autoencoder for Highway Vehicle Anomaly Detection," IFAAMAS International Conference on Autonomous Agents and Multiagent Systems (AAMAS) 2023 [Paper] [Website] [Code] **(Accepted as full paper with 23.3% acceptance rate and received student scholarship)**

- S. Liu, P. Chang, H. Chen, **N. Chakraborty**, and K. Driggs-Campbell. "Learning to Navigate Intersections with Unsupervised Driver Trait Inference," IEEE International Conference on Robotics and Automation (ICRA) 2022 [Paper] [Website] [Code]

- S. Liu*, P. Chang*, W. Liang[+], **N. Chakraborty[+]**, and K. Driggs-Campbell. "Decentralized Structural-RNN for Robot Crowd Navigation with Deep Reinforcement Learning," IEEE International Conference on Robotics and Automation (ICRA) 2021 [Paper] [Website] [Code]

Workshop Papers:

- A. Hasan, **N. Chakraborty**, C. Wu, and K. Driggs-Campbell. "Towards Co-operative Congestion Mitigation," Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust, ICRA 2022 Workshop [Paper]

Theses:

- "Detecting the Unpredictable: Advanced Trajectory and Camera-Based Anomaly Detection Methods for Vehicles," Illinois Digital Environment for Access to Learning and Scholarship (IDEALS), 2023 [Paper]

- "Hierarchical Self-Imitation Learning in Single-Agent Sparse Reward Environments," Illinois Digital Environment for Access to Learning and Scholarship (IDEALS), 2021 [Paper]

Industry Experience:

- **Research and Advanced Engineering Intern in Core AI/ML at Ford Motor Company**   Summer 2022
  Designing sample efficient model-free + model-based RL methods
  Outperforming classical PID controllers by 41% in complex autonomous vehicle use case
  Conducting both independent and collaborative research and guiding experimental design according to results

- **Perception Engineering Intern in Autonomy Team at Brunswick i-Jet Lab**   Summer 2021
  Localizing swimmers around boats using filtering, tracking, and computer vision techniques
  Researching sensors and communicating with sensor companies to increase autonomy stack capabilities
  Analyzing functional safety standards practiced at company and presenting findings to global management team

- **Engineering Intern in Global CAD Team at Qualcomm**   Summer 2020
  Building generalized data gathering solutions to support Design For Test pipeline   [Website]
  Leading design process of a base framework for data gathering tool
  Collaborating and adapting with international teams to consider multiple perspectives

- **Global Management Trainee Intern in Solutions at Anheuser Busch**   Summer 2019
  Identifying root causes of a multi-million-dollar annual problem with Six Sigma LEAN exercises   [Website]
  Implementing short- and long-term process solutions leveraging technology with an annual ROI of $1.5M
  Pitching solutions to multidisciplinary teams in the People department including managers and directors

- **Global Management Trainee Intern in Logistics at Anheuser Busch**   Summer 2018
  Increasing productivity of critical decision-making team by developing clear visualizations   [Website]
  Creating effective data visualizations with Qlik Sense and SQL databases
  Connecting with multidisciplinary logistics teams and interns

Teaching Experience:

- **Lab Teaching Assistant for Introduction to Robotics (ECE 470)**   Fall 2021 – Fall 2022
  Guiding students to program a UR3 arm with ROS and implement kinematics and computer vision

- **Undergraduate Course Assistant for Digital Systems Laboratory (ECE 385)**   Fall 2019 – Spring 2021
  Providing impactful assistance to students on TTL and System Verilog hardware labs

Coursework:

- Artificial Intelligence
  - **Intro to Artificial Intelligence**   search, classification, NLP, CV, robotics
  - **Intro to Deep Learning**   linear classifiers, MLPs, CNNs, RNNs, generative models, deep RL
  - **Intro to Reinforcement Learning**   RL foundations, model-free, policy gradient, exploration/exploitation
  - **Pattern Recognition**   nearest neighbor, regression, optimization primal/dual, SVM, learning theory
  - **Generative AI Models**   normalizing flows, VAEs, GANs, RNNs, transformers, applications, explainability
  - **Random Processes**   measure theory, convergence of sequences, estimators, random walks, martingales
  - **Computer Vision**   image processing, fitting, geometric vision, recognition
  - **Statistical Learning Theory**   concentration inequalities, empirical risk minimization, generalization bounds
- Robotics
  - **Intro to Robotics**   rigid motion, forward/inverse kinematics, motion planning, vision
  - **Human-Centered Robotics**   design robots that interact with people safely
  - **Principles of Safe Autonomy**   path planning, localization, lane detection, safety verification
  - **Control Systems**   dynamic models and response, root locus/frequency response techniques
  - **Control System Theory & Design**   state space models, stability, controllability, observability, tracking
  - **Hybrid Systems and Control**   stability, observability, etc. of switched and hybrid control systems
- Hardware/Software Systems
  - **Digital Systems Lab**   logic types, storage, design tradeoffs, FPGAs, microprocessor design
  - **Computer Systems Engineering**   operating system design, I/O, synchronization, interrupts, virtualization

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Additional Projects

- **Efficient FPGA Smart Home Security Camera System (Project Watchdog)**   Apr 2019 – Oct 2019
  Leading hardware design of accelerated IoT security system   Student Group Project
  Regional Finalist in InnovateFPGA 2019   [Website]

- **Brain Computer Interface Platform for IoT Applications (Project HackMe)**   Feb 2019
  Leading data analytics and storage team   Student Group Project
  HackIllinois 2019 runners-up and sponsor award winners   [Website]

- **Human interactive Balancing Security Robot**   Aug 2016 – Jun 2017
  Advisor: Dr. George Kantor   Carnegie Mellon University
  Engineering a human interactive segway security robot to roam halls of an institution for safety   [Website]

- **Robotics Project at ZeGoBeast LLC Pittsburgh**   May 2016 – Jun 2017
  Advisors: Mr. Daniel Goncharov and Mr. Alex Thomson   ZeGoBeast LLC Pittsburgh
  Building & improving the wooden ZeGoBeast Electric robot and presenting at New York Maker Faire   [Website]

Organizations & Extracurriculars

- **Eta Kappa Nu (HKN) Electrical Engineering Honor Society**   Aug 2019 –
  Dedicated to serving the ECE & Engineering student body by providing services to help students succeed   Member
  Holding course review sessions and sharing university experiences with other students

- **Human-Centered Autonomy Lab**   Aug 2021 – Aug 2024
  Connecting passionate undergraduate researchers with graduate mentors   Research Volunteer Coordinator

- **iRobotics Combotics & Projects Student Organization**   Aug 2017 – May 2018
  Collaborated on the mechanical design team by developing CAD designs that model the real robot   Member

- **Children's Library of Pittsburgh**   Jun 2012 – Jun 2017
  Shelved, counted, & organized books in the Children's section of the Main Library   Volunteer
  Supported in the planning & development of tech programs to introduce children to programming

Academic Honors and Services

Awards

- AB InBev GMT Full Tuition Scholarship   2017 – 2021
- James Scholar   2017 – 2021
- HackIllinois   2019
    - 2nd Place
    - Caterpillar Sponsor Award
    - Particle Sponsor Award
- InnovateFPGA Regional Finalist   2019
- Dean's List   2019 – 2021
- Eta Kappa Nu Member   2019 – present
- Graduated BS with Honors   2021
- AAMAS Student Scholarship   2023
- IROS Last-Mile Robotics Workshop Best Poster   2023

Students Mentored

- Nikil Ravi   2022 – 2023; BS Computer Science 2023; Now studying MS at Stanford
- Blerim Abdullai   2022 – 2023; BS Electrical and Computer Engineering 2023; Now studying MS at U of T
- Haomiao Chen   2022 – 2023; BS Physics; Now studying PhD at Cornell
- Devika Prasad   2022 – 2023; BS Computer Science, Now at Applied Intuition
- Wenjian Zhao   2023; BS Engineering Mechanics 2023; Now studying MEng at MIT
- Louis Sungwoo Cho   2023; BS Civil and Environmental Engineering 2023; Now studying MS at UIUC
- ChuLin Huang   2024; MEng Autonomy & Robotics
- Chun-Yen Yeh   2024; MEng Autonomy & Robotics
- Yixiao Fang   2023 – present; BS Computer Engineering 2023; Now studying MS at UIUC
- Cassidy Wall   2024 – present; BS Systems Engineering and Design
- Abdulrahman Almana 2024 – present; KAUST Gifted Student Program at UIUC

Journal and Conference Reviews

- IEEE International Conference on Robotics and Automation (ICRA) 2022, 2023
- IEEE Robotics and Automation Letters (RAL)   2023
- IEEE Transactions on Network Science and Engineering (TNSE)   2023
- IEEE Transactions on Control Systems Technology (TCST)   2024
- Springer International Journal of Social Robotics   2024