Anshul Nayak

CONTACT INFORMATION

Clemson University

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SUMMARY

Safe and trust-aware multi-agent systems under uncertainty:
My research lies at the intersection of artificial intelligence, robotics, and human–machine interaction, with a focus on multi-agent systems, planning under uncertainty, and trust modeling and recovery. I integrate probabilistic inference, reinforcement learning, and multi-modal reasoning to enable safe and cooperative decision-making. My goal is to develop heterogeneous autonomous teams that adapt to uncertain scenarios, align with human expectations, and support trust recovery following unexpected events.

EDUCATION

Virginia Polytechnic and State University, Blacksburg, VA

Ph.D., Mechanical Engineering, December 2024

- Thesis: *Cooperative prediction and planning under uncertainty for autonomous robots*
- Adviser: Dr. Azim Eskandarian

M.S., Mechanical Engineering, December 2020

- Thesis: *Effect of kinematic and physical properties of caudal fin on performance of a robotic fish*
- Adviser: Dr. Hodjat Pendar

National Institute of Technology, Rourkela, India

B.S., Mechanical Engineering, May 2015

- Thesis: *Modelling, simulation and experimental investigation for generating 'I'shaped contour using electro chemical machining*
- Adviser: Dr. Soumya Gangopadhyay

HARDWARE AND SOFTWARE SKILLS

Computer Programming:
- Python, C++, Matlab

Frameworks:
- Deep learning: PyTorch, TensorFlow
- Robotics: Robot Operating System (ROS), CasADi
- Miscellaneous: Linux, Docker, git

Embedded and Real-time Systems:
- Software and hardware development with Jetson developer boards (e.g., Jetson TX2, Jetson AGX Xavier etc.).
- Real-time control of multi-agent turtle bots with zero-shot policy transfer.

Simulation:
- Simulation and analysis of autonomous agents in traffic scenarios using simulators like Isaac-Sim, ROS-Gazebo and CARLA.

PROFESSIONAL EXPERIENCE

Clemson University, Clemson, SC

Postdoctoral Research Scholar Nov 2025 -

- Proposed **MA-VLCM** that replaces learned critic with a pretrained VLM for sample efficiency and zero-shot generalizable multi-agent policies.
- Developed **reason-guided preference-based reward learning (PbRL)** for interpretable and human-aligned policies.
- Proposed a **belief-aware VLM** via memory retrieval using vector database resulting in improved reasoning for VLMs.
- Devised a **deep-Koopman** based social navigation framework for proactive collision avoidance resulting in improved computational efficiency over non-linear optimal control.

Virginia Tech Transportation Institute, Blacksburg, VA

Research Associate Jan 2025 - Oct 2025

- Enhanced long-range detection using camera and range sensors for autonomous emergency braking.
- Simulated rainy conditions using monocular depth estimation and physics-based particles to study sensor degradation.

Honda Research Institute, San Jose, CA

Research Associate Feb 2024 - May 2024

- Developed a 7 DOF human arm dynamics model and implemented Model Predictive control (MPC) for **upper-limb motion** generation for reaching and orientation tasks.
- Performed hyperparameter optimization minimizing the overall cost to generate smooth anthropomorphic motion and validated against actual human upper-limb motion data.

Research Experience

Virginia Tech, Blacksburg, VA

Graduate Research Associate Jan 2021 - Dec 2024

- Developed an **uncertainty-aware social navigation planner** using MPC/MPPI and Control Barrier Functions (CBFs) for proactive robot navigation among dynamic pedestrians.
- Developed a **vision-based obstacle avoidance planner** using learning-based control to learn cost function maps for avoiding collision.
- Developed a seq2seq Kalman filter surrogate to capture and propagate sensing uncertainty via **deep ensembles** for robust trajectory prediction.
- Created a Bayesian inference model with **Monte Carlo Dropout** for trajectory prediction, improved accuracy by 15% over deterministic models.
- Designed a **cooperative prediction algorithm** to forecast trajectories of occluded objects in GPS-denied environments.
- Proposed a **probabilistic RRT (PRRT)** planner using Gaussian Processes, enhancing proactive collision avoidance.

Refereed Journal Publications

[1] Shaik, Shahil, Aditya Parameshwaran, **Anshul Nayak**, Jonathon M. Smereka, and Yue Wang. "MA-VLCM: A Vision Language Critic Model for Value Estimation of Policies in Multi-Agent Team Settings." arXiv preprint arXiv:2603.15418 (2026) [under review at IEEE RAL].

[2] **Nayak, Anshul**, and Azim Eskandarian. "Prediction uncertainty-aware planning using deep ensembles and trajectory optimisation." arXiv preprint arXiv:2502.10585 (2025).

[3] **Nayak, Anshul**, Azim Eskandarian, Zachary Doerzaph, and Prasenjit Ghorai. "Pedestrian Trajectory Forecasting Using Deep Ensembles Under Sensing Uncertainty." IEEE Transactions on Intelligent Transportation Systems (2024).

[4] **Nayak, Anshul**, and Azim Eskandarian. "Cooperative probabilistic trajectory prediction under occlusion." IEEE Transactions on Intelligent Vehicles (2024).

[5] **Nayak, Anshul**, Azim Eskandarian, and Zachary Doerzaph. "Uncertainty estimation of pedestrian future trajectory using Bayesian approximation." *IEEE Open Journal of Intelligent Transportation Systems* 3 (2022): 617-630.

[6] Mehr, Goodarz, Prasenjit Ghorai, Ce Zhang, Anshul Nayak, Darshit Patel, Shathushan Sivashangaran, and Azim Eskandarian. "X-CAR: An experimental vehicle platform for connected autonomy research." *IEEE Intelligent Transportation Systems Magazine* (2022).

[7] Xihui Wu, Anshul Nayak, Azim Eskandarian. Motion Planning of Autonomous Vehicles under Dynamic Traffic Environment in Intersections Using Probabilistic Rapidly Exploring Random Tree. *SAE International Journal of Connected and Automated Vehicles*, 4:383–399. 2021.

[8] **AA Nayak**, S Gangopadhyay, DK Sahoo. Modelling, simulation and experimental investigation for generating 'I' shaped contour on Inconel 825 using electro chemical machining. *Journal of Manufacturing Processes*, 23:269–277. 2016.

Refereed Conference Publications

[9] **Nayak, Anshul**, Zhi Xu, Ran Dai, and Yue Wang. "Koopman Predictive Control for Social Navigation with Learned Pedestrian Motion," *American Control Conference (ACC)*, under review, 2027.

[10] **Anshul Nayak**, Shahil Shaik, Jon Smereka, and Yue Wang, "Reason-Guided Human Reward Modeling for Preference-Based Reinforcement Learning (PbRL)," *2026 IFAC Workshop on Cyber-Physical Human Systems (CPHS)*, accepted, 2026.

[11] **A. Nayak**, S. Shaik and Y. Wang, "Belief-Aware VLM Model for Human-Like Reasoning," 2026 IEEE 35th International Conference on Robot and Human Interactive Communication (RO-MAN), Kitakyushu, Japan, 2026, pp. 719-724, doi: 10.1109/RO-MAN72286.2026.11714787.

[12] **Anshul Nayak**, Azim Eskandarian, Prasenjit Ghorai, Zachary Doerzaph. A Comparative Study on Feature Descriptors for Relative Pose Estimation in Connected Vehicles. In: *ASME International Mechanical Engineering Congress and Exposition, 2021*, Nov 1–5, 2021. Virtual, online. doi:https://doi.org/10.1115/IMECE2021-70693

[13] Prasenjit Ghorai, Azim Eskandarian, Anshul Nayak, Zachary Doerzaph. Relative Pose Estimation for Cooperative Vehicles and Tracking of Multiple Dynamic Objects. In: *ASME International Mechanical Engineering Congress and Exposition, 2021*, Nov 1–5, 2021. Virtual, online. doi:https://doi.org/10.1115/IMECE2021-69651

[14] **Anshul Nayak**, Hodjat Pendar. Effect of kinematics and physical properties of caudal fin on performance of a robotic fish. In: *APS March Meeting Abstracts*, 2021:B14. 011, March 15–19, 2021. Virtual conference.

PATENTS

[15] Expected human trajectory generation for teleoperation S Li, **AA NAYAK**, P Baskaran - US Patent App. 19/083,337, 2025
https://patents.google.com/patent/US20250345933A1/en

Conference Talks

[16] Anshul Nayak, Hodjat Pendar. Effect of kinematics and physical properties of caudal fin on performance of a robotic fish. In: *Southeast Regional SICB Meeting, November 14 2020, Wake Forest University, North Carolina*.

BOOK CHAPTERS

[17] Eskandarian, Azim, Goodarz Mehr, Anshul Nayak, and Xu Shang. "Challenges and Algorithms for Connected and Autonomous Vehicle Safety and Mobility in Smart Cities." In Transportation Mobility in Smart Cities, pp. 239-262. Cham: Springer Nature Switzerland, 2024.

AWARDS

Pratt Fellowship

- Awarded the prestigious Pratt fellowship from Mechanical Engineering department, 2018–2019, Fall 2024

TEACHING EXPERIENCE

Clemson University, Clemson, SC

Creative Inquiry Course Fall 2026

- Principal Investigator for the course "multi-robot off-road terrain navigation"
  - Lead a team of six students in designing and developing an F1-TENTH autonomous vehicle for heterogeneous multi-robot data collection.
  - Mentor students in high-fidelity, multi-modal sensor data acquisition and processing to develop training datasets for vision-language models (VLMs).

Virginia Polytechnic and State University, Blacksburg, VA

Teaching Assistant Fall 2018 - Fall 2020
(sample graded material and student evaluations available upon request)

- Teaching Assistant for ME 4124: CAD of Fluid/Thermal Lab
  - Fall 2018 and Fall 2020
  - Responsible for 2-hour lecture and laboratory. Students design and implement Thermal and Fluid simulations in Ansys.
  - Guided a batch of 50 students; graded the lab work, arranged lectures, quizzes and took office hours.
- Teaching Assistant for PHY 2305 introductory physics lab
  - Spring 2019, Fall 2019 and Spring 2020
  - Responsible for making students familiar with practical physics problems related to kinematics of motion through experiments.

PAST EXPERIENCE

Bajaj Auto Limited, Pune, India

Graduate Trainee Engineer July 2015 - July 2018

- Multi-Body Dynamics simulation of chassis subsystems (steering, suspension etc.) using ADAMS.
- Development of Low Rolling resistance tires to improve mileage of electric vehicles.
- Performance optimization of engines using Ricardo Wave.

Indian Institute of Science, Bangalore, India

Summer Research Fellow (under Dr. Saptharshi Basu) APR 2014 - July 2014

- Experimental study of swirl flows inside a compact combustor.
- Numerical simulation to capture swirl patterns validating experimental analysis using ANSYS CFD.

PROFESSIONAL SERVICE

- Co-chaired session on “Cognition, Intent and Embodied AI III” at IEEE RO-MAN 2026.
- Reviewer for Regular papers: IEEE *Intelligent Transportation Systems conference* 2022, 2023.
- Reviewer for IEEE *Intelligent Vehicle symposium* 2022.

Courses and Experience

Mathematics:

- Applied Mathematics, Bayesian Statistics, Probability Theory, Real and Complex Analysis, Linear Algebra, Optimization

Computer Science and Engineering:

- Deep Learning, Reinforcement Learning, Data structures, Computer Vision

Control Theory and Engineering:

- Linear and Nonlinear Systems Theory, Model Predictive Control, Robotics and Automation, Biomimicry and Bioinspiration