Neil Janwani

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RESEARCH INTERESTS

Broadly, my interests are in **robotics and human robot interaction (HRI)**. I am more specifically interested in answering the following questions:

1. How can we design robots and algorithms that *collaborate* with a person, especially someone who depends on that robot for their well-being?
2. How can we *interpret* qualitative objectives into well-defined robot tasks?
3. How do we maintain the *performance* of HRI systems without losing formal safety guarantees?

My technical interests are grounded in **robotics AI, ML, and control theory**. I am eager to expand my knowledge in these areas through HRI research.

EDUCATION

California Institute of Technology, Pasadena, California, USA — SEP 2020 — JUN 2024
Bachelor of Science in Computer Science — Cumulative GPA: 4.0/4.3

Herbert Henry Dow High School, Midland, Michigan, USA — SEP 2016 — JUN 2020
High School Diploma — Cumulative GPA: 4.0/4.0

ACADEMIC AND WORK EXPERIENCE

Burdick Group, Caltech — Pasadena, California
Research Fellow: Kiyo and Eiko Tomiyasu Named Scholar — JUN 2023 — Present

- Applied backup control barrier functions (BCBFs) to driver assistance by leveraging driver intention to choose between multiple BCBFs with different backup controllers.
- Fused LSTM architecture for intention estimation with BCBFs without losing theoretical safety guarantees.
- Implemented algorithms on hardware and showed experimentally that human-robot alignment and general reachability of the robot was enhanced.
- Developed graphical and haptic user interface for 20+ DARPA team in accordance with team meetings and deadlines.
- Wrote first author paper **accepted** to the International Conference on Robotics and Automation.
- Currently investigating uncertainty estimation and preference-based reinforcement learning to improve robustness and tunability of the framework respectively.

AMBER Lab, Caltech — Pasadena, California
Research Fellow — JAN 2021 — Present

- Developed a novel ankle exoskeleton built from a shin-mounted hand-shearing auxetic elastic actuator.
- Devised accurate LSTM and DNN regressors for gait state estimation from ankle-mounted IMUs.
- Designed PCBs to house electronic components, optimally placed biometric sensors, and prioritized user safety.
- Programmed field oriented control and controller communication protocol for Maxon motors using SimpleFOC.
- Currently conducting human trials to evaluate the effectiveness of ankle exoskeleton as measured by metabolic output.

MIT: Lincoln Laboratory — Lexington, Massachusetts
Research Intern — JUN 2022 — SEP 2022

- Formulated additions to linear time-invariant control methodology for sensorless control of gimbal motor.
- Refactored Simulink and Jupyter API for experimentation of sensorless control algorithms on gimbal testbed.
- Achieved accurate sensorless estimation of steady-state electrical phase in under 20 seconds.

PUBLICATIONS

- **Janwani, N. C.**, Daş, E., Touma, T., Wei, S. X., Molnar, T. G., & Burdick, J. W. (2023). A Learning-Based Framework for Safe Human-Robot Collaboration with Multiple Backup Control Barrier Functions. *arXiv preprint arXiv:2310.05865.* **Accepted at the International Conference of Robotics and Automation, 2024.**

TEACHING EXPERIENCE

Single Board Computers in Research, Caltech CS 12 Course Pasadena, California
Course founder and instructor JAN 2023 — Present

- Developed 10-week course on prototyping robotic and computing systems for research applications.
- Taught 20 students in concurrent software and circuit design, sensor interfacing, microcontroller communication.
- Wrote hands-on labs in basic circuitry, hardware input, motor control and coached groups through final projects.
- Hired and trained an undergraduate teaching assistant to assist with course activities and grading.
- Granted $3000 from Caltech in funding for larger iteration of the course for the 2024 cycle

Caltech Robotics and Computer Science Pasadena, California
Teaching Assistant JAN 2022 — Present

- Designed a differential drive robot as Robotics Head Teaching Assistant for a 35 student diversity, equity and inclusion program.
- Held office hours and wrote exam materials for classes of 100+ students in Experimental Robotics (ROS2: Python), Kinematics (ROS2: Python), Data Structures (Java), Software Design (C), and Computing Systems (x86 Assembly).

SELECTED PROJECTS

- *Medical Image Diagnosis:* Used large vision models and high performance computing to predict pathologies from "CheXpert" chest X-rays.
- *Quadruped kinematics demonstration:* Wrote kinematics chain to simulate a walking quadrupedal robot designed in Solidworks using ROS1.
- *Hierarchical Quadruped Planner:* Formulated a hierarchical A* and PRM planner for quadrupedal locomotion on diverse terrains.
- *Robot algorithms on hardware:* Implemented occupancy-grid based localization, obstacle avoidance, and odometry algorithms on hardware.
- *Planner Computational Analysis:* Built a D* planner and compared computational efficiency with A* and Dijkstra for replanning on large graphs.
- *Exploration-based Planner:* Wrote an exploration algorithm and simulative environment to prioritize information gain of an unknown space with probabilistic sensor feedback

SELECTED COURSES

Robotics
Upcoming: Advanced Kinematics
Upcoming: Robotic Systems
Advanced Motion Planning
Motion Planning and Kinematics
Mobile Robotics

Learning
Upcoming: Consciousness
Large Language and Vision Models
Learning Systems
Machine Learning and Data Mining
Causation and Explanation

Control theory
Upcoming: Nonlinear Dynamics
Linear Systems Theory
Feedback Control Systems

Software & Math
Computing Systems
Software Design
Discrete Mathematics
Differential Equations
Probability and Statistics
Applied Linear Algebra

AWARDS

Kiyo and Eiko Tomiyasu Research Fellowship Pasadena, California
Fully funded summer undergraduate research at the Burdick Group, Caltech JUL 2023

Caltech Housner Fund Pasadena, California
Granted $3300 to develop my own robotics course and support increased student interest DEC 2023

VOLUNTEER OUTREACH

Caltech Y Pasadena, California
Tutor OCT 2021 — JUN 2023

- One-on-one tutored secondary school students in math, physics, and robotics

GENERAL SKILLS

- **Programming Languages:** `Python, C/C++, x86 Assembly, OCaml, Haskell, Java`
- **Software:** ROS1&2, Linux, Git, Catkin, OpenCV, PyTorch, TensorFlow, Scipy, Scikit-learn, Matplotlib, Bokeh, Numpy, Pandas, MATLAB/Simulink, Solidworks, SimpleFOC