Benjamin Forbes

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Research Summary

My research centers on creating human-centered robotic systems that utilize the strengths of humans - for long horizon and high order control, and robots - for accurate and repetitive movements. Thus driving my work developing learning-based **shared autonomy** algorithms for human embodiment in robotic systems using human cues such as **eye gaze**. I am also interested in creating **robust tactile sensing** for contact-rich robotic manipulation in extreme environments. I believe policies that utilize tactile sensing and human body language lead to safer and more comfortable human interaction with robots.

Education

- **University of California, Los Angeles** *Expected June 2030*
  PhD, Mechanical Engineering - Design, Robotics, and Manufacturing Los Angeles, CA
  ◦ Advisor: Dr. Veronica Santos
- **Northwestern University** *March 2024*
  B.S./M.S., Mechanical Engineering Evanston, IL
  ◦ Advisor: Dr. Edward Colgate
  ◦ Thesis Project: Electroadhesion and the Capstan Effect

Fellowships, Grants & Awards

- **DOD SMART Fellowship (did not accept)** *2025*
  U.S. Department of Defense
  ◦ Awarded to research underwater tactile sensing and manipulation at Naval Expeditionary Warfare Center, Keyport
- **Big Ten Postgraduate Scholarship** *2024*
  Big Ten Conference
  ◦ Awarded graduate scholarship for exceptional academic and athletic achievement in the Big Ten Conference
- **First Prize ASME/SME Student Manufacturing Design Competition** *2023*
  North American Manufacturing Research Conference (NAMRC)
  ◦ First prize for work on my senior capstone: "Desktop Robotic English Wheeling System"
- **Academic All-Big Ten (3×)** *2022-2024*
  Big Ten Conference
  ◦ Received for maintaining GPA above 3.0 during the Big Ten Conference competition season
- **Big Ten Distinguished Scholar (2×)** *2023-2024*
  Big Ten Conference
  ◦ Awarded for maintaining GPA above 3.7 while competing as a Division 1 athlete in the Big Ten Conference

Research Experience

- **Biomechatronics Lab, University of California, Los Angeles** *Sept 2024 - Present*
  Graduate Student Researcher - Advisor: Dr. Veronica Santos Los Angeles, CA
  ◦ Designed waterproof optical-based tactile sensor for use in learning dexterous manipulation policies in marine environments
  ◦ Created simulation in MuJoCo for training of shared autonomy control algorithms for teleoperation of a bimanual robotic system
  ◦ Utilized Varjo headset and eyetracking capabilities to as policy input predict the user's task intent
- **Human Factors Institute, UCLA/ Case Western Reserve University/ Cleveland State University** *Oct 2024 - Present*
  Controls Team Lead - Advisor: Dr. Veronica Santos Los Angeles, CA
  ◦ Developed optimization-based control scheme for serial robot manipulators that maximizes the manipulability and avoids singularities that increases the feeling of human embodiment during teleoperation
  ◦ Deployed the controller in a bimanual robotic system with a Franka Emika FR3 and Universal Robots UR5e in ROS2 to complete complex manipulation tasks
- **Center for Robotics and Biotechnology, Northwestern University** *June 2023 - June 2024*
  Graduate Student Researcher - Advisor: Dr. Edward Colgate Evanston, IL
  ◦ Explored the idea of using a capstan to amplify the holding force of a thin-film electroadhesive clutch by deriving mechanical equations relating the wrapping angle to the holding force of the clutch
  ◦ Built comprehensive test rigs with load cells to measure the holding force of the clutch when voltage was applied across it - which validated of the theoretical equations

- Utilizing my analysis, designed, manufactured, and assembled a novel actuator for high-force, high-displacement applications

- **Advanced Manufacturing Processes Lab, Northwestern University** *June 2023 - Jan 2024*
  Graduate Student Researcher - Advisor: Dr. Kornel Ehmann Evanston, IL
  - Designed specialized robot end-effector and custom desktop hardware to automate English wheeling - a sheet metal forming process
  - Integrated load cell in the frame of the English wheel and using a NI DAQ, LabVIEW for implemented force feedback into the control algorithm of the UR5e robot arm

Teaching Experience

- **Teaching Assistant - Dynamics of Rigid Particles and Bodies** *Fall 2024*
  University of California, Los Angeles
  - Prepared materials for and taught a weekly 2 hour long discussion section consisting of a review of material and practice problems, with attendance of approximately 80 students

- **Grader - Computer Integrated Manufacturing II: CAD/CAM** *2023-2024*
  Northwestern University
  - Evaluated student homework and labs on CAD/CAM systems and manufacturing processes ranging from injection molding to FDM printing

Professional Experience

- **Northwestern University Segal Design Institute** *June 2022 - Sept 2022*
  Design Engineering Intern Evanston, IL
  - Designed and manufactured and polished multiple biomedical products for infant video fluoroscopy, gait training, and diabetes management

- **WAGIC, Inc.** *June 2021 - Sept 2021*
  Product Design Engineer Remote via Fresno, CA
  - Tested products, communicated safety concerns, and remodeled "AutoSpout" - a hands free faucet attachment - with necessary considerations for safety compliance and injection molding optimization

- **Clovis Sports Magazine** *June 2020 - Oct 2020*
  Content Coordinator Fresno, CA
  - Head writer for a monthly local sports magazine covering highschool sports

Academic & Professional Service

- **Assistant Head Swim Coach** *Sept 2024 - Present*
  Bruin Swim Club
  - Coached children aged 7-15 years to swim competitively by developing age-appropriate training programs and skill progressions

- **Executive Committee Member** *2020 - 2024*
  Student Athlete Advisory Committee, Northwestern
  - Liaised between varsity athletes and university administration, making departmental changes to better the lives of student-athletes
  - Led planning for student-focused events and community outreach programs

Skills

- **Programming Languages and Robotics:** Python, ROS2, MATLAB, C++, LabVIEW, R
- **CAD/Engineering Software:** SolidWorks, OnShape, CREO
- **Manufacturing & Fabrication:** CNC Machining, 3D Printing, Laser Cutting
- **Data Acquisition & Analysis:** National Instruments DAQ, Load Cells, Sensor Integration, Signal Processing
- **Research Skills:** Experimental Design, Statistical Analysis, Technical Writing, Patent Filing

Publications

[J.1] Suarez, D., Chen, F., Kang, P., **Forbes, B.**, Gao, M., Ineza, O., Benton, K., Dewberry, N., Jaiswal, C., Gokaraju, B., Ehmann, K., & Cao, J. (2024). **On the feasibility of an integrated English wheel system**. *Journal of Manufacturing Systems*, Vol. 73, pp. 373-384. DOI: 10.1016/j.jmsy.2024.05.003

In Progress

[C.2] **Forbes, B.**, Harber, E., Penaloza, J., Yared, H., Kasmalkar, P., & Santos, V. J. (2025). **H2Opti: A Vision-based Underwater Tactile Sensor**. *In Preparation*,2025.