Calvin Joyce

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Research Interests

Medical robotics and physical human–robot interaction (pHRI): haptic and bilateral teleoperation, robot learning for contact-rich manipulation, clinical safety formalization, continuum/endovascular robots, and humanoids for clinical tasks, grounded in years of hands-on robot hardware design and deployment.
Seeking a medical robotics R&D / New Product Development internship, available January–September 2027.

Education

University of California, San Diego · B.S. & M.S. Mechanical Engineering, GPA 3.8/4.0 *B.S. 2024 · M.S. expected June 2027*
Graduate advisor: Prof. Michael C. Yip, Advanced Robotics and Controls Lab (ARCLab)

Research & Work Experience

Advanced Robotics and Controls Lab (ARCLab), UC San Diego *June 2021 – Present*
R&D Engineer / Graduate Student Researcher, previously Undergraduate Researcher · Advisor: Prof. Michael C. Yip La Jolla, CA

- **PHABS (Portable Haptic Assisted Bimanual System)** **Project lead; first author, ICRA 2027 submission**
  - Attacking the force-blindness of video, simulation, and position-only teleoperation data, by capturing force-annotated bimanual demonstrations that anchor imitation-learning corpora.
  - Invented the first handheld bimanual device to render the internal force between two hands on a shared object, the signal that decides crushing, slipping, or tearing, by pairing capstan-driven pinch actuators (maxon RE 36, 27.6 N continuous, 7.94:1 cable transmission) with a gimbal-motor linear squeeze stage on carbon-fiber rails over recirculating-ball bearings.
  - Closed the bilateral teleoperation loop on an Anvil OpenArm dual-arm robot, by estimating contact wrenches from gravity-compensated joint effort (recursive Newton–Euler, damped Jacobian pseudoinverse) and rendering per-hand pinch plus a signed inter-hand internal-force channel.
  - Built the embedded sensing and actuation stack: a Teensy 4.1 fusing IMUs, magnetic encoders, barometers, and time-of-flight ranging over I^2C/UART, driving H-bridge and field-oriented-control motor stages, with synchronized device- and robot-frame logging to LeRobot format.
  - Now training ACT policies on matched haptic vs. no-haptic demonstrations across three contact-rich bimanual tasks, with a stiffness-discrimination and NASA-TLX human-subjects study; verified force-rendering fidelity against a reference load cell.
- **RIC (Robotic Infant Care)** — *first framework for direct robotic infant handling* **Project lead; first author, ICRA 2027 submission**
  - Defining safe robotic care for the NICU's most frequent physical interventions: bimanual infant pickup and CPAP nasal-mask repositioning, contact-rich tasks no robotic system has performed on a physical infant.
  - Formalized the safety bar, by deriving continuously measurable clinical thresholds with four NICU clinicians (a NICU nurse, a NICU physician, and two neonatal respiratory therapists): cervical pitch and head acceleration for pickup; contact pressure, eye/mouth exclusion zones, and a PEEP-interruption time budget for CPAP.
  - Benchmarking direct-human, teleoperated, and autonomous (ACT) execution on a Unitree G1 humanoid, by building a REMI-manikin OptiTrack pipeline, molding a Fisher & Paykel nasal mask with embedded force-sensitive resistors and in-situ load-sharing calibration, and verifying every trial against the clinical thresholds.
- **Humanoid Surgery** *(video)* · *in vivo feasibility of humanoid robots in laparoscopic surgery* **Co-author, *Nature* 2026**
  - Enabled humanoid robots to operate standard medical tools in dry-lab and in vivo porcine surgeries, by designing the tool-mount system (optimized mass/CoM, bench- and sim-validated rigidity) and running mechanical setup for every surgical session.
  - Coordinated a 10-person robot–clinician team through live surgeries, turning surgeon feedback into hardware revisions.
- **Autonomous Catheter Navigation** — *early-stage ARPA-H & DARPA project; RL for endovascular robotics* **Jul 2026 – Present**
  - Developing autonomous catheter steering in simulation, by training PPO policies with domain randomization in GPU-physics models of patient-derived vasculature; early policies outperform the project's prior baseline.
  - Made sampling-based MPC tractable in simulation, by building state snapshot/restore for the GPU catheter-physics solver.
  - Built three catheter simulation demos for Newton, an open-source physics engine from NVIDIA, DeepMind, and Disney.

ArtemisAI Labs · *Mechanical Engineer, La Jolla, CA* *Jan 2026 – Present*

- Made a NICU bedside camera mount clinically deployable, by writing its load, retention, and cleanability requirements (rough-handling loads benchmarked against the IEC 60601-1 instability test; no-disassembly hydrogen-peroxide wipe-down) and redesigning it against them with low-cost, manufacturable, and COTS components.
- Split the unit into separately specified clamp, arm, and phone-interface subassemblies with acceptance criteria for each (pole capture range, slip torque, pull-off force, reposition-cycle stiffness retention), then wrote the assembly protocol and bill of materials so labor could be quoted independently of parts.
- Reached the bedside: the mount fields the cameras for NOVA (Neonatal AI Vision Assessment), ArtemisAI's Phase II multi-center trial of computer-vision neurological monitoring of newborns, running at Mount Sinai; lining up assembly partners to kit and ship units to purchasing hospitals.

Research Projects

- **Haptic Shoulder** *(paper)* · *pHRI phantom; co-first author, ICRA 2025; provisional patent* **Jan 2024 – June 2024**
  - Invented a biomechanically accurate shoulder phantom for safe pHRI testing (provisional patent in progress), by dedicating one motor-encoder module to each anatomical DOF to reproduce joint center, coupled kinematics, and configuration-dependent range of motion.
  - Enabled real-time testing and deployment of pHRI planning tasks onto physical robots without human subjects, standing in for a patient the way a medical phantom does.
- **ARCSnake V2 (w/ NASA JPL)** *(paper)* · *amphibious screw-propelled snake robot; IROS 2026* **June 2021 – Sep 2025**
  - Increased propulsion-screw output torque 40%, by raising the torque ratio, aligning the belt drive, and cutting friction (shorter drive stack, relieved rubbing surfaces), validated on a testbed I built.

- Characterized which screw parameters drive performance across media, by engineering a mobile testbed for constrained axial measurement with a 6-DOF force-torque sensor, validated via SolidWorks FEA (co-first author, ICRA 2023).
- Designed NASU (Novel Actuating Screw Unit), the first Archimedes-screw locomotion design with a dynamically reconfigurable angle of attack for sand, water, and dirt (first author, ISRR 2024).
- Built the "Voodoo Doll," a 10-DOF specialized teleoperation controller, by designing lockable U-joints with magnetic encoders to command ARCSnake V2's joint positions.
- Led hardware integration, electrical and mechanical, for validation of the full robot in underwater testing.

- **Autonomous Driving RC Car** — *course project: vision-based autonomy on embedded hardware* **April 2024 – June 2024**
  - Completed a track autonomously, by implementing edge-detection and line-following in Python with OpenCV on embedded Linux; integrated an IMU to detect hydroplaning and trigger corrective steering.

Publications (Google Scholar)

Presented or co-presented at ICRA 2023, ISRR 2024, ICRA 2025, and ICRA 2026. * denotes equal contribution.

1. Z. Liang, N. Thareja, P. Zhang, **C. Joyce**, S. Atar, F. Richter, G. Jacobsen, S. Liu, R. Broderick, and M. C. Yip, "In vivo feasibility study of humanoid robots in surgery," *Nature*, 2026.
2. **C. Joyce**, J. Honma, T. Tattala, V. Benedicto, and M. C. Yip, "PHABS (Portable Haptic Assisted Bimanual System) for Force-Annotated Bimanual Shared Object Teleoperated Data," ICRA 2027 submission, Sept 2026.
3. **C. Joyce**, S. Hong, R. Fellbaum, F. Richter, and M. C. Yip, "How Safe Is Robotic Infant Handling? Benchmarking Learning from Demonstration Against Clinical Thresholds for Neonatal Pickup and CPAP Mask Repositioning," ICRA 2027 submission, Sept 2026.
4. Z. Liang, X. Liang, S. Atar, S. Das, Z. Chiu, P. Zhang, **C. Joyce**, F. Richter, S. Liu, and M. C. Yip, "LapSurgie: Humanoid Robots Performing Surgery via Teleoperated Handheld Laparoscopy," in *Proc. IEEE Int. Conf. Robotics and Automation (ICRA)*, 2026.
5. S. Wickenhiser*, E. Peiros*, **C. Joyce**, P. Gavrilov, S. Mukherjee, S. Sylvester, J. Zhou, M. Cheung, J. Lim, F. Richter, and M. C. Yip, "ARCSnake V2: Mechanical Adaptations For An Amphibious Multi-Domain Screw-Propelled Snake-Like Robot," in *Proc. IEEE/RSJ Int. Conf. Intelligent Robots and Systems (IROS)*, 2026, to appear.
6. **C. Joyce***, E. Peiros*, T. Murugesan*, R. Nguyen, I. Fiorini, R. Galibut, and M. C. Yip, "Haptic Shoulder for Rendering Biomechanically Accurate Joint Limits for Human-Robot Physical Interactions," in *Proc. IEEE Int. Conf. Robotics and Automation (ICRA)*, 2025.
7. **C. Joyce**, J. Lim, R. Nguyen, M. Owens, S. Wickenhiser, E. Peiros, F. Richter, and M. C. Yip, "NASU — Novel Actuating Screw Unit: Origami-Inspired Screw-Based Propulsion on Mobile Ground Robots," in *Proc. Int. Symp. Robotics Research (ISRR)*, 2024.
8. S. Atar, **C. Joyce***, X. Liang*, F. Richter, W. Ricardo, C. Goldberg, P. Suresh, and M. C. Yip, "Humanoids in Hospitals: A Technical Study of Humanoid Surrogates for Dexterous Medical Interventions," arXiv:2503.12725, 2025. (co-second author)
9. **C. Joyce***, J. Lim*, E. Peiros, M. Yeoh, P. V. Gavrilov, S. G. Wickenhiser, D. A. Schreiber, F. Richter, and M. C. Yip, "Mobility Analysis of Screw-Based Locomotion and Propulsion in Various Media," in *Proc. IEEE Int. Conf. Robotics and Automation (ICRA)*, 2023.

Patents

- Haptic Shoulder: biomechanically accurate shoulder phantom for pHRI testing. Provisional patent, in progress (co-inventor).
- PHABS: handheld bimanual haptic teleoperation device with inter-hand force rendering. Patent in preparation (lead inventor).
- Helping Hand: catheter-tip end-effector for grasping and cutting. Provisional patent, in progress (co-inventor).

Mentorship

- Mentored 7 students on the humanoid surgery project (concluded): CAD/FEA reviews, DFMA, fixture design, and test plans.
- Mentoring 2 students on PHABS and 2 on RIC toward their ICRA 2027 submissions.
- Mentored 5+ students on ARCSnake V2 through mechanical design reviews, supporting its IROS 2026 paper.
- Coached 20+ mechanical members across Triton Robotics subteams; ran design reviews, fabrication, and assembly for 3 robots.
- Directly mentored 5 members as subteam lead from concept to assembly: requirements, BOM, and manufacturing.

Leadership

Triton Robotics, UC San Diego · *Team President / Advisor* *June 2020 – June 2023*

- Scaled the team 20→80+ members and the proportion of non-male members from 15% to over 35%, by formalizing onboarding and training, DEI partnerships, targeted recruiting, and anonymous feedback loops.
- Led 17 team leads with OKRs, roadmaps, and stand-ups, by founding Business, Marketing, and Project Development teams; produced a formal business plan, sponsorship packet, donation page, and lab fit-out.
- Obtained nationally recognized nonprofit status, leading immediately to $3K in funding, a corporate sponsorship pipeline, and permanent workspace.

Service & Professional Memberships

- IEEE Robotics and Automation Society (RAS), member since 2023.
- Robotics outreach with Triton Robotics, including events at the UCSD Women's Center; built DEI partnerships that raised team diversity from 15% to 35%+.

Skills

- **Medical Robotics & pHRI:** haptics & bilateral teleoperation, catheter/continuum robots, clinical safety thresholds, OptiTrack
- **Software & Control:** Python, C++, MATLAB, PyTorch, ROS 2; imitation learning (ACT), PPO, MPPI; NVIDIA Warp/Newton
- **Hardware:** SolidWorks + FEA, Fusion 360, DFMA, resin/FDM printing, laser cutting; design requirements & acceptance criteria, verification testing, test fixtures, capstan drives, motor drivers, sensors

Coursework

Robotics; Haptics; Soft Robotics; Intro to Autonomous Vehicles; Linear Control; Signals and Systems; Mechanical Design; Computational Methods in Design; Experimental Techniques; Mechanical Engineering Lab; Ocean Technology Design & Development; Solid Mechanics; Dynamics and Vibrations; Elements of Materials Science; Fluid Mechanics; Heat Transfer; Linear Circuits; MATLAB for Engineering Analysis; Recommender Systems and Web Mining