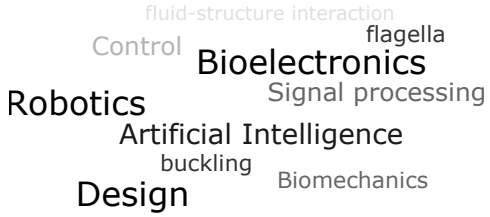
Yayun Du

Web: https://yayundu.com/
Email: duyayun1hit@northwestern.edu
GitHub: github.com/duyayun
LinkedIn: yayun-du
Address: 2145 Sheridan Road, Tech. Institute
Evanston, IL 60208



Profile Highlights

- **Research and collaboration:** Current research focuses on artificial intelligence (AI)-driven wearable and implantable devices. Leading five major projects and contributed to ten in the areas of circuit design, sensor fusion, signal processing, and machine learning. My projects involve the collaboration with seven universities and hospitals, garnering significant interest from hundreds of researchers. Prior research focused on developing and modeling biolocomotions (e.g., untethered flagellar robots in granular media and viscous fluids), autonomous under-canopy agricultural robots, and the control of robotic arms. Expertise: Bioelectronics, robotics, mechatronics, signal processing, and machine learning.

- **Publications and awards:** Published or submitted 10 first-authored articles and four co-authored articles within 5.5 years in top journals (e.g., Proceedings of the National Academy of Sciences, IEEE Robotics and Automation Letters) and conference proceedings (International Conference on Intelligent Robots and Systems (IROS), International Conference on Robotics and Automation (ICRA)) in robotics despite completely different expertise from Ph.D. advisor's (solid mechanics). Several are in preparation. Received a provisional patent on the agricultural robot. Finalists for **Best Paper Award on Agri-Robotics**, **Best Paper Award on Robot Mechanisms and Design** at IROS, 2021 (4/1261 for each category). Awarded MIT Civil and Environmental Engineering Rising Stars and four-year UCLA Graduate Division Fellowship. Awarded 2016 "Top Ten Students" at Harbin Institute of Technology, Weihai.

- **Grant Writing:** Aided in securing $2.5M in funding. Gathered preliminary data for a successful $450k federal grant from US Department of Agriculture, and a $700k National Science Foundation (NSF) grant. Contributed to one-third of an awarded $1.2M NSF proposal with four PIs. Also participated in writing a quarter of of a National Institutes of Health (NIH) Small Business Innovation Research (SBIR) proposal.

- **Mentorship and Teaching:** Mentored two Ph.D. students, seven master's students, 20 undergraduates, including seven females and two community college transfers. Co-authored peer reviewed papers with 16 supervisees. Out of these supervisees was awarded the 2022 Dean's Prize for Excellence in Research in NSF Summer-funded Undergraduate Researcher Program at UCLA in 2022, Jacqueline etc later joined Stanford, UCLA, Cornell, UMichigan as graduate students. Averaged 8.0/9.0 on student evaluations in six courses across five departments, with departmental averages of $\sim$ 7.2/9.0.

- **Leadership and Professional:** Co-founder of Student Researchers United (SRU) at UCLA to waive non-residential fees for international researchers and advocate for them. Conference planner and event coordinator of Southern California Robotics Symposium 2020, at UCLA (postponed due to COVID-19). Attended 2022 NorthEastern University and 2023 invitation-only Notre Dame future faculty workshops.

- **Media Coverage:** MIT Civil and Environmental Engineering Rising Star; Cover of UCLA Samueli School of Engineering Announcement 2022-23; Cover of Welcome Message from UCLA Interim Dean; Finalists for two Best Paper awards in IROS 2021; Published work covered by Bioinspired Design Program at UC, Berkeley.

Education

University of California, Los Angeles, CA
Ph.D. (Mech. Eng.); Major: Systems & Control; Minor: Structural & Solid Mechanics 03/2018 - 08/2022
M.S. (Mech. Eng.); Systems & Control 09/2016 - 03/2018

Harbin Institute of Technology, Heilongjiang, China Ranking: 1/144 (major), 1/260 (in department)
B.S.E. (Automotive Engineering) 09/2012 - 07/2016

Research experience

Rogers Research Group, Northwestern University, Chicago, IL — Sep 22 - present
Postdoctoral scholar — Advisor: Prof. John A. Rogers
Research area: wearable devices, bioelectronics, implantable devices, human robot interaction (stress measurement)

Structure-Computer Interaction Lab, UCLA, Los Angeles, CA — 04/2018 - 08/2022
Graduate Research Assistant — Advisor: Prof. M. Khalid Jawed
Research area: underwater & agriculture robots, robot modeling & control, biolocomotion, learning, sensor fusion

Biomechatronics Lab, UCLA, Los Angeles, CA — 04/2017 - 04/2018
Assistant in Research — Advisor: Prof. Veronica Santos
Research area: FEA model enabling BioTac haptic sensor, sensation of touch through supervised learning-FEA

New Energy Vehicle Research Institute, Harbin Institute of Tech, Harbin, China — 07/2014 - 08/2016
Assistant in Research — Advisor: Prof. Dafang Wang
Research area: distributed vehicle system control, alternative fuel vehicle

Selected Awards and Honors

Graduate

2023 **Humboldt Fellowship** from Alexander von Humboldt Foundation (25% - 30%)
2021 Finalists for **Best Paper Award on Agri-Robotics**, **Best Paper Award on Robot Mechanisms and Design** in IROS, 2021 (4/1261 for each category)
2021 **Supervisor of Honorable Mention Best Researcher** in the National Science Foundation Summer-funded Undergraduate Researcher Program (SURP) 2021 at UCLA
2021 **MIT Civil and Environmental Engineering (CEE) Rising Stars**
2021 **Chinese-American Engineers and Scientists Association of Southern California (CESASC) Scholarship** ($1,000)
2018-2021 **Graduate Division Fellowship** from UCLA Graduate Division ($ 49,097.72/year)

Undergraduate

2012-2016 **National Scholarship** from Ministry of Education of the People's Republic of China with **first** GPA ranking (**1/144**) for four years in Department of Automotive Engineering
2015 **Top Ten Students** of Harbin Institute of Technology, Weihai for combined top **1%** GPA, excellent publications and outstanding leadership. I was the only junior gaining this honor while others were seniors (**10/12000**)
2015 **Honorable Mention** from COMAP for Mathematical Contest in Modeling (MCM)
2015 **Outstanding Leader Award** from Harbin Institute of Technology for academic excellence and fantastic student club activity organization
2014 **Best-organized Volunteer Team Leader** from Harbin Institute of Technology for establishing the first volunteer team of college students to teach in Tibet and building long-term cooperation with the local government
2013 **First Prize** from Heilongjiang Provincial Education Department in Mathematics Competition for College Students (Top **8%**)
2013 **First Prize** from College Foreign Language Teaching Committee and College Foreign Language Teaching Research Association in National English Competition for College Students (Top **0.5%**)
2013 **Most Creative Award** from Department of Automotive Engineering for the lowest cost and most efficient pressure oil pump design (**1/10**)

Media Coverage

M1. The precision agriculture robot that I developed covered in 2023-2024 HSSEAS announcement and as the cover of UCLA 2022-2023 Announcement [link1]

M2. MAE Ph.D. Student Yayun Du selected as a "Rising Star" by MIT CEE, *MIT Civil and Environmental Engineering* (2021) [link1], *UCLA Mechanical and Aerospace Engineering Departmental News* [link2]

M3. Student researchers from Khalid Jawed's lab are finalists at the top robotics conference, *UCLA Mechanical and Aerospace Engineering Departmental News* [link]

M4. Paper, Simple Flagellated Soft Robot for Locomotion near Air-Fluid Interface, *UC, Berkeley* [link]

Peer-Reviewed Publications and Proceedings

# indicates students supervised or mentored by Yayun Du;

W1. **Du, Y.***, Gu, J.,#*, Duan, S. #*, Trueb, J., Travelis, A., Shin, H., Davies, C., Rogers, J., "Automated vital monitoring with interpretable deep learning for sleep stage and apnea prediction in both clinical and home settings", Proceedings of the National Academy of Sciences, (*Under review*)

W2. **Du, Y.**, Miller, A.,#, Lovekin, A. #, Jawed, M. K., "Like bacteria: untethered underwater robots exploiting flagellar instability for steering", Science Robotics, (*Figure set ready and finishing the manuscript*)

W3. Slattery, S., Pessano, S., Yoo, **Du, Y.**, J., Oh, S., Jeong, H., Alla, A., Rand, C., Hamvas, A., Mayer, D., Rogers, J., "Continuous monitoring with wireless sensors and applied diagnostics for pain with Clinical Sensor Pain Scale and computer-aided Automated Sensor Pain Scale in the NICU", BMJ Health & Care Informatics, (*Under review*)

W4. Saha, S., **Du, Y.**, Sandha, S., Garcia, L., Jawed, M. K.,Srivastava, M., "Inertial Navigation on Extremely Resource-Constrained Platforms: Methods, Opportunities and Challenges, IEEE/ION PLANS, 2023 [link]

W5. **Du, Y.***, Saha, S.*, Sandha, S., Lovekin, A.#, Wu, J., Siddharth, S.,Chowdhary, M., Jawed, M. K.,Srivastava, M., "Neural-Kalman GNSS/INS Navigation for Precision Agriculture", ICRA, 2023 [link, video1, video2]

W6. Lim, S., **Du, Y.**, Lee, Y., Panda, S., Tong, D., Jawed, M. K., "Modeling, control, and fabrication of robots inspired by flagella and cilia", Bioinspiration and Biomimetics, 2022 [link]

W7. **Du, Y.**, Bansal, K., Palan, E., Quadir, M., Jawed, M. K., "Robotic Painting: Mimicking Human Applicators", Journal of Coatings Technology and Research 2022 [link]

W8. **Du, Y.**, Miller, A.,#, Jawed, M. K., "Mechanics-based analysis on flagellated robots", 2022 [link]

W9. **Du, Y.**, Lam, J.,#, Sachanandani, K.#, Jawed, M. K., "Modeling the locomotion of articulated soft robots in granular medium", *IEEE Robotics and Automation Letter (RAL) 2022 & ICRA* 2023 [link]

W10. **Du, Y.**, Zhang, G.,#, Tsang D.#, Jawed, M. K., "Deep-CNN based real-time robotic multi-class weed identification", *IEEE International Conference on Robotics and Automation (ICRA)*, 2022 [link, video1, video2]

W11. **Du, Y.**, Mallajosyula, B.#, Sun, D.#, Chen, J.#, Zhao, Z.#, Rahman, M., Quadir, M., Jawed, M. K., "A Low-cost Robot with Autonomous Recharge and Navigation for Weed Control in Fields with Narrow Row Spacing", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Prague, Czech Republic, 2021 (Finalists for **Best Paper Award on Agri-Robotics**, **Best Paper Award on Robot Mechanisms and Design**) [video1, video2]

W12. **Du, Y.**, Miller, A.#, Jawed, M. K., "Simple Flagellated Soft Robot for Locomotion near Air-Liquid Interface", *IEEE International Conference on Soft Robotics (RoboSoft)*, Yale, CT, 2021 [link, video]

W13. **Du, Y.**, Deng, Z. #, Fang, Z.#, Wang, Y.#, Nagata, T.#, Bansal, K., Quadir, M., Jawed, M. K.,"Vision and force based autonomous coating with rollers", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Las Vegas, NV, USA, pp. 9954-9960, 2020 [link, video1, video2]

W14. Qin, L., Huang W., **Du, Y.**, Zheng, L., "Genetic algorithm-based inverse design of elastic gridshells", *Structural and Multidisciplinary Optimization*, 62(5), pp.2691-2707, 2020 [link]

W15. Wang, D., Zhou, C., Zou, M., Liao, J., **Du, Y.**, "Study on Inspection of the Initial Rotor Position of BLDC Based on High-frequency Signal Injection", *IEEE Transportation Electrification Conference and Expo Asia-Pacific*, pp. 1-4, 2014 [link]

Patents

P1. Mohammad Khalid Jawed, Yayun Du, Mukhlesur Rahman, Mohiuddin Quadir, U.S. Provisional Patent Application No. 63/239,266 entitled AUTONOMOUS WEED CONTROL ROBOT, filed on 8/31/2021

Presentations

PT1. **Du, Y.***, Saha, S.*, Sandha, S., Lovekin, A., Wu, J., Siddharth, S., Chowdhary, Jawed, M. K., "Neural-Kalman GNSS/INS Navigation for Precision Agriculture", IEEE International Conference on Robotics and Automation (ICRA), London, UK, June 1, 2023 (*Poster*)

PT2. **Du, Y.***, Lam, J., Sachanandani K., Jawed, M. K., "Modeling the locomotion of articulated soft robots in granular medium", IEEE International Conference on Robotics and Automation (ICRA), London, UK, May 30, 2023 (*Oral*)

PT3. **Du, Y.***, Zhang, G., Tsang D., Jawed, M. K., "Deep-CNN based real-time robotic multi-class weed identification", IEEE International Conference on Robotics and Automation (ICRA), Philadelphia, PA, May 23-27, 2022 (*Oral*)

PT4. **Du, Y.***, Mungekar, M., Jawed, M. K.,"A modular approach to discrete differential geometry-based simulation of soft robots.", American Physical Society (APS) March Meeting, Chicago, March 14-19, 2022 (*Oral*)

PT5. **Du, Y.**,"Simple untethered flagellated robot in fluids and granular media.", MIT CEE Rising Star Workshop, Oct 27th-29th, 2021 (*Oral*)

PT6. **Du, Y.***, Jawed, M. K.,"A Low-cost Robot with Autonomous Recharge and Navigation for Weed Control in Fields with Narrow Row Spacing.", International Conference on Intelligent Robots and Systems (IROS), Online, Sep 28th, 2021 (*Oral*)

PT7. **Du, Y.***, Jawed, M. K.,"Simple untethered flagellated robot in fluids and granular media.", Seminar in Mechanical and Aerospace Engineering 298 at UCLA, May 28th, 2021 (*Oral*)

PT8. **Du, Y.***, Miller, A., Jawed, M. K.,"Simple flagellated soft robot near air-fluid interface", IEEE International Conference on Soft Robotics, Online, April 12-16, 2021 (*Oral*)

PT9. **Du, Y.***, Miller, A., Jawed, M. K.,"Simple untethered flagellated robot in fluids and granular media", APS March Meeting, Online, March 14-19, 2021 (*Oral*)

PT10. **Du, Y.***, Deng, Z. , Fang, Z., Wang, Y., Nagata, T., Bansal, K., Quadir, M., Jawed, M. K.,"Vision and force based autonomous coating with rollers", IROS, Online, Oct 25, 2020 (*Oral*)

PT11. **Du, Y.***, Lam, J., Sachanandani K., Jawed, M. K.,"Locomotion of Soft Robots with Flexible Flagella in Granular Medium", 1^{st} Southern California Mechanics Workshop, San Diego, CA, Jan 2020 (*Oral*)

PT12. **Du, Y.***, Lam, J., Sachanandani K., Jawed, M. K.,"Locomotion of Soft Robots with Flexible Flagella in Granular Medium", APS March Meeting, Boston, MA, March 4-8, 2019 (*Oral*)

PT13. Qin L.*, **Du, Y.**, Huang, W., Jawed, M. K., "Numerical Simulations for Physics-based Training of Robots for Manipulation of Flexible Rods", APS March Meeting, Boston, MA, March 4-8, 2019 (*Oral*)

PT14. **Du, Y.***, Jawed, M. K.,"Locomotion of Soft Robots with Flexible Flagella in Granular Medium", Southern California Robotics Symposium, Caltech, CA, April 2019 (*Poster*)

Grant Writing

G1. Collected preliminary data for Grant # 2021-67022-34200, "Autonomous Robotic Systems for Precision Weed Control in Flax", National Institute of Food and Agriculture, **United States Department of Agriculture**, $453,190, 2021 - 2025. PI: Mukhlesur Rahman (NDSU), co-PI: Mohiuddin Quadir (NDSU) and M. Khalid Jawed (UCLA)

G2. Developed the preliminary soft robots and collected preliminary data for **National Science Foundation CAREER** Award # 2047663, "MaLPhySiCS - Machine Learning-assisted Physics-based Simulation and Control of Soft robots", $700,000, 2021 - 2026. PI: M. Khalid Jawed (UCLA)

G3. Wrote ∼ 33% and doctoral work critically contributed to a multi-institution grant, titled "DSFAS: Harnessing Data for Accurate Yield and Oil Content Prediction", National Institute of Food and Agriculture, **United States Department of Agriculture**, $1.2M, Award # 2022-67022-37021, 2022. PIs: Wei Wang (UCLA), co-PI: M. Khalid Jawed (UCLA), Joao Paulo Flores (NDSU), Mukhlesur [link]; and "CCRI: Planning-C: A Framework for Development of Robots and IoT for Precision Agriculture", CISE Community Research Infrastructure, $116,000, 2022-2024, Award # 2213839, **National Science Foundation** [link]

G4. Wrote 1.5-page (out of 6 pages) hardware and firmware technical details for an **National Institutes of Health (NIH) - Small Business Innovation Research (SBIR)** proposal, Fall 2023, PIs: Theresa Brancaccio (Northwestern), John Rogers (Northwestern), Aaron Johnson (New York University)

Service to professional community

Reviewer

- ☐ Nature Electronics
- ☐ Nature Medicine
- ☐ Nature Biomedical Engineering
- ☐ Advanced Materials
- ☐ Proceedings of the National Academy of Sciences (PNAS)
- ☐ Transactions on Industrial Electronics
- ☐ IEEE Robotics and Automation Letters (RA-L)
- ☐ IEEE International Conference on Robotics and Automation (ICRA)
- ☐ IEEE International Conference on Intelligent Robots and Systems (IROS)
- ☐ IEEE International Conference on Advanced Robotics and Mechatronics (ICARM)

Leadership

- ☐ **Co-founder of Student Researchers United (SRU), UCLA**, Los Angeles, CA 02/2021 - 05/2022
  Advocate for and provide legal resources and peer support to international researchers
- ☐ **Organizer of Southern California Robotics Symposium 2020, UCLA**(postponed), Los Angeles, CA
  Settle on the agenda, venues, and budget, arrange and book the right venues for various sessions on-site; this includes the presentation, posters, lunch and dinner bars
  Cooperate with another Ph.D. peer to design and UCLA IT support team to launch the conference website
  Finalize and invite speakers and sponsors
- ☐ **Co-founder of Yuan Meng Tibet**, Tibet, China 06/2013 - 09/2013
  Create and lead the first volunteer team at Harbin Institute of Technology to teach in rural areas in Tibet
  Establish long-term collaboration with local Tibetan government since 2013 Summer

Professional Development

08/2022 NorthEastern faculty online workshop

05/2023 Notre Dame University faculty workshop (**invitation only**)

Partial Student Supervision

Northwestern University

10/2022-present Jianyu Gu and Shiyuan Duan (04/2023-), Yifan Zhang (02/2023-08/2023), Beige Xi and Yiqi Yuan (02/2023-06/2023), Jared Berry, Michael Jenz, and Ryan Kelly (10/2023-)

"Sleep study with wearable mechano-acoustic sensors", "Wearable EXG (electroencephalogram/electrocardiogram/electromyography)", "Two-channel implantable battery-free EXG"

High School Student Supervision

04/2022-05/2022 Kerry Huang (now at New York University) with Prof. Chen at Dartmouth College

"Raspberry Turk – a chess robot"

UCLA Research Experience for Undergraduates (REU)

2019-2021 Andrew Miller, Arthur Lovekin

"Like bacteria: untethered underwater robots exploiting flagellar instability for steering"

Undergraduate Student Research Program (SRP)

- ☐ 2022-2023 Janathan Chan

  "Fast and robust motion planning of soft articulated soft robots in water with discrete differential geometry and machine learning"
- ☐ 2021-2022 Yuchen Yao, Wenjie Mo

  "Learning hydrodynamics of soft articulated soft robots with discrete differential geometry and motion planning with reinforcement learning"
- ☐ 2020-2022 Chenda Duan

  "Inverse design and control of soft robots by hybrid simulation-learning"
- ☐ 2020-2021 Wenjie Mo, Chenda Duan, Yu Zhou, Guofeng Zhang, Darren Tsang, Jingyi Chen, Bhrugu Mallajosyula

  "Low-cost autonomous agricultural robot for weed control"
- ☐ 2019 Keerthi Pradaa Balajee

  "Bacteria-inspired soft robot capable of traveling through granular media"
- ☐ 2019 Taiki Nagata, Zhaoxing Deng

  "Collaborative robotic drawing simulation in Vrep with constant force", "Autonomous robotic paiting with rollers"
- ☐ 2019 Karunesh Schanandani, Jacqueline Lam

  "2D movement control of soft robots in low Reynolds number of fluid"
- ☐ 2019 Zihang Zhao, Visiting Summer Undergraduate Student

  "Build a compact agriculture robot for weed control"

Teaching Experience

Department of Biomedical Engineering, Northwestern University, Evanston, IL 04/2023 - 04/2024
Teaching Associate for hemodynamics measurement lab in Bioelectronics (Graduate)

Department of Electrical and Computer Engineering, UCLA, Los Angeles, CA 09/2017 - 09/2020
Teaching Associate for online *ECE 205A Matrix Analysis for Scientists and Engineers* (Graduate)
Student evaluation: **8.0/9.0** (Department average: 7.2/9.0)

Department of Mechanical and Aerospace Engineering, UCLA, Los Angeles, CA 09/2018 - 12/2021
Teaching Fellow for *M20 Introduction to Computer Programming with MATLAB* (Undergraduate)
Student evaluation: **8.0/9.0** (Department average: 7.0/9.0)

Department of Physics & Astronomy, UCLA, Los Angeles, CA 03/2018 - 06/2018
Teaching Assistant for *Physics 5C Physics for Life Sciences Majors: Electricity, Magnetism, and Modern Physics*
Physics 1C Physics for Scientists and Engineers: Electrodynamics, Optics, and Special Relativity (Undergraduate)
Student evaluation: **8.0/9.0** (Department average: 7.4/9.0)

Department of Psychology, UCLA, Los Angeles, CA 09/2017 - 12/2017
Teaching Assistant for *Psychology 120B Sensation & Perception* (Undergraduate)
Student evaluation: **8.0/9.0** (Department average: 7.2/9.0)

Technical Skills

Circuitry: Designed low-power and robust circuits; soldered >100 boards under a microscope.

Design and fabrication: Engineered and refined hardware for autonomous agricultural robots, including chassis, suspension, tank, and spraying system design and fabrication; designed and milled molds with CNC machines for silicone encapsulation of wearable and implantable sensors

Coding: Authored approximately 20,000 lines of firmware in **C** under **Zephyr**, a small real-time operating system, for implantable and wearable sensors; 10,000 lines of **C++** for simulating bio-locomotion by adapting Discrete Elastic Rods; Developed an extensive **Python** codebase exceeding 6,500 lines; Wrote **Rust** codes for data compression.

Signal processing and machine learning: Focused on advanced signal processing techniques, which involve the extraction of vital parameters such as heart rate (variability) and respiration rate (variability). These parameters served as partial inputs for the creation of efficient, lightweight machine learning models. These models were adept at classifying various sleep stages and identifying sleep apnea; integrated sensor fusion techniques on agricultural robots, utilizing data from cameras, LiDAR, IMU, and GPS. A key aspect of this project was the adaptation of these machine learning models for deployment in embedded systems, ensuring both performance and efficiency.