Daniel S Drew

Assistant Professor, Electrical and Computer Engineering
Adjunct Assistant Professor, Mechanical Engineering
The University of Utah

www.danieldrew.me
https://drl.ece.utah.edu/
daniel.drew@utah.edu

Research Interests

In the near future, swarms of millimeter scale robots will be vital and common tools in industrial, commercial, and personal settings. The research effort to get us there is inherently interdisciplinary and represents a tremendous opportunity for collaboration, for training a new generation of interdisciplinary investigators, and for forging new ties between the worlds of industry, academia, and design; I look forward to pushing it forward.

microrobotics, millisystems, swarms, human-robot interaction, wireless sensor networks/ubiquitous computing

Education and Academic Appointments

The University of Utah — Utah, USA
Assistant Professor, Electrical and Computer Engineering — May 2021 -
Adjunct Assistant Professor, Mechanical Engineering

Stanford University — California, USA
Postdoctoral Fellow, Mechanical Engineering — 2019 - 2021
Funded proposal: "Design and Control of Heterogeneous Microrobot Swarms"
Advisor: Sean Follmer

University of California, Berkeley — California, USA
PhD, Electrical Engineering and Computer Science — 2013 - 2018
Dissertation: "The Ionocraft: Flying Microrobots with No Moving Parts"
Committee: Kristofer S. J. Pister, Michel Maharbiz, Liwei Lin

Virginia Polytechnic Institute — Virginia, USA
BSc, Materials Science and Engineering — 2009 - 2013

Research Experience

New Directions for Microrobot Mobility and Communication — Stanford
PI: Sean Follmer — 2019 - present
I am exploring multi-material laminant device structures for improved atmospheric ion thrusters and new low resource overhead acoustic communication strategies for microrobot swarms.

Autonomous Flying Microrobots — UC Berkeley
PI: Kristofer S. J. Pister — 2013 - present
I have designed and built the ionocraft, a flying microrobot based on electrohydrodynamic propulsion; it flies completely silently and with no moving parts.

Next-Generation Wireless Sensor Networks — UC Berkeley
PI: Kristofer S. J. Pister — 2017 - 2019
New ubiquitous computing platforms enabled by modern microelectronics and mesh networking implementations will move us from an Internet of Things to an Internet of Everything.

Novel Embedded Systems Debugging and Development Tools — UC Berkeley
PI: Bjoern Hartmann — 2014 - 2018
A new generation of Makers requires a new generation of tools for designing and debugging cyber-physical systems.

A Low-Loss Voltage Actuated Switch Using Polymer-Metal Nanocomposite — MIT
PIs: Vladimir Bulovic & Jeffrey Lang — Summer 2012
Micro electromechanical system-based switches hold promise for circumventing some of the issues with leakage and energy-per-operation of traditional CMOS.

Design and Construction of a Reduced-Scale Railgun — Virginia Tech
PI: Hardus Odendaal — 2011 - 2012
An interdisciplinary effort in system design; my responsibilities ranged from safe encapsulation of high power density inductors to mechanical design of a "catch" for the projectile.

Refereed Publications

In the fields of both MEMS and robotics, full-length paper submissions to conferences such as MEMS, Transducers, IROS, ICRA, and RSS represent the ideal publication track for the majority of researchers. In the field of human-computer interaction, top-tier ACM conferences (e.g. CHI, UIST) are highly selective venues that are comparable to or exceed many IEEE journals in their impact.

Journal Publications

J6. **Drew, D. S.**, (2021). Multi-agent Systems for Search and Rescue Applications. Current Robotics Reports.

J5. Lambert, N., Schindler, C., **Drew, D. S.**, & Pister, K. S.. (2020). Nonholonomic Yaw Control of an Underactuated Flying Robot with Model-based Reinforcement Learning. IEEE Robotics and Automation Letters (RA-L).

J4. Park, S., **Drew, D. S.**, Follmer, S., & Rivas-Davila, J. (2020). Lightweight High Voltage Generator for Untethered Electroadhesive Perching of Micro Air Vehicles. IEEE Robotics and Automation Letters (RA-L).

J3. Lambert, N. O., **Drew, D. S.**, Yaconelli, J., Calandra, R., Levine, S., & Pister, K. S. (2019). Low Level Control of a Quadrotor with Deep Model-Based Reinforcement Learning. IEEE Robotics and Automation Letters (RA-L). Presented at IROS2019.

J2. **Drew, D. S.**, Lambert, N. O., Schindler, C. B., & Pister, K. S. (2018). Towards Controlled Flight of the Ionocraft: A Flying Microrobot Using Electrohydrodynamic Thrust With Onboard Sensing and No Moving Parts. IEEE Robotics and Automation Letters 3 (RA-L). **Speaker, presented at IROS2018.**

J1. **Drew, D. S.**, & Pister, K. S. (2017). Geometric Optimization of Microfabricated Silicon Electrodes for Corona Discharge-Based Electrohydrodynamic Thrusters. Micromachines journal, 8(5), 141.

Conference Publications (full papers)

C13. Selden, M., Zhou, J., Campos, F., Lambert, N., **Drew, D. S.**, & Pister, K.S. (2021). BotNet: A Simulator for Studying the Effects of Accurate Communication Models on Multi-agent and Swarm Control. In the 3rd IEEE International Symposium on Multi-Robot and Multi-Agent Systems (MRS), 2021, to appear.

C12. **Drew, D. S.**, & Follmer, S. (2021). High Power Density Electrohydrodynamic Jets Using Folded Laser Microfabricated Electrodes. In 21st International Conference on Solid-State Sensors, Actuators and Microsystems (TRANSDUCERS), 2021. **Speaker.**

C11. **Drew, D. S.**, Devlin, M., Hawkes, E., & Follmer, S. (2021). Acoustic Communication and Sensing for Inflatable Soft Modular Robots. IEEE International Conference on Robotics and Automation (ICRA) 2021. **Speaker.**

C10. Kim, L. H., **Drew, D. S.**, Domova, V., & Follmer, S. (2020). User-defined Swarm Robot Control. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems. ACM, 2020. **Best Paper Award Honorable Mention.**

C9. Schindler, C. B., **Drew, D. S.**, Kilberg, B., Campos, F., Yanase, S., & Pister, K. S. (2019). MIMSY: The Micro Inertial Measurement System for the Internet of Things. Internet of Things (WF-IoT), IEEE 5th World Forum on. IEEE, 2019.

C8. Zoll, R. S., Schindler, C. B., Massey, T. L., **Drew, D. S.**, Maharbiz, M. M., & Pister, K. S. (2018). MEMS-Actuated Carbon Fiber Microelectrode for Neural Recording. EMBS Micro and Nanotechnology in Medicine Conference.

C7. McGrath, W., Warner, J., Karchemsky, M., Head, A., **Drew, D. S.**, & Hartmann, B. (2018). WiFrost: Bridging the Information Gap for Debugging of Networked Embedded Systems. In Proceedings of the 31st Annual ACM Symposium on User Interface Software and Technology (UIST). ACM.
acceptance rate: 21%

C6. McGrath, W., **Drew, D.**, Warner, J., Kazemitabaar, M., Karchemsky, M., Mellis, D., & Hartmann, B. (2017). Bifrost: Visualizing and Checking Behavior of Embedded Systems across Hardware and

Software. In Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology (UIST). ACM.
acceptance rate: 23%

C5. **Drew, D. S.**, & Pister, K. S. (2017). First takeoff of a flying microrobot with no moving parts. In Manipulation, Automation and Robotics at Small Scales (MARSS), 2017 International Conference on (pp. 1-5). IEEE. **Plenary Speaker, Best Paper Award Honorable Mention**.

C4. **Drew, D. S.**, Kilberg, B., & Pister, K. S. (2017). Future mesh-networked pico air vehicles. In Unmanned Aircraft Systems (ICUAS), 2017 International Conference on (pp. 1075-1082). IEEE.

C3. Contreras, D. S., **Drew, D. S.**, & Pister, K. S. (2017). First steps of a millimeter-scale walking silicon robot. In Solid-State Sensors, Actuators and Microsystems (TRANSDUCERS), 2017 19th International Conference on (pp. 910-913). IEEE.
acceptance rate: 26%

C2. **Drew, D.**, Contreras, D. S., & Pister, K. S. (2017). First thrust from a microfabricated atmospheric ion engine. In Micro Electro Mechanical Systems (MEMS), 2017 IEEE 30th International Conference on (pp. 346-349). IEEE. **Speaker**.
oral presentation acceptance rate: 11%

C1. **Drew, D.**, Newcomb, J. L., McGrath, W., Maksimovic, F., Mellis, D., & Hartmann, B. (2016). The Toastboard: Ubiquitous Instrumentation and Automated Checking of Breadboarded Circuits. In Proceedings of the 29th Annual Symposium on User Interface Software and Technology (UIST). ACM. **Speaker**.
acceptance rate: 21%

Workshop Publications

W2. **Drew, D. S.**, & Pister, K. S. (2018). Takeoff of a Flying Microrobot with COTS Sensor Payload Using Electrohydrodynamic Thrust Produced by Sub-millimeter Corona Discharge. Technical Digest of Solid-State Sensors, Actuators, and Microsystems Workshop 2018 (Hilton Head 2018) **Speaker, full paper.**
oral presentation acceptance rate: 19%

W1. **Drew, D. S.**, Greenspun, J.T., & Pister, K. S. (2014). Investigation of Atmospheric Ion Thrusters using Rapid Prototyping Techniques. Robot Makers (RoMa) workshop, held in conjunction with Robotics Science and Systems (RSS) 2014. **Speaker, extended abstract.**

Teaching Experience

Fundamentals of Robotics and Cyberphysical Systems (ECE3960) — University of Utah
Primary Instructor — Spring 2022

Designing Information Devices and Systems (EE16A) — UC Berkeley
Content Development and Discussion Section Graduate Student Instructor — Fall 2018

Interactive Device Design (CS294) — UC Berkeley
Graduate Student Instructor — Summer 2017

Interactive Device Design (CS294) — UC Berkeley
Graduate Student Instructor — Spring 2017

Fundamentals of Materials Engineering (MSE2044) — Virginia Tech
Undergraduate Teaching Assistant — Spring 2012

Research Support

Intelligence Community Postdoctoral Fellowship — 2019 - 2021
National Science Foundation Graduate Research Fellowship — 2013 - 2018

Awards & Press

Awards

Best Paper Honorable Mention, CHI	2020
UC Berkeley Graduate Slam Finalist, 2nd Place	2018
Best Poster, Berkeley Sensor and Actuator Center IAB	2018
Best Paper Honorable Mention, MARSS Conference	2017
UC Berkeley EECS Chair's Excellence Award	2013
Materials Science and Engineering Merit Scholarship	2011, 2012
Best in Undergraduate Poster Presentations, SACNAS Conference	2012
Best in Undergraduate Poster Session, AGMUS Conference	2012
Robert C. Morris Jr. Freshman Merit Scholarship	2009 - 2010

Selected Press

"Penny-Sized Ionocraft Flies With No Moving Parts", IEEE Spectrum	2019
"Microrobots fly, walk and jump into the future", BerkeleyENGINEER Magazine	2018
"The Same Tech Propelling Satellites in Space Could Power Tiny Robots on Earth", Futurism.com	2017
"The Sci-Fi Technology that Could Power Microrobots", Smithsonian Digital	2017
"ToastBoard", BerkeleyENGINEER Magazine	2015

Selected Presentations

Oral *(conference oral presentations noted in Publications section)*

Invited Talk - University of Utah Robotics Seminar	Fall 2021
Invited Talk - University of Utah ECE Seminar	Fall 2021
Invited Talk - University of Utah Robotics Seminar	Winter 2019
Invited Talk - Cornell ECE Special Seminar	Winter 2019
Invited Talk - San Francisco Exploratorium After-Dark event	Winter 2019
Invited Talk - Pentagon "Drumbeat" briefing	Fall 2019
Invited Talk - MIT EECS Special Seminar	Winter 2018
Invited Talk - Cornell ECE Special Seminar	Winter 2018
Invited Talk - Stanford SystemX Seminar	Winter 2018
Berkeley Sensor and Actuator Center Seminar Series	Fall 2018
Berkeley Sensor and Actuator Center IAB	Spring 2017, Spring 2014
Berkeley Artificial Intelligence Research (BAIR) Seminar	Spring 2017
Berkeley Institute of Design (BiD) Seminar	Fall 2016
Berkeley SWARM Lab Seminar	Spring 2013

Poster

New Directions for Effective and Efficient Microrobot Mobility and Communication, Intelligence Community Academic Research Symposium	Summer 2019
The Ionocraft: A Flying Microrobot With No Moving Parts, Bay Area Robotics Symposium	Fall 2018
Applications of Future Wireless Mesh Networks, Berkeley Sensor and Actuator Center IAB	2017 - 2018
Autonomous Flying Microrobots, Berkeley Sensor and Actuator Center IAB	2013 - 2018
The Toastboard, TerraSwarm Research Seminar	2015 - 2017
A Low-Loss Voltage Actuated Switch, Ana G. Mendez University System Research Symposium	Fall 2013
A Low-Loss Voltage Actuated Switch, SACNAS National Conference	Fall 2013

Professional Development

IEEE Member	
IEEE Robotics and Automation Society Member	
Program Committee Member, IEEE MARSS	2019
Session Chair, "Design and Fabrication", IEEE MARSS	2017
Reviewer, IEEE International Conference on Intelligent Robots and Systems (IROS)	2021, 2022
Reviewer, Nano Energy	2021
Reviewer, International Journal of Human-Computer Studies	2021
Reviewer, IEEE Robotics and Automation Letters	2021
Reviewer, IEEE Electron Device Letters	2020
Reviewer, IEEE Transactions on Robotics	2020, 2021
Reviewer, IEEE Transactions on Electron Devices	2020
Reviewer, MARSS	2020
Reviewer, IEEE Transaction on Industrial Electronics	2019, 2020, 2021
Reviewer, IMWUT	2019
Reviewer, ICUAS	2019
Reviewer, Nature	2018
Reviewer, UIST	2017, 2018, 2019, 2020
Reviewer, CHI	2018
Reviewer, Mechatronics	2017

Mentorship

PhD Mentor, *Magnetic Field Assisted Microplasma Actuators*	2021- present
PhD Mentor, *Power Autonomous Ion Thrust Propelled Millisystems*	2021 - present
Undergraduate Mentor, *Induced Stress from Proximal Flying Robots*	2022
Undergraduate Mentor, *Electrohydrodynamic Devices for Mobile Electronics Cooling*	2022
Undergraduate Mentor, *Model Based Reinforcement Learning for Quadcopter Control*	2018
Undergraduate Mentor, *Virtual Reality for Human-Swarm Interaction*	2017 - 2018
Undergraduate Mentor, *Novel Debugging and Development Tools for Cyberphysical Systems*	2017 - 2018
Undergraduate Mentor, *Visual Odometry for Microrobots*	2017

Volunteering and Service

University of Utah Summer Research Internship Student Mentor	2022
University of Utah Summer Research Internship Application Reviewer	2022
University of Utah ACCESS Program Application Reviewer	2022
University of Utah ACCESS Program Student Mentor	2022
Application Committee, MIT Summer Research Program (MSRP)	2018, 2020
Graduate Student Panelist, Energy Efficient Electronics and Systems (E3S) REU	2016 - 2018
Peer Advisor, Bay Area Graduate Pathways to STEM (GPS) Program	2018
Volunteer, ReNUWit Ingenuity Lab at Lawrence Hall of Science	2016 - 2018
Treasurer, Electrical Engineering Graduate Student Association	2016 - 2017
Social Chair, Electrical Engineering Graduate Student Association	2015 - 2016