

# Daniel S Drew

Postdoctoral Fellow at Stanford University

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## 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, wireless sensor networks/ubiquitous computing, swarms, human-robot interaction*

## Education and Academic Appointments

### Stanford University

*Postdoctoral Fellow, Mechanical Engineering*

Funded proposal: "Design and Control of Heterogeneous Microrobot Swarms"

Advisor: Sean Follmer

California, USA

2019 -

### University of California, Berkeley

*PhD, Electrical Engineering and Computer Science*

Dissertation: "The Ionocraft: Flying Microrobots with No Moving Parts"

Committee: Kristofer S. J. Pister, Michel Maharbiz, Liwei Lin

California, USA

2013 - 2018

### Virginia Polytechnic Institute

*BSc, Materials Science and Engineering*

Virginia, USA

2009 - 2013

## Research Experience

### New Directions for Microrobot Mobility and Communication

*PI: Sean Follmer*

I am exploring multi-material laminant device structures for improved atmospheric ion thrusters and new low resource overhead acoustic communication strategies for microrobot swarms.

Stanford

2019 - present

### Autonomous Flying Microrobots

*PI: Kristofer S. J. Pister*

I have designed and built the ionocraft, a flying microrobot based on electrohydrodynamic propulsion; it flies completely silently and with no moving parts.

UC Berkeley

2013 - present

### Next-Generation Wireless Sensor Networks

*PI: Kristofer S. J. Pister*

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.

UC Berkeley

2017 - 2019

### Novel Embedded Systems Debugging and Development Tools

*PI: Bjoern Hartmann*

A new generation of Makers requires a new generation of tools for designing and debugging cyber-physical systems.

UC Berkeley

2014 - 2018

### A Low-Loss Voltage Actuated Switch Using Polymer-Metal Nanocomposite

*PIs: Vladimir Bulovic & Jeffrey Lang*

Micro electromechanical system-based switches hold promise for circumventing some of the issues with leakage and energy-per-operation of traditional CMOS.

MIT

Summer 2012

### Design and Construction of a Reduced-Scale Railgun

*PI: Hardus Odendaal*

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.

Virginia Tech

2011 - 2012

## 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.

### Papers Under Review

xxx, x., **Drew, D. S.**, & xxx, x. (2020). Untethered Electroadhesive Perching of Micro Air Vehicles. *Under Blind review, not exact title*

### Journal Publications

- 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)

- 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. (To Appear)
- 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

- W3. **Drew, D. S.**, & Follmer, S. (2020). High Power Density Electrohydrodynamic Jet Arrays Using Folded Laser Microfabricated Electrodes. Technical Digest of Solid-State Sensors, Actuators, and Microsystems Workshop 2020 (Hilton Head 2020) (To Appear) **Full paper.**
- 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

<b>Designing Information Devices and Systems (EE16A)</b>	UC Berkeley
Content Development and Discussion Section Graduate Student Instructor	Fall 2018
<b>Interactive Device Design (CS294)</b>	UC Berkeley
Graduate Student Instructor	Summer 2017
<b>Interactive Device Design (CS294)</b>	UC Berkeley
Graduate Student Instructor	Spring 2017
<b>Fundamentals of Materials Engineering (MSE2044)</b>	Virginia Tech
Undergraduate Teaching Assistant	Spring 2012

## Grants, Awards & Press

### Grants and Fellowships

Intelligence Community Postdoctoral Fellowship	2019 - 2020
National Science Foundation Graduate Research Fellowship	2013 - 2018
UC Berkeley EECS Chair's Excellence Award	2013
Materials Science and Engineering Merit Scholarship	2011, 2012
Robert C. Morris Jr. Freshman Merit Scholarship	2009 - 2010

### Awards

UC Berkeley Graduate Slam Finalist, 2nd Place	2018
Best Poster, Berkeley Sensor and Actuator Center IAB	2018
Best Paper Honorable Mention, MARSS Conference	2017
Best in Undergraduate Poster Presentations, SACNAS Conference	2012
Best in Undergraduate Poster Session, AGMUS Conference	2012

## Selected Press

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

## Selected Presentations

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

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

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

## Professional Development

Reviewer Board Member, MDPI Robotics	2019
Program Committee Member, IEEE MARSS	2019
Session Chair, "Design and Fabrication", IEEE MARSS	2017
Reviewer, MARSS	2020
Reviewer, IEEE Transaction on Industrial Electronics	2019
Reviewer, IMWUT	2019
Reviewer, ICUAS	2019
Reviewer, Nature	2018
Reviewer, UIST	2017, 2018, 2019
Reviewer, CHI	2018
Reviewer, Mechatronics	2017
Institute of Electrical and Electronics Engineers (IEEE) Student Member	
Association for Computing Machinery (ACM) Student Member	

## Mentorship and Research Opportunity Outreach

Undergraduate Mentor, <i>Model Based Reinforcement Learning for Quadcopter Control</i>	2018
Undergraduate Mentor, <i>Virtual Reality for Human-Swarm Interaction</i>	2017 - 2018
Undergraduate Mentor, <i>Novel Debugging and Development Tools for Cyberphysical Systems</i>	2017 - 2018
Undergraduate Mentor, <i>Visual Odometry for Microrobots</i>	2017
Application Committee, MIT Summer Research Program (MSRP)	2018, 2020
Graduate Student Panelist, Energy Efficient Electronics and Systems (E3S) REU	2016 - 2018

## Volunteering and Service

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
Class Relations Officer, Materials Engineering Professional Societies	2010 - 2013

## References

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