# Kevin J. McDonald, PhD

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## Summary


- Driven engineer with experience leading robot hardware projects from conception to multiple publications
- Expert in the design of soft robotic mechanisms using magnetorheological fluids
- Helped secure $500,000 in grant money for a multi-year project and led a team to meet regular goals
- Five years as most senior student in lab, with experience mentoring younger and older students of all levels


## Education

**PhD in Mechanical Engineering** *Boston University* GPA: 4.00 May 2023
**MS in Mechanical Engineer** *Boston University* GPA: 4.00 January 2022

**Research:** Morphable Biorobotics Lab *(Principle Investigator: Dr. Tommaso Ranzani)*
**Dissertation:** *Enabling Complexity in Fluidically Actuated Soft Robots via Onboard Control Hardware*
**Classes:**
- Continuum Mechanics
- Nano/Microelectronic Device Technology
- Precision Machine Design and Instrumentation
- Polymers and Soft Materials
- Simulation of Physical Processes
- Vision, Robotics, and Planning
- Applied Mathematics in Mechanics
- Medical Robotics

**BS in Mechanical Engineering** *Northeastern University* GPA: 4.00 May 2018
Minors in Electrical Engineering and Mathematics

**Research:** Expeditionary Robotics Lab *(Principle Investigator: Dr. Samuel Felton)*
**Honors:**
- President's Award (2017, 2018)
  - Awarded to the top 10 students by GPA in the junior and senior class, university-wide
- Sears B. Condit Award (2018)
  - Awarded to the top 100 graduating seniors by GPA, university-wide
- Engineering Class Marshal at Commencement
  - Honor granted to the top graduating senior (or several if tied) in each college by GPA
- Ferretti Scholarship (2016, 2017)
  - Awarded to the top 10 sophomores and juniors in the Mechanical and Industrial Engineering department by GPA
- University Honors Program
- Dean's List (All Semesters)

## Academic Experience

*Graduate Researcher in Morphable Biorobotics Lab, Boston University* 2018–2023

**Project Management**

- Co-authored a grant application resulting in a $500,000 award from the Office of Naval Research
- Organized and mentored PhD, masters, and undergraduate students on a project with diverse technical areas
- Led weekly technical meetings to direct progress toward ONR reports, project reviews, and publication goals

**Research**

- Developed new hardware for controlling pneumatic and hydraulic soft robots with smart fluids and magnets
- Integrated novel control hardware, sensors, and actuation mechanisms into multi-degree of freedom robots
- Disseminated research through publication in highly ranked journals
- Presented at top conferences including the International Conference on Robotics and Automation and the International Conference on Soft Robotics
- Constructed testing platforms for hardware validation using rapid prototyping of fixtures designed in SolidWorks and test code written in LabVIEW and Python
- Simulated mechanical and electromagnetic systems in COMSOL to inform design decisions
- Conducted extensive data analysis using MATLAB
- Visualized results via schematics designed in Adobe Illustrator and videos edited in Adobe Premiere

**Lab Management**

- Promoted an inclusive lab space that celebrated diversity of nationality, gender, and background
- Selected equipment and materials from external suppliers to furnish a new lab space
- Oversaw lab cleanliness and safety through role as Lab Safety Officer
- Trained students on lab processes and served as the lab expert on experiment design and equipment upkeep
- Provided technical expertise for projects in the lab and for collaborating groups

## Teaching Experience

*Boston University*, Boston, MA Fall 2019

Graduate Student Teacher - Fluid Mechanics

- Independently prepared and presented three weekly hour long lectures presenting exercises to reinforce key course topics
- Independently prepared and presented review lectures in advance of exams for a class of over 60 students
- Held weekly office hours to teach concepts to students in need of extra help
- Codeveloped and revised course exams

*Boston University*, Boston, MA Spring 2019

Graduate Student Teacher - Mechanical Engineering Senior Design

- Assembled, tested, and assisted students in the use of SLA and FDM 3D printers for a class of over 100 students
- Held several office hours a week in the build space to help students in various aspects of mechanical design
- Assisted in the administration of purchase orders for over 20 teams of students

# Publications

## Journal Articles

L. Gaeta, **K. McDonald**, L. Kinnicutt, M. Le, S. Wilkinson-Flicker, T. Ranzani, "Magnetically induced stiffening for soft robotics," *Soft Matter*, vol. 19, no. 14, pp. 2623–2636, 2023.

J. Rogatinsky, K. Gomatam, Z. H. Lim, M. Lee, L. Kinnicutt, C. Duriez, P. Thomson, **K. McDonald**, and T. Ranzani, "A collapsible soft actuator facilitates performance in constrained environments," *Advanced Intelligent Systems*, vol. 4, no. 10, p. 2200085, Oct. 2022.

**K. J. McDonald**, L. Kinnicutt, A. M. Moran, and T. Ranzani, "Modulation of magnetorheological fluid flow in soft robots using electropermanent magnets," *IEEE Robotics and Automation Letters*, vol. 7, no. 2, pp. 3914–3921, Apr. 2022.

**K. McDonald** and T. Ranzani, "Hardware methods for onboard control of fluidically actuated soft robots," *Frontiers in Robotics and AI*, vol. 8, pp. 1–19, Aug. 2021.

**K. McDonald**, A. Rendos, S. Woodman, K. A. Brown, and T. Ranzani, "Magnetorheological fluid-based flow control for soft robots," *Advanced Intelligent Systems*, vol. 2, no. 11, pp. 1–8, 2020.

A. Rendos, S. Woodman, **K. McDonald**, T. Ranzani, and K. A. Brown, "Shear thickening prevents slip in magnetorheological fluids," *Smart Materials and Structures*, vol. 29, no. 7, pp. 1–6, Jun. 2020.

## Conference Proceedings

**K. J. McDonald**, L. Kinnicutt, A. M. Moran, and T. Ranzani, "Modulation of magnetorheological fluid flow in soft robots using electropermanent magnets," *IEEE International Conference on Robotics and Automation*, May 2022

A. Gupte, L. Kinnicutt, **K. McDonald**, and T. Ranzani, "A soft ionic sensor for simultaneous pressure and strain measurements," *2020 IEEE International Conference on Soft Robotics (RoboSoft)*, pp. 266–271, 2020.

C. Liu, C. M. Gomes, **K. J. McDonald**, L. F. Deravi, and S. M. Felton, "A chemo-mechatronic origami device for chemical sensing," *Proceedings of the ASME 2018 Conference on Smart Materials, Adaptive Structures and Intelligent Systems*, pp. 1–7.

## Other Presentations

L. Kinnicutt, J. Lee, J. Oden, L. Gaeta, S. Carroll, P. Sultania, A. Rathi, L. Zi Heng, C. Orakwue and **K. McDonald**, " A Soft Laparoscopic Grasper for Retraction of the Small Intestine," *The 15th Hamlyn Symposium on Medical Robotics*, London, UK, June 26, 2023

L. Kinnicutt, A. Pathak, T. Bohac, A. Peng, C. Taglietti, C. Lee, R. Rauf, J. Lee, L. Zi Heng, J. Rogatinsky, **K. McDonald**, S. Mori Carroll, J. Siracuse, and T. Ranzani, "Minimally Invasive Soft Robotic Prototypes Provide Variable Occlusion in Simplified Aortic Flow Model," *American Heart Association Resuscitation Science Symposium*, Chicago, IL, November 5, 2022

**K. McDonald** and T. Ranzani, "Comparison Criteria for Hardware Methods for Onboard Control of Fluidically Actuated Soft Robots," lightning talk at the New Directions for Simplified Control of Soft Robots workshop, *2022 IEEE International Conference on Soft Robotics (RoboSoft)*, Edinburgh, UK, April 4, 2022

A. Rendos, **K. McDonald**, T. Ranzani, and K. A. Brown, "Designing magnetorheological fluids for soft robotics," *Material Research Society Fall Meeting*, December 2, 2019, Boston, MA

## Professional Experience

*Boston Micromachines Corp.*, Cambridge, MA July 2017–December 2017
Mechanical Engineering Co-op

- Independently developed a package for a new MEMS deformable mirror for adaptive optics
- Designed PCBs and rigid-flex circuits to interface MEMS devices with high voltage drivers
- Designed metal fixtures for electron beam PVD and interfacing of MEMS mirror with optical testbeds
- Measured physical and electromechanical properties of untested MEMS die using interferometry
- Developed and tested wire bonding recipes for new MEMS product
- Troubleshooted and bug-tested proprietary software in Windows and Linux

*The Charles Stark Draper Laboratory Inc.*, Cambridge, MA July 2016–December 2016
Microfabrication Process Engineering Co-op

- Collaborated on the development of proprietary high density microcircuits and other microelectronic devices
- Worked in several specialized labs, including Class 10, 100, and 1000 cleanrooms and static sensitive areas
- Programmed and operated manual and semi-automated measurement and production equipment
- Interfaced with technicians, inspectors and engineers to discuss results of analyses with the goal of quality improvement and cost reduction
- Developed standard operating procedures for laboratory tasks including rapid thermal annealing and weekly maintenance tracking

## Selected Technical Skills

- Design, fabrication, and testing of soft robotic actuators and sensors
- Synthesis, modeling, and applications of smart fluids, especially magnetorheological fluids, for developing novel actuators and sensors
- Experimental design including the development and troubleshooting of hardware test fixtures and control software in LabView and Python
- Data acquisition with Arduino, Raspberry Pi, and National Instruments DAQs
- Data analysis in MATLAB
- 3D design and rendering in Solidworks and Fusion360
- Rapid prototyping via additive manufacturing, laser cutting, and plastics processing
- Modeling and simulation of electromagnetic, mechanical, and fluidic systems via finite element analysis in COMSOL
- PCB design in Eagle
- Graphic design and figure preparation with Adobe Illustrator and Photoshop
- Video editing in Adobe Premiere