

Robert Herbert

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Department of Mechanical Engineering | Carnegie Mellon University

RESEARCH INTERESTS

- Design and manufacturing of medical devices, bio-interfaced electronics, and soft robotics
- Additive manufacturing, conformal printing, and soft material integration
- Vascular electronics and human health monitoring and treatments

EDUCATION

Ph.D., Mechanical Engineering, Georgia Institute of Technology (GT) 2017-2022
Advisor: Dr. Woon-Hong Yeo

B.S. and M.S., Mechanical Engineering, The Ohio State University (OSU) 2012-2017
Advisor: Dr. Samir Ghadiali

ACADEMIC EXPERIENCE

Postdoctoral Research Associate, Carnegie Mellon University 2023-present
- Advisor: Dr. Carmel Majidi
- Developing a robot-assisted additive manufacturing system towards conformal direct ink writing, advanced material control, mobile printing, and in-space manufacturing
- Printing and characterizing soft multifunctional materials and liquid metal-based bioelectrodes

Postdoctoral Research Associate, GT 2022-2023

Graduate Research Assistant, GT 2017-2022
- Advisor: Dr. Woon-Hong Yeo
- Designed, fabricated, and validated soft wearable and implantable electronics, with emphasis on vascular applications
- Developed manufacturing and printing strategies for soft material-based electronics
- Conceived and wrote funding proposals for biomedical and printed electronics research
- Mentored undergraduate students each semester

Graduate Researcher, OSU 2016-2017

Undergraduate Researcher, OSU 2014-2016
- Advisor: Dr. Samir Ghadiali
- Developed computational fluid-structure interaction models to investigate mechanical factors and biomarkers associated with inferior vena cava filter complications
- Created patient-specific computational models to study inferior vena cava filters

EXECUTIVE SUMMARY

- **Expertise:** additive manufacturing, biomedical devices, vascular monitoring, soft electronics
- **Publication:** over 16 papers including *Sci. Adv.*, *Adv. Funct. Mater.*, and *Nature* journals
- **Awards:** over 10 awards and grants including Medtronic design competition and NSF funding

Selected GRANT EXPERIENCE

AWARDED

- **National Science Foundation ECCS** (\$400,000) 2022
 - o #2152638; "All-Printed Nanomembrane Sensors and Bioelectronics for Wireless and Continuous Monitoring of Vascular Health"
 - o Role: Not a PI; Developed project idea and authored proposal, responded to reviewers

- **Emory School of Medicine Imagine, Innovate, Impact Nexus Grant** (\$125,000) 2022
 - o “Fully Integrated Nano-Membrane Sensors in Arteriovenous Endografts for Continuous and Wireless Monitoring of Hemodialysis Access Health”
 - o Role: Not a PI; Designed preliminary device, collected preliminary data
- **Nakatani Research and International Experience** (\$3,000) 2022
 - o “Soft Wearable Patch with Printed Wireless Sensors towards Human Health Monitoring”
 - o Role: PI as student; Developed idea and authored proposal; mentored international students
- **Institute of Electronics and Nanotechnology Seed Grant** (\$6,000) 2019
 - o “Fully Wireless, Nanostructured, Hemodynamic Sensor System for Continuous Monitoring of Blood Pressure and Flow Rate”
 - o Role: PI as student; Developed and authored proposal

PENDING

- **American Heart Association 2024 Career Development Award** (in progress; \$231,000)
 - o “Design and manufacturing of embedded electronics for transcatheter aortic valve replacement”
 - o Role: PI; Developed project idea and authored proposal
 - o Collaborators: Dr. Youngjae Chun (University of Pittsburgh), Dr. Ram Devireddy (Louisiana State University)
- **American Heart Association 2024 Innovative Project Award** (submitted; \$200,000)
 - o “Soft, sensor-embedded dynamic model of inferior vena cava filter complications”
 - o Role: PI; Developed project idea and authored proposal
 - o Collaborators: Dr. Debkalpa Goswami (Cleveland Clinic, Case Western Reserve University)
- **Institute of Electronics and Nanotechnology Exponential Electronics** (submitted; \$225,000)
 - o “Biomaterials-based electronic systems”
 - o Role: Not a PI; Developed project idea and authored proposal
- **National Institute of Health ISD R01** (submitted; \$1,500,000)
 - o “Smart stent system with nanomembrane sensors for wireless continuous assessment of in-stent restenosis”
 - o Role: Not a PI; Collaborating, revising, and writing research strategy

HONORS AND AWARDS

- Herbert P. Haley Fellowship (at GT) 2022
- 1st place FLEX Student Poster Competition 2021
- 3rd place MDPI Poster Competition on Materials Science 2021
- 3rd place BMES Medtronic Design Competition 2020
- President’s Undergraduate Research Award (at GT; as student mentor) 2020
- Student Travel Grant, International Meeting on Chemical Sensors 2020
- 1st Place in Innovation Competition (at GT; as student team mentor) 2019
- President’s Undergraduate Research Award (at GT; as student mentor) 2019
- President’s Fellowship (at GT) 2017
- Undergraduate Research Scholarship (at OSU) 2015

PROFESSIONAL ACTIVITIES

- **NSF GRFP Workshop Reviewer**, Louisiana State University
- **Ad-Hoc Journal Reviewer**: Nanoscale, ACS Sensors, Computer Methods in Biomechanics and Biomedical Engineering
- **Professional Memberships**: Biomedical Engineering Society, American Heart Association

TEACHING EXPERIENCE

- Graduate Teaching Assistant, GT** 2019-2020
- Organized labs and substituted for lectures
 - o Mechanics of Materials (COE3001), 2020 Summer
 - o Microelectromechanical Systems (graduate level) (ME6229), 2019 Fall
 - o Dynamics of Rigid Bodies (ME2202), 2019 Spring
- Graduate Teaching Assistant, OSU** 2016-2017
- Planned and led weekly lab classes
 - o Applied Finite Element Method (graduate level) (ME5139), 2017 Spring
 - o Numerical Methods (ME2850), 2016 Fall
- Undergraduate Teaching Assistant, OSU** 2014-2016
- Planned and led weekly recitation classes
 - o Dynamics (ME2030), 2014 Fall - 2016 Spring

Selected MENTORING EXPERIENCE

- Bruno Rigo**, Undergraduate student at Georgia Institute of Technology 2019-2023
Current status: M.S. student at Georgia Institute of Technology
- Mofoluwasade Popoola**, Undergraduate student at Georgia Institute of Technology 2019-2022
Current status: Ph.D. student at University of Georgia
- Rohan Ravula**, Undergraduate student at Georgia Institute of Technology 2022
Current status: B.S./M.S. student at Georgia Institute of Technology
- Erina Kure**, Nakatani Fellow from Kumamoto University (Japan) 2022
Current status: Undergraduate student at Kumamoto University
- Bernardo Perloiro**, Undergraduate student at Georgia Institute of Technology 2021-2022
Current status: M.S. student at University of California San Diego
- Yuna Yoo**, Visiting student from Seoul National University (Korea) 2021
Current status: Ph.D. student at University of California, Berkeley
- Ahmet Korkaya**, Undergraduate student at Georgia Institute of Technology 2018-2020
Current status: Research Specialist at University of Michigan
- David Simiele**, Undergraduate student at Georgia Institute of Technology 2018-2020
Current status: Cardiac Device Engineer at Emory Healthcare

PEER-REVIEWED JOURNAL PUBLICATIONS (* *Corresponding author*)

18. **R. Herbert**, P. Mocny, Y. Zhao, T.C. Lin, J. Zhang, M. Vinciguerra, S. Surprenant, W.Y. Chan, S. Kumar, M.R. Bockstaller, K. Matyjaszewski, C. Majidi. "Thermally stable, liquid metal embedded soft materials for high-temperature applications". ***Advanced Functional Materials***, (under minor revision).
17. J. Lee, H. Kim, H.R. Lim, Y.S. Kim, T.T.H. Thi, J. Choi, G.J. Jeong, I. Soltis, K. Kim, H. Kim, **R. Herbert**, S.H. Lee, Y. Kwon, Y. Lee, Y. Jang, W.H. Yeo. "Large-scale smart bioreactor with fully integrated wireless multivariate sensors and electronics for long-term in situ monitoring of stem cell culture". (under review).

16. B. Rigo, A. Bateman, J. Lee, H. Kim, Y. Lee, L. Romero, Y.C. Jang, **R. Herbert***, WH, Yeo. "Soft implantable printed bioelectronic system for wireless continuous monitoring of restenosis". ***Biosensors and Bioelectronics***, 241, 2023.
15. **R. Herbert**, M. Elsisy, B. Rigo, H. Lim, H. Kim, C. Choi, S. Kim, S. Ye, W. Wagner, Y. Chun, WH, Yeo. "Fully implantable batteryless soft platforms with printed nanomaterial-based arterial stiffness sensors for wireless continuous monitoring of restenosis in real time". ***Nano Today***, 46 (1), 2022.
14. **R. Herbert**, H. Lim, B. Rigo, WH. Yeo. "Fully implantable wireless batteryless vascular electronics with printed soft sensors for multiplex sensing of hemodynamics". ***Science Advances***, 8 (19), 2022. Authored follow-up news article at *The Science Breaker*.
13. N. Rodeheaver, H. Kim, **R. Herbert**, H. Seo, WH. Yeo. "Breathable, wireless thin-film wearable biopatch using noise-reduction mechanisms". ***ACS Applied Electronic Materials***, 4 (503), 2022.
12. N. Zavanelli, H. Kim, J. Kim, **R. Herbert**, M. Mahmood, Y. Kim, S. Kwon, N. Bolus, B. Torstrick, C. Lee, WH. Yeo. "At-home wireless monitoring of acute hemodynamic disturbances to detect sleep apnea and sleep stages via a soft sternal patch". ***Science Advances***, 7 (52), 2021.
11. N. Rodeheaver, **R. Herbert**, Y. Kim, M. Mahmood, H. Kim, J. Jeong, WH. Yeo. "Strain-isolating materials and interfacial physics for soft wearable bioelectronics and wireless, motion artifact-controlled health monitoring". ***Advanced Functional Materials***, 31 (36), 2021.
10. **R. Herbert**, H. Lim, S. Park, J. Kim, WH. Yeo. "Recent Advances in Printing Technologies of Nanomaterials for Implantable Wireless Systems in Health Monitoring and Diagnosis". ***Advanced Healthcare Materials***, 10 (17), 2021.
9. Y. Kwon, Y. Kim, S. Kwon, M. Mahmood, H. Lim, S. Park, S. Kang, J. Choi, **R. Herbert**, Y. Jang, Y. Choa, WH. Yeo. "All-printed nanomembrane wireless bioelectronics using a biocompatible solderable graphene for multimodal human-machine interfaces". ***Nature Communications***, 11 (1), 2020.
8. **R. Herbert**, H. Lim, WH. Yeo. "Printed, soft, nanostructured strain sensors for monitoring of structural health monitoring and human physiology". ***ACS Applied Materials & Interfaces***, 12 (22), 2020. Selected as a journal cover.
7. S. Mishra, Y. Kim, J. Intarasirisawat, Y. Kwon, Y. Lee, M. Mahmood, H. Lim, **R. Herbert**, K. Yu, CS. Ang, WH. Yeo. "Soft, wireless periocular wearable electronics for real-time detection of eye vergence in a virtual reality toward mobile eye therapies". ***Science Advances***, 6 (11), 2020.
6. **R. Herbert**, J. Jeong, WH. Yeo. "Soft material-enabled electronics for medicine, healthcare, and human-machine interfaces". ***Materials***, 13 (3), 2020.
5. Y. Kim, A. Basir, **R. Herbert**, J. Kim, H. Yoo, WH. Yeo. "Soft materials, stretchable mechanics, and optimized designs for body-wearable compliant antennas". ***ACS Applied Materials and Interfaces***, 12(2), 2020.
4. M. Mahmood, D. Mzuikwao, Y. Kim, Y. Lee, S. Mishra, **R. Herbert**, A. Duarte, CS. Ang, WH. Yeo. "Fully portable and wireless universal brain-machine interfaces enabled by flexible scalp electronics and deep learning algorithm". ***Nature Machine Intelligence***, 1 (9), 2019.

3. **R. Herbert**, S. Mishra, H. Lim, H. Yoo, WH. Yeo. "Fully printed, wireless, stretchable implantable biosystem toward batteryless, real-time monitoring of cerebral aneurysm hemodynamics". *Advanced Science*, 6 (18), 2019. Selected as a journal cover.

2. Y. Kim, M. Mahmood, Y. Lee, NK. Kim, S. Kwon, **R. Herbert**, D. Kim, HC. Cho, WH. Yeo. "All-in-one, wireless, stretchable hybrid electronics for smart, connected, and ambulatory physiological monitoring". *Advanced Science*, 6 (17), 2019. Selected as a journal cover.

1. **R. Herbert**, JH. Kim, Y. Kim, HM. Lee, WH. Yeo. "Soft material-enabled, flexible hybrid electronics for medicine, healthcare, and human-machine interfaces". *Materials*, 11 (187), 2018.

CONFERENCE PROCEEDINGS

4. B. Liu, **R. Herbert**, WH. Yeo, F. Hammond. "Kirigami skin based flexible whisker sensor". *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2022.

3. M. Elsisy, **R. Herbert**, WH. Yeo, J. Pacella, Y. Chun "Development of a nanosensor-integrated stent for wireless, continuous monitoring of restenosis progression". *Nano-, Bio-, Info-Tech Sensors and 3D Systems III. Vol. 11590*, 2021.

2. **R. Herbert**, WH. Yeo. "Stretchable, implantable nanomembrane biosensor for wireless, real-time monitoring of hemodynamics". *IEEE ECTC*, 2019.

1. Y. Kim, M. Mahmood, S. Kwon, **R. Herbert**, WH. Yeo. "Robust human-machine interfaces enabled by a skin-like electromyogram sensing system". *Nano-, Bio-, Info-Tech Sensors and 3D Systems III. Vol. 10969*, 2019.

BOOK CHAPTERS

2. **R. Herbert**, M. Popoola, W. Zhang, H. Cheng. "Health monitoring from the skin". *Smart and Connected Wearable Electronics*, 2023.

1. **R. Herbert**, WH. Yeo. "Soft material-enabled packaging for stretchable and flexible hybrid electronics". *Nano-Bio-Electronic, Photonic and MEMS Packaging*, 2021.

INVITED SEMINARS AND PANEL DISCUSSIONS

2. **BD Medical**, Biomedical Materials Innovation Seminar, Sept. 2023.

1. **Nextflex**, The FHE Commercialization Path for Aerospace Applications, Jun. 2023.

ORAL PRESENTATIONS

8. **R. Herbert**, WH. Yeo. "Implantable vascular platform with multi-material stent and printed, soft sensors for wireless monitoring of restenosis". *Society for Biomaterials*, 2023.

7. **R. Herbert**, WH. Yeo. "Implantable, Wireless Stent Platform with Printed Soft Sensors for Monitoring of Hemodynamics". *Active Materials and Soft Mechatronics*, 2022.

6. **R. Herbert**, WH. Yeo. "Multi-material, implantable vascular stent platform with printed, soft-material based sensors for wireless monitoring of arterial stiffness". *Southeast Biomaterials Day*, 2022.

5. **R. Herbert**, H. Lim, WH. Yeo. "Smart and Connected Stent System with Nanomembrane Sensors for Wireless Monitoring of Hemodynamics". *BMES Annual Meeting*, 2021.

4. **R. Herbert**, H. Lim, WH. Yeo. "Implantable smart stent with nanomembrane soft sensors for wireless monitoring of hemodynamics". *ECS and IMCS*, 2020.
3. **R. Herbert**, S. Mishra, H. Lim, WH. Yeo. "Stretchable, implantable nanomembrane biosensor for wireless, real-time monitoring of hemodynamics". *2019 IEEE ECTC*, 2019.
2. **R. Herbert**, WH. Yeo. "Soft material-enabled packaging for stretchable and flexible hybrid electronics". *Packaging Research Center IAB Meeting*, 2019.
1. **R. Herbert**, J. Dowell, S. Ghadiali. "Computational modeling of inferior vena cava filters: identifying fluid-structure interactions that lead to filter perforation". *BMES Annual Meeting*, 2017.

POSTER PRESENTATIONS

7. **R. Herbert**, WH. Yeo. "Implantable vascular platform with multi-material stent and printed, soft sensors for wireless monitoring of restenosis". *Society for Biomaterials*, 2023.
6. **R. Herbert**, H. Lim, WH. Yeo. "Smart and Connected Stent System with Nanomembrane Soft Sensors for Wireless Monitoring of Hemodynamics". *FLEX*, 2021.
5. **R. Herbert**, H. Lim, WH. Yeo. "Smart and Connected Stent with Nanomembrane Sensors for Wireless Monitoring of Hemodynamics". *First Poster Competition on Materials Science, MDPI*, 2020.
4. **R. Herbert**, S. Mishra, H. Lim, H. Yoo, WH. Yeo. "Fully printed, wireless, stretchable implantable biosystem toward batteryless, real-time monitoring of cerebral aneurysm hemodynamics". *Career, Research, and Innovational Development Conference*, 2020.
3. **R. Herbert**, S. Mishra, H. Lim, H. Yoo, WH. Yeo. "Fully printed, wireless, stretchable implantable biosystem toward batteryless, real-time monitoring of cerebral aneurysm hemodynamics". *IN User Day*, 2019.
2. **R. Herbert**, WH. Yeo. "Soft material-enabled packaging for stretchable and flexible hybrid electronics". *Packaging Research Center IAB Meeting*, 2019.
1. **R. Herbert**, WH. Yeo. "Wireless, low-profile biosensor and optimization of inductive coupling for a neurovascular monitoring system". *IN Technical Exchange*, 2018.

PATENTS

3. WH. Yeo, **R. Herbert**, Y. Chun, M. Elsisy. "Nano sensor-embedded stent system and method". U.S. Patent Application No. PCT/US22/19009. (2022)
2. WH. Yeo, **R. Herbert**. "Wireless hemodynamic sensors and methods of using same". U.S. Patent Application No. 17/664,167. (2021)
1. WH. Yeo, **R. Herbert**. "Implantable cerebral sensing devices and systems and methods Related thereto". U.S. Patent Application No. 17/600,775. (2021)