Keqin 'Catherine' Ding

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Summary

- PhD researcher with experience in **real-time neural recording (EEG, EMG)**, **computational modeling**, and **visual-tactile feedback systems** for multisensory integration in neural interfaces and human-computer interaction
- Developed expertise in **multimodal human data analysis**, **behavioral and neural signal processing**, and graph-theoretic modeling of cortical dynamics for sensory feedback systems
- Lead multiple **cross-functional teams** of 10+ researchers across neuroscience, robotics, data science, and clinical domains, and contributing to $400,000+ in NSF and institutional grants

Education

Johns Hopkins University (JHU)   Baltimore, MD
Ph.D. in Biomedical Engineering | *Advisor:* Nitish Thakor, PhD | GPA: 4.00/4.00   08/2020--present
M.S.E. in Biomedical Engineering | GPA: 3.86/4.00   08/2018--08/2020

Smith College   Northampton, MA
B.S. in Engineering Science | *summa cum laude* with high honors | GPA: 3.98/4.00   08/2014--05/2018

Research Experience

Graduate Research Assistant JHU   01/2019--present
Neuroengineering and Biomedical Instrumentation Lab
Advisor: Nitish Thakor, PhD

Graduate Research Intern National University of Singapore   06/2019--08/2019
Cognitive Engineering Group, The N.1 Institute for Health
Advisors: Andrei Dragomir, PhD, Anastasios Bezerianos, PhD, Nitish Thakor, PhD

Undergraduate Research Assistant Boston University   05/2017--08/2017
The Skeletal Mechanobiology and Biomechanics Lab
Advisor: Elise Morgan, PhD

Undergraduate Research Assistant Smith College   05/2016--08/2016
Advisor: Paramjeet Pati, PhD

Awards & Fellowships

2025 **Travel Award**, Brain-Computer Interface Society
2025 **F31 Predoctoral Fellowship (1 year)**, funded by the National Institute of Neurological Disorders and Stroke (NINDS), National Institutes of Health
2024 **Trainee Professional Development Award**, Society for Neuroscience
2023 **Graduate Student Association Conference Travel Award**, JHU School of Medicine
2021 **Graduate Representative Organization Conference Travel Award**, JHU

2018 **The Adeline Devor Penberthy Memorial Prize**, Smith College (This is an award for academic excellence in engineering and outstanding contributions toward building a community of learners within the Picker Engineering Program.)

2016, 2017 **Summer Undergraduate Research Fellowship**, Smith College

2014-2018 **Dean's List**, Smith College

Research Areas

neural prostheses, sensory feedback, sensorimotor integration, computational modeling, neural signal processing

Skills

Programming Python, R, MATLAB

Software and Tools Git, Jupyter, Bash, Arduino, LaTex, Adobe Illustrator

Technical Skills neural signal processing, graph-theoretic network analysis, statistical modeling and testing, machine learning, human subjects research, psychophysics

Systems real-time EMG sensory feedback systems, EEG/EMG acquisition, noninvasive electrical stimulation (Digitimer), haptics

Languages English, Mandarin Chinese

Key Research Projects

Computational modeling for sensory feedback spatial reliability for long-term use   06/2022--present
- Design and implement a computational hand model to simulate human tactile perceptual information
- Develop a quantitative framework to assess spatial reliability of sensory feedback percept maps
- Validate scalability with data from 3 different stimulation paradigms collected across multi-month to multi-year experimental sessions
- Implement statistical models to improve stimulation electrode selection based on functional use
- Lead a cross-disciplinary team of 4 students with 6 collaborators and consultants

Neural recording and sensory feedback for prosthetic sensorimotor integration   09/2019--08/2023
- Built real-time human-in-the-loop setup for multi-channel neural recording (64-channel EEG, 8-channel EMG) with sensory (tactile, force) and visual feedback, validated with 4 upper limb amputee participants and 14 intact-limb controls
- Applied graph theory algorithms to investigate dynamic functional connectivity in cortical networks under visual-tactile integration
- Collaborated with hardware teams on sensor-stimulation integration, contributing to published work on neuromorphic tactile sensing systems
- Led regulatory compliance managing human subject protocols and IRB documentation

Cortical diagnostic biomarkers for chronic pain   09/2020--12/2024
- Designed and conducted experiments with simultaneous measurements of neural signals (EEG) and behavior (pain responses) (8 chronic pain patients and 8 healthy participants)
- Implemented time-frequency decomposition to identify EEG spectral features as potential biomarkers for chronic pain conditions
- Secured $25,000 internal funding through collaboration with clinicians

# Peer-Reviewed Publications   † denotes equal contribution

In Preparation / Under Review

[1] **Ding, K.,** Iskarous, M.M., D'Almeida, D., Yu, K., Lyu, Z., Osborn, L.E., Christie, B.P., Fifer, M.S., Celnik, P.A., Tenore, F.V., Thakor, N.V. (2025). Quantifying spatial reliability of tactile hand maps evoked by sensory stimulation in neural prostheses. *(In Preparation).*

[2] Mesik, L., Pham, K.H.T., **Ding, K.,** Huang, Y., Severin, D., Kirkwood, A., Dragomir, A., Thakor, N., Lee, H-K. (2025). Rapid plasticity of default-mode local network architectures following adult-onset blindness. *(Under Review).*

Journal Articles

[1] **Ding, K.**[†]**,** Arginteanu, T.[†], Anderson White, M., Lovell, L., Thakor, N.V., Doshi, T. (2024). Electroencephalographic power ratio and peak frequency difference associate with central sensitization in chronic pain. *Journal of Neural Engineering*, 10.1088/1741-2552/ad995d.

[2] **Ding, K.,** Chen, Y., Bose, R., Osborn, L.E., Dragomir, A., Thakor, N.V. (2022). Sensory stimulation for upper limb amputations modulates adaptability of cortical large-scale systems and combination of somatosensory and visual inputs. *Scientific Reports*, 10.1038/s41598-022-24368-2.

[3] Sankar, S.[†], Balamurugan, D.[†], Brown, A., **Ding, K.,** Xu, X., Low, J.H., Yeow, C.H., Thakor, N. (2021). Texture Discrimination with a Soft Biomimetic Finger through Passive Palpation using a Flexible Neuromorphic Tactile Sensor Array and Sensory Feedback. *Soft Robotics*, 10.1089/soro.2020.0016.

[4] Osborn, L.E., **Ding, K.**[†]**,** Hays, M.A.[†], Bose, R., Iskarous, M.M., Dragomir, A., Tayeb, Z., Lévay, G.M., Hunt, C.L., Cheng, G., Armiger, R.S., Bezerianos, A., Fifer, M.S., Thakor, N.V. (2020). Sensory stimulation enhances phantom limb perception and movement decoding. *Journal of Neural Engineering*, 10.1088/1741-2552/abb861.

[5] **Ding, K.**[†]**,** Dragomir, A.[†], Bose, R., Osborn, L.E., Seet, M.S., Bezerianos, A., Thakor, N.V. (2020). Towards machine to brain interfaces: sensory stimulation enhances sensorimotor dynamic functional connectivity in upper limb amputees. *Journal of Neural Engineering*, 10.1088/1741-2552/ab882d.

Review Articles & Book Chapters

[1] **Ding, K.,** Rakhshan, M., Paredes-Acuña, N., Cheng, G., Thakor, N.V. (2024). Sensory Integration for Neuroprostheses: from Functional Benefits to Neural Correlates. *Medical & Biological Engineering & Computing*, 10.1007/s11517-024-03118-8.

[2] Paredes-Acuña, N., Utpadel-Fischler, D., **Ding, K.,** Thakor, N.V., Cheng, G. (2024). Upper limb intention tremor assessment: opportunities and challenges in wearable technology. *Journal of NeuroEngineering and Rehabilitation*, 10.1186/s12984-023-01302-9.

[3] Masteller, A.[†], Sankar, S.[†], Kim, H.B.[†], **Ding, K.**[†]**,** Liu, X., All, A.H. (2021). Recent Developments in Prosthesis Sensors, Texture Recognition, and Sensory Stimulation for Upper Limb Prostheses. *Annals of Biomedical Engineering*, 10.1007/s10439-020-02678-8.

[4] Bodala, I.P., **Ding, K.**[†]**,** Al-Nashash, H. (2020). Vigilance Assessment and Enhancement. *Handbook of Neuroengineering*, 10.1007/978-981-15-2848-4_75-1.

Research Grants

Computational Models of Multisensory Integration by Upper Limb in Humanoids and Amputees

PI: Nitish Thakor, PhD   09/2021--04/2025

NSF Collaborative Research in Computational Neuroscience (CRCNS)

Contributions: assisted in writing (literature review, visualization, preliminary results, study protocol, and data analysis methods)

Neurodiagnostic Biomarkers of Central Sensitization in Chronic Pain

PI: Tina Doshi, MD; Co-I: Nitish Thakor, PhD   2021

Blaustein Pain Grant -- Johns Hopkins Medicine Internal Research Fund

Contributions: aim development, literature review, proposed approach, and study protocol

Invited Talks

2025 Sensory Neural Prostheses. *Introduction to Biomedical Engineering (EGR 351, Upper Class Engineering Seminar)*, Smith College

2024 Upper Limb Neuroprostheses. *Hopkins Engineering Applications & Research Tutorials (HEART) Course: Exploring Arm Movement Control*, JHU

# Conference Presentations + talks, * posters, † equal contribution

Workshop

+[1] **Ding, K.**[†]**,** Dragomir, A.[†] (2024). Spatial Stability and Cortical Responses of Sensory Stimulation in Upper Limb Prostheses. *TUM-IAS-JHU Workshop Sensory Integration in Neuroprostheses and Rehabilitation* , Technical University of Munich (TUM), Munich, Germany.

Conference Papers

*[1] Hunt, C.L.[†], **Ding, K.**[†]**,** Wagner, C.S., Berberich, N., Yilmazer, K., Gonzalez-Fernandez, M., Cheng, G., Thakor, N.V. (2023). Investigating the relationship between cue immersion and the strength of motor imagery during hand and wrist movements. *2023 11th International IEEE/EMBS Conference on Neural Engineering (NER)*, Baltimore, Maryland, USA.

+[2] **Ding, K.,** Dragomir, A., Bose, R., Osborn, L., Seet, M., Bezerianos, A., Thakor, N. (2021). Sensory Stimulation Enhances Functional Connectivity towards the Somatosensory Cortex in Upper Limb Amputation. *2021 10th International IEEE/EMBS Conference on Neural Engineering (NER)*, virtual.

+[3] Bose, R., **Ding, K.,** Seet, M., Osborn, L., Bezerianos, A., Thakor, N., Dragomir, A. (2020) Sensory Feedback in Upper Limb Amputees Impacts Cortical Activity as Revealed by Multiscale Connectivity Analysis. *2020 42nd Annual International Conference of the IEEE Engineering in Medicine Biology Society (EMBC)*, virtual.

Posters & Talks (presenting author)

*[1] **Ding, K.,** Iskarous, M.M., Osborn, L.E., Christie, B.P., D'Almeida, D., Yu, K., Fifer, M.S., Celnik, P.A., Tenore, F.V., Caffo, B.S., Thakor, N.V. (2025). Quantifying the spatial stability of sensory stimulation projected fields for neuroprostheses. *Neural Interfaces 2025*, Arlington, VA, USA.

*[2] **Ding, K.,** Iskarous, M.M., Osborn, L.E., Christie, B.P., D'Almeida, D., Yu, K., Fifer, M.S., Celnik, P.A., Tenore, F.V., Caffo, B.S., Thakor, N.V. (2025). Quantifying the spatial stability of sensory stimulation projected fields for neuroprostheses. *BCI Society Meeting*, Banff, AB, Canada.

*[3] **Ding, K.,** Iskarous, M.M., Osborn, L.E., Christie, B.P., Fifer, M.S., Celnik, P.A., Tenore, F.V., Thakor, N.V. (2024). Quantifying the spatial stability of sensory stimulation projected fields for neuroprostheses. *Society for Neuroscience*, Chicago, IL, USA.

*[4] **Ding, K.,** Chen, Y., Bose, R., Osborn, L.E., Dragomir, A., Thakor, N.V. (2024). Sensory stimulation for upper limb amputations modulates adaptability of cortical large-scale systems and combination of somatosensory and visual inputs. *10th Annual BRAIN Initiative Conference*, Rockville, MD, USA.

*[5] **Ding, K.,** Iskarous, M.M., Osborn, L.E., Christie, B.P., Fifer, M.S., Celnik, P.A., Tenore, F.V., Thakor, N.V. (2023). A network-inspired method to quantify sensory mapping stability for neuroprosthesis. *Society for Neuroscience*, Washington D.C., USA.

*[6] **Ding, K.,** Arginteanu T., Anderson White, M., Thakor, N.V., Doshi, T. (2023). Resting-state electroencephalographic correlates of central sensitization in chronic pain. *2023 11th International IEEE EMBS Conference on Neural Engineering (NER)*, Baltimore, MD, USA.

*[7] **Ding, K.,** Iskarous, M.M., Osborn, L.E., Thakor, N.V. (2022). Long-term sensory mapping and detection sensitivity of targeted transcutaneous electrical nerve stimulation. *Society for Neuroscience*, San Diego, CA, USA.

+[8] **Ding, K.**[†]**,** Dragomir, A.[†], Bose, R., Osborn, L.E., Seet, M.S., Bezerianos, A., Thakor, N.V. (2020). Towards machine to brain interfaces: sensory stimulation enhances sensorimotor dynamic functional connectivity in upper limb amputes. *Neuromatch 3*, virtual, [Recording].

Mentoring * published or presented

I have mentored 16 undergraduate and master's students, 5 of whom are currently pursuing a Ph.D.

Master's Zihan Lyu (2025--), Yiyang Huang* (2024--), Kaichen Yu* (2024--), Mingfeng Cao (2022--2023), Jin Dai (2022--2023), Zhuojun Yu (2023), Shuming Xu (2020--2021), Yunru Chen* (2019--2022)

Undergraduate Dayann D'almeida* (2023--2025), Stephen Ebaseh-Onofa (2024), Christoph Wagner* (2022--2023), Kings Jiang (2022--2023), Ruixiang Li* (2021--2023), Sharanya Parvathaneni (2021--2023), Ze Ou* (2020--2023), Jinghua Zhang (2020--2021)

Teaching

Introduction to Rehabilitation Engineering *EN.580.456/656,* BME, JHU   Fall 2021--2025
Lab creator and instructor
Neural Implants and Interfaces *EN.580.742,* BME, JHU   Spring 2022, 2023
Teaching assistant and grader
Principles of the Design of Biomedical Instrumentation *EN.580.471/771,* BME, JHU   Fall 2019
Teaching assistant
Engineering Circuit Theory *EGR220,* Picker Engineering Program, Smith College   Spring 2017, 2018
Teaching and lab assistant
Engineering Thermodynamics *EGR290,* Picker Engineering Program, Smith College   Spring 2017
Teaching assistant
Introductory Physics I *PHY117,* Physics, Smith College   Fall 2015
Teaching assistant

Leadership

Co-Organizer IAS-TUM-JHU Workshop: "Sensory Integration in Neuroprostheses and Rehabilitation"   2024
Technical University of Munich (TUM), Munich, Germany
Assembled 7 professors for research talks and discussions; collaborated with TUM colleagues to design session themes, itinerary, and ensure logistics. [Webpage]

Founding Member Neural Engineering Cross University Student Society (NEXUS^2)   2024--present
JHU, Baltimore, MD

President Translational Neuroengineering Technologies (TNT) Network   2023--2024

Co-Treasurer TNT Network   2021--2023
JHU, Baltimore, MD
Established the financial infrastructure, secured funding and assisted in organizing academic, professional development, and social events. Over $10k was raised between the TNT Network's industry partner, graduate student organizations, and professor support.

Co-Organizer Workshop: ``Machine-Brain Interfaces: Improving the Human and Machine Interactions"   2023
IEEE NER 2023, Baltimore, MD

Vice President Society of Women Engineers Chapter   2017--2018
Smith College, Northampton, MA

Professional Activities & Service

Professional Societies

Graduate student member Brain-Computer Interface (BCI) Society; Society for Neuroscience (SfN); Institute of Electrical and Electronics Engineers (IEEE); IEEE Engineering in Medicine and Biology Society (EMBS); Society of Women Engineers (SWE)

Honor societies Sigma Xi, Phi Beta Kappa, Tau Beta Kappa

Peer Review

Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)
IEEE Transactions on Neural Systems and Rehabilitation Engineering (TNSRE)
Journal of Neural Engineering
Journal of NeuroEngineering and Rehabilitation
Medical & Biological Engineering & Computing
Neurophysiologie Clinique (Elsevier)
Physiological Measurement (IOPscience)
Scientific Reports

Volunteering & Outreach

Volunteer Judge Principles of the Design of Biomedical Instrumentation, JHU   2022, 2024
Judged wearable device and biogaming projects, in which students developed devices based on measured biosignals.

Podcast Guest Design Clinic Download Podcast, Smith College   2022
Interviewed for the Design Clinic 20th Anniversary podcast. Design Clinic is the capstone engineering design course at Smith College. [Podcast episode 4]

Mentor SWE@Smith Alumni Network   2022
Shared experience and offered advice on topics such as work-life balance, communication, and setting goals during monthly meetings with a graduating senior.

Speaker SWE@Smith Alumni Network   2021
Participated in a panel on courses at Smith, graduate school application, and determining professional interest.

Volunteer SWE@Smith College   2017
Assisted organizing the annual "Introduce a Girl to Engineering Day", with hands-on workshops to create more exposure to STEM fields for middle-school-aged students.