

Curriculum Vitae

Manu S. Madhav

Assistant Professor

Neural Circuits for Computation, Cognition and Control (*NC⁴*) Laboratory

School of Biomedical Engineering

Djawad Mowafaghian Centre for Brain Health

University of British Columbia

Contact

F127 Koerner Pavilion
2211 Wesbrook Mall
Vancouver, BC, Canada V6T 1Z3

manu.madhav@ubc.ca
nc4.bme.ubc.ca
manusmad.com

Career

- **(January 2021–present)** Assistant Professor
University of British Columbia
- **(July 2019—December 2020)** Assistant Research Scientist
- **(May 2014—Jun 2019)** Postdoctoral Research Fellow
The Zanvyl Krieger Mind / Brain Institute
Johns Hopkins University (JHU), Baltimore, MD, U.S.A.
- **(Sep 2008—Apr 2014)** Graduate Research Assistant
Department of Mechanical Engineering
Johns Hopkins University (JHU), Baltimore, MD, U.S.A.

Education

- **(2014)** Ph.D. in Mechanical Engineering
Johns Hopkins University (JHU), Baltimore, MD, U.S.A.
Advisor: Prof. Noah Cowan
- **(2010)** M.S.E. in Mechanical Engineering
Johns Hopkins University (JHU), Baltimore, MD, U.S.A.
- **(2008)** B.Tech. in Mechanical Engineering
National Institute of Technology Calicut (NITC), Calicut, Kerala, India

Research Experience

- **(2021 – present)** Currently pursuing research projects related to quantifying algorithms underlying spatial navigation in rodents and humans.
- **(2013 – 2020)** Worked on quantifying aspects of spatial navigation in rats by recording place cells and grid cells in a novel virtual reality experimental rig, in a joint project with Profs. James Knierim, Noah Cowan (JHU), and Hugh T. Blair (UCLA).

- **(2012 – 2018)** Developed algorithms to localize groups of weakly electric fish in frequency and space by using a spatially distributed grid of electrodes, both in a laboratory setting and in the field.
- **(2013 – 2015)** Worked with Profs. Noah Cowan and Amy Bastian (JHU) on quantifying bilateral symmetry in the dynamics of human walking using Poincaré analysis.
- **(2009 – 2014)** Worked with Profs. Noah Cowan (JHU) and Eric Fortune (NJIT) on several problems related to modeling multisensory behaviors in weakly electric knifefish. Modeling the Jamming Avoidance Response (JAR) and the discovery of the Social Envelope Response (SER) in these fish comprised my doctoral thesis.
- **(2012 – 2014)** Exploring the role of MSTd in primate navigational tasks, in a joint project with Profs. Charles Duffy and Bill Page (Univ. Rochester) and Noah Cowan (JHU).
- **(2008 – 2009)** As a member of Prof. Allison Okamura’s Haptics Lab, helped in designing and conducting a human subject study for determining the efficacy of vibration feedback to the feet.
- **(2007 – 2008)** Designed and fabricated a 20-Degree-of-freedom servo-based humanoid robot, as the senior undergraduate project.
- **(2006 – 2007)** Designed and fabricated a mobile manipulator arm, as the junior undergraduate mini-project.

Teaching Experience

- **(Spring 2018)** Instructed the Johns Hopkins University graduate course “Locomotion II: Dynamics”
- **(Spring 2012)** Teaching Assistant for JHU graduate course “System Identification”.
- **(Intersession 2012)** Instructed a three-week course entitled “The Kalman Filter” at JHU.
- **(Fall 2009)** Teaching Assistant for JHU graduate course “Introduction to Linear Systems”.
- **(Fall 2008, Spring 2009)** Teaching Assistant for two semesters of “Freshman Experiences in Mechanical Engineering”, an introductory class for Mechanical Engineering freshmen at JHU.

Publications

Thesis

- *Nonlinear processing of sensory interference drives social behavior in weakly electric fish*. Doctoral thesis, Johns Hopkins University, 2014.

Journal Publications

- Eric S. Fortune, Nicole Andanar, **Manu S. Madhav**, Ravikrishnan P. Jayakumar, Noah J. Cowan, Maria Elina Bichuette and Daphne Soares, *Spooky interaction at a distance in cave and surface dwelling electric fishes*. *Frontiers in Integrative Neuroscience*, 2020.

- **Manu S. Madhav** and Noah J. Cowan. *The synergy between neuroscience and control theory: the nervous system as inspiration for hard control challenges*. Annual Review of Control, Robotics, and Autonomous Systems, 2020.
- Ravikrishnan P. Jayakumar*, **Manu S. Madhav***†, Francesco Savelli, Hugh T. Blair, Noah J. Cowan and James J. Knierim. *Recalibration of path integration in hippocampal place cells*. Nature, 2019. *Contributed equally. †Corresponding author.
- **Manu S. Madhav***, Ravikrishnan P. Jayakumar*, Alican Demir, Sarah A. Stamper, Eric S. Fortune and Noah J. Cowan. *High-resolution behavioral mapping of electric fishes in Amazonian habitats*. Scientific Reports, 2018. *Contributed equally.
- M. Mert Ankarali, Shahin Sefati, **Manu S. Madhav**, Andrew Long, Amy J. Bastian and Noah J. Cowan. *Walking dynamics are symmetric (enough)*. Journal of the Royal Society Interface, 2015.
- Noah J. Cowan, M. Mert Ankarali, Jonathan P. Dyrh, **Manu S. Madhav**, Eatai Roth, Shahin Sefati, Simon Sponberg, Sarah A. Stamper, Eric S. Fortune, and Thomas L. Daniel. *Feedback control as a framework for understanding tradeoffs in biology*. Integrative and Comparative Biology, 2014.
- **Manu S. Madhav**, Sarah A. Stamper, Eric S. Fortune, and N. J. Cowan. *Closed-loop stabilization of the jamming avoidance response reveals its locally unstable and globally nonlinear dynamics*. Journal of Experimental Biology, 2013.
- Sarah A. Stamper*, **Manu S. Madhav***, Noah J. Cowan, and Eric S. Fortune. *Beyond the Jamming Avoidance Response: Weakly electric fish respond to the envelope of social electrosensory signals*. Journal of Experimental Biology, 2012. *Contributed equally. Ranked as one of the top 3 publications in 2012 in J Exp Biol. Highlighted in Inside JEB: “Gregarious Electric Fish Adjust To Maintain Social Envelope”

Book Chapters

- Sarah A. Stamper*, **Manu S. Madhav***, Noah J. Cowan, and Eric S. Fortune. *Using Control Theory to Characterize Active Sensing in Weakly Electric Fishes*. Electroreception: Fundamental Insights from Comparative Approaches. Springer Handbook of Auditory Research Vol. 70, 2019.

Refereed Conference Papers and Preprints

- Eric S. Fortune, Nicole Andanar, **Manu S. Madhav**, Ravikrishnan P. Jayakumar, Noah J. Cowan, Maria Elina Bichuette, Daphne Soares. *Spooky interaction at a distance in cave and surface dwelling electric fishes*. bioRxiv 747154, 2019, preprint.
- Netta Gurari, Kathryn Smith, **Manu S. Madhav**, and Allison M. Okamura. *Environment Discrimination with Vibration Feedback to the Foot, Arm, and Fingertip*. 11th International Conference on Rehabilitation Robotics (ICORR), 2009.

Magazine Articles and Opinions

- **Manu S. Madhav**, Robert Nickl. *Mimicry or Scrutiny? Striking a Partnership Between Engineering Design and Biological Research*. IEEE Potentials, March-April 2015

Abstracts / Talks

- “Using augmented reality and a control theoretic approach to characterize computation of path integration in rodents”, Neuroscience 2019, Chicago, IL, U.S.A.
- “Robust tracking of neuronal spatial dynamics enables discovery of recalibration of the path integrator in hippocampal place cells”, Neuroscience 2018, San Diego, CA, U.S.A.
- “Recalibration of the path integrator in virtual reality as revealed in CA1 place cells”, Neuroscience 2017, Washington D.C., U.S.A.
- “Extreme control of CA1 spatial maps by coherently moving virtual reality landmarks”, Sixth Annual Winter Workshop on Neuromechanics and Dynamics of Locomotion, 2017, New Orleans, LA, U.S.A.
- “Extreme control of CA1 spatial maps by coherently moving virtual reality landmarks”, Neuroscience 2016, San Diego, CA, U.S.A.
- “Place cells in virtual reality dome reveal interaction between conflicting self-motion and landmark cues”, Neuroscience 2015, Washington D.C., U.S.A.
- “Investigation of cognitive map formation using virtual reality closed-loop control”. International Conference on Robotics and Automation 2014, Seattle, WA, U.S.A.
- “A closed-loop virtual reality apparatus for investigating place and grid cell formation.”, Neuroscience 2014, Washington D.C., U.S.A.
- “Neural control of steering by self-movement stimuli: a closed-loop system identification analysis”, Neuroscience 2014, Washington D.C., U.S.A.
- “Localization of weakly electric fish within groups using spatially distributed electrode recordings”. SICB Southeast Regional meeting, Raleigh, NC, U.S.A.
- “Fitting low-order transfer function models to messy biological data”, Spring 2014 Eastern Sectional Meeting of the American Mathematical Society, Baltimore, MD, U.S.A.
- “Frequency tracking and spatial localization of unconstrained weakly electric fish reveal complex social interactions in natural populations”, Society for Integrative and Comparative Biology (SICB) annual meeting 2014, Austin, TX, U.S.A.
- “Closed-loop stabilization of the Jamming Avoidance Response reveals its locally unstable and globally nonlinear dynamics”, Society for Integrative and Comparative Biology (SICB) annual meeting 2014, Austin, TX, U.S.A.
- “Stride-to-Stride vs. Step-to-Step return maps for human running”, International Symposium on Adaptive Motion of Animals and Machines (AMAM) 2013, Darmstadt, Germany.
- “Contribution of self-movement cues in MSTd due to optic flow and object motion”, Neuroscience 2012, New Orleans, LA, U.S.A.
- “Social envelope responses (SERs) in *Eigenmannia* and *Apteronotus*”, Neuroscience 2012, New Orleans, LA, U.S.A.
- “Beyond the Jamming Avoidance Response: Weakly electric fish respond to the envelope of social electrosensory signals”, International Society for Neuroethology 2010, College Park, MD, U.S.A.
- “Weakly electric fish change their electric organ discharges in response to electrosensory envelopes.”, Neuroscience 2011, Washington D.C., U.S.A.
- “A linear behavior: Understanding the JAR”, Annual Mont St. Hilaire Conference on Electrosensory Processing 2011, Mont St. Hilaire, Quebec, Canada.
- “Identifying an unstable sensorimotor behavior: The Jamming Avoidance Response in *Eigenmannia*”, COSYNE 2011, Salt Lake City, UT, U.S.A.

- “Low-frequency envelope avoidance in weakly electric fish”, International Society for Neuroethology 2010, Salamanca, Spain.
- “Balancing the Jamming Avoidance Response: Closed-loop identification of an unstable sensorimotor behavior”, Neuroscience 2009, Chicago, IL, U.S.A.

Invited talks

- “Interaction between sensory cues in the hippocampal cognitive map revealed through augmented reality and closed-loop methods”. Baltimore Brain Series, September 2019.
- “Interaction between landmarks and path integration in the hippocampal cognitive map revealed through augmented reality and closed-loop methods”. JHU Department of Neuroscience and Neuroscience Training Program Annual Retreat, September 2019.
- “Closing the loop around biological systems”. 2018 ASME Baltimore OctoberFest, Baltimore, MD, U.S.A.
- “Stabilizing the cognitive map with real-time feedback in virtual reality to quantify the influence of optic flow”. Kavli NDI Postdoctoral Award Symposium, April 2017.
- “Closing the loop towards understanding the neural basis of navigation”. 2016 East Coast Nerve Net meeting, Woods Hole, MA, U.S.A.

Awards / Honors

- Awarded the Kavli Distinguished Postdoctoral Fellowship, 2017-2019 by the Kavli Neuroscience Discovery Institute, Johns Hopkins University.
- Best poster award at the Johns Hopkins Department of Neuroscience Annual Retreat, 2017.
- Successfully completed the Neural Systems & Behavior Course offered by the Marine Biological Laboratories, Woods Hole, MA in Summer 2017.
- Awarded the SGP scholarship by the Society of General Physiology, Marine Biological Laboratories, Woods Hole, MA in Summer 2017.

Co-curricular Experience

- Baltimore Hospital Coordinator for Frontline Foods, facilitating meals to healthcare workers during the COVID-19 pandemic.
- Editor of the “The Johns Hopkins University GRO Guide to Living in Baltimore”. (2012 – 2014)
- Served as Chair of the Graduate Representative Organization (GRO), which represents all Graduate Students in Arts & Sciences and Engineering at JHU. (2010 – 2011)
- Communications chair for the GRO. (2009 – 2010, 2011 – 2012)
- Secretary of IEEE Student Branch, NITC. (2007 – ’08)
- Sponsorship Head for FOSSMeet@NITC 2008, then the fourth largest open source community event in India.