Gautam Kumar

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Education

- 2013 PhD, Chemical Engineering, Lehigh University, Bethlehem, Pennsylvania, USA (Advisor: Mayuresh V. Kothare)
- 2008 MS, Chemical Engineering, Lehigh University, Bethlehem, Pennsylvania, USA

2005 B.Tech., Chemical Engineering, Indian Institute of Technology Kanpur, Kanpur, India

Postdoctoral Training

2013-2016 Postdoctoral Research Associate, Department of Electrical and Systems Engineering, Washington University in St. Louis, St. Louis, Missouri, USA (Mentor: ShiNung Ching)

Faculty Positions Held

- 2016- Assistant Professor, Chemical and Biological Engineering, University of Idaho, Moscow, ID, USA
- 2016- Affiliate Faculty, Electrical and Computer Engineering, University of Idaho, Moscow, ID, USA

Industrial Employment

2005-2006 Research Engineer, I-3 Nanotec India Pvt. Ltd., Noida, India

Awards & Honors

2011 Rossin Doctoral Fellow, P. C. Rossin College of Engineering, Lehigh University, Bethlehem, USA

Grants

NIH SPARC: CONTROL-CORE: A Modular Simulation Environment for Design and Prototyping of Closed-loop Peripheral Neuromodulation Control Systems using the O2S2PARC Platform (September 15, 2020 - September 14, 2022); co-I: Gautam Kumar; Amount: \$150,000. Murdock Partners in Science (M. J. Murdock Charitable Trust): Deep Learning-based Noninvasive Brain Decoder (May 15, 2019 - July 31, 2022); PI: Gautam Kumar; Amount: \$15,000.

University of Idaho Seed Grant: Harnessing Neuroplasticity for Rewiring Brain Circuits (May 15, 2017 - Aug 31, 2018); PI: Gautam Kumar; Amount: \$11,915.

Areas of Specialization

Model Predictive Control, Linear and Nonlinear Dynamical Systems Theory, Multi-scale Modeling, Optimization, Stochastic Systems, Bayesian Statistics, Neural Engineering, Computational Neuroscience, Deep Learning, Reinforcement Learning

Teaching Accomplishments

Courses Taught

CHE 444, Process Analysis and Control, Fall 2016, 2017, 2018, 2019, 2020 (3 cr.) CHE 445/ECE 477, Digital Process Control, Spring 2017, 2018, 2019, 2020, 2021 (3 cr.) CHE 433, Chemical Engineering Lab I, Fall 2018, 2019, 2020 (1 cr.) CHE 434, Chemical Engineering Lab II, Spring 2017, 2018 (1 cr.) CHE 210, Integrated Chemical Engineering Fundamentals, Fall 2018, Spring 2020, Spring 2021 (1 cr.) CHE 404/504, Dynamics of Brain Networks, Spring 2019, 2020 (1 cr.)

Students Advised

High School Students: 3

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Undergraduate Students: 15-20/semester
Advised on research projects: 3
Joseph Schmalz, Spring 2017-Summer 2017
Nathan Myers, Spring 2018
Niko Hansen, Spring 2019-current
Senior Design Team: "Humidity Control for Vapor Sorption Analyzers", 2016-2017
Senior Design Team: "Low-cost EEG Device", 2018-2019
Senior Design Team: "Low-cost EEG Device", 2019-2020
Senior Design Team: "Low-cost EEG Device", 2020-2021
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Graduate Students (major professor):

Vishwanath Ketkar, Ph.D. candidate in Electrical Engineering, Spring 2017 - Fall 2017 (Currently a Ph.D. student in Mechanical Engineering)

Joseph Schmalz, Ph.D. candidate in Chemical Engineering, Fall 2017-present (Thesis Defense: April 2021)

Benjamin Plaster, M.S. candidate in Chemical Engineering, Fall 2018-present (Defended

MS thesis on December 07, 2020. Thesis title: Deep Learning Approaches for Modeling and Inferring Neuronal Dynamics)

Andrew Branen, Ph.D. candidate in Chemical Engineering, Fall 2019-present (anticipated graduation: Spring 2023)

Courses Developed

CHE 444, Process Analysis and Control, Fall 2016 CHE 445, Digital Process Control, Spring 2017 CHE 210, Integrated ChE Fundamentals, Fall 2018 CHE 404/504, Dynamics of Brain Networks, Spring 2019

Publications & talks (*: with Graduate Students)

Manuscripts under preparation

- 2020 Schmalz, J.*, Richardson, B. and **Kumar, G.**, "Spatiotemporal dopaminergic modulation of Schaffer collateral-CA1 plasticity: a computational modeling approach", *Planned to be submitted by January 31, 2021.*
- 2021 Schmalz, J.*, Kothare, M. and **Kumar, G.**, "Controlling Epileptic Seizures using Forced Temporal Spike-Time Stimulation", *Planned to be submitted by February 2021*.
- 2021 Branen, A.*, Yao, Y., Kothare, M. and **Kumar, G.**, "Data-driven predictive modeling of cardiac dynamics using long short-term memory", *Planned to be submitted in 43rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society by February 22, 2021.*
- 2021 Plaster, B.* and **Kumar, G.**, "Discovering Latent Dynamics Embedded in Large-Scale Hippocampal Neural Spiking Activity", *Planned to be submitted by March 15, 2021*.
- 2021 Branen, A.* and **Kumar, G.**, "Computational Modeling to Understand the Spatiotemporal Cholinergic Modulation of Hippocampal Synaptic Plasticity", *Planned to be submitted by April 30, 2021.*

Peer-reviewed journal articles

- 2019 Plaster, B.* and **Kumar, G.**, "Data-driven predictive modeling of neuronal dynamics using long short-term memory", *Algorithms*. 12(10), 203.
- 2019 Schmalz, J.* and **Kumar, G.**, "Controlling synchronization of spiking neuronal networks by harnessing synaptic plasticity", *Frontiers in Computational Neuroscience*. 13(61), 1-17.
- 2018 **Kumar, G.**, Menolascino, D. and Ching, S., "Sensitivity of Linear Systems to Input Orientation and Novelty", *Automatica*, 93, 462-468 (Impact Factor: 5.451)
- 2016 **Kumar, G.** and Ching, S., "The geometry of plasticity-induced sensitization in isoinhibitory rate motifs", *Neural Computation*, 28(9), 1889-1926. (Impact Factor: 1.938)
- 2016 Kumar, G., Kothare, M. V., Thakor, N. V., Schieber, M. H., Pan, H., Ding, B., Zhong, W.

(2016), "Designing closed-loop brain-machine interfaces using model predictive control", *Technologies special issue "Brain-Machine Interface Technology"*, 4(2), 18.

- 2016 **Kumar, G.**, Kim, S. and Ching, S. (2016), "A Control-theoretic Approach to Neural Pharmacology: Optimizing Drug Selection and Dosing", *ASME Journal of Dynamic Systems, Measurement and Control*, 138(8), 084501.(Impact Factor: 1.388)
- 2014 **Kumar, G.** and Kothare, M. V. (2014), "Trapping Brownian ensemble optimally using broadcast stochastic receding horizon control", *Automatica*, 50(2), 389-398. (Impact Factor: 5.451)
- 2013 **Kumar, G.** and Kothare, M. V. (2013), "Broadcast stochastic receding horizon control of multi-agent systems", *Automatica*, 49(12), 3600-3606. (Impact Factor: 5.451)
- 2013 **Kumar, G.** and Kothare, M. V. (2013), "On the continuous differentiability of inter-spike intervals of synaptically connected cortical spiking neurons in a neuronal network", *Neural Computation*, 25(12), 3183-3206. (Impact Factor: 1.938)

Book Chapters

2016 **Kumar, G.**, Ritt, J. and Ching, S., "Control theory for closed-loop neurophysiology", *Book chapter in Closed Loop Neuroscience, Editor: Ahmed EI Hady, Publisher: Elsevier*

Peer-reviewed conference proceedings

- 2015 **Kumar, G.** and Ching, S., "Design of optimally sparse dosing strategies for neural pharmacology", *In Proceedings of the 2015 American Control Conference*, pages: 5865-5870, Chicago, IL, USA
- 2015 **Kumar, G.**, Menolascino, D., Kafashan, M. and Ching, S., "Controlling Linear Networks with Minimally Novel Inputs", *In Proceedings of the 2015 American Control Conference*, pages: 5896-5900, Chicago, IL, USA
- 2015 Pan, H., Ding, B., Zhong, W., Kumar, G. and Kothare, M. V., "Designing Closed-loop Brain-Machine Interfaces with Network of Spiking Neurons Using MPC Strategy", In Proceedings of the 2015 American Control Conference, pages: 2543-2548, Chicago, IL, USA
- 2014 **Kumar, G.** and Ching, S. (August 2014), "Maximizing relaxation time in oscillator networks with implications for neurostimulation", *In Proceedings of the* 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, pages: 6589-6592, Chicago, IL, USA
- 2013 **Kumar, G.**, Schieber, M. H., Thakor, N. V. and Kothare, M. V. (June 2013), "Designing closed-loop brain-machine interfaces using optimal receding horizon control", *In Proceedings of the 2013 American Control Conference*, pages: 4933-4938, Washington DC, DC, USA
- 2011 Kumar, G., Aggarwal, V., Thakor, N. V., Schieber, M. H. and Kothare, M. V. (December 2011), "An optimal control problem in closed-loop neuroprostheses", *In Proceedings of the* 2011 50th Conference on Decision and Control and European Control Conference, pages: 53-58, Orlando, FL, USA
- 2010 **Kumar, G.**, Aggarwal, V., Thakor, N. V., Schieber, M. H. and Kothare, M. V. (June 2010), "Optimal parameter estimation of the Izhikevich single neuron model using experimental inter-spike interval (ISI) data", *In Proceedings of the 2010 American Control Conference*, pages:

3586-3591, Baltimore, MD, USA

2009 **Kumar, G.**, Tiwari, P. Y., Marcopoli, V. and Kothare, M. V. (June 2009), "A study of a gunturret assembly in an armored tank using model predictive control", *In Proceedings of the 2009 American Control Conference*, pages: 4848-4853, St. Louis, Missouri, USA

Refereed abstracts & talks

- 2021 Schmalz, J.*, **Kumar, G.** and Kothare, M. (January 2021), "Controlling Epileptic Seizures using Forced Temporal Spike-Time Stimulation", *In the 2020 Society for Neuroscience Annual Meeting*
- 2020 Plaster, B.*, Hansen, N.* and **Kumar, G.** (November 2020), "Discovering Latent Dynamics Embedded in Large-Scale Neural Spiking Activity", *In the 2020 AICHE Annual Meeting*, San Francisco, CA, USA
- 2020 Branen, A.* and **Kumar, G.** (November 2020), "Computational Modeling to Understand the Spatiotemporal Cholinergic Modulation of Hippocampal Synaptic Plasticity", *In the 2020 AICHE Annual Meeting*, San Francisco, CA, USA
- 2020 Schmalz, J.* and **Kumar, G.** (November 2020), "Spatiotemporal Dopaminergic Modulation of Schaffer Collateral-CA1 Plasticity: A Computational Modeling Approach", *In the 2020 AICHE Annual Meeting*, San Francisco, CA, USA
- 2019 Schmalz, J.* and **Kumar, G.** (October 2019), "Spatiotemporal dopaminergic modulation of Schaffer collateral - CA1 plasticity: A computational modeling approach", *In the 2019 Society for Neuroscience (SFN) Annual Meeting*, San Diego, CA, USA
- 2018 Schmalz, J.* and **Kumar, G.** (October 2018), "Disruption of homeostasis of the Basal Ganglia circuit in Parkinson's disease", *In the 2018 Society for Neuroscience (SFN) Annual Meeting*, San Diego, CA, USA
- 2018 Schmalz, J.* and **Kumar, G.** (October 2018), "Understanding the Basal Ganglia Dynamic Transition from the Healthy to the Parkinsonian State", *In the 2018 AICHE Annual Meeting*, Pittsburgh, PA, USA
- 2018 Schmalz, J.* and **Kumar, G.** (October 2018), "Designing Stochastic Model Predictive Control based Neural Interface to Restore Communication between Brain Regions", *In the 2018 AICHE Annual Meeting*, Pittsburgh, PA, USA
- 2018 Schmalz, J.* and **Kumar, G.** (April 2018), "Restoring dynamics in spiking neuronal networks by harnessing plasticity", *In the 6th Minnesota Neuromodulation Symposium*, Minneapolis, MN, USA
- 2016 Liu, S., **Kumar, G.** and Ching, S., "Regularization-free synthesis of stable, informationoptimal plasticity rules in recurrent networks", *Abstract in Computational and Systems Neuroscience 2016 Meeting*, Salk Lake City, UT, USA
- 2015 **Kumar, G.** and Ching, S. (October 2015), "Plasticity-induced sensitization in recurrent E-I networks", *In the 2015 Society for Neuroscience (SFN) Annual Meeting*, Chicago, IL, USA
- 2014 Ching, S. and **Kumar, G.** (November 2014), "Measuring the Expressiveness of Plastic Neuronal Networks", *In the 2014 IEEE EMBS BRAIN Grand Challenges Conference*, Washington D.C., DC, USA
- 2013 **Kumar, G.**, Schieber, M. H., Thakor, N. V. and Kothare, M. V. (November 2013), "Designing closed-loop brain-machine interfaces using charge balanced biphasic stimulating cur-

rents", In the 2013 Society for Neuroscience (SFN) Annual Meeting, San Diego, CA, USA

- 2012 **Kumar, G.** and Kothare, M. V. (October 2012), "Regulating and Trapping an ensemble of Brownian particles by broadcast the stochastic receding horizon control policy", *In the 2012 AICHE Annual Meeting*, Pittsburgh, PA, USA
- 2012 **Kumar, G.**, Schiesser, W. E. and Kothare, M. V. (October 2012), "A quantitative assessment of the Izhikevich neuron model against experimental data", *In the 2012 AICHE Annual Meeting*, Pittsburgh, PA, USA
- 2011 **Kumar, G.**, Thakor, N. V. and Kothare, M. V. (November 2011), "Cortical neuronal network based neuroprosthetic finger control: A control theoretic approach", *In the 2011 Society for Neuroscience (SFN) Annual Meeting*, Washington DC, USA (Poster)
- 2011 **Kumar, G.**, Thakor, N. V. and Kothare, M. V. (October 2011), "Control of a motor intended neural prosthetic finger using a network of cortical motor neurons", *In the 2011 AICHE Annual Meeting*, Minneapolis, MN, USA
- 2010 **Kumar, G.**, Aggarwal, V., Thakor, N. V., Schieber, M. H. and Kothare, M. V. (November 2010), "A control approach towards closed-loop neural prosthesis", *In the 2010 Society for Neuroscience (SFN) Annual Meeting*, San Diego, CA, USA
- 2010 **Kumar, G.**, Aggarwal, V., Thakor, N. V., Schieber, M. H. and Kothare, M. V. (November 2010), "Optimal parameter estimation of stochastic Izhikevich single neuron model using experimental inter-spike interval data", *In the 2010 AICHE Annual Meeting*, Salt Lake City, Utah, USA
- 2010 **Kumar, G.**, Aggarwal, V., Thakor, N. V., Schieber, M. H. and Kothare, M. V. (November 2010), "Design and control of a closed-loop neural prosthesis", *In the 2010 AICHE Annual Meeting*, Salt Lake City, Utah, USA
- 2010 **Kumar, G.** and Kothare, M. V. (November 2010), "A mathematical theory of manipulating suspended multiple Brownian particles simultaneously in a solution", *In the 2010 AICHE Annual Meeting*, Salt Lake City, Utah, USA
- 2009 **Kumar, G.**, Aggarwal, V., Thakor, N. V. and Kothare, M. V. (November 2009), "Optimal control of closed-loop neural prostheses", *In the 2009 AICHE Annual Meeting*, Nashville, TN, USA
- 2009 **Kumar, G.** and Kothare, M. V. (November 2009), "Broadcast model predictive control of multi-cellular system", *CAST Plenary Session, In the 2009 AICHE Annual Meeting*, Nashville, TN, USA

Service

Major Committee Assignments

Department Graduate Application Review Committee (Fall 2016-present) College Curriculum Committee (Fall 2017-present)

Others

Faculty Tenure Review Committee, CHE, Fall 2018 Faculty Tenure Review Committee, ECE, Fall 2017 Faculty Third-Year Review Committee, MSE, Fall 2017 Department Chair Review Committee, CHE, Fall 2017 Ph.D. Dissertation Defense Committee, ECE, Spring 2020

Professional and Scholarly Organizations

American Institute for Chemical Engineers (AIChE), Member, 2009 (active) Institute for Electrical and Electronics Engineers (IEEE), Member, 2009 (active) Society for Neuroscience, Member, 2010 (active) Organization for Computational Neuroscience, Member, 2020 (active)

Reviewer Duties—two or more per year (on average): manuscripts, textbook chapters, proposals, etc., for Automatica, IEEE Conference on Decision and Control, American Control Conference, Processes (MDPI Journal), Applied Sciences (MDPI), Algorithms (MDPI), Energies (MDPI), Neurocomputing, Mathematical Methods in Applied Sciences, IEEE Transactions on Systems, Man, and Cybernetics: Systems.

Outreach Service

Initiated an educational outreach program in Neural Engineering with Jacquelin Alvarez Martinez, CHE Undergraduate at the Moscow High School in Fall 2017.

Professional Development

NASA ISGC Undergraduate Research Grant Review Panel, 2017. AICHE CAST session co-chair, 2019 AICHE Annual Meeting. ORED RISE Advancing Collaborative Efforts (ACE) Program Review Panel, University of Idaho, 2019. NSF Review Panel, 2018-2021.