Bharat Singhal

St Louis,MO

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Education

Washington University in St. Louis, Missouri **Sep'20 - May'25 (Exp.)**

Ph.D. Candidate in Systems Science and Mathematics *GPA: **3.96/4.00***

M.S. in Systems Science and Mathematics

Indian Institute of Technology Kharagpur, India (IIT-Kharagpur) **July'16 - June'17**

M.Tech. in Control System Engineering *CGPA: **8.85/10.00***

B.Tech.(Honors) in Electrical Engineering

Research Experience

Graduate Research Assistant | *Washington University in St. Louis* **Sep. 2020 - Present**

7 Research articles published, 5 under review | Mentored one master's and one undergraduate student

- Understanding how neuron connectivity influences the behavior of populations as a whole, as well as how to harness the connectivity structure for effective regulation, which is essential to neuroscience and circadian biology.
- Developed data-driven protocols to decode the connectivity structure of complex networks and to predict the collective dynamics. The developed protocols are being applied to decipher the connectivity structure of the Suprachiasmatic Nucleus.
- Designing optimal control techniques for the control of large-scale networks of nonlinear agents by utilizing population-level measurement data, which have potential applications in controlling power-grid networks and treating neurological disorders.

Master's Research | *IIT Kharagpur* **July 2016 - June 2017**

Master's Thesis: Modeling and Control of an Anti-lock Braking System in Hybrid Electric Vehicles

- Developed a complete four-wheel vehicle model for its longitudinal motion and implemented a sliding mode controller to prevent wheel lock-out and minimize stopping distance by 70%.
- Designed a controller to maximize the amount of regenerative energy, in case of braking, while maintaining stopping distance for hybrid vehicles.

Undergraduate Researcher | *IIT Kharagpur* **July 2015 - April 2016**

Bachelor's Project: Speed Control of E-bikes Based on User-Customized Assistance Level

- Built a Simulink model of a three-phase star-connected BLDC motor using state space and implemented a PI controller to regulate the speed of the motor as per assistance level.
- Simulated dynamics of a bicycle from the force on pedals, through the transmission system, to wheels in Simulink.

Undergraduate Summer Researcher | *IIT Kharagpur* **May 2014 - July 2014**

Online Monitoring System for Overhead Equipment Traction Parameter Measurement

- Developed image segmentation and blob detection algorithm using real-time image processing software (Sapera APF) for non-contact measurement of dynamic conditions of overhead equipment synchronized with position obtained via GPS.

Work Experience

Taiwan Semiconductor Manufacturing Company (TSMC) | *Research Engineer* **Oct. 2017 - Sep. 2020**

- Worked on Integrating different SOC designs like ASIC on ASIC (AOA), system on integrated chip (SOIC), and wafer on wafer (WOW) to implement 3D-IC RC tech files for 7nm and 12nm nodes.
- Developed a comprehensive Gate resistance model to reduce silicon to simulation gap when multiple vias land on gate-poly by analyzing multiple resistance network combinations for 5nm finfet.
- Modelled various RC features like Cfi tables to compensate for gate-to-drain and gate-to-source capacitance, damage-based dielectric constant, and marker layers by anatomizing silicon data for 5nm and 7nm nodes.

Altisource Business Solutions | *Intern, Business Analyst* **May 2015 - July 2015**

- Designed and implemented the front end for Vresolve, Altisource's web-based mortgage collection platform which resulted in increased efficiency of the company's mortgage collection.

Publications

Submitted Papers

- **Bharat Singhal**, and Jr-Shin Li. "Feedback Control of Heterogeneous Nonlinear Oscillator Ensembles with Uncertain Parameters." Systems & Control Letters.
- **Bharat Singhal**, ShiCheng Li, and Jr-Shin Li. "Decoding Network Interactions from Time Series Data: A Model-Free Iterative Approach." Chaos: An Interdisciplinary Journal of Nonlinear Science.
- **Bharat Singhal**, Jorge Luis Ocampo-Espindola, K.L. Nikhil, Erik Herzog, István Z. Kiss, and Jr-Shin Li. "Uncertainty Quantification of Network Inference with Data Sufficiency." IEEE Transactions on Network Science and Engineering.
- **Bharat Singhal**, and Jr-Shin Li. "Cluster synchronization in oscillator networks using population-level measurements." IEEE Control Systems Letters.
- Jorge Luis Ocampo-Espindola*, **Bharat Singhal***, Jr-Shin Li, and István Z. Kiss. "Optimal phase-selective entrainment of electrochemical oscillators with different phase response curves." Chaos: An Interdisciplinary Journal of Nonlinear Science (*: equal contribution).

Accepted Papers

- **Bharat Singhal**, István Z. Kiss, and Jr-Shin Li. "Optimal phase-selective entrainment of heterogeneous oscillator ensembles." SIAM Journal on Applied Dynamical Systems 22, no. 3 (2023): 2180-2205.
- Walter Bomela, **Bharat Singhal**, and Jr-Shin Li. "Engineering Spatiotemporal Patterns: Information Encoding, Processing, and Controllability in Oscillator Ensembles." Biomedical Physics & Engineering Express, vol. 9, no. 4, p. 045033, 2023.
- Walter Bomela, Michael Sebek, Raphael Nagao, **Bharat Singhal**, István Z. Kiss, and Jr-Shin Li. "Finding influential nodes in networks using pinning control: Centrality measures confirmed with electrochemical oscillators." Chaos: An Interdisciplinary Journal of Nonlinear Science 33, no. 9 (2023).
- Minh Vu*, **Bharat Singhal***, Shen Zeng, and Jr-Shin Li. "Data-Driven Control of Oscillator Networks with Population-Level Measurement." Chaos: An Interdisciplinary Journal of Nonlinear Science, In Press (*: equal contribution).
- **Bharat Singhal**, Minh Vu, Shen Zeng, and Jr-Shin Li. "An Iterative Approach to Optimal Control Design for Oscillator Networks." In 2023 American Control Conference (ACC), pp. 3466-3471. IEEE, 2023.
- **Bharat Singhal**, Minh Vu, Shen Zeng, and Jr-Shin Li. "A Data-efficient Framework for Inference of Nonlinear Oscillator Networks." IFAC-PapersOnLine 56, no. 2 (2023): 10089-10094.
- Minh Vu, **Bharat Singhal**, Jr-Shin Li, and Shen Zeng. "Data-driven moment-based control of linear ensemble systems." (Accepted for ACC 2024).

Conference Talks & Poster Presentations

SIAM Conference on Applications of Dynamical Systems, 2023

Organized by Society for Industrial and Applied Mathematics, Portland, United States

- Talk: Optimal Phase-Selective Entrainment of Heterogeneous Oscillator Populations.

American Control Conference, 2023

Organized by American Automatic Control Council, San Diego, United States

- Talk: An Iterative Approach to Optimal Control Design for Oscillator Networks.

22nd World Congress of the International Federation of Automatic Control, 2023

Organized by International Federation of Automatic Control, Yokohama, Japan

- Talk: A Data-efficient Framework for Inference of Nonlinear Oscillator Networks.

Making Connections in Computational Neuroscience (MCCN)

Center for Theoretical and Computational Neuroscience, WashU

- Poster: A novel 2-step network inference method for inferring functional connectivity in the suprachiasmatic nucleus (co-presented).

Teaching Experience

Optimization | *Department of Electrical & Systems Engineering, WashU* **Fall 2021 & 2022**

- Taught optimization algorithms, such as Gradient Descent, Newton's method, and Conjugate Gradient method, to a class of 70 undergraduate students.

Control & Instrumentation Laboratory | *Department of Electrical Engineering, IIT Kharagpur* **Fall 2016**

- Guided 35 undergraduate students through laboratory experiments and helped them to understand the theoretical ideas behind the experiment.

Embedded Systems Laboratory | *Department of Electrical Engineering, IIT Kharagpur* **Spring 2016**

- Taught assembly language programming for AVR ATmega32 microcontroller to 40 students.

Technical Skills

Skills: Statistical Inference, Machine Learning, Deep Learning, Data-Driven Control
Languages: Python, R, MATLAB, C, C++
Technologies/Frameworks: Tensorflow, PyTorch, Matplotlib, Keras, pandas, scikit-learn, NumPy

Awards & Achievements

- Ranked 1130 in the Joint Entrance Examination (JEE) 2012, top 0.2% out of 500,000 participants.
- Awarded excellent grade for outstanding performance in the Advanced Very Large Scale Integration (VLSI) Design summer course at IIT Kharagpur.
- Ranked 2nd among Dual Degree students in the Department of Electrical Engineering, IIT Kharagpur.

Extra-Curricular Activities

- Member of hostel's weightlifting team during my undergraduate degree.
- Member of hostel's Field Hockey team in 1st and 2nd year.
- Part of gold winning illumination team in 2nd year and silver winning team in 1st year.