

Bharat Singhal

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Research Interests

- My research interests lie primarily in the area of control theory, optimization, network science, and nonlinear dynamics. Specifically, I apply tools from control theory and optimization to understand complex networks of nonlinear units and effectively regulate their collective behavior.

Education

Ph.D. in Systems Science and Mathematics

Exp. May'25

WASHINGTON UNIVERSITY IN ST. LOUIS, MISSOURI

- GPA 3.98/4.0, Advisor: Jr-Shin Li

M.Tech. in Control System Engineering

July'16-June'17

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR, INDIA (IIT-KHARAGPUR)

- GPA 8.85/10, Advisor: Siddhartha Mukhopadhyay

B.Tech. (Honours) in Electrical Engineering

July'12-June'16

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR, INDIA (IIT-KHARAGPUR)

- GPA 8.85/10

Publications

Accepted:

- **Bharat Singhal**, Minh Vu, Shen Zeng, and Jr-Shin Li, "An Iterative Approach to Optimal Control Design for Oscillator Networks" (Accepted for 2023 American Control Conference).

In-Submission:

- **Bharat Singhal**, István Z. Kiss, and Jr-Shin Li, "Optimal phase-selective entrainment of heterogeneous oscillator ensembles" (Currently under revision at SIAM Journal on Applied Dynamical Systems).
- Walter Bomela, **Bharat Singhal**, and Jr-Shin Li, "Engineering Spatiotemporal Patterns: Information Encoding, Processing, and Controllability in Oscillator Ensembles" (Currently under revision at Biomedical Physics & Engineering Express).
- **Bharat Singhal**, Minh Vu, Shen Zeng, and Jr-Shin Li, "A Data-efficient Framework for Inference of Nonlinear Oscillator Networks" (Submitted for IFAC World Congress 2023).

Research Experience

Graduate Research Assistant

Sep. 2020 - Present

APPLIED MATHEMATICS LAB, WASHINGTON UNIVERSITY IN ST. LOUIS

- 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.
- Developing data-driven protocols to decode the connectivity structure of complex networks and predict the collective dynamics.
- Designing fast entrainment protocols for the heterogeneous nonlinear oscillators.

Professional Experience

Taiwan Semiconductor Manufacturing Company (TSMC)

Oct. 2017-Sep. 2020

ENGINEER (RC INTERCONNECT MODELING FOR SUB 10NM CMOS TECHNOLOGY NODES)

Hsinchu, Taiwan

- 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.
- Provided 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.
- Modeling of 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

May 2015-July 2015

INTERN, BUSINESS ANALYST

Bangalore, India

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

Research Projects

Modeling and Control of an Anti-lock Braking System in Hybrid Electric Vehicles

July 2016 - May 2017

MASTER'S THESIS, DEPARTMENT OF ELECTRICAL ENGINEERING, IIT KHARAGPUR

- 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.
- Designed a controller to maximize the amount of regenerative energy, in case of braking, while maintaining stopping distance for hybrid vehicles.

Speed Control of E-bikes Based on User-Customized Assistance Level

July 2015 - April 2016

BACHELOR'S PROJECT, DEPARTMENT OF ELECTRICAL ENGINEERING, IIT KHARAGPUR

- 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 motor as per assistance level
- Simulated dynamics of a bicycle from the force on pedals, through the transmission system, to wheels in Simulink.

Online Monitoring System for Overhead Equipment Traction Parameter Measurement

May 2014 - June 2014

SUMMER RESEARCH PROJECT, DEPARTMENT OF ELECTRICAL ENGINEERING, IIT KHARAGPUR

- Implemented 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.

Teaching Experience

Control and Instrumentation Laboratory

Fall 2016

DEPARTMENT OF ELECTRICAL ENGINEERING, IIT KHARAGPUR

- Guided 35, 3rd-year undergraduate, students through laboratory experiments and helped them to understand the theory behind the experiment.

Embedded Systems Laboratory

Spring 2016

DEPARTMENT OF ELECTRICAL ENGINEERING, IIT KHARAGPUR

- Taught assembly language programming for AVR ATmega32 microcontroller and helped 40 students to implement keyboard, LCD, and ADC interface.

Optimization

Fall 2021 & 2022

DEPARTMENT OF ELECTRICAL & SYSTEMS ENGINEERING, WASHINGTON UNIVERSITY

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

Technical Skills

Languages, C, C++, R, Python, Matlab

Libraries, NumPy, pandas, Matplotlib, Tensorflow, Keras, scikit-learn,

EDA Tools, StarRC, Calibre, Hspice, Cadence Virtuoso