Zhong Fang

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PROFILE

Electrical and Computer Engineering master student with research on optimization and control of cyber-physical systems. Research experience mainly focused on optimal controller synthesis with developing theory and algorithms.

EDUCATION

University of Waterloo, Waterloo, Canada   September 2023 - August 2025 (expected)
M.A.Sc., Electrical and Computer Engineering
Advised by Michael W. Fisher
Relevant Coursework: Fundamentals of Optimization, Multivariable Control Systems, Filtering and Control of Stochastic Linear Systems, Optimization Methods, Distributed Optimization

Wuhan University, Wuhan, China   September 2019 - June 2023
B.Sc., Applied Mathematics
Advised by Shuang Miao

PUBLICATION

[1] **Z. Fang** and M. W. Fisher, "Hybrid State Space and Frequency Domain System Level Synthesis for Sparsity-Promoting $\mathcal{H}_2/\mathcal{H}_\infty$ Control Design," in *IEEE Conference on Decision and Control (CDC)*, 2024, to appear. [Paper]

PRESENTATION

IEEE Conference on Decision and Control in Milan, Italy   19th December 2024

RESEARCH EXPERIENCE

Simple Pole Approximation in Continuous Time   April 2024 - Present
Dynamics, Optimization, and Control of Complex Systems (DOCS) Group, University of Waterloo
- Writing manuscript to share the novel ideas with control community
- Contributed to the approximation method gap of the system level synthesis community in continuous time, derived finite approximation policy for the bounds of $\mathcal{H}_2/\mathcal{H}_\infty$ norms with provably convergent guarantees
- Applied proved theorem to a power system with RL Filter under the numerical simulation

$\mathcal{H}_2/\mathcal{H}_\infty$ Controller Synthesis   September 2023 - March 2024
Dynamics, Optimization, and Control of Complex Systems (DOCS) Group, University of Waterloo
- Designed a novel conic optimization framework combined frequency system level synthesis constraints with a state space formulation of the $\mathcal{H}_2/\mathcal{H}_\infty$ norms using linear matrix inequalities so as to eliminate the finite time horizon approximation in prior work
- Proposed an optimal sparse selection method of simple poles to preserve the robustness while promoting performance and enforced group lasso to maintain convexity
- Implemented the proposed control synthesis method on the control of a wind turbine interfaced to the power grid via a power converter using YALMIP with MOSEK to evaluate and illustrate the superior performance than the finite time horizon approximation method

Algebraic Connectivity Analysis of Directed Double-Ring Network   Spring 2023
Bachelor Thesis, Wuhan University
- Contributed to the synchronization of directed rings network by exploring the algebraic connectivity of double-ring case which can be applied for master stability function method
- Developed from the simple case of the Laplacian matrix of single-ring and extended it to double-ring by exploiting flow graph to derive the eigenvalue polynomial of sparse asymmetric block matrix with respect to the number of nodes
- Adapted Inverse Power Method with shift to simulate the algebraic connectivity in MATLAB and analyzed the relationship of algebraic connectivity and the combination of rings

GRAD COURSE PROJECTS

ECE 682 | Filtering and Control of Stochastic Linear Systems   Winter 2024
Advisor: Dr. Stephen L. Smith
- Reproduced a CDC paper focusing on discrete-time $\mathcal{H}_\infty$ Gaussian filter design in the context of data packet dropout, reexplained the proof of the theorem by utilizing cyclic permutation invariance and ARE replacement techniques learned from the course

○ Reimplemented iterative modified AREs algorithm, benchmarked against the paper and presented the project [Slides]

SYDE 632 | Optimization Methods   Winter 2024
Advisor: Dr. Nasser Lashgarian Azad
○ Extracted an optimization problem from simultaneous research and presented the project

Selected UnderGrad Contest	China Undergraduate Mathematical Contest in Modeling (CUMCM) [Poster] 2021 ○ Led a team with other two undergraduates to explore reaction conditions for the preparation of C4 olefins by ethanol coupling aimed at solving existing chemical industrial issues ○ Established nonlinear ODEs model for chemical reaction process, analyzed the intermediates oscillation stability and inferred coupled reactants and products by retrieving from chemical references on ethanol coupling ○ Enabled data-driven techniques such as `Curve Fitting` toolbox in MATLAB by cleaning and preprocessing experimental data while resorting to the fundamental - chemical reaction isotherm and Gaussian process regression to back the functionals of yield and temperature ○ Conducted BPNN algorithm with separating data as training and testing sets to obtain the correlation of reaction conditions and objectives so as to optimize the yield ○ Culminated in a scheme paper and won the National First Prize (0.65%, 292/45075) by demonstrating strong self-learning skills facing a new scenario and creating a cooperative workflow
Teaching Experience - UnderGrad Courses	MTE 484	Control Applications (130 hours/term) Fall 2024 Topics covered include:Continuous/Discrete system stability and dynamic performance, Input-Output Parameterization combined with Simple Pole Approximation control design ○ Assisted students with laboratory projects in controller design of a ball and beam system, proctored, and marked lab reports NE 488B	Nano-instrumentation Lab (54 hours/term) Winter 2024 ○ Supervised wet labs in microfabrication processes, passed security and emergency training, graded assignments
Teaching Experience - Graduate Course	ECE 608	Quantitative Methods in Biomedical Engineering (91 hours/term) Spring 2024 Topics covered include: probability theory and statistics, statistical analysis of biomedical data ○ Held regular office hours to address students' questions, wrote solutions of assignments in R projects, invigilated, and corrected exams

Community Involvement	American Control Conference, *Student Volunteer* WHU Math Undergrad-Mentor Program, *Mentor* WHU Mathematical Modeling Association, *Director*	2024 2021 - 2022 2019 - 2022

Honors and Awards

International Master's Award of Excellence, Graduate Research Studentship   2023 - 2025
- 2 years of full tuition support, University of Waterloo

WHU Merit Student (top 5%)	2021	WHU Outstanding Student (top 15%)	2020
School of Mathematics Scholarship (9/all math undergraduates) - ¥5000	2021	CUMCM Award - ¥5000	2021
		ICM Award - ¥2000	2022
WHU First Prize - ¥3000	2021	HZMCM Award - ¥2000	2022
WHU Second Prize - ¥2000	2020	EEMCM Award - ¥3000	2022

Educational Equality Commitment

Summer Aid Education in Ganquan	S'21	Tutor for Kids of Cafeteria Staff	F'19, F'20, S'21
Winter Aid Education in Yichang	W'21	Orphanage Volunteer	F'20
Remote Aid Education	F'21	Book Sharing for Left-Behind Children	W', S'20

References

Dr. Michael W. Fisher, michael.fisher@uwaterloo.ca
Assistant Professor of Electrical and Computer Engineering, University of Waterloo

Dr. Shuang Miao, shuang.m@whu.edu.cn
Professor of Mathematics and Statistics, Wuhan University

Dr. Stephen L. Smith, stephen.smith@uwaterloo.ca
Professor of Electrical and Computer Engineering, University of Waterloo