Aiping Zhong

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Educational Background:

South China University of Technology (SCUT) Sep. 2021- Jun. 2025

- Project 985 and 211 University in China, National Ranking top 20, Ranking by Subject Engineering (top-level)
- Bachelor of Engineering in Dual Degrees of Automation and Mathematics & Applied Mathematics

Research Interests:

Model Predictive Control, Dynamical Systems, Machine Learning, Reinforcement Learning

Introduction:

I am very interested in the fields of **robotics**, **control theory**, and **machine learning**, particularly in the **intersection** of learning and control. I have spent most of my spare time on research at university and hope to devote my career to academic research. I am honored to have been advised and collaborated with Prof. Langwen Zhang (SCUT, Guangzhou), Prof. Philip E. Paré (Purdue University, West Lafayette) and Dr. Baike She (Georgia Institute of Technology, Atlanta) during my undergraduate studies. I am looking for an opportunity to pursue a **Ph.D.** The following is my research experience. and other information.

Research Experience

Coworker: Prof. Philip E. Paré (Purdue University) and Dr. Baike She (Georgia Institute of Technology)

[1] A Physics-Informed Neural Networks-Based Model Predictive Control Framework for *SIR* Epidemics | Oct. 2024 – Now

Status:

- Submitted to the Conference on ***Neural Information Processing Systems (NeurIPS 2025)*** as **first author** (NeurIPS is widely regarded as one of the top three conferences in machine learning, alongside ICML and ICLR.)

Introduction:

- This work proposes a novel **model predictive control (MPC)** framework based on **physics-informed neural networks (PINNs)** for real-time epidemic control using **only noisy infection data**. Unlike prior studies that assume either known parameters or known states, we **jointly estimate both states and parameters** under limited prior knowledge (e.g., only recovery rate or only basic reproduction number known). We design three PINNs variants, i.e., basic PINNs, log-scaled PINNs (LS-PINNs), and split-integral PINNs (SI-PINNs), and integrate them into the MPC framework. Extensive simulations on *SIR* models show that our methods significantly improve estimation robustness and control accuracy.

My Contribution:

- - Conducted extensive literature review and identified a key modeling gap in existing MPC-based epidemic control studies.
  - Proposed the use of PINNs to overcome state-parameter joint estimation challenges.
  - Formulated more realistic and challenging modeling conditions than prior related work, and developed two novel PINNs algorithms tailored to epidemic dynamics.
  - Self-learned Python and independently implemented the entire codebase; conducted nearly 300 simulation experiments.
  - Drafted the full manuscript under co-authors' guidance and revised it nearly 40 times throughout the submission process.

Coworker: Prof. Langwen Zhang (SCUT, Guangzhou)

[3] Resilient distributed MPC of state-delayed LPV systems with quantitative communication against denial of service attacks | Feb 2023 – Apr 2024

Status:

- **Accepted by *Asian Journal of Control*** as **first author** (IF: 2.7, affiliated with the Asian Control Association (ACA) and Chinese Automatic Control Society (CACS), the first international journal from the Asia Pacific region)

Introduction:

- This project proposes a resilient **distributed model predictive control (DMPC)** framework for **linear parameter-varying (LPV) systems** subject to **state delays and communication attacks**. To address uncertainties and **denial-of-service (DoS)** disruptions in inter-agent coordination, a min–max DMPC algorithm with quantized feedback exchange is developed. **An iterative interaction scheme** is proposed to exchange feedback control laws among subsystems. The stability of the closed-loop system under the proposed algorithm is ensured by using a **Lyapunov function method**. The effectiveness of the proposed DMPC is demonstrated through two simulation examples.

My Contribution:

- - Conceived the main idea of the paper, addressing the issue of communication link DoS attacks in DMPC.
  - Introduced a quantization scheme for communication in DMPC.
  - Independently completed the LMI mathematical derivations and designed the corresponding iterative algorithm.
  - Conducted and coded two simulation experiments independently.
  - Drafted the initial manuscript, and revised the manuscript based on reviewer feedback with team member and my advisor.

[4] Adaptive Event-Triggered MPC for Linear Parameter-Varying Systems with State Delays, Actuator Saturation and Disturbances | Apr 2024 – Now

Status:

- Under review at ***Journal of Process Control*** as **first author** (a leading Q1 journal in control systems, published by **IFAC**).

Introduction:

- This work proposes a unified adaptive event-triggered model predictive control (ETMPC) framework for linear parameter-varying (LPV) systems with state delays, actuator saturation, and external disturbances. Existing ETMPC methods rarely address ether delays or saturation, and all of them lack co-design between the event-triggering mechanism and the control law. To overcome these limitations, this work develops a Lyapunov-based strategy that enables joint optimization of both components. Invariant set constraints are introduced to ensure recursive feasibility, and mean-square input to-state stability (ISS) under multiple uncertainties is rigorously established. Simulations validate the proposed method's effectiveness.

My Contribution:

- - Embedded an adaptive internal variable into the Lyapunov-Krasovskii-like function, enabling joint optimization of the event-triggering parameter matrix and control law.
  - Derived a redundancy-injected conditions for constructing invariant sets to handle external disturbances.
  - Proved recursive feasibility via invariant set properties and established mean-square ISS of the closed-loop system.
  - Reformulated the robust control problem using convex LMI constraints.
  - Conducted all simulations and co-authored the manuscript.

[5] Learning-based Predictive Control Method for Autonomous Vehicles Using Long Short-Term Memory Networks | Sep 2022 – Feb 2023

Status:

- **Chinese patent granted** as **first author** (authorized by China National Intellectual Property Administration, 2024)

Introduction:

- This work presents a predictive control method for autonomous vehicles using long short-term memory (LSTM) networks. It combines the linearized force formulas of the Pacejka tire model to create a nonlinear vehicle dynamics model based on Ackermann steering. Historical data trains the LSTM-based model, optimizing it for control. Model predictive control (MPC) is then used to solve an optimization problem with a gradient descent method and adaptive learning parameters. This approach leverages LSTM for dynamic driving adaptation and uses MPC for optimal control, enhancing autonomous vehicle decision-making and performance.
- My Contribution:
  - Conceived the main idea of the invention, successfully derived a nonlinear vehicle dynamics model that utilizes LSTM for prediction and MPC for control.
  - Authored the initial draft and further refined it with the guidance of my advisor and patent office experts.

[6] Off-Policy Output Feedback Data-Driven Q-Learning Control Method Based on VI Strategy | Feb 2024 – Jun 2024

Status:

- **Chinese patent under substantive examination** as **first author** (submitted to China National Intellectual Property Administration, 2024)

Introduction:

- This invention discloses a control method, system, device, and storage medium for off-policy output feedback data-driven Q-learning based on the Value Iteration (VI) strategy. The method includes: constructing a state-space representation of an inverter model based on the discrete-time system model of a **single-phase voltage source UPS inverter**; formulating an **off-policy Q-function for the VI based on state feedback** using the algebraic Riccati equation; deriving **the output feedback-based** off-policy Q-function through a state reconstruction lemma, allowing the solution to be independent of system state variable measurements; solving the Q-function using **least squares methods**.

My Contribution:

- - Proposed the main idea and successfully combined VI with off-policy strategies, extending the approach to output feedback.
  - Authored the initial draft of the patent application and refined it with guidance from advisors and patent office experts.

Major Courses:

- **Mathematics and Applied Mathematics:**
  Mathematical Analysis, Mathematical Analysis Exercises Course, **Advanced Algebra**, Analytic Geometry, **The Method of Mathematical Modeling**, **Integral Transformation**, Probability Theory, Ordinary Differential Equation, Mathematical Statistic, Complex Function, **Operational Research**, **Matrix Computations.**
- **Automation:**
  Engineering Drawing, **Foundations of Computer**, Electric Circuits Ⅱ, **General Physics Ⅲ**, **C++ Language and Programming**, Analog Electronics, Signal Analysis and Processing, **Digital Electronics Ⅱ**, **Artificial Intelligence**, Fundamentals of Control Theory, **Data Structure and Algorithms I**, Exercitation of Electronic Technology Ⅰ, **Motor Drive Foundation**, Microcomputer System and Application, Computer Network and Communication, Technical Fundamentals of Robotics, **Power Electronics Technology**, "Sensors, Detection and Measurement Technology", Electrical control and PLC, Technique of Computer Control, Image Processing and Machine Vision, **Real-Time Networked Control Systems**, **Introduction and Practice of Reinforcement Learning Techniques**, **Motion Control System**
- **Laboratory Course:**
  Circuit Experiment, Experiment of Digital Electronics, Experiment of Analog Circuits, Experiment of Motor and Drive Foundation, **Basic Experiment of Control Theory**, **College Physical Experiment (Ⅰ)**, **College Physical Experiment (Ⅱ)**, **"Experiment of Sensors, Detection and Measurement Technology"**, **Experiment of Motion Control System.**
- **Ps:** Those courses in bold are over 90 or 5% or A of the class , most of courses over 85 or 20%.

GPA: 3.75/4, Rank: 3

Technical Skills:

I am proficient in **MATLAB, Python** and **C++**, with strong learning capabilities and patience. I have a basic level of confidence and I am further enhancing my understanding of **ROS2** through small projects and online courses. I can replicate research work and implement innovative ideas. I excel in team building and leadership, effectively guiding projects. Skilled in **LaTeX, MathType**, and various research software, I can independently write and format research papers.

Research Fund Project and Awards

Awards:

Meritorious Winner in the 2022 ICM of the American Mathematical Modeling Contest (779/12100, top 6.44% of participants)

Provincial Second Prize in the 13th Guangdong Province College Student Mathematics Competition (top 12% of participants)

2022 Sunwoda New Energy Social Donation Scholarship (5,000 CNY, ranked 3st of 30 student)

2024 Haopeng Technology Diligence Scholarship, Shenzhen (10,000 CNY, ranked 1st of 30 students)

University-Level Outstanding Undergraduate Thesis Award (Ranked 1st out of 335 students)

Research Fund Project:

The principal responsible persons for 2023 Student Research Project work (research funding: 3,000 CNY)

The principal responsible persons for 2024 Student Research Project work (research funding: 3,000 CNY)