Yushan Li

Ph.D. Candidate

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Biography: I'm a Ph.D. candidate at Dept. of Automation, Shanghai Jiao Tong University, supervised by Prof. Xinping Guan and Prof. Jianping He. I'm also a member of Center for Intelligent Wireless Networks and Cooperative Control (*IWIN-Center*). My current research focuses on the inference and the security of networked control systems.

Education and Experience

2018–date **Ph.D. Candidate, Control Science and Engineering**
Department of Automation, Shanghai Jiao Tong University (SJTU)
Advisor: Xinping Guan Co-advisor: Jianping He

2019 Oct. – Nov. **Visiting Student**
School of Electrical and Computer Engineering, The University of Newcastle, Australia

2014–2018 **Bachelor's Degree, Automation**
School of Automation & Qiming College, Huazhong University of Science and Technology
Experimental Class for Automation, Ranking 1/26

Publications and Preprints

Publications ***Journal Articles***

[1] **Yushan Li**, Jianping He, Lin Cai, and Xinping Guan, "Local Topology Inference of Mobile Robotic Networks Under Formation Control", IEEE Transactions on Automatic Control, 2023 (Full Paper). [Publisher] [arXiv]

[2] **Yushan Li**, Jianping He, Cailian Chen and Xinping Guan, "Intelligent Physical Attack against Mobile Robots with Obstacle-avoidance", IEEE Transactions on Robotics, 2023 (Full Paper). [Publisher] [arXiv]

Publications ***Conference Articles***

[1] **Yushan Li**, Tao Xu, Jianping He, Cailian Chen and Xinping Guan, "Inferring State-feedback Cooperative Control of Networked Dynamical Systems", IFAC World Congress, 2023, in press.

[2] **Yushan Li**, Jianping He, Cailian Chen and Xinping Guan, "Inferring Topology of Networked Dynamical Systems by Active Excitations", IEEE Conference on Decision and Control (CDC), 2022. [Publisher]

[3] **Yushan Li** and Jianping He, "Topology Inference for Networked Dynamical Systems: A Causality and Correlation Perspective", IEEE Conference on Decision and Control (CDC), 2021. [Publisher]

[4] **Yushan Li**, Qing Jiao, Han Wang and Jianping He, "Consensus and Approximation-based Distribution Statistics in Network Systems", American Control Conference (ACC), 2021. [Publisher]

[5] **Yushan Li**, Jianping He and Lin Cai, "Topology Inference on Partially Observable Mobile Robotic Networks under Formation Control", European Control Conference (ECC), 2021. [Publisher]

[6] **Yushan Li**, Jianping He, Cailian Chen and Xinping Guan, "Learning-based Intelligent Attack against Formation Control with Obstacle-avoidance", American Control Conference (ACC), 2019. [Publisher]

[7] **Yushan Li**, Han Wang, Jianping He and Xinping Guan, "Optimal Topology Recovery Scheme for Multi-robot Formation Control", IEEE International Symposium on Industrial Electronics (ISIE), 2019. [Publisher]

Preprints ***Under Review***

[1] **Yushan Li**, Jianping He, Cailian Chen and Xinping Guan, "Topology Inference for Network Systems: Causality Perspective and Non-asymptotic Performance", submitted to IEEE Transactions on Automatic Control, conditionally accept. [arXiv]

[2] **Yushan Li**, Jianping He, Cailian Chen, Xinping Guan, and Lin Cai, "Securing Mobile Robotic Networks Against Replacement Attack", under review.

[3] Jianping He, **Yushan Li**, Lin Cai, and Xinping Guan, "I Can Read Your Mind: Control Mechanism Secrecy of Networked Dynamical Systems under Inference Attacks", under review. [arXiv]

Honors and Awards

- 2023 The 2022 Shanghai Association of Automation Best Paper Award
- 2022 The National Scholarship for Graduate Student
- 2021 Annual Triple-A Student of SJTU
- 2020 The Best Presentation Award (*Multi-robot System Platform*), Academic Annual Meeting of Shanghai Association of Automation. [Link]
- 2019 The National Scholarship for Graduate Student
- 2018 Outstanding Graduate & Qiming Honors Bachelor of HUST
- 2017 The National Engagement Scholarship for Undergraduate

Invited Talks

- 2022 Dec. "Topology Inference and Cooperation Security of Mobile Robotic Networks", 2022 ZJU Swarm Intelligence Unmanned Systems National Academic Forum For Ph.D Candidates, Zhejiang University, Hangzhou, China (online), Outstanding Speech Award. [Details]
- 2021 May "Intelligent Physical Attacks against Mobile Robotic Networks", Network Intelligence Forum, Jiangnan University, Wuxi, China. [PDF]

Professional Services

Conference Organization

- 2022 Student Co-Chair, The 2nd Distributed Control, Optimization, and Security Zhizhen Academic Forum For Postgraduates(Online), Beijing Institute of Technology, Beijing, China.

2021 Co-Founder and Student Co-Chair, The 1st Distributed Control, Optimization, and Security Zhizhen Academic Forum For Postgraduates(Online), Shanghai Jiao Tong University, Shanghai, China. [Detailed Forum Information (in Chinese)]

2020 Technical Program Committee (TPC) Member, IEEE 92nd Vehicular Technology Conference (VTC2020-Fall), Virtual Conference. [Link]

Peer Reviewer

From 2019 *Journals*: IEEE Transactions on Automatic Control; Automatica; IEEE Transactions on Control of Network Systems; IEEE Transactions on Industrial Informatics; IEEE Transactions on Vehicular Technology; IEEE Open Journal of Vehicular Technology; KSII Transactions on Internet and Information Systems; ACTA Automatica Sinica

Conferences: IEEE Conference on Decision and Control; American Control Conference; IFAC Word Congress; IEEE Vehicular Technology Conference; IFAC Conference on Cyber-Physical and Human-Systems; The Chinese Automation Congress

Research Experience

2018 Sep. – 2021 Nov. **Intelligent Physical Attack Against Mobile Robots**
Supervised by Prof. Jianping He, Prof. Cailian Chen, and Prof. Xinping Guan

Background: The mobile robots can be seen as a typical cyber-physical system, whose security issues become critical yet imperatively challenging. Prior works mainly focus on cyberspace perspectives, while physical attacks are less noticed yet critically important.

Contributions: We focus on how to learn the obstacle-avoidance mechanism of a mobile robot from external observation without any prior knowledge, and then leverage it to fool the target robot into a preset trap. Specifically,

- We investigate the possibility of achieving an intelligent and advanced physical attack against mobile robots, merely utilizing external observations and not relying on any prior information of the system dynamics.
- By characterizing the obstacle-avoidance behaviors and disguising the attacker as an obstacle, various avoidance reactions of the victim robot were excited. Based on observations over this process, the underlying mechanism was regressed.
- Two driving-to-trap attack algorithms were designed by taking the attack path length and activity period as the objectives, respectively. The performance bounds of the algorithms are further derived concerning the optimal cost in theory.

2020 Sep. – 2022 Apr. **Topology Inference for Networked Dynamical Systems**
Supervised by Prof. Jianping He, Prof. Cailian Chen, and Prof. Xinping Guan

Background: Network dynamical systems (NDSs) are characterized by the locality of information exchange between individual nodes. Topology inference helps to better understand the systems and implement coordinated tasks, and thus plays a crucial role.

Contributions: We focus on the directed topology inference of NSs in state-space representation, where the observations are corrupted by noises. Specifically, we

- Reveal the principles of inferring the topology by utilizing causality and correlation, where the system is driven by unknown driving input, and the topology is directed.
- Analyze non-asymptotic performance of the proposed method, point out the equivalent conditions with benchmark methods, and prove the convergence and accuracy.
- Prove that the proposed estimator is essentially a deregularization version of the OLS estimator, and provide the online/recursive form of the proposed estimator.

2021 May. – 2021 Sep. **Local Topology Inference of Mobile Robotic Networks Under Formation Control**
Supervised by Prof. Jianping He, Prof. Lin Cai, and Prof. Xinping Guan

Background: The interaction topology is critical for efficient formation control of mobile robotic networks (MRNs). External attackers can utilize the topology inference method to find the critical robot that has significant control impacts in the formation.

Contributions: We focus on the local topology inference problem of MRNs under first-order linear formation control, where an inference robot can manoeuvre among the formation robots and observe their motions. Specifically, we

- Determine a constant subset from the time-varying set of robots within the observation range, and identify the unknown formation input parameters.
- Develop an active excitation based method to obtain a reliable estimate of the interaction range, and perfectly avoid the influence of unobservable robots.
- Establish an OLS based topology estimator by filtering the formation input's influence on observations before the steady stage, along with convergence and accuracy analysis.

Joint Works

2020 Sep. – 2021 Oct. **Distributed Topology-preserving Collaboration Algorithm against Inference Attack**
With Zitong Wang, PhD Student in Class of 2020, Dept. of Automation, SJTU

Develop a distributed topology-preserving collaboration algorithm for multi-agent systems against the topology inference attacks. The novelties lie in:

- By adding well-designed noises to the system states, the irregularity of the state evolution is largely enhanced, weakening the inference performance.
- By dividing the noises into the random and disturbing terms with mutual compensation properties, the proposed algorithm guarantees the convergence of the system state.

2019 Sep. – 2020 Apr. **Topology Inference for Consensus-based Cooperation under Unmeasurable Input**
With Qing Jiao, PhD Student in Class of 2019, Dept. of Automation, SJTU

Infer the directed network topology from the observations that consist of a single, noisy and finite time-series system trajectory. The novelties lie in:

- Propose two-layer optimization-based topology inference algorithms, which eliminates the unknown influence of timeinvariant input on system dynamics.
- Design iterative estimation-based topology inference algorithm, which exploits the identifiability and estimability of more general time-varying input.

Other Activities

Teaching Assistant

- 2020–2023 Intelligent Optimization of Network Systems, Automation, AU339

Member of Academic Institutes

- From 2020 Member of Youth Workers Committee of Shanghai Association of Automation
- From 2019 IEEE Student Member

Voluntary Activities

- From 2018 volunteers of Shanghai International Marathon, conference volunteer of IEEE ISAS, conference volunteer of NFC3, voluntary unpaid blood donor, etc.