JIAMIN WANG

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RESEARCH INTERESTS

Multi-agent Networks: Coordination control; Robust Control; Networked dynamics; Protocol selection; Topological features; Collective performance; Game theory

Complex Networks: Heterogeneity; Fractal networks; Physical networks; Higher-order networks

EDUCATION

Ph.D. Candidate in Control Science and Engineering Sep. 2019 – Present
School of Mechano-electronic Engineering, Xidian University Xi'an, China
Advisor: Prof. Yuanshi Zheng

B.S. in Automation Sep. 2015 – Jun. 2019
School of Electronics and Control Engineering, Chang'an University Xi'an, China

RESEARCH EXPERIENCE

During my Ph.D. research, I have been trying to provide theoretical explanation of collective behaviors and disentangle the inherent relationships between the **a**) networked dynamics, **b)** the communication protocols, **c)** the topological features and **d)** the performance of multi-agent networks by using control theory, matrix theory, graph theory, and frequency-domain analysis, etc.

1. The Effect of Sampling Control on Robustness of Consensus Networks

Interactions among agents are usually in the form of sampling data, but how sampling control affects collective performance **is rarely explicitly included in a rigorous analysis** as far as we know. Thus, We investigated the robustness of the continuous-time multi-agent consensus network and that of the corresponding sampled-data network in the presence of external disturbances.

- For the continuous-time consensus network, we showed that robustness is determined by the eigenvalues of directed graph Laplacian.
- For the sampled-data consensus network, robustness also depends on the sampling period besides the Laplacian spectrum.
- It was proved that there exists a unique **optimal sampling period**. Moreover, the robustness of the sampled-data multi-agent network is **not better than** that of the original continuous-time multi-agent network.
- Numerical tests illustrated a trade-off between robustness and sampling cost.

2. Protocol Selection for Robust Consensus Networks

Absolute velocity protocol and relative velocity protocol are two classic second-order consensus protocols, but how protocol structures affect robustness **is still in the balance**. Therefore, We investigated which of the above protocols has better robustness.

- The analytic expressions of the robustness in terms of two protocols were derived.
- It was shown that both the robustness are determined only by the minimum non-zero eigenvalues of Laplacian matrices and the tunable gains of position-like and velocity-like states.
- A **concise graph condition** that is only related to *Fiedler engenvalue* is established to tell which protocol has better robustness.

- Our numerical tests exhibited an interesting correlation between **network density** and our graph condition.

3. Scalable Consensus of Hierarchical Groups
Inspired by widespread dominance hierarchy, growth of group sizes, and feedback mechanisms in social species, we explored the scalable second-order consensus of hierarchical groups, which **provides novel insights** for hierarchical groups.

- Feedbacks (e.g., food resources, suitable habitats, and dangerous predators) occur from lower-ranked individuals to higher-ranked ones, which are considered as extra reverse edges in directed acyclic graphs (DAGs).
- It was proved that the absolute velocity protocol can obtain **completely scalable** second-order consensus while the relative velocity protocols cannot.
- The result seems to explain why the local interaction rules for coordination behaviors are changed when a small hierarchical group grows to a large-scale one.
- We designed a hierarchical structure, on which the completely scalable second-order consensus can be always guaranteed.

4. Robustness and Scalability of Consensus Networks: the Role of Memory Information
Most consensus algorithms are constructed by using real-time information of agents, and once agents update the local information, their previous states are forgotten. Thus, we proposed a memory-based consensus protocol. Then, we revealed the effect of memory information on robustness and scalability that **has not been reported before**.

- We surprisingly found that the memory-based protocol could produce **manifold consensus behaviors**. Furthermore, we built the quantitative relation between robustness, control parameters, and the non-zero minimum and maximum Laplacian eigenvalues.
- The optimal control parameters were derived with respect to robustness and scalability, and it is exciting that the optimal memory coefficient is **invariant** (i.e., 2/3) regardless of topological structures.
- It was proved that the memory information is able to **simultaneously improve** robustness and scalability.
- We observed an interesting phenomenon that robustness and scalability are **positively correlated**.

PUBLICATIONS

[1] **Jiamin Wang**, Jian Liu, Feng Xiao, and Yuanshi Zheng* (2025). Robustness and scalability of consensus networks: the role of memory information. *IEEE Transactions on Automatic Control* (**Full Paper**, Early Access).

[2] **Jiamin Wang**, Jian Liu, Yuanshi Zheng*, and Jianxiang Xi (2024). Analysis of H_∞ performance for multi-agent networks. *IEEE Transactions on Automatic Control* (**Full Paper**), 69(8): 5125–5140.

[3] **Jiamin Wang**, Liqi Zhou, Dong Zhang, Jian Liu, Feng Xiao, and Yuanshi Zheng* (2024). Protocol selection for second-order consensus against disturbance. *Automatica*, 161: 111497.

[4] **Jiamin Wang**, Jian Liu, Feng Xiao, Ning Xi, Lipo Mo*, and Yuanshi Zheng (2025). Scalable second-order consensus of hierarchical groups. *Systems & Control Letters*, 197: 106032.

[5] **Jiamin Wang**, Jian Liu*, Yuanshi Zheng*, and Dong Zhang (2023). Data-based $\mathcal{L}_2$ gain optimal control for discrete-time system with unknown dynamics. *Journal of the Franklin Institute*, 360(6): 4354–4377.

[6] Liqi Zhou, **Jiamin Wang**, Maojiao Ye, Bao-Lin Zhang, and Yuanshi Zheng* (2023). Consensus of hybrid behavior for graphical coordination games. *IEEE Transactions on Circuits and Systems II: Express Briefs*, 70(8): 3009–3013.

[7] Liqi Zhou, **Jiamin Wang**, Feng Xiao, Bohui Wang, Chaobo Chen, and Yuanshi Zheng* (2024). The impact of neutral actions on hybrid graphical coordination games. Submitted to *Systems & Control Letters*.

[8] Daning Lei, **Jiamin Wang**, Jian Liu*, Jianxiang Xi, and Yuanshi Zheng (2024). Distributed nash equilibrium seeking in two-coalition zero-sum game under edge-agreements. Submitted to *IEEE Transactions on Automatic Control*.

[9] Daning Lei, **Jiamin Wang**, Jian Liu*, and Yuanshi Zheng (2024). Distributed Nash equilibrium seeking for N-coalition games: a memory-based accelerated algorithm. Submitted to *Automatica*.

HONORS & AWARDS

2024	National Scholarship for Graduate Student	Xi'an, China
2024	The First Prize Academic Scholarship of Xidian University	Xi'an, China
2023	Outstanding Graduate Student of Xidian University	Xi'an, China
2020	The First Prize Academic Scholarship of Xidian University	Xi'an, China
2019	Outstanding Undergraduate Graduation Thesis of Chang'an University	Xi'an, China