SMC eNewsletter's Student Corner Column (March 2024 Issue)

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In this issue of the Student Corner Column, we interview Haifan Su, a student author of the paper titled "Bearing-Based Robust Formation Tracking Control of Underactuated AUVs with Optimal Parameter Tuning" published in the IEEE Transactions on Cybernetics.

1. Please tell us a bit about your background and your research area.

I am Haifan Su, currently pursuing my Ph.D. at Shanghai Jiao Tong University. My research focuses on the cooperative formation control of marine vehicles using bearing measurements, specifically on designing control laws for the vehicles to achieve different maneuvers. Bearing measurement is the directional unit vector from one vehicle to another. The advantage of using relative bearings is their ability to be obtained through energy-efficient hydroacoustic observation in water.

2. How did you become interested in your field?

In the dynamic marine environment, the motion of marine vehicles is often impacted by external forces such as wind and water flow, as well as the energy carried away by surface waves. These environmental factors introduce large uncertainties into the control system. However, the bearings are characterized by unit vectors with small upper bounds. Thus, it is difficult to eliminate large uncertainties by small bearing errors. This challenge has inspired me to delve into the issue of bearing-based formation control of marine vehicles.

3. What motivated you to join the IEEE SMC Society?

The IEEE SMC Society offers me an opportunity to share ideas and work with researchers all over the world. This community provides me access to the latest developments within my research fields, allowing me to gain valuable insights and stay ahead in my research.

4. What motivated you to publish in the IEEE Transactions on Cybernetics?

The IEEE Transactions on Cybernetics is a top journal in the field of systems, control, and robotics. In this paper, we solved the problem of bearing-based formation tracking control of underactuated underwater vehicles. The proposed strategy ensures the convergence of tracking errors, robustness against unknown and time-varying disturbances, feasibility of actuator constraints, and optimality of performance. The paper is within the scope of the journal.

5. What is the main innovation in your paper titled "Bearing-Based Robust Formation Tracking Control of Underactuated AUVs with Optimal Parameter Tuning" and its importance to IEEE Transactions on Cybernetics?

The main innovation of this paper is that we propose a strategy integrating a bearing rigidity-based control method and a parameter tuning method. The control method comprises a reference velocity estimator, a virtual velocity for achieving the desired formation, and a robust controller for tracking the virtual velocity and compensating for disturbances. The gains in the control method are tuned by solving optimization problems that involve cost functions, closed-loop dynamic equations, actuator constraints, and convergence-guarantee constraints. This allows for separate analysis of convergence, robustness, feasibility, and optimality of the closed-loop system.

6. Where would you see yourself in 5-years' time career wise?

Over the next five years, I plan to complete my Ph.D. degree and continue my dedication to the research field of marine vehicles and bearing measurements. I am excited about the opportunity to delve deeper into this field, discovering and addressing scientific challenges while working alongside a diverse group of collaborators.

Biography:

Haifan Su received a B.S. degree in automatic control from Northwestern Polytechnical University, Xi'an, China, in 2019. He is currently pursuing a Ph.D. degree in control science and engineering with the School of Electronic Information and Electrical Engineering, Shanghai Jiao Tong University, Shanghai, China. His current research interests include distributed control of autonomous underwater vehicles, optimal motion planning for bearing-based marine vehicle positioning, and cooperative sensing and control of multiagent systems.