Shizhuang Wang

Ph.D. Candidate (Expected to graduate in Sep. 2023)
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Education

- **2019.09 — Present** **Ph.D. Student in Aerospace Science and Technology**
  Shanghai Jiao Tong University (SJTU), Shanghai, China
  Department of Information and Control, School of Aeronautics and Astronautics
  Advisor: Prof. Xingqun Zhan, Cumulative GPA: 3.93 / 4.0, Rank: 2 / 82
- **2014.09 — 2018.07** **B.S. in Aerospace Engineering**
  Shanghai Jiao Tong University (SJTU), Shanghai, China
  Department of Information and Control, School of Aeronautics and Astronautics
  Advisor: Prof. Xingqun Zhan, Cumulative GPA: 3.95 / 4.3, Rank: 1 / 28

Research Experience

2016 — Present: Research Assistant, GNC Laboratory, Shanghai Jiao Tong University

- **Research Interests**: (a) Navigation Integrity, (b) Multi-Agent Cooperative Navigation.
  (a) Characterize signal-in-space range errors of Beidou from integrity perspective; Establish scenario-insensitive error models for visual odometry; Develop fault detection & exclusion (FDE) methods and integrity monitoring algorithms for GNSS, PPP-RTK, GNSS/INS, visual navigation, and multi-sensor integrated navigation; Design and develop an integrity-embedded multi-sensor navigation prototype.
  (b) Develop mathematical models for multi-agent cooperative navigation based on graph theory; Establish the methodology to perform offline and online design of fusion strategies for cooperative navigation; Investigate event-triggered mechanism in cooperative navigation to improve its efficiency and robustness.

Publications

- Published over 20 journal papers, including 5 first-authored SCI papers and 3 first-authored EI papers.
- **First-authored Publications**

1. **Wang, S.,** Zhan, X*., Zhai Y., Zheng, L., and Liu, B., "Enhancing Navigation Integrity for Urban Air Mobility with Redundant Inertial Sensors" *Aerospace Science and Technology* (SCI, Q1, IF: 5.1), 2022.
2. **Wang, S.,** Zhai, Y., and Zhan, X*., "Characterizing Beidou Signal-In-Space Range Errors from Integrity Perspective," *NAVIGATION: Journal of the Institute of Navigation* (SCI, Q2, IF: 2.1), 2021, 68 (1): 157-183.
3. **Wang, S.,** Zhan, X*., Zhai, Y., et al., "Highly Reliable Relative Navigation for Multi-UAV Formation Flight in Urban Environments," *Chinese Journal of Aeronautics* (SCI, Q1, IF: 2.8), 2021, 34 (7): 257-270.
4. **Wang, S.,** Zhan, X*., Zhai, Y., Shen, J., and Wang, H., "Performance Estimation for Kalman Filter based Multi-Agent Cooperative Navigation by Employing Graph Theory," *Aerospace Science and Technology* (SCI, Q1, IF: 5.1), 2021, 112 (106628): 1-16.

5. **Wang, S.,** Zhan, X*., Zhai, Y., and Liu, B., "Fault Detection and Exclusion for Tightly Coupled GNSS/INS System Considering GNSS Ramp Faults and IMU Faults," *Sensors* (SCI, Q2, IF: 3.6), 2020, 20 (3): 590.
6. **Wang S.,** Zhai Y, Chi C, Zhan X, and Jiang Y, "Improved Fault Hypothesis Grouping for Multi Constellation Advanced RAIM," Advances in Space Research (SCI, Q2, IF: 2.2), Accepted.
7. **Wang, S.,** Zhan, X*, Xiao, Y., and Zhai Y., "Integrity Monitoring of PPP-RTK based on Multiple Hypothesis Solution Separation," *China Satellite Navigation Conference* 2022 (EI conference), Best Student Paper Award.
8. **Wang, S.,** Zhan, X*., Zhai, Y., and Fu, Y., "Feature-Based Visual Navigation Integrity Monitoring for Urban Autonomous Platforms," *Aerospace Systems* (EI), 2020, 3: 167-179.
9. **Wang, S.,** Zhan, X*., Zhai, Y., et al., "Ensuring High Navigation Integrity for Urban Air Mobility Using Tightly Coupled GNSS/INS System," *Journal of Aeronautics, Astronautics and Aviation* (EI), 2020, 52 (4): 429-442.
10. **Wang, S.,** Zhan, X*., and Pan, W., "GNSS/INS Tightly Coupling System Integrity Monitoring by Robust Estimation," *Journal of Aeronautics, Astronautics and Aviation* (EI), 2018, 50 (1): 61-80.
11. **Wang, S.,** Zhan, X*., Zhang X., and Mei H., "Research on Airborne ARAIM Algorithm Testing Technology Based on UAV Platform," *Measurement and Control Technology* (in Chinese), 2018, 37 (5): 24-28.
12. **Wang, S.,** Zhai, Y., and Zhan X*., "Solution Separation based Kalman Filter Integrity Monitoring Against All-Source Faults for Multi-Sensor Integrated Navigation," *GPS Solutions* (SCI, Q2, IF: 4.1), under review.

- **Co-supervised Publications**

13. Fu, Y., **Wang, S.**, Zhai, Y., Zhan, X., and Zhang X*., "Measurement Error Detection for Stereo Visual Odometry Integrity," *NAVIGATION: Journal of the Institute of Navigation* (SCI, Q2, IF: 2.1), 2022. (My contributions: advice, and review).
14. Shen, J., **Wang, S.,** and Zhan, X*., "Multi-UAV Cluster-based Cooperative Navigation with Fault Detection and Exclusion Capability," *Aerospace Science and Technology* (SCI, Q1, IF: 5.1), 2022. (My contributions: idea, advice, and review)
15. Wang, H., **Wang, S.,** Zhan, X*., and Shen, J., "Offline Optimization of Sensor Configuration and Integration Architecture for Efficient Cooperative Navigation," *Aerospace Science and Technology* (SCI, Q1, IF: 5.1), 2022. (My contributions: idea, advice, and review)
16. Shen, J., **Wang, S.,** Zhai, Y., and Zhan, X*., "Cooperative Relative Navigation for Multi-UAV Systems by Exploiting GNSS and Peer-to-Peer Ranging Measurements," *IET Radar, Sonar & Navigation* (SCI, Q3, IF: 2.0), 2021, 15 (1): 21-36. (My contributions: idea, advice, and review)
17. Fu, Y., **Wang, S.,** Zhai, Y., and Zhan, X*., "Visual Odometry Errors and Fault Distinction for Integrity Monitoring," *Aerospace Systems* (EI), 2020, 3: 265-274. (My contributions: advice and review)
18. Liu, X., Zhan, X*., **Wang, S.,** and Zhai, Y., "Measurement-Domain Cooperative Navigation for Multi-UAV Systems Augmented by Relative Positions," *Journal of Aeronautics, Astronautics and Aviation* (EI), 2020, 52(4): 403-416. (My contributions: idea, advice, and review)

- **Co-authored Publications**

19. Chang, J., Zhan, X*., Zhai, Y., **Wang, S**., and Yang, R., "Multipath and NLOS Detection and Exclusion Based on Doppler Aided Solution Separation," *GPS Solutions* (SCI, Q2, IF: 4.1), 2022.
20. Liu, B*., Gao Y., Gao, Y., and **Wang, S.**, "HPL Calculation Improvement for Chi-squared Residual-based ARAIM," *GPS Solutions* (SCI, Q2, IF: 4.1), 2022, 26-45.
21. Zheng, L., Zhan, X*., Zhang, X., **Wang, S.,** and Yuan, W., "Heading Estimation for Multi-Mode Pedestrian Dead Reckoning," *IEEE Sensors Journal* (SCI, Q2, IF: 3.3), 2020, 20 (15): 8731-8739.
22. Pan, W., Zhan, X*., Zhang, X., and **Wang, S.,** "A Subset-Reduced Method for FDE ARAIM of Tightly-Coupled GNSS/INS," *Sensors* (SCI, Q2, IF: 3.6), 2019, 19 (22): 4847.
23. Chi, C., Zhan, X*., **Wang, S.,** and Zhai, Y., "Enabling robust and accurate navigation for UAVs using real-time GNSS precise point positioning and IMU integration," *The Aeronautical Journal* (SCI, Q3, IF: 0.8), 2020, 125 (1283): 87-108.
24. Chang, J., Zhan, X*., Zhai, Y. **Wang, S.,** and Lin, K., "Analysis of BDS GEO Satellite Multipath Effect for GNSS Integrity Monitoring in Civil Aviation", *Aerospace Systems* (EI), 2021, 4: 133-141.
25. Zhai, Y., Fu, Y., **Wang, S**., and Zhan, X., "Mechanism Analysis and Mitigation of Visual Navigation System Vulnerability," China Satellite Navigation Conference 2021 (EI), Best Paper Award.

Patents

1. Zhan, X., **Wang, S.**, Shen, J., Liu, X., Zhai, Y., Cooperative Relative Navigation Algorithm for Multi-UAV Systems based on GNSS Observations and Peer-to-Peer Ranging Measurements. CN111273687A, 2020.06.12.
2. Zhan, X., **Wang, S.**, Liu, X., Shen, J., Zhai, Y., A Cooperative Navigation Algorithm for Multi-Receiver Systems based on Virtual Centroid. CN111175797A, 2020.05.19.

Professional Activities

Membership: IEEE student member (since 2018)

Reviewers: Submitted over 30 peer-review reports to international journals and conferences, including:

Aerospace Science and Technology (SCI, Q1)
IEEE Transactions on Aerospace and Electronic Systems (SCI, Q1)
Journal of Navigation (SCI, Q2)
International Journal of Distributed Sensor Networks (SCI)
IET Radar Sonar and Navigation (SCI)
IEEE Sensors Journal (SCI, Q1)
Aerospace Systems (EI)
Chinese Automation Congress (EI Conference)

Project Participation

- **Research Foundations and Projects**

1. Event-Driven Dynamic Programming of Integration Architectures for Large-Scale Swarm Cooperative Navigation. *Natural Science Foundation of China*, **Student Leader**, RMB 570,000, 2022.01 ― 2025.12.
   - My tasks: completely writing and revising the proposal; providing the technical roadmap; guiding students.
2. Research on Time Sequential Integrity Monitoring for GNSS/INS/VO Integrated Navigation. *Natural Science Foundation of China*, **Student Leader**, RMB 300,000, 2022.01 ― 2024.12.
   - My tasks: reviewing the proposal; investigating multi-sensor integrity monitoring algorithms; guiding students.
3. High-Precision GNSS Navigation Services for Maritime Applications. *National Key Research and Development Program*, **Group Member**, RMB 1,000,000, 2022.05 ― 2025.05.
   - My tasks: integrity monitoring algorithm design; BDS integrity performance analysis.
4. Trustworthy Navigation Services for Wide-Area Intelligent Transportation Systems. *National Key Research and Development Program*, **Group Member**, RMB 3,000,000, 2022.09 ― 2025.09.
   - My tasks: multi-sensor integrity monitoring algorithm design.
5. Design and Evaluation of Integrity Monitoring Algorithms for Precise Point Positioning – Real-time Kinematic (PPP-RTK). *Geely*, **Subtask Student Leader**, RMB 1,500,000, 2021.08 ― 2022.12.
   - My tasks: designing the user-end integrity monitoring algorithms and implementing it using C/C++; experimental evaluation with over 50,000-kilometer data; writing technical reports.
6. Multi-Sensor Integrated Navigation System with High Integrity for Autonomous Urban Air Mobility. *Honeywell Technology Solution China*, **Student Leader**, RMB 400,000, 2019.08 – 2020.12.
   - My tasks: designing and validating integrity monitoring schemes for visual navigation system; designing integrity monitoring algorithm for GNSS/INS/Vision integrated navigation systems; writing reports.
7. Multi-UAV Cooperative Navigation and Control for Urban Applications. *SJTU Global Strategic Partnership Fund (2019 SJTU-University of Toronto)*, **Student Leader**, RMB 75,000, 2019.06 – 2020.06.
   - My tasks: prototyping a multi-UAV test platform with GNSS, IMU, and UWB; writing technical reports.
8. Multi-constellation GNSS Integrity for Aviation. *Honeywell Technology Solution China*, **Group Member**, RMB 300,000, 2016.08 – 2017.10.
   - My tasks: evaluating the integrity monitoring algorithms; establishing flight test platform; writing reports.
9. Implementation of a Pose Reference System for Outdoor Experiments. *GNC Laboratory*, **PI**, 2021.01 – 2021.07.

- Motivations: providing the ground truth for outdoor experiments with GNSS and optical-fiber IMU; providing a platform to collect the hardware-synchronized data from GNSS, IMU, and cameras.

10. Design and Implementation of a MATLAB-Unreal Engine Simulation Platform for Multi-Agent Cooperative Navigation. *GNC Laboratory*, **PI**, 2021.07 – 2021.09.
    - Motivations: providing a simulation platform to simulate the sensor data from multiple sensors in multi-agent systems under different 3D scenarios.
11. Enabling Indoor Navigation for Unmanned Aerial Vehicles based on Optical Flow. *The 13th National Undergraduate Innovation Program*, **PI**, RMB 10,000, 2016.06 – 2017.06, Score: Excellent.
    - My tasks: developing a UAV platform; testing the optical flow algorithm; modifying the flight controller.
12. Prototyping Vertical Take-off and Landing Unmanned Aerial Vehicles. *Shanghai Undergraduate Innovation Program*, **Collaborator**, RMB 10,000, 2015.01 – 2016.01, Score: Excellent.
    - My tasks: aircraft design and flight test.
13. Localization-based Service Systems for Ships by Employing Beidou Short Messages and WeChat Mini Programs. *Undergraduate Research Programs of SJTU*, **Group Leader**, RMB 5,000, 2017.01 – 2017.12, Score: Excellent.
    - My tasks: high-level architecture design; coding; testing; and writing the report.

Skills

1. Responsible and Highly Efficient; A Self-Motivated Quick Learner; A Good Team Player.
2. Navigation Integrity, Satellite Navigation (SPP/PPP/RTK/PPP-RTK), Inertial Navigation, Visual Navigation, Multi-Sensor Integrated Navigation, Cooperative Navigation
3. Least Squares, Kalman Filter, Factor Graph, Probability, Statistics, Matrix, Computational Methods
4. Tools: MATLAB (experienced), C, Linux, STM32, UAV
5. Professional Writing: English, Chinese.

Honors and Awards

- **Scholarships**

1. National Scholarship for Graduate Students, RMB 20,000, *Ministry of Education of China*, 2020.
2. Zhao Zhu Mulan Scholarship, RMB 12,000, *Shanghai Jiao Tong University*, 2021.
3. Excellent Graduate Student Scholarship, RMB 5,000, *Shanghai Jiao Tong University*, 2022.
4. Fan Hsu-chi Scholarship, RMB 10,000, *Shanghai Jiao Tong University*, 2016.
5. Luo Mai Astronautics Technology Scholarship, RMB 10,000, *Shanghai Jiao Tong University*, 2017.
6. Leo Ko-guan Scholarship, RMB 10,000, *Shanghai Jiao Tong University*, 2018.

- **Honors**

7. Excellent Undergraduate Student Award of Shanghai, *Shanghai Municipal Education Commission*, 2018.
8. Excellent Bachelor Thesis Award (Top 1%), *Shanghai Jiao Tong University*, 2018.
9. Excellent League Member Award, *Shanghai Jiao Tong University*, 2016.
10. Excellent Student Award, *Shanghai Jiao Tong University*, 2016, 2017, 2020.

- **Competition Awards**

11. Special Award (No.1) of the College Student AI+ Self-Driving Car Contest, *Chinese Association for Artificial Intelligence*, 2018.
    - Task: developing an autonomous lane-tracking algorithm and deploying it in a toy car.
12. The Most Creative Award in Honeywell's Aerospace Innovation Competition, *Honeywell*, 2016.
    - Submission: Autonomous Navigation of UAVs based on Optical Flow.
13. American Mathematical Contest in Modeling, Honorable Mention, 2017.
14. Chinese Mathematical Contest in Modeling, Second Prize, 2016.
15. First Prize of Shanghai Undergraduate Physics Competition, *Shanghai Society of Physics*, 2015.