Weisong Wen, Member of IEEE, Member of ION
Intelligent Positioning and Navigation Laboratory
Research Assistant Professor, Department of Aeronautical and Aviation Engineering
The Hong Kong Polytechnic University, Hong Hom, Kowloon, Hong Kong
Tel: (852) 3400-8234 Email: welson.wen@polyu.edu.hk
Web, Google Scholar, LinkedIn, ORCID, GitHub, Zhihu
Research Interest: Autonomous Driving, Mapping, and Localization, Robotics

Education:

- Ph.D. in Mechanical Engineering, The Hong Kong Polytechnic University, Hong Kong — 2020
- Visiting Ph.D. in Mechanical Engineering, University of California, Berkeley, U.S — 2018
- M.Sc.in Mechanical Engineering, China Agricultural University, China — 2017
- B.Sc. in Mechanical Engineering, Beijing Information Science and Technology University, China — 2015

Selected Awards and Fellowships:

- TechConnect World Innovation Conference and Expo, Innovation Award, U.S — 2021
- Best Presentation Award, ION GNSS+ 2020, U.S — 2020
- First Prize in Hong Kong Section in Qianhai-Guangdong-Macao Youth Innovation and Entrepreneurship Competition, Shenzhen, China — 2020
- Excellent Project Award in Songshan Lake Innovation and Entrepreneurship Competition, Dongguan, Guangdong, China — 2018
- National Scholarship for Graduate Students, Beijing, China — 2016
- Excellent Graduate of Beijing, China — 2015
- China Telecom Scholarship. (Only One Candidate per University) — 2014

Selected Working Experience:

The Hong Kong Polytechnic University, Hong Kong
Apr 2021 – Present, Research Assistant Professor, Aviation and Aeronautical Engineering
Jan 2021 – Apr 2021, Senior Research Fellow, AAE

Idriverplus (Autonomous Driving Startups), Beijing, China
2016 – 2017, Research Algorithm Engineer with the autonomous driving research group

Institute of Automation, Chinese Academy of Sciences, Beijing, China
2014 – 2015, Research Assistant with the autonomous driving research group

Selected Professional Service:

Session Chair, *IPIN 2022*, Special Session: Indoor maps, Indoor Spatial Data Model & Indoor Mobile Mapping, and 3D building models, Beijing, China.
Session Chair, *ION GNSS+ 2022* (to be held), Special Session: ALTERNATIVE TECHNOLOGIES FOR GNSS-DENIED ENVIRONMENTS, Colorado, U.S.
Workshop Leading Chair, *IEEE ITSC 2022* (to be held), Workshop: intelligent Vehicle Meets Urban: Safe and Certifiable Navigation and Control for Intelligent Vehicles in Complex Urban Scenarios, Macau, China.
Session Chair, *ICGNC 2022*, Special Session: Intelligent Navigation and Advanced Information Fusion Technology, Harbin, China.
Leading Guest Editor in *Frontiers in Robotics and AI*, Navigation, Perception, Control for Unmanned Autonomous Systems in Dynamic Urban Scenarios, 2021.
Leading Guest Editor in *Electronics*, Advanced Integrated Navigation Methods, 2022.
Young Editorial Board Member in *Journal of Marine Science and Application*. (2021~)

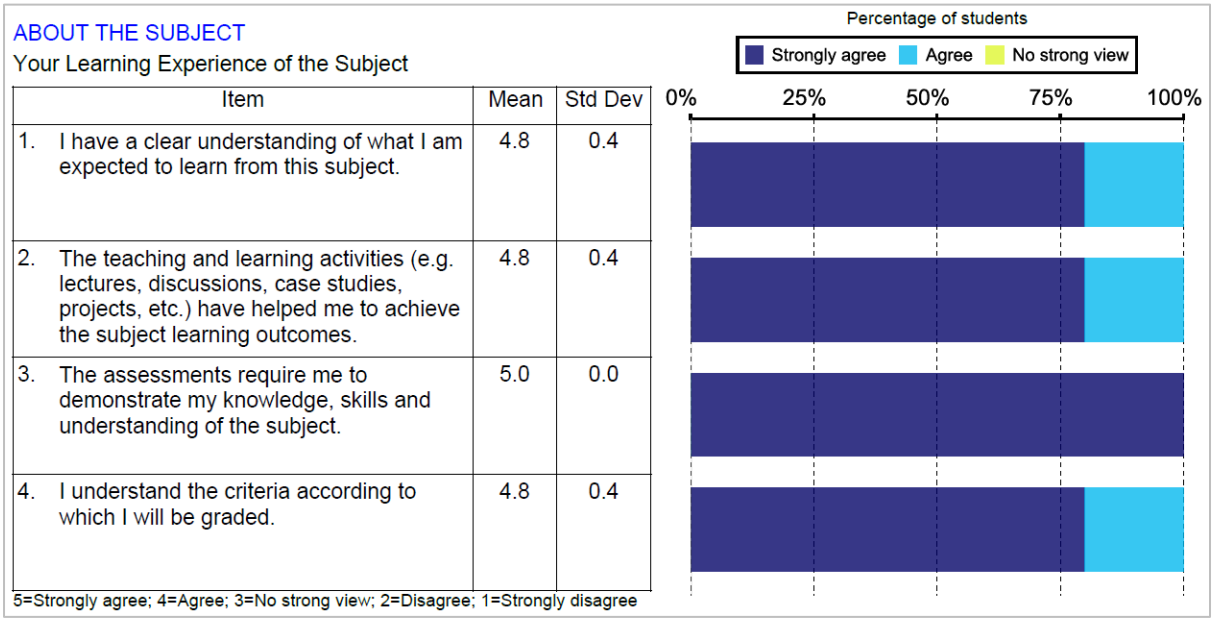
Editorial Board Member in *The Open Transportation Journal*. (2022~)
Regular reviewer in *IEEE Transactions on Intelligent Transportation System* (2017~), *IEEE Intelligent Transportation Systems Magazine* (2017~), *IEEE Sensors Journal* (2018~), *IEEE Transactions on Vehicular Technology* (2017~). *IEEE International Conference on Robotics and Automation* (2019, 2020, 2021), *IEEE International Conference on Intelligent Robots and Systems* (2019, 2020, 2021).

Selected Invited Talks:

- Navigation Research group in Wuhan University, Wuhan, China. 2020
- Riemann Laboratory, Huawei Technologies, Dongguan, China 2020
- Shenzhen Institutes of Advanced Technology, Chinese Academic of Sciences, China. 2019
- Mechanical System Control (MSC) Lab, University of California, Berkeley, CA, U.S. 2018
- Autonomous Driving Research Groups in Baidu.inc, Jingchi. inc, Deepmap.ai, CA, U.S. 2018

Selected Teaching Experience:

- AAE4203, Guidance, and Navigation (semester 1, 2022/2023) 2022
- AAE4203, Guidance, and Navigation (semester 2, 2021/2022) 2022
- AAE4002, Undergraduate Capstone Project 2021
- ENG1003 Freshman Seminar for Engineering (*With Dr. Li-Ta Hsu*) 2021



ABOUT THE SUBJECT

Your Learning Experience of the Subject

Item	Mean	Std Dev
1. I have a clear understanding of what I am expected to learn from this subject.	4.8	0.4
2. The teaching and learning activities (e.g. lectures, discussions, case studies, projects, etc.) have helped me to achieve the subject learning outcomes.	4.8	0.4
3. The assessments require me to demonstrate my knowledge, skills and understanding of the subject.	5.0	0.0
4. I understand the criteria according to which I will be graded.	4.8	0.4

5=Strongly agree; 4=Agree; 3=No strong view; 2=Disagree; 1=Strongly disagree

Student Feedback Questionnaire for AAE4203 Guidance, and Navigation (semester 1, 2022/2023)

Selected Research Grants (Past 5 Years):

- **PI**, Natural Science Foundation of Guangdong, *Research on 3D LiDAR Aided Urban GNSS Positioning Algorithm* (Project amount: RMB$100,000; Project period: Oct 1, 2021–Sept 30, 2024; Status: On-going)
- **PI**, Huawei Technologies, *Huawei-PolyU High-accuracy Localization Project (second phase)* (Project amount: HK$2,150,000; Project period: Aug 27, 2021–Aug 28, 2022; Status: On-going)

- **PI**, PolyU AAE Startup Fund, *Gaussian Mixture Models for GNSS Error Noise Characterization in Urban Canyons for Autonomous Systems* (Project amount: HK$50,000; Project period: Apr 26, 2021–Apr 25, 2023; Status: On-going)
- **PI**, PolyU Startup Fund, *Resilient GNSS Positioning for Autonomous Aerial Vehicle in Urban Scenarios* (Project amount: HK$200,000; Project period: Apr 26, 2021–Apr 25, 2023; Status: On-going)
- **Co-PI**, Research Funding Scheme for Supporting Intra-Faculty Interdisciplinary Projects 2021/22, *Perception-based GNSS PPPRTK/LVINS integrated navigation system for unmanned autonomous systems operating in urban canyons* (Project amount: HK$400,000; Project period: Apr 20, 2022– April, 2023; Status: On-going)
- **Co-PI**, Huawei Technologies, *Factor Graph Optimization for GNSS Positioning* (Project amount: HK$1,260,000; Project period: Apr 20, 2021– Feb 20, 2022; Status: On-going)

Selected Representative Journal Publications (Past 5 Years): (*: Corresponding author)

1. Zhong, Y., Huang, F., Zhang, J., **Wen, W. *** and Hsu, L.T., 2021. Low-cost Solid-state LiDAR/Inertial Based Localization with Prior Map for Autonomous Systems in Urban Scenarios. *IET Intelligent Transport Systems*.
2. Li, X., Li, S., Shen, Z., Zhou, Y., Wang, X., Li, X., and **Wen, W**., 2021. Continuous and precise positioning in urban environments by tightly coupled integration of GNSS, INS, and Vision, *IEEE Robotics and Automation Letters.* [*Accpeted in 16th Aug 2022*]
3. **Wen, W**., & Hsu, L. T. (2022). AGPC-SLAM: Absolute Ground Plane Constrained 3D Lidar SLAM. *NAVIGATION: Journal of the Institute of Navigation*, *69*(3). (Paper, Video)
4. Zhang, J., **Wen, W***., Huang, F., Wang, Y., Chen, X., & Hsu, L. T. (2022). GNSS-RTK Adaptively Integrated with LiDAR/IMU Odometry for Continuously Global Positioning in Urban Canyons. Applied Sciences, 12(10), 5193. (Paper)
5. **Wen, W**., and Hsu, L.T., 2021. 3D LiDAR Aided GNSS NLOS Mitigation in Urban Canyons. *IEEE transactions on intelligent transportation systems*. (Paper, Video)
6. Bai, X., **Wen, W**.* and Hsu, L.T., 2022. Time-correlated Window Carrier-phase Aided GNSS Positioning in Urban Canyons, *IEEE Transactions on Aerospace and Electronic Systems*. (Paper)
7. Bai, X., **Wen, W**. and Hsu, L.T., 2021. Degeneration-Aware Outlier Mitigation for Visual Inertial Integrated Navigation System in Urban Canyons. *IEEE Transactions on Instrumentation and Measurement*, 70, pp.1-15. (Paper)
8. **Wen, W.**, Zhang, G. and Hsu, L.T., 2021. Gnss outlier mitigation via graduated non-convexity factor graph optimization. *IEEE Transactions on Vehicular Technology*, 71(1), pp.297-310. (Paper)
9. **Wen, W**., Pfeifer, T., Bai, X. and Hsu, L.T., 2021. Factor graph optimization for GNSS/INS integration: A comparison with the extended Kalman filter. *NAVIGATION, Journal of the Institute of Navigation*, 68(2), pp.315-331. (Paper, Video)
10. Zhang, J., **Wen, W. ***, Huang, F., Chen, X. and Hsu, L.T., 2021. Coarse-to-Fine Loosely-Coupled LiDAR-Inertial Odometry for Urban Positioning and Mapping. *Remote Sensing*, 13(12), p.2371. (Paper)
11. Yue, J., **Wen, W**. *, Han, J. and Hsu, L.T., 2021. 3D Point Clouds Data Super Resolution-Aided LiDAR Odometry for Vehicular Positioning in Urban Canyons. *IEEE Transactions on Vehicular Technology*, 70(5), pp.4098-4112. (Paper)
12. Huang, F., **Wen, W**., Zhang, J. and Hsu, L.T., 2021. Point-wise or Feature-wise? Benchmark Comparison of Public Available LiDAR Odometry Algorithms in Urban Canyons. *IEEE Intelligent Transportation Systems Magazine*. [***Accepted***] (Paper)
13. Bai, X., **Wen, W**. and Hsu, L.T., 2020. Robust visual-inertial integrated navigation system aided by online sensor model adaption for autonomous ground vehicles in urban areas.

Remote Sensing, 12(10), p.1686. (Paper)

14. **Wen, W**., Bai, X., Zhang, G., Chen, S., Yuan, F. and Hsu, L.T., 2020. Multi-agent collaborative GNSS/camera/INS integration aided by inter-ranging for vehicular navigation in urban areas. *IEEE Access*, 8, pp.124323-124338. (Paper)
15. Zhang, G., Ng, H.F., **Wen, W**. and Hsu, L.T., 2020. 3D mapping database aided GNSS based collaborative positioning using factor graph optimization. *IEEE Transactions on Intelligent Transportation Systems*. (Paper)
16. Zhang, G., **Wen, W**., Xu, B. and Hsu, L.T., 2020. Extending shadow matching to tightly-coupled GNSS/INS integration system. *IEEE Transactions on Vehicular Technology*, 69(5), pp.4979-4991. (Paper)
17. **Wen, W**., Zhang, G. and Hsu, L.T., 2020. Object-Detection-Aided GNSS and Its Integration With Lidar in Highly Urbanized Areas. *IEEE Intelligent Transportation Systems Magazine*, 12(3), pp.53-69. (Paper)
18. Bai, X., **Wen, W. *** and Hsu, L.T., 2020. Using Sky-pointing fish-eye camera and LiDAR to aid GNSS single-point positioning in urban canyons. *IET Intelligent Transport Systems*, 14(8), pp.908-914. (Paper)
19. **Wen, W**., Bai, X., Kan, Y.C. and Hsu, L.T., 2019. Tightly coupled GNSS/INS integration via factor graph and aided by fish-eye camera. *IEEE Transactions on Vehicular Technology*, 68(11), pp.10651-10662. (Paper)
20. **Wen, W**., Zhang, G. and Hsu, L.T., 2019. GNSS NLOS exclusion based on dynamic object detection using LiDAR point cloud. *IEEE transactions on intelligent transportation systems*. (Paper)
21. **Wen, W**., Zhang, G. and Hsu, L.T., 2019. Correcting NLOS by 3D LiDAR and building height to improve GNSS single point positioning. *Navigation*, 66(4), pp.705-718. (Paper)
22. Zhang, G., **Wen, W**. and Hsu, L.T., 2019. Rectification of GNSS-based collaborative positioning using 3D building models in urban areas. *GPS solutions*, 23(3), pp.1-12. (Paper)
23. **Wen, W**., Hsu, L.T. and Zhang, G., 2018. Performance analysis of NDT-based graph SLAM for autonomous vehicle in diverse typical driving scenarios of Hong Kong. *Sensors*, 18(11), p.3928. (Paper)
24. **Wen, W**., Bai, X., Zhan, W., Tomizuka, M. and Hsu, L.T., 2019. Uncertainty estimation of LiDAR matching aided by dynamic vehicle detection and high definition map. *Electronics letters*, 55(6), pp.348-349. (Paper)

Journal Publications In Submission or Under Revision: (*: Corresponding author)

1. **Wen, W**.*, Bai, X., and Hsu, L.T., 2021. 3D Vision Aided GNSS Real-time Kinematic Positioning for Autonomous Systems in Urban Canyons, *NAVIGATION: Journal of the Institute of Navigation*. [*Under Review*]
2. Hsu, L.T*, Cheng, M., **Wen, W**., Li, B., and Wen, C., 2021. Using GitHub as a Supplementary Educational Tool to Improve Problem-solving and Learning-to-learn Attributes, *IEEE transactions education*. [*Under Review*]

Selected Representative Conference Publications (Past 5 Years):

1. **Wen, W*.**, Li, B., Chen, J., Huang, Y. (2022, October). Workshop on Intelligent Vehicle Meets Urban: Safe and Certifiable Navigation and Control for Intelligent Vehicles in Complex Urban Scenarios, *IEEE ITSC 2022. In 2022 IEEE 25th International Conference on Intelligent Transportation Systems (ITSC)*. IEEE.
2. **Wen, W***. (2022, September). Tutorial on Enablers of Indoor Positioning and Navigation: From Radionavigation Fundamentals, Robotic SLAM, to Absolute Indoor GNSS, *In 2022 International Conference on Indoor Positioning and Indoor Navigation (IPIN). IEEE*.
3. **Wen, W**. and Hsu, L.T., 2022, September. Factor Graph Optimization for Tightly−

coupled GNSS Pseudorange/Doppler/Carrier phase/INS Integration: Performance In Urban Canyons of Hong Kong. In *Proceedings of the 35th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2022)*.

4. Zhong, Y., **Wen, W*.**, Ng, H., Bai, X., and Hsu, L.T. 2022, September. Real-time Factor Graph Optimization Aided by Graduated Non-convexity Based Outlier Mitigation for Smartphone Decimeter Challenge. In *Proceedings of the 35th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2022)*.
5. Huang, F., **Wen, W*.**, Ng, H., Hsu, L.T. (2022, October). LiDAR Aided Cycle Slip Detection for GNSS Real-Time Kinematic Positioning in Urban Environments, *IEEE ITSC 2022. In 2022 IEEE 25th International Conference on Intelligent Transportation Systems (ITSC)*. IEEE.
6. Bai, X., **Wen, W.**, Zhang, G., Ng, H., Hsu, L.T*. (2022, October). GNSS Outliers Mitigation in Urban Areas Using Sparse Estimation Based on Factor Graph Optimization, *IEEE ITSC 2022. In 2022 IEEE 25th International Conference on Intelligent Transportation Systems (ITSC)*. IEEE.
7. **Wen, W**. and Hsu, L.T., 2021, September. 3D LiDAR Aided GNSS Real-time Kinematic Positioning. In *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021)* (pp. 2212-2220). (Paper, Video)
8. **Wen, W**., Meng, Q. and Hsu, L.T., 2021, September. Integrity Monitoring for GNSS Positioning Via Factor Graph Optimization in Urban Canyons. In *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021)* (pp. 1508-1515). (Paper, Video)
9. Zhang, J., **Wen, W**., Huang, F., Chen, X. and Hsu, L.T., 2021, September. Continuous GNSS-RTK Aided by LiDAR/Inertial Odometry with Intelligent GNSS Selection in Urban Canyons. In *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021)* (pp. 4198-4207). (Paper, Video)
10. Huang, F., Shen, D., **Wen, W**., Zhang, J. and Hsu, L.T., 2021, September. A Coarse-to-Fine LiDAR-Based SLAM with Dynamic Object Removal in Dense Urban Areas. In *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021)* (pp. 3162-3172). (Paper, Video)
11. Ng, H.F., Zhang, G., **Wen, W**. and Hsu, L.T., 2021, September. 3D Mapping Aided GNSS Using Gauss-Newton Algorithm: An Example on GNSS Shadow Matching. In *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021)* (pp. 1954-1960). (Paper)
12. Hsu, L.T., Kubo, N., **Wen, W**., Chen, W., Liu, Z., Suzuki, T. and Meguro, J., 2021, September. UrbanNav: An open-sourced multisensory dataset for benchmarking positioning algorithms designed for urban areas. In *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2021)* (pp. 226-256). (Paper)
13. **Wen, W**. and Hsu, L.T., 2021, May. Towards Robust GNSS Positioning and Real-time Kinematic Using Factor Graph Optimization. In 2021 *IEEE International Conference on Robotics and Automation (ICRA)*. IEEE. (Paper, Video, Code)
14. **Wen, W**., 2020, September. 3D LiDAR Aided GNSS and Its Tightly Coupled Integration with INS Via Factor Graph Optimization. In *Proceedings of the 33rd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+*

2020) (pp. 1649-1672). (Paper, Video)

15. Fang, W., Li, H., Dang, S., Huang, H., Peng, L., Hsu, L.T. and **Wen, W**., 2019, December. Combining deep gaussian process and rule-based method for decision-making in self-driving simulation with small data. In 2019 15th *International Conference on Computational Intelligence and Security (CIS)* (pp. 267-271). IEEE. (Paper)
16. Bai, X., Zhang, B., **Wen, W**., Hsu, L.T. and Li, H., 2020, April. Perception-aided visual-inertial integrated positioning in dynamic urban areas. In 2020 *IEEE/ION Position, Location and Navigation Symposium (PLANS)* (pp. 1563-1571). IEEE. (Paper)
17. **Wen, W**., Bai, X., Hsu, L.T. and Pfeifer, T., 2020, April. GNSS/LiDAR integration aided by self-adaptive Gaussian mixture models in urban scenarios: An approach robust to non-Gaussian noise. In 2020 *IEEE/ION Position, Location and Navigation Symposium (PLANS)* (pp. 647-654). (Paper)
18. **Wen, W**., Zhou, Y., Zhang, G., Fahandezh-Saadi, S., Bai, X., Zhan, W., Tomizuka, M. and Hsu, L.T., 2020, May. Urbanloco: a full sensor suite dataset for mapping and localization in urban scenes. In 2020 *IEEE International Conference on Robotics and Automation (ICRA)* (pp. 2310-2316). IEEE. (Paper, Video, Code)
19. **Wen, W**., Kan, Y.C. and Hsu, L.T., 2019, September. Performance comparison of GNSS/INS integrations based on EKF and factor graph optimization. In *Proceedings of the 32nd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2019)* (pp. 3019-3032). (Paper, Video)
20. Bai, X., **Wen, W**., Zhang, G. and Hsu, L.T., 2019, April. Real-time GNSS NLOS detection and correction aided by sky-pointing camera and 3D LiDAR. In *Proceedings of the ION 2019 Pacific PNT Meeting* (pp. 862-874). (Paper)
21. Zhang, G., **Wen, W**. and Hsu, L.T., 2018, September. Collaborative GNSS positioning with the aids of 3D city models. In *Proceedings of the 31st International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2018)* (pp. 143-149). (Paper)
22. **Wen, W**., Zhang, G. and Hsu, L.T., 2018, September. Correcting GNSS NLOS by 3D LiDAR and building height. In *Proceedings of the 31st International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2018)* (pp. 3156-3168). (Paper)
23. **Wen, W**., Zhang, G. and Hsu, L.T., 2018, April. Exclusion of GNSS NLOS receptions caused by dynamic objects in heavy traffic urban scenarios using real-time 3D point cloud: An approach without 3D maps. In 2018 *IEEE/ION Position, Location and Navigation Symposium (PLANS)* (pp. 158-165). IEEE. (Paper)
24. Zhang, G., **Wen, W**. and Hsu, L.T., 2018, April. A novel GNSS based V2V cooperative localization to exclude multipath effect using consistency checks. In 2018 *IEEE/ION Position, Location and Navigation Symposium (PLANS)* (pp. 1465-1472). (Paper)

Selected Open-sourced Code and Datasets to the Community

- **Wen, W**, et al, UrbanLoco: A Full Sensor Suite Dataset for Mapping and Localization in Urban Scenes, *ICRA 2020*, Paris, France. (*Collaborative with the team in UC Berkeley, **118 Stars in Github***)
- Hsu, L.T., Kubo, N., **Wen, W**., et al, 2021, September. UrbanNav: An open-sourced multisensory dataset for benchmarking positioning algorithms designed for urban areas., *ION GNSS+ 2021*, MO, U.S. (*Collaborative with the research group in Japan, **174 Stars in Github***)

- GraphGNSSLib: An Open-source Package for GNSS Positioning and Real-time Kinematic Using Factor Graph Optimization (*Accepted and presented in ICRA 2021, **264 Stars in Github***).

References

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