

Shubh Gupta

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Education

Stanford University

Sep 2019–Present

PhD Candidate, Electrical Engineering

Thesis: *High-Integrity Urban Localization: Bringing Safety in Aviation to Autonomous Driving*

Advisor: Grace X. Gao

Stanford University

Sep 2019–Jan 2021

Master of Science, Electrical Engineering

University of Illinois at Urbana-Champaign

Aug 2018–Sep 2019

Graduate Student, Electrical and Computer Engineering

Advisor: Grace X. Gao

Indian Institute of Technology, Kanpur

May 2014–June 2018

Bachelor of Technology, Electrical Engineering, Minor Computer Architecture

GPA: 9.3/10.0

Academic Excellence Award (Top 10 EE Students)

Journal Publications

- S. Gupta**, A. Mohanty, G. Gao, Urban Localization using Robust Filtering at Multiple Linearization Points. *EURASIP Journal on Advances in Signal Processing* 2023 (submitted).
- S. Gupta***, A. Kanhere*, A. Shetty, G. Gao, Improving GNSS Positioning using Neural Network-based Corrections. *NAVIGATION: Journal of the Institute of Navigation*, December 2022. <https://doi.org/10.33012/navi.548>.
- A. Mohanty, **S. Gupta**, G. Gao, A Particle-filtering Framework for Integrity Risk of GNSS-Camera Sensor Fusion. *NAVIGATION: Journal of the Institute of Navigation*, December 2021. <https://doi.org/10.1002/navi.455>.
- S. Gupta**, G. Gao, Data-Driven Protection Levels for Camera and 3D Map-based Safe Urban Localization. *NAVIGATION: Journal of the Institute of Navigation*, September 2021. <https://doi.org/10.1002/navi.445>.
- R. Moss, **S. Gupta**, R. Dyro, K. Leung, M. Kochenderfer, G. Gao, M. Pavone, E. Schmerling, A. Corso, R. Madigan, M. Stroila, T. Gibson, Autonomous Vehicle Risk Assessment. *Department of Aeronautics and Astronautics, Stanford University*, June 2021. [Technical Report](#).

Patents

- S. Gupta**, N. Jaipuria, P. Narayanan, V. Murali, “Dynamically routed patch discriminator”, U.S. Patent Application No. 16/800,950.
- P. Gupta, **S. Gupta**, R. Sinha, S. Pal, A. Jayagopal, “Saliency prediction for informational documents”, U.S. Patent No. 11,263,470. 1 Mar. 2022.
- N. Jaipuria, R. Bhasin, **S. Gupta**, G. Sholingar “Training deep neural networks with synthetic images”, U.S. Patent No. 11,100,372. 24 Aug. 2021.
- P. Gupta, **S. Gupta**, R. Sinha, S. Pal, A. Jayagopal, “Saliency prediction for a mobile user interface”, U.S. Patent No. 10,664,999. 26 May 2020.

Research

Stanford University, Navigation and Autonomous Vehicles Lab with Grace Gao

Aug 2019–Present

- Improved Global Navigation Satellite System (GNSS) Positioning through Deep Neural Network (DNN) Approaches

- Developed DNN models to overcome multipath and non-line-of-sight errors in GNSS positioning in urban environments.
- Addressed numerical conditioning, variable GNSS code phase measurements, and overfitting issues through set-based deep learning methods and data augmentation strategies.
- Hybridized traditional and data-driven approaches to reduce data, memory, and computational overhead for GNSS positioning over time.
- Validated the models using real-world smartphone data.
- Uncertainty Quantification in Multi-Sensor Fusion
 - Designed algorithm for state and uncertainty estimation in urban environments using multi-sensor fusion of GNSS code/carrier phase, camera, and IMU measurements.
 - Enhanced tracking efficiency and quantified uncertainty through Rao-Blackwellized design and stochastic bank of Kalman filters.
 - Validated algorithm on real-world data collected in urban environments.
- Safe localization using camera images
 - Developed approach to compute safety bounds by matching camera images to 3D point cloud map of a city
 - Specified a Gaussian mixture model for position error with data-driven models and outlier weighting techniques
 - Validated method through experimentation on real-world data in urban environments.
- Risk Assessment in Autonomous Systems
 - Developed end-to-end risk assessment framework combining driving scenarios, sensor observation models, autonomous driving policies, and rare event simulation techniques
 - Designed a surrogate modeling and adaptive stress testing technique for efficient identification of failures under various sensing errors
 - Derived adaptive importance sampling algorithms for risk estimation in sequential decision making systems
 - Implemented efficient tree-based algorithms for importance sampling and risk estimation in diverse autonomous systems with discrete actions.
- Urban Localization with Neural Radiance Fields (NeRF)
 - Developed an algorithmic approach to generate high-quality 3D maps of cities using NeRFs
 - Implementing novel algorithms for vehicle localization by matching camera images with NeRF maps of city structures
 - Enhancing GNSS positioning accuracy by incorporating NeRF occupancy estimates along signal paths to assess quality

University of Illinois at Urbana-Champaign, GPS Lab with Grace Gao

Aug 2018–May 2019

- Safe Localization under GPS Faults in Urban Environments
 - Developed a modified particle filter-based state estimation framework that jointly optimizes for state and error-free measurements
 - Used a Gaussian Mixture Model to accurately measure the accuracy and risk associated with localization, determining system availability at each time instant
 - Improved performance in challenging simulated and real urban driving scenarios compared to existing techniques

Industry Experience

Ford Motor Company

May–Aug 2019

Research Intern at Greenfield Labs

Palo Alto, California

- Developed GAN algorithms to convert simulations to realistic data for training DNNs in autonomous driving
- Devised methods for leveraging unpaired datasets to increase the variety and size of training data and improving the robustness of DNNs.
- Designed techniques for incorporating out-of-domain real-image datasets to further improve scalability.

Smartphone Biz Apps

June–July 2018

- Built and deployed conversational chatbots for businesses using Dialogflow
- Developed strategies to connect natural language user queries with MongoDB database queries
- Streamlined chatbot integration with social media platforms

Adobe

May–July 2017

Research Intern at Big Data Experience Lab

Bangalore, India

- Created neural network-based predictors for identifying salient elements in smartphone interfaces
- Conducted large scale user A/B testing and data collection using Amazon MTurk

Teaching**Stanford University, AA Department** Teaching Assistant

Sep 2021–Dec 2021

- Sole TA for second offering of AA 275: Navigation of Autonomous Systems

Stanford University, AA Department Teaching Assistant

Sep 2020–Dec 2020

- Sole TA for first offering of AA 275: Navigation of Autonomous Systems
- Created homework assignments and lectures

Stanford University, AA Department Teaching Assistant

Jan 2020–March 2020

- Sole TA for AA 272C: Global Positioning Systems
- Redesigned homework assignments and lectures

Preprints

- A. Corso, K. Kim, **S. Gupta**, G. Gao, M. Kochenderfer, A Deep Reinforcement Learning Approach to Rare Event Estimation. [arXiv:2211.12470 \[cs.LG\]](https://arxiv.org/abs/2211.12470).
- S. Gupta**, G. Gao, Reliable GNSS Localization Against Multiple Faults Using a Particle Filter Framework. [arXiv:2101.06380 \[cs.RO\]](https://arxiv.org/abs/2101.06380).

Conference Publications

- D. Neamati, **S. Gupta**, M. Partha, and G. Gao, Neural City Maps for GNSS NLOS Prediction, *Proceedings of the 36th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2023. (accepted)
- M. Partha, **S. Gupta**, and G. Gao, Neural City Maps: A Case for 3D Urban Environment Representations Based on Radiance Fields. *Proceedings of the 36th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2023. (accepted)
- A. Dai, **S. Gupta**, and G. Gao, Neural Radiance Maps for Extraterrestrial Navigation and Path Planning. *Proceedings of the 36th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2023. (accepted)
- S. Gupta**, A. Mohanty, G. Gao, Getting The Best of Particle and Kalman Filters: GNSS Sensor Fusion using Rao-Blackwellized Particle Filter. *Proceedings of the 35th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2022, pp. 1610-1623. <https://doi.org/10.33012/2022.18470>.
- S. Gupta**, A. Kanhere, A. Shetty, G. Gao, Designing Deep Neural Networks for Sequential GNSS Positioning. *Proceedings of the 35th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2022, pp. 1209-1219. **(Best Presentation Award)**. <https://doi.org/10.33012/2022.18494>.
- S. Gupta***, A. Kanhere*, A. Shetty, G. Gao, Improving GNSS Positioning using Neural Network-based Corrections. *Proceedings of the 34th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2021, pp. 3068-3080. <https://doi.org/10.33012/2021.17999>.
- A. Mohanty, **S. Gupta**, G. Gao, A Particle Filtering Framework for Integrity Risk of GNSS-Camera Sensor Fusion. *Proceedings of the 33rd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2020, pp. 2440-2452. <https://doi.org/10.33012/2020.17660>.

- S. Gupta**, G. Gao, Data-Driven Protection Levels for Camera and 3D Map-based Safe Urban Localization. *Proceedings of the 33rd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2020, pp. 2483 - 2499. <https://doi.org/10.33012/2020.17698>.
- N. Jaipuria, **S. Gupta**, P. Narayanan, V. Murali, On the Role of Receptive Field in Unsupervised Sim-to-Real Image Translation. *Machine Learning for Autonomous Driving Workshop at the 33rd Conference on Neural Information Processing Systems (NeurIPS)*, December 2019. [arXiv:2001.09257](https://arxiv.org/abs/2001.09257) [cs.CV].
- S. Gupta**, G. Gao, Particle RAIM for Integrity Monitoring. *Proceedings of the 32nd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+)*, September 2019, pp. 811-826. <https://doi.org/10.33012/2019.16939>.
- P. Gupta, **S. Gupta**, A. Jayagopal, S. Pal, R. Sinha, Saliency Prediction for Mobile User Interfaces. *IEEE Winter Conference on Applications of Computer Vision (WACV)*, March 2018, pp. 1529-1538. <https://doi.org/10.1109/WACV.2018.00171>.

Invited Talks and Posters

- S. Gupta**, “Data-Driven Protection Levels for Camera and 3D Map-based Safe Urban Localization”, Institute of Navigation Webinar, November 2022. <https://www.ion.org/publications/webinar-gupta.cfm>
- S. Gupta**, “Incorporating Observation Noise in Adaptive Stress Testing of Autonomous Vehicles”, Bay Area Robotics Symposium, October 2021.
- S. Gupta**, “Particle RAIM”, Stanford Position, Navigation and Time Symposium, October 2019.