

# UAV supported road traffic safety and ADS deployment



- Organizers:
  - Abhijit Sarkar, Virginia Tech Transportation Institute
  - Hong Wang, Tsinghua University
  - Yuxin Zhang, State Key Laboratory of Automotive Simulation and Control.

## Call for paper

### Scope and Topic

The rapid emergence of recent technologies and their intersection with transportation research has opened new avenues for study. Unmanned Aerial Vehicles (UAVs) technologies present a unique opportunity for transportation research to study road safety and Automated Driving Systems (ADS). This workshop aims to delve into the details of modeling traffic participants' behavior, the effectiveness of UAVs in managing changing dynamics and increasing traffic demands, and current global research and development in this field. Understanding the importance of this topic to Intelligent Transportation Systems (ITS) is crucial, as it offers fresh, independent perspectives on existing environments, detailed insights, and the potential to set new benchmarks in road safety with emerging datasets.

Over the last few years, interest in aerial imagery and associated research in ITS has significantly grown. Academic research accompanied by development in industry has opened up opportunity for advanced research. As a result, we have seen the emergence of multiple new datasets that are captured through UAVs. These datasets capture key behaviors of multimodal traffic [1], infrastructure health, and traffic incident management. UAVs enable novel directions to existing research in ITS community, including VRU safety, trajectory tracking, traffic modeling, safety modeling, smart infrastructure, perception, sensor fusion, and V2X. It covers a large spectrum of research from fundamental methods to key applications. UAVs have shown tremendous promises, however, yet to demonstrate true disruption. We expect that the proposed workshop will help pioneer the field of UAV research in ITS.

## Key topics

Researchers in related areas from academia and industry are invited to submit extended abstracts (at least 3-pages long with conference template) or full papers to be presented in the format of spotlight presentation and poster presentation

1. Traffic safety analysis using UAVs
2. New Drone based dataset
3. Modeling traffic from aerial image/video/data
4. Edge technology for Drones to benefit on device processing
5. Scene analysis from aerial images using computer vision and advance algorithms
6. Intersection safety using aerial images
7. Smart City management using drone dataset
8. Driving behavior analysis in complex infrastructure
9. Graph based application to aerial scene analysis
10. Perception and sensor fusion
11. ADS applications and integration with UAV
12. Traffic incident management through traffic cameras and drones
13. Infrastructure health assessments including bridge and pavement
14. Novel applications

## Objectives:

Additionally, researchers are encouraged to look at the overall objectives of the workshop:

1. To demonstrate the utility of drone imagery and associated datasets to study traffic safety.
2. To investigate the dynamics of Vulnerable Road Users (VRUs) and their interactions with other vehicles.
3. Discuss merits and limitation of aerial imagery based traffic safety analysis.
4. To facilitate discussions on creating large-scale drone data collections, targeted for multiple applications in ITS.
5. To examine the role and utilities of UAVs in accident scene analysis and emergency response.
6. To examine the role and utilities of UAVs in roadway infrastructure analysis.
7. To provide insights into current drone technology and industry standards.
8. Discuss regulations governing drone-based deployments and research. This can include regulations from industry, and government agencies.
9. To explore the use of drone datasets for studying ADS behavior and their interactions with traffic participants.
10. To analyze human driver behavior at intersections.
11. To explore the roles and utilities of UAVs in smart cities.

## Note:

- **Workshop Paper Review:** Papers submitted for the workshop will undergo the same review process as the conference papers and will be published in the same proceedings. This means that submission to a workshop does not guarantee acceptance. In light of this, we suggest that workshop organizers hold off on scheduling and prepping sessions until the review process is finalized and accepted papers are assigned

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## Workshop Organizers:

- Main Contact Person: *Abhijit Sarkar*
- Co-Organizer: *Hong Wang, Yuxin Zhang*

## Contact details

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## Brief Bios of Workshop Organizers:

### **Abhijit Sarkar**

*Dr. Abhijit Sarkar is a Senior Research Associate in the Division of Data and Analytics at the Virginia Tech Transportation Institute. He currently leads the Computer Vision and Machine Learning team at VTTI. Prior to that he received his doctoral degree from Virginia Tech in 2017. Over the course of a decade, his research concentrated in intersection of artificial intelligence and transportation research. His involvement spans through various federally and state-funded projects, addressing domains such as traffic safety monitoring, intersection safety analysis, driver distraction and attention monitoring, automated vehicle safety, vehicle-to-vehicle applications, naturalistic driving studies (NDSs), and heavy vehicle operations. His extensive involvement in research projects has encompassed roles as Principal Investigator (PI) and Co-PI for projects with private and public sectors including NSF, FMCSA, FHWA, NCHRP. He has authored more than 30 publications including technical reports, journals and proceedings. He is currently the guest editor of Special Issue on Computer Vision and Pattern Recognition: Advanced Techniques and Applications, Applied Science.*

### **Hong Wang**

*Hong Wang is Research Associate Professor at Tsinghua University. She received the Ph.D. degree in Beijing Institute of Technology, Beijing, China, in 2015. From the year 2015 to 2019, she was working as a Research Associate of Mechanical and Mechatronics Engineering with the University of Waterloo. Her research focuses on the safety of the on-board AI algorithm, the safe decision-making for intelligent vehicles, and the test and evaluation of SOTIF. She becomes the IEEE member since the year 2017. She has published over 60 papers on top international journals. Her domestic and foreign academic part-time includes the associate editor for IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Vehicular Technology and IEEE Transactions on Intelligent Vehicles, Young Communication Expert of Engineering, lead Guest Editor of Special Issues on Intelligent Safety of IEEE Intelligent Transportation Systems Magazine. In the field of UAV applications, Dr. Wang's team is using UAV to collect data in various cities in China. At present, a dataset of unmanned aerial vehicles at typical intersections in China has been established, and the research results have won the IEEE ITSC2023 Best Student Paper Award . The scale of the dataset is still expanding. Based on the data obtained from UAV, her team is also continuously conducting research on intelligent vehicle prediction [2], decision-making [3], verification and validation.*

### **Yuxin Zhang**

*Yuxin Zhang, Ph.D., is an Associate Professor at State Key Laboratory of Automotive Simulation and Control, Jilin University. He currently leads the Automated Driving Safety Joint Laboratory at Jilin University. His main research interests are automated vehicle systems safety engineering, especially functional safety and SOTIF. He was a postdoc in Systems Engineering from 2016 to 2018 in Jilin University. He received a Joint Ph.D. degree from Jilin University and UC Berkeley in 2016. He is standard technical representative of international safety standards, including ISO 21448, ISO 3450X, SAE J3187, UL4600, etc. He is Member, Paper Chair and Editor of SAE International Automated Driving Safety Technical Committee. He conducts research and practice in highly automated driving systems safety based on projects from NSFC, MIIT and Industry partners. He is also a Senior Safety Consultant at DJI Automotive, and his joint research team*

*from Jilin University and DJI Automotive open-sourced the first Aerial Dataset for China's Congested Highways & Expressways (AD4CHE) based on UAV[4], which is published in IEEE Transactions on Intelligent Vehicles and IEEE TechRxiv and applied in automated driving system development, traffic congestion and risk analysis, etc.*

## Background:

The rapid emergence of recent technologies and their intersection with transportation research has opened new avenues for study. Unmanned Aerial Vehicles (UAVs) technologies present a unique opportunity for transportation research to study road safety and Automated Driving Systems (ADS). This workshop aims to delve into the details of modeling traffic participants' behavior, the effectiveness of UAVs in managing changing dynamics and increasing traffic demands, and current global research and development in this field. Understanding the importance of this topic to Intelligent Transportation Systems (ITS) is crucial, as it offers fresh, independent perspectives on existing environments, detailed insights, and the potential to set new benchmarks in road safety with emerging datasets.

Over the last few years, interest in aerial imagery and associated research in ITS has significantly grown. Academic research accompanied by development in industry has opened up opportunity for advanced research. As a result, we have seen the emergence of multiple new datasets that are captured through UAVs. These datasets capture key behaviors of multimodal traffic [1], infrastructure health, and traffic incident management. UAVs enable novel directions to existing research in ITS community, including VRU safety, trajectory tracking, traffic modeling, safety modeling, smart infrastructure, perception, sensor fusion, and V2X. It covers a large spectrum of research from fundamental methods to key applications. UAVs have shown tremendous promises, however, yet to demonstrate true disruption. We expect that the proposed workshop will help pioneer the field of UAV research in ITS.

## Objectives:

The objectives of the workshop are as follows:

12. To demonstrate the utility of drone imagery and associated datasets to study traffic safety.
13. To investigate the dynamics of Vulnerable Road Users (VRUs) and their interactions with other vehicles.
14. Discuss merits and limitation of aerial imagery based traffic safety analysis.
15. To facilitate discussions on creating large-scale drone data collections, targeted for multiple applications in ITS.
16. To examine the role and utilities of UAVs in accident scene analysis and emergency response.
17. To examine the role and utilities of UAVs in roadway infrastructure analysis.
18. To provide insights into current drone technology and industry standards.
19. Discuss regulations governing drone-based deployments and research. This can include regulations from industry, and government agencies.
20. To explore the use of drone datasets for studying ADS behavior and their interactions with traffic participants.
21. To analyze human driver behavior at intersections.

22. To explore the roles and utilities of UAVs in smart cities.

## Workshop Details

We propose a full day workshop. The workshop will cover a broad set of topics including fundamental research, industry standards, and regulation guidelines. We will also introduce a new dataset that have been collected by Tsinghua University, China, and Virginia Tech Transportation Institute, USA. We expect that this dataset will start a new benchmark competition in upcoming IEEE IVs. We expect to invite three keynote speakers who are experts in the field. We have already started to communicate with experts and prepared a tentative list. The list will be finalized before the actual program and will be shared with the IEEE IV organizing committee.

The workshop will also include a call for paper. We encourage researchers across the world to submit their cutting edge research involving aerial images, videos and/or data that helps to solve advanced problems in ITS. The submissions will be peer reviewed following the guideline by IEEE ITS. Finally, we plan to include a panel discussion involving experts from academia, industry, and government to discuss current state and future scope in the field. The tentative subjects of interests include but not limited to:

15. Traffic safety analysis
16. Traffic control
17. New Drone based dataset
18. Modeling traffic from aerial image/video/data
19. Edge technology for Drones
20. Scene analysis from aerial images
21. Intersection safety using aerial images
22. Smart City management using drone dataset
23. Driving behavior analysis in complex infrastructure
24. Graph based application to aerial scene analysis
25. Perception and sensor fusion
26. ADS applications
27. Traffic incident management
28. Infrastructure health assessments including bridge and pavement
29. Novel applications

### Justification:

This workshop aligns with the IEEE IV 2024 requirements, focusing on a relevant and engaging topic, a full-day format, and inclusivity for participants with varying expertise. We will continue to update the proposal as additional information becomes available. Also, we plan to continue this workshop in following IEEE IV conferences and extend its scope and functionalities. This includes starting of a new benchmark challenge with UAV based traffic videos. The team will introduce this dataset in the 2024 version.

## Tentative Schedule

A tentative schedule is shown in Table 1. We planned three keynote sessions, four paper presentation sessions, one panel discussion.

*Table 1 Tentative Schedule of the Workshop*

<b>Time</b>	<b>Title</b>	<b>Speaker</b>
<b>09:00 AM - 09:15 AM</b>	Introduction and Welcome	Abhijit Sarkar, Hong Wang
<b>09:15 AM - 09:45 AM</b>	Dataset Introduction	Hong Wang, Abhijit Sarkar
<b>09:45 AM - 10:30 AM</b>	Keynote 1: Technical?	Tentative, Technische Universität München
<b>10:30 – 10:45</b>	Break	
<b>10:45 AM - 11:20 AM</b>	Paper Presentation: Track 1	Led by Yuxin Zhang, Jilin University
<b>11:20 AM – 12:00 PM</b>	Paper Presentation: Track 2	Led by Hong Wang
<b>12:00 PM – 1:15 PM</b>	Lunch	
<b>1:15 PM – 1:45 PM</b>	Keynote 2: Industry, regulation?	Tentative, DJI Automotive
<b>1:45 PM – 2:20 PM</b>	Paper Presentation: Track 3	Led by Abhijit Sarkar
<b>02:20 PM – 2:55 PM</b>	Paper Presentations: Track 4	Led by Hong Wang
<b>2:55 – 3:10</b>	break	
<b>3:10 PM - 3:40 PM</b>	Keynote3: Research/ Regulations	Tentative: Oak Ridge National Lab/ FAA
<b>3:40 PM – 04:40 PM</b>	Panel Discussion: Future of UAV in safety research	Moderator: Abhijit Sarkar, Hong Wang
<b>4:40 PM – 5:00 PM</b>	Conclusion	Abhijit Sarkar, Hong Wang

### Possible tracks for paper presentation:

1. Intersection Safety/Road Safety
2. VRU safety
3. ADS Applications
4. Smart city applications
5. Trajectory tracking
6. Edge Computing
7. Sensor Processing and Perception from Aerial Images
8. Driving Behavior Analysis in Complex Infrastructure

### Sponsor/Support:

We are currently in the process of seeking sponsorship and support. We will update this section as sponsors are confirmed.

## List of Speakers (tentative):

- Keynote 1: Technical (Tentative, Technische Universität München)
- Keynote 2: Industry, Regulation (Tentative, *DJI Automotive*)
- Keynote 3: Practice/ Research/ Governnance? (Tentative: Oak Ridge National Laboratory)
- Additional speakers for *paper presentation tracks* to be confirmed.

## Expected Attendance:

IEEE IV attracts a diverse audience including academia, industry, and government. We anticipate a capture a diverse audience of 100-150 individuals with a keen interest in this workshop. Given the popularity of UAV research and demonstrated utilities in recent years, we expect a large group of researchers and practitioners to be involved in this workshop.

## Special Requests:

1. Adequate presentation facilities.
2. Remote meeting capabilities, as a contingency for last-minute visa issues for potential speakers and attendees.
3. Accessible room arrangements (details to be determined closer to the conference).
4. Certification of participation.

## Publicity and Outreach Efforts:

During the preparation of the proposal the team has already reached out to several researchers across the world and received positive responses. This includes representatives from DJI Automotive, Oak Ridge National Laboratory, and Technische Universität München.

After acceptance, we will actively use social media at both personal and institute levels, engage with relevant organizations such as Mid-Atlantic Aviation Partnership (MAAP) and Center for Equitable Advanced Aerial Mobility (CEAAM) at Virginia Tech, and DOTs. This will ensure wide outreach and participation. The organizing team will reach out to researchers who have already worked in this area. Additionally, the organizers will communicate with local research groups and industry partners at South Korea to attract participation including KAIST. The organizers and their respective institution will use social media outlets to promote this workshop. The team will work with IEEE ITS group to promote the workshop as well.

## References

- [1] Xu, Y., Shao, W., Li, J., Yang, K., Wang, W., Huang, H., ... & Wang, H. (2022, October). SIND: A drone dataset at signalized intersection in China. In *2022 IEEE 25th International Conference on Intelligent Transportation Systems (ITSC)* (pp. 2471-2478). IEEE.
- [2] Shao, W., Xu, Y., Li, J., Lv, C., Wang, W., & Wang, H. (2023). How Does Traffic Environment Quantitatively Affect the Autonomous Driving Prediction?. *IEEE Transactions on Intelligent Transportation Systems*.



- [3] Yang, Kai, Boqi Li, Wenbo Shao, Xiaolin Tang, Xiaochuan Liu, and Hong Wang. "Prediction Failure Risk-Aware Decision-Making for Autonomous Vehicles on Signalized Intersections." *IEEE Transactions on Intelligent Transportation Systems* (2023).
- [4] Yuxin Zhang, Cheng Wang, Ruilin Yu, Luyao Wang, Wei Quan, Yang Gao, Pengfei Li, "The AD4CHE Dataset and Its Application in Typical Congestion Scenarios of Traffic Jam Pilot Systems," in *IEEE Transactions on Intelligent Vehicles*, vol. 8, no. 5, pp. 3312-3323, May 2023.
- [5] Max G. Bareiss. A Dataset of Vehicle and Pedestrian Trajectories from Normal Driving and Crash Events in One Year of Virginia Traffic Camera Data. PhD thesis, Biomedical Engineering, Virginia Tech, 2023.
- [6] Papakis, I., Sarkar, A., & Karpatne, A. (2020). Gcnmatch: Graph convolutional neural networks for multi-object tracking via sinkhorn normalization. arXiv preprint arXiv:2010.00067.
- [7] Papakis, I., Sarkar, A., & Karpatne, A. (2021, September). A graph convolutional neural network based approach for traffic monitoring using augmented detections with optical flow. In 2021 IEEE International Intelligent Transportation Systems Conference (ITSC) (pp. 2980-2986). IEEE.
- [8] Sonth, A. P. (2023). Enhancing Road Safety through Machine Learning for Prediction of Unsafe Driving Behaviors (Masters' thesis, Virginia Tech).
- [9] Sonth, A. P., Sarkar, A., et al (2023), Real Time Risk Prediction at Signalized Intersection Using Graph Neural Network, Safe-D UTC final report (under review)

## Bibliography

- [1] Christoph Glasmacher, Robert Krajewski, and Lutz Eckstein. An automated analysis framework for trajectory datasets. arXiv preprint:2202.07438, 2022.
- [2] Frederik Diehl, Thomas Brunner, Michael Truong Le, and Alois Knoll. Graph neural networks for modelling traffic participant interaction. In *IEEE Intelligent Vehicles Symposium (IV)*, pages 695–701, 2019.
- [3] Xiaoyu Mo, Yang Xing, and Chen Lv. Heterogeneous edge-enhanced graph attention network for multi-agent trajectory prediction. arXiv preprint:2106.07161, 2021.
- [4] Julian Bock, Robert Krajewski, Tobias Moers, Steffen Runde, Lennart Vater, and Lutz Eckstein. The ind dataset: A drone dataset of naturalistic road user trajectories at german intersections. In *IEEE Intelligent Vehicles Symposium (IV)*, pages 1929–1934, 2020.
- [5] Tobias Fleck, Karam Daaboul, Michael Weber, Philip Schörner, Marek Wehmer, Jens Doll, Stefan Orf, Nico Sußmann, Christian Hubschneider, Marc Ren'e Zofka, Florian Kuhnt, Ralf Kohlhaas, Ingmar Baumgart, Raoul Zöllner, and J. Marius Zöllner. Towards large scale urban traffic reference data: Smart infrastructure in the test area autonomous driving baden-württemberg. In *Intelligent Autonomous Systems 15 - Proceedings of the 15th International Conference*, pages 964–982, 2018.
- [6] Wei Zhan, Liting Sun, Di Wang, Haojie Shi, Aubrey Clausse, Maximilian Naumann, Julius Kümmerle, Hendrik Königshof, Christoph Stiller, Arnaud de La Fortelle, and Masayoshi Tomizuka. INTERACTION Dataset: An INTERNATIONAL, Adversarial and Cooperative moTION Dataset in Interactive Driving Scenarios with Semantic Maps. arXiv:1910.03088, 2019.

- [7] Maximilian Zipfl and J Marius Zöllner. Towards traffic scene description: The semantic scene graph. In IEEE 25th International Conference on Intelligent Transportation Systems (ITSC), pages 3748–3755, 2022.
- [8] Xiwen Chen, Hao Wang, Abolfazl Razi, Brendan Russo, Jason Pacheco, John Roberts, Jeffrey Wishart, Larry Head, and Alonso Granados Baca. Network-level safety metrics for overall traffic safety assessment: A case study. IEEE Access, 2022.'
- [9] Bianchi, E., Abbott, A. L., Tokekar, P., & Hebdon, M. (2021). COCO-bridge: Structural detail data set for bridge inspections. Journal of Computing in Civil Engineering, 35(3), 04021003.