IEEE ITSC 2025

Invited Session Proposal

- Title:

Foundation Model-Enabled Scene Understanding, Reasoning, and Decision-Making for Autonomous Driving and ITS

- Modality:
  - Half-day (3 hours plus breaks)

- Scope (no longer than 1 page), including the following sections:

Motivation and general scope

This year's invited session continues the focus on foundation models, with a particular emphasis on large language models (LLMs) and vision-language models (VLMs) as emerging tools for advancing scene understanding, reasoning, and decision-making in autonomous driving and intelligent transportation systems (ITS). These models offer new pathways to incorporate general, human-like knowledge into machine perception and cognition, enabling more capable and context-aware autonomous systems. The session will explore a broad set of topics, including, but not limited to, multimodal perception, knowledge-driven planning, the development of traffic- and driving-specific LLMs/VLMs, integration of these models with reinforcement learning, and knowledge-assisted continual and lifelong learning.

Relevance to the ITS community

Recent developments in LLMs and VLMs have shown promising abilities in visual-linguistic reasoning, structured decision-making, and interpreting complex, multimodal inputs. These capabilities open new possibilities for improving the robustness, interpretability, and generalization of autonomous systems in diverse traffic environments. In addition, the session will highlight emerging directions such as vision-language-action (VLA) models, hybrid learning frameworks, and the integration of foundation models with traditional ITS methods. We welcome original contributions that are not published or currently under review elsewhere.

Topics of interest for the invited session (include, but not limited to)

• Foundation models (LLMs/VLMs) for autonomous driving and ITS.
• Continual learning, lifelong learning, reinforcement learning, and imitation learning for transportation systems and autonomous vehicles.
• LLMs/LMs enhanced situational awareness, scene understanding, and reasoning.
• Foundation-model enhanced prediction, decision-making and control.
• Knowledge-distillation for autonomous driving.
• Embodied intelligence in autonomous driving and ITS.
• Explainable and interpretable autonomous driving.
• Human-in-the-loop AI and human–vehicle interactions.
• Driving safety validation and closed-loop evaluation.
• System safety and cyber security of foundation model-based systems.
• Simulation and real-world deployment of learning-based driving systems.

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- Organizers (names, affiliations, emails, and short bio):

Organizer 1:
Songyan Zhang
Nanyang Technological University, Singapore
Songyan001@e.ntu.edu.sg
Songyan Zhang received his M.S. degree from Tongji University in 2022, and B.E. degree from Yanshan University in 2019. He worked as a research associate at Zhejiang University and is currently a Ph.D. candidate at the School of Mechanical and Aerospace Engineering, Nanyang Technological University (NTU), Singapore. His research interests lie at the VLM&VLA, autonomous driving, and 3D perception.

Organizer 2:
Wenhui Huang
Harvard University, USA.
oscarhuang@seas.harvard.edu
Wenhui Huang (Member of IEEE, ITSS, and RAS) is a Ph.D. candidate at the School of Mechanical and Aerospace Engineering, Nanyang Technological University (NTU), Singapore, and he is currently a visiting Ph.D. scholar in the Computational Robotics Group at Harvard University. His research interests lie at the intersection of continual/lifelong reinforcement learning, foundation models (VLM&VLA), automated vehicles, and embodied AI.

Organizer 3:
Yuxiao Chen
NVIDIA, USA
yuxiaoc@nvidia.com
Yuxiao Chen is a research scientist associated with the autonomous vehicle research group at Nvidia. His research focuses on planning and decision making of safety-critical autonomous systems and multi-agent systems. He received the Bachelor's degree from Tsinghua University in 2013 and Ph.D. degree from University of Michigan in 2018. Dr. Chen spent 3 years as a postdoc at Caltech before joining Nvidia in 2021. He has worked on safety-critical control and planning for autonomous vehicles, ground and aerial robots, and power networks during his Ph.D. and postdoc years, and now he mainly focuses on autonomous vehicles.

Organizer 4:
Peng Hang
Tongji University, China
hangpeng@tongji.edu.cn
Peng Hang is a Research Professor with the Department of Traffic Engineering, Tongji University, Shanghai, China. His research interests include decision making, motion planning and control for connected autonomous vehicles. He received the Ph.D. degree with the School of Automotive Studies, Tongji University, in 2019. He was a Visiting Researcher with the Department of Electrical and Computer Engineering, National University of Singapore in 2018, and a Software Engineer in the Research & Advanced Technology Dept., SAIC Motor, China in 2019. From 2020 to 2022, he served as a Research Fellow with RRC, Nanyang Technological University, Singapore.

Organizer 5:
Zhiyu Huang
University of California, Los Angeles, USA
zhiyuh@ucla.edu
Dr. Zhiyu Huang is a postdoctoral scholar at the UCLA Mobility Lab. Previously, he was a research intern at the NVIDIA Research Autonomous Vehicle Group and a visiting student researcher at UC Berkeley. He earned his Ph.D. from Nanyang Technological University in 2024. His research focuses on the intersection of robotics, mobility, and artificial intelligence (AI). His work has led to the publication of over 30 papers in top AI, ITS, and robotics journals and conferences.

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Organizer 6:
Jian Sun
Tongji University, China
sunjian@tongji.edu.cn
Jian Sun received the Ph.D. degree in traffic engineering from Tongji University in 2006. Subsequently, he was a Lecturer with Tongji University and then promoted to Professor in 2011, where he is currently a Professor with the College of Transportation Engineering, Tongji University, China. His main research interests include traffic flow theory, traffic simulation, connected vehicle-infrastructure systems, and intelligent transportation systems.

Organizer 7:
Xiaoyu Mo
KTH Royal Institute of Technology, Sweden
xmo@kth.se
Xiaoyu Mo is a postdoc researcher at KTH Royal Institute of Technology, Sweden. He received the B.E. degree from Yangzhou University, Yangzhou, China, in 2015, the M.E. degree from the Huazhong University of Science and Technology, Wuhan, China, in 2017, and the Ph.D. degree from Nanyang Technological University, Singapore in 2023. His research interests include trajectory prediction and decision making for connected autonomous vehicles.

Organizer 8:
Chen Lv
Nanyang Technological University, Singapore
lyuchen@ntu.edu.sg
Chen Lv is an Associate Professor at the School of Mechanical and Aerospace Engineering, Nanyang Technological University, and the Cluster Director in Future Mobility Solutions at ERI@N. He received his Ph.D. degree from Tsinghua University in 2016. He was a joint Ph.D. researcher at UC Berkeley, USA during 2014-2015, and a Research Fellow at Cranfield University, UK during 2016-2018. His research focuses on autonomous driving, human-machine systems, and cyber-physical systems.

- List of potential contributors (including as much detail as possible):

1. WiseAD: Knowledge Augmented End-to-End Autonomous Driving with Vision-Language Model
Songyan Zhang, Chen Lv
Nanyang Technological University, Singapore
The emergence of general human knowledge and impressive logical reasoning capacity in rapidly progressed vision-language models (VLMs) have driven increasing interest in applying VLMs to high-level autonomous driving tasks, such as scene understanding and decision-making. However, an in-depth study on the relationship between knowledge proficiency—especially essential driving expertise—and closed-loop autonomous driving performance requires further exploration. In this paper, we investigate the effects of the depth and breadth of fundamental driving knowledge on closed-loop trajectory planning and introduce WiseAD, a specialized VLM tailored for end-to-end autonomous driving capable of driving reasoning, action justification, object recognition, risk analysis, driving suggestions, and trajectory planning across diverse scenarios. We employ joint training on driving knowledge and planning datasets, enabling the model to perform knowledge-aligned trajectory planning accordingly. Extensive experiments indicate that as the diversity of driving knowledge extends, critical accidents are notably reduced on the Carla closed-loop evaluations, achieving state-of-the-art performance. Moreover, WiseAD also demonstrates remarkable performance in knowledge evaluations on both in-domain and out-of-domain datasets.

2. Vision-Language Model for Enhanced Traffic Intersection Safety

Wenhui Huang
Harvard University, USA

This study proposes a novel vision-language model (VLM) designed to enhance safety at traffic intersections by addressing vulnerabilities among road users and identifying potential environmental hazards. The model places particular emphasis on motorcyclists and elderly pedestrians, employing advanced behavior recognition to detect abrupt lane deviations, delayed crossing behaviors, and dynamically evolving hazards such as construction-induced lane obstructions. Beyond detection, the VLM contextualizes local observations by modeling inter-junction interactions within a linguistic space, enabling comprehensive risk assessments and the identification of latent vulnerabilities. Additionally, the model performs semantic reasoning to infer implicit rules from rare scenarios, including interactions between unauthorized vehicle detours and provisional infrastructure configurations. These capabilities support knowledge-driven interventions, such as generating natural language alerts, translating perceptual data into policy recommendations, and forecasting congestion risks across arterial networks. By integrating fine-grained scene semantics with urban mobility governance, the proposed framework offers a scalable and adaptive solution for aging populations and mixed-traffic environments, where transient risks demand responsive and intelligent regulatory strategies.

3. Multimodal Embodied Intelligence for Autonomous Racing

Xiangkun He
University of Electronic Science and Technology of China, China

Autonomous racing envisions a future where AI-driven vehicles accelerate technological innovation and redefine the limits of competitive mobility.

This emerging sport, grounded in frontier technologies, epitomizes the challenges of embodied intelligence under extreme conditions, compelling artificial intelligence (AI) systems to achieve human-level or even superhuman perception, decision-making, and control at physical limits. To cope with these challenges, AI racing drivers are required to explore and learn optimal driving strategies while dynamically interacting with competitors in environments characterized by high speeds, intense accelerations, and near-saturation tire forces. Human multimodality, the innate ability to simultaneously integrate multiple sensory and cognitive channels, is fundamental to cognitive development, social interaction, survival, and the construction of a rich, contextual understanding of complex environments.

Inspired by this capability, here we present Pilot, a multimodal embodied agent designed to ensure optimal racing performance at physical limits through the integration and coordination of multimodal sensing, learning, and tasking. Drawing on extensive real-world data and specialized domain knowledge optimized for operation under extreme conditions, Pilot demonstrates versatile performance across both individual time trials and competitive multi-car racing scenarios, consistently outperforming leading state-of-the-art agents.

The architecture of Pilot embodies a human-like multimodality, underscoring the potential of multimodal embodied intelligence at physical limits. Additionally, this work may inspire the adoption of integrated data- and knowledge-driven solutions across various complex, real-world applications.

4. Towards Human-Centric Autonomous Driving: A Fast-Slow Architecture Integrating Large Language Model Guidance with Reinforcement Learning

Chengkai Xu
Tongji University, China

Enabling autonomous vehicles to interpret and adapt to high-level human preferences is critical for ensuring both passenger satisfaction and operational safety. However, existing driving policies often lack the flexibility to accommodate diverse user goals and the interpretability required for seamless human-vehicle interaction. To address these challenges, we propose a “fast-slow” decision-making framework that integrates a Large Language Model (LLM) for high-level instruction parsing with a Reinforcement Learning (RL) agent for low-level real-time control. In this approach, the LLM acts as the “slow” system, translating user directives into structured guidance, while the DRL agent functions as the “fast” system, executing fine-grained control actions under strict latency requirements. This division of roles allows the system to fulfill personalized user needs while maintaining robust safety margins. Experimental evaluations across various driving scenarios demonstrate the effectiveness of our method. Compared to baseline DRL and rule-based strategies, our architecture not only

reduces collision rates but also delivers more intuitive and responsive behavior aligned with diverse passenger demands, achieving a human-centric and explainable autonomous driving paradigm.

5. A Distributed Platoon Reorganization Framework based on Multi-Agent Reinforcement Learning
Aijing Kong
Tongji University, China
Currently, most autonomous driving platoons are highly susceptible to collisions in sudden hazardous scenarios due to insufficient evasion time. This paper proposes a distributed platoon reorganization framework aimed at achieving safe avoidance of unexpected hazardous obstacles through adaptive platoon formation coordination. The proposed platoon reorganization decision-making framework is based on multi-agent reinforcement learning, treating each vehicle as an intelligent agent. the reorganization process is executed through coordinated cooperation among the agents. Additionally, this framework employs a role-based local parameter sharing mechanism, in which agents with identical roles share a common policy network, effectively addressing the issue of heterogeneous vehicle functions during the reorganization process. Moreover, the distributed decision-making framework can be conveniently extended to scenarios involving the reorganization of formations with a larger number of vehicles. Finally, we validate the algorithm's effectiveness in sudden hazardous scenarios through simulation experiments. The results demonstrate that, compared with baseline methods, the proposed formation reorganization algorithm enhances both the safety and efficiency of formation driving.

6. A Vehicle-Infrastructure Multi-layer Cooperative Decision-making Framework
Yiming Cui
Tongji University, China
Autonomous driving has entered the testing phase, but due to the limited decision-making capabilities of individual vehicle algorithms, safety and efficiency issues have become more apparent in complex scenarios. With the advancement of connected communication technologies, autonomous vehicles equipped with connectivity can leverage vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, offering a potential solution to the decision-making challenges from individual vehicle's perspective. We propose a multi-level vehicleinfrastructure cooperative decision-making framework for complex conflict scenarios at unsignalized intersections. First, based on vehicle states, we define a method for quantifying vehicle impacts and their propagation relationships, using accumulated impact to group vehicles through motif-based graph clustering. Next, within and between vehicle groups, a sequential negotiation process based on Large Language Models (LLM) is employed to determine the vehicle passage order, resulting in planned vehicle actions. Simulation results from ablation experiments show that our approach reduces negotiation complexity and ensures safer, more efficient vehicle passage at intersections, aligning with natural decision-making logic

- Intended audience and expected attendance of the invited session:

Intended audience:
Our invited session is aimed at researchers working on automated vehicles (AVs) and intelligent transportation systems (ITS), with a particular focus on learning-based methods, perception, decision-making, and motion planning and control. It also seeks to engage researchers and engineers in the coordinated automated vehicle domain who are interested in the latest advancements in safety assurance, fault-tolerant foundation models, and continual/lifelong learning techniques—recognized as key bottlenecks to achieving truly safe and reliable autonomous vehicles and intelligent transportation systems. The session will cover topics of broad interest to the ITS community, including knowledge-driven autonomous driving, shared and smart mobility, and cooperative driving technologies, fostering cross-disciplinary discussions that bridge foundational research and real-world deployment.

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Expected attendance:
Based on our analysis of attendance at similar sessions in previous ITSC conferences, we estimate that our invited session will attract between 50 and 100 attendees. This projection reflects both the continued popularity of intelligent transportation topics and the growing global interest in autonomous driving technologies. We anticipate strong engagement from a diverse audience, including professionals and researchers from the transportation, robotics, and automotive industries worldwide. Our organizing team has extensive experience in planning, promoting, and executing successful academic and industry-facing events, and we are confident in our ability to reach a large, relevant, and engaged audience.

- Contact details of the main proposers (email & mobile number):

Chen Lv
Associate Professor
Nanyang Technological University, Singapore
lyuchen@ntu.edu.sg
+65-87990961

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Call for Invited Session Proposals

IEEE International Conference on Intelligent Transportation Systems (ITSC 2025)

Gold Coast, Australia | November 18 – 21, 2025

The IEEE ITSC 2025 Technical Program Committee (TPC) solicits for **Invited Session Proposals** on cutting-edge research topics, industry applications, and emerging innovations in Intelligent Transportation Systems (ITS). The **ITSC Invited Sessions** provide a platform for focused discussions on key challenges, advancements, and interdisciplinary perspectives within the ITS community. Interested organizers are invited to submit their invited session proposals in the topic areas listed in the **Call for Papers** of the conference.

The invited session proposals should align with the conference theme:
*"**Innovative Solutions for Future Transportation**"*

Scope & Topics

Proposed sessions should focus on ITS-related topics, including (but not limited to):

- Advanced ITS Mobility Systems
- Air, Road, and Rail Traffic Systems
- Autonomous Vehicle Systems
- Cooperative and Connected Vehicles
- Cyber-Physical Systems and IoT
- Emerging ITS Technologies and Innovations
- Human Factors and Vehicle Interaction
- Infrastructure and ITS Technologies
- Intelligent Waterborne Systems
- ITS Field Tests and Implementation
- ITS Validation and Verification
- Logistics and Intelligent Freight
- Public Transport and Mobility Services
- Safety, Security, and Privacy
- Sensing, Perception, & Scene Understanding
- Traffic Data Analytics and Machine Learning

Proposal Submission Guidelines

Each Invited Session Proposal must include the following:

- **Title** – A concise and clear session title.
- **Scope** (Max. 1 pages), covering:
  - Motivation and general scope
  - Relevance to the ITS community
  - Topics of interest
- **Organizers** – Names, affiliations, emails, and short bios.
- **List of Potential Contributors** – Including tentative paper titles, authors, and affiliations (if available).
- **Intended Audience & Expected Attendance** – Identify the target audience and estimated participation.
- **Contact Details** – Provide full contact information of the proposers.

Please Note: Proposals must be submitted through the **PaperPlaza Portal**.

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Important Notes:

- Proposals that do not follow the required format or are incomplete will not be evaluated.
- Invited sessions must have at least 6 accepted papers (half-day) or 10 accepted papers (full day).
    - If a proposal does not meet the threshold, it will either not be allocated or the TPC may add additional papers from the main track to the session to ensure that the final program is properly balanced across parallel rooms.

Important Dates

- Proposal Deadlines:
    - Deadline for submitting proposals: March 23, 2025
    - Notification to proposers: March 26, 2025
- Papers Deadlines:
    - Submission Deadline: May 1, 2025
    - Notification of Acceptance: July 1, 2025
    - Final Paper Submission: July 15, 2025

Please Note: There will be no deadline extensions for any of these dates.

Submitted papers will go through the normal review process, and **proposers** will be invited to serve as **Associate Editors (AEs)** as part of the TPC. However, this does not imply that only papers from their respective sessions will be allocated; rather, session papers will be considered in the context of the overall conference program.

Review Process & Acceptance Criteria

Proposals will be evaluated based on:

- Relevance to the conference scope and theme
- Novelty and significance of the topic
- Quality and diversity of proposed contributions
- Potential impact and community interest

Further enquiries can be forwarded to: **program@2025.ieee-itsc.org**

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