Social Radars for Social Vision of Intelligent Vehicles From Skyways in Low Altitude Airspaces

Dear All,

Welcome to 2024 and Happy New Year!

The following content provides a brief summary of what we have accomplished in 2023:

- We have received 4,726 submissions have received last year, with an average acceptance rate (AR) at 10.5%, average processing days per paper (PDPP) at 20.2, and average submissions per day (SPD) at 12.9. Our current SPD is 20.9, we have received 313 manuscripts by Jan 15, 2024. A big improvement compared to what we started [1], [2], [3]. See Figs. 1 and 2 for detailed.

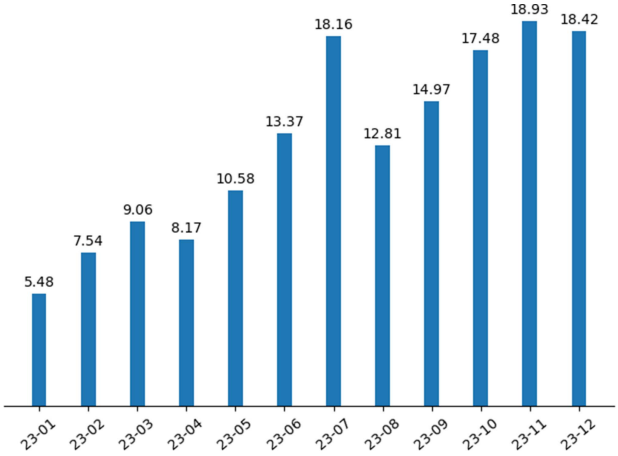

Fig. 1. SPD by Month in 2023.

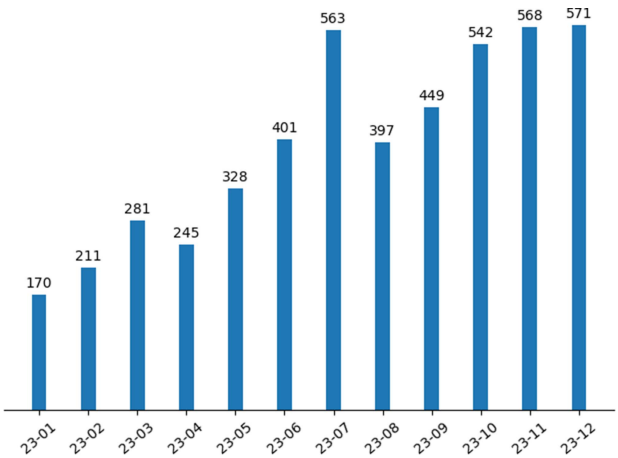

Fig. 2. Number of Submissions by Month in 2023.

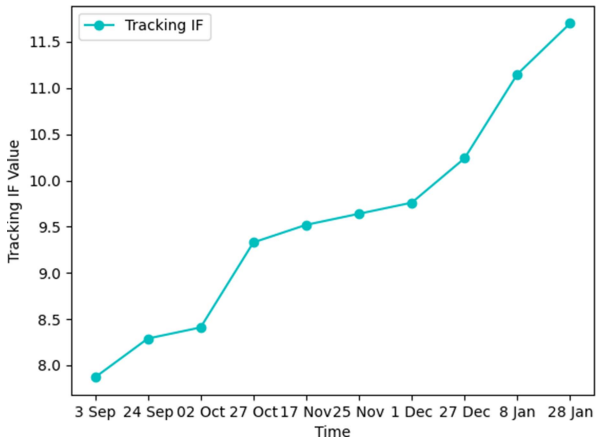

Fig. 3. Tracking Impact Factor (IF) for 2023.

- A good news, 39 of our 2023 published papers have been listed as Highly Cited Papers (HCP) by Web of Science, which is 27.86% of our total publications, a milestone since TIV has only 3 (2016-2021) and 2 (2022) HCP in 2016-2021 and 2022, respectively, reflecting the quality of our papers.
- According to the Web of Science, TIV's current tracking Impact Factor (IF) is **11.7**, another new record for our young publication, doubling our initial IF released last year [4], [5], and increasing our previous IF by more than 20%. Now we are among the Top 10 of All IEEE Publications (ranking between 5th-7th). See Fig 3 for our tracking IF.
- In 2023, the CiteScore of IEEE TIV has reached 11.8, marking a 136% increase compared to 2022. Among all academic publications in the field of transportation technology, Our TIV journal is ranked 6th.
- Starting from this issue, we would like to announce an update to our policy regarding resubmitted manuscripts as follows:
- In the interest of fairness and efficiency, we would like to provide authors with a maximum of three opportunities to resubmit the improved manuscript. Please note that after three submissions, we would no longer offer the authors the chance to resubmit unless there is a justified cause and approved by our emergency management committee.

Over the past two years, we have received a lot of emails regarding our letters from our decentralized and hybrid workshops or symposia (DHW or DHS), which not only fostered a dynamic interaction with our readers but also enhanced the visibility of TIV. To furfure enhance our interaction with authors and readers.

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This year, we would like to establish a new section "Perspective", focusing on current developments and future directions on any particular topic fitting to TIV. We warmly invite contributions and extend our sincere gratitude for your continued support of IEEE TIV.

This issue comprises 2 Perspectives, 4 letters and 237 regular papers. After Scanning the Issue, I would like to talk about social radars for social vision of Intelligent Vehicles (IVs) from skyways in low altitude airspaces.

I. Scanning the Issue

Perspective

X. Han et al., "**Foundation Intelligence for Smart Infrastructure Services in Transportation 5.0**," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3349324.

J. Chen, J. Liang, S. Teng, H. Zhang and F.-Y. Wang, "**A Lifetime Management Framework for SOTIF-Oriented Vehicle Dynamics Control: A Data-driven Approach**," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3341144.

Communication and Letters

L. Fan et al., "**A Secured Vehicle Brain: DAO-Based Collaborative Perception and Decision-Making Systems for Intelligent Vehicles in CPSS**," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3341698.

R. Guo, M. Vallati, Y. Wang, H. Zhang, Y. Chen and F.-Y. Wang, "**Sustainability Opportunities and Ethical Challenges of AI-Enabled Connected Autonomous Vehicles Routing in Urban Areas**," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3345661.

B. Li et al., "**Integrating Large Language Models and Metaverse in Autonomous Racing: An Education-Oriented Perspective**," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2024.3349466.

S. Zhou, J. Chen, S. Teng, H. Zhang and F.-Y. Wang, "**Integrating Sustainability in Future Traffic Lighting: Designing Efficient Light Systems for Vehicle, Road, and Traffic**," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3331002.

Regular Papers

K. Liu, Y. Zhang, Y. Xie, L. Li, Y. Wang and L. Chen, "SynerFill: A Synergistic RGB-D Image Inpainting Network via Fast Fourier Convolutions," in IEEE TIV doi: 10.1109/TIV.2023.3326236.

A synergistic RGB-D images inpainting method that can simultaneously inpaint RGB and depth images is presented. A large-scale, multi-scene, multi-weather RGB-D dataset based on UE4 and Carla is developed. An end-to-end RGB-D synergistic inpainting loss function based on GAN is proposed. Multiple comparative experiments are conducted on the proposed dataset and public datasets. The results show the effectiveness of the proposed model.

H. Wang, W. Hao, J. So, X. Xiao, Z. Chen and J. Hu, "A Faster Cooperative Lane Change Controller Enabled by Formulating in Spatial Domain," in IEEE TIV doi: 10.1109/TIV.2023.3317957.

This research proposes an optimal control based Cooperative Lane-Change controller. It bears a feature of a faster completion of a CLC maneuver by making space and changing lane at the same time. A formulation method in the relative spatial domain is proposed. It enhances computation efficiency by linearizing nonlinear avoidance constraints into a relative longitudinal distance fixed lateral-only avoidance constraint. The results show the effectiveness of the proposed controller.

W. Xiong, J. Liu, T. Huang, Q.-L. Han, Y. Xia and B. Zhu, "LXL: LiDAR Excluded Lean 3D Object Detection with 4D Imaging Radar and Camera Fusion," in IEEE TIV, doi: 10.1109/TIV.2023.3321240.

This paper introduces the LiDAR-Excluded Lean (LXL) model, designed for 4D imaging radar and camera fusion-based 3D object detection. It employs an innovative technique to enhance the precision of image bird's-eye view feature extraction by integrating predicted image depth distribution maps and radar 3D occupancy grids for image view transformation. Experimental results unequivocally demonstrate the LXL model's exceptional accuracy in 3D object detection, positioning it as a potential benchmark within this domain.

M. Awan, J. Shin and T. K. Whangbo, "Trajectory Prediction of Heterogeneous Traffic Agents With Collision Vigilance and Avoidance," in IEEE TIV, doi: 10.1109/TIV.2023.3293088.

The extent of collision likelihood is computed for each agent's move and guided to long short-term memory network during model training. Ground-truth information about the collision alertness among neighboring nodes' trajectories is not available, therefore, reinforcement learning is employed for learning this task. Extensive evaluation results on Apolloscape and Argoverse benchmark datasets are conducted. A substantial performance improvement of the proposed method over the state-of-the-art methods is achieved in terms of average displacement error and the final displacement error

P. S. Chib and P. Singh, "Recent Advancements in End-to-End Autonomous Driving using Deep Learning: A Survey," in IEEE TIV, doi: 10.1109/TIV.2023.3318070.

A comprehensive survey delves into the End-to-End autonomous driving paradigm. The survey categorizes recent developments by principles, methodologies, and functionality. It also addresses sensor input, learning approaches, and model evaluation. Safety and explainability aspects are discussed in depth. The review concludes by assessing the current state, highlighting challenges, and exploring promising future directions.

V. P. Chellapandi, L. Yuan, C. G. Brinton, S. H. Żak and Z. Wang, "Federated Learning for Connected and Automated Vehicles: A Survey of Existing Approaches and Challenges," in IEEE TIV, doi: 10.1109/TIV.2023.3332675.

Federated learning (FL) is a decentralized ML approach that enables multiple vehicles to collaboratively develop models, broadening learning from various driving environments, enhancing overall performance, and simultaneously securing local vehicle data privacy and security. This survey paper presents a review of the advancements made in the application of FL for CAV (FL4CAV).

Z. Shen, G. Zhou, H. Huang, C. Huang, Y. Wang and F.-Y. Wang, "Convex Optimization-Based Trajectory Planning for Quadrotors Landing on Aerial Vehicle Carriers," in IEEE TIV, doi: 10.1109/TIV.2023.3327263.

This paper presents a novel trajectory planning algorithm for quadrotors landing on aerial vehicle carriers (AVCs). The algorithm involves a quadrotor trajectory planning method based on the lossless convexification (LC) theory and a sequential convex programming (SCP) method enabling quadrotors to autonomously land on both static and moving AVCs in a three-dimensional space. By incorporating landing cone constraints, the safety of the quadrotor during landing is ensured.

S. Choi, H. Shon and K. Huh, "Interpretable Vehicle Speed Estimation Based on Dual Attention Network for 4WD Off-Road Vehicles," in IEEE TIV, doi: 10.1109/TIV.2023.3323283.

A robust algorithm for estimating the speed of four-wheel drive (4WD) vehicles on off-road terrain is proposed. The algorithm leverages a dual attention network to capture vehicle-terrain interactions by identifying important signals and times. Instead of directly estimating the vehicle speed, the wheel slip ratios are estimated, and the vehicle speed is calculated from the slip ratios to provide interpretability and accuracy. The effectiveness of the proposed method is demonstrated through real-world data from various terrains.

W. T. Chor, C. P. Tan, A. S. M. Bakibillah, Z. Pu and J. Y. Loo, "Robust Vehicle Mass Estimation Using Recursive Least M-Squares Algorithm for Intelligent Vehicles," in IEEE TIV, doi: 10.1109/TIV.2023.3318972.

This paper proposes a robust Recursive Least M-Squares with Multiple Forgetting Factors (RLM-SMFF) algorithm for reliable vehicle mass estimation in the presence of impulsive disturbance. In particular, a restructured longitudinal dynamics model and a bias reduction strategy are introduced to enhance the accuracy of the mass estimation even when the sampling rate is low. An M-estimator is incorporated to suppress the effects of the impulsive disturbance. The stability of our proposed algorithm is also verified mathematically. We evaluated our proposed algorithm using extensive simulations, which showed that our method demonstrates superior accuracy compared to existing mass estimation algorithms, at low computational demand.

M. Fayaz, J. Khan and M. Bilal, "Effectual Energy Consumption and User Comfort Optimization Based on Dynamic User Set Parameters in Electric Vehicles," in IEEE TIV, doi: 10.1109/TIV.2023.3331969.

This paper propose a model based on optimization, machine learning, smoothing, and control algorithms. The purpose of the proposed model is two folds, first, to minimize energy consumption and second, to maximize user comfort. The suggested model comprises three main modules: the smoothing module, the optimization module, and the control module. In the smoothing module, the alpha-beta filter, the simplest and most effective filter, has been used to remove noise and smooth the data. The optimization module is further divided into two sub-modules: the FA-GA module and the support vector machine module.

A. Forootani, M. Rastegar and H. Zareipour, "Transfer Learning-based Framework Enhanced by Deep Generative Model for Cold-Start Forecasting of Residential EV Charging Behavior," in IEEE TIV, doi: 10.1109/TIV.2023.3328458.

This paper proposes a transfer learning-based framework to address the cold-start forecasting of newly committed EVs' behavior at homes. First, plug-out hours of charging events are forecasted. Then, they are used as an auxiliary feature to predict the required energy. In the proposed framework, middle layers of the pre-trained model are frozen and a shortcut is made between the output and input layers during backpropagation. A generative adversarial network is also employed to improve the accuracy of forecasting.

A. Gkillas, A. S. Lalos, E. K. Markakis and I. Politis, "A Federated Deep Unrolling Method for Lidar Super-resolution: Benefits in SLAM," in IEEE TIV, doi: 10.1109/TIV.2023.3331533.

A novel federated deep unrolling framework for Lidar Super resolution is proposed, notably improving Lidar-based SLAM methodologies using only low-cost and low-resolution lidar sensors. Our method enables collaboration among individual vehicles during the learning phase via an adaptive federated optimization problem, which can be solved using an explainable deep unrolling method. Through extensive numerical evaluations on real-world Lidar based SLAM applications, our proposed framework demonstrates superior performance compared to other approaches.

Y. Jin, M. Hoffmann, A. Deligiannis, J.-C. Fuentes-Michel and M. Vossiek, "Semantic Segmentation-Based Occupancy Grid Map Learning With Automotive Radar Raw Data," in IEEE TIV, doi: 10.1109/TIV.2023.3322353.

Autonomous driving relies on precise road scene understanding. While occupancy grid mapping is commonly used for road scene interpretation, radar sensors are emerging due to their robustness and affordability. This study introduces a transformer-based, data-driven model for radar-based occupancy grid mapping that utilizes the range-Doppler matrix. Compared to traditional methods, the new model shows superiority, especially at distant ranges. Additionally, the model distinguishes moving objects effectively using a radar-based occupancy flow.

D. L. S. Lubanco, A. Hashem, M. Pichler-Scheder, A. Stelzer, R. Feger and T. Schlechter, "R3O: Robust Radon Radar Odometry," in IEEE TIV, doi: 10.1109/TIV.2023.3324941.

The odometry algorithm is under the realm of direct methods, and it exploits properties of the Fourier transform for decoupling the changes in orientation from the changes in translation. In the first step, the Radon transform along with phase-correlation, outlier removal, robust measure of central tendency, keyframe selection and graph optimization are used in order to achieve a robust method for estimating the change in orientation, next the translation is estimated with the support of phase-correlation. The algorithm's performance was evaluated with real world data. Significant improvements in position and orientation error in terms of relative pose error and the KITTI odometry error metric are shown as compared to other direct methods for radar based odometry.

S. Miraliev, S. Abdigapporov, V. Kakani and H. Kim, "Real-Time Memory Efficient Multitask Learning Model for Autonomous Driving," in IEEE TIV, doi: 10.1109/TIV.2023.3270878.

This study proposes a real-time memory efficient multitask learning-based model for joint object detection, drivable area segmentation, and lane detection tasks. To accomplish this research objective, the encoder-decoder architecture efficiently utilized to handle input frames through shared representation. Comprehensive experiments conducted on a challenging public Berkeley Deep Drive(BDD100 K) dataset. For further performance comparisons, a private dataset consisting of 30 K frames was collected and annotated for the three aforementioned tasks.

S. Park, E. Andert and A. Shrivastava, "Blame-Free Motion Planning in Hybrid Traffic," in IEEE TIV, doi: 10.1109/TIV.2023.3264684.

Given that eliminating accidents is impossible, an achievable goal is to design AVs in a way so that they will not be blamed for any accident in which they are involved in. In this paper, we propose BlaFT Rules – or Bla me- F ree hybrid T raffic motion planning Rules. An AV following BlaFT Rules is designed to be cooperative with HVs as well as other AVs, and will not be blamed for accidents in a structured road environment. We provide proofs that no accidents will happen if all AVs are using a BlaFT Rules conforming motion planner, and that an AV using BlaFT Rules will be blame-free even if it is involved in a collision in hybrid traffic. We implemented a motion planning algorithm that conforms to BlaFT Rules called BlaFT.

N. Pourjafari, A. Ghafari and A. Ghaffari, "Navigating Unsignalized Intersections: A Predictive Approach for Safe and Cautious Autonomous Driving," in IEEE TIV, doi: 10.1109/TIV.2023.3321275.

This work addresses the challenging problem of online speed planning along a predefined traverse path based on an interaction-aware prediction algorithm in an unsignalized intersection. Our goal is to mimic the behavior of a real driver and calculate the appropriate acceleration value at every time step based on that behavior. The algorithm aims to promote a more comprehensive and cautious driving behavior in autonomous vehicles.

F. R. Ghadi, M. Kaveh and D. Martín, "Performance Analysis of RIS/STAR-IOS-aided V2V NOMA/OMA Communications over Composite Fading Channels," in IEEE TIV, doi: 10.1109/TIV.2023.3337898.

This paper investigates how the deployment of reconfigurable intelligent surface (RIS) and a simultaneous transmitting and reflecting intelligent omni-surface (STAR-IOS) affect the performance of vehicle-to-vehicle (V2V) networks under non-orthogonal multiple access (NOMA) and orthogonal multiple access (OMA) scenarios, where all corresponding channels undergo composite fading. Therefore, the authors derive the closed-form expressions of the outage probability, ergodic capacity, and energy efficiency. The results indicate that considering RIS/STAR-RIS in V2V communications significantly improves the communication performance of intelligent transportation systems (ITS).

F. Tarhini, R. Talj and M. Doumiati, "Dual-Level Control Architectures for Over-Actuated Autonomous Vehicle's Stability, Path-Tracking, and Energy Economy," in IEEE TIV, doi: 10.1109/TIV.2023.3333273.

A novel dual-level control architecture for autonomous over-actuated vehicles is proposed, comprising high and low levels. Two control approaches are developed at the high level, leveraging Super-Twisting Sliding Mode and LPV/H-infinity control techniques. At the low level, four strategies, including static, dynamic, and optimal approaches, are conceived and centred around an original torque allocation configuration. The control architectures are assessed globally in the viewpoint of performance, stability, and energy economy.

M. R. Oudainia, C. Sentouh, A.-T. Nguyen and J.-C. Popieul, "Adaptive Cost Function-Based Shared Driving Control for Cooperative Lane-Keeping Systems With User-Test Experiments," in IEEE TIV, doi: 10.1109/TIV.2023.3317979.

A shared control method with a dynamic driver-automation conflict management is developed for cooperative lane keeping systems. This human-centered control approach considers the driver activity and the surrounding risks to adapt the driving assistance level via an adaptive cost function. LPV control is leveraged to handle the time-varying speed and the assistance level. Using Lyapunov theory, the shared control design is recast as a convex optimization problem. User-test experiments are performed to demonstrate the effectiveness from both objective and subjective viewpoints.

V. Renganathan, Q. Ahmed and D. Jung, "Enhancing the Security of Automotive Systems using Attackability Index," in IEEE TIV, doi: 10.1109/TIV.2023.3332006.

An attack index is derived by analyzing the placement of attack vectors in relation to the redundant and non-redundant parts, using the canonical decomposition of the structural model. The security implications of the residuals are determined by analyzing the computational sequence and the placement of the sensors. Thus, this work promotes the notion of security by design by proposing sensor placement strategies to enhance the overall security index. Finally, it is verified how the proposed attack index and its analysis could be used to enhance automotive security using Model-In-Loop (MIL) simulations.

J. Dandapat, N. Gupta, S. Agarwal and B. Kumbhani, "Service Time Maximization for Data Collection in Multi-UAV-Aided Networks," in IEEE TIV, doi: 10.1109/TIV.2023.3287629.

This paper aims to maximize the service time of the UAVs by jointly optimizing the three-dimensional (3D) trajectory of the UAVs and resources allocated to each node by the UAVs such that each mobile node receives a minimum specified data rate. To facilitate a solution, we construct an equivalent problem that considers the UAV's energy consumption. In particular, we minimize the maximum energy consumed by the UAVs in each time slot. To solve the problem, an iterative approach is presented that decouples the problem into two sub-problems. The optimal location of the UAVs is computed in the first sub-problem, while resource allocation is carried out in the second sub-problem.

T. D. Micklitz, M. Fellmann and C. Röcker, "Designing User Interfaces for Automated Driving: A Simulator Study on Individual Information Preferences," in IEEE TIV, doi: 10.1109/TIV.2023.3322261.

This paper familiar with Automatic Cruise Control prefer less system limit information, while higher experience with Steering Assists relates to higher preference in this regard. These findings add concrete mechanisms to the theory of personalized AD UIs and inform product development on how to create more personalized user experiences. By this, we aim to address challenges regarding the acceptance, adoption, and usage of AD.

T. Mijit, E. Firkat, X. Yuan, Y. Liang, J. Zhu and A. Hamdulla, "LR-Seg: A Ground Segmentation Method for Low-Resolution LiDAR Point Clouds," in IEEE TIV, doi: 10.1109/TIV.2023.3329824.

This paper achieves faster processing speed, the method first divides the original point cloud into sub-regions of different sizes based on the distribution characteristics of the sparse point cloud data in the XOY plane. Then, the point clouds are appropriately assigned, and most of the non-ground points in each sub-region are removed using the PCA plane fitting method. Finally, the point cloud geometric feature information within each sub-region is used to reduce over-segmentation. The experimental results show that our method can perform ground segmentation quickly on flat and slope road sections, and the average F1 score can be maintained above 90% with an average time of 3 ms, which is suitable for various road environments.

J. F. Medina-Lee, V. Trentin, J. L. Hortelano, A. Artuñedo, J. Godoy and J. Villagra, "IAMP¬: Framework for Online Motion Planning Using Interaction-Aware Motion Predictions in Complex Driving Situations," in IEEE TIV, doi: 10.1109/TIV.2023.3315323.

The resulting predictions are fed into a sampling-based maneuver and trajectory planning algorithm that identifies the possible collision points for every generated trajectory candidate and acts accordingly. This framework enables the automated driving system to have a more agile behavior than other strategies that use more simplistic motion prediction models and where the planning stage does not provide feedback. The approach has been successfully evaluated and compared with a state-of-art approach in highly-interactive scenarios generated from public datasets and real-world situations in a software-in-the-loop simulation system.

X. Zhang, X. Xu, J. Li, Z. Zhang, Z. Zhang and G. Brunauer, "Observer-based Fuzzy Adaptive Fault-tolerant Control for NSC System of USV with Sideslip Angle and Steering Machine Fault," in IEEE TIV, doi: 10.1109/TIV.2023.3332866.

The fault-tolerant control of unmanned surface vehicle (USV) is discussed. An observer-based fuzzy adaptive fault-tolerant control technique is proposed to mitigate the effect of fault and ensure the stability of navigation. The simulation results show the effectiveness and apparent performance of the developed method.

F. Cao et al., "MCHFormer: A Multi-Cross Hybrid Former of Point-Image for 3D Object Detection," in IEEE TIV, doi: 10.1109/TIV.2023.3323518.

The proposed Multi-Cross Hybrid Former (MCHFormer) addresses the issue of mismatch between local and global information in downscaling multimodal data for 3D object detection in autonomous driving by cross-fusing LiDAR with cameras. The proposed approach integrates fine-grained area information, incorporates raw point coordinates via position coding, and aligns point cloud with image information. Extensive experiments demonstrate its accuracy, generalization capability, and effectiveness in real road scenarios compared to SOTA algorithms.

L. Chen et al., "HVP-Net: A Hybrid Voxel- and Point-Wise Network for Place Recognition," in IEEE TIV, doi: 10.1109/TIV.2023.3308116.

This article proposes a point-cloud-based place recognition method to improve the generalization ability for unseen environments. The model combines sparse convolutions to capture local details and efficient attention mechanisms for global representations and fuses voxel- and point-wise features interactively. Additionally, a positive-ranking guided triplet loss is proposed to keep the consistency of distance ranking between anchor-positive pairs in both Euclidean and feature space. Experimental results on the benchmark, KITTI, NCLT, and a self-collected dataset show that HVP-Net achieves state-of-the-art performance.

P. Chen et al., "ECMD: An Event-Centric Multisensory Driving Dataset for SLAM," in IEEE TIV, doi: 10.1109/TIV.2023.3339144.

This paper proposes, ECMD, an event-centric multisensory dataset containing 81 sequences and covering over 200 km of various challenging driving scenarios. ECMD provides data from two sets of stereo event cameras with different resolutions, stereo industrial cameras, an infrared camera, a top-installed mechanical LiDAR with two slanted LiDARs, two consumer-level GNSS receivers, and an onboard IMU. Meanwhile, the ground-truth of the vehicle was obtained using a centimeter-level high-accuracy GNSS-RTK/INS navigation system.

S.-A. Chen, Y.-Z. Sun, J.-C. Tong and J.-C. Wang, "Newly developed current source based shortening and modeling methods for magnetorheological damper response time," in IEEE TIV, doi: 10.1109/TIV.2023.3321986.

To design an effective intelligent control algorithm for performance improvement of the MR semi-active suspension for intelligent vehicles, there is a demand to considerably shorten and precisely model the MR damper response time. A rapid response current source is developed to shorten the output current response time, and the corresponding experimental method is proposed to provide measurement data to accurately model both the MR damper's rising and descending response times. Firstly, a unilateral series pre-charged capacitor based current source and the corresponding receding design method are presented. Subsequently, the experimental scheme is designed to test the MR damper's rising and descending response times under both different exciting sine displacement frequencies and square-waved control current amplitudes. Consequently, both the MR damper's rising and descending response times are precisely modeled.

X. Chen, W. Zhang, H. Bai, C. Xu, H. Ding and W. Huang, "Two-Dimensional Following Lane-Changing (2DF-LC): A Framework for Dynamic Decision-Making and Rapid Behavior Planning," in IEEE TIV, doi: 10.1109/TIV.2023.3324305.

This paper introduces a novel framework for lane-changing trajectory planning, named 2DF-LC, which applies a sigmoid-based intelligent driver model (SIDM) to simulate both longitudinal and lateral motion of vehicles. The framework can generate human-like and safe lane-changing trajectories by imitating human drivers' behavior and decision-making, and by optimizing the comfort and smoothness of the maneuvers. The simulation shows the high efficiency, effectiveness, and realism of the 2DF-LC in trajectory planning by comparing it with other methods, testing it in CarSim simulations, and demonstrating that it can finish calculations within milliseconds.

L. Cheng, F. Zhao, P. Zhao and J. Guan, "UWB/INS Fusion Positioning Algorithm based on Generalized Probability Data Association for Indoor Vehicle," in IEEE TIV, doi: 10.1109/TIV.2023.3332319.

Inertial Navigation System (INS) and Ultra-wideband (UWB) fusion localization algorithm can overcome their shortcomings and achieve good localization performance for indoor vehicle. In the fusion system, the non-line of sight (NLOS) error of UWB is still a problem to be overcome. This article presents a loosely coupled method based on generalized probability data association (GPDA) to fuse INS and UWB, and on the basis of traditional GPDA, a GPDA based on modified verification gate (MVG) is proposed.

F. Dang, D. Chen, J. Chen and Z. Li, "Event-Triggered Model Predictive Control With Deep Reinforcement Learning for Autonomous Driving," in IEEE TIV, doi: 10.1109/TIV.2023.3329785.

Event-triggered model predictive control aims to alleviate the computation and/or communication burden of MPC. However, it generally requires a priori knowledge of the closed-loop system behavior for designing the event-trigger policy. This paper attempts to solve this challenge by proposing an efficient eMPC framework and demonstrates successful implementation of this framework on the autonomous vehicle path following.

T.-F. Ding, M.-F. Ge, Z.-W. Liu, L. Wang and J. Liu, "Reinforcement Learning Formation Tracking of Networked Autonomous Surface Vehicles with Bounded Inputs via Cloud-Supported Communication," in IEEE TIV, doi: 10.1109/TIV.2023.3323767.

This paper investigates formation tracking (FT) problem of the networked autonomous surface vehicles (NASVs) with bounded inputs. In order to achieve distributed control, a prescribed-time observer is employed to reshape the leader's states for the follower ASVs, which can only receive the message from the neighbor ASVs. For reducing communication costs and the negative effect of bounded inputs and the unknown uncertainties, a hierarchical reinforcement learning control (HRLC) algorithm based on the cloud-supported communication is proposed, where the cloud-supported estimator is constructed such that the estimated states approach the leader's states with the less communication costs. The local reinforcement learning controller is designed according to the actor-critic strategy such that the actual states converge to the estimated states with the given formation offset.

S. Gu, J. Lu, J. Yang, C.-Z. Xu and H. Kong, "Dense Top-View Semantic Completion with Sparse Guidance and Online Distillation," in IEEE TIV, doi: 10.1109/TIV.2023.3268241.

It is difficult to directly perform dense semantic segmentation in the top-view with sparse LiDAR data. This paper utilizes the guidance from a point-wise semantic segmentation module to simplify the task, and utilizes an online distillation strategy to only use voxel representation and 3D convolution in the teacher model, achieving a balance between efficiency and accuracy.

G. Guo, X. Zhang, Y.-X. Liu, Z. Zhao, R. Zhang and C.-L. Zhang, "Disturbance Observer-Based Finite-Time Braking Control of Vehicular Platoons," in IEEE TIV, doi: 10.1109/TIV.2023.3335151.

This paper is concerned with a problem of cooperative braking control for a platoon of vehicles subject to external disturbances. To reject the disturbances, a novel disturbance observer that requires no prior knowledge on the derivative of disturbances is developed using the time transformation method. Based on this observer, a distributed platooning controller is derived in the context of terminal sliding mode control theory. It is proved by the proposed controller that all following vehicles can track the leader to reach the target stopping positions (TSPs) with guaranteed stability, and the spacing error between two successive vehicles converges to zero in a finite time.

Y. Guo, H. Kong and S. Gu, "Unsupervised Multi-Spectrum Stereo Depth Estimation for All-Day Vision," in IEEE TIV, doi: 10.1109/TIV.2023.3331387.

Depth estimation with multi-spectrum images has the potential for more reliable depth estimation under varying illumination conditions. However, most of the existing multi-spectrum depth estimation methods rely on the supervision of ground-truth depth information or other additional complex labels or equipment, resulting in limited convenience for practical application. To address these challenges, we propose a new unsupervised all-day depth estimation framework with multi-spectrum stereo images, specifically, a thermal image (acting as the right view) and a visible-light image (acting as the left view), and they are denoted as a single frame of multi-spectrum stereo sequences.

X.-j. Han, Z. Qu, S.-y. Wang, S.-. fang Xia and S.-y. Wang, "End-to-End Object Detection by Sparse R-CNN with Hybrid Matching in Complex Traffic Scenes," in IEEE TIV, doi: 10.1109/TIV.2023.3330545.

We propose to optimize the sparse R-CNN with gated channel space attention (GCSA) and dynamic spatial multi-scale fusion (DSMSF), and perform a hybrid matching strategy for this optimized model, which combines the original one-to-one matching branch with the added one-to-many matching branch during training, and uses the one-to-one matching during inference, thus maintaining the end-to-end benefits. Our work significantly improves the detection accuracy on both traffic and non-traffic datasets, and is suitable for object detection in complex traffic scenes.

Z. Han, M. Chen, S. Shao, H. Zhu and Q. Wu, "Cooperative Multi-task Assignment of Unmanned Autonomous Helicopters Based on Hybrid Enhanced Learning ABC Algorithm," in IEEE TIV, doi: 10.1109/TIV.2023.3319110.

A hybrid enhanced artificial bee colony algorithm is proposed based on cognitive-psychological learning for the cooperative multi-task assignment of UAHs in complex battlefield environments. Individual expectation effect and personality variability are introduced to guide the evolution of the population, and the randomness of individual renewal has been effectively controlled. The simulation and physical flight experiments results show that the proposed cooperative multi-task assignment method can provide safe and efficient task execution solutions for UAHs.

L. He, W. Li, Y. Guan and H. Zhang, "IGICP: Intensity and Geometry Enhanced LiDAR Odometry," in IEEE TIV, doi: 10.1109/TIV.2023.3336376.

An improved LiDAR-only odometry method is proposed. To handle the unstable covariance matrix of side-view points, we combine the normal vector, the smallest eigenvalue of spatial covariance, and the KL divergence of local intensity to calculate the pair similarity. We then obtain the optimization weights from both the proposed similarity and planarity to consider both pair-wise and point-wise uncertainty. IGICP runs at 27 FPS on a laptop and achieves lower errors than several SOTA. The source code is open available.

X. He et al., "SSD-MonoDETR: Supervised Scale-aware Deformable Transformer for Monocular 3D Object Detection," in IEEE TIV, doi: 10.1109/TIV.2023.3311949.

A transformer-based method for monocular 3D object detection is proposed, in which a novel "Supervised Scale-aware Deformable Attention"(SSDA) layer is designed to alleviate

the noisy key points generation and support high-quality query feature aggregation. Extensive experiments on the KITTI and Waymo Open datasets demonstrate that SSDA significantly improves the detection accuracy, especially on moderate and hard objects, yielding state-of-the-art performance as compared to the existing approaches.

Y. Hou, J. Zhao, R. Zhang, X. Cheng and L. Yang, "UAV Swarm Cooperative Target Search: A Multi-Agent Reinforcement Learning Approach," in IEEE TIV, doi: 10.1109/TIV.2023.3316196.

The development of machine learning and artificial intelligence algorithms, as well as the progress of unmanned aerial vehicle swarm technology, has significantly enhanced the intelligence and autonomy of unmanned aerial vehicles in search missions, resulting in greater efficiency when searching unknown areas. However, as search scenarios become more complex, the existing unmanned aerial vehicle swarm search method lacks scalability and efficient cooperation. Furthermore, due to the increasing scale of search scenarios, the accuracy and real-time performance of global information are difficult to ensure, necessitating the provision of local information. This paper focuses on the large-scale search scenario and split it to provide both local and global information for running unmanned aerial vehicle swarm search algorithms.

Z. Hou et al., "A Learning-and-tube-based Robust Model Predictive Control Strategy for Plug-in Hybrid Electric Vehicle," in IEEE TIV, doi: 10.1109/TIV.2023.3331268.

In this paper, a learning-and-tube-based robust model predictive control (LTRMPC) strategy is proposed for a 4WD PHEV, enhancing the economic efficiency of the intricate powertrain while preserving control robustness across diverse driving scenarios. A novel observer is proposed, which uses a deep learning technique named Gated Recurrent Unit (GRU), thereby reflecting state changes accurately within the predictive horizon. Secondly, a tube-based cost function is integrated into the learning-MPC framework to restrain the state changes, further reinforcing the control robustness.

X. Hu, S. Li, T. Huang, B. Tang, R. Huai and L. Chen, "How Simulation Helps Autonomous Driving: A Survey of Sim2real, Digital Twins, and Parallel Intelligence," in IEEE TIV, doi: 10.1109/TIV.2023.3312777.

A main challenge of developing safe and low-cost autonomous driving technologies lies in transferring driving knowledge from the simulation world to the reality world, known as the reality gap. This paper reviews the solutions of this issue from the perspectives of sim2real, digital twins, and parallel intelligence, including their state-of-the-art methods, technologies, applications, and involved simulators. The presentation also sheds light on the challenges and future perspectives in the development of autonomous driving.

Y. Hui, X. Zhang, H. Shen, H. Lu and B. Tian, "DPPM: Decentralized Exploration Planning for Multi-UAV Systems Using Lightweight Information Structure," in IEEE TIV, doi: 10.1109/TIV.2023.3322705.

A decentralized exploration planning framework for multi-UAV systems is presented to balance between bandwidth usage and exploration efficiency. To conserve bandwidth, a lightweight information structure with spatial structure and exploration information is developed. Using the structure, a hierarchical planner is performed to plan exploration path, and the path is optimized by model predictive path integral control framework to generate continuous-time trajectory. Comparative experiments validate the performance of the proposed framework.

X. Jiao, J. Chen, K. Jiang, Z. Cao and D. Yang, "Autonomous Driving Risk Assessment with Boundary-based Environment Model," in IEEE TIV, doi: 10.1109/TIV.2023.3285762.

A boundary-based risk assessment method and corresponding decision-making mechanism for intelligent vehicles is proposed. The risk in the driving scenario is modeled on the environment boundary in the ego-centered polar coordinate, then the safe boundary is set to serve for decision-making as boundary constraint. Experiment results proved that the proposed method has significantly reduced computational burden than surface-level dense risk assessment with similar decision performance.

Z. Jin, C. Wang, D. Liang, S. Wang and Z. Ding, "Fixed-Time Consensus for Multiple Tractor-Trailer Vehicles with Dynamics Control: A Distributed Internal Model Approach," in IEEE TIV, doi: 10.1109/TIV.2023.3338238.

A dynamics fixed-time consensus control strategy for multiple tractor-trailer vehicles is devised. Two newly proposed dynamic compensators ensure that all vehicles estimate and construct global consensus information in fixed time only through neighbor information. And a fixed-time velocity ideal controller capable of overcoming nonholonomic constraints, exerting the desired control over postures with fixed time, and with first-order derivability capable of being tracked by the actual velocity through the design of the control torque at the dynamics level is devised.

S. Kong et al., "A Collision-Free Target Tracking Controller With Uncertain Disturbance Rejection for Quadruped Robots," in IEEE TIV, doi: 10.1109/TIV.2023.3296669.

With respect to the dynamic target tracking issue in the obstacle environment, this paper proposes a collision-free tracking framework combining a modified guidance vector field (GVF) and a disturbance rejection controller. Simulation and experimental results demonstrate that the proposed method is efficient in the multi-obstacle environment in terms of tracking the virtual dynamic target and the dynamic quadruped robot target even in the environment with uncertain disturbances.

B. Li, Y. Li, P. Yang and X. Zhu, "Adaptive neural network-based fault-tolerant control for quadrotor-slung-load system under marine scene," in IEEE TIV, doi: 10.1109/TIV.2023.3333888.

An adaptive neural network fault-tolerant control strategy is presented for quadrotor-slung-load system, in which actuator faults, marine wind and suspended payload are considered simultaneously. To effectively suppress the problem of comprehensive disturbances, a fault tolerant controller is designed by innovatively combining disturbance observer with radial basis function (RBF) neural network. In addition, the gradient descent algorithm is introduced to train the RBF to better approximate the unknown dynamics and compensate the system.

D. Li et al., "Planning-Inspired Hierarchical Trajectory Prediction Via Lateral-Longitudinal Decomposition for Autonomous Driving," in IEEE TIV, doi: 10.1109/TIV.2023.3307116.

This paper proposes a novel Planning-inspired Hierarchical (PiH) trajectory prediction framework that selects path and goal intentions through a hierarchical lateral and longitudinal decomposition. For path selection, we propose a hybrid lateral predictor to choose fixed-distance lateral paths from a candidate set of map-based road-following paths and cluster-based free-move paths. For goal selection, we propose a lateral-conditional longitudinal predictor to choose plausible goals by sampling from the selected lateral paths.

H. Li et al., "A Nonlinear Trajectory Tracking Control Strategy for Quadrotor With Suspended Payload Based on Force Sensor," in IEEE TIV, doi: 10.1109/TIV.2023.3317444.

This paper proposes a nonlinear payload trajectory tracking strategy based on the force sensor. The system employs a force sensor to measure the tension on the cable, in conjunction with the position of the quadrotor, to provide a real-time estimate of the payload position. A payload velocity observer is designed to ensure its status is always available. Furthermore, in order to meet the needs of transporting objects of varying weights, the system utilizes data feedback from the force sensor to autonomously adapt to various payload masses. Based on the payload state estimation, a payload trajectory tracking controller that only relies on onboard sensing to achieve outdoor operation is designed.

J. Li, G. Zhang, W. Zhang, Q. Shan and W. Zhang, "Cooperative Path Following Control of USV-UAVs Considering Low Design Complexity and Command Transmission Requirements," in IEEE TIV, doi: 10.1109/TIV.2023.3317336.

This paper investigates a robust cooperative path following control algorithm for an unmanned surface vessel and unmanned aerial vehicles (USV-UAVs) that releases the design complexity and command transmission requirements for the potential significance to implement a maritime square search mission. A novel threshold rule of the dynamic event-triggered mechanism and a L-function are presented aiming to the control part. Two numerical examples show the effectiveness and advantages of the proposed scheme in aspects of the design complexity and command transmission requirements.

Y. Li, S. Dong and K. Li, "Fuzzy Adaptive Finite-Time Event-Triggered Control of Time-Varying Formation for Nonholonomic Multirobot Systems," in IEEE TIV, doi: 10.1109/TIV.2023.3304064.

This paper studies the problem of fuzzy adaptive finite-time event-triggered time-varying formation tracking control for nonholonomic multirobot systems with multiple constraints. The adaptive method and fuzzy logic systems (FLSs) are employed to approximate unknown nonlinear functions in robotic dynamics. Considering the limitations of robot's vision field and communication distance, a universal barrier function and the prescribed performance technique are introduced to achieve collision avoidance and connectivity maintenance.

J. Liang et al., "A Hierarchical Control of Independently Driven Electric Vehicles Considering Handling Stability and Energy Conservation," in IEEE TIV, doi: 10.1109/TIV.2023.3335251.

This study presents a hierarchical control scheme to simultaneously guarantee the vehicle energy conservation and handling stability. In the upper layer, a robust controller is developed to address the model uncertainties and ensure the vehicle handling stability. Considering the uncertain longitudinal velocity, the lower layer utilizes a linear time-varying model predictive controller to develop the torque allocation strategy and realize energy conservation. The control authority is dynamically adjusted by assessing the vehicle safety state.

A. Lin, S. Wen, M. Zhu and X. Cai, "Risk-Aware Coordination of Logistics Scheduling and Energy Management for Maritime Mobile Microgrid Clusters," in IEEE TIV, doi: 10.1109/TIV.2023.3336523.

Exploring maritime mobile microgrid clusters, this paper presents a novel approach to coordinate energy management and logistics scheduling for all-electric ship fleets. To reduce navigation risk, a hierarchical optimization framework for efficient and safe routing, generation scheduling, and energy usage. The proposed method significantly reduces operation costs and carbon emissions, while maintaining high-quality logistics services.

Y.-H. Lin and Y.-S. Wang, "Modular Learning: Agile Development of Robust Traffic Sign Recognition," in IEEE TIV, doi: 10.1109/TIV.2023.3322407.

In contrast to a typical AI task, the self-driving car system requires a long-term development process or even endless maintenance activities. We have to address the newly discovered image corruption rapidly for a robust recognition system. Hence, we proposed our agile development framework for AI system, which is inspired from agile software development paradigm. Our agile framework of AI system, modular learning, accelerates

the development cycle significantly for each newly discovered image corruption.

C. Liu, E. J. C. Nacpil, W. Hou, Y. Qin and R. Zheng, "Evaluation of Visual Risk Perception of Automated Driving Tasks by Analyzing Gaze Pattern Dispersion," in IEEE TIV, doi: 10.1109/TIV.2023.3323340.

This study aims to evaluate the visual risk perception of automated driving tasks by analyzing the gaze pattern dispersion, which reflects the coverage of visual attention distribution. Ten participants perform manual and automated driving tasks. Each driving task includes acceleration, maintaining constant speeds, and deceleration phases. The constant speeds were set to 40, 60, and 80 km/h, and the deceleration rates were set to -2.5, -5.0, and -7.5 m/s2. The probability density estimation method is proposed to calculate gaze density regions that reflect the gaze patterns dispersion. The results indicate that automated driving causes more dispersed gaze patterns in the initial acceleration and lower speed phases.

H. Liu, N. Wang, Z. Zhang and H. Yin, "Agile and Precise Attitude Control of Tiltrotor Aircraft in Transition Flight," in IEEE TIV, doi: 10.1109/TIV.2023.3317387.

A constraint-based adaptive robust prescribed performance control (CARPPC) is proposed for TRA to follow the desired attitude while guaranteeing PTSSP, with no approximations or linearizations invoked. The desired attitudes and PTSSP are respectively described as equality and inequality servo constraints. A constraint-based control with state transformation is introduced to render both equality and inequality constraint-following. An adaptive law is established for online estimation of unknown uncertainty bounds to compensate time-varying uncertainty. Both theoretical proofs and simulation results demonstrated that CARPPC can realize agile and precise attitude control robustly in transition flight.

J. Liu, Q. Zhao, W. Xiong, T. Huang, Q.-L. Han and B. Zhu, "SMURF: Spatial Multi-Representation Fusion for 3D Object Detection with 4D Imaging Radar," in IEEE TIV, doi: 10.1109/TIV.2023.3322729.

This paper introduces a new 3D object detection model, SMURF (Spatial Multi-Representation Fusion), which relies solely on 4D millimeter-wave radar data to detect objects. SMURF addresses the challenges posed by the noise and sparsity in radar point clouds by incorporating kernel density estimation. Additionally, SMURF improves detection accuracy by extracting and fusing various representation features from the radar point cloud. The effectiveness, generalization proficiency, and real-time performance of SMURF in 3D object detection are confirmed through experimental results.

J. Liu et al., "MCVCO: Multi-MEC Cooperative Vehicular Computation Offloading," in IEEE TIV, doi: 10.1109/TIV.2023.3299381.

To overcome the challenges of poor efficiency of data transmission and limited system resources, a Multi-MEC Cooperative Vehicular Computation Offloading (MCVCO) scheme is proposed. By integrating and designing optimization algorithms of the three key phases in vehicular computation offloading, MCVCO could enhance system performance efficiently. Extensive simulation results and analyses demonstrate the effectiveness of MCVCO.

J. Liu, D. Zhou, P. Hang, Y. Ni and J. Sun, "Towards Socially Responsive Autonomous Vehicles: A Reinforcement Learning Framework with Driving Priors and Coordination Awareness," in IEEE TIV, doi: 10.1109/TIV.2023.3332080.

The framework integrates a driving prior learning (DPL) model based on a variational autoencoder to infer the driver's driving priors from human drivers' trajectories. A policy network based on a multi-head attention mechanism is designed to effectively capture the interactive dependencies between AVs and other traffic participants to improve decision-making quality. The introduction of SCA into the autonomous driving decision-making system, and the use of Coordination Tendency (CT) to quantify the willingness of AVs to coordinate the traffic system is explored.

J. Liu, S. Ding, Y. Jing and X. Xie, "A Periodic Event-triggered Vehicle Platooning Scheme Against Denial-of-Service Attacks," in IEEE TIV, doi: 10.1109/TIV.2023.3338235.

The problem of periodic event-triggered platooning control problem subject to denial-of-service attacks is addressed. Compared with common event-triggered mechanisms, the proposed periodic event-triggered communication mechanism enables monitoring periodically and increases effectively the lower bound of event intervals. A novel piecewise Lyapunov functional is developed to obtain the co-design criterion for periodic event-triggered parameters and resilient platooning controller. Such functional not only matches the sawtooth constraint but also accommodates the adverse impacts of DoS attacks.

S. Liu and J. Zhu, "Efficient Map Fusion for Multiple Implicit SLAM Agents," in IEEE TIV, doi: 10.1109/TIV.2023.3297194.

This paper presents a collaborative implicit SLAM framework that supports multiple agents running independent implicit SLAM onboard by sharing map information with the server for map fusion. Specifically, we propose a floating-point sparse octree as the structure for storing map information and aligning local maps by transforming three vertices in the octree. To ensure more accurate and efficient map fusion, our backend employs place recognition, implicit alignment, and removal of redundant data. The evaluation results show that our methods can achieve more accurate map fusion through effectively reducing overlap and noise areas.

Y. Liu, C. Yang, X. Chen and F. Wu, "Joint Hybrid Caching and Replacement Scheme for UAV-Assisted

Vehicular Edge Computing Networks," in IEEE TIV, doi: 10.1109/TIV.2023.3323217.

This propose a novel joint hybrid caching and replacement scheme in a scene that a single UAV assists RSU to cover a set of vehicle users with large number of iterative calculation tasks. In particular, both the content caching and service caching are considered for the RSU and UAV. To minimize the whole task completion delay of users, we joint optimize the hybrid caching data selection of UAV and the task offloading strategy of users, a deep Q-network (DQN)-based solution is proposed to improve the utility of UAV.

S. Lu et al., "Efficient Deep-Learning 4D Automotive Radar Odometry Method," in IEEE TIV, doi: 10.1109/TIV.2023.3311102.

Odometry is a crucial technology for the autonomous positioning of intelligent vehicles. While estimating the odometry from LiDAR and cameras has progressed recently, it remains to be seen how to estimate the odometry from a 4D radar, an emerging sensor with unique advantages over cameras and LiDAR. In this study, a deep-learning-based 4D radar odometry method, named 4DRO-Net, is proposed. The method employs a coarse-to-fine hierarchical optimization technique based on a sliding window to estimate and refine an autonomous vehicle's pose in an iterative manner.

D. Ma, X. Chen, W. Ma, H. Zheng and F. Qu, "Neural Network Model-Based Reinforcement Learning Control for AUV 3-D Path Following," in IEEE TIV, doi: 10.1109/TIV.2023.3282681.

A reinforcement learning (RL)-based control method for AUV path following is proposed. The proposed method integrates the traditional proximal policy optimization (PPO) algorithm with a neural network model. The neural network model is used to learn the state transition function to explore the spatio-temporal change patterns of the AUV as well as the surrounding environment. The simulation results show the effectiveness and robustness of the proposed control method.

Z. Qu, Z. Chen, X. Ning and P. Tiwari, "QEPP: A Quantum Efficient Privacy Protection Protocol in 6G-Quantum Internet of Vehicles," in IEEE TIV, doi: 10.1109/TIV.2023.3304852.

This protocol utilizes quantum communication technology in edge-to-cloud communication of the IoV to transmit sensitive information embedded in quantum state data, thereby ensuring privacy protection. It employs quantum error-correction coding and efficient coding techniques to extract information and recover the carriers. In addition, the protocol utilizes an improved quantum Grover algorithm in the cloud to accelerate the processing speed of quantum data. By addressing security vulnerabilities and improving cloud-computing capabilities, the QEPP can effectively accommodate critical requirements, including precision, timeliness, and robust privacy protection.

S. Shao, Z. Pei, W. Chen, Q. Liu, H. Yue and Z. Li, "Sparse Pseudo-LiDAR Depth Assisted Monocular Depth Estimation," in IEEE TIV, doi: 10.1109/TIV.2023.3299935.

The pseudo-LiDAR depends only on the camera and thus achieves a lower cost than LiDAR. To emulate the scan pattern of LiDAR, geometric sampling and appearance sampling are proposed. The former measures the vertical and horizontal azimuths of 3D scene points to establish the geometric correlation. The latter helps determine which " pseudo-LiDAR rays" return an answer and which do not. Then, we build a sparse pseudo-LiDAR-based depth estimation framework.

S. Shao, Z. An, M. Chen and Q. Zhao, "Resilient neural control based on event-triggered extended state observers and the application in unmanned aerial vehicles," in IEEE TIV, doi: 10.1109/TIV.2023.3288524.

Firstly, the constraint problem of the tracking error is transformed into an unconstrained problem based on the performance function, then the NNs are employed to approximate the uncertainties, and the ETESO with NNs is designed to estimate the combination of the approximation error and the external disturbance. Secondly, the perturbation of the controller gain is described by an external system, which is estimated by a fault observer. To avoid the problem of the differential explosion, the resilient controller is designed by the backstepping control method based on the command filter.

M. Shen, R. A. Dollar, T. G. Molnar, C. R. He, A. Vahidi and G. Orosz, "Energy-efficient Reactive and Predictive Connected Cruise Control," in IEEE TIV, doi: 10.1109/TIV.2023.3281763.

We introduce a framework for the longitudinal control of CAVs traveling in mixed traffic including connected and non-connected human-driven vehicles. Reactive and predictive connected cruise control strategies are proposed. Beyond-line-of-sight information obtained via vehicle-to-vehicle communication (V2V) is leveraged by the proposed reactive and predictive controllers. Simulations utilizing real traffic data show that connectivity can bring up to 30% energy savings in certain scenarios.

R. Song, R. Xu, A. Festag, J. Ma and A. Knoll, "FedBEVT: Federated Learning Bird's Eye View Perception Transformer in Road Traffic Systems," in IEEE TIV, doi: 10.1109/TIV.2023.3310674.

In this paper, we introduce FedBEVT, a federated transformer learning approach for BEV perception. In order to address two common data heterogeneity issues in FedBEVT: (i) diverse sensor poses, and (ii) varying sensor numbers in perception systems, we propose two approaches - Federated Learning with Camera-Attentive Personalization (FedCaP) and Adaptive Multi-Camera Masking (AMCM), respectively. To evaluate our method in real-world settings, we create a dataset consisting of four typical federated use cases.

W. Song, Y. Li and S. Tong, "Fuzzy Finite-Time H Hybrid-Triggered Dynamic Positioning Control of Nonlinear Unmanned Marine Vehicles Under Cyber-Attacks," in IEEE TIV, doi: 10.1109/TIV.2023.3281578.

This paper studies the finite-time H hybrid-triggered dynamic positioning (DP) control design problem of the T-S fuzzy unmanned marine vehicles against the deception attacks. Firstly, a state observer is designed to estimate the immeasurable states of UMVs. After that, a hybrid-triggered mechanism described by a Bernoulli variable is designed to save the communication resources. Then, a fuzzy finite-time H hybrid-triggered DP output feedback controller based on the deception attacks model is developed. The stability conditions are given in the form of LMIs.

H.-T. Sun, C. Peng, X. Ge and Z. Chen, "Secure Event-Triggered Sliding Control for Path Following of Autonomous Vehicles Under Sensor and Actuator Attacks," in IEEE TIV, doi: 10.1109/TIV.2023.3278697.

A general nonlinear security model is established to characterize the impacts of sensor and actuator attacks. Then, the feedback linearization method is exploited to linearize the established attacked model. The event-triggered control scheme is utilized to alleviate communication burden under sampled-data control framework. The sliding control design is augmented to mitigate the malicious impacts caused by such injection attacks. Thus, the security control problem for networked path following of autonomous vehicles is solved from the perspective of control theory and method.

J. Sung, S. Choi and K. Huh, "A Differential Brake-Actuated Steering System for Redundancy of Steer-by-Wire," in IEEE TIV, doi: 10.1109/TIV.2023.3337531.

This paper introduces a backup system that employs longitudinal differential forces to address Steer-by-Wire (SbW) system failures. The lateral motion and wheel steering mechanism are modeled to consider the effect of the differential longitudinal forces. A controller based on a linear quadratic regulator is developed to accurately perform the steering motion of the vehicle according to the driver's intention. The proposed brake-actuated steering system is validated through simulations and real-world experiments.

Y. Tan et al., "Dynamic Simulation Analysis of Null-flux Coil Superconducting Electrodynamic Suspension System," in IEEE TIV, doi: 10.1109/TIV.2023.3307879.

Based on dynamic circuit theory, Neumann equation, and virtual displacement method, the electromagnetic force calculation model of the null-flux coil superconducting electrodynamic suspension system is obtained, and a dynamic window algorithm is designed to accelerate the electromagnetic force calculation speed. Co- simulation platform is built to overcome the difficulty in dynamic solution of the vehicle. The results of the co-simulation reflect the motion status of the vehicle under different working conditions, revealing the potential dynamic problems of the superconducting electrodynamic suspension system.

X. Tian, Z. Zhu, J. Zhao, G. Tian and C. Ye, "DL-SLOT: Tightly-Coupled Dynamic LiDAR SLAM and 3D Object Tracking Based on Collaborative Graph Optimization," in IEEE TIV, doi: 10.1109/TIV.2023.3317308.

A tightly-coupled dynamic LiDAR SLAM and 3D object tracking system, DL-SLOT, is developed. A sliding window-based 3D object tracking method is proposed considering the historical trajectories of the tracked objects. The states of the ego-vehicle and surrounding objects are jointly estimated based on collaborative graph optimization. The experimental results confirm that solving SLAM and object tracking simultaneously is mutually beneficial in dynamic road scenarios.

T. M. Hoang, Q.-N. Van, L. T. Dung, B. C. Nguyen, N. V. Vinh and T. Kim, "Performance Analysis and Optimization of Multi-Antenna UAV-Aided Multi-User Backscatter SPC Systems," in IEEE TIV, doi: 10.1109/TIV.2023.3315281.

This paper investigates the block error rate, throughput, goodput, reliability, latency, and age of information of a multiple antenna unmanned aerial vehicle (UAV)-aided backscatter short packet communication (SPC) system. The closed-form BLER expressions are approximated by the Gaussian-Chebyshev quadrature with line-of-sight (LoS) and non-LoS (NLoS) probabilities. Optimization problems to maximize the throughput subject to the number of transmit bits and the UAV altitude and to minimize BLER subject to the UAV altitude are formulated, then solved by using the one-dimensional search method. Monte Carlo simulations verify the accuracy of analysis results.

F. Wang, J. Huang, K. H. Low and T. Hu, "Collective Navigation of Aerial Vehicle Swarms: A Flocking Inspired Approach," in IEEE TIV, doi: 10.1109/TIV.2023.3271667.

Drawing inspiration from natural migratory species, this paper presents a novel flocking-inspired approach for collective navigation in aerial vehicle swarms. By utilizing a bionic visual projection field, flocking operation can be achieved in communication-denied unknown environments. By introducing an implicit heterogeneous flocking framework, the swarm is divided into informed and uninformed agents, enabling few-to-many control and rapid navigation. Simulations and experiments validate the adaptability to different environments, swarm scalability, and robustness to vehicle failures.

S.-Y. Wang, Z. Qu and L.-Y. Gao, "Multi-spatial Pyramid Feature and Optimizing Focal Loss Function for Object Detection," in IEEE TIV, doi: 10.1109/TIV.2023.3282996.

In this paper, we propose a new architecture called YOLOM, which is specifically designed to achieve enhanced multi-object

(small objects) detection precision. YOLOM incorporates several innovative features: a multi-spatial pyramid (MSP), an optimized focal loss (OFLoss) function, and an objectness loss that incorporates effective intersection over union (EIoU) calculations. These features collectively yield enhanced accuracy and reduce the miss rate of small objects, particularly in the multi-object cases. According to the sizes of receptive field features with different spatial scales with pooling layers, we propose the MSP module.

Y. Wang et al., "A Novel Fault-tolerant Scheme for Multi-model Ensemble Estimation of Tire Road Friction Coefficient with Missing Measurements," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3336048.

A novel fault-tolerant estimation framework was proposed to estimate tire-road friction coefficient (TRFC). With the consideration of missing measurements, a fault-tolerant unscented Kalman filter was employed to predict longitudinal and lateral TRFCs respectively. To further enhance estimation accuracy, an event-driven multi-model fusion algorithm was designed to dynamically adjust the weight of different models. Different test results indicate that the designed method has high accuracy and strong adaptability under various roads

W. Li, F. Qiu, L. Li, Y. Zhang and K. Wang, "Simulation of Vehicle Interaction Behavior in Merging Scenarios: A Deep Maximum Entropy- Inverse Reinforcement Learning Method Combined with Game Theory," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3323138.

A data-driven approach to enhance safety testing for high-level autonomous vehicles in virtual scenarios is introduced. The method employs game theory to model background vehicles' behaviors, utilizing deep maximum entropy-inverse reinforcement learning to identify reward functions. The reward functions are further used to design a deep Q-network algorithm for behavior simulation. Comparative tests with natural driving data and baseline methods confirm the method's effectiveness in accurately simulating vehicle interactions in virtual scenarios.

W. Wu and S. Tong, "Collision-Free Finite-Time Adaptive Fuzzy Output-Feedback Formation Control for Unmanned Surface Vehicle Systems," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3335467.

This paper studies the collision-avoidance finite-time adaptive formation control problem for USVs. A collision-free fuzzy adaptive output-feedback formation control scheme is proposed, where a fuzzy state observer is designed to estimate the unmeasured states of USVs and a potential function is proposed to design a collision-avoidance strategy. By using finite-time stable, it is proved that the USVs are semi-global finite-time stable, the follower vehicles' output can track to the leader vehicle's output and the follower vehicle and its leader vehicle are free of collision.

M. Xie, D. Ding, B. Shen and Y. Song, "Learning-Based Platooning Control of Automated Vehicles Under Constrained Bit Rate," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3335866.

A learning-based platooning control scheme is presented for nonlinear automated vehicles under constrained bit rate. An observer based on a neural network is created to estimate the vehicle's state, and a coding-decoding scheme is implemented to decrease the communication burden. The upper bound of platoon tracking errors dependent on bit rate is analytically derived, and the desired gains can be obtained by resolving matrix inequalities that are not sensitive to the number of vehicles.

D. Xu, G. Gao, Q. Qiu, X. Shang and H. Li, "A car-following model considering missing data based on TransGAN networks," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3270336.

Car-following behavior is closely related to the longitudinal control of the vehicle, affecting the safety of the vehicle and traffic flow stability. In order to interact with the preceding vehicle, the target vehicle usually collects the driving data of the preceding vehicle. However, data acquisition devices often face malfunctions caused by various unpredictable disruptions, resulting in missing value problems. This may cause the target vehicle to make wrong control decisions. Given this situation, a new car-following(CF) model considering missing data based on Transformer-Generative Adversarial Networks (TransGAN) is proposed.

H. Xu et al., "A Mobile Edge Computing Framework for Traffic Optimization At Urban Intersections Through Cyber-Physical Integration," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3332256.

Addressing the energy inefficiencies in urban traffic, our paper introduces a mobile edge computing framework leveraging IoT. By integrating real-time vehicle-to-infrastructure communication and intelligent speed optimization algorithms into a mobile app, we aim to mitigate stop-and-go traffic patterns. The framework utilizes dynamic messaging systems, real-time speed optimization algorithms, and ad-hoc mobile computing environments. Our simulations and experiments demonstrate a 24% energy savings in the transportation system with 100% mobile app usage.

W. Xu et al., "Parallel Dispatching: An ACP-based High-speed Railway Intelligent Dispatching System," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3305536.

The antiquated method of train dispatching relying solely on dispatchers' knowledge is unable to meet the need for rapid response and effective solutions in emergency situations. This paper proposes an ACP method (Artificial System, Computational Experiment, and Parallel Execution) to explore the potential of automating the management of high-speed railway trains.

A parallel high-speed railway dispatching system is created, comprised of an actual system and its artificial counterpart.

J. Yin et al., "Reliable Global Path Planning of Off-Road Autonomous Ground Vehicles Under Uncertain Terrain Conditions," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317833.

A global path planning approach subject to two reliability constraints is proposed under uncertain terrain conditions. Two surrogate models are developed to predict off-road vehicle mobility in terms of speed and vertical acceleration. They overcome the computational challenges in path planning introduced by high-fidelity simulations. Results of a case study demonstrated the effectiveness of the proposed methods for path planning with the consideration of uncertainty in the deformable terrain.

Z. Yu, M. Zhu, K. Chen, X. Chu and X. Wang, "LF-Net: A Learning-based Frenet Planning Approach for Urban Autonomous Driving," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3332885.

We propose LF-Net, a learning-based framework to tackle the challenge of selecting appropriate terminal states and generating human-like trajectories in rule-based Frenet planning. LF-Net consists of a Transformer-based sub-network for encoding environmental and vehicle interaction features, a classification and scoring sub-network using cross-attention mechanisms to generate the optimal terminal states, and a trajectory generator based on LQR. Experimental results on the large-scale dataset show that LF-Net plans safe and human-like trajectories, outperforming baseline methods.

J. Yuan, Z. Liu, X. Xiong, Y. Ai, L. Chen and B. Tian, "UAV Path Planning with Terrain Constraints for Aerial Scanning," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3307217.

A novel global path planning approach for Vertical Takeoff and Landing (VTOL) Unmanned Aerial Vehicles (UAVs) is introduced, considering dynamics, kinematics, and terrain constraints. The method involves interpolating constant-altitude waypoints above the terrain, optimizing horizontal waypoint interpolation to account for sensor coverage, and utilizing Soft Actor-Critic-based Particle Swarm Optimization (SAC-PSO) for height optimization. The approach is further enhanced by a deep residual network (DRSN) to address optimization failures and improve algorithm stability. Simulation experiments highlight the effectiveness and path quality, while real-world tasks confirm its practical applicability.

R. Yuan, M. Abdel-Aty, Q. Xiang, Z. Wang and X. Gu, "A Temporal Multi-Gate Mixture-of-Experts Approach for Vehicle Trajectory and Driving Intention Prediction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3336310.

A Temporal Multi-task Mixture Of Experts (TMMOE) model is proposed for simultaneously predicting the vehicle trajectory and driving intention. The homoscedastic uncertainty algorithm is employed to construct the multi-task loss function. The CitySim dataset is chosen to validate the performance of the proposed model. A novel lane line reconstruction method is introduced to mitigate errors in the dataset. Experimental results demonstrate the utility of the proposed model.

Z. Zang et al., "A Unified Framework Integrating Trajectory Planning and Motion Optimization Based on Spatio-Temporal Safety Corridor for Multiple AGVs," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3285911.

In this paper, a novel unified framework integrating trajectory planning and motion optimization (TPMO) is proposed based on spatio-temporal safety corridor (STSC), which guarantees collision avoidance and trajectory smoothness. The first part is to establish the STSC for each AGV based on the mixed integer quadratic programming algorithm. The second part is to design a motion optimization methodology, which considers the constraints of AGV geometry as well as longitudinal and lateral coupled motion characteristics.

C. Zhang, F. Steinhauser, G. Hinz and A. Knoll, "Occlusion-Aware Planning for Autonomous Driving With Vehicle-to-Everything Communication," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3308098.

This paper presents a Partially Observable Markov Decision Process (POMDP) behavior planner enhanced with Vehicle-to-Everything (V2X) communication to safely navigate Autonomous Vehicles (AVs) in occlusion scenarios. The planner uses the information obtained from AV's sensors to identify occlusion areas and estimate collision risks while enhancing the estimation of the existence of phantom road users using available V2X messages. The experiments demonstrate that the presented approach efficiently generates safe and comfortable driving behaviors for challenging occlusion scenarios.

J. Zhang, J. Ge, S. Li, S. Li and L. Li, "A Bi-level Network-wide Cooperative Driving Approach Including Deep Reinforcement Learning-based Routing," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3305818.

This paper proposes a bi-level network-wide cooperative driving approach for CAVs. The dynamic routing problem is addressed in the upper level and we propose a multi-agent DRL-based routing model. In the lower level, we propose an adaptive cooperative driving algorithm for signal-free intersections. Essentially, the upper level determines which conflict areas the vehicles will pass through, and the lower level addresses how the vehicles use the limited road resources more efficiently in each conflict area.

J. Zhang, L. Zhang, S. Liu and J. Wang, "Event-Triggered Adaptive Fuzzy Approach-based Lateral Motion Control for

Autonomous Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3336794.

Event-triggered adaptive fuzzy control is proposed for the motion control problem of autonomous vehicles. The fuzzy logic system (FLS) approximates the boundary of uncertain parameters and nonlinearity in the control system, which ensures control accuracy and robustness of the system. Additionally, to reduce the communication burden of the vehicle, an event-triggering strategy with relative threshold values is designed.

J. Zhang, S. Huang, J. Liu, X. Zhu and F. Xu, "PYRF-PCR: A Robust Three-Stage 3D Point Cloud Registration for Outdoor Scene," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3327098.

Point Cloud Registration (PCR) has been viewed as an essential part of photogrammetry, remote sensing, and autonomous robot mapping. Existing methods are either sensitive to rotation transformations, or rely on feature learning networks with poor generalization. We propose a novel outdoor point cloud registration algorithm, including preprocessing, yaw angle estimation, coarse registration, and fine registration (in short, PYRF-PCR).

Y. Zhang, H. Wang, M. Yin, J. Wang and C. Hua, "Bi-AM-RRT$*$: A Fast and Efficient Sampling-Based Motion Planning Algorithm in Dynamic Environments," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3307283.

This paper proposes a novel motion planning method based on bidirectional RRT and assisting metric (AM) with a larger connection distance, namely Bi-AM-RRT$*$, to reduce the search time and path length in dynamic environments. Experimental results show that the Bi-AM-RRT$*$ can achieve better performance in terms of path length and search time, and always finds near-optimal paths with the shortest search time when the diffusion metric is used as the AM.

X. Zhao et al., "Target-Driven Visual Navigation by Using Causal Intervention," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3288810.

In target-driven visual navigation, the agent sometimes got stuck in specific locations. Based on causality, a critical hurdle is the neglect of confounders. Mitigating the confounding effect helps discover causality. We propose Causal Intervention Visual Navigation(CIVN) based on causal intervention using front-door adjustment. CIVN is implemented by Causal Attention, which approximates intervention. Causal intervention is applied in solving confounding effect in target-driven visual navigation. Experiments demonstrate better performance than prior arts. A generalization experiment is proposed utilizing pre-trained models.

J. Zhou, B. Olofsson and E. Frisk, "Interaction-Aware Motion Planning for Autonomous Vehicles with Multi-Modal Obstacle Uncertainty Predictions," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3314709.

This paper presents an interaction and safety-aware motion-planning method for autonomous vehicles based on model predictive control. The method addresses interaction awareness and multi-modal motion uncertainties of surrounding obstacles in multi-vehicle traffic environments, where both longitudinal and lateral motion uncertainties of obstacles are considered. The efficiency of the method is illustrated in challenging highway-driving simulation scenarios and a driving scenario from a recorded traffic dataset.

K. Zhou, N. Lu, B. Jiang, Z. Liu, B. Zhang and J. Chen, "An Information Fusion Based Incipient Fault Diagnosis Method for Railway Vehicle Door System," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3331709.

This study proposes an incipient fault diagnosis method for railway vehicle door system, aimed at enhancing its safety and efficiency. The approach utilizes data-driven techniques, analyzing signals from both motor and vibration sensors. Information fusion plays a crucial role in reducing false alarms by addressing conflicting evidence. Experimental validation conducted on a door test bench demonstrates a notable minimum 10% improvement in diagnosis accuracy, highlighting the method's effectiveness in improving reliability.

Y. Zhu et al., "Hierarchical Control of Connected Vehicle Platoon by Simultaneously Considering the Vehicle Kinematics and Dynamics," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3277477.

This article develops a hierarchical control strategy for connected vehicle (CV) platoon. To this end, the article first characterizes the communication connectivity between CVs using the predecessor-leader following (PLF) topology. Then, a hierarchical control strategy, consisting of first-level and second-level controllers, is proposed by simultaneously considering the vehicle kinematics and dynamics. In particular, the vehicle kinematic model-based controller is proposed in first-level by incorporating the nonlinear coupling and interaction between the CVs and the heterogeneous communication delays; and the vehicle dynamic model-based adaptive integral sliding-mode controller is designed in second-level according to the vehicle desired states obtained by the first-level controller and external disturbance.

D. ZiWen and Y. Dong, "Multi-objective Neural Architecture Search for Efficient and Fast Semantic Segmentation on Edge," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3332594.

This paper propose RealtimeSeg, one of the first semantic segmentation model to be searched by neural architecture search(NAS), capable of running at real-time speed on edge

devices. The RealtimeSeg achieved an accuracy of 71.7 mIoU(%) on Cityscapes while maintaining a frame rate of 25.25 FPS on the NVIDIA Jetson NX, using the input resolution of 1024×2048.

C. Cui, Y. Ma, J. Lu and Z. Wang, "REDFormer: Radar Enlightens the Darkness of Camera Perception with Transformers," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3329708.

Enhancing the accuracy and reliability of perception systems in automated vehicles is critical, especially under varying driving conditions. Unfortunately, the challenges of adverse weather and low-visibility conditions can seriously degrade camera performance, introducing significant risks to vehicle safety. To address these concerns, in this study, we introduce a novel transformer-based 3D object detection model named 'REDFormer'. By exploiting bird's-eye-view camera-radar fusion, the REDFormer offers a more practical and financially viable solution for tackling low-visibility conditions.

Z. Wang, J. Zhang, J. Chen and H. Zhang, "Spatio-Temporal Context Graph Transformer Design for Map-Free Multi-Agent Trajectory Prediction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3329885.

Predicting the motion of surrounding vehicles is an important function of autonomous vehicles. However, most of the current state-of-the-art trajectory prediction models rely heavily on map information. In order to overcome the shortcomings of the existing models, our paper proposes a map-free trajectory prediction model and names it TR-Pred (Trajectory Relative two-stream Prediction). The trajectory stream employs LSTM to embedding the trajectory information of each agent. Subsequently, it utilizes graph neural networks (GNN) to extract latent traffic information in the current scenario, such as lane lines, drivable areas, and traffic control conditions.

A. Abdo, H. Chen, X. Zhao, G. Wu and Y. Feng, "Cybersecurity on Connected and Automated Transportation Systems: A Survey," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3326736.

This paper reviews connected and automated transportation system (CATS) cybersecurity via surveying recent pertinent studies focusing on the transportation system level, ranging from individual and multiple vehicles to the traffic network (including infrastructure). It also highlights threat analysis and risk assessment (TARA) tools and evaluation platforms, particularly for analyzing the CATS cybersecurity problem. Finally, this paper provides valuable insights into developing secure CAV applications and investigating remaining open cybersecurity challenges that must be addressed.

Y. Ai et al., "PMWorld: A Parallel Testing Platform for Autonomous Driving in Mines," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3332739.

Autonomous driving will be widely deployed in the near future which can efficiently reduce the workload on human drivers. Unlike complicated urban driving conditions, fully autonomous driving is expected to be implemented in closed and relatively simple environments, e.g., mines. Autonomous driving in mines holds substantial practical value that can significantly reduce mining costs and enhance operational efficiency. To ensure vehicle safety, unmanned driving systems should be rigorously tested before deployment. With the rapid development of digital twin technology, offline testing in cyberspace has gained increasing significance.

X. Liu, W. Wen and L.-T. Hsu, "GLIO: Tightly-Coupled GNSS/LiDAR/IMU Integration for Continuous and Drift-free State Estimation of Intelligent Vehicles in Urban Areas," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3323648.

A tightly-coupled GNSS/LiDAR/IMU integration odometry (GLIO) is proposed to address the limitations of individual systems arising from challenging urban environments to achieve continuous and drift-free estimation for intelligent vehicles. Two-stage optimization consisting of sliding-window scheme and batch scheme is proposed in the paper involving raw GNSS pseudorange and Doppler measurements, IMU measurements, and LiDAR measurements. Experimental results using the UrbanNav dataset demonstrate impressive improvement in positioning performance compared to the current state-of-the-art method. More importantly, GLIO is open-sourced to benefit the community at https://github.com/XikunLiu-huskit/GLIO.

C. Wang, Z. Cao, J. Li, J. Yu and S. Wang, "Hierarchical Distribution-based Tightly-Coupled LiDAR Inertial Odometry," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3273288.

A tightly-coupled LiDAR inertial odometry based on distribution is proposed. With anti-degeneration point-to-distribution constraints, a dual tightly-coupled framework with a low-level LiDAR inertial odometry based on IEKF and a high-level factor graph optimization is designed. The experimental results demonstrate the effectiveness of the proposed method.

S. Li, M. Wei, S. Li and X. Yin, "Temporal Logic Task Planning for Autonomous Systems with Active Acquisition of Information," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3327312.

This paper studies high-level task planning for autonomous systems with active acquisition of information. The objective is to synthesize an active-sensing controller such that a given LTL formula can always be satisfied with a provably correct formal guarantee. A sound and complete synthesis procedure is provided to solve this problem. Both numerical experiments and hardware implementations are provided to illustrate the effectiveness of the proposed approach.

Y. Cui et al., "DriveLLM: Charting The Path Toward Full Autonomous Driving with Large Language Models," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3327715.

A decision-making framework that integrates large language models (LLMs) with existing autonomous driving stacks that allows for commonsense reasoning in decision-making. DriveLLM also enables interaction with passenger inputs while guarding against adversarial attacks. In real-world case studies, the proposed framework outperforms traditional decision-making methods in complex scenarios, including difficult edge cases. Empirical evaluations demonstrate that this framework responds correctly to complex human instructions.

Z. Hu and X. Jin, "Formation Control for an UAV Team With Environment-Aware Dynamic Constraints," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3295354.

State-of-the-art literature on constrained multiagent system operations can only deal with constant or at best time-varying constraint requirements. Such constraint formulations cannot respond well to the dynamic environment and presence of external agents outside of the multiagent system. In this work, we consider a formation tracking problem for a group of unmanned aerial vehicles (UAVs) in the presence of a physical attacker. The safety/performance constraint functions are environment-aware and dynamic in nature, whose formulation depends on certain path parameters and presence of the attacker.

S. Wang, X. Jiang and Y. Li, "Focal-PETR: Embracing Foreground for Efficient Multi-Camera 3D Object Detection," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3332608.

A semantic-aggregated and spatial-aligned method, called Focal-PETR, is proposed for efficient multi-camera 3D object detection. The key ideas include instance-guided supervision and a spatial alignment module to adaptively focus object queries on discriminative foreground regions, and a down-sampling strategy to reduce the consumption of global attention. The proposed method is validated on the nuScenes benchmark, showing superior accuracy and speed trade-off.

Z. Li, H. Liang, H. Wang, M. Zhao, J. Wang and X. Zheng, "MKD-Cooper: Cooperative 3D Object Detection for Autonomous Driving via Multi-teacher Knowledge Distillation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3310580.

The paper presents MKD-Cooper, a novel cooperative perception framework for 3D object detection in autonomous driving. By integrating multi-teacher knowledge distillation and the Collaborative Attention Fusion method, the model's accuracy is enhanced through valuable information sharing among neighboring vehicles. The approach demonstrates state-of-the-art performance in accuracy and efficiency across various datasets and real-world scenarios, showcasing its potential for advancing autonomous systems.

Q. Shi and H. Zhang, "An Improved Control-Oriented Tire Model and Its Applications on Intelligent Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3294534.

We propose a general control-oriented tire model considering the effect of friction coefficient, vertical force, and combined slip. Proposed tire model is in linear parameter varying (LPV) form, which facilitates stability analysis and controller design. The number of unknown parameters in proposed tire model is minimized and grey wolf optimizer (GWO) method is adopted to identify the unknown parameters. Based on proposed tire model, lateral stability analysis and path-following controller design methods are introduced.

Q. Jiang, C. Hu, B. Zhao, Y. Huang and X. Zhang, "Scalable 3D Object Detection Pipeline With Center-Based Sequential Feature Aggregation for Intelligent Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3299619.

Considering the semantic ambiguity issue caused by the sparse points, this paper presents a scalable 3D object detection pipeline CenterSFA and a series of new modules are proposed to improve the detection performance. Extensive experiments are conducted on the large-scale nuScenes dataset to verify the state-of-the-art performance of the proposed model, especially for occluded objects and far-range detection.

Z. Yu, W. Wan, M. Ren, X. Zheng and Z. Fang, "SparseFusion3D: Sparse Sensor Fusion for 3D object detection by Radar and Camera in Environmental Perception," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3331972.

In the context of autonomous driving environment perception, multi-modal fusion plays a pivotal role in enhancing robustness, completeness, and accuracy, thereby extending the performance boundary of the perception system. However, directly applying Lidar-related algorithms to radar and camera fusion leads to significant challenges, such as radar sparsity, absence of height information, and noise, resulting in substantial performance loss. To address these issues, our proposed method, SparseFusion3D, utilizes a dual-branch feature-level fusion network that fully models sensor interactions, effectively mitigating the adverse effects of radar sparsity and noise on modality association.

S. Khan, J. Guivant, Y. Li, W. Liu and X. Li, "Hybrid Model Predictive Control for Unmanned Ground Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3307737.

This paper introduces a hybrid approach for efficient path planning in unmanned ground vehicles (UGVs). By integrating stochastic dynamic programming (SDP) and Dijkstra-based pseudo priority queues (PPQ), the method considers skid-slip effects, dynamic obstacles, and uses a global cost-to-go (CTG)

function. The hybrid model predictive control (HMPC) incorporates up-to-date CTG data, the vehicle model, and environment perception, including static and dynamic obstacles. Simulations demonstrate its superior performance over existing methods in diverse scenarios.

S. Qiu et al., "Subclassified Loss: Rethinking Data Imbalance from Subclass Perspective for Semantic Segmentation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3325343.

Semantic segmentation plays a crucial role in enabling intelligent vehicles to perceive and understand their surroundings. However, datasets used for semantic segmentation often suffer from data imbalance, where the number of pixels belonging to different classes varies significantly. To address this challenge, various novel loss functions have been proposed at the class or pixel level to counterbalance the data imbalance. In this study, we propose a novel approach to mitigate this problem from a subclass perspective. Specifically, we identify subclasses within each class based on the similarity of feature maps.

H. Yang, Y. He, Y. Xu and H. Zhao, "Collision avoidance for autonomous vehicles based on MPC with adaptive APF," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3337417.

In this paper, a model predictive control (MPC) strategy is developed to realize collision avoidance with dynamic obstacle vehicles for an autonomous vehicle. A novel collision constraint based on road width and vehicle shape is proposed to ensure a safe distance between the autonomous vehicle and an obstacle vehicle. A smooth path is guaranteed in collision avoidance by the adaptive artificial potential field (APF) method for the autonomous vehicle using the MPC strategy. Both recursive feasibility and practical stability are analyzed for the autonomous vehicle based on the MPC strategy with multiple constraints and variable longitudinal velocity. Experimental results are presented to demonstrate the effectiveness and superiority of the MPC strategy with the adaptive APF method.

K. Lin, Y. Li, S. Chen, D. Li and X. Wu, "Motion Planner with Fixed-Horizon Constrained Reinforcement Learning for Complex Autonomous Driving Scenarios," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3273857.

A fixed-horizon constrained reinforcement learning framework is developed to solve decision-making and planning problems in autonomous driving. To achieve lane-level navigation, a constrained A-star algorithm is proposed to build the state space. In addition, a motion planning policy network (planner) with vectorized input is constructed. The proposed motion planner achieves a good balance between safety, goal completion, and comfort in complex autonomous driving scenarios.

S. Zhang, L. Zhang, G. Li, P. Li and Z. Liu, "Multi-Prototype Guided Source-Free Domain Adaptive Object Detection for Autonomous Driving," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3337795.

The paper introduces a novel approach, Multi-Prototype Guided (MPG), for source-free domain adaptive object detection (DAOD). Unlike existing methods that face challenges with intra-class variation and noisy pseudo labels, MPG incorporates multi-prototype guided pseudo labeling (MPPL) and multi-prototype guided consistency regularization (MPCR) modules. MPPL employs category-specific prototypes to address intra-class variations, while MPCR introduces multi-level consistency regularization for domain-invariant representations. Experimental results on five driving datasets demonstrate MPG's superiority over current state-of-the-art source-free DAOD methods.

P. Ni, X. Li, W. Xu, D. Kong, Y. Hu and K. Wei, "Robust 3D Semantic Segmentation Based on Multi-Phase Multi-modal Fusion for Intelligent Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317784.

The problem of LiDAR-camera fusion methods lagging behind LiDAR-only methods in complex and varied scenarios containing sparse and similar geometric features is addressed. A multi-phase LiDAR-camera fusion method is introduced to comprehensively fuses information of two modalities in three phases. Through experiments under various scenarios, the proposed methodology is proved to be effective in improving accuracy and scene-adaptivity.

S. Chen, G. Liu, Z. Zhou, K. Zhang and J. Wang, "Robust Multi-Agent Reinforcement Learning Method Based on Adversarial Domain Randomization for Real-World Dual-UAV Cooperation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3307134.

This paper proposes a method to enhance the robustness of a control system of dual-UAV cooperation transportation based on multi-agent reinforcement learning (MARL) and domain randomization. The method can ensure the robustness and stability of the trained policy when states of the system are disturbed. Our prioritized experience replay method can increase the convergence speed of a training process in a randomization environment. This paper contributes theoretically and practically to the sim2real method in the MARL field.

X. Wang et al., "CMBUV: A Composite-Mechanism Bioinspired Underwater Vehicle Integrated With Elasticity and Shear Damping Possesses High-Performance Capability," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3286820.

This paper proposes a novel underwater vehicle design integrated with elasticity and shear damping. A lightweight compact shear damper is developed with large shearing torque intensity. A dynamic model is derived for estimating the propulsive performance. The simulated and experimental results demonstrate

that the proposed design possesses superior speed and efficiency performance over a wide frequency range.

L. Zhang, W. Wen, L.-T. Hsu and T. Zhang, "An Improved Inertial Preintegration Model in Factor Graph Optimization for High Accuracy Positioning of Intelligent Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3282623.

Accurate and reliable positioning is of great importance for the realization of intelligent vehicles (IV). Factor graph optimization (FGO) has been popularized in the field of robotics for state estimation. As a ubiquitous sensor, the IMU is widely used for vehicular positioning based on the preintegration theory using FGO. However, the existing preintegration model fails to consider the earth's rotation, which challenges the attitude and positioning performance of vehicles equipped with high-precision inertial measurement units (IMU).

Y. He, Y. Liu, L. Yang and X. Qu, "Deep adaptive control: Deep reinforcement learning-based adaptive vehicle trajectory control algorithms for different risk levels," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3303408.

This paper presents a solution to adaptive vehicle trajectory control for varying risk levels. It investigates how to effectively measure the risk level of car-following scenarios, establishes a comprehensive scenario library with different risk levels, and develops a deep reinforcement learning-based trajectory control model named 'Deep Adaptive Control'. The proposed algorithm's performance is validated across multiple dimensions using real trajectory data sets.

Y. Hu, X. Li, D. Kong, K. Wei, P. Ni and J. Hu, "A Reliable Position Estimation Methodology based on Multi-Source Information for Intelligent Vehicles in Unknown Environment," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3332860.

To further improve LiDAR positioning performance, a reliable position estimation methodology based on multi-source information is proposed. Initially, a deep neural network based on multi view features multi-head self-attention fusion is designed to estimate the relative heading value to offer initial value. Then, the cooperative positioning multilayer perceptron is proposed to obtain reliable cooperative position observation just by one road side unit. Lastly, the probabilistic graphical model is used to fuse multi-source information.

C. O. Yaldiz and Y. Yildiz, "Driver Modeling Using a Continuous Policy Space: Theory and Traffic Data Validation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3333337.

In the context of highway driving, continuous human driver reasoning levels are developed within the framework of level-k reasoning from game theory. A best-response theorem defining the hierarchy between these continuous levels is introduced. The validity of this framework is demonstrated using a real traffic dataset and is contrasted with prior work employing a discrete level-k framework. The findings indicate that human driver policies extracted through reinforcement learning exhibit greater alignment with continuous levels rather than discrete ones.

S. Wang et al., "Performance Analysis of Satellite-Vehicle Networks With a Non-Terrestrial Vehicle," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3284394.

In this work, a communication network is proposed, which is assisted by an unmanned aerial vehicle used as a relay and a reconfigurable intelligent surface (RIS) used between the relay and ground, while free-space optical is applied to the relay-satellite link. We analyze the system performance, including the outage probability, average bit error rate and average channel capacity. Results show that the RIS can effectively improve system performance while the shadowing effects significantly degrade the system performance.

X. Shi, Y. Li, W. Hu, C. Du, C. Chen and W. Gui, "Optimal Lateral Path-Tracking Control of Vehicles With Partial Unknown Dynamics Via DPG-Based Reinforcement Learning Methods," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3319642.

This article tackles optimal lateral path-tracking control of vehicles with unknown drift dynamics. It employs two novel deterministic policy gradient (DPG) based reinforcement learning (RL) methods, eliminating the need for precise vehicle model and the limitation of the initial admissibility of the control policy. The proposed algorithms use explicit form only using a single sampling data for each calculation, reducing sampling and computational complexity. Simulations confirm the superiority of the two DPG-based RL algorithms over existing methods.

C. Sun, Y. Cui, N.-D. Đào, R. V. Mehrizi, M. Pirani and A. Khajepour, "Medium-Fidelity Evaluation and Modeling for Perception Systems of Intelligent and Connected Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3314731.

This paper introduces a probabilistic framework to assess and model perception systems, particularly for autonomous driving in diverse environments. The approach incorporates stochastic processes to account for perception failures and errors, considering spatial and temporal aspects. It demonstrates strong performance in modeling perception error patterns using a variety of virtual and real traffic data alongside benchmark perception algorithms, offering a valuable tool for evaluating the data-driven based perception systems heavily used in modern autonomous driving applications.

P. Ni, X. Li, D. Kong and X. Yin, "Scene-Adaptive 3D Semantic Segmentation Based on Multi-Level Boundary-Semantic-Enhancement for Intelligent Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3274949.

3D semantic segmentation is a key technology of scene understanding in the self-driving field, which remains challenging problems. Recent 3D segmentation methods have achieved competitive results in indoor or typical urban traffic scenes. However, in complex and changeable scenarios where structured features are sparse and irregular, few of these methods could achieve well segmentation results, especially causing blurry and inaccurate boundary distinctions between inter-class objects, drivable areas, and backgrounds.

S. Dong et al., "Cooperative Eco-Driving Control of Connected Multi-Vehicles With Spatio-Temporal Constraints," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3282490.

In this article, we propose a novel time-energy optimal control approach with applications in cooperative eco-driving of connected and automated vehicles (CAVs) in urban traffic networks. To generate time- and energy-optimal trajectories, the optimal crossing times are treated as characteristic time constraint. Then the direct multiple shooting method and time transformation technique are applied to find a numerical solution. The results show that the proposed strategy can achieve a significant reduction in energy consumption and travel time.

J. Chang, Y. Zhang, S. Fan, F. Huang, D. Xu and L.-T. Hsu, "An Anti-spoofing Model based on MVM and MCCM for a Loosely-coupled GNSS/INS/LiDAR Kalman Filter," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3335356.

A security defense algorithm for multi-sensor fusion systems is proposed based on the Measurement Variance Monitoring (MVM) and Minimum Constraint of Covariance Matrix (MCCM) model. MVM effectively constrains the impact of GNSS signals with large positioning errors. MCCM fully leverages LiDAR information between two consecutive GNSS signals, thus improving the positioning correction capability. Real-world data demonstrates the proposed model can significantly mitigate positioning errors caused by GNSS spoofing attacks without affecting navigation accuracy.

J. Huang, S. Zhao, T. Zhang and L. Zhang, "MC-VEO: A Visual-Event Odometry With Accurate 6-DoF Motion Compensation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3323378.

This paper proposed a novel visual-event odometry, namely MC-VEO. In MC-VEO, a novel 6-DoF motion compensation method based on an improved contrast maximization framework is utilized to create pseudo measurements from the events. By minimizing the brightness increment errors between these measurements and the measurements predicted from image frames, the relative poses of event frames and keyframes are accurately estimated. The superior performance of MC-VEO is evaluated by both qualitative and quantitative experimental results.

Z. Sun, Z. Gao, G. Guo and S. Wen, "Finite-Time Control of Vehicular Platoons With Global Prescribed Performance and Actuator Nonlinearities," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3292393.

The problem of finite-time global prescribed performance control (GPPC) for vehicular platoon control system (VPCS) with actuator nonlinearities is investigated in this paper. A smooth equivalent transformation is first presented to process both actuator dead-zone and saturation under the same framework. Then, a GPPC method based on improved finite-time performance function (IFnTPF) is proposed, and makes the tracking error tend to the prescribed region within the predefined time, while removes the strict restrictions on the initial conditions of the system. To realize the platoon in given time, an adaptive finite-time sliding mode control scheme is further developed, and both individual vehicle stability and string stability are guaranteed. Numerical simulations demonstrate the validity of the given scheme.

Z. Wang, J. Guo, H. Zhang, R. Wan, J. Zhang and J. Pu, "Bridging the Gap: Improving Domain Generalization in Trajectory Prediction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3299600.

Domain generalization in trajectory prediction for autonomous driving is investigated. The model incorporates a module for velocity refinement and uses self-distillation and an environment-specific loss to improve performance on unseen datasets. Comprehensive evaluations on two datasets demonstrate the effectiveness of the proposed method.

M. M. Karim, Z. Yin and R. Qin, "An Attention-guided Multi-stream Feature Fusion Network for Early Localization of Risky Traffic Agents in Driving Videos," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3275543.

This paper introduces a new model, Attention-guided Multi-stream feature fusion Network (AM-Net), and a benchmark dataset called Risky Object Localization (ROL), for early localization of risky traffic agents in driving videos. AM-Net achieves promising performance on the ROL dataset, and it outperforms the current state-of-the-art for video anomaly detection on a public dataset. AM-Net provides the ability to localize risky traffic agents early, making it a vision-based intelligence that can improve vehicle safety across various levels of autonomy.

G. Wen, J. Lam, J. Fu and S. Wang, "Distributed MPC-Based Robust Collision Avoidance Formation Navigation of Constrained Multiple USVs," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3315367.

A novel distributed model predictive control (MPC) based controller is introduced in this study to achieve robust collision avoidance formation navigation of underactuated unmanned surface vehicles. The controller takes into account state and input constraints as well as unknown external disturbances. To

estimate these disturbances accurately, time delay observers are constructed, which contribute to the development of a reliable predictive model. Subsequently, a distributed collision avoidance MPC formation navigation control strategy is presented, enabling synchronized determination of control inputs for the USVs. Numerical experiments are conducted to validate the effectiveness of the proposed control strategy.

Z. Li, Y. Cui, Y. Lin and Z. Fang, "MMF-Track: Multi-Modal Multi-Level Fusion for 3D Single Object Tracking," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3326790.

A multi-modal multi-level fusion tracker is proposed and expected to improve tracking robustness by leveraging both geometry and texture clues. The proposed method first ensures the alignment of different modalities and then realizes layer-wise feature interaction via a dual-stream structure. Finally, it combines geometry with texture similarity to track target accurately. The experiments show that our method achieves competitive performance on KITTI and NuScenes datasets.

P. Li, Z. Xiao, X. Wang, K. Huang, Y. Huang and H. Gao, "EPtask: Deep Reinforcement Learning based Energy-efficient and Priority-aware Task Scheduling for Dynamic Vehicular Edge Computing," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3321679.

In the Vehicular Edge Computing (VEC) paradigm, energy-efficient task scheduling is critical to achieving optimal completion time and energy consumption. This paper introduces the Multi-action and Environment-adaptive Proximal Policy Optimization (MEPPO) algorithm for energy-efficient task scheduling in Vehicular Edge Computing (VEC). MEPPO combines task scheduling, transmit power allocation, and adaptability to dynamic environments to optimize completion time and energy consumption in VEC.

Z. Song et al., "Synthetic Datasets for Autonomous Driving: A Survey," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3331024.

Focusing on the application of synthetic datasets in autonomous driving, this paper summarizes the evolution of synthetic dataset generation methods and reviews the related dataset work to date. It proposes an evaluation method for synthetic datasets and emphasizes the importance of domain gap and trustworthiness and safety tests. Furthermore, examples of evaluation experiments are given and limitations and future directions of synthetic datasets are discussed.

C. Wu, Z. Cai, Y. He and X. Lu, "A review of vehicle group intelligence in a connected environment," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3321891.

This study utilizes bibliometric approaches to uncover knowledge bases and prevailing research perspectives within the field of vehicle group intelligence (VGI) over the past two decades. Two analytical techniques (document co-citation and keyword co-occurrence) are employed to highlight highly co-cited publications and popular research topics. Six representative knowledge bases and five core research trends are identified. Based on these findings, we delineate potential research opportunities across four key aspects.

Y. Zhao, F. Lin and G. Guo, "Composite Anti-disturbance Dynamic Positioning for Mass-switched Unmanned Marine Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3279296.

This article presents a composite anti-disturbance dynamic positioning control technique for a mass-switched unmanned marine vehicle subject to the influence of wave drifts and residual filtered wave.The wave drifts and residual filtered wave are described as unmeasurable modeled disturbances and measurable unmodeled disturbances, respectively. Then, the unmanned marine vehicle with mass switching is modeled as a switched system. Further, by virtue of the multiple Lyapunov functions technique, dynamic positioning of the unmanned marine vehicle is achieved with composite disturbance rejection capability. The effectiveness of the presented method is illustrated by simulations with a supply vessel.

K. Wang, L. Pu and W. Dong, "Cross-domain Adaptive Object Detection Based on Refined Knowledge Transfer and Mined Guidance in Autonomous Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3308896.

Obeject detection as a fundamental task of environmental perception systems in autonomous vehicles(AVs), is significant for intelligent driving safety that precise detection results improve control accuracy. Facing the cross-domain adaptation scenarios, the generalization capability of the detector is poor due to the lack of target supervised information and the influence of covariate shift among domains especially. To takle such an issue, this paper proposes a reliable domain adaptation method based on refined knowledge transferring and mined guidance for cross-domain detection in AVs.

G. Zhang, S. Chai, R. Chai, M. Garcia and Y. Xia, "Fuzzy Goal Programming Algorithm for Multi-objective Trajectory Optimal Parking of Autonomous Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3311536.

An improved fuzzy goal programming method for multi-objective trajectory optimization automatic parking problem is proposed. The related algorithm framework which shows the solution steps is presented. Simulation and experimental results demonstrate the effectiveness of the improved fuzzy goal programming approach. It successfully finds a good compromised solution for the multi-objective trajectory optimization automatic parking problem.

W. Zhou, S. Dong, M. Fang and L. Yu, "CACFNet: Cross-Modal Attention Cascaded Fusion Network for RGB-T Urban Scene

Parsing," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3314527.

Color–thermal (RGB-T) urban scene parsing has recently attracted widespread interest. However, most existing approaches to RGB-T urban scene parsing do not deeply explore the information complementarity between RGB-T features. In this study, we propose a cross-modal attention-cascaded fusion network (CACFNet) that fully exploits cross-modality. In our design, a cross-modal attention fusion module mines complementary information from two modalities. Subsequently, a cascaded fusion module decodes the multi-level features in an up-bottom manner.

Z. Huang, W. Lan and X. Yu, "A Formal Control Framework of Autonomous Vehicle for Signal Temporal Logic Tasks and Obstacle Avoidance," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3283055.

A formal control framework is proposed for autonomous vehicles based on control barrier function and potential field methods, such that the allocated signal temporal logic specifications can be achieved. A detection mechanism algorithm is developed to determine the structure of the proposed framework. The satisfaction of the task is analyzed and discussed. It is illustrated that a better performance is obtained by the proposed method compared with the existing works.

L. Wang, Z. Wang, Z. Ying, X. Bai and N. Xu, "A Path Planning Framework Based on an Improved Weighted Heuristic RRT and Optimization Strategy," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3320401.

This article investigates a local obstacle avoidance (LOA) problem in terms of the planning efficiency and driving safety of low-speed driving unmanned vehicles. A novel improved weighted heuristic RRT (IWH-RRT) method and an optimization strategy are proposed to address the LOA problem with constraints. The sampling space optimization (SPO) and vehicle non-integrity constraint detection (NICD) are first adopted to improve sampling efficiency and guide RRT tree to expand nodes that satisfy driveability towards the target point.

H. Meng, C. Li, G. Chen, L. Chen and a. A. Knoll, "Efficient 3D Object Detection Based on Pseudo-LiDAR Representation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3319985.

Existing Pseudo-LiDAR methods tend to involve intensive computations for the adaptation of complex stereo matching algorithms and, therefore, cannot meet the real-time requirement. In this work, the authors propose a lightweight BNN-based Pseudo-LiDAR 3D detection system that achieves both high accuracy and high responsiveness. The authors also provide an in-depth analysis of the architecture of the 3D detector and develop several promotion schemes to improve accuracy. Experimental results indicate that the proposed system can achieve state-of-the-art results in a mere 36ms.

Z. Hou, S. Wang, H. Liu, Y. Yang and Y. Zhang, "Twin Scenarios Establishment for Autonomous Vehicle Digital Twin Empowered SOTIF Assessment," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3304353.

The scenario-based tests have been an important means of improving the safety and reliability of autonomous vehicles (AVs). Moreover, ensuring the fidelity of generated scenarios is a safeguard for scenario-based tests. This paper presents a new approach to generate twin scenarios for the virtual testing of AVs using meta scenarios. By extracting key parameter clusters from real-world scenarios and redefining and reassembling them, many twin scenarios are generated. This approach addresses the need for diverse scenarios in AV virtual testing and enhances efficiency and hazard detection in the Safety of the Intended Functionality (SOTIF) assessment.

B. Ning, Q.-L. Han, X. Ge and J. Sanjayan, "A Zeroing Neural Network-Based Approach to Parameter-Varying Platooning Control of Connected Automated Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3298578.

By utilizing a distributed observer and a nonlinear manifold, a parameter-varying finite-time controller is designed to achieve the platooning control of connected automated vehicles. The proposed parameter-varying controller has advantages of both fast response and disturbance rejection. Numerical examples under different communication graphs are provided to demonstrate the effectiveness of the proposed controller.

Y. Ai, R. Song, C. Huang, C. Cui, B. Tian and L. Chen, "A Real-time Road Boundary Detection Approach in Surface Mine Based on Meta Random Forest," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3296767.

Efficient and accurate road boundary detection is a fundamental building component of the perception system for autonomous driving. Specially, the challenges for road bound- ary detection in surface mine are high generalization error of model and difficulty in boundary generation, which caused by diversity of samples along with scarcity for corresponding samples and complexity of terrain respectively. Therefore, a novel road boundary detection framework, which execute in a high efficiency way with considerable performance, is proposed for the problems mentioned above.

Z. Fang et al., "Authority Allocation Strategy for Shared Steering Control Considering Human-Machine Mutual Trust Level," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3300152.

A hierarchical shared control framework based on the human-machine mutual trust evaluation is proposed to improve the co-driving cooperation performance. The driver's trust level and machine's trust level are evaluated by the human-machine steering difference and driver skills, respectively. The lower level is to dynamically optimize the authority allocation considering

mutual trust states. Experimental results demonstrate the effectiveness of the proposed control framework.

Y. Liang et al., "An Interpretable Image Denoising Framework Via Dual Disentangled Representation Learning," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3331017.

This paper proposes a dual disentangled representation learning framework for the robust and interpretable image denoising under all-weather conditions. The proposed solution is able to decompose an image into content factors and weather factors by learning their decomposable interaction. The experimental results show that the proposed solution shows competitive performance with good generalization capability and high robustness under numerous weather conditions.

M. Chai, H. Wang, T. Tang, J. Chai and H. Liu, "A Relative Operation-Based Separation Model for Safe Distances of Virtually Coupled Trains," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3301009.

A relative operation-based train separation model to reduce the safe distances between virtually coupled trains is proposed. The time-position trajectories of the preceding train are predicted safely by computing the reachable sets of a hybrid automaton formalizing the behaviour of the train. It shows that the approach provides a 90.7% decrease in unnecessary waiting time for virtually coupled trains at stations and a 4.9% increase in the capacity of a real metro railway line.

P. K. Wong and D. Ao, "A novel event-triggered torque vectoring control for improving lateral stability and communication resource consumption of electric vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3284220.

A novel event-triggered sliding mode controller (ET-SMC) is developed to improve lateral stability of electric vehicles through torque vectoring control. The ET-SMC is designed based on a nonlinear vehicle model and rigorously proven to be stable using the Lyapunov and input-to-state stable theorems. The controller is validated using the Sine-with-Dwell test scenario and evaluated using a hardware-in-the-loop test bench. The experimental results demonstrate that the ET-SMC can enhance lateral stability while reducing communication resource consumption by approximately 30%.

H. Vijayakumar et al., "A Holistic Safe Planner for Automated Driving Considering Interaction With Human Drivers," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317338.

This paper introduces an advanced framework for automated driving, focusing on decision-making, manoeuvre planning, and trajectory tracking. This paper proposes a decision-making approach for automated vehicles to ensure safe lane keeping or changing while interacting with human-driven vehicles (HDVs). The method employs an LSTM model to predict HDVs' future movements and an error ellipse to quantify associated uncertainties. Additionally, the paper proposes a novel parametric curve generation method for lateral and replanning manoeuvres.

W. Wang, W. Shangguan, J. Liu and J. Chen, "Enhanced Fault Detection for GNSS/INS Integration Using Maximum Correntropy Filter and Local Outlier Factor," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3312654.

This paper proposed an enhanced fault detection method for safety-critical applications using Global Navigation Satellite Systems. The maximum correntropy filter with an adaptive kernel bandwidth is introduced to handle the undetected faults. Moreover, a new test statistic is obtained by the local outlier factor, bringing new insights to detect GNSS faults without a prior distribution assumption. The effectiveness of the proposed approach is demonstrated by the simulations under different fault scenarios.

S. Yao et al., "Radar-Camera Fusion for Object Detection and Semantic Segmentation in Autonomous Driving: A Comprehensive Review," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3307157.

This review aims to provide a comprehensive guideline for radar-camera fusion, particularly concentrating on perception tasks related to object detection and semantic segmentation. We delve into the data processing process and representations, followed by an in-depth analysis and summary of radar-camera fusion datasets. In the review of methodologies in radar-camera fusion, we address interrogative questions, including "why to fuse", "what to fuse", "where to fuse", "when to fuse", and "how to fuse", subsequently discussing various challenges and potential research directions.

Y. Zhang, J. Hou and X. Zhao, "Secure V2V Communications in Relay-assisted Cognitive Radio Vehicular Networks with Imperfect CSI," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317647.

This paper investigates secrecy performance over a relay-based underlay cognitive radio vehicular network. Transmitting power of secondary network is determined by the maximum transmitting power of secondary transmit vehicle and the interference temperature constraint imposed on primary communication. Besides, an adaptive time allocation scheme is presented to improve system secure performance. As considering imperfect channel state information and time selective fading channels caused by vehicles' mobility, closed-form expressions of secure outage probability are derived under this Internet of Vehicles scenario.

W. Yu, D. Huang and K. Xu, "Active Quantizer-Based Model-Free Adaptive Consensus Tracking for Multiple HSTs Against Sensor Bias," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3314824.

To enhance traffic efficiency and operational safety of multiple high-speed trains running on the same track, train-to-train-based coordination among train groups has become necessary means. In this study, the authors present an active quantizer-based model-free adaptive control approach for train groups that accounts for random sensor bias in output channels. The proposed controller scheme is validated using a real-time StarSim hardware-in-the-loop semi-physical test platform.

X. Cai, K. Shi, Y. Sun, Y. Soh and Z. Tian, "Performance Analysis and Design of Intelligent Optimising Integral-Based Event-Trigger Control for Autonomous Ground Vehicles Under DoS Attacks," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317238.

This study investigates the stability of an autonomous ground vehicle dynamics model in the presence of novel denial of service (DoS) attacks. An algorithm that utilizes an asymmetric Lyapunov-Krasovskii function to reduce decision variables effectively is proposed. The experimental results serve to validate the effectiveness and superiority of our proposed method.

H. Liu and L.-Y. Hao, "An Improved Data-Driven Iterative Learning Secure Control for Intelligent Marine Vehicles with DoS Attacks," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3305497.

An improved data-driven iterative learning strategy within the iterative domain is proposed, which has demonstrated that the speed of iterations is improved. A compensation mechanism is designed to mitigate the effects of DoS attacks for intelligent marine vehicles by utilizing the data from previous iterations. And, an improved data-driven iterative learning secure controller is designed to ensure convergence of trajectory tracking error. Simulation results demonstrate the efficacy of the proposed control scheme.

T. Yang, Z. Nan, H. Zhang, S. Chen and N. Zheng, "Traffic Agent Trajectory Prediction Using Social Convolution and Attention Mechanism," 2020 IEEE Intelligent Vehicles Symposium (IV), Las Vegas, NV, USA, 2020, pp. 278-283, doi: 10.1109/IV47402.2020.9304645.

In this paper, we propose a model to predict the trajectories of target agents around an autonomous vehicle. The main idea of our method is considering the history trajectories of the target agent and the influence of surrounding agents on the target agent. To verify the effectiveness of our method, we widely compare with several methods on a public dataset, achieving a 20% error decrease.

D. Jeong and S. B. Choi, "Tube-based Robust Model Predictive Control for Tracking Control of Autonomous Articulated Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3320795.

A robust tracking control algorithm for autonomous articulated vehicles is discussed. The primary objective is to achieve precise path tracking while ensuring safety and robustness against modeling errors. The algorithm utilizes tube-based robust model predictive control and a lumped dynamics model. Moreover, it incorporates specific vehicle constraints to ensure stability and adherence to actuator limits. Comparative simulations demonstrate that the proposed algorithm enables accurate and safe tracking control of complex autonomous articulated vehicles.

L. Hong, X. Wang, D.-S. Zhang, M. Zhao and H. Xu, "Vision-Based Underwater Inspection with Portable Autonomous Underwater Vehicle: Development, Control, and Evaluation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3335270.

A portable autonomous underwater vehicle (AUV) named Shark is developed for vision-based underwater inspections. Considering that the Shark AUV is underactuated in the sway degree of freedom, a novel heading control model is developed that reasonably tackles the motion coupling between sway and yaw, facilitating the design of a robust H∞ controller to regulate the heading angle of the AUV for vision-based underwater inspections. The experimental results demonstrate that the Shark AUV prototype can provide satisfactory vision-based underwater inspection performance.

Y. Han, Q. Liu, H. Liu, B. Wang, Z. Zang and H. Chen, "TP-FRL: An Efficient and Adaptive Trajectory Prediction Method Based on the Rule and Learning-Based Frameworks Fusion," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3279825.

A rule-based framework vectorizes trajectory that improves the adaptability of the method. A learning-based framework encodes trajectory for efficient predicting in the variable scope of the local area in a global prediction scenario. The rule and learning-based frameworks are fused to the whole method as TP-FRL. The results show efficient performance and strong adaptability of the proposed method.

Y. Yang, C. Shan, F. Zhao, W. Liang and J. Han, "On Exploring Shape and Semantic Enhancements for RGB-X Semantic Segmentation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3296219.

We propose a Shape and Semantic Enhancements Module (SASEM) in this paper, which is characterized by innovations on the decoder side. Our proposed SASEM serves as an excellent plug-and-play module for different networks, as is evident by the experiments on various RGB-Thermal and RGB-Depth datasets, where our module can be easily integrated and help to improve the performance consistently.

P. Yan, W. Wen and L.-T. Hsu, "Integration of Vehicle Dynamic Model and System Identification Model for Extending the Navigation Service Under Sensor Failures," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3273185.

Mainstream localization approaches in autonomous vehicles (AV) are limited by the reliability of onboard sensors, which could be vulnerable to sensor failure, such as signal outages of the camera and signal spoofing of the global navigation satellite systems (GNSS). To tackle this issue, this study proposes a sensor-free localization method VDM-SI by integrating system identification into the design of vehicle dynamic models (VDM). A system identification process based on low-order process models is proposed to identify the system dynamics of the AV, where the identified system responses are taken as the control input of VDM to estimate the vehicular positioning.

T. Wang et al., "GSC: A Graph and Spatio-temporal Continuity Based Framework for Accident Anticipation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3257169.

Accident anticipation attempts to predict whether an accident may occur in advance, which is greatly significant for improving the safety of intelligent vehicles. To address this issue, we propose a G raph and S patio-temporal C ontinuity based framework for accident anticipation called GSC, which takes the missing agents into account.

D. Liu, S. Mair, K. Yang, S. Baldi, P. Frasca and M. Althoff, "Resilience in Platoons of Cooperative Heterogeneous Vehicles: Self-organization Strategies and Provably-correct Design," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317977.

This work proposes provably-correct self-organizing strategies for platoons of heterogeneous vehicles. Self-organization is the capability to autonomously homogenize to a common group behavior. We show that self-organization keeps resilience to acceleration limits and communication failures, i.e., homogenizing to a common group behavior makes the platoon recover from these impairments.

P. Wen, Z.-S. Ye, Y. Li, S. Chen, P. Xie and S. Zhao, "Physics-Informed Neural Networks for Prognostics and Health Management of Lithium-Ion Batteries," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3315548.

A novel approach for Lithium-ion battery Prognostics and Health Management (PHM) has been proposed, which utilizes a Physics-Informed Neural Network (PINN) to fuse empirical and data-driven models. It incorporates a semi-empirical semi-physical Partial Differential Equation (PDE) for flexible modeling and employs a Deep Hidden Physics Model (DeepHPM) for cases with limited prior knowledge. An uncertainty-based adaptive weighting ensures practical training. Validation is performed on a public Li-ion Phosphate (LFP)/graphite battery dataset.

Y. Xue and W. Chen, "Multi-Agent Deep Reinforcement Learning for UAVs Navigation in Unknown Complex Environment," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3298292.

With UAVs' growing importance, reinforcement learning for safe multi-UAV navigation is a hot topic. Current decentralized systems struggle with partially observable properties in unknown and unstable environments, leading to poor learning effects. In this paper, we proposed a new multi-agent recurrent deterministic policy gradient algorithm based on the depth deterministic policy gradient algorithm for controlling the navigation action of multi-UAV. Thorough simulation showed its superiority in convergence and efficacy over the state-of-the-art DRL approach.

S. Chen, L. Zheng, L. Huang, J. Bai, X. Zhu and Z. Ma, "UMT-Net: A Uniform Multi-Task Network with Adaptive Task Weighting," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3319546.

Presenting UMT-Net, our unique multi-task learning framework, purposely built for resource-constrained scenarios. It encompasses a globally shared backbone, task-specific self-attention modules, and joint-attention fusion, culminating in a versatile architecture. The Adaptive Task Weighting (ATW) training method ensures stability by balancing short-term variations and long-term task loss statistics. UMT-Net's superior performance over baseline methods is demonstrated through experiments on datasets like CityScapes, NYUv2, and BDD100K. Remarkably, UMT-Net exhibits real-world generalization ability. Despite its compact design with fewer parameters and lower computational demands, it sustains competitive performance, making it a suitable choice for deployment on mobile devices.

D. Li, B. Liu, Z. Huang, Q. Hao, D. Zhao and B. Tian, "Safe Motion Planning for Autonomous Vehicles by Quantifying Uncertainties of Deep Learning-Enabled Environment Perception," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3297735.

Conventional perception-planning pipelines of autonomous vehicles (AV) utilize deep learning (DL) techniques that typically generate deterministic outputs without explicitly evaluating their uncertainties and trustworthiness. Therefore, the downstream decision-making components may generate unsafe outputs leading to system failure or accidents, if the preceding perception component provides highly uncertain information. To mitigate this issue, this paper proposes a coherent safe perception-planning framework that quantifies and transfers DL-based perception uncertainties.

S. Han, K. Yoon, G. Park and K. Huh, "Robust Lane Keeping Control for Tractor With Multi-Unit Trailer Under Parametric Uncertainty," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3272655.

A lane-keeping system is developed for the tractor with two articulated trailers. Based on the dynamic model of the Tractor with Multi-Unit Trailer (T-MUT) vehicles, the Model Predictive Control (MPC) algorithm is designed with considering the

uncertainty of the weight change at each trailer. The geometry constraints on each unit of the T-MUT vehicle are described in detail to prevent the vehicle from lane invasion. The constraint tightening method is also applied for robust MPC performance.

Y. Yu, W. Ji, R. Li, A. Lu and G. Tian, "Vehicle Motion Control Beyond and Within the Stability Limits for 4WD Electric Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3312318.

A unified approach to vehicle motion control beyond and within the stability limits is proposed. An iterative framework with guarantees on maximum number of iterations is designed to replace the computationally troublesome optimisation-based method for model inversion. The characteristics of vehicle input couplings are exploited to make the controller comprehensibly track desired sideslips only when the yaw dynamic is unstable. The prioritisation between path-tracking and yaw stabilisation, and the velocity lower bounds when operates beyond the limits, are also discussed.

C. Wang, F. Guo, R. Yu, L. Wang and Y. Zhang, "The Application of Driver Models in the Safety Assessment of Autonomous Vehicles: Perspectives, Insights, Prospects," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3333796.

The paper offers an in-depth review of driver models, highlighting their crucial roles in autonomous vehicle (AV) safety assessment: as control policies for surrounding vehicles in simulation-based testing and as benchmarks. It explores the necessary requirements for these models, presents key contributions of current models, and establishes evaluation criteria to assess their effectiveness and limitations. Aimed at researchers and regulators, this study serves as a comprehensive guide to selecting and defining optimal driver models for AV safety evaluation.

P. Sun, B. Zhu and S. Li, "Vision-based Prescribed Performance Control for UAV Target Tracking Subject to Actuator Saturation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3302689.

This paper proposes a vision-based control method for UAVs with actuator saturation to track uncooperative aerial targets. States are estimated using an onboard camera. The controller is designed with a backstepping framework, applying error-transforming and Barrier Lyapunov functions. The robust adaptive controller handles initial conditions violating the performance requirements. It is proven that the proposed controller ensures convergence to the desired performance boundary within a finite time.

M. Chen, R. Zeng, Z. Zhang and H. Wang, "Multiple-RIS-Aided Vibrio Foraging Optimization Positioning Algorithm under Internet of Vehicles environment," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3324605.

The paper proposes a Vibrio Foraging Optimization (VFO) positioning algorithm assisted by multiple Reconfigurable Intelligent Surfaces (RISs). Additionally, the Direction of Arrival (DOA) parameter is introduced and matrix reconstructed estimation of signal parameters by rotational invariance technique (MR-ESPRIT) algorithm is employed for reducing the computational complexity and further improving the performance of the positioning algorithm. Simulation results further demonstrate that the proposed VFO algorithm based on multiple RISs can achieve better positioning performance with relatively low system complexity.

C. Wang and Z. Liu, "CAFI-Pillars: Infusing Geometry Priors for Pillar-Based 3D Detectors Through Centroid-Aware Feature Interaction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3323377.

Pillar-based feature learning patterns have demonstrated high efficiency for 3D object detection, but aggressive downsampling during pillarization leads to a problem of lacking explicit geometry clues in pillar vectors. To address this limitation, a centroid-aware feature interaction (CAFI) unit is employed to enhance pillar feature representation by infusing more geometric information as prior knowledge. The effectiveness of CAFI-Pillars is verified by extensive experiments, showcasing its engineering potential for environmental perception tasks of autonomous vehicles.

H. Zhang, J. Sun and Y. Tian, "Accelerated Safety Testing for Highly Automated Vehicles: Application and Capability Comparison of Surrogate Models," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3319158.

A surrogate-based method is proposed to accelerate scenario-based simulated safety testing for Highly Automated Vehicles. Multiple evaluations are conducted to compare the accuracy, efficiency, and stability of surrogate models. An adjustment strategy is provided for the parameter setting of the searching algorithm in the surrogate-based safety testing method. The results show the selection of risky scenarios can evolve with the testing process, thereby significantly improving the efficiency of safety testing.

Z. Zhang, P. Sun, M. Wei, Q. Wang and X. Feng, "Trajectory Optimization for Heavy Haul Train With Pneumatic Braking via QCMIP," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3316146.

Heavy haul train manipulation is extremely challenging due to cyclic pneumatic brake application and safe operation demand. To reduce the driving difficulties and enhance transportation efficiency, this paper proposes a trajectory optimization method to conduct optimal speed profile with pneumatic brake application regimes. The discontinuous characteristics and safe guidelines of cyclic pneumatic brake application are fully included in trajectory optimal model to find out optimal brake regimes without

stopping release, which ensures transportation efficiency to the largest extent.

J. Li, J. Pi, P. Wei, Z. Luo and G. Yan, "Automatic Multi-Camera Calibration and Refinement Method in Road Scene for Self-driving Car," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3323665.

A targetless calibration method used for multi-fish-eye camera systems was proposed, which is based on the deviable coarse-to-fine random-search strategy to make up for falling into the local optimal domain in nonlinear optimization methods. This paper also includes a novel strategy for extracting and solving texture and fusing multi-frames to make calibration robust.

T. Zhao, P. Guo, J. He and Y. Wei, "A Hierarchical Scheme of Road Unevenness Perception with LiDAR for Autonomous Driving Comfort," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3337236.

To improve the comfort of autonomous vehicles, a hierarchical framework for separately describing the road regular and irregular unevenness is proposed. A real-scenario point cloud dataset with road irregular unevenness labels is released. An improved point cloud segmentation model is developed to detect the singular bumps or potholes. Road profile maps are accurately reconstructed. The effectiveness of the scheme is validated in diverse real-vehicle scenarios.

A.-X. Chong, H. Yin, J. Wan, Y.-T. Liu and Q.-Q. Du, "Adaptive Neighbor Embedding for Efficient Stereo Matching," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3320399.

A novel adaptive neighbor embedding paradigm (ANE paradigm) for capturing discriminative stereo features is proposed, and its two instantiation operators (ANE conv and ANE filter) are designed. The stereo matching effect of existing stereo matching learning models applying ANE conv and ANE filter is significantly improved. ANE paradigm provides a new solution for the development of intelligent vehicle perception system based on machine vision.

W. Wei, G. Yin and T. He, "Physics-Informed Data-Based LPV Modeling and Validations of Lateral Vehicle Dynamics," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3303013.

An innovative integrated physics-data-based approach is proposed to derive a linear parameter varying (LPV) model for nonlinear lateral vehicle dynamics. The system evolution of nonlinear lateral dynamics can be precisely recovered by parametric matrices formed by a small amount of data snapshots without model training or calibrations. The modeling accuracy was validated by simulations and experimental results on passenger commercial vehicles.

Y. Li, S. Ma, K. Li and S. Tong, "Adaptive Fuzzy Output Feedback Fault-Tolerant Control for Active Suspension Systems," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3272529.

In this paper, a novel adaptive fuzzy output feedback fault-tolerant control (FTC) method is proposed for active suspension systems. Eventually, the feasibility of the proposed control algorithm is evaluated through random road surface and bump road surface tests.

Q. Wang et al., "Fixed-time Consensus Based on a Fractional Adaptive Gain for Multi-agent Systems," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3288677.

In this article, a fractional adaptive gain is adopted to solve fixed-time consensus problem. Both leaderless and leader-following consensus based on different communication topologies are considered and the stability is proved by Lyapunov analysis.

J. Li et al., "BEV-LGKD: A Unified LiDAR-Guided Knowledge Distillation Framework for Multi-View BEV 3D Object Detection," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3319430.

We propose a unified framework named BEV-LGKD to transfer knowledge in a teacher-student manner However, directly applying the teacher student paradigm to BEV features fails to achieve satisfying results due to heavy background information in RGB cameras. To solve this problem, we propose to leverage the localization advantage of LiDAR points.

S. Liu, L. Zhang, J. Zhang, J. Wang and C. Ren, "Cooperative Control of Path Tracking and Driving Stability for Intelligent Vehicles on Potholed Road," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3264799.

When an in-wheel motors drive intelligent vehicle hits a pothole, it may deviation and lose stability. The dynamics mechanism of above phenomena is investigated in this paper, and a cooperative control method based on RSMC is proposed. By reasonably distributing the drive torques between the in-wheel motors, the generated additional yaw and roll moments ensure the ideal vehicle motion state, which can effectively reduce the control difficulty and better realize cooperative control of path tracking and drving stability.

Z. Wang, A. Sahin and X. Zeng, "Efficient Data Collection for Connected Vehicles With Embedded Feedback-Based Dynamic Feature Selection," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3314788.

In this work, we propose an efficient data collection workflow featuring a loop involving a connected vehicle fleet, a ML algorithm and a feedback-based dynamic feature selection strategy

in the pipeline. Results show that the proposed algorithm in the closed-loop procedure achieves adequate performance with relatively few irrelevant and redundant data.

P. Li, K. Wu, Y. Cheng, S. T. Parker and D. A. Noyce, "How Does C-V2X Perform in Urban Environments? Results From Real-World Experiments on Urban Arterials," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3326735.

The efficiency and reliability of C-V2X in urban environments in evaluated using data collected by roadside units (RSUs) and onboard units from field test experiments. Results suggest that C-V2X has relatively stable efficiency, while its reliability is affected by various factors such as the distance from the vehicle to RSUs. Moreover, a concept of machine learning-assisted RSU planning is proposed to facilitate the deployment of RSUs in urban environments.

N. Zhao, B. Wang, K. Zhang, Y. Lu, R. Luo and R. Su, "LC-RSS: A Lane-Change Responsibility-Sensitive Safety Framework Based on Data-Driven Lane-Change Prediction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3321775.

This paper develops a Lane-Change Responsibility-Sensitive Safety (LC-RSS) model to improve the safety of lane-change decisions and solve the above research gap. A novel lane-change trajectory planning method is proposed, which considers multiple interactions between the ego vehicle and surrounding vehicles with realistic position constraints and fuel consumption optimization.

J. G. Song and J. W. Lee, "A CNN-Based Online Self-Calibration of Binocular Stereo Cameras for Pose Change," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3281034.

The installation of a pair of cameras spaced in parallel horizontally on vehicles or robots is increasing. However, the camera position can change for various reasons. This paper proposes a CNN-based online self-calibration method to recognize and correct these changes. In this study, we employed miscalibration to solve the problem of obtaining images with actual changes and used a patchwise cross-attention module to implement five-DOF camera pose estimation.

Y. Zheng, B. Shyrokau and T. Keviczky, "Mitigating Motion Sickness with Optimization-based Motion Planning," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3289854.

In order to mitigate motion sickness in automated vehicles, we propose an optimization-based motion planning algorithm that minimizes the distribution of acceleration energy within the frequency range that is found to be the most nauseogenic. The results demonstrate considerable potential for improving motion comfort and mitigating motion sickness using our approach in automated vehicles.

K. Li, Y. Qian, C. Wang and M. Yang, "Forehead or Headlights-At Which Height Should LiDARs Be Mounted on the Vehicle?," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3318628.

To investigate the influence of LiDAR installation height, we introduced the Height3 dataset, which is collected simultaneously by LiDAR sensors with three heights in the CARLA simulation environment. Based on the studies on the simulated Height3 dataset, we have an overall understanding of the performance differences of commercial vehicle-mounted LiDARs installed at different heights, providing suggestions for the installation positions of LiDAR sensors on production vehicles.

Z. Zhang, X. Peng and A. Zhang, "Trajectory Tracking Control for Quadrotor Slung Load System With Unknown Load's Linear Velocity and Cable Length," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3270165.

This paper addresses the trajectory tracking control problem for a quadrotor suspended load system without load's linear velocity measurement and cable length information. Firstly, the cable length is estimated by designing an immersion and invariance (I&I)-based adaptive law. Secondly, a virtual thrust force vector is designed for the load position subsystem with the denoted auxiliary variables in the lack of load's linear velocity measurement. Then, through the cable direction subsystem and quadrotor attitude subsystem, the angular velocity input is presented to drive the real thrust input to virtual thrust input via the backstepping method. Thereafter, the uniformly boundedness of the whole closed-loop system is obtained by means of building suitable Lyapunov functions. Ultimately, numerical simulations attest to the performance of the proposed trajectory tracking control law.

D. Xu, P. Liu, H. Li, H. Guo, Z. Xie and Q. Xuan, "Multi-View Graph Convolution Network Reinforcement Learning for CAVs Cooperative Control in Highway Mixed Traffic," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3297310.

A Multi-View Graph Convolution Network Reinforcement Learning (MVGRL) algorithm is proposed for the decision-making and control of CAVs in mixed traffic scenarios. A multi-view graph method is proposed to model vehicle interactions in mixed traffic, multi-view graph convolutional network reinforcement learning is used to extract informative features from complex traffic states. In the highway off-ramp scenario, the constructed traffic control model is able to control the CAVs to complete the ramp exit task and maintain an overall smooth traffic flow.

J. lian, S. Li, D. Yang, J. Zhang and L. Li, "Encoding the intrinsic interaction information for vehicle trajectory prediction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3288976.

This paper proposes a vehicle trajectory prediction method without HD maps. It fully encodes the vehicle intrinsic interaction information to model the state of the traffic scene. The proposed model employs graph attention to aggregate and propagate local interaction features, then a bi-axial multi-scale Transformer is used to alternately update different levels of motion features with global interaction features. The experimental results show that the proposed method can effectively improve the prediction performance without HD map information.

Z. Hu, J. Yuan, Y. Gao, B. Wang and X. Zhang, "NALO-VOM: Navigation-Oriented LiDAR-Guided Monocular Visual Odometry and Mapping for Unmanned Ground Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3303355.

In this article, we propose a navigation-oriented LiDAR-guided monocular visual odometry and mapping (NALO-VOM) to obtain scale-consistent camera poses and a semi-dense environment map which is more suitable for navigation of UGVs. The structure representation ability of the 3D LiDAR point cloud is learned by a major-plane prediction network and then transferred into the monocular VO system in NALO-VOM. As a result, NALO-VOM can construct a more dense and high-quality map using only a monocular camera.

N. Ding, C. Zhang and A. Eskandarian, "SalienDet: A Saliency-based Feature Enhancement Algorithm for Object Detection for Autonomous Driving," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3287359.

Object detection (OD) is crucial to autonomous driving. On the other hand, unknown objects, which have not been seen in training sample set, are one of the reasons that hinder autonomous vehicles from driving beyond the operational domain. To addresss this issue, we propose a saliency-based OD algorithm (SalienDet) to detect unknown objects. Our SalienDet utilizes a saliency-based algorithm to enhance image features for object proposal generation. Moreover, we design a dataset relabeling approach to differentiate the unknown objects from all objects in training sample set to achieve Open-World Detection.

N. Ou, H. Cai and J. Wang, "Targetless Lidar-camera Calibration via Cross-modality Structure Consistency," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3337490.

This study emphasizes a specific degeneration problem that frequently arises when solving hand-eye calibration equations, particularly in multi-sensor systems mounted on ground vehicles. To address this problem, we introduce a targetless Lidar-camera calibration method based on cross-modality structure consistency. Our method exhibits global convergence and demonstrates satisfactory performance in extensive experiments, even in extreme degenerate scenarios where the vehicle exclusively travels in a straight line on a flat road. We have released our codes to benefit the autonomous driving community.

J. You, Z. Chen, H. Jiang and P. Z. H. Sun, "Dynamic AGV Conflict Detection Under Speed Uncertainty Considerations," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3316249.

In this paper, we propose a dynamic AGV conflict detection scheme with time windows to detect possible AGV conflicts timely. The proposed scheme fully considers the accuracy, dynamics, and predictability requirements of detection, which encompasses the following three components: preliminary conflict detection, potential motion trajectory generation, and conflict detection and alarm.

J. Chen, J. Zhu, R. Xu, Y. Chen, H. Zeng and J. Huang, "ORNet: Orthogonal Re-parameterized Networks for Fast Pedestrian and Vehicle Detection," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3323204.

An orthogonal re-parameterized network (ORNet) is proposed for pedestrian and vehicle detection. The two keys of ORNet are (1) ghost structural re-parameterized (GS-ReP) module and (2) feature orthogonal loss (FOL) function. GS-ReP is a low computational method integrating ghost multi-branch structures and structural re-parameterization to learn rich features while constrain computation/parameter costs. FOL encourages orthogonal features learned by GS-ReP to further boost detection accuracy. Experiments on KITTI and Cityscapes shows that our ORNet is superior to state-of the-art methods.

X. Zhang, B. Wang, Y. Lu, H. Liu, J. Gong and H. Chen, "A Hierarchical Multi-Vehicle Coordinated Motion Planning Method Based on Interactive Spatio-Temporal Corridors," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3280898.

This paper proposes a novel hierarchical multi-vehicle coordinated motion planning method based on interactive spatio-temporal corridors (ISTCs). In the first layer, Mixed Integer Quadratic Programming is designed to construct ISTCs capable of resolving conflicts in generic multi-vehicle scenarios. And then in the second layer, Non-Linear Programming is settled to generate in-corridor trajectories that satisfy the vehicle dynamics. Simulated experiments in unsignalized intersection and challenging dense scenarios have been conducted to verify the feasibility and adaptability of the proposed framework.

S. Richter, F. Bieder, S. Wirges and C. Stiller, "A Dual Evidential Top-View Representation to Model the Semantic Environment of Automated Vehicles," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3284400.

We present a generic evidential grid mapping pipeline designed for imaging sensors such as LiDAR and cameras. Our grid-based evidential model contains semantic estimates for cell occupancy and ground separately. Our method estimates cell occupancy robustly and with a high level of detail while maximizing efficiency and minimizing the dependency to external processing modules.

J. Yang, Y. Chen, Z. Lin, D. Tian and P. Chen, "Distributed Computation Offloading in Autonomous Driving Vehicular Networks: A Stochastic Geometry Approach," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3290369.

A traffic model based on a stochastic geometry framework is proposed to simulate a real traffic environment of autonomous driving vehicles. A distributed computation offloading scheme based on mobile edge computing (MEC) is proposed to reduce the cost of processing tasks. An average cost minimization optimization problem is formulated and solved by the Lagrange multiplier with KKT constraints. Simulation results show that the proposed strategy outperforms other benchmarks and the proposed modeling method is rational.

J. Nan, W. Deng, R. Zhang, Y. Wang, R. Zhao and J. Ding, "Interaction-Aware Planning With Deep Inverse Reinforcement Learning for Human-Like Autonomous Driving in Merge Scenarios," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3298912.

This paper presents an interaction-aware decision-making and planning method for human-like autonomous driving in merge scenarios. To consider the interaction factor, the reward function for planning is utilized to evaluate the joint trajectories of the autonomous driving vehicle (ADV) and traffic vehicles. And, the trajectories of traffic vehicles are predicted by responding to the ADV's behavior. The results indicate that the planned trajectories with the presented method are highly similar to those of human drivers.

B. Zhou, Y. Tu, Z. Jin, C. Xu and H. Kong, "HPPLO-Net: Unsupervised LiDAR Odometry Using a Hierarchical Point-to-Plane Solver," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3288943.

We propose a HPPLO-Net to predict the relative pose of a LiDAR sensor in a hierarchical way. Specifically, we estimate accurate pose using a differentiable Point-to-Plane solver with the assistance of scene flow. The novel Point-to-Plane solver consists of a multi-scale aggregation (MSA) normal estimation layer and a differentiable weighted Point-to-Plane SVD module, which makes our method achieve comparable performance and outperforms other recent unsupervised LO methods on three datasets.

Z. Li and J. Zhu, "Point-Based Neural Scene Rendering for Street Views," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3304347.

A novel point-based neural rendering framework that facilitates a photo-realistic street simulation environment.Our approach treats the raw point cloud as the geometric representation of the scene, and learns neural textures to capture both geometric and photometric properties.

Y. Liu, M. Wang, P. Lasang and Q. Sun, "Importance Biased Traffic Scene Segmentation in Diverse Weather Conditions," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3272922.

An importance biased network (IBN) model is proposed to improve the generalization of segmentation models for both hazardous and normal weather. It can adapt its prediction ability according to the severity of the weather, and gives high priority to the importance classes (such as road, person and car) when the conditions are too severe to maintain the accuracy of all classes.

H. Guo et al., "Game-theoretic Human-Machine Shared Steering Control Strategy Under Extreme Conditions," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3322137.

This study proposes a game-theoretic human-machine shared control approach to ensure safety under extreme conditions. A differential game framework is utilized to model the human-machine interaction. Piecewise affine (PWA) approximation is utilized to deal with vehicle dynamic nonlinearities and game problems. The weighted shared driving strategy dynamically allocates driving weights based on driving risks and human-machine conflicts, thus enhancing lateral stability. Simulation results verify the effectiveness and robustness of the method, which has better path-tracking performance and shared control performance.

J. Yang, Y. Hu, Z. Yu, F. Chen and X. Xu, "In-Depth Coordination and Extension: Decentralized Onboard Conflict Resolution of UAVs in the Low Altitude Airspace," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3313599.

This paper proposes a decentralized in-depth coordination algorithm to resolve the short-term conflicts between UAVs that fly in the low altitude airspace. Each UAV would determine the conflict avoidance maneuvers with considering the surroundings of the neighbors that conflict with it. Furthermore, this paper extends the coordination algorithm to the bio-inspired UAV flocks coordination algorithm. The simulation results show that the proposed algorithm is able to reduce the impact on the air traffic, and deal with complex conflict scenarios.

Z. Yi et al., "FocusFlow: Boosting Key-Points Optical Flow Estimation for Autonomous Driving," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3317933.

Key-point-based scene understanding is fundamental for autonomous driving applications. Due to the implicit bias of equal attention on all points, classic data-driven optical flow estimation methods yield less satisfactory performance on key points, limiting their implementations in key-point-critical safety-relevant scenarios. To address these issues, we introduce a points-based modeling method that requires the model to learn key-point-related priors explicitly.

Z. Wang, M. Abdel-Aty, L. Yue, J. Zhu, O. Zheng and M. H. Zaki, "Investigating the Effects of Human-Machine Interface on Cooperative Driving Using a Multi-Driver Co-Simulation Platform," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3296678.

In this study, three HMIs were designed: Δv HMI (baseline, displays the speed difference between optimal and current driving speed), Δt HMI (displays the time difference between optimal and estimated arrival time), and Δv -graphic HMI (displays the speed difference using a variable graphic form). The HMI designs follow the skills, rules, and knowledge (SRK) taxonomy. To test the effects of the HMI design on cooperative driving performance, we developed a multi-driver driving co-simulation platform, which can simulate a cooperative driving environment and thus verify the HMI design.

Z. Huang and M. Chen, "Augmented Disturbance Observer-based Appointed-Time Tracking Control of UAVs Under Exogenous Disturbance," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3303348.

The tracking control issue of the unmanned aerial vehicle (UAV) subject to the disturbance generated by the exogenous system (ES) with uncertain structures is proposed. Based on a known finite set describing the mentioned uncertainty, the ES in augmented form is constructed, and the augmented disturbance observer (ADO) is designed to estimate the disturbance. Then, the controller of the UAV is designed based on the appoint-time prescribed performance function and the disturbance estimation obtained from the ADO.

C. Zhang, Z. Ni and C. Berger, "Spatial-Temporal-Spectral LSTM: A Transferable Model for Pedestrian Trajectory Prediction," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3285804.

We propose a transferable model, namely the Spatial-Temporal-Spectral (STS) LSTM model, that represents the motion pattern of pedestrians with spatial, temporal, and spectral domain information. The proposed model demonstrates good prediction accuracy when transferring to target datasets without any prior knowledge, and has a faster inference speed compared to the state-of-the-art models.

Z. Wen, Y. Zhang, X. Chen, J. Wang, Y.-H. Li and Y.-K. Huang, "TOFG: Temporal Occupancy Flow Graph for Prediction and Planning in Autonomous Driving," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3296209.

An environment representation that unifies the map information and vehicle trajectories is proposed, enabling a simultaneous processing of vehicle-to-vehicle and vehicle-to-lane interactions. The application of the proposed representation in trajectory prediction and motion planning tasks is thoroughly discussed. The experimental results show that the proposed environment representation improves the quality of the generated trajectory and computation efficiency in both tasks.

E. Palacios-Morocho, S. Inca and J. F. Monserrat, "Enhancing Cooperative Multi-Agent Systems With Self-Advice and Near-Neighbor Priority Collision Control," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3293198.

A novel neighbor-agent cooperation algorithm based on a semi-centralized architecture and centralized learning is proposed. This configuration allows all agents to act as if they were Independent Learning (IL) since they only use their data to determine the action to be executed. In addition, the concept of Joint Action Learning (JAL) is used; however, the joint action is replaced by one suggested by a self-advice module. Moreover, a collision controller module is designed to mitigate collisions.

D. Jeong and S. B. Choi, "Efficient Trajectory Planning for Autonomous Vehicles Using Quadratic Programming with Weak Duality," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3315387.

An optimization-based trajectory planning algorithm with a Quadratic Programming (QP) form is discussed, addressing the computational load challenge in real-time implementation. Novel dual functions enabling efficient conversion from Nonlinear Programming (NP) to QP are proposed. Extensive simulations showcase its performance in general and emergency driving scenarios. The proposed algorithm offers a compelling balance of computational efficiency and trajectory planning precision, enhancing autonomous driving systems.

A. Yusefi, A. Durdu, F. Bozkaya, Ş. Tığlıoğlu, A. Yılmaz and C. Sungur, "A Generalizable D-VIO and Its Fusion with GNSS/IMU for Improved Autonomous Vehicle Localization," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3316361.

This paper introduces a robust approach to improving autonomous vehicle localization in outdoor environments. It tackles GNSS signal issues with a multi-step correction filter while integrating data from multiple sensors to enhance accuracy. The paper also presents the Generalizable Deep Visual Inertial Odometry (GD-VIO) for better localization during GNSS signal disruptions. Real-world experiments validate the effectiveness of these algorithms, ensuring precise and reliable vehicle pose estimation for autonomous navigation.

S. Kim, K. Han and S. B. Choi, "Imitation Learning of Nonlinear Model Predictive Control for Emergency Collision Avoidance," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3309962.

This study introduces an imitation learning (IL) control structure based on nonlinear model predictive control (NMPC) for vehicle collision avoidance. NMPC optimizes collision avoidance

through integrated steering and braking, and a deep neural network (DNN) is used for real-time implementation. The study overcomes limitations of data collection and parameter handling in collision avoidance systems by proposing an IL-based control structure with offline training and input dimensionalization for parameter robustness. CarSim-based simulations validate the approach's effectiveness and robustness.

B. Hazarika, K. Singh, A. Paul and T. Q. Duong, "Hybrid Machine Learning Approach for Resource Allocation of Digital Twin in UAV-aided Internet-of-Vehicles Networks," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3335277.

In this study, we present a novel approach for efficient resource allocation in a digital twin (DT) framework for task offloading in a UAV-aided Internet-of-Vehicles (IoV) network. Our approach incorporates a hybrid machine learning approach that combines asynchronous federated learning (AFL) and multi-agent deep reinforcement learning (DRL) to jointly optimize task completion rate, energy consumption, and delay parameters, enhancing overall system efficiency.

J. Oh and H. Kim, "A Camera Center Estimation Based on Perspective One Point Method," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3298938.

A method of estimating a moving camera pose using one matching feature pair from two images, corresponding 3D points, and an essential matrix was proposed. It is completely different from the existing method using multiple features, and its accuracy has been verified in simulation and actual moving images. It can be usefully applied in a limited vehicle environment where there are not many matching features.

L. Cultrera, F. Becattini, L. Seidenari, P. Pala and A. D. Bimbo, "Addressing Limitations of State-Aware Imitation Learning for Autonomous Driving," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3336063.

In this paper we propose a multi-task learning agent based on a multi-stage vision transformer with state token propagation. We feed the state of the vehicle along with the representation of the environment as a special token of the transformer and propagate it throughout the network. This allows us to tackle the aforementioned issues from different angles: guiding the driving policy with learned stop/go information, performing data augmentation directly on the state of the vehicle and visually explaining the model's decisions.

K. Fujiwara, H. Iwamoto, K. Hori and M. Kano, "Driver Drowsiness Detection Using R-R Interval of Electrocardiogram and Self-Attention Autoencoder," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3308575.

Drowsy driving detection is crucial for avoiding serious traffic accidents. Changes in sleep conditions affect the autonomic nervous system (ANS) and, subsequently, heart rate variability (HRV), which is fluctuation in the R-R interval (RRI) in an electrocardiogram (ECG). RRI is easy to measure with a wearable sensor, and it may be possible to use RRI to detect drowsy driving. This article proposed a novel method for detecting drowsy driving based on self-attention autoencoder (SA-AE) whose input is RRI of drivers.

V. A. Puligandla and S. Lončarić, "A Continuous Camera Placement Optimization Model For Surround View," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3299199.

This article proposes a novel approach to optimize camera poses for vehicle surround-view in the continuous domain using gradient-free blackbox optimization techniques by defining a non-linear objective function. Experimental results on more than 100 instances of real world 3D models of vehicles of various shapes and sizes show that the proposed method is effective in maximizing coverage for vehicle surround-view by a multiple camera network in a reasonable amount of time.

J. Talbot, M. Brown and J. C. Gerdes, "Shared Control up to the Limits of Vehicle Handling," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3300989.

An advanced driver assistance system formulated using nonlinear model predictive control (NMPC) is proposed. This system keeps a vehicle safely within the boundaries of the roadway while closely matching a driver's steering, throttle, and braking commands when possible. Simulation results show improved robustness over previous techniques by utilizing a safe reference speed objective. Experimental results show the algorithm's effectiveness on a full size research vehicle.

Y. Kim, S. B. Choi, J. J. Oh and J. Eo, "Satisfactory Driving Mode Classification Based on Pedal Operation Characteristics," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3304656.

A satisfactory driving mode classification for enhancing the driver's satisfaction is developed. The proposed algorithm determines the changes required for the current driving mode. Features suitable for classification are extracted from the driver's pedal operation characteristics. The performance of the proposed algorithm is evaluated through nested cross-validation and compared with conventional algorithms based on driving style recognition, demonstrating its superiority and generality.

H. Courtois, N. Aouf, K. Ahiska and M. Cecotti, "NDT RC: Normal Distribution Transform Occupancy 3D Mapping with Recentering," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3250326.

The Normal Distribution Transform Occupancy Map (NDT OM) is a mapping scheme that is restricted to a fixed spatial zone due to limited memory. An extension of NDT OM is proposed, to allow the robot to operate over an unlimited area. The proposed

algorithm is evaluated on two publicly available datasets that validate the precision of the approach. Moreover, a sensitivity analysis to the different tuning parameters is carried out.

K. T. Mori and S. Peters, "SHARD: Safety and Human Performance Analysis for Requirements in Detection," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3320395.

In this work, the issue is addressed by systematically considering safety and human performance across different aspects of the object detection task. This approach yields interpretable detection metrics as well as thresholds for pass/fail criteria. Therefore, the results indicate the necessity of explicit safety consideration in the development of perception algorithms for the automated driving task.

H. Alai and R. Rajamani, "Multi-Stage Estimation Algorithm for Target Vehicle Trajectory Tracking with Applications to E-Scooter Protection∗," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3307973.

This paper develops a multi-stage estimation algorithm for use on an e-scooter for target vehicle trajectory tracking. Three stable observers are designed for these models which are all shown to be stable and robust to uncertainties, in addition to requiring low computational effort. The new estimation algorithm outperforms previous observers in both simulations and experimental results. The developed observer can be especially valuable for use with low-cost sensors in collision prediction and avoidance applications.

A. Dhar, C. H. Ulfsjoo, J. Lofberg and D. Axehill, "Disturbance-Parametrized Robust Lattice-based Motion Planning," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3296691.

A novel disturbance-parametrized robust lattice-based motion planner is proposed, which handles nonlinear systems subjected to bounded additive disturbances. The planner utilizes motion primitives, computed utilizing the system model, parametrized with local estimates of the disturbance, to generate the overall motion. The proposed robust lattice-based motion planner analytically guarantees collision free, resolution optimal and disturbance-aware motions for uncertain nonlinear systems. The performance of the proposed strategy is validated by a simulation experiment considering a ship, modelled as a Euler-Lagrange system.

N. Caber et al., "Driver Profiling and Bayesian Workload Estimation Using Naturalistic Peripheral Detection Study Data," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3313419.

A novel on-road study for collecting subjective workload data via a modified PDT in naturalistic settings is presented. The produced data is used to develop and validate: a) a supervised learning framework using SOTA time-series classifiers to profile drivers based on the average workload they experience (i.e. macro-scale measure); and b) an adaptable (e.g. personalised as per the aforementioned driver profile) Bayesian filtering approach for sequentially estimating, in real-time, the driver's instantaneous workload (i.e. micro-scale measure). Only driving performance (CAN-bus) signals are utilised.

M. Naderi, M. Papageorgiou, D. Troullinos, I. Karafyllis and I. Papamichail, "Controlling Automated Vehicles on Large Lane-free Roundabouts," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3338261.

A comprehensive methodology to control automated vehicles within large lane-free roundabouts is proposed. Appropriate OD corridors and desired orientations are specified and a distributed movement control strategy, using nonlinear feedback controllers, is employed to navigate each vehicle collision-free toward its destination. Boundary controllers are designed to respect corridor boundaries. The famous roundabout of Place Charles de Gaulle is considered a complicated case study. The effectiveness of the presented method is verified via microscopic simulation and evaluation of macroscopic data.

A. Alan, C. R. He, T. G. Molnar, J. C. Mathew, A. H. Bell and G. Orosz, "Integrating Safety with Performance in Connected Automated Truck Control: Experimental Validation," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3305204.

Combining efficiency with safety is one of the most important design challenges for connected automated trucks. In order to address this challenge for longitudinal control problems, we propose a scheme that integrates a performance-based controller with a safety-oriented controller in a seamless manner. This safe integration scheme operates instantaneously, and it is compatible with a large class of controllers. Finally, experiments are extended to a public highway, and similar results are obtained with up to 4.3% energy saving.

II. Social Radars for Social Vision of IVs from Skyways in Low Altitude Airspaces

The concept of Social Radar originated from the necessity to improve the social intelligence of autonomous systems in CPSS, enabling them to interpret and respond to complex human behaviors and social cues more effectively [6], [8]. Traditional sensors were adept at detecting objects and measuring distances, but they lacked the capability to understand the social relationships of human behavior. Social Radar metaphorically extends the concept of radar from the purely physical domain into the social and behavioral perspective. Just as radar systems detect and interpret electromagnetic waves to understand the physical environment, Social Radar aims to detect and interpret human social signals to understand social intentions and behaviors.

Social Vision is proposed when integrated with contextual insights from Social Radar, which provides information on entity

movement and behavior of transportation participants, Social Vision enables a nuanced analysis of the social scenarios[7], [9]. This comprehensive approach involves fusing high-resolution visual data with radar data, utilizing feature extraction, and applying machine learning models to predict the behaviors of moving obstacles. Social Vision continuous improvement through feedback loops, combined with rigorous testing and a strong commitment to ethical and privacy standards, ensures the system's ongoing refinement, reliability, and safe integration into human-centric spaces.

Social Radar and Social Vision are critical to IVs as they give vehicles the ability to understand and adapt to their social environment, significantly improving road safety and driving efficiency[10]. Low Altitude Airspace (LAA) is a space area close to the ground. It's safe and effective management is crucial to the operation of helicopters, drones, and other aircraft, and is of great significance to the development of future urban air transportation. IVs in LAA play a very important role, especially in terms of their potential interoperability with drones and other aircraft, such as the cooperation of drone delivery services and smart vehicles, to achieve more efficient and smarter transportation and logistics system to provide support. Social radar systems are crucial for the safe navigation of IVs in LAA because it provides precise collision avoidance, environmental adaptation, and efficient communication capabilities in three-dimensional space.

To make a clear understanding of these topics. we have organized a series of DHW or DHS on these issues since last year[1], [3], [4]. We welcome submissions on these topics, including Perspectives, Communications and Letters, and Regular Papers.

The above content was produced with ChatGPT's assistance, through three steps: Prompting, Prescription, and Alignment. We believe that with the further development of Artificial Intelligence and Large Language Models, three new types of engineers will be needed and emerged in the future: Prompting Engineers, Prescription Engineers, and Alignment Engineers. We would like to start to try them first here at IEEE TIV.

III. Call for Participation: Decentralized Hybrid Workshops

At IEEE TIV we will continue to organize decentralized and hybrid workshops or symposia (DHW or DHS) on various issues in ITS and IVs.

Welcome to participate in our investigations online or off-line. Our discussions will be summarized and reported as perspectives, letters, or regular papers at IEEE TIV. The following DHWs have been organized so far:

1. Verification and Validation for IVs (V&V4IV)
2. Autonomous Mining (AM)
3. Ethics, Responsibility, and Sustainability (ERS)
4. Intelligent Vehicles for Education (IV4E)
5. Data Science for Intelligent Vehicles (DSiV)
6. Vehicle 5.0 (V5)
7. Scenarios Engineering for Smart Mobility (SE4SM)
8. CrowdSensing Intelligence (CSI)
9. Sustainability for Transportation and Logistics (STL)
10. Autonomous Services (AS)
11. Foundation/Infrastruce Intelligence (FII)

Any suggestions or proposals for future topics of DHW/DHS are greatly appreciated. Looking forward to having you in IEEE TIV DHW/DHS.

IV. The "3323" Review Guideline

As reaffirmed in [3], our review guideline for EIC/SE/AE is "3323", specified as below:

- 3 weeks for the first decision
- 3 rounds of revision in maximum
- 2 weeks for minor revisions
- 3 weeks for major revisions

Under this guideline, we expect a maximum total 15-week review process for a submission.

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