Academic Corner
Hang Su

In this issue, we interview IEEE SMC member **Prof. Shichun Yang**, Fellow of the IET and the IIAV. He is the leading authority in intelligent battery management for new energy vehicles, and is the Professor at the School of Transportation Science and Engineering in Beihang University. Prof. Yang earned his Ph.D. from Jilin University since 2004, and has dedicated his career to safe management and controlling for intelligent new energy vehicles. His contributions have earned him major national recognitions, including the National Distinguished Scientist and Technologist Award (2016), and selection into the National Leading Talents (2019). In 2024, he established the group for intelligent unmanned equipment and selected into National Innovation Group. And in 2025, he was listed among the world's top 2% most-cited scientists.

Prof. Yang plays a central role in shaping China's automotive technology ecosystem. He chairs the China SAE Intelligent and Connected Vehicle Safety Sub-committee, the Flying Vehicle Sub-committee of the Chinese Society of Aeronautics and Astronautics, and serves as Deputy Secretary-General of the National EV Standards Committee. He was elected Fellow of the China SAE (2020), IIAV (2024), and IET (2025). His research covers cross-scale state detection, full-lifecycle battery management, and vehicle-cloud collaborative early-warning technologies for thermal runaway, with advances including digital-twin-based state inversion, electro-thermal decoupling, and cloud-driven safety prediction. He has published over 229 high quality papers in journals such as Nature Communications, Advanced Energy Materials, and Energy Storage Materials; authored four monographs. He has also held 131 national invention patents. He has led over 30 major national projects, including National Key R&D Program of China, and NSFC key projects. According to his contribution, he has been awarded as the first contributor for multiple top awards, including the National Science and Technology Award (2019, 2025) and the China SAE Highest Award for Invention.

Internationally, Prof. Yang has collaborated with Prof. Hamid Reza Karimi (Politecnico di Milano) since 2015 on machine learning and fault diagnosis for electric vehicles, co-supervising PhD students and contributing to EU-funded programs such as LIS4.0 and the Horizon Europe MSCA Doctoral Network. Over the past decade, he has supervised more than 20 Ph.D. and 50 Master's graduates, many now serving in leading European institutions, contributing significantly to global EV research and industry development.

(1) What inspired you to focus on autonomous driving, vehicle cybersecurity, and intelligent transportation systems?

My research for autonomous driving is beginning from personal original aspiration and the real requirements from engineering practice. After acquiring doctoral degree at Jilin University, I specialized in vehicle intelligent control theory. However, with the rapid development of China automotive industry, the number of vehicles has increased dramatically. The long traffic jams during peak hours in major cities have made me deeply realize that as the most common mobile terminal, where the intelligent upgrade of automobiles is not only a technical issue but also a livelihood project related to the travel safety of millions of people and the improvement of social operation efficiency.

Coincidentally, when the national strategy for intelligent new energy vehicles was launched, the state clearly identified intelligent connected vehicles as a strategic emerging industry. The policy guidance and industrial demand have formed a strong synergy. In 2011, I took the lead in establishing the subject of new energy vehicle engineering in Beihang University, which is recognized as a key interdisciplinary subject under the Ministry of Industry and Information Technology. Over the past 15 years, I have continuously conducted research in the field of intelligent and new energy vehicles.

During this period, we have carried out a large number of industry cooperation projects with leading enterprises such as Huawei and BYD, promoted the application of autonomous driving vehicle along with network security technologies. As the first contributor, I have won 2 National Science and Technology Progress Awards, along with the Special Prize of Technological Invention from the China Society of Automotive Engineers and many other awards. I have also been elected as an IET Fellow and a CSAE Fellow, and have offered suggestions for making policy as expert, continuously contributing to the large-scale promotion of intelligent connected vehicles in China.

(2) What do you see as the major challenges in developing safe and reliable autonomous driving systems today?

From a technical perspective, the most prominent aspects are the generalization ability in long-tail scenarios and the fusion robustness of multi-source data. Currently, high-level autonomous driving performs excellently in standardized scenarios. However, when facing unstructured scenarios such as water reflection on rainy days, temporary markings on construction sections, and pedestrians suddenly crossing the road, significant optimization is still necessary for the misjudgment rate of algorithms, which is originated from the disconnection between data-driven and knowledge-driven approaches. Simply relying on massive data training makes it difficult to cover all extreme scenarios. A hybrid intelligent system combining data and knowledge based on mechanism models must be established. Meanwhile, redundant design for sensor fusion is also crucial. For example, complementary calibration between lidar and vision sensors can significantly improve perception accuracy in complex environments.

At the regulatory level, the contradiction lies in the rapid iteration of technology and the relative lag of regulations. A unified standard for the testing and evaluation system of autonomous driving has not yet been established. Issues such as the quantitative indicators of safety redundancy and the legal boundaries of liability division still need to be clarified. In response, the China State Administration for Market Regulation has established a sandbox regulatory mechanism, allowing enterprises to conduct tests in specific areas and scenarios. Data accumulated from these tests can then be used to inform rule-making. On the other hand, it is promoting the standardization of infrastructure for vehicle-road collaboration. By leveraging the auxiliary perception capabilities of roadside units, the difficulty on single-vehicle intelligence can be reduced. This is also a unique advantage of Chinese autonomous driving development.

Vehicle network security is an invisible challenge that persists throughout. From the firmware security of in-vehicle controllers to data encryption in V2X communication, any vulnerability in the system can lead to safety incidents. The zero-trust security architecture our team is promoting aims to build a secure foundation for autonomous driving through full-link protection that combines identity authentication, behavior auditing, and dynamic defense.

(3) How do you foresee the integration of cloud-based battery management and vehicle-to-everything (V2X) communication transforming the transportation ecosystem?

The integration of cloud battery management system (Cloud-BMS) and V2X is the key to breaking the current information barriers in intelligent transportation. It will drive the transformation of the transportation ecosystem from single-vehicle intelligence to group intelligence, and its impact is reflected in three aspects.

First, it enables the coordinated optimization of energy and transportation. Traditional BMS can only achieve local management of the battery system of a single vehicle. However, by aggregating the battery data of all vehicles in a region and combining real-time traffic information obtained through V2X, Cloud-BMS can realize the coordinated scheduling of charging demand, power grid load, and traffic flow. For example, the system can predict that a charging peak will occur in a certain area after the evening rush hour and push off-peak charging suggestions in advance through V2X. This not only avoids overloading the power grid but also reduces the queuing time for vehicle owners, providing a technical path for the coordination between new energy vehicles and the smart grid.

Second, it improves both safety and efficiency. Through big data analysis, Cloud-BMS can issue early warnings of battery degradation risks. By combining with V2X, it can push fault information to surrounding vehicles and the traffic management platform in real time, achieving a closed-loop of fault warning, emergency response, and traffic diversion. The intelligent battery management method that integrates mechanism, data, and AI multi-modalities can provide safety risk warnings more than 24 hours in advance, effectively reducing the probability of vehicle accidents. Our research results have been published in Nature Communications and have been applied in batches to nearly 22 million new energy vehicles, significantly enhancing the safety of power batteries.

In the next decade, the key technological trends defining intelligent transportation will inevitably be the coordination between the cloud, edge, and end, as well as multi-modal integration. In addition to the integration of Cloud-BMS and V2X, the dynamic update of high-precision maps, the application of digital twin technology in traffic control, and the combination of large models and autonomous driving algorithms will all drive the transportation ecosystem to evolve towards efficiency, low carbon, and safety.

(4) You have led numerous national and international research projects bridging academia and industry. How has this cross-sector experience influenced your approach to research and innovation?

Intelligent driving is inherently interdisciplinary. Over the past decade, I have led major national projects, including China’s National Key R&D Program and key projects under the NSFC Fund, and co-established joint laboratories with industry partners such as BYD and Changan Automobile. This has enabled an engineering-driven pathway from isolated advances to system-level solutions. When developing decision-making algorithms for autonomous driving, industry requirements shifted our focus from accuracy alone to lightweight models that balance performance with computational efficiency. In on-vehicle deployment, these models reduce hardware cost while improving real-time responsiveness. Consequently, our outputs have moved beyond laboratory prototypes to deployable products, and real-world industrial challenges continuously inform and refine our academic research agenda.

(5) In your view, how can China and the global community work together to advance vehicle cybersecurity and autonomous systems?

Autonomous driving and vehicle cybersecurity are global challenges; sustained progress requires international cooperation. Currently, national standards for autonomous driving vary in areas such as data-collection protocols and safety evaluation metrics, which hinders cross-border deployment for multinational companies. China has developed strengths in cooperative vehicle–infrastructure systems (C-V2X) and new energy vehicle safety, and we will actively contribute to international standardization efforts through bodies such as ISO and IEEE. We aim to bring practice-validated metrics from China into international standards while learning from European and U.S. experience in ethical governance and data-privacy protection, thereby building a more harmonized framework that balances global interoperability with regional differences. We will also promote open innovation, prevent the misuse of core technologies and sensitive data, and jointly develop ethical decision frameworks.

(6) As an accomplished scholar and leader, what advice would you give to young researchers who aspire to contribute to the fields of intelligent vehicles and smart transportation?
Early-career researchers should first build strong interdisciplinary integration skills. In this field, there are few purely mechanical or purely software roles. You need to understand vehicle dynamics, be proficient in AI, and also be familiar with communication technologies as well as legal and regulatory requirements. It is recommended that strengthen your core disciplinary fundamentals while pursuing targeted cross-training. For instance, mechanical-engineering students should master deep learning, while computer-science students should learn vehicle dynamics and chassis control. We have also put this philosophy into practice through a professional master program co-launched with Baidu, using project-based learning to integrate knowledge through real-world problem solving.

Second, they should balance the conceptual innovation with engineering application and deployment. They should tackle foundational theoretical challenges, such as improving decision-making logic under uncertainty, while maintaining an engineering mindset that prioritizes cost, reliability, safety, and compliance. They should avoid optimizing only for publication metrics and instead engage in industry collaborations to gain experience through on-vehicle testing.

Third, long-term perseverance is essential. Breakthroughs in intelligent driving are iterative: model refinement may require thousands of experiments, and deployment may take years of testing and validation. Early-career researchers should stay resilient, track near-term advances, and anchor their work in long-term societal and industrial value by focusing on future-defining directions such as vehicle cybersecurity and low-carbon transportation.

(7) How has your engagement with IEEE and the IEEE Systems, Man, and Cybernetics Society influenced your academic career and research vision, and what advice would you offer to young researchers on making the most of IEEE platforms to advance their growth and global impact?
IEEE SMC has been instrumental in broadening my research horizons and enabling international collaboration. Academic research must be rigorous, clearly communicated, and externally validated; IEEE provides a critical channel for disseminating Chinese technological contributions globally and for emphasizing not only performance metrics but also international generalizability and industry impact.

For young researchers, leveraging IEEE requires active engagement in scholarly exchange; in addition to attending conferences, they could submit manuscripts, deliver oral presentations, and use dialogue with international peers to identify gaps and generate new ideas. They could also build collaborative networks by connecting with leading scholars and industry experts through IEEE communities and focused workshops, particularly to pursue joint research opportunities in emerging areas. Finally, they could join IEEE technical committees and standards working groups to help translate research into standards and contribute to the field's long-term development.