

# Research on X-by-Wire Chassis Technology for Intelligent Driving of New Energy Vehicles

Honghong Xiao\*

JMCG Jingma Motor Co., Ltd., Nanchang 330001, Jiangxi Province, China

\*Corresponding author: Honghong Xiao, xiaoh168@163.com

**Copyright:** © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

**Abstract:** As China's economy develops, new energy technologies and intelligent driving have become a trend in the automobile industry. The development of new energy vehicles has accelerated, with X-by-wire chassis technology becoming the core technology for intelligent driving. This technology includes steer-, brake-, shift-, and throttle-by-wire systems. It is not only the key technology for new energy vehicles but also an important support for promoting their sustainable development. This article presents an in-depth study on X-by-wire chassis technology in new energy vehicles and its basic working principle.

**Keywords:** New energy vehicles; Intelligent driving; X-by-wire chassis technology

**Online publication:** March 30, 2024

## 1. Introduction

For China to transition from being a major automobile producer to becoming a powerhouse in the automotive industry, it is essential to continuously advance the development of new energy vehicles. This is also an important measure to strive towards sustainable development. Similarly, new energy vehicles are preferred because of their low noise, green environmental protection, and diverse functions. Intelligent driving has become one of the main directions for developing new energy vehicles. X-by-wire chassis technology eliminates the complex equipment connections and components of traditional chassis systems, making electrical signals the primary means of transmission. This approach can significantly enhance energy utilization efficiency, thereby improving the endurance of new energy vehicles <sup>[1]</sup>. Currently, "wireless control, non-autonomous driving" has become the consensus in the new energy vehicle industry. This shows that x-by-wire chassis technology occupies an important position in the automatic driving of new energy vehicles.

## 2. The difference between X-by-wire chassis and traditional chassis

As society evolves, cars have become an essential mode of transportation for everyday journeys. Their control systems are relatively straightforward. Standard control mechanisms include the accelerator pedal, brake

pedal, steering wheel, gear shift lever, and more. In most traditional automobiles, these controls are operated directly by the driver, who uses them to manipulate mechanical structures and components, thereby controlling the vehicle <sup>[2]</sup>. However, with the advancement of technology, innovations continuously emerge, making car functionalities increasingly robust. For instance, automatic transmission vehicles achieve automatic shifting and engine start through onboard sensors and Vehicle Control Units (VCU). X-by-wire chassis technology, on the other hand, replaces the complex mechanical structures found in traditional cars with cables and utilizes onboard computer technology to control the vehicle.

### **3. Working principles of X-by-wire chassis technology for new energy vehicles**

#### **3.1. Steer-by-wire**

A steer-by-wire system is one of the core actuators that control the lateral movement of the vehicle. In traditional automobiles, the connection between the steering wheel and the wheels relies on mechanical structures. However, a steer-by-wire system consists of three components: the steering wheel, the Electronic Control Unit (ECU), and the actuator module. When the driver turns the steering wheel, giving a steering command, the steer-by-wire system automatically measures and monitors the action. It then sends this data to the ECU. At the same time, the ECU sends force feedback to the steering wheel, allowing the driver to understand the road conditions and adjust their driving accordingly. The ECU is the heart of the steer-by-wire system <sup>[3]</sup>. It centrally processes the gathered data through powerful computational capabilities, ensuring that both the steering motor and torque motor can receive signals to ensure smooth steering motion and timely road feedback. Additionally, the ECU can continuously monitor the driver's state, enabling systematic centralized intelligent management. Compared to mainstream electric power steering systems, the steer-by-wire system offers advantages such as better responsiveness and greater potential for expanding intelligent driving functionalities.

#### **3.2. Brake-by-wire**

The braking system is the most important safety feature whether it is a traditional car or a new energy vehicle. The braking system serves to decelerate or stop the vehicle by utilizing the friction between the brake and the wheel. This not only maintains stability during driving but also enhances maneuverability in different environments. The brake-by-wire system consists of a brake pedal, a displacement sensor, a speed sensor, and other signal transmission lines <sup>[4]</sup>. The main function of the brake pedal sensor is to record the force and speed at which the driver presses the brake pedal. It then converts this information into electrical signals, which are sent to the controller. The controller comprehensively calculates the received instructions. To prevent accidental operations, the controller evaluates the received information. If it confirms that the driver's operation is normal, the actuator receives the signal from the controller, leading to the execution of the braking action.

The utilization of brake-by-wire systems in new energy vehicles offers the following advantages: The structure of a brake-by-wire system is simpler than the brake systems of traditional cars. Secondly, the braking system controlled by electrical signals is extremely efficient as it can reach the maximum braking force within 150ms. Thirdly, the modular structure of the system facilitates future maintenance and repair. Lastly, it is easy to update and modify and can be equipped with a variety of electronic control functions.

#### **3.3. Shift-by-wire**

For automatic transmission cars to achieve fully automated parking, they need to shift from the traditional method of using a gear lever to an electronic sensor-based shifting system. This system is called a shift-by-wire system. A shift-by-wire system can achieve more efficient and accurate shifting than traditional shifting

systems. This system is preferred in assisted driving. A shift-by-wire system consists of automatic transmission, automatic P gear, door safety protection, seat belt protection device, driving habit adaptive system, and other functions [5]. Typically, the main components of a shift-by-wire system are the controller, the electronic gear selector, the engine and transmission module, the shift actuator, and the vehicle signal module. When the system detects a shift command, it will send a signal to the controller. Then, the controller will analyze and judge the vehicle's safety status and the driver's operation to decide whether the shift operation can be performed. When it is determined to be safe, and the shift operation can be performed, the actuator is responsible for receiving the final electrical signal sent by the controller and executing the shift operation. At the same time, the instrument panel will display gear-shifting information to the driver. If there is a safety hazard in the vehicle, the controller can also display the corresponding information on the dashboard immediately, allowing the driver to take relevant measures. Compared to the traditional gear lever-based shifting system, the shift-by-wire system offers two advantages: first, its simple structure not only saves interior space but also facilitates maintenance in the long term. Secondly, shift-by-wire systems are easy to operate, thereby enhancing the safety of shifting operations.

### **3.4. Throttle-by-wire system**

The throttle-by-wire system comprises the accelerator pedal, controller, transmission circuit, and throttle actuator. In addition to the accelerator pedal sensor, the sensors include a vehicle speed sensor, an oxygen sensor, and a throttle-opening sensor. Throttle-by-wire systems control the opening and closing of the throttle through cables. Structurally, the wire-controlled throttle system replaces the traditional throttle cable with an electronic control system. However, in essence, the electronic control system not only changes the traditional structural method but also controls the entire vehicle's power output. For example, when the driver presses the accelerator pedal for acceleration, the sensor module collects data on the force applied to the pedal and transmits it to the ECU, which then integrates and analyzes the data. This allows the electronic control unit to fully understand the driver's intentions and issue commands based on preset parameters, completing the acceleration operation. Sensor signals may be influenced by other factors, leading to some degree of deviation. In response, the wire-controlled throttle system can accurately adjust and process these deviations through information processing, preventing signal errors from occurring.

## **4. Application of full vector X-by-wire chassis technology**

As society continues to evolve, electric vehicles have become a key focus in the automotive industry, driven by market demands. After undergoing significant changes over the years, the automotive sector is now experiencing a new phase of transformation and advancement. In China, electric vehicles are moving towards a greener and more intelligent future. X-by-wire chassis technology emerged around a decade ago. However, its effectiveness was limited back then. Conventional fuel-powered vehicles, relying on 12V lead-acid batteries, struggled to supply enough power for advanced control systems while meeting their own propulsion needs. In recent years, the adoption of electronic control systems in electric vehicles has addressed this challenge effectively. Electric vehicles, whether fully electric or hybrid, inherently possess ample energy reserves. Moreover, they boast significant power outputs, capable of meeting the energy demands of wire-controlled chassis systems, thereby ensuring the smooth operation of electric vehicles [6].

Most traditional gasoline vehicles use an under-driven system with a relatively simple structure consisting of a gas pedal, a brake pedal, and a steering wheel [7]. Generally, they only provide control over the vehicle's lateral and longitudinal movements, making them somewhat challenging to handle and slow to respond.

However, with the continuous advancement of electronic control technology, the data collection capabilities of electronic control modules are becoming increasingly powerful. As a result, new energy vehicles are transitioning to all-wheel-drive and overdrive systems. Under the control of all-wheel-drive systems, each wheel of a new energy vehicle can receive three forces from different directions, with each force being independently controllable. This is what we refer to as vector-controlled vehicles<sup>[8]</sup>.

The full vector control system is a common over-drive system. Under a vector control system, each wheel can be controlled independently. The vector control system includes 16 controllable collection modules, enabling effective control over 12 forces for the vehicle. Vector-controlled vehicles not only enhance the control performance of each wheel but also complement certain functions' actuators. This ensures that even if an issue arises at one point, the system's stability and reliability can still be maintained<sup>[9]</sup>.

The chassis stands as a focal point in the development of vector-controlled vehicles. Therefore, to achieve further advancements in new energy vehicles, the emphasis should be on optimizing X-by-wire chassis technology. This entails independently designing and fine-tuning optimizations by integrating the functionalities and implementation methods of full vector wire-controlled driving chassis<sup>[10]</sup>.

## **5. Prospects of new energy vehicle intelligent driving and x-by-wire chassis technology**

New energy vehicles have addressed the issue of insufficient energy in X-by-wire chassis technology, which has propelled the advancement of intelligent driving for these vehicles. This, in turn, has provided endless possibilities for the development of new energy vehicles. The two complement each other, fostering mutual growth. As an execution system for the auxiliary driving system of new energy vehicles, X-by-wire chassis technology lays the foundation for the development of autonomous driving. For example, the Lincoln MKZ is preferred by many autonomous driving companies as a test vehicle precisely because it is equipped with a complete X-by-wire chassis system, including throttle-, brake-, and steer-by-wire systems. Therefore, although it is not a new energy vehicle, it has become a classic representative of autonomous driving models.

## **6. Conclusion**

The X-by-wire chassis technology for intelligent driving in new energy vehicles offers several technical advantages compared to traditional cars. Firstly, it optimizes traditional chassis structures, improving the flexibility of new energy vehicles. Secondly, by using an ECU as the actuator, it not only enhances sensor speed for quicker braking but also reduces space requirements and vehicle weight. Lastly, the modular nature of X-by-wire chassis technology facilitates maintenance and allows for modifications and customization. With continuous advancements in science and technology, it is clear that full-vector wire-controlled chassis systems are set to become the future direction for intelligent driving technology in new energy vehicles.

## **Disclosure statement**

The author declares no conflict of interest.

## **References**

- [1] He L, Zhou S, 2023, Application of Control-By-Wire Chassis Technology for Intelligent Driving of New Energy

Vehicles. *Automobile Test Report*, 2023(3): 53–55.

- [2] Cheng X, 2022, Research on the Application of Wire-Controlled Chassis Technology for Intelligent Driving of New Energy Vehicles. *Automotive Knowledge*, 22(10): 22–24.
- [3] Hu H, Zhao C, 2022, Application Analysis of Wire-Controlled Chassis Technology for Intelligent Driving of New Energy Vehicles. *Computer Enthusiasts (Popular Edition) (Electronic Journal)*, 2022(4): 3659–3660.
- [4] Liu J, Liu J, Zhang F, 2022, Research on the Application of Wire-Controlled Chassis Technology for Intelligent Driving of New Energy Vehicles. *Times Automobile*, 2022(3): 101–103.
- [5] Li F, 2023, Analysis of Wire-Controlled Chassis Technology for Intelligent Driving of New Energy Vehicles. *Digital Users*, 29(8): 79–81.
- [6] Liu Q, 2022, Application Analysis of Wire-Controlled Chassis Technology for Intelligent Driving of New Energy Vehicles. *Automobile Test Report*, 2022(8): 109–111.
- [7] Chen M, Du W, 2022, Analysis and Research on the Development Trend of Automobile Control-By-Wire Chassis Technology. *Automobiles and Parts*, 2022(24): 54–59.
- [8] Hubei Meibiao Kangqing Heavy Industry Technology Co., Ltd., 2021, A Four-Wheel Steering Wire-Controlled Chassis for New Energy Vehicles. CN202123226145.8.
- [9] Li Q, Bai J, 2021, Technical Research on a High-Energy Recovery Brake-By-Wire System. *Automotive Knowledge*, 2021(9): 27–30.
- [10] Gao H, 2022, Analysis of New Energy Vehicle Braking Systems (1). *Automobile Repair and Maintenance*, 2022(3): 53–57.

**Publisher's note**

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.