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Longitudinal Human-machine Cooperative Control of Intelligent Vehicle: A Review

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Abstract Human-machine cooperative driving is a human-machine hybrid enhancement technology that cooperates with the human driver and the assistance system to drive the vehicle. It can give full play to the respective advantages of the driver and the assistance system. The human-machine cooperative control is divided into lateral human-machine cooperative control and longitudinal human-machine cooperative control. In this paper, longitudinal human-machine cooperative control is summarized and analyzed from two aspects of driver braking behavior modeling and longitudinal human-machine cooperative control method. Firstly, the driver state monitoring, driver braking intention recognition and driver braking behavior modeling are analyzed. Then, the longitudinal human-machine cooperative control is systematically analyzed and discussed from three aspects: braking system which can be used for longitudinal human-machine cooperative control, only longitudinal human-machine cooperative control, and longitudinal and lateral human-machine cooperative control. Finally, the recommendations for future research directions are prospected from the longitudinal driving characteristics of the driver considering the impact of lateral motion and regenerative braking, the driver-vehicle-environment oriented human-machine cooperative control of composite braking, coupling relationship of longitudinal and lateral human-machine cooperative system and situation evaluation of the safety of the intended functionality, and the longitudinal and lateral coordinated control strategy of the human-machine cooperative system.

Index Terms Longitudinal control, braking intention, braking system, human-machine, cooperative control

I. Introduction

With the continuous increase in the number of vehicles, road traffic safety has become a great social and public concern.[1] Statistics reveal that road traffic accidents claim the lives of over millions of people and cause tens of millions of injuries and substantial economic losses worldwide each year.[2], [3] Human errors—such as unsafe driving practices, fatigue, negligence, and illegal driving—are the leading cause of traffic accidents. The rapid development of intelligent vehicle technologies, including driver assistance and autonomous driving, offers promising solutions to mitigate this issue. The driver assistance system can help the driver deal with frequent and complex manipulations to improve the driving safety of the vehicle. Experts, scholars, and industry leaders believe that autonomous driving technology has great potential to fundamentally reduce the incidence of traffic accidents and liberate drivers from the demands of manual driving.[4], [5]

In recent years, the rapid development of information, sensing, and artificial intelligence technologies has significantly driven advancements in autonomous driving. In 2014, the Society of Automotive Engineers (SAE) established a classification standard for autonomous driving technology to create uniformity in management and oversight, categorizing it into six levels from L0 to L5 based on the extent of control and the driving environment.[6] On March 9, 2020, the Ministry of Information Technology released the "Automobile Driving Automation Classification" standard, which aligns with China's current development status.[7] This classification system also consists of six levels, ranging from 0 to 5, based on the allocation of driving automation systems responsible for performing dynamic driving tasks and the limitations of design operating conditions. Level 5 represents fully autonomous driving, a goal that remains challenging to achieve in the near future due to technical, financial, infrastructural, and regulatory constraints. This paper focuses on human-machine cooperative driving from levels 0 to 4, where the driver still plays a role in vehicle control, in contrast to level 5, which denotes full autonomy (see Fig. 1).

Human-machine cooperative driving is a hybrid enhancement technology that integrates human and machine capabilities.[8] It can not only take advantage of the exceptional perception, the standardized trajectory planning,

and precise control of the assist system but also harness the ability of the driver to comprehend and adapt to the complex scenarios to maximize the strengths of both parties. The driver's personal experience with autonomous driving determines their willingness to engage in driving activities. In particular, the intervention of the driver becomes common place when there is a lack of trust in the autonomous system during emergency driving scenarios.[9] The ultimate goal of developing autonomous vehicle technology is to establish a more intelligent driving system that enables drivers to seamlessly transition among manual driving, cooperative driving, and autonomous driving. Therefore, human-machine cooperation is the focus of intelligent vehicle technology, relevant both in the current phase of assistance driving and in the future when fully autonomous driving is achieved.

The ability of the driver to manage the vehicle primarily involves controlling lateral motion and longitudinal motion. Based on the driver control actions, human-machine cooperative control is divided into lateral human-machine cooperative control and longitudinal human-machine cooperative control (LHMCC) (see Fig. 1). Lateral cooperative control refers to the steering system where both the driver and the assist system cooperate to manage the vehicle, sharing the control right to accomplish driving tasks such as lane keeping[10], lane changing [11], [12] and actively avoiding collisions [13], [14] through a hybrid enhancement of the driver and the assist system. LHMCC involves a braking system where the driver and an assist system work together to manage the vehicle. This system enables shared control, facilitating cooperation between the driver, brake energy recovery, and assist braking through a hybrid enhancement of the driver's actions.

The lateral and longitudinal human-machine cooperative control of the intelligent vehicle involves three parts: environmental perception, driver behavior modeling, and control execution (see Fig. 1). The research on environmental perception extends beyond individual intelligence systems, encompassing the identification and orientation of other traffic participants, such as lane markings, [15] vehicle positions ,[16] and pedestrians.[17] This field has attracted attention from various disciplines, including computing, automation, and artificial intelligence. Many scholars have provided detailed overviews of sensor fusion techniques, methods for implementing fusion perception, and the detection accuracy of different identification targets [18]-[20]. The research on driver behavior modeling has mainly focused on driver steering behavior modeling. Wang et al. summarized the steering driver model from the system structure of cooperative control [21]. Marcano et al. summarized the concept, categories, algorithms, and technical status of the cooperative control system, analyzed the influence of the driver model on the human-machine conflict of steering from the perspective of theory and application, and sorted out the cooperative steering control methods based on the model and without the driver model [22]. Hu et al. conducted a more detailed analysis and summary of driver state supervision, intention recognition, and driver steering behavior modeling involved in lateral human-machine cooperative control, and put forward the technical difficulties of driver steering behavior modeling in lateral human-machine cooperative control.[23] For the review research on human-machine cooperative control execution, Wang et al. summarized intelligent assisted driving, human-machine driving authority switching, and dynamic cooperative control of the human-machine system, but mainly focused on lateral human-machine cooperative control. [23] De et al. [24], [25] and Roche et al. [26], [27] respectively studied the take-over of human-machine driving rights from two aspects: the system initiative take-over and the driver initiative take-over, and clarified the take-over timing of the system and the driver. Wang et al. analyzed and summarized the human-machine takeover from three aspects: the task of the driver, the driving load of the driver, and the trust of the driver for the autonomous driving system, and compared it with shared control.[28] Yang et al. discussed the decision-making method of human-machine shared control from the objective risk assessment index and driver factors, and analyzed the characteristics and application scope of direct and indirect shared control mode in detail, but still focused on the lateral human-machine cooperative control. [29]

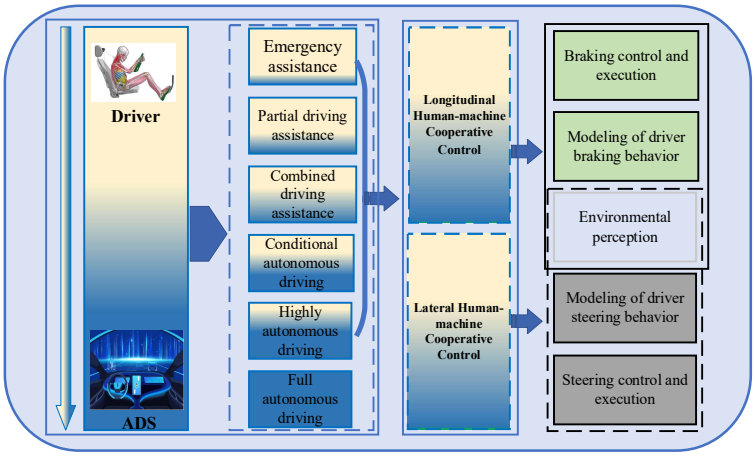

Figure 1: Autonomous driving classification and longitudinal and lateral human-machine Cooperative

Although many works of literature have been done on lateral human-machine cooperative control, there is no paper to review and discuss the LHMCC comprehensively. Therefore, this paper provides an overview of the field of LHMCC by analyzing and summarizing the related literature on the driver's braking behavior modeling, braking system for LHMCC, only LHMCC, longitudinal and lateral human-machine cooperative control.

The contents of this paper are organized as follows. In the second section, the driver's braking behavior modeling is presented, including driver status monitoring, braking intention recognition, and driver's braking behavior modeling. The research status of LHMCC is analyzed and discussed in the third section, including the braking system for LHMCC, only LHMCC, and longitudinal and lateral human-machine cooperative control. Finally, the conclusion and perspective are made in the last section.

II. Driver's braking behavior modeling

The driver and the human-machine cooperative control system are the two primary entities responsible for controlling the motion of the vehicle. The driver's braking behavior significantly impacts the driving process. In different braking scenarios, the longitudinal human-machine cooperative system needs to perform varied controls according to the specific braking behavior. Therefore, to achieve safe and effective LHMCC, it is essential to conduct state monitoring, braking intention recognition, and driver behavior modeling. The following sections elaborate on these two aspects: driver braking behavior monitoring and intention recognition, and driver's braking behavior modeling.

II. A. Driver status monitoring and braking intention recognition

II. A. 1)Driver Status Monitoring

Driver status is primarily classified into normal driving states and three types of abnormal driving states: fatigued driving,[30] distracted driving,[31] and extreme abnormal driving.[32] The monitoring of these four driver states is mainly conducted through direct and indirect monitoring methods. Direct monitoring involves obtaining signals that directly characterize the driver's condition, such as head movement, facial expressions, eye movement, electrocardiograph, or encephalogram, through sensors to assess the driver's state. Indirect monitoring, on the other hand, infers the driver's state by acquiring vehicle operating parameters related to driving behavior. Monitoring driver status is a part of both longitudinal and lateral human-machine cooperative control systems. The methods and results of driver state recognition do not vary significantly between these two systems. The different driver status monitoring and driver status monitoring methods have been analyzed and summarized in detail by many scholars.[33]-[35] Therefore, this paper does not delve into the driver status monitoring.

II. A. 2)Driver Braking Intention Recognition

Currently, the recognition of driver braking intention is primarily achieved by analyzing data from brake pedal sensors, brake system pressure signals, wear sensor signals, and vehicle state parameters (see Fig. 2). The research on brake pedal sensor data analysis focused on using pedal displacement and pedal speed to monitor driver braking behavior. Yu et al.[36] analyzed the advantages and disadvantages of various parameters and their combinations for driver braking intention recognition, concluding that brake pedal displacement is the most suitable parameter for this purpose. Based on this, Ji et al. used pedal displacement and pedal speed as inputs to classify and recognize low-intensity braking, medium-intensity braking, and emergency braking.[37] Yang et al. determined the ideal braking pressure under different driver states based on fuzzy control rules of brake pedal travel and its rate of change.[38] Given that this method has high recognition accuracy for emergency and medium braking but is less accurate for gentle braking due to the subtle nature of brake pedal operations in the time domain, a clustering recognition method based on the Hilbert-Huang transform of braking intention in electric vehicles was proposed by Tang et al. [39] This method achieves accurate recognition of the medium and gentle braking intention. To further improve recognition accuracy, Wang et al. designed an ensemble empirical mode decomposition algorithm to decompose the brake pedal signal into intrinsic mode function components, which allows for more precise feature extraction of the brake pedal signal. [40] It used sample entropy to extract the features of the intrinsic mode function components from the filtered brake pedal signal, offering better real-time performance than the Hilbert-Huang transform -based method. Additionally, by incorporating vehicle braking deceleration speed as a recognition parameter along with brake pedal displacement and force data, Wang et al. proposed a braking intention recognition method based on support vector machines, enabling accurate recognition of emergency braking, continuous braking, and regular braking.[41] Zuo et al. designed an adaptive network fuzzy inference system to further enhance the recognition accuracy of these three braking conditions.[42]

Regarding the recognition of driver braking intention using internal brake system pressure data, Wang et al. employed fuzzy reasoning to identify driver braking intentions based on current brake master cylinder pressure and its rate of change, categorizing braking intentions into regular deceleration and emergency braking.[43] Ye et al.

introduced hydraulic brake pressure as a feedback parameter in addition to pedal data, achieving accurate identification of slip braking, mild braking, moderate braking, and emergency braking, even in cases where brake pedal intention recognition may be delayed or erroneous.[44] Recognizing braking behavior from the source can improve the accuracy of braking behavior analysis, thus enabling more reasonable braking control for intelligent vehicles.[45] Wang et al. analyzed the influence of collision urgency on the driver's collision avoidance behavior.[46] Their results indicated that as the urgency level increased, drivers exhibited multi-stage braking behavior, requiring more time to reach maximum brake pedal pressure.

Braking intention recognition using wearable sensors falls under pre-braking implementation detection, offering certain advantages over methods based on brake pedal sensor data and internal brake system pressure. Hernandez et al. recognized emergency braking behavior using brainwave signals from drivers.[47] Teng et al. and Ju et al. proposed a method for classifying emergency braking intentions based on connectivity features derived from electroencephalogram signals.[48], [49] This method can detect a driver's emergency braking intention approximately 420ms after an emergency occurs. Liang et al. utilized deep learning to recognize drivers' electroencephalogram signals, improving the recognition rate of emergency braking intentions.[50] Additionally, surface electromyography of the driver's lower limb muscles has been introduced as a recognition parameter for emergency braking intention.[51] Qiao et al. used a support vector machine multi-classification algorithm based on directed acyclic graphs, and a model was developed to recognize emergency braking intentions using electromyography. Although this approach can reduce braking response time and improve overall braking performance, the technology is still immature, reliability is low, and it is generally only used as supplementary evidence in braking intention recognition.

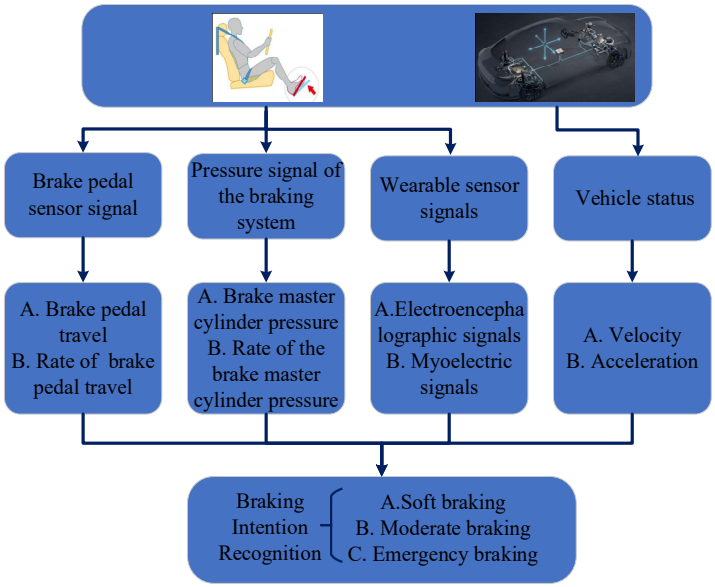

Figure 2: Structure of driver's braking intention recognition

With the advancement of braking systems, an increasing number of parameters are available for recognizing braking intentions, such as booster motor angle, booster motor speed, brake actuator displacement, and brake actuator speed. How to effectively utilize these abundant braking system parameters to recognize the driver's braking intention while accounting for the stochastic and time-varying nature of the braking process requires in-depth research.

II. B.Driver's braking behavior modeling

When the vehicle brakes, the driver acts as an executor, playing a decisive role in the vehicle braking process. In the study of longitudinal human-machine cooperation, a critical problem is how to mathematically describe the driver's braking behavior. The driver's braking behavior model can help researchers understand the operational laws and characteristics of the driver during braking, providing an important basis for the design of intelligent driving systems. Additionally, the driver's braking behavior model can be used for the simulation, testing, and evaluation of intelligent driving systems, offering vital support for optimizing and improving such systems.

Current research has clarified that the driver's braking process is divided into four parts: the reaction process, the process of releasing the gas pedal, the process of pressing the brake pedal, and the sustained braking process. Depending on the vehicle-road environment, the driver achieves a safe vehicle speed through sustained braking, and the entire process is represented in the model by two mapping relationships: (1) from the vehicle-road environment to vehicle speed or distance between the two vehicles; (2) from vehicle speed or distance between the two vehicles to the brake pedal opening degree(see Fig. 3). The study of the vehicle-road environment to vehicle speed or distance between the two vehicles is mainly covered in the driver-following model. This model includes both acceleration and braking components, where the braking component represents the mapping relationship from the vehicle-road environment to vehicle speed in the driver-braking behavior model. Since Gazis et al. first proposed the following-distance model in 1959,[52] its accuracy has significantly improved with the continuous development of related research. Current car-following models can be categorized into early models, advanced models, technology application models, and data-driven models. Typical early models include the Gazis-Herman-Rothery model (GHR model),[53] the Pipes model,[54] and the Greenberg model,[55] all of which establish a simple functional relationship between the speed or acceleration of the vehicle, the relative distance or relative speed of the vehicle in front, and the time interval. Advanced models, such as the Gipps model,[56] incorporate driver factors, taking into account the driver's reaction time under different conditions and the maximum braking capacity during emergencies. The intelligent driver model, proposed by Treiber et al in 2000, considers the driver's comfortable acceleration and deceleration in various scenarios.[57], [58] As automotive technology has advanced, these models have been optimized and adjusted based on actual vehicle dynamics and sensor characteristics, forming technical application models applied to intelligent driving systems like adaptive cruise control.[59] With the advent of computer technology, data-driven models based on vehicle-road environment data have emerged. These models utilize neural networks,[60] deep learning,[61] and reinforcement learning[62] to construct predictive models of the vehicle-road environment to speed variables derived from vehicle data. Theoretically, as long as the data samples used to train the model are sufficiently large, a data-driven car-following model with high prediction accuracy can be obtained.

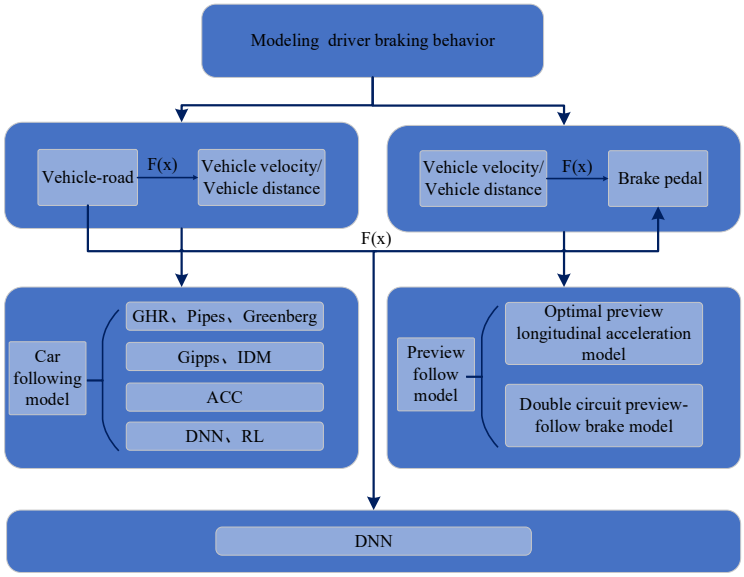

Figure 3: Driver braking behavior model

The car-following model focuses on the kinematic relationship between the ego vehicle and the vehicle in front and does not consider the response characteristics of the braking system, the dynamics, and the interaction characteristics between the driver and the braking system. Regarding the research on the mapping relationship from vehicle speed to brake pedal opening degree, Gao et al.[63]established a driver optimal pre-scan longitudinal acceleration model by using the pre-scan following theory, the fuzzy decision theory, and the nonlinear system descriptive function method, which takes into account the factors of driver hysteresis characteristics and nonlinear characteristics of the vehicle dynamics system and reflects the driver's control behavior of the speed, which is embodied as follows:

$$\frac{\ddot{x}}{\alpha}(s) = G_{ax}\frac{1+T_{nx}s}{1+T_{dx}s} \tag{1}$$

where $\ddot{x}$ is the longitudinal acceleration of the car and α represents the brake pedal travel, G_{ax}can be understood as the longitudinal acceleration gain of the car; T_{nx} and T_{dx} are two constants; and G_{ax}, T_{nx}, and T_{dx} can be used to identify the parameters by the autoregressive sliding model method.

Chen et al.[64] established a driver model that can reflect the driver's pre-scanning-following braking behavior on the basis of analyzing the braking process, designed a driver-vehicle closed-loop control system model that contains gain coefficients, pre-scanning time, and hysteresis time, and verified the reasonableness of the driver braking model, which is embodied as follows:

$$F(p) = \hbar(\tau_D s + 1)e^{-\tau_L s}[L(t) + L_m(t)] + \int_0^t [A\omega(t) + B]\,dt \tag{2}$$

where $\hbar$ is the gain coefficient, τ_D is the differential time, τ_L is the reaction time, $L(t)$ is the expected value of longitudinal displacement at the time of the driver, $L_m(t)$ is the calculated value of longitudinal displacement of the vehicle at the time t, and $F(p)$ is the reference value of brake pedal force. A is the body pitch angle feedback gain and B is the expected value of the driver's pitch angle during braking; $\omega(t)$ is the pitch angle of the vehicle at the time t. $\hbar(\tau_D s + 1)e^{-\tau_L s}[L(t) + L_m(t)]$ is the driver's control module of pedal force according to speed. $\int_0^t [A\omega(t) + B]\,dt$ is the correction control module for the brake pedal force of the driver affected by the pitch angle. This model combines $\hbar(\tau_D s + 1)e^{-\tau_L s}[L(t) + L_m(t)]$ and $\int_0^t [A\omega(t) + B]\,dt$ to realize the tracking and correction dual-loop control of the driver-vehicle model. In most of the pre-sight-following models, the driver's reaction time is usually set as a constant parameter or a continuous parameter, which is not rigorous because the driver's reaction time is different in different following situations and the driver's response to the motion of the front vehicle is not continuous. Umair et al.[65]studied the calculation method of different driver reaction times during braking, and the study showed that the accumulator model to assume the beginning of the driver's reaction can also well represent the driver's intermittent reaction and the accumulator model was integrated into the vehicle following model in the driver braking model to further improve the accuracy of the driver braking behavior model.

Considering the complexity of driver braking behavior, some scholars have used neural networks to characterize the mapping relationship from the vehicle-road environment to brake pedal opening. Ren et al. established a deep neural network model of the relative positions of two vehicles, the respective velocities of two vehicles, the respective accelerations and swing velocities of two vehicles as inputs, and the moments of the accelerator pedal action, the moments of the braking action, the accelerator pedal openings, and the brake pedal openings as outputs.[66] This model was trained using data from an ADSL driving simulator, achieving end-to-end accurate simulation of driver braking behavior.

With the development of new energy vehicles, braking energy recovery has become the standard of new energy vehicles. And regenerative braking is also generated when braking energy recovery is enabled. However, many of the current studies on driver braking behavior modeling do not consider the effects of regenerative braking. The motor braking during brake energy recovery may alter the driver's braking habits due to the strong learning ability of the driver, which adds challenges to modeling driver braking behavior. Moreover, several challenges, including uncertainty modeling and complex system modeling, real-time requirements, prediction accuracy of the model, and real-time performance of the algorithm, still need to be addressed to achieve truly effective driver braking behavior modeling.

III. Research status of LHMCC

With the development of braking systems, LHMCC has attracted the attention of many researchers in the past 45 years, from the introduction of the anti-lock braking system as the first active assistance system in 1978 to the emergence of the intelligence driver system. The braking system is the core part of the longitudinal man-machine cooperative control. Different braking systems have different ways of human-machine cooperative control. According to the different longitudinal and lateral control, the LHMCC can be divided into only LHMCC and longitudinal and lateral human-machine cooperative control. The following three aspects are elaborated from the braking system that can be used for LHMCC, only LHMCC, and longitudinal and lateral human-machine cooperative control.

III. A. Braking system for LHMCC

According to the existing research, service brake systems can be divided into the traditional braking system (including mechanical braking relying entirely on human and hydraulic braking), brake-by-wire (including electronic hydraulic braking and electronic mechanical braking), and motor feedback braking system. The structure of the

braking system is closely related to the human-machine cooperative control. In the following, the above three braking systems are analyzed and discussed from the perspective of human-machine cooperative control.

III. A. 1) Traditional braking system

At the beginning of the emergence of vehicles, mechanical braking was used in the vehicle, and the braking energy was completely derived from the human, and the whole process of braking was controlled by the human driver. The vehicles of this period were of small mass, simple structure, and low speed. In the 1930s, as vehicles got bigger and faster, mechanical braking systems could not meet the demand. With the help of external force-related booster devices (such as the vacuum booster), the hydraulic braking system that transfers brake pressure through brake fluid comes into being. The braking effect of the vehicle was mainly determined by the driver's input, and the braking effect was greatly affected by the driver's state and road conditions. In this period, the hydraulic system in the braking system only had the function of private service, and there were still problems such as long the braking distance and uneven braking force distribution. The braking system did not change the power assist characteristics due to the change of the vehicle state, the role of the braking system was completely dependent on the driver, and there was no human-machine cooperative control, as shown in Fig 4.

In the late 1980s, to solve the problems existing in the traditional braking system, a new electronic brake and centralized overall control of the electronic control unit (ECU) is used for brake system control, each brake has its control unit, which provides the basis for the active control of the system.[67] ECU can assist the driver in operating the vehicle better, and human-machine collaboration is preliminarily presented. The respective advantages of human drivers and intelligent assistance control systems gradually became the focus of research. To solve the problem that the wheels in the traditional braking system are easy to lock when the ground adhesion coefficient is small, Wang et al. developed the Anti-locked-braking system (ABS) to realize the control of the wheel anti-lock by controlling the brake oil pressure.[68] Under the action of ABS, the vehicle is always in the critical clearance rolling state, and the slip rate is kept in the optimal range.[69] Since the 1990s, the concept of vehicle stability control has been proposed. The electronic stability control system (ESC) analyzes the vehicle state information from various sensors and then judges the driver's steering intention by collecting information on the steering wheel angle. The driving force or braking force on the wheels is allocated to adjust the yaw motion of the vehicle to ensure the driving stability of the vehicle.[70] In this period, the application of new technologies in vehicles has led to further development of braking systems in terms of human-machine cooperation. The early structure of human-machine cooperation has been preliminarily formed, and the braking safety and stability have been further improved, as shown in Fig 4.

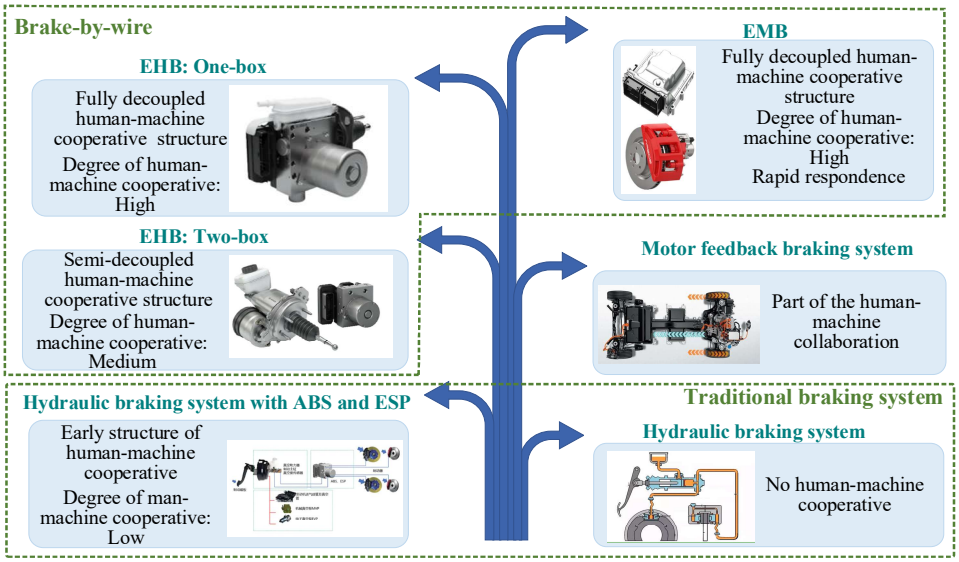

Figure 4: Braking system and human-machine cooperativeBrake-by-wire

With the continuous development of new energy vehicles and intelligent vehicle technologies, the vehicle braking system needs to meet new requirements.[71] On the one hand, it is necessary for the braking system to realize the decoupling between the pedal force and the wheel braking force, and maintain a good pedal feeling to realize the braking energy recovery. It is also necessary that the braking system can realize the independent adjustment of

four-wheel braking force with high precision and fast response. On the other hand, the braking system needs to have an active braking function to adapt to the requirements of intelligent driving assistance systems such as emergency braking.[72]

According to whether the hydraulic system is retained, the brake-by-wire is divided into Electronic Hydraulic Brake (EHB) [73]and Electronic Mechanical Brake (EMB).[74] Among them, the realization difficulty of the electronic hydraulic brake is low, and only some mechanical components in the traditional braking system are replaced by electronic components, and the traditional hydraulic pipeline is retained.[75] When the wire control system fails, the standby valve is opened, and the brake system returns to the traditional hydraulic brake system to realize brake redundancy and ensure driving safety. The EHB system changes the way pressure is established, and the pedal force no longer affects the braking force, which makes up for the shortcomings caused by the design and principle of the traditional braking system, and has many incomparable advantages compared with the traditional braking system. For the traditional braking system, the characteristics of system components may change after emergency braking or long braking time, which affects the braking performance. And the traditional braking system can only achieve the distribution of front and rear braking pressure to a certain extent. For the EHB control system, changes in the mechanical properties of the components can be compensated by the control algorithm, and the braking pressure level and pedal travel are always consistent. The EHB system can provide the most reasonable pressure variation characteristics by analyzing the driver's intention and judging different braking behaviors. Because the EHB system has a large degree of freedom in the four-wheel pressure distribution, the braking effect of the vehicle on the road surface with different adhesion coefficients between the left and right is significant. The electronic control unit of the EHB system can adjust the brake pressure according to the pedal movement speed and pedal travel detected by the brake sensor. The control system can provide different pedal sensations to the driver by changing the control algorithm and pedal sensation simulator according to different vehicle models and the analysis of the driver's habits.[76] The active control characteristics of the braking pressure and the decoupling characteristics of the driver and the brake pedal of the EHB system provide a good hardware foundation for human-machine cooperative control.

At present, the EHB system is the mainstream line control scheme. The EHB is divided into One-box and Two-box depending on whether the electronic stabilization system of the vehicle is integrated or not. The One-box scheme integrates the electronic booster and the electronic stabilization system to make an integrated decision on the vehicle braking. In Two-box, the electronic booster and the automotive electronic stability system are separated to complete their respective functions independently, but the relationship between the two needs to be coordinated during cooperative braking. Compared with Two-box, One-box has higher efficiency and lower cost, but it is not as mature and reliable as Two-box.[77] From the structural point of view, One-Box only has one electronic control unit and one brake unit, the number is half of Two-Box, and there is no need to coordinate the relationship between Two brake units, which also brings lower cost. Due to the higher integration level, the One-box scheme can recover energy more efficiently. From the perspective of decoupling degree, Two-Box can only achieve semi-decoupling of pedaling. The One-box scheme can completely decouple the pedal input strength and the electric mechanism power, support a more intelligent braking scheme, and is more conducive to the longitudinal man-machine cooperative control. The use of the EHB system based on One-box provides a basic guarantee for the human-machine cooperative control of the braking system. It has a human-vehicle-road framework to realize complex human-machine cooperative control, and the braking safety and stability are greatly improved, as shown in Fig 4.

However, the integrated design is not conducive to meeting the redundancy requirements of high-level intelligent driving functions, which require additional electronic redundant braking modules. In the intelligent driving stage of L3 and below, EHB can better meet the system requirements. In the higher stages of intelligent driving, human-machine interaction is closer, and the requirements for system response speed and control accuracy are higher. The EHB system uses hydraulic as the braking energy source and has complex hydraulic control pipelines. The generation of hydraulic pressure and electrical control have certain hysteresis, which makes it difficult to meet the requirements of higher-level automatic driving.[78] The EMB system further reduces mechanical components based on the EHB system. The brake hydraulic line is completely removed and the motor is integrated into the disc brake. The EMB system controls the braking force of each wheel independently through the electric signal control motor to achieve complete decoupling of the driver and braking system. Due to the high response speed and precise execution of action for the brake motor, the EMB system is better suited for intelligent driving systems. The EMB system improves the control accuracy of man-machine collaboration greatly because of the rapid response of the terminal execution structure and the complete decoupling of the driver-braking system. The human-vehicle-road framework for human-machine collaborative control is further optimized, and the braking safety and stability are further improved, as shown in Fig 4.

III. A. 2) Motor feedback braking system

With the development of intelligent and electric of the vehicle, braking systems are required to achieve braking energy recovery to improve the fuel economy of vehicles.[79] Energy recovery is divided into coasting energy recovery and braking energy recovery. The coasting energy recovery applies to the coasting condition when the driver loosens the accelerator and does not press the brake pedal.[80] The reverse current generated by the motor reversal is used to charge the battery, and the reverse drag torque of the motor can slow down the vehicle. When the vehicle is in the process of coasting energy recovery, the motor generates feedback braking. Although there is no interaction between the driver and the brake pedal, the feedback braking of the motor will affect the driver's longitudinal control of the vehicle. Considering the comfort of the driver and passenger and the possibility of the driver mistakenly stepping on the pedal when the vehicle is coasting, the research on feedback braking during coasting energy recovery mainly focuses on the degree of feedback braking. Tesla gives the option of motor feedback braking strength and adds a reminder to press the accelerator pedal deeply for long periods for drivers.[81] The Volkswagen ID series vehicles offer three different modes of coasting energy recovery, which can be flexibly selected according to the driving scenario and individual needs.[82] In addition, BYD, Dongfeng, JAC, and other electric vehicles have set up the taxiing energy recovery selection mode.[83] According to the coupling relationship between the feedback braking force and the friction braking force, the braking energy recovery system can be divided into superposition type and coordination type.[84] The superposition braking energy recovery system directly superimposes the motor feedback braking force on the original friction braking force, without adjusting the original friction braking force, which is convenient to implement, but the feedback efficiency is low and the braking feeling is poor.[85] The braking force of the superposition feedback braking does not need to be adjusted and can be realized by the traditional hydraulic braking system. The coordinated braking energy recovery system gives priority to the use of feedback braking force. The braking force is adjusted accordingly based on the braking system with decoupled mode so that the sum of the two braking forces is coordinated with the total braking demand. The feedback efficiency is higher and the braking feeling is better.[86] The cooperative feedback braking needs to make use of the decoupling characteristics of the line control system to realize the cooperative control of the driver, feedback braking system, and friction braking system. While maximizing the braking energy recovery and braking efficiency of the vehicle, the vehicle comfort during braking is also guaranteed.[87] In the cooperative braking based on EHB, the braking pressure is controlled by the hydraulic control system which is the key actuator for braking energy recovery. The braking intention and demand are analyzed by the driver's pedal displacement and rate obtained from the brake pedal signal. By controlling the feedback braking system and hydraulic actuator, the human-machine cooperative control of the driver-feedback braking system-hydraulic braking system is realized.[88] The coordinated braking based on EMB, in which the brake motor acts as the executive part of the friction braking, has rapid braking and high braking energy efficiency. It has higher control accuracy when realizing the cooperative control of the driver, feedback braking system, and motor braking system, which is the key research direction of intelligent new energy vehicles at present.[89]

III. B. Only longitudinal human-machine cooperative control

With the development of the braking system, in addition to passively executing the driver braking instruction, the braking system can also realize the complex dynamic interaction of human-machine parallel control according to the driver state, vehicle state, and driving environment. As shown in Table 1, The current research on the single longitudinal human-machine cooperative system mainly focuses on the following two aspects:

(1) According to the human-vehicle state, the closed-loop cooperative control of the driver-brake system is studied considering vehicle safety, economy, and comfort.

(2) According to the state of human-vehicle-road, the closed-loop cooperative control of the driver-braking system-driving environment is studied considering the safety of the vehicle-road environment.

The following will be analyzed from the above two aspects.

III. B. 1) Cooperative control for driver-brake system

For the research of driver-brake system closed-loop cooperative control, the ABS based on hydraulic braking can be regarded as the first application of human-machine cooperative control in longitudinal control. When the driver continuously increases the braking force, the speed signal is used by the anti-lock system to calculate the wheel slip rate, and the wheel slip rate is controlled by adjusting the braking pressure, so that the vehicle is always in the clearance rolling state of critical lock.[90]

The anti-lock braking system controls the longitudinal motion of the vehicle with the driver in a minimally invasive assisted intervention manner. With the development of braking systems and new energy vehicles, braking force control and composite braking considering the driver's braking intention have received great attention from

researchers, most of which focus on braking energy recovery, braking comfort, and braking safety, as shown in Fig 5.

For the research on human-machine cooperative control with braking energy recovery as the goal, divided the driver braking intention into mild braking, moderate braking, and emergency braking for the dual-axle composite braking system, and the regenerative braking force of the front and rear axles is adjusted during light and medium braking.[91] The average braking energy recovery is increased by about 10%. Zhao et al. established the driving intention identification model of double braking based on the hidden Markov theory, which could maximize the recovery of braking energy under the premise of ensuring braking safety, and the energy recovery rate could reach 43.84% at low speed and slight braking.[92] Based on the driver braking intention, Xu et al. designed a braking force distribution strategy in light and medium braking, which mainly uses regenerative braking, and with the increase of braking intensity, the front axle mechanical braking intervenes first.[93] The braking energy recovery rate of commercial vehicles is further improved while the braking performance is guaranteed. Considering the safety of emergency braking, Li et al. adopted the classified control strategy.[94] In conventional braking, the braking energy is recovered as much as possible without violating the driver's braking intention. In emergency braking, the optimal slip rate control based on sliding mode is used to minimize the braking distance. To further improve the energy recovery rate and braking performance of regenerative braking, based on the objective function determined by using the identified braking intention and road information and the vehicle load estimated by the FRLS method, the braking intensity and the constraints established by the road information, Ming et al. used an artificial ant colony optimization algorithm to solve the optimal braking force distribution ratio.[95] The designed regenerative braking control strategy significantly improves the energy recovery rate and effectively reduces the braking distance.

The variation of vehicle pitch angle during braking is one of the key indexes affecting ride comfort.[96] Most of the researches on human-machine cooperative control aiming at braking comfort consider the variation of vehicle pitch. Based on the maximum braking deceleration value determined by road conditions and driver comfort limits, front and rear axle load, and center of mass position, Zhao et al. performed the ideal distribution of braking force on the front and rear axles of the vehicle for non-emergency braking intention identified by pedal speed.[97] However, the braking deceleration is restricted according to comfort, which will increase the braking distance, and there are certain safety risks. Chen et al. proposed a vehicle optimal braking force distribution strategy based on slip rate, driver's braking intention, and braking intensity, which realized the improvement of comfort under different braking intentions.[98] In this strategy, the braking intention and braking intensity were output in real-time by the established braking intention recognifier based on fuzzy logic. Taking advantage of the decoupling of the front and rear axle braking forces of the EHB system, Zhao et al. designed a braking intention recognition method based on adaptive neuro-fuzzy logic and proposed a comfortable control mode switching method for braking pitch angle to improve the nodding phenomenon in the braking process, in which, the pitch angle comfort controller based on MPC is designed for the early and middle period of braking and the late period of braking respectively, and the braking force distribution of the front and rear axle and the total braking force are adjusted and output in real-time.[99] The coupling interference between the anti-lock braking system and the active suspension system affects the braking safety and braking ride of the vehicle. Zhang et al. utilized a robust comfort brake controller to comprehensively adjust the braking torque of the front and rear wheels to achieve reasonable control of the vehicle pitch motion and braking safety.[100]

The development of the braking system has brought different execution ways to the longitudinal control of the vehicle. Most of the research on closed-loop cooperative control of driver-braking systems aiming at braking safety has focused on anti-lock control. Since Two-BOX has a separate ESP control mechanism, the study of Two-Box-based ABS is similar to that of traditional hydraulic braking systems. For the One-box and EMB, due to the fully decoupled nature of the driver brake pedal force, the control system can achieve the ideal brake pressure control of the wheel after the driver's braking intention is accurately identified. After the wheel braking force reaches the maximum value, the control system is not affected by the brake pedal force that the driver continues to increase. At present, the research on ABS of the brake-by-wire system is more focused on using different control methods to improve the control effect, Researchers designed a control algorithm of redundant ABS based on sliding mode control for the Two-BOX braking system, which can well realize the function of redundant ABS and improve vehicle safety under the premise of ensuring braking strength and comfort.[101]-[103] For the One-box braking system, Wang designed two anti-lock braking control strategies based on dual-power source time-sharing frequency control and based on type Ⅱ four-channel time-sharing control, respectively. The two proposed anti-lock control strategies can meet the functional requirements of anti-lock braking. Based on the established EMB-based simulation model of automotive ABS, Zhou et al. designed the sliding mode control system and verified the effectiveness of ABS under various working conditions. [104]

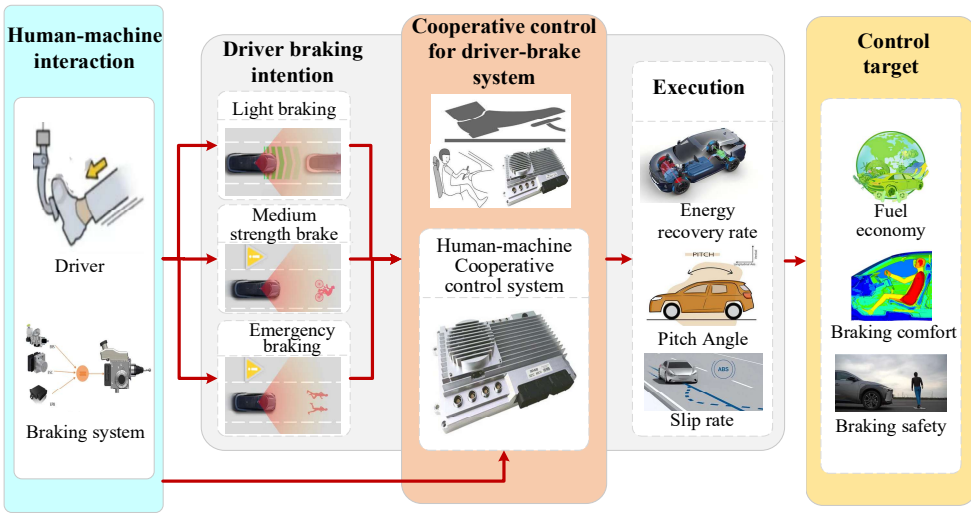

Figure 5: Cooperative control for driver-brake system

III. B. 2) Cooperative control of driver-brake system- driving environment

The safety of the autonomous vehicle and the traffic participants is the main consideration in the closed-loop cooperative control of the driver-braking system-environment. From the perspective of driver intervention braking, the research on driver-braking system-environment closed-loop cooperative control mainly focuses on braking assistance and automatic emergency braking. In adaptive cruise control, the driver has full control over the braking system. For cruise control, there is sovereign switching between the longitudinal control and the driver, and there is no cooperative control.[105], [106] The cruise control is not analyzed and discussed in this paper.

The assist braking aims to ensure driving safety and smooth braking by reasonably controlling the braking force of the vehicle based on the driver's braking status and the current traffic environment. Wang et al. used the extension decision method to divide the dynamic safety boundary to solve the coordinated control problem between the driver and the active braking system[107]. In coordinated braking mode, the driver's operation is compensated by the active braking system, and the driver's operation is guaranteed while the risk of longitudinal collision is reduced. This method can effectively avoid the longitudinal collision of vehicles, and improve braking smoothness and safety. By fitting the effect of environmental risk and the driver's expected driving acceleration, He et al. proposed a flexible control switching model based on strategy deviation for human-machine co-driving.[108] In the car-following state, the driver's driving operation in dangerous scenes is corrected by the smooth switching of man-machine control during the braking process, and the driving safety is improved. As shown in Equation (3), the assist braking is activated only in dangerous situations for such methods. Based on this, Wang et al. established the improved Seungwuk Moon safe distance model to obtain the ideal braking pressure by weighted summation of the expected deceleration of the driver and the expected deceleration of the assist system.[109] Guo et al. designed a braking control strategy to cover the driver's braking force for the freeway confluence scenario.[110] The final braking force is calculated according to the driver's braking force and the ideal braking force of the automatic driving system. As shown in Equation (4), the calculated final braking force is used to directly cover the driver's braking force. However, this coverage strategy has an impact on the driver's driving feeling and driving habits.

$$F_b = \begin{cases} f(\boldsymbol{x}_d) & safe \\ f(\boldsymbol{x}_d, \boldsymbol{y}_b, \boldsymbol{z}_e) & else \end{cases} \tag{3}$$

$$F_b = f(\boldsymbol{x}_d, \boldsymbol{y}_b, \boldsymbol{z}_e) \tag{4}$$

where F_b is the ideal braking force, $\boldsymbol{x}_d$ is the driver's braking state parameter, $\boldsymbol{y}_b$ is the status parameter of the braking system, and $\boldsymbol{z}_e$ is the state parameter of the vehicle and road. Automatic emergency braking is the active braking control according to the perceived environmental information when the driver does not perform braking operations. The research on automatic emergency braking can be traced back to 1960 when Germany and the United States began to study automatic emergency braking.[111] Until 1980, the rapid development of radar technology and microcomputer technology promoted the decisive breakthrough of active collision avoidance technology, and the active collision avoidance system began to develop rapidly.[112] In the 21st century, with the further study of the active collision avoidance system by major automobile manufacturers and research institutions, AEB with the sole goal of collision avoidance safety began to be assembled on various vehicles.[113]-[115] With the development of AEB, avoidance security is no longer the only goal. Hu et al. proposed a hierarchical braking

strategy for the active collision avoidance system based on TTC and self-vehicle speed, in which the modeling method of the new hazard judgment index TTC was designed.[116] This method not only realizes safe active collision avoidance but also improves the priority of driver control and the coordination of man and machine. In order to further optimize the collision avoidance algorithm of automobile automatic emergency braking system, Hu et al. designed a brake deceleration control strategy considering driving comfort.[117] The brake deceleration and its change rate are limited by setting the brake deceleration change buffer, and the deceleration control curve that meets the comfort condition is obtained, which meets the comfort condition while achieving safe collision avoidance.[118] proposed an AEB control strategy based on different driving styles to effectively improve the adaptability of the driver to the AEB system and enhance the braking comfort, considering the individual requirements of drivers with different driving styles on the psychological expectations of AEB system intervention timing and minimum safety distance.

Table 1: Only longitudinal human-machine cooperative control

Type	Control authority	Control objective	References
Cooperative control for driver-brake system	Driver-brake system	Braking energy recovery	[91,92,93,94,95]
		Comfort	[96,97,98,99,100]
		Safety	[101,102,103,104]
Cooperative control of driver-brake system- driving environment	Driver-brake system	Safety and smooth braking	[107,108,109,110]
	Brake system	Safety	[111,112,113, 114,1115]
		Smooth braking	[116,117,118]

III. C. Longitudinal and lateral human-machine cooperative control

The driver sometimes needs to perform steering and braking operations at the same time while the vehicle is moving. In this state, different from the single longitudinal man-machine cooperative control, the longitudinal man-machine cooperative control of the vehicle and the lateral control of the vehicle affect each other, and the longitudinal and lateral mutual interference may bring adverse effects on vehicle safety. To further improve the driving safety of vehicles, some scholars have studied the longitudinal and transverse human-machine cooperative control. The current research on longitudinal and lateral man-machine cooperative control mainly falls into the following two categories: (1) Assuming that the longitudinal speed is constant or the vehicle speed is completely controlled by the driver. (2) The longitudinal velocity is jointly controlled by the driver and the machine.

The first type of research on longitudinal and lateral human-machine cooperative control pays much attention to lateral human-machine cooperative control. Researchers investigated the lateral human-machine cooperation for lane departure prevention under the assumption that the vehicle speed is constant.[119]-[122] In the longitudinal and lateral human-machine cooperative control , the vehicle speed is completely controlled by the driver, the vehicle model with time-varying speed is established, and two safety envelope boundaries are used to realize driver shared steering control.[123] Iwano et al. established a human-machine cooperative obstacle avoidance assistance system, where the speed of the vehicle is completely controlled by the driver.[124] In the human-machine cooperative control method of emergency braking collision avoidance proposed by Wu et al., the multi-constraint model predictive control method is used to calculate the additional yaw torque input by the driver to correct the excessive stress input by the driver.[125] The change in the longitudinal motion state of the vehicle is matched by reasonable lateral man-machine cooperative control.

Different from the state that the speed of the vehicle is constant or the speed is controlled by the driver, the vehicle sometimes needs to perform longitudinal and lateral cooperative control at the same time, and the longitudinal motion state of the vehicle is controlled by the driver and the control system. In the second type of research on longitudinal and lateral human-machine cooperative control, Li et al. applied the improved deep neural network that learns the optimal driving strategy for pedestrian collision avoidance to the collision avoidance scenario.[126] When the driving behavior of the driver is dangerous to pedestrians, the learned driving strategy is used to control the speed and steering of the vehicle with a human driver to avoid colliding with pedestrians. Based on the analysis of the acceptance and effectiveness of human-machine cooperative control in the case of hidden risks, Saito et al. proposed a longitudinal human-machine cooperative control

method based on risk prediction to deal with the potential risks in the avoidance process.[127], [128] When the braking intensity applied by the driver is not enough in the avoidance process, there is a danger of collision between the vehicle and the pedestrian, the vehicle speed is controlled by active braking to ensure safety.

The current research on the longitudinal and lateral human-machine cooperative control of the intelligent vehicle mainly focuses on how to realize the longitudinal or lateral human-machine cooperative control, and less involves the longitudinal and lateral human-machine cooperative control. Some studies consider the longitudinal or lateral cooperative control separately, but the longitudinal or lateral man-machine cooperative control affects each other. The safety of the intended functionality (SOTIF) issues that may be caused by the coupling of the longitudinal and lateral human-machine cooperative control system and the unreasonable operation of the driver have not been deeply discussed in the current research.

IV. Conclusion and perspective

Whether it is for assist driving or fully autonomous driving, human-machine cooperative control is a key focus for intelligent vehicle technology. Although many scholars have carried out relevant research on the LHMCC of intelligent vehicles from the aspects of driver status monitoring, braking intention recognition, modeling driver braking behavior, and braking system that can be used for longitudinal human-machine cooperative, only longitudinal human-machine cooperative and LHMCC in longitudinal and lateral human-machine cooperative control, the current research scope and depth need to be expanded. In this section, the future research direction of LHMCC of intelligent vehicles is discussed and prospected from three important aspects, aiming to encourage and inspire researchers to propose more innovative technical ideas and schemes. The discussion and perspective are as follows.

(1) Driver braking characteristics considering lateral motion of the vehicle and regenerative braking

In different driving scenarios, the driver has different driving behaviors, such as steering only, braking only, simultaneous steering, and braking. The driver has different braking characteristics in different longitudinal and lateral operating states. When the driver makes steering and braking at the same time, the steering and braking affect each other and have certain relevance. However, the current research rarely considers the influence of the driver's steering behavior on braking behavior. When there is an obstacle in front of the vehicle, the driver's operating behavior will be different under different time to collision. The same driving behavior will show different effects in different driving environments. The rational use of vehicle-road environment data is conducive to the accurate recognition of driver braking behavior. In addition, the braking behavior of the driver can also be affected by regenerative braking. The driver will show different braking states for the different intensity of regenerative braking. The LHMCC of the intelligent vehicle is directly affected by the driver's braking behavior. Therefore, it is an important aspect of human-machine cooperative control research of the intelligent vehicle to study the driver braking characteristics considering the vehicle lateral motion and regenerative braking from the human-vehicle-road, realize the accurate recognition of driver braking behavior, and establish a longitudinal driver model suitable for intelligent vehicle.

(2) Human-machine cooperative control of composite braking for driver-vehicle-environment

Regenerative braking has become a key means to improve the economy of intelligent vehicles. When the driver presses the brake pedal, regenerative braking and brake-by-wire provide braking force. In different driving environments, the proportion of braking force provided by regenerative braking and brake-by-wire control should also change with the driver's braking intention and braking intensity. However, most of the current researches on composite braking control aiming at braking energy recovery and braking comfort only consider the state of the driver and the vehicle. In addition, the braking system based on EMB has become an important research direction for intelligent vehicles, and the application of ABS control based on EMB with the goal of braking safety is not yet mature. Therefore, it is a future research hotspot to realize the precise control of ABS and the human-machine cooperative control of composite braking for driver-vehicle-environment based on the new line control system.

(3) Coupling relationship of longitudinal and lateral human-machine cooperative system and situation evaluation of the SOTIF

There are many scenarios where the human-machine cooperative driving system plays a role. The longitudinal and lateral human-machine cooperative control systems sometimes need to work at the same time. From the perspective of the driver-vehicle, the different lateral and longitudinal driving behaviors of the driver will make the lateral and longitudinal human-machine cooperative control systems affect each other, and the mutual interference between the systems may bring adverse effects on the SOTIF. From the perspective of vehicle-road, the adhesion force of the ground to the tire is easy to reaches the limit, and the lateral motion and longitudinal motion of the vehicle show strong nonlinear coupling characteristics. The stability margin of the vehicle control system decreases sharply, and improper control input can easily lead to vehicle instability and uncontrollable. The influence between

lateral and longitudinal human-machine cooperative systems is closely related to the human-machine weight in the lateral and longitudinal direction, the operating state of the driver, and the driving state of the vehicle. For example, if the longitudinal human-machine conflict is minimized, the active braking system only plays a compensatory control role in the longitudinal control of the vehicle. The driver braking state will affect the weight between the driver and the steering system, and the lateral motion control of the vehicle from the driver should be adjusted according to the longitudinal motion state of the vehicle. In addition, there is the problem of evaluating the situation of the SOTIF in this state. When the driver's braking behavior exceeds a certain threshold, the change of the lateral man-machine weight may also not ensure the safety of the vehicle in collision avoidance. Particularly, when the adhesion of the ground to the tire is close to the limit, the influence between the lateral and longitudinal human-machine cooperative system of the vehicle is more obvious under the nonlinear coupling of the lateral and longitudinal motion of the vehicle. Therefore, based on considering the driver operating state, the lateral and longitudinal human-machine weight, and the vehicle driving state, the coupling relationship of the lateral and longitudinal human-machine cooperative system is analyzed and the situation of the SOTIF is evaluated, which can provide an accurate basis for the lateral and longitudinal coordinated control of the human-machine cooperative system of intelligent vehicles. This is an important aspect of the research on human-machine cooperative control of intelligent vehicles.

(4) Longitudinal and lateral coordination control for human-machine cooperative system

Human-machine cooperative system is a complex dynamic system with coupling, nonlinear multi-input, and multi-output. The vehicle-moving target can be decomposed into longitudinal and lateral moving targets. For different operating states of the driver, the longitudinal and lateral moving targets of the vehicle and the distribution of man-machine driving rights will change. In emergency avoidance, it is necessary to balance the driving safety and the control authority of the driver in the longitudinal and lateral, reasonably allocate the longitudinal and lateral moving targets of the vehicle and the human-machine driving authority, and adopt effective coordinated control strategies before the harm occurs to reduce the adverse effects caused by the mutual interference of the longitudinal and lateral man-machine collaborative system. The current research rarely deals with the longitudinal and lateral coordination control of the human-machine cooperative control system.

Therefore, it is of great significance for human-machine cooperative driving to study the longitudinal and lateral coordinated control strategy of the human-machine cooperative system under different human-machine control states of drivers, timely and effectively change the motion state of the vehicle, and improve the safety of vehicle avoidance.

Author Contributions

Conceptualization, H.W. and W.C.; methodology, H.W. and W.C.; software, Y.B.; validation, H.W. and Y.B.; formal analysis, M.Z.; investigation, Y.B.; resources, H.W.; data curation, H.W.; writing—original draft preparation, H.W. and Y.B.; writing—review and editing, H.W.; visualization, L.Z.; supervision, W.Q. and L.Z.; project administration, W.Q.; funding acquisition, H.W., M.Z. and M.Y. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

All relevant data are within the paper.

References

[1] Traffic Management Bureau. Ministry of Public Security. Annual Statistical Report of Road Traffic Accidents of the People's Republic of China (2015). Guangzhou .2016.
[2] R. R. S. M. Scarboro M. National Highway Traffic Safety Administration. Public Health Reports (1974-). 2012. 102(6). 667.
[3] World Health Organization. Global status report on road safety. 2015. 1.
[4] N. Adnan, S. M. Nordin, M. A. B. Bahruddin. Sustainable Interdependent Networks from Smart Autonomous Vehicle to Intelligent Transportation Networks: From Smart Power Grids to Intelligent Transportation Networks. 2019.

[5] H. Wang, Q. Wang, W. Chen. Lateral Driver-Automation Driver Authority Decision Considering Safety of the Intended Functionality. Adv. Theory Simul. 2024. 2400122. 7.
[6] SAE On-Road Automated Vehicle Standards Committee. Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems. Hong Kong, China .2014.
[7] G. Yan. China's Automatic Driving Classification Standard Announces the accelerated mass production of high-level autonomous vehicles. China Strategic Emerging Industries. 2020. 85.
[8] K. Bengler, K. Dietmayer, B. Farber, M. Maurer, H. Winner. Three Decades of Driver Assistance Systems: Review and Future Perspectives. IEEE. 2014.
[9] K. Bengler, K. Dietmayer, B. Farber, M. Maurer, C. Stiller, H. Winner. Three Decades of Driver Assistance Systems: Review and Future Perspectives. IEEE Intell. Transp. Syst. Mag. 2014. 6. 6-22.
[10] J. Lee, J. Choi, K. Yi, M. Shin, B. Ko. Lane-keeping assistance control algorithm using differential braking to prevent unintended lane departures. Control Eng. Pract. 2014. 23. 1.
[11] Y. Tian, Y. Zhao, Y. Shi, X. Cao, D. L. Yu. The Indirect Shared Steering Control Under Double Loop Structure of Driver and Automation. IEEE/CAA Journal of Automatica Sinica. 2020.
[12] X. Yang, Kaiming, X. Chen, Y. Liu. Shared Steering Torque Control for Lane Change Assistance: A Stochastic Game-Theoretic Approach. IEEE Trans. Ind. Electron. 2019.
[13] S. M. Erlien, S. Fujita, J. C. Gerdes. Shared Steering Control Using Safe Envelopes for Obstacle Avoidance and Vehicle Stability. IEEE Trans. Intell. Transp. Syst. 2016. 17. 441.
[14] A. M. Benclоucif, A. T. Nguyen, C. Sentouh, J. C. Popieul. Cooperative Trajectory Planning for Haptic Shared Control between Driver and Automation in Highway Driving. IEEE Trans. Ind. Electron. 2019. 9846.
[15] C. F. Wu, C. J. Lin, C. Y. Lee. Applying a Functional Neurofuzzy Network to Real-Time Lane Detection and Front-Vehicle Distance Measurement. IEEE Transactions on Systems Man and Cybernetics Part C (Applications and Reviews). 2012. 42. 1.
[16] M. Betke, E. Haritaoglu, L. S. Davis. Real-time multiple vehicle detection and tracking from a moving vehicle. Machine Vision & Applications. 2000. 12. 69.
[17] H. Wang, B. Wang, B. Liu, X. Meng, G. Yang. Pedestrian recognition and tracking using 3D LiDAR for autonomous vehicle. Robot. Auton. Syst. 2016. 88. 71.
[18] Q. Chen, Y. Xie, S. Guo, J. Bai, Q. Shu. Sensing System of Environmental Perception Technologies for Driverless Vehicle: A Review of State of the Art and Challenges. Sensors and Actuators A Physical. 2021. 319. 112566.
[19] G. Yu, H. Li, Y. Wang, P. Chen, B. Zhou. A review on cooperative perception and control supportedinfrastructure-vehicle system. Green Energy and Intelligent Transportation. 2022. 2.
[20] Q. Liu, Z. Li, S. Yuan, Y. Zhu, X. Li. Review on Vehicle Detection Technology for Unmanned Ground Vehicles. Sensors. 2021.
[21] W. Wang, X. Na, D. Cao, J. Gong, F. Y. Wang. Decision-Making in Driver-Automation Shared Control: A Review and Perspectives. IEEE/CAA Journal of Automatica Sinica. 2020. 7. 19.
[22] M. Marcano, S. Díaz, J. Pérez, E. Irigoyen. A Review of Shared Control for Automated Vehicles: Theory and Applications. IEEE T. Hum.-Mach. Syst. 2020. Early Access. 1.
[23] Y. Hu, Q. Ting, J. Liu. Research status and prospect of human-machine cooperative control in intelligent vehicle. Acta Automatica Sinica. 2019. 7. 1261.
[24] De, Winter, Joost, C., F., Kyriakidis, Miltos, Happee, Riender, Lu. Human factors of transitions in automated driving: A general framework and literature survey. Transportation Research Part F Traffic Psychology & Behaviour. 2016.
[25] Mccall, R. Mcgee, F. Meschtscherjakov. Towards a taxonomy of Autonomous vehicle handover situations. Proceedings of the 8th International Conference on Automotive User Interfaces and Interactive Vehicular Applications. 2016.
[26] F. Roche, S. Becker, M. Thuering. What happens when drivers of automated vehicles take over control in critical lane change situations? Transportation research, Part F. Traffic psychology and behaviour. 2022. 84. 407.
[27] F. Roche, M. Thüring, A. K. Trukenbrod. What happens when drivers of automated vehicles take over control in critical brake situations? Accident Analysis & Prevention. 144.
[28] Y. Xing, C. Lv, D. Cao, P. Hang. Toward human-vehicle collaboration: Review and perspectives on human-centered collaborative automated driving. Transportation Research Part C Emerging Technologies. 2021. 128. 103199.
[29] J. Yang, D. Chu, L. Lu. Review on Human-machine Shared Control of Intelligent Vehicles. Journal of Mechanical Engineering. 2022. 58. 31.
[30] S. Chen. Robust and Efficient Driver Monitoring System Using A Synthesis Of Facial Features And Biosignals. International journal of computational intelligence research. 2018. 14. 929.
[31] T. Liu, Y. Yang, G. B. Huang, Y. K. Yeo, Z. Lin. Driver Distraction Detection Using Semi-Supervised Machine Learning. IEEE Trans. Intell. Transp. Syst. 2016. 17. 1108.
[32] J. Hu, X. Li, X. He, H. Jiang, W. Meng. Abnormal Driving Detection Based on Normalized Driving Behavior. IEEE Trans. Veh. Technol. 2017. 6645.
[33] J. Yang, D. Chu, L. Lu. Review on Human-machine Shared Control of Intelligent Vehicles. Journal of Mechanical Engineering. 2022. 58. 31.
[34] Y. Qu, H. Hu, J. Liu, Z. Zhang, Y. Li, X. Ge. Driver State Monitoring Technology for Conditionally Automated Vehicles: Review and Future Prospects. IEEE Trans. Instrum. Meas. 2023. 1.
[35] G. Sikander, S. Anwar. Driver Fatigue Detection Systems: A Review. Automotive Engineering. 2018. 2500.
[36] W. Yingfan, N. G. Amp. Parameter Selection for the Identification of Driver's Braking Intention for Passenger Car. Automotive Engineering. 2011. 8. 2500.
[37] F. Ji, F. Du, W. Zhu. Electric vehicle energy economy based on braking intention identification. Journal of Beijing University of Aeronautics and Astronautics. 2016. 42. 21.
[38] Y. Yang, Y. He, Z. Yang, C. Fu, Z. Cong. Torque Coordination Control of an Electro-Hydraulic Composite Brake System During Mode Switching Based on Braking Intention. Energies. 2020. 13. 2031.
[39] X. Tang, B. Wang, S. Yang. Braking intention cluster recognition based on Hilbert-Huang transform. Automotive engineering. 2016. 42. 580.

[40] B. Wang, X. Tang, L. Wang. Braking intention recognition method for electric vehicles based on EEMD and Entropy Theory. Automotive Engineering. 2018. 40. 7.
[41] W. Kuiyang, R. He. Braking Intention Recognition Method Based on Support Vector Machine. Journal of Jilin University. 2022. 52.
[42] J. Zuo, Y. Tang. Braking Intention Recognition Method Based on the Fuzzy Neural Network. Wireless Communications and Mobile Computing. 2022. 54.
[43] W. Wang, Y. Wu, J. Shi. Driver intention recognition based electronic hydraulic braking control strategy of power system. Journal of jilin university. 2021. 406.
[44] Y. Ye, X. Wu, T. Lin. Braking Intention Identification Strategy of Electric Loader Based on Fuzzy Control. applied sciences. 2023. 13.
[45] G. Xu, W. Li, K. Xu, Z. Song. An Intelligent Regenerative Braking Strategy for Electric Vehicles. Energies. 2011. 4. 1461.
[46] X. Wang, M. Zhu, M. Chen. Impact of emergency Degree on Driver's Collision Avoidance Behavior. Journal of Tongji University. 2016. 44. 876.
[47] L. Hernandez, E. Martinez, J. Antelis. Detection of emergency braking intention using driver's electroencephalographic signals. IEEE Latin Am. Trans. 2019. 17. 111.
[48] T. Teng, L. Bi, Y. Liu. EEG-Based Detection of Driver Emergency Braking Intention for Brain-Controlled Vehicles. IEEE Trans. Intell. Transp. Syst. 2017. 1.
[49] J. Ju, L. Bi, A. G. Feleke. Noninvasive neural signal-based detection of soft and emergency braking intentions of drivers. Biomed. Signal Process. Control. 2022. 72. 103330.
[50] X. Liang, Y. Yu, Y. Liu, K. Liu, Y. Liu, Z. Zhou. EEG-based emergency braking intention detection during simulated driving. Biomed. Eng. Online. 2023. 22. 65.
[51] Q. Bingchen. Research on Emergency Braking Intention Recognition Based on Driver's Lower extremity-surface EMG. Wuhan University of Technology. 2019.
[52] S. Ossen, S. P. Hoogendoorn. Car-Following Behavior Analysis from Microscopic Trajectory Data. Transp. Res. Rec. 2005. 13.
[53] Gunawan, E. Fergyanto. Two-Vehicle Dynamics of the Car-Following Models on Realistic Driving Condition. Journal of Transportation Systems Engineering and Information Technology. 2012.
[54] L. Yang, C. Zhang, Q. Xiaoyun. Research progress of vehicle following model. Journal of Traffic and Transportation Engineering. 2019. 19. 125.
[55] P. L. A. An Operational Analysis of Traffic Dynamics. J. Appl. Phys. 1953. 24. 274.
[56] H. Rakha, C. Pecker, H. Cybis. Calibration Procedure for Gipps Car-Following Model. Transportation Research Record Journal of the Transportation Research Board. 2007. 1999. 115.
[57] A. Kesting, M. Treiber, D. Helbing. Enhanced intelligent driver model to access the impact of driving strategies on traffic capacity. Philos Trans A Math Phys Eng. 2010. 368. 4585.
[58] M. Treiber, D. Helbing. Memory effects in microscopic traffic models and wide scattering in flow-density data. Physical Review E Statistical Nonlinear & Soft Matter Physics. 2003. 68. 46119.
[59] B. V. Arem, C. J. G. V. Driel, R. Visser. The Impact of Cooperative Adaptive Cruise Control on Traffic-Flow Characteristics. IEEE Trans. Intell. Transp. Syst. 2006. 7. 429.
[60] D. Yang, L. Zhu, Y. Liu, D. Wu, B. Ran. A Novel Car-Following Control Model Combining Machine Learning and Kinematics Models for Automated Vehicles. IEEE Trans. Intell. Transp. Syst. 2019. 20. 1991. https://doi.org/10.1109/TITS.2018.2854827.
[61] W. Xiao, J. Rui, L. Li, Y. Lin, X. Zheng. Capturing Car-Following Behaviors by Deep Learning. IEEE Trans. Intell. Transp. Syst. 2017. 19. 910.
[62] F. Hart, O. Okhrin, M. Treiber. Towards robust car-following based on deep reinforcement learning. Transportation Research Part C: Emerging Technologies. 2024. 159. 104486. https://doi.org/10.1016/j.trc.2024.104486.
[63] Z. Gao, X. Guan, Q. Li. Driver optimal preview longitudinal acceleration Model. Automotive Engineering. 2002. 434.
[64] K. Chen. Evaluation of Vehicle Braking Sensation Based on Driver Model. Yanshan University. 2021.
[65] U. Durrani, C. Lee. Applying the Accumulator model to predict driver's reaction time based on looming in approaching and braking conditions. J. Saf. Res. 2023. 86. 298.
[66] R. You. Driving Behavior Simulation and Emergency Driving Reliability Modeling in Traffic Environment. Changchun: Jilin University. 2007.
[67] H. Y. Zheng, C. F. Zong, Y. Gao, T. J. Zhu, C. W. Tian. Research on pedal force simulation for brake-by-wire system. Journal of System Simulation. 2008.
[68] R. Li, T. Zheng. Hirarchical intelligent control of automobile anti-lock braking. Journal of mechanical engineering. 2007. 81.
[69] Z. Wang, L. Yu, J. Song. The statue quo of resaerch on vehicle wheel slip control based on brake system. Automotive engineering. 2014. 81.
[70] J. K. Ahn, K. H. Jung, D. H. Kim, H. B. Jin, H. S. Kim, S. H. Hwang. Analysis of a regenerative braking system for Hybrid Electric Vehicles using an Electro-Mechanical Brake. Int. J. Automot. Technol. 2009. 10. 229.
[71] J. Guo, L. Wang, L. Chengling. Research on coordinated control of brake regenerative efficiency and pedal feel for electic cars. Advanced Technology of Electrical Engineering and Energy. 2013. 32. 65.
[72] Z. Yu, W. Han. Review on Hydraulic Pressure Control of Electro-hydraulic Brake System. Journal of mechanical engineering. 2017. 53. 1.
[73] H. Z. D. C. F. Meng. System Modeling, Coupling Analysis, and Experimental Validation of a Proportional Pressure Valve With Pulsewidth Modulation Control. IEEE/ASME Transactions on Mechatronics. 2016. 1742.
[74] Y. Li, T. S. D. H. Control System Design for Electromechanical Brake System Using Novel Clamping Force Model and Estimator. IEEE Transactions on Vehicular Technology. 2021. 8653.
[75] W. Xiang, Richardson, C. Paul, Zhao, Z. Chenming, Mohammad, Syed. Automobile Brake-by-Wire Control System Design and Analysis. IEEE Trans. Veh. Technol. 2008.
[76] Christian, Riese, Frank, Gauterin. Evaluation of a State of the Art Hydraulic Brake System with Regard to Future Requirements. Sae International Journal of Passenger Cars Mechanical Systems. 2016.
[77] Y. Ji, Z. J, C. He. Wheel Braking Pressure Control Based on Central Booster Electrohydraulic Brake-by-Wire System. IEEE Trans. Transp. Electrif. 2023. 222.
[78] J. Scobie, M. Maiolani, M. Jordan. A Cost Efficient Fault Tolerant Brake By Wire Architecture. 2000.

[79] G. H. B. Foo, X. Zhang, D. M. Vilathgamuwa. A Sensor Fault Detection and Isolation Method in Interior Permanent-Magnet Synchronous Motor Drives Based on an Extended Kalman Filter. IEEE Trans. Ind. Electron. 2013. 60. 3485.
[80] S. Xu, J. Li, X. Zhang. Research on Composite Braking Control Strategy of Four-Wheel-Drive Electric Vehicles With Multiple Motors Based on Braking Energy Recovery Optimization. IEEE Access. 2003. 110151.
[81] C. M. Overview. Energy recovery intensity optional Tesla 2023.12.9 update. 2024. https://baijiahao.baidu.com/s?id=1799100690740819952&wfr=spider&for=pc.
[82] SVW-ID Science - Three different degrees of coasting energy recovery setting methods. 2024. https://baijiahao.baidu.com/s?id=1799145143692623957&wfr=spider&for=pc.
[83] 2023. https://m.pcauto.com.cn/x/3794/37947268.html.
[84] M. Yamato. Eco-vehicle assessment system (Eco-VAS): A comprehensive environmental impact assessment system for the entire development process. Toyota Technical Review. 2005. 54. 80.
[85] F. Sasaki, Y. Mtomo. Toyota Braking System for Hybrid Vehicle with Regenerative System. Florida. 1997.
[86] L. Yu. Research on Control Strategy of Electro-hydraulic Composite Brake System based EHB with Electric Vehicle. Journal of China Jiaotong University. 2021. 156.
[87] X. Jian, M. Huang. Modeling and simulation of electric vehicle regenerative braking control based on advisor. BEIJING AUTOMOTIVE ENGINEERING. 2008. 25.
[88] W. Peng, Z. Li, Q. Chen. Multi-Objective Optimization of Braking Stability and Braking Energy Recovery for BEV Based on EMB. Automobile Technology. 2021. 35.
[89] X. Lu, Q. Chao, Y. Zhuoping. Review on Composite Braking System of Electric Vehicle. Automobile Technology. 2015.
[90] C. M. Lin, C. F. Hsu. Self-learning fuzzy sliding-mode control for antilock braking systems. IEEE Trans. Control Syst. Technol. 2003. 11. 273.
[91] Y. Zhang, Z. Yu, X. Le. A Study on the Strategy of Braking Force Distribution for the Hybrid Braking Systemin Electric Vehicles Based on Braking Intention. Automobile Technology. 2009. 31. 244.
[92] X. Zhao, J. Ma, G. Wang. Composite braking control strategy of pure electric bus based on brake driving intention intention recognition. Journal of Traffic and Transportation Engineering. 2014. 14. 64.
[93] S. Xu, J. Ma, G. Wang. Composite braking control strategy based on braking intention recognition for range-extended heavy commercial vehicles. China Journal of Highway and Transport. 2017. 30. 12.
[94] W. Li, H. Du, W. Li. Driver intention based coordinate control of regenerative and plugging braking for electric vehicles with in-wheel PMSMs. IET Intell. Transp. Syst. 2018. 12. 1300.
[95] M. Tang, X. Zhang.Optimal Regenerative Braking Control Strategy for Electric Vehicles Based on Braking Intention Recognition and Load Estimation. IEEE Trans. Veh. Technol. 2024. 73. 3378.
[96] G. A. O. C. Quality. Standards Press of China. Beijing. 2010.
[97] W. Zhao, C. Zong, C. Zheng. Control strategy of commercial vehicle electonic braking system based on braking comfort. Journal of Jilin University(Information Science Edition). 2012. 42. 22.
[98] S. Chen, X. Zhang, J. Wang. Sliding Mode Control of Vehicle Equipped with Brake-by-Wire System considering Braking Comfort. Shock Vib. 2020. 2020. 1.
[99] L. Zhang, Q. Wang, Z. Wang. Research on Brake Pitch Comfort Control for Distributed-drive Electric Vehicles Based on Brake-by-wire System. Journal of mechanical engineering. 2024. 1.
[100] J. Zhang, W. Sun, Z. Liu, M. Zeng. Comfort braking control for brake-by-wire vehicles. Mech. Syst. Signal Proc. 2019. 133. 106255.
[101] A. Aksjonov, V. Vodovozov, K. Augsburg, E. Petlenkov. Design of Regenerative Anti-Lock Braking System Controller for 4 In-Wheel-Motor Drive Electric Vehicle with Road Surface Estimation. Int. J. Automot. Technol. 2018. 19. 727.
[102] D. Savitski, V. Ivanov, K. Augsburg, B. Shyrokau, R. Wragge-Morley, T. Pu Tz, P. Barber. The new paradigm of an anti-lock braking system for a full electric vehicle: experimental investigation and benchmarking. Proceedings of the Institution of Mechanical Engineers Part D Journal of Automobile Engineering. 2015. 197.
[103] X. Liu, Y. Liangyao, Z. Sheng. Research on redundant anti-lock braking algorithm based on eBooster. Automotive Engineering. 2022. 44. 82.
[104] S. Zhou, S. Zhang, Q. Chen. Vehicle ABS Equipped with an EMB System Based on the Slip Ratio Control. Trans. Famena. 2022. 43. 1.
[105] J. Li, L. Y, Fotouhi. Cooperative Ecological Adaptive Cruise Control for Plug-In Hybrid Electric Vehicle Based on Approximate Dynamic Programming. IEEE Trans. Veh. Technol. 2023. 72.
[106] M. Yang, J. Tian. Research on Curving Acc System for Electric Vehicle Driven by In-wheel Motors Based on Fmpc And Smc. Adv. Theory Simul. 2023. 2300599. 7.
[107] L. Zhao, Z. Dingzhi, H. Wang. Study on Longitudinal Collision Avoidance with Human-machine Cooperation Based on Improved Safety Distance Model. Automotive Engineering. 2021. 43. 588.
[108] R. He, X. Zhao, Y. Yan. Man-machine shared driving model using risk-response mechanism of human driver. Journal of Jilin University(Information Science Edition). 2021. 51. 799.
[109] X. Wang, W. Chen, C. Ma. Man-machine cooperative control strategy of the longitudinal collision avoidances based on the factors of driver, vehicle and road. Journal of Automotive Safety and Energy. 2023. 14. 46.
[110] C. Guo, C. Sentouh, J. C. Popieul, B. Soualmi, J. B. Haue. Shared Control Framework Applied for Vehicle Longitudinal Control in Highway Merging Scenarios. IEEE. 2016.
[111] M. Bing. Research on rear-facing anti-collision warning system of automobile. Chang'an University. 2008. 23.
[112] W. J. Gillan. PROMETHEUS and DRIVE: their implications for traffic managers. Vehicle Navigation & Information Systems Conference. 1989.
[113] E. Ncap. Reward 2010 - Volvo City Safety. 2014. https ://www.euroncap. com/en/ratings-rewards/euro-ncap-advanced-rewards/2010-volvo-city-safety/.
[114] E. Ncap. Ford Active City Stop. 2014. https ://www.euroncap.com /en/ratings-rewards /euro-ncap-advanced-rewards/2011-ford-active-city-stop/.
[115] E. Ncap. Reward 2013 - Skoda Front Assistant. 2014. https ://www.euroncap.com /en/ratings-rewards /euro-ncap-advanced-rewards/ 2013 -skoda -front -assistant/.

[116] Y. Hu, C. Yang, X. Liu. Hierarchic Braking Strategy for Active Collision Avoidance and Its Verification Based on Driver's Characteristics. Automotive Engineering. 2019. 41. 298.
[117] H. Cheng, J. J. Chen, Q. Hong. Simulation Verification of AEB Collision Avoidance Algorithm in Consideration of Comfort. Journal of chongqing university of technology. 2021. 35. 39.
[118] K. Lv, X. Li, T. Han. AEB Control Strategy Based on Driving Style Recognition. Automobile Technology. 2021. 16-21.
[119] D. Tan, W. Chen, W. H. Shared control for lane departure prevention based on the safe envelope of steering wheel angle. Control Eng. Pract. 2017. 51. 98.
[120] D. Tan. Human-machine Sharing and Hierarchical Control Based Lane Departure Assistance System. Journal of Mechanical Engineering. 2015. 51. 98.
[121] Draou, Azeddine, Merah, Abdelkader, Hartani, Kada. A new shared control for lane keeping and road departure prevention. Vehicle System Dynamics: International Journal of Vehicle Mechanics and Mobility. 2016.
[122] B. Soualmi, C. Sentouh, J. C. Popieul, S. Debernard. A shared control driving assistance system: interest of using a driver model in both lane keeping and obstacle avoidance situations. IFAC/IFIP/IFORS/IEA Symposium on Analysis, Design, and Evaluation of Human-Machine Systems. 2013.
[123] B. Soualmi, C. Sentouh, J. C. Popieul, S. Debernard. A shared control driving assistance system: interest of using a driver model in both lane keeping and obstacle avoidance situations. IFAC/IFIP/IFORS/IEA Symposium on Analysis, Design, and Evaluation of Human-Machine Systems. 2013.
[124] K. Iwano, P. Raksincharoensak, M. Nagai. A Study on Shared Control between the Driver and an Active Steering Control System in Emergency Obstacle Avoidance Situations. Ifac Proceedings Volumes. 2014. 47. 6338.
[125] X. Wu, C. Yuan, J. Shen, L. Chen, Y. Cai. Cooperative Control Research on Emergency Collision Avoidance of Human-Machine Cooperative Driving Vehicles. IEEE Trans. Veh. Technol. 2024. 73. 1.
[126] J. Li, L. Yao, X. Xu, B. Cheng, J. Ren. Deep reinforcement learning for pedestrian collision avoidance and human-machine cooperative driving. Inf. Sci. 2020. 532. 110.
[127] Y. Saito, P. Raksincharoensak. Shared Control in Risk Predictive Braking Maneuver for Preventing Collisions With Pedestrians. IEEE T. Intell. Veh. 2017. 1. 314.
[128] Y. Saito, T. Mitsumoto, P. Raksincharoensak. Effectiveness of a Risk Predictive Shared Steering Control Based on Potential Risk Prediction of Collision with Vulnerable Road Users. IFAC Symposium on Analysis, Design, and Evaluation of Human-Machine Systems. 2017.